MCUXpresso SDK Documentation

Release 25.06.00



NXP
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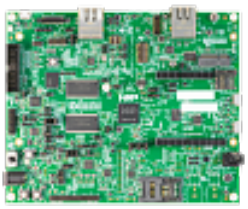
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This documentation contains information specific to the evkbmimxrt1170 board.

Chapter 1

MIMXRT1170-EVKB

1.1 Overview



MCU device and part on board is shown below:

- Device: MIMXRT1176
- PartNumber: MIMXRT1176DVMAA

1.2 Getting Started with MCUXpresso SDK Package

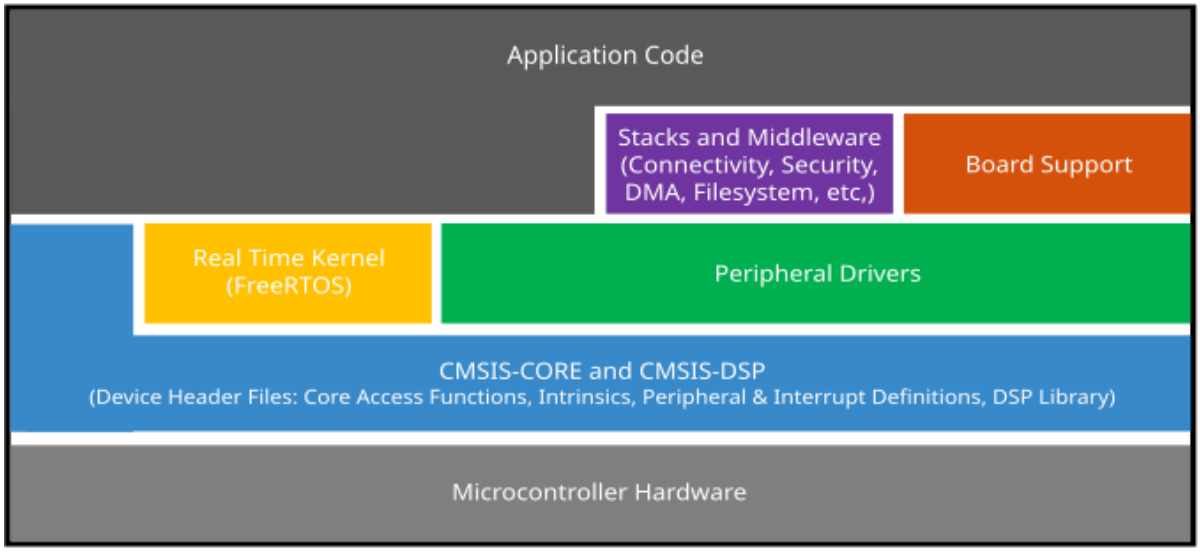
1.2.1 Getting Started with Package

Overview

The MCUXpresso Software Development Kit (SDK) provides comprehensive software support for Kinetis and LPC Microcontrollers. The MCUXpresso SDK includes a flexible set of peripheral drivers designed to speed up and simplify development of embedded applications. Along with the peripheral drivers, the MCUXpresso SDK provides an extensive and rich set of example applications covering everything from basic peripheral use case examples to full demo applications. The MCUXpresso SDK contains FreeRTOS and various other middleware to support rapid development.

For supported toolchain versions, see *MCUXpresso SDK Release Notes for MIMXRT1170-EVKB* (document MCUXSDKMIMXRT117XBRN).

For more details about MCUXpresso SDK, see MCUXpresso Software Development Kit (SDK).



MCUXpresso SDK board support package folders

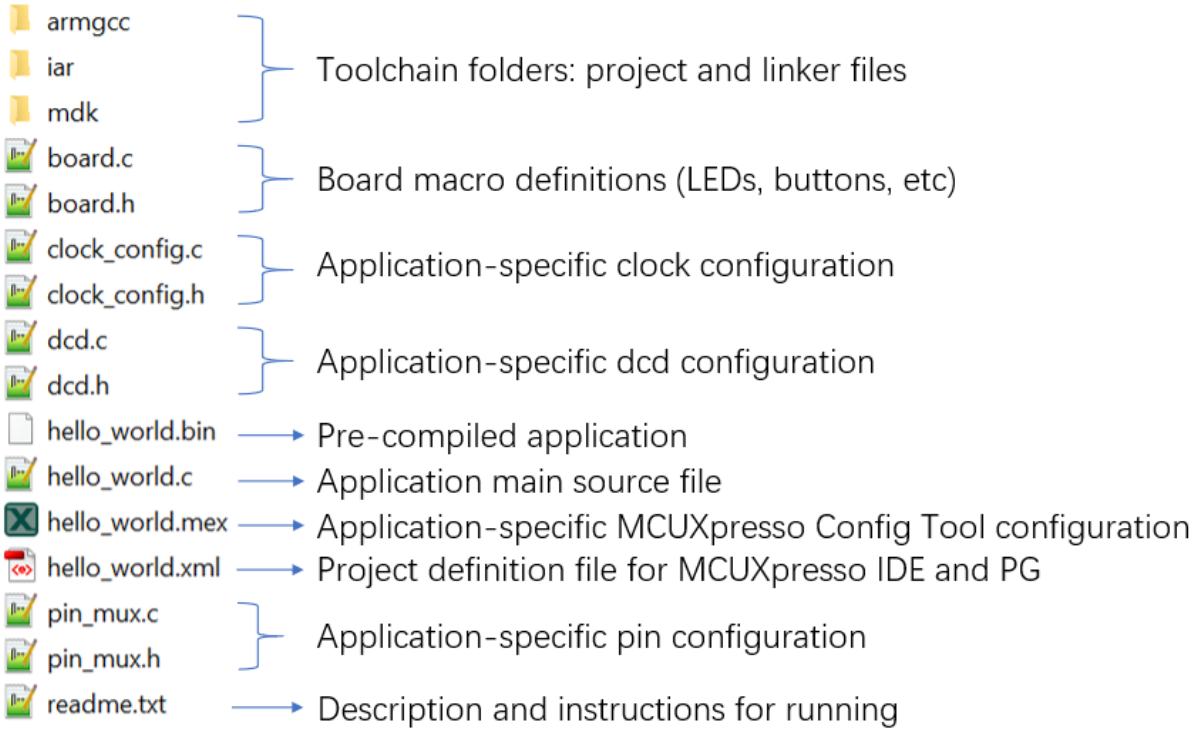
MCUXpresso SDK board support package provides example applications for NXP development and evaluation boards for Arm® Cortex®-M cores including Freedom, Tower System, and LPCXpresso boards. Board support packages are found inside the top level boards folder and each supported board has its own folder (an MCUXpresso SDK package can support multiple boards). Within each <board_name> folder, there are various sub-folders to classify the type of examples it contain. These include (but are not limited to):

- cmsis_driver_examples: Simple applications intended to show how to use CMSIS drivers.
- demo_apps: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- driver_examples: Simple applications that show how to use the MCUXpresso SDK's peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI conversion using DMA).
- rtos_examples: Basic FreeRTOSTM OS examples that show the use of various RTOS objects (semaphores, queues, and so on) and interfaces with the MCUXpresso SDK's RTOS drivers.
- usb_examples: Applications that use the USB host/device/OTG stack.
- multicore_examples: Applications for both cores showing the usage of multicore software components and the interaction between cores.
- Other_examples: See detail in package *boards/evkbmimxrt1170*.

Example application structure This section describes how the various types of example applications interact with the other components in the MCUXpresso SDK. To get a comprehensive understanding of all MCUXpresso SDK components and folder structure, see *MCUXpresso SDK API Reference Manual*.

Each <*board_name*> folder in the boards directory contains a comprehensive set of examples that are relevant to that specific piece of hardware. Although we use the hello_world example (part of the demo_apps folder), the same general rules apply to any type of example in the <board_name> folder.

In the *hello_world* application folder you see the following contents:



All files in the application folder are specific to that example, so it is easy to copy and paste an existing example to start developing a custom application based on a project provided in the MCUXpresso SDK.

Parent topic:*MCUXpresso SDK board support package folders*

Locating example application source files When opening an example application in any of the supported IDEs, a variety of source files are referenced. The MCUXpresso SDK devices folder is the central component to all example applications. It means the examples reference the same source files and, if one of these files is modified, it could potentially impact the behavior of other examples.

The main areas of the MCUXpresso SDK tree used in all example applications are:

- devices/<device_name>: The device's CMSIS header file, MCUXpresso SDK feature file and a few other files
- devices/<device_name>/drivers: All of the peripheral drivers for your specific MCU
- devices/<device_name>/<tool_name>: Toolchain-specific startup code, including vector table definitions
- devices/<device_name>/utilities: Items such as the debug console that are used by many of the example applications
- devices/<devices_name>/project_template Project template used in CMSIS PACK new project creation

For examples containing an RTOS, there are references to the appropriate source code. RTOSes are in the *rtos* folder. The core files of each of these are shared, so modifying one could have potential impacts on other projects that depend on that file.

Parent topic:*MCUXpresso SDK board support package folders*

Run a demo using MCUXpresso IDE

Note:

Most MCUXpresso projects provide two targets (debug and release). For CM7 projects, they are actually flash target. For CM4 projects, they are linked to RAM. To debug and run the CM7 examples, set **SW1[1:4]** to **0010** as internal flash boot mode. Currently, MCUXpresso IDE does not support CM4 download/debug.

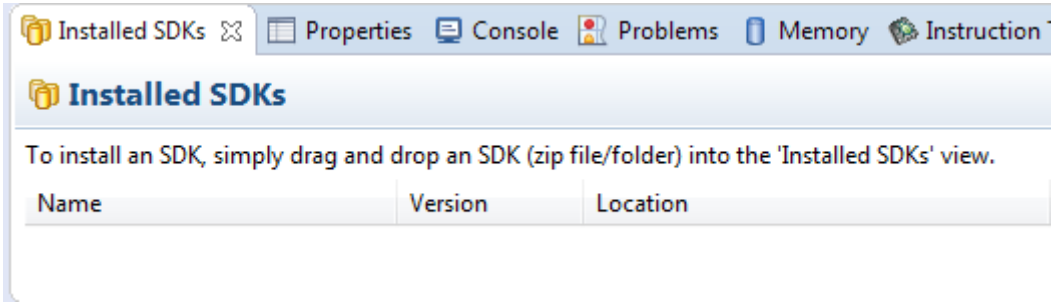
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The hello_world demo application targeted for the MIMXRT1170-EVKB hardware platform is used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

Select the workspace location Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse which uses workspace to store information about its current configuration, and in some use cases, source files for the projects are in the workspace. The location of the workspace can be anywhere, but it is recommended that the workspace be located outside of the MCUXpresso SDK tree.

Parent topic:*Run a demo using MCUXpresso IDE*

Build an example application To build an example application, follow these steps.

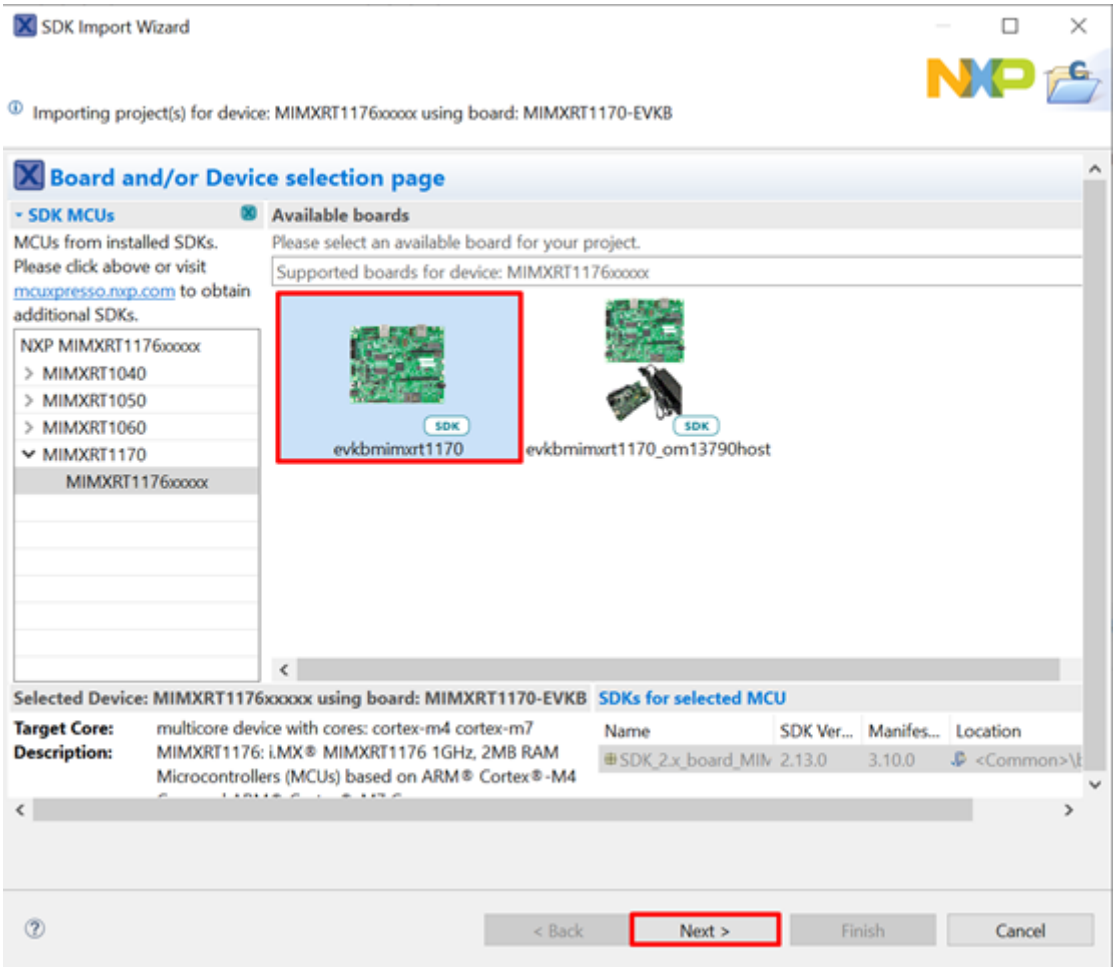
1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.



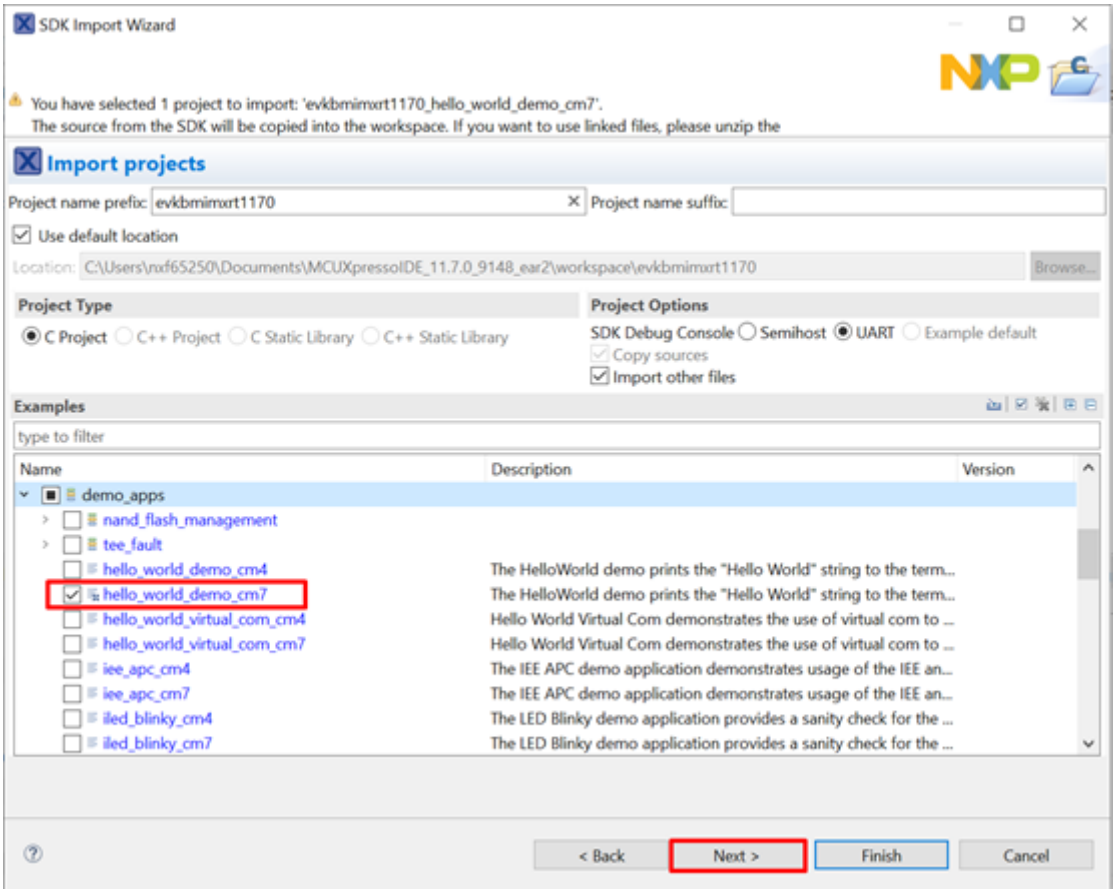
2. On the **Quickstart Panel**, click **Import SDK example(s)...**.



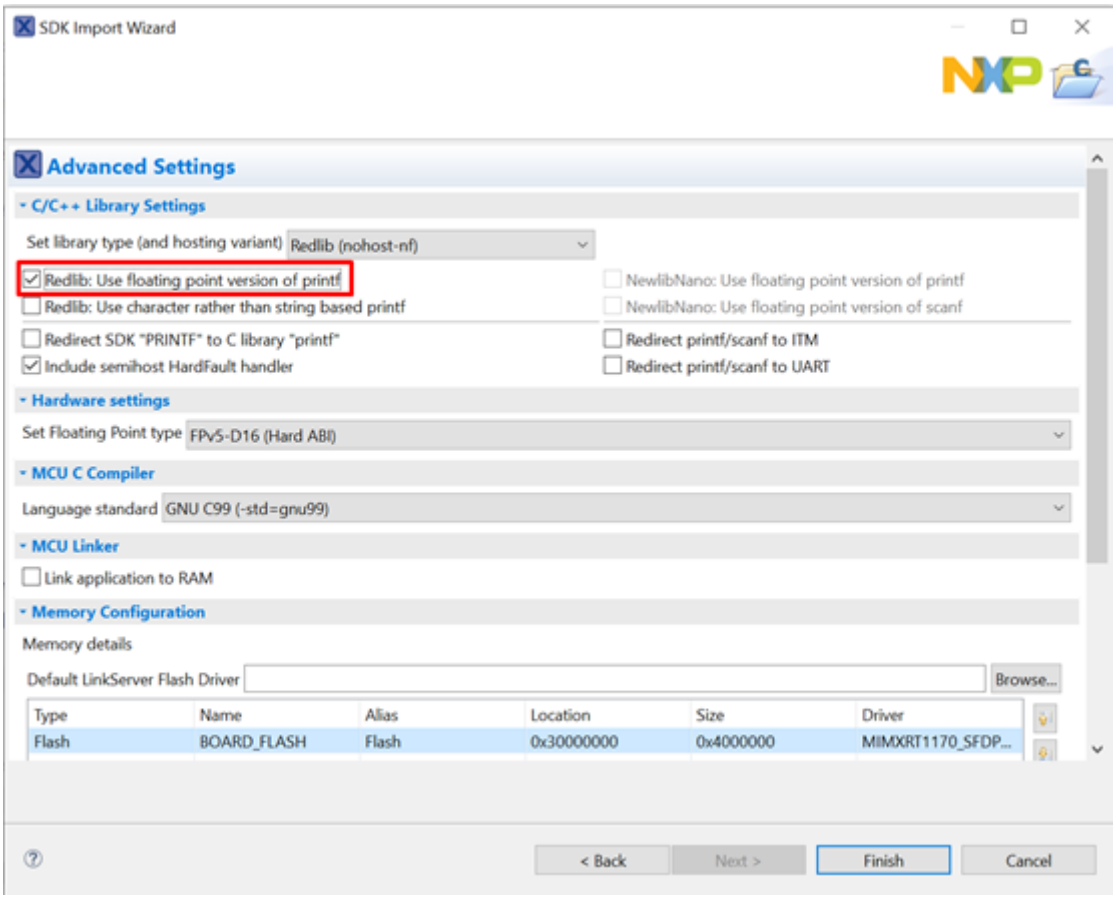
3. In the window that appears, select **MIMXRT1176xxxxx**. Then, select **evkbmimxrt1170** and click **Next**.



4. Expand the *demo_apps* folder and select hello_world. Then, click **Next**.



5. Ensure **Redlib: Use floating point version of printf** is selected if the example prints floating point numbers on the terminal for demo applications such as adc_basic, adc_burst, adc_dma, and adc_interrupt. Otherwise, it is not necessary to select this option. Then, click **Finish**.

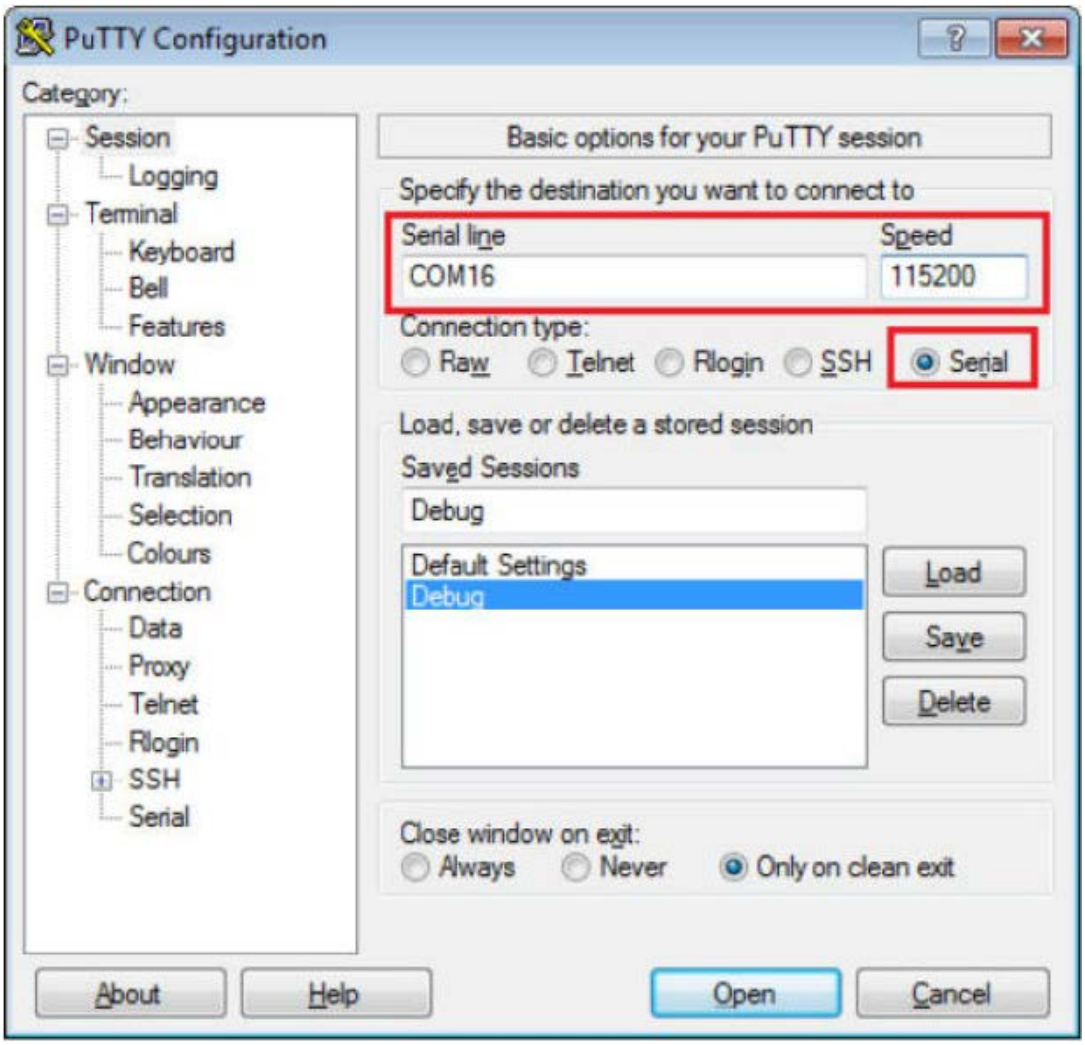


Parent topic:*Run a demo using MCUXpresso IDE*

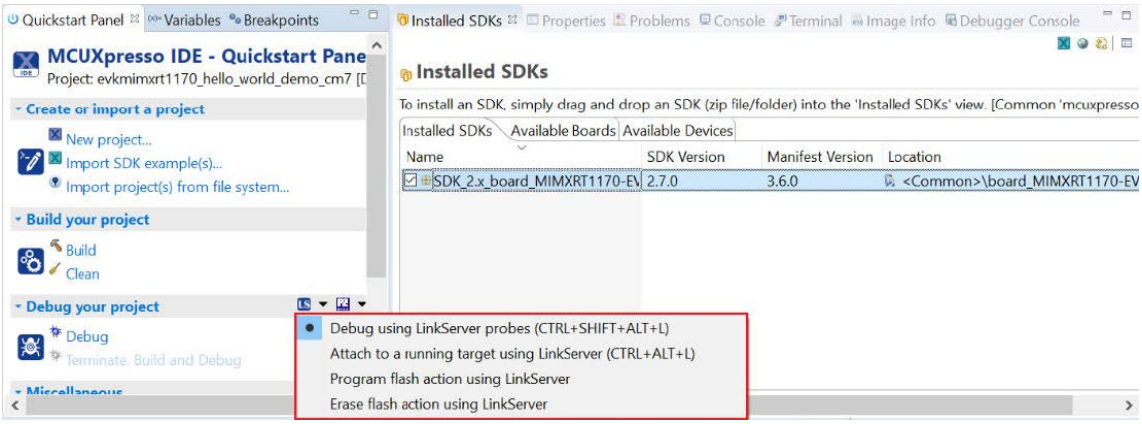
Run an example application To download and run the application, perform the following steps:

1. See *Table 1* to determine the debug interface that comes loaded on your specific hardware platform.
   - If using J-Link with either a standalone debug pod or OpenSDA, install the J-Link software (drivers and utilities) from SEGGER.
   - To use J-Link for debug, remove J5, J6, J7, J8 jumpers and attach external J-Link on J1.
   - For boards with the OSJTAG interface, install the driver from KEIL.
2. Connect the development platform to your PC via a USB cable.
3. Connect USB cable between J11 on EVKB and PC USB port.
4. Open the terminal application on the PC, such as PuTTY or TeraTerm, J11 on EVKB, and connect to the debug serial port number. To determine the COM port number, see *How to determine COM port*. Configure the terminal with these settings:
   1. 115200 baud rate or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the *board.h* file)
   2. No parity
   3. 8 data bits

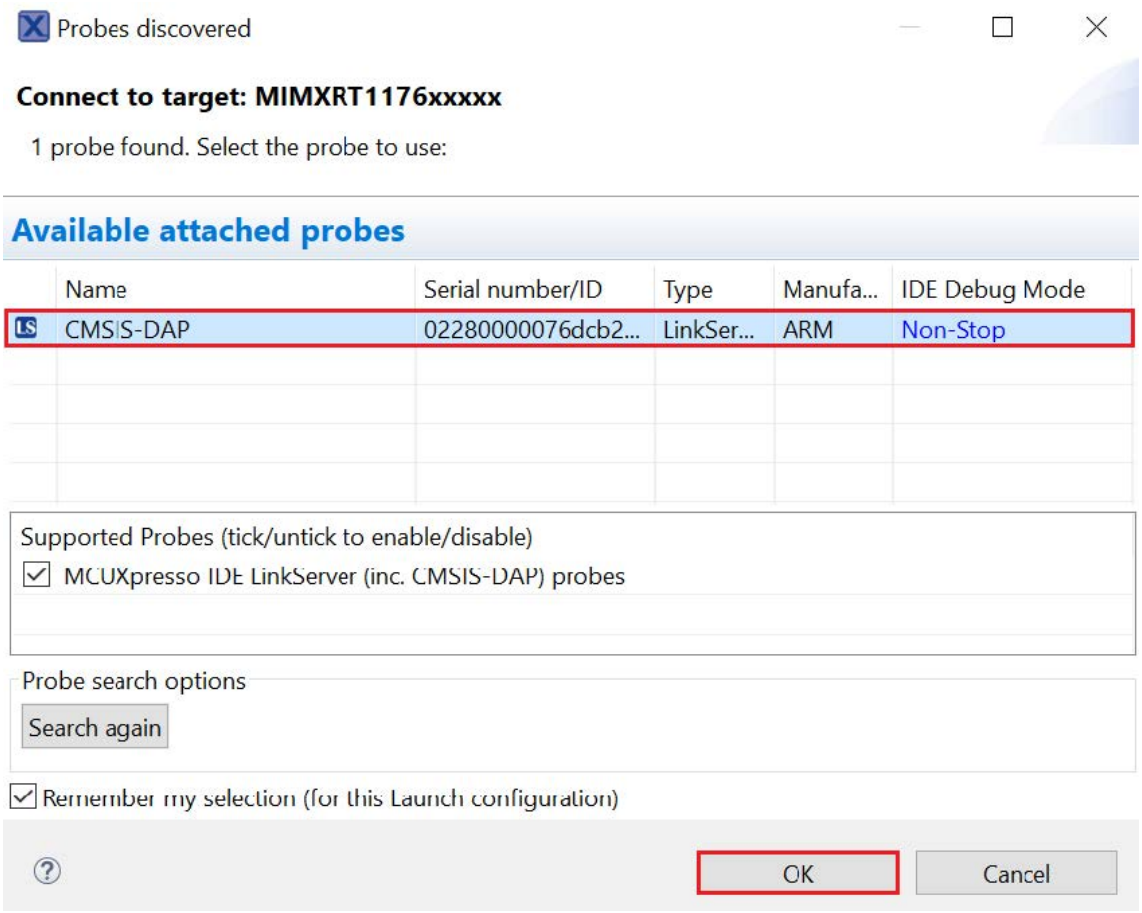
4. 1 stop bit



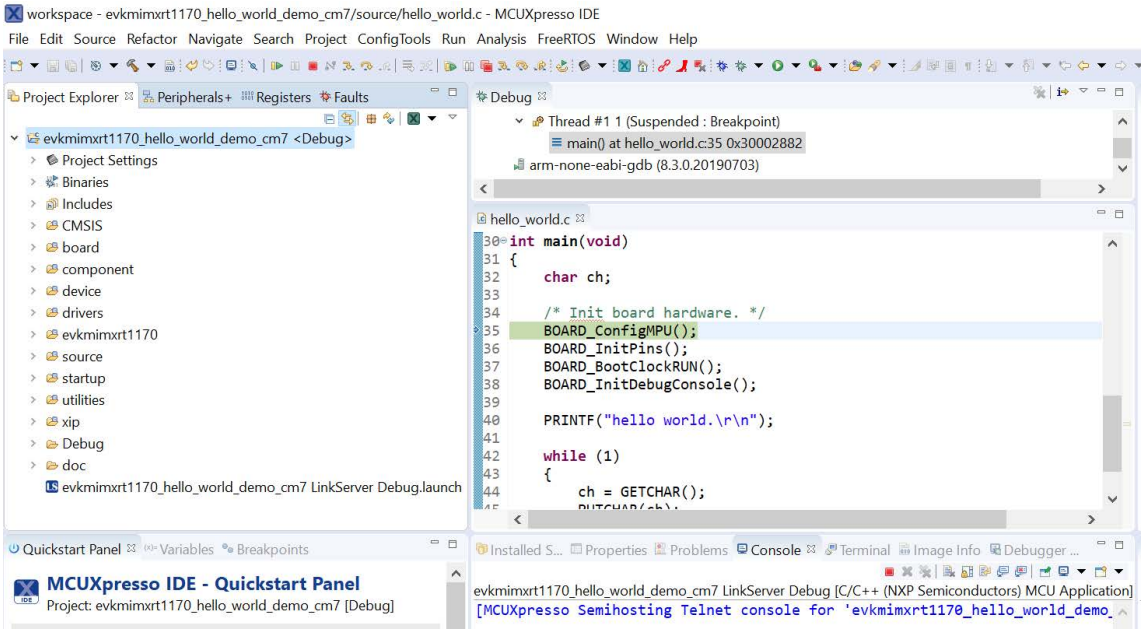
5. On the **Quickstart Panel**, click **Debug 'evkbmimxrt1170_demo_apps_hello_world' [Debug]**.



6. The first time you debug a project, the **Debug Emulator Selection** dialog is displayed, showing all supported probes that are attached to your computer. Select the probe through which you want to debug and click **OK**. (For any future debug sessions, the stored probe selection is automatically used, unless the probe cannot be found.)



7. The application is downloaded to the target and automatically runs to main().

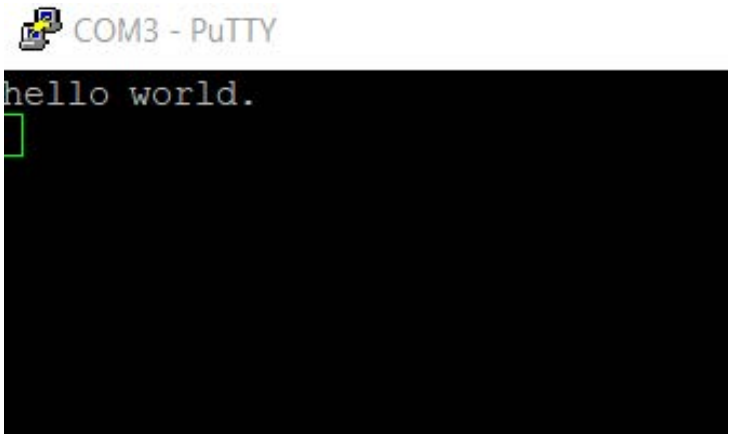


8. Start the application by clicking **Resume**.



The hello_world application is now running and a banner is displayed on the terminal. If not ,

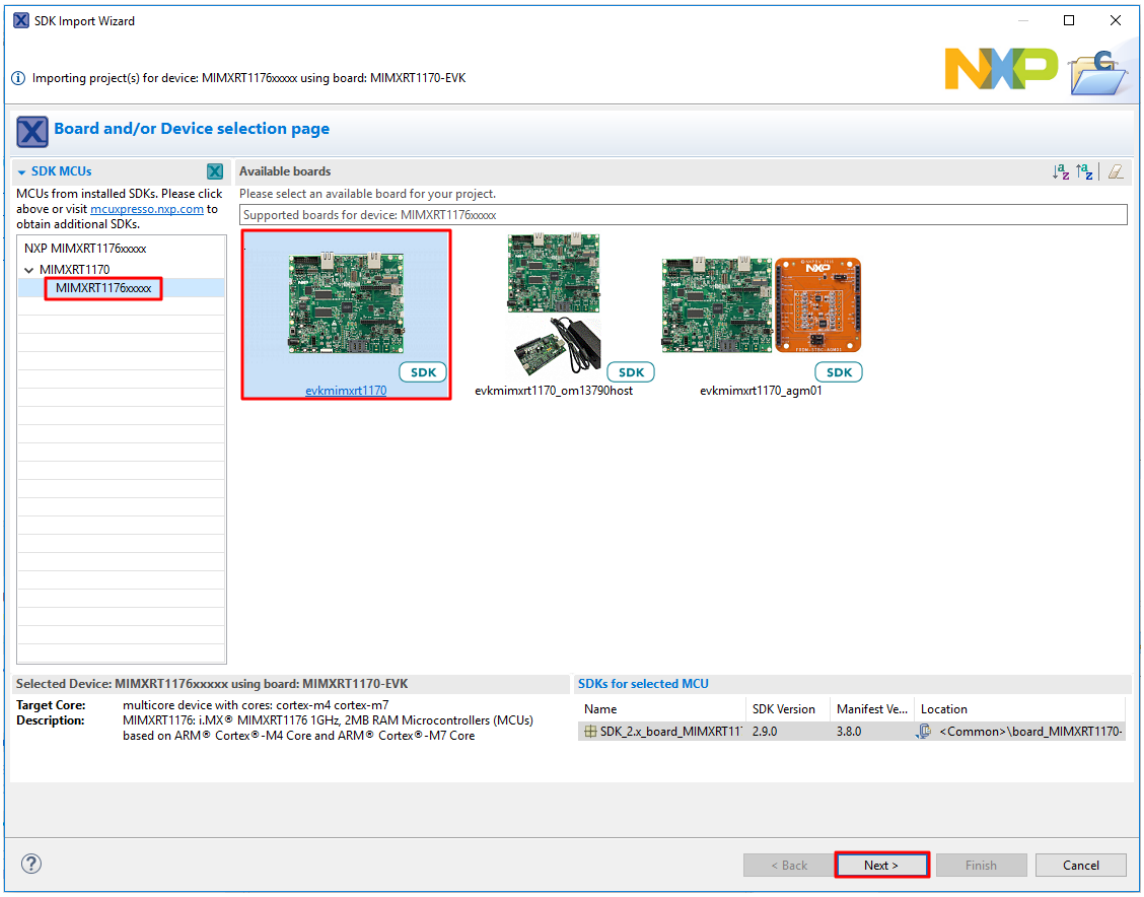
check your terminal settings and connections.



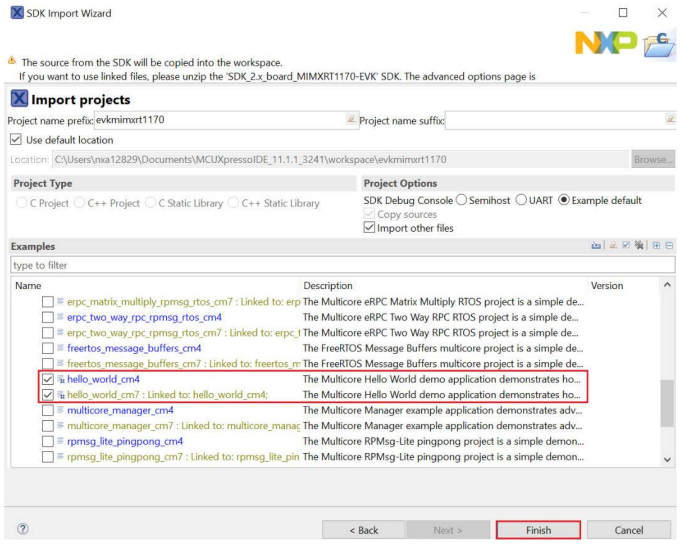
Parent topic:*Run a demo using MCUXpresso IDE*

Build a multicore example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of hello_world example application targeted for the **evkbmimxrt1170** hardware platform is used as an example.

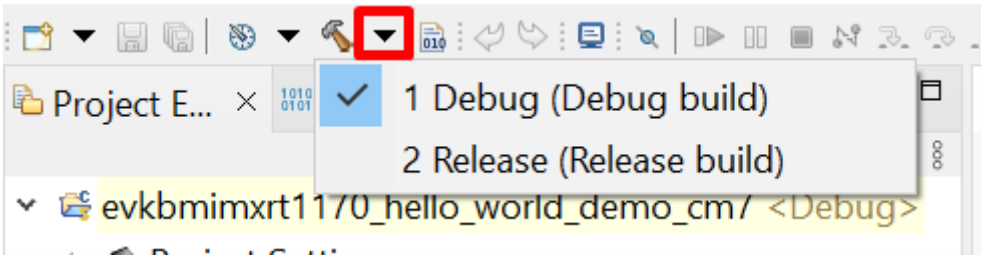
1. Multicore examples are imported into the workspace in a similar way as single core applications, explained in Build an example application. When the SDK zip package for **evkbmimxrt1170** is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, select **MIMXRT1176xxxxx**. Then, select **evkbmimxrt1170** and click **Next**.



2. Expand the multicore_examples folder and select **hello_world_cm7**. The hello_world_cm4 counterpart project is automatically imported with the cm7 project, because the multicore examples are linked together and there is no need to select it explicitly. Click **Finish**.



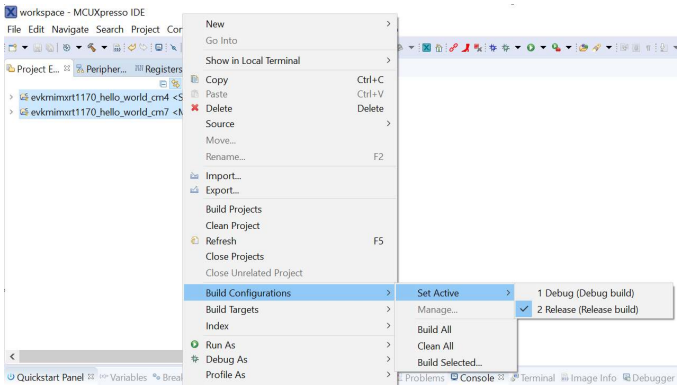
3. Now, two projects should be imported into the workspace. To start building the multi-core application, highlight the hello_world_cm7 project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing arrow next to the hammer icon, as shown in *Figure 3*. For this example, select **Debug**.



Press the **Build** button to start the multi-core project build.. Because of the project reference settings in multicore projects, triggering the build of the primary core application (cm7) also makes the referenced auxiliary core application (cm4) to build.

Note:

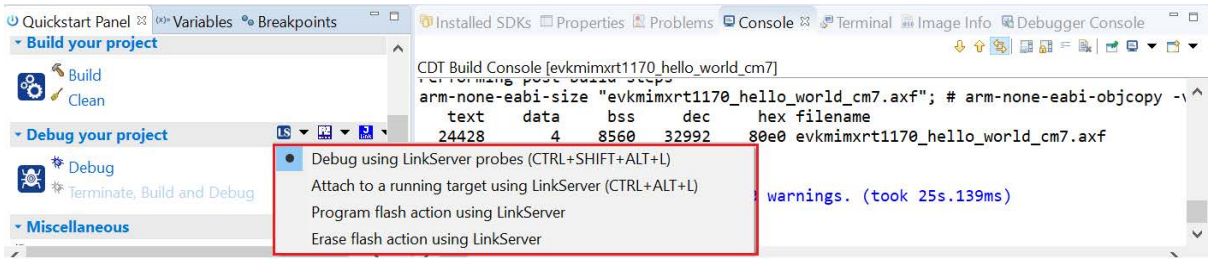
When the **Release** build is requested, it is necessary to change the build configuration of both the primary and auxiliary core application projects first. To do this, select both projects in the Project Explorer view and then right click which displays the context-sensitive menu. Select **Build Configurations** -> **Set Active** -> **Release**. This alternate navigation using the menu item is **Project** -> **Build Configuration** -> **Set Active** -> **Release**. After switching to the **Release** build configuration, the build of the multicore example can be started by triggering the primary core application (cm7)build.

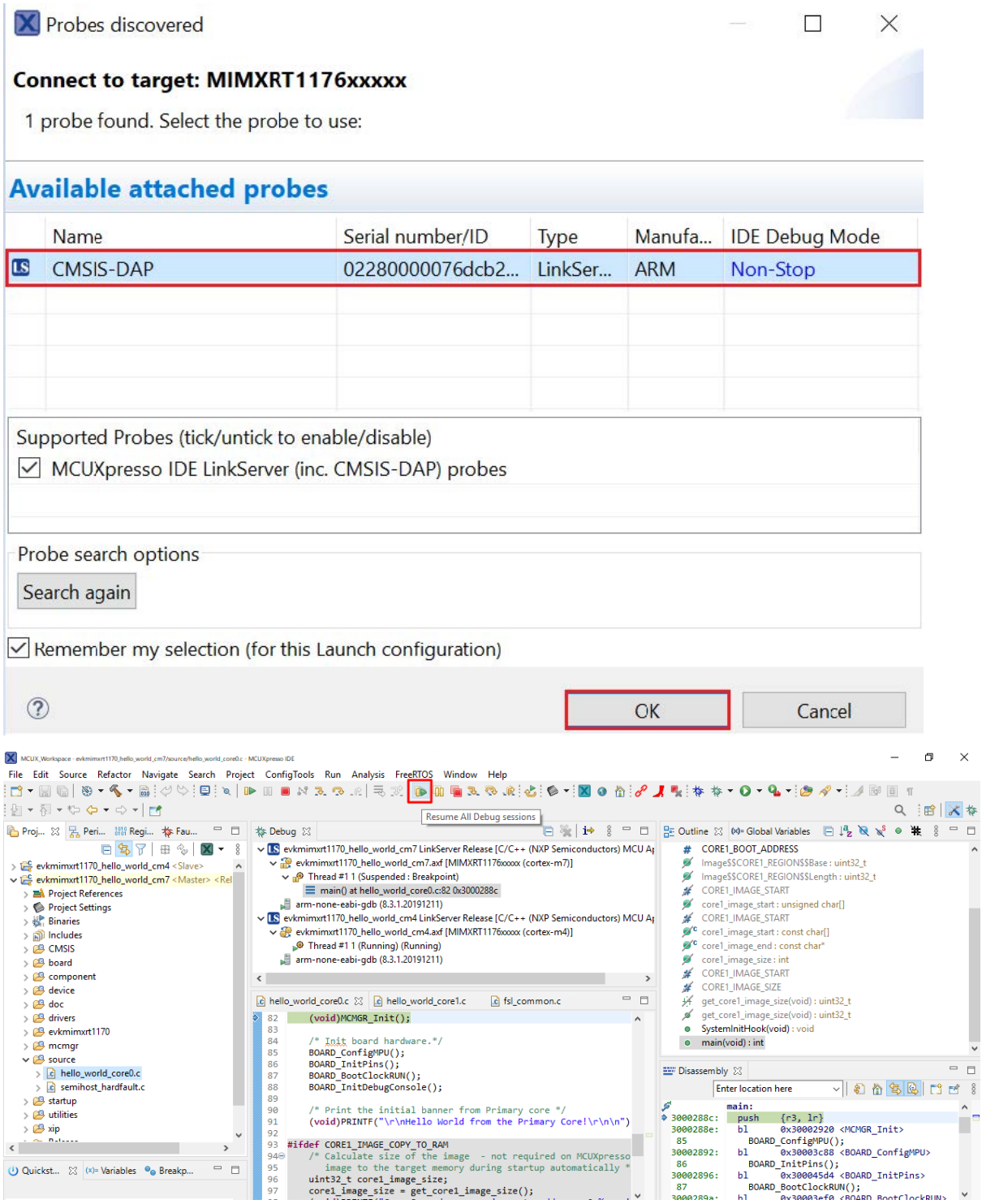


Parent topic:*Run a demo using MCUXpresso IDE*

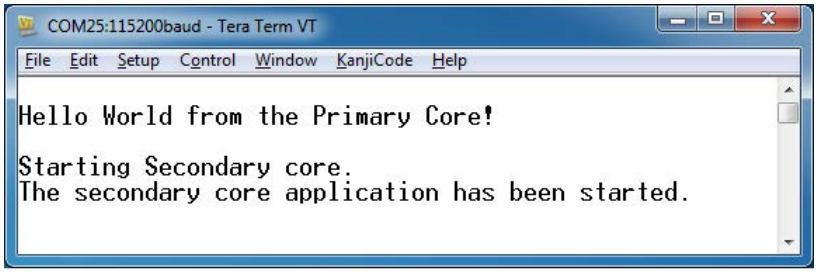
Run a multicore example application The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in Run an example application. These steps are common for both single-core applications and the primary side of dual-core applications, ensuring both sides of the multicore application are properly loaded and started. However, there is one additional dialogue that is specific to multicore examples which requires selecting the target core. See *Figure 1* to *Figure 3* as reference.

Note: On MCUXpresso IDE, the feature to simultaneously debug two cores is only supported by CMSIS-DAP debugger.





After clicking **Resume All Debug** sessions, the hello_world multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.



Note: There are some limitations on MCUXpresso IDE debugging. For details, see **Section 8.5 MCUXPresso IDE limitation** in *MCUXpresso SDK Release Notes for MIMXRT1170-EVKB* (document MCUXSDKMIMXRT117XBRN).

Parent topic:*Run a demo using MCUXpresso IDE*

Run a demo application using IAR

Note:

When erasing flash on IAR, IAR will show all range that can connect to flash. Please only check address flash connect to practically. Take the evkbmimxrt1170 for example:

- M7: 0x30000000-0x3fffffff
- M4: 0x8000000-0x17ffffff

When using IAR download/debug flexspi_nor related targets, make sure the boot switch is put to internal flash boot mode **SW1[1:4]:0010**

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK. The hello_world demo application targeted for the MIMXRT1170-EVKB hardware platform is used as an example, although these steps can be applied to any example application in the MCUXpresso SDK.

Build an example application Do the following steps to build the hello_world demo application.

1. Open the desired demo application workspace. Most example application workspace files can be located using the following path:

   <install_dir>/boards/<board_name>/<example_type>/<application_name>/<core_type>/iar

   Using the MIMXRT1170-EVKB hardware platform as an example, the hello_world workspace is located in:

   <install_dir>/boards/evkbmimxrt1170/demo_apps/hello_world/cm7/iar/hello_world_demo_cm7.eww

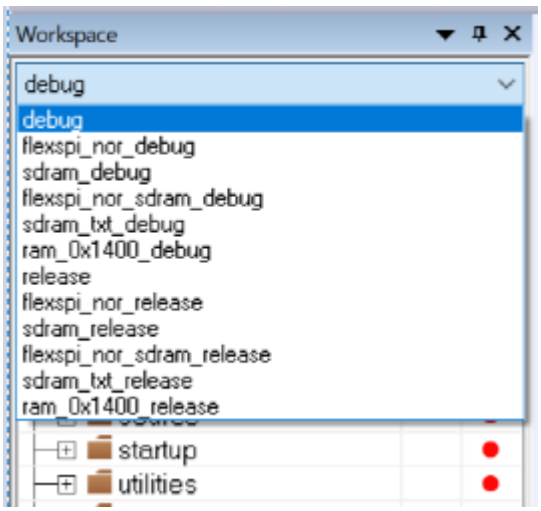
   Other example applications may have additional folders in their path.

2. Select the desired build target from the drop-down menu.

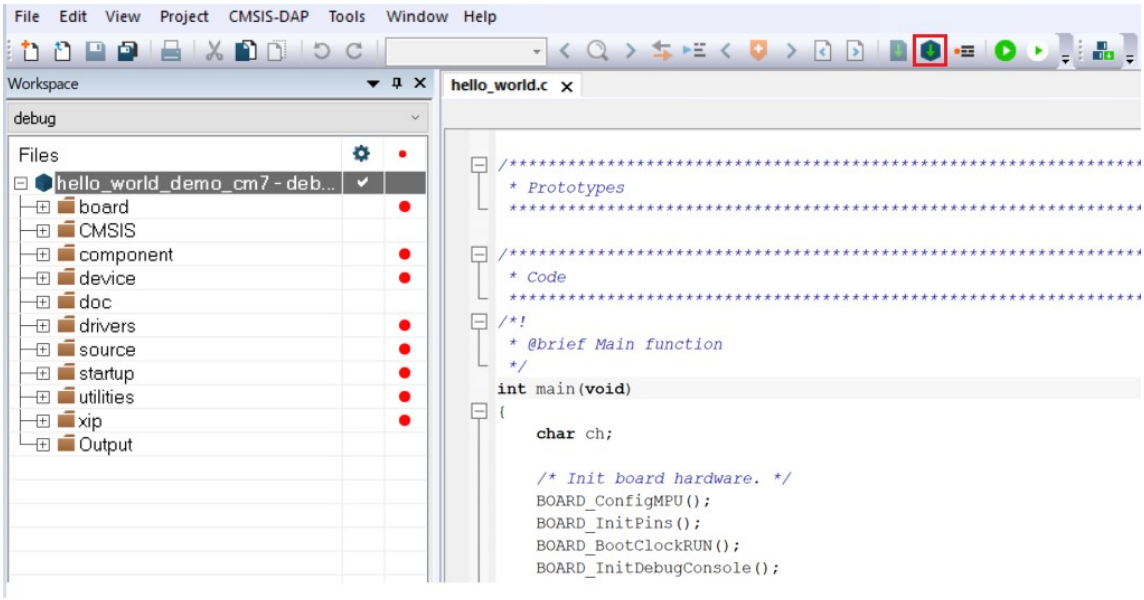
   There are twelve project configurations (build targets) supported across MCUXpresso SDK projects:

   - Debug– Compiler optimization is set to low, and debug information is generated for the executable. The linker file is RAMlinker, where text and data section is put in internal TCM.
   - Release– Compiler optimization is set to high, and debug information is not generated. The linker file is RAM linker, where text and data section is put in internal TCM.
   - ram_0x1400_debug– Project configuration is same as the debug target. The linker file is RAM_0x1400linker, where text is put in ITCM with offset 0x1400 and data put in DTCM.

- ram_0x1400_release– Project configuration is same as the release target. The linker file is RAM_0x1400 linker, where text is put in ITCM with offset 0x1400 and data put in DTCM.
- sdram_debug– Project configuration is same as the debug target. The linker file is SDRAMlinker, where text is put in internal TCM and data put in SDRAM.
- sdram_release– Project configuration is same as the release target. The linker file is SDRAMlinker, where text is put in internal TCM and data put in SDRAM.
- sdram_txt_debug– Project configuration is same as the debug target. The linker file is SDRAM_txtlinker, where text is put in SDRAM and data put in OCRAM.
- sdram_txt_release– Project configuration is same as the release target. The linker file is SDRAM_txtlinker, where text is put in SDRAM and data put in OCRAM.
- flexspi_nor_debug– Project configuration is same as the debug target. The linker file is flexspi_nor linker, where text is put in flash and data put in TCM.
- flexspi_nor_release– Project configuration is same as the release target. The linker file is flexspi_nor linker, where text is put in flash and data put in TCM.
- flexspi_nor_sdram_release- Project configuration is same as the release target. The linker file is flexspi_nor_sdramlinker, where text is put in flash and data put in SDRAM.
- flexspi_nor_sdram_debug– Project configuration is same as the debug target. The linker file is flexspi_nor_sdramlinker, where text is put in flash and data put in SDRAM. For some examples need large data memory, only sdram_debugand sdram_releasetargets are supported. For this example, select **hello_world** – **debug**.



3. To build the demo application, click **Make**, highlighted in red in *Figure 2*.

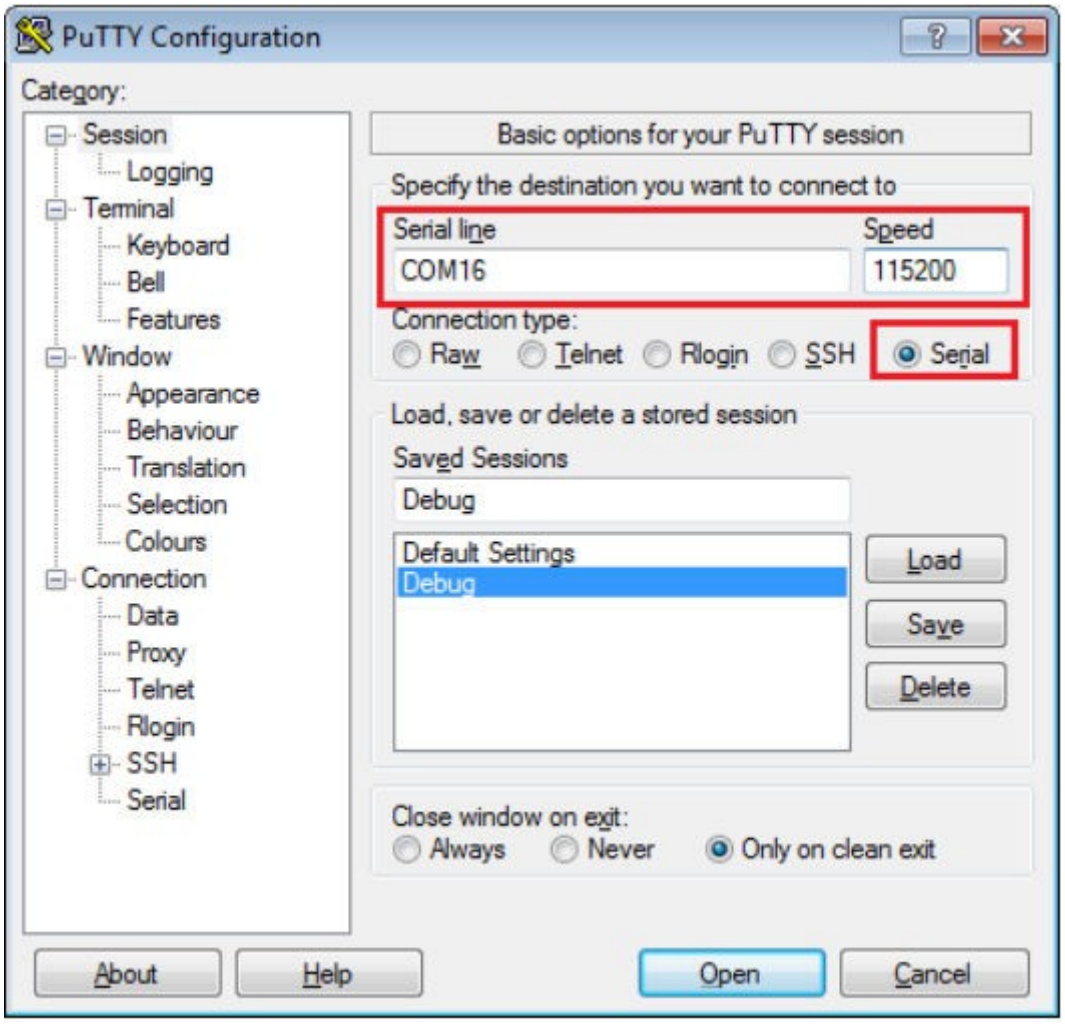


4. The build completes without errors.

Parent topic:*Run a demo application using IAR*

Run an example application To download and run the application, perform these steps:

1. This board supports the CMSIS-DAP/mbed/DAPLink debug probe by default. Visit MBED and follow the instructions to install the Windows® operating system serial driver. If running on Linux OS, this step is not required.
2. Connect the development platform to your PC via USB cable. Connect the USB cable to J11 and make sure SW1[1:4] is **0010b**.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug COM port (to determine the COM port number, see *How to determine COM port*). Configure the terminal with these settings:
    1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATEvariable in the *board.h*file)
    2. No parity
    3. 8 data bits

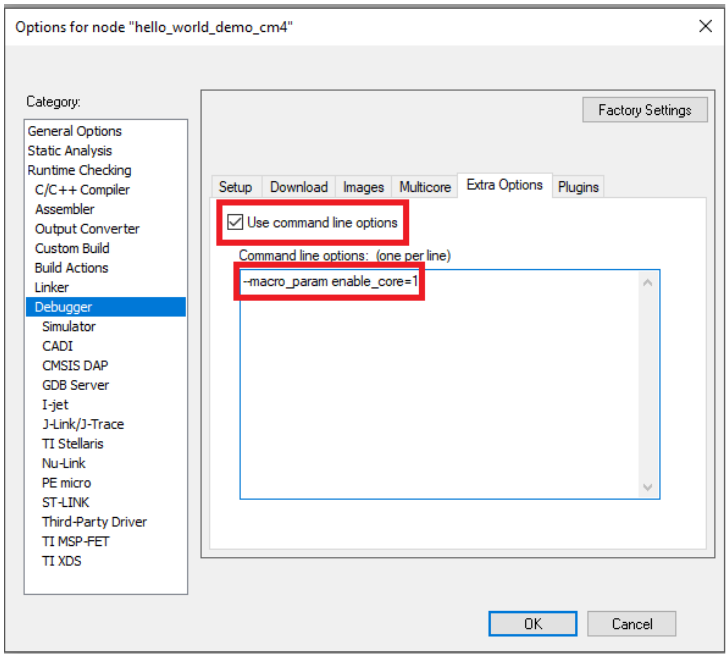


4. 1 stop bit

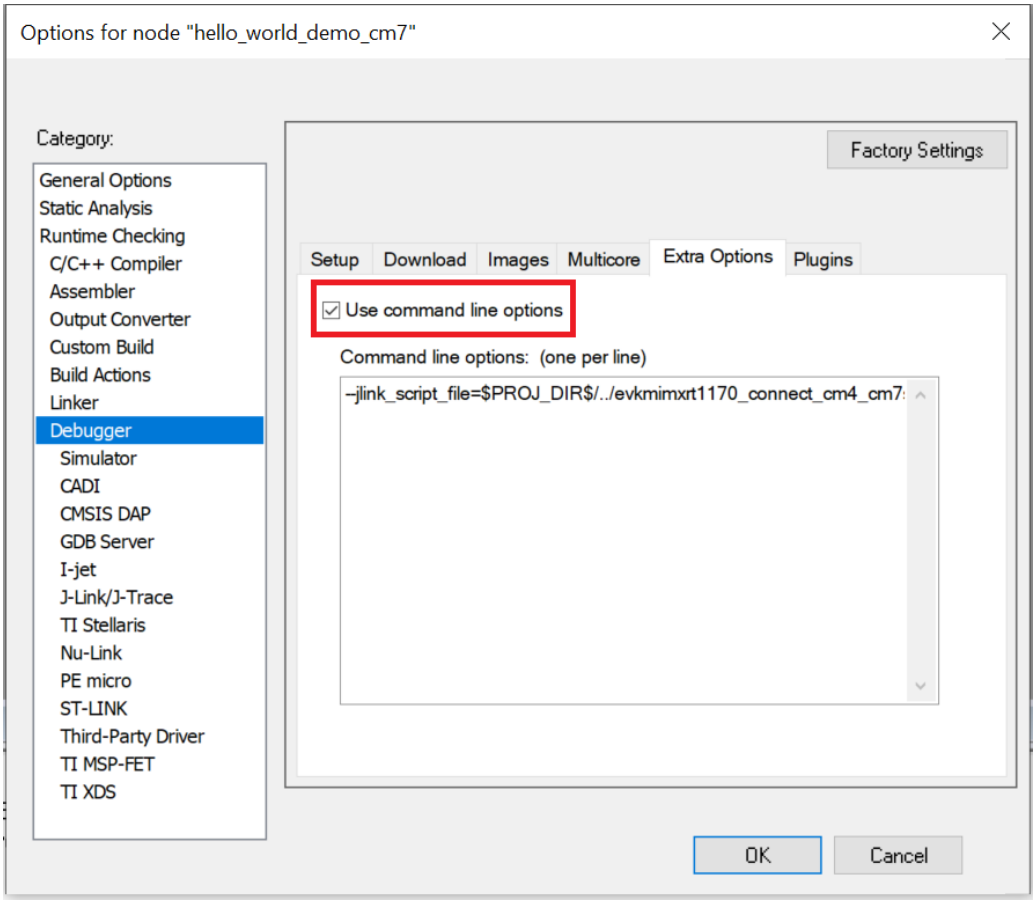
4. In IAR, click the **Download and Debug** button to download the application to the target.



- When using CMSIS-DAP to debug cm4 project on IAR, an extra option need to be specified in debugger settings. Check and fill in –**macro_param enable_core=1** in **Debugger** -> **Extra Options** -> **Command line options**, as shown in *Figure 3*.



- If debug with JLINK as probe, jlinkscript file is needed.
  - When downloading the cm7 project, check **Use command line options**, as shown in *Figure 4*.



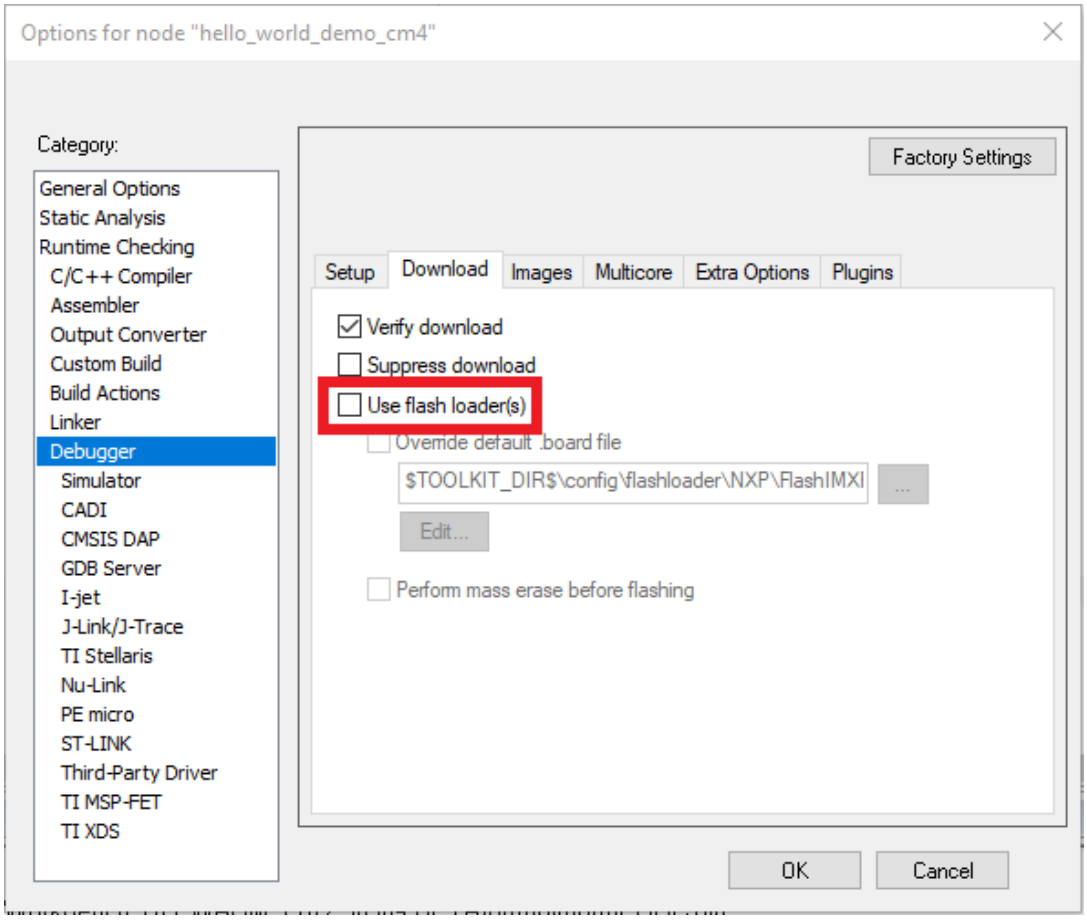
  - When downloading the cm4 project, uncheck **Use flash loaders**, as shown in *Figure 5*, and change the contents of command line options as below:

* Target with SDRAM

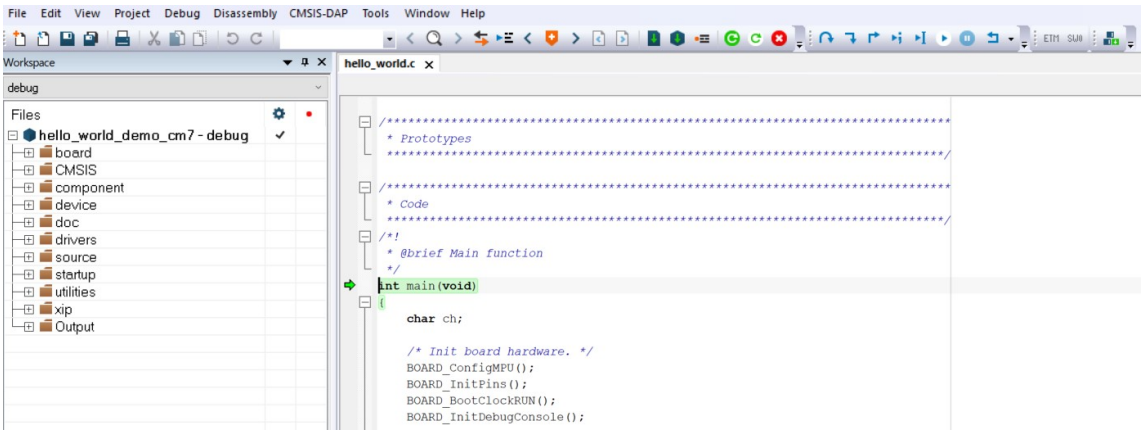
```
_ --jlink_script_file=$PROJ_DIR$/../evkbmimxrt1170_connect_cm4_cm4side_sdram.
↪jlinkscript
```

* Other target

```
--jlink_script_file=$PROJ_DIR$/../evkbmimxrt1170_connect_cm4_cm4side.jlinkscript
```



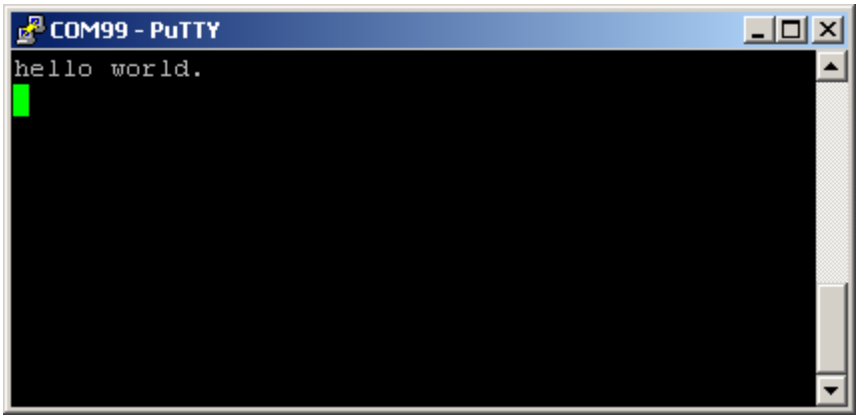
5. The application is then downloaded to the target and automatically runs to the main() function.



6. Run the code by clicking the **Go** button to start the application.



7. The hello_world application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.



Note: There are some limitations on MCUXpresso IDE debugging. For details, see **Section 8.6 IAR debug limitation** in *MCUXpresso SDK Release Notes for MIMXRT1170-EVKB* (document MCUXSDKMIMXRT117XBRN).

Parent topic:*Run a demo application using IAR*

Build a multicore example application This section describes the steps to build and run a dual-core application. The demo applications workspace files are located in this folder:

<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/iar

Begin with a simple dual-core version of the Hello World application. The multicore Hello World IAR workspaces are located in this folder:

<install_dir>/boards/evkbmimxrt1170/multicore_examples/hello_world/cm4/iar/hello_world_cm4.eww

<install_dir>/boards//evkbmimxrt1170/multicore_examples/hello_world/cm7/iar/hello_world_cm7.eww

Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm4) first, because the primary core application project (cm7) needs to know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

Because the auxiliary core runs always from RAM, only debug and release RAM targets are present in the project. When building the primary core project, it is possible to select either *debug/release* RAM targets or flexspi_nor_debug/flexspi_nor_release Flash targets. When choosing Flash targets (preferred) the auxiliary core binary is linked with the primary core image and stored in the external SPI Flash memory. During the primary core execution the auxiliary core image is copied from flash into the CM4 RAM and executed.

Parent topic:*Run a demo application using IAR*

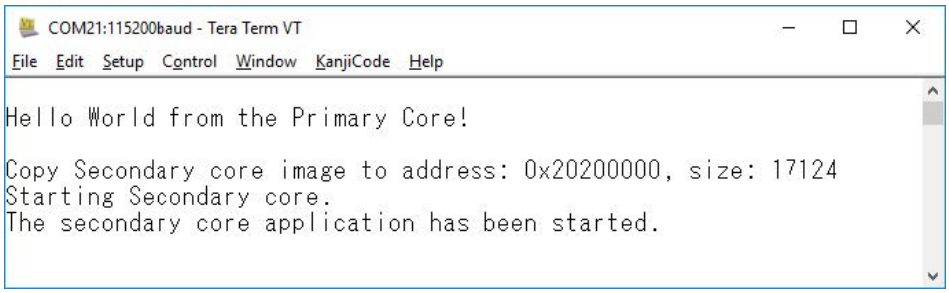
Run a multicore example application The primary core debugger handles flashing both primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform Steps 1 – 4 as described in Figure 5. These steps are common for both single core and dual-core applications in IAR.

After clicking the **Download and Debug** button, the auxiliary core project is opened in the separate EWARM instance. Both the primary and auxiliary image are loaded into the device flash memory and the primary core application is executed. It stops at the default C language entry point in the main() function.

Run both cores by clicking the **Start all cores** button to start the multicore application.



During the primary core code execution, the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this does not appear, check the terminal settings and connections.



An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and is running correctly. When both cores are running, use the **Stop all cores** and **Start all cores** buttons to stop or run both cores simultaneously.



Note: On IAR, the feature to simultaneously debug two cores is only supported by CMSIS-DAP debugger.

Parent topic:*Run a demo application using IAR*

Run a demo using Keil MDK/µVision

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK.

Install CMSIS device pack After the MDK tools are installed, Cortex Microcontroller Software Interface Standard (CMSIS) device packs must be installed to fully support the device from a debug perspective. These packs include things such as memory map information, register definitions and flash programming algorithms. Follow these steps to install the MIMXRT117x CMSIS pack.

1. Download the MIMXRT1171, MIMXRT1172, MIMXRT1173, MIMXRT1175 and MIMXRT1176 packs.
2. After downloading the DFP, double click to install it. Be patient when the DFP is installed. It will take approximate 15 minutes for the installation to complete.

Parent topic:*Run a demo using Keil MDK/µVision*

Build an example application

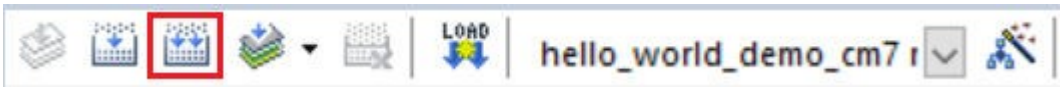
1. Open the desired example application workspace in:

   <install_dir>/boards/<board_name>/<example_type>/<application_name>/mdk

   The workspace file is named as <demo_name>.uvmpw. For this specific example, the actual path is:

   <install_dir>/boards/evkbmimxrt1170/demo_apps/hello_world/cm7/mdk/hello_world_demo_cm7.uvmpw

2. To build the demo project, select **Rebuild**, highlighted in red.

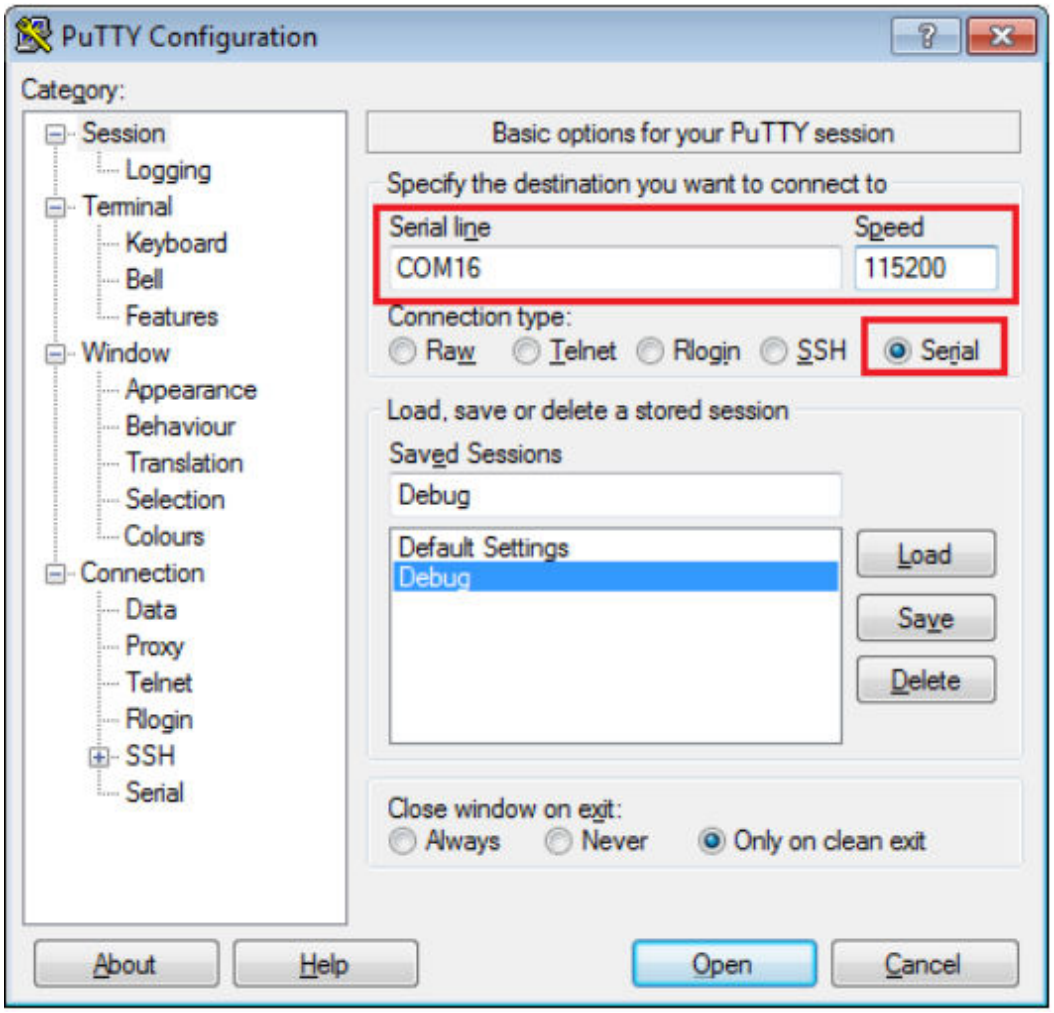


3. The build completes without errors.

Parent topic:*Run a demo using Keil MDK/µVision*

Run an example application To download and run the application, perform these steps:

1. This board supports the CMSIS-DAP/mbed/DAPLink debug probe by default. Visit MBED serial-configuration and follow the instructions to install the Windows® operating system serial driver. If running on Linux OS, this step is not required.
2. Connect the development platform to your PC via USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, J11, and connect to the debug serial port number. To determine the COM port number, see *How to determine COM port*. Configure the terminal with these settings:
   1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATEvariable in the *board.h*file)
   2. No parity
   3. 8 data bits
   4. 1 stop bit

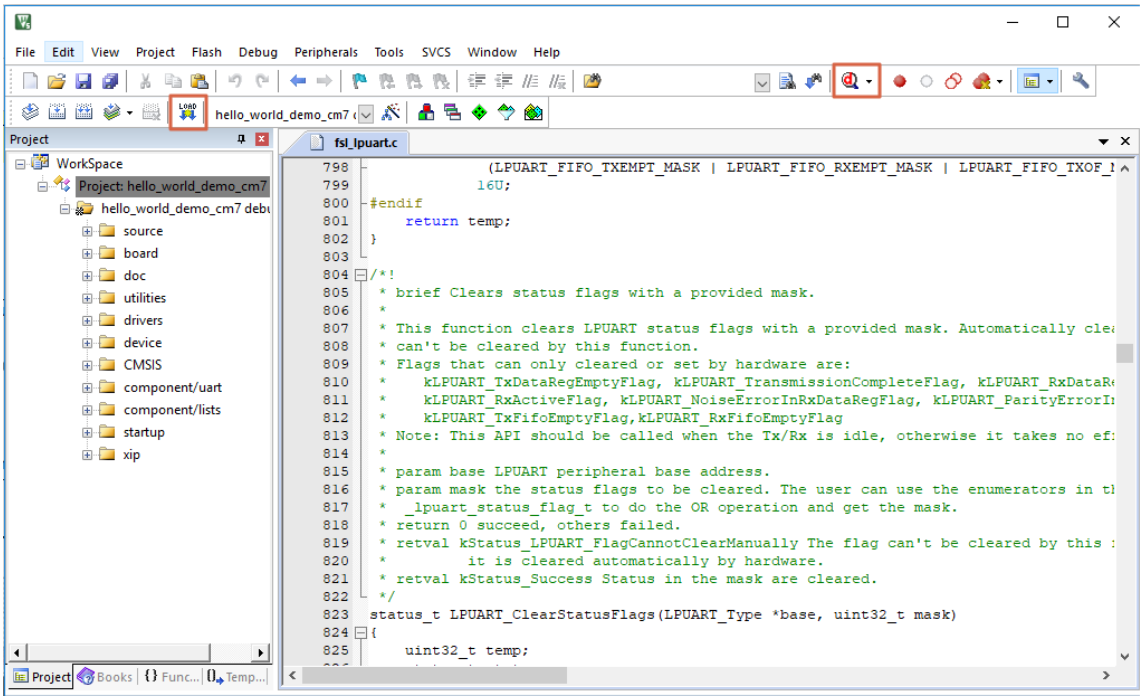


4. To debug the application, click **load** or press the F8 key for flexspi target which needs to download the program to flash memory. Then, click the **Start/Stop Debug Session**button, highlighted in red in *Figure 2*. If using **J-Link**as the debugger, click **Project option**>**Debug**>**Settings**>**Debug** >**Port**, and select **SW**.

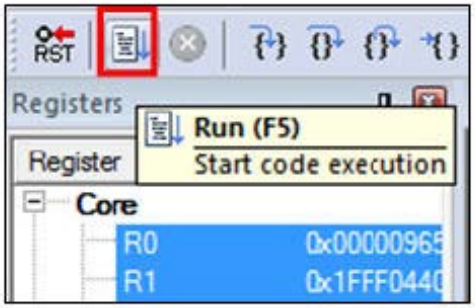
   Note:

   When using jlink in MDK for cm4 projects, it expects one jlinkscript file named JLinkSettings.JLinkScript in the folder where the uVision project files are located. Please refer to Segger Wiki for more information.

   For the contents in this JlinkSettings.JLinkScript, use contents in evkbmimxrt1170_connect_cm4_cm4side.jlinkscript (non-sdram targets) and evkbmimxrt1170_connect_cm4_cm4side_sdram.jlinkscript (sdram targets).



5. Run the code by clicking **Run** to start the application, as shown in *Figure 3*.



The hello_world application is now running and a banner is displayed on the terminal, as shown in *Figure 4*. If this is not true, check your terminal settings and connections.



Parent topic:*Run a demo using Keil MDK/µVision*

Build a multicore example application This section describes the particular steps that need to be done in order to build and run a dual-core application. The demo applications workspace files are located in this folder:

<install_dir>/boards/evkbmimxrt1170/multicore_examples/<application_name>/<core_type>/mdk

Begin with a simple dual-core version of the Hello World application. The multicore Hello World MDK workspaces are located in this folder:

<install_dir>/boards/evkbmimxrt1170/multicore_examples/hello_world/cm4/mdk/hello_world_cm4.uvmpw

<install_dir>/boards//evkbmimxrt1170/multicore_examples/hello_world/cm7/mdk/hello_world_cm7.uvmpw

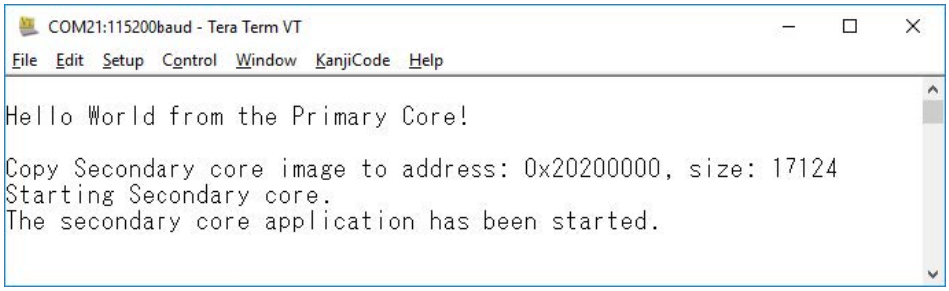
Build both applications separately by clicking the **Rebuild** button. Build the application for the auxiliary core (cm4) first, because the primary core application project (cm7) needs to know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

Because the auxiliary core runs always from RAM, debug and release RAM targets are present in the project only. When building the primary core project, it is possible to select flexspi_nor_debug/flexspi_nor_release Flash targets. When choosing Flash targets the auxiliary core binary is linked with the primary core image and stored in the external SPI Flash memory. During the primary core execution the auxiliary core image is copied from flash into the CM4 RAM and executed.

Parent topic:*Run a demo using Keil MDK/µVision*

Run a multicore example application The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform Steps 1 – 5 as described in Run an example application. These steps are common for both single-core and dual-core applications in µVision.

Both the primary and the auxiliary image is loaded into the flash memory. After clicking **Run**, the primary core application is executed. During the primary core code execution, the auxiliary core code is re-allocated from the SPI flash memory to the RAM, and the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.

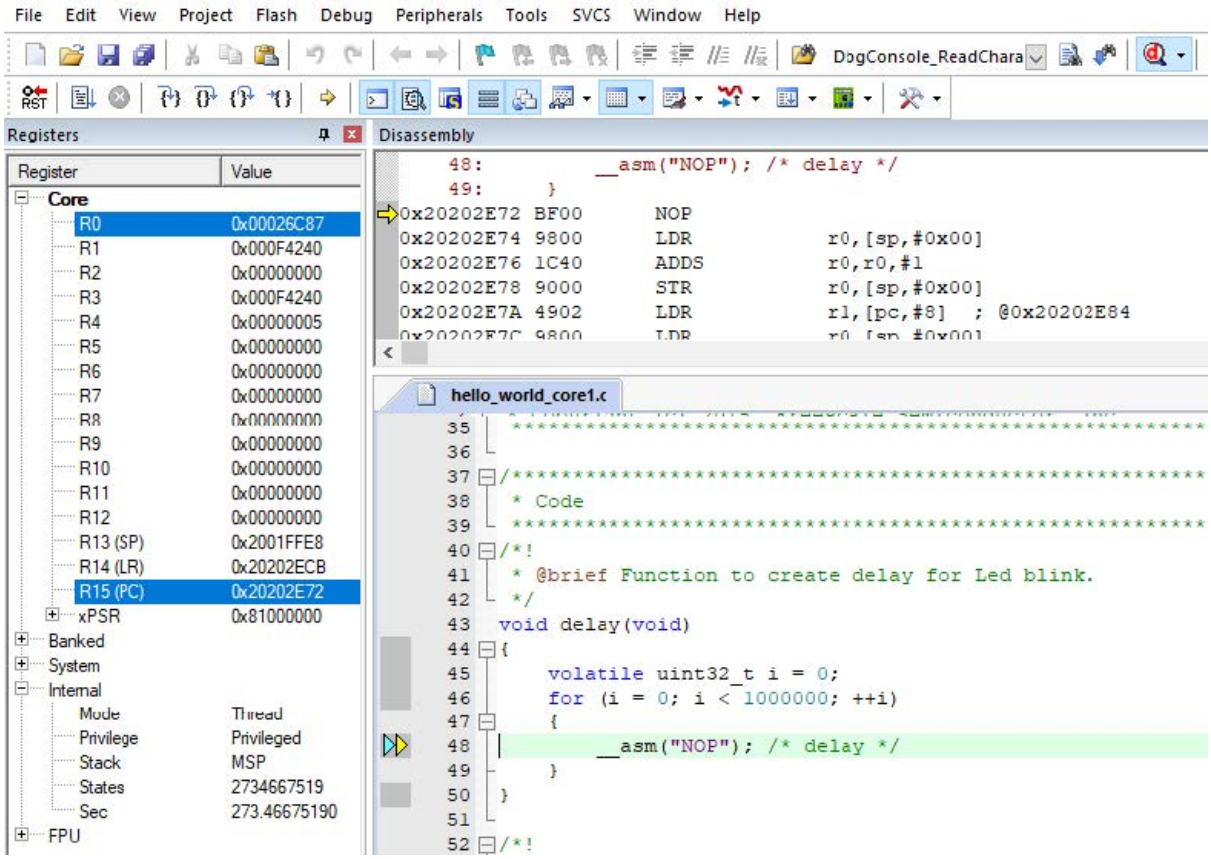


An LED controlled by the auxiliary core starts flashing indicating that the auxiliary core has been released from the reset and is running correctly.

Attach the running application of the auxiliary core by opening the auxiliary core project in the second µVision instance and

clicking the **Start/Stop Debug Session** button. After this, the second debug session is opened and the auxiliary core

application can be debugged.



Parent topic:*Run a demo using Keil MDK/µVision*

Run a demo using Arm GCC

This section describes the steps to configure the command line Arm GCC tools to build, run, and debug demo applications and necessary driver libraries provided in the MCUXpresso SDK. The hello_worlddemo application is targeted which is used as an example.

Set up toolchain This section contains the steps to install the necessary components required to build and run an MCUXpresso SDK demo application with the Arm GCC toolchain, as supported

by the MCUXpresso SDK. There are many ways to use Arm GCC tools, but this example focuses on a Windows operating system environment.

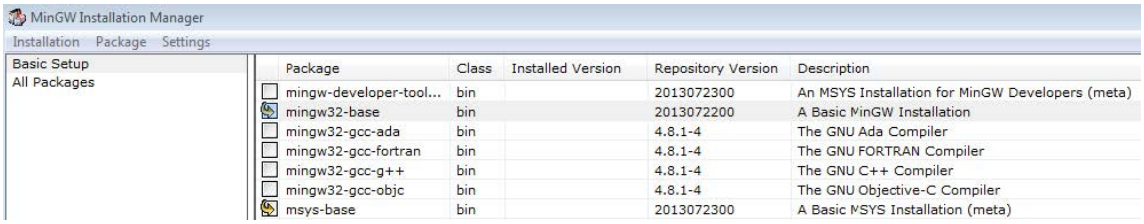
Install GCC Arm Embedded tool chain Download and run the installer from GNU Arm Embedded Toolchain. This is the actual toolset (in other words, compiler, linker, etc.). The GCC toolchain should correspond to the latest supported version, as described in *MCUXpresso SDK Release Notes for MIMXRT1170-EVKB*(document MCUXSDKMIMXRT117XBRN).

Parent topic: Set up toolchain

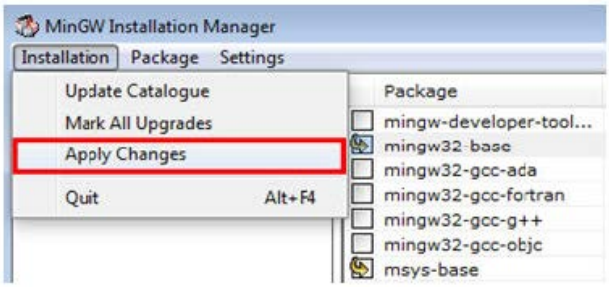
Install MinGW (only required on Windows OS) The Minimalist GNU for Windows (MinGW) development tools provide a set of tools that are not dependent on third-party C-Runtime DLLs (such as Cygwin). The build environment used by the MCUXpresso SDK does not use the MinGW build tools, but does leverage the base install of both MinGW and MSYS. MSYS provides a basic shell with a Unix-like interface and tools.

1. Download the latest MinGW mingw-get-setup installer from SOURCEFORGE.
2. Run the installer. The recommended installation path is *C:\MinGW*. However, you may install to any location.

   Note: The installation path cannot contain any spaces.
3. Ensure that the **mingw32-base** and **msys-base** are selected under **Basic Setup**.



4. In the **Installation** menu, click **Apply Changes** and follow the remaining instructions to complete the installation.

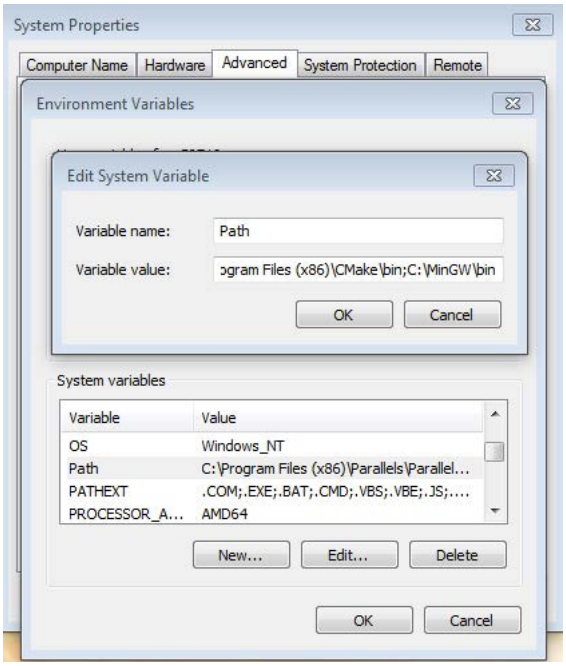


5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel**->**System and Security**->**System**->**Advanced System Settings**in the **Environment Variables...**section. The path is:

   <*mingw_install_dir*>*bin*

   Assuming the default installation path is *C:\MinGW*, an example is as shown in *Figure 3*. If the path is not set correctly, the toolchain will not work.

   Note: If you have *C:\MinGW\msys\x.x\bin*in your PATH variable (as required by Kinetis SDK 1.0.0), remove it to ensure that the new GCC build system works correctly.



Parent topic: Set up toolchain

Add a new system environment variable for ARMGCC_DIR Create a new systemenvironment variable and name it as ARMGCC_DIR. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

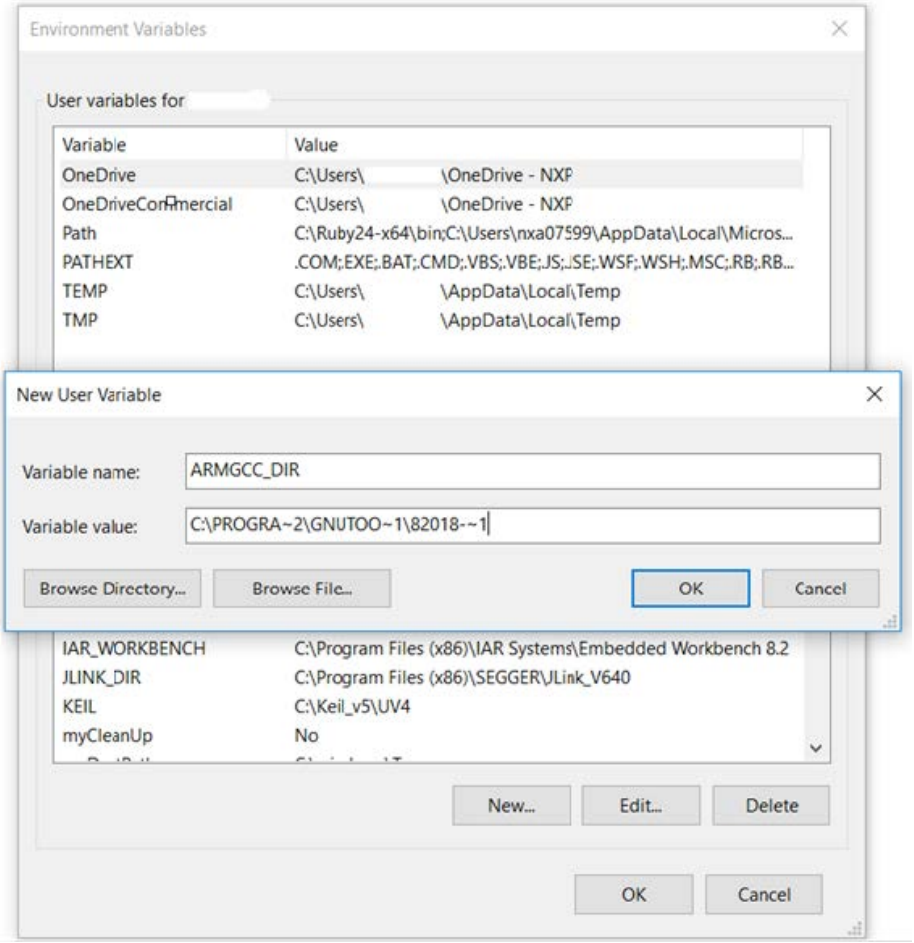
C:\Program Files (x86)\GNU Tools ARM Embedded\8 2018-q4-major

See the installation folder of the GNU Arm GCC Embedded tools for the exact path name of your installation.

Short path should be used for path setting, you could convert the path to short path by running the for %I in (.) do echo %~sI command in above path.

```
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>for %I in (.) do echo %~sI

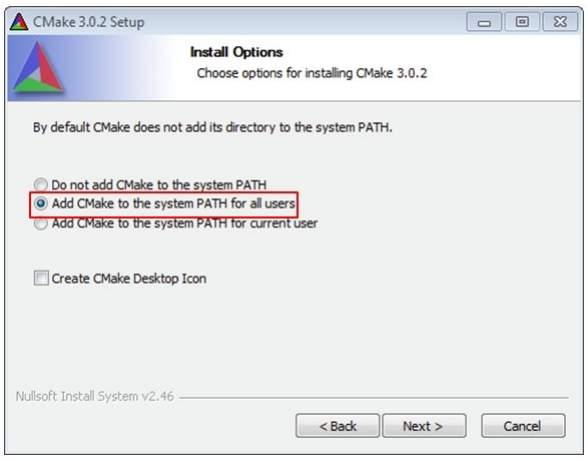
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>echo C:\PROGRA~2\GNUTOO~1\82018-~1
C:\PROGRA~2\GNUTOO~1\82018-~1
```



Parent topic: Set up toolchain

Install CMake

1. Download CMake 3.0.x from CMAKE.
2. Install CMake, ensuring that the option **Add CMake to system PATH**is selected when installing. The user chooses to select whether it is installed into the PATH for all users or just the current user. In this example, it is installed for all users.



3. Follow the remaining instructions of the installer.
4. You may need to reboot your system for the PATH changes to take effect.

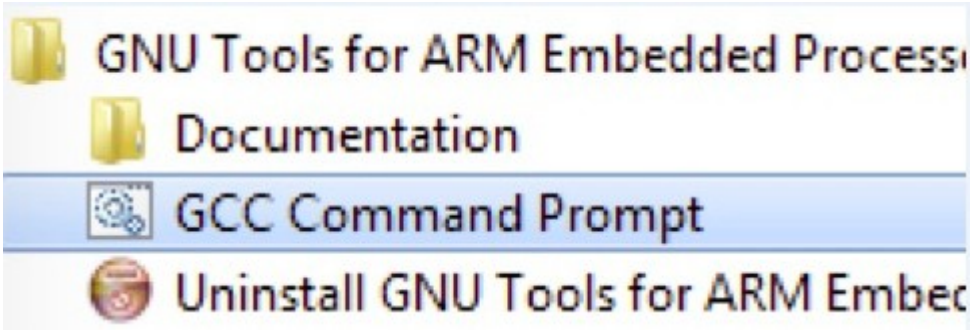
5. Make sure sh.exe is not in the Environment Variable PATH. This is a limitation of mingw32-make.

Parent topic: Set up toolchain

Parent topic:*Run a demo using Arm GCC*

Build an example application To build an example application, follow these steps.

1. Open a GCC Arm Embedded tool chain command window. To launch the window, from the Windows operating system **Start**menu, go to **Programs**>**GNU Tools ARM Embedded <version>**and select **GCC Command Prompt**.



2. Change the directory to the example application project directory which has a path similar to the following:

   <install_dir>/boards/<board_name>/<example_type>/<core_type>/<application_name>/armgcc

   For this example, the exact path is:

   <install_dir>/examples/evkbmimxrt1170/demo_apps/hello_world/cm7/armgcc

   Note: To change directories, use the cd command.

3. Type **build_debug.bat**on the command line or double click on **build_debug.bat**file in Windows Explorer to build it. The output is as shown in *Figure 2*.

```
[ 90%] Building C object CMakeFiles/hello_world_demo_cm7.elf.dir/C_/Users/nxa12829/Desktop/rt1170/boards/evkmimxrt1170/x
ip/evkmimxrt1170_sdram_ini_dcd.c.obj
[ 95%] [100%] Building C object CMakeFiles/hello_world_demo_cm7.elf.dir/C_/Users/nxa12829/Desktop/rt1170/devices/MIMXRT1
176/drivers/fsl_anatop.c.obj
Building C object CMakeFiles/hello_world_demo_cm7.elf.dir/C_/Users/nxa12829/Desktop/rt1170/devices/MIMXRT1176/drivers/fs
l_anatop_ai.c.obj
Linking C executable debug\hello_world_demo_cm7.elf
[100%] Built target hello_world_demo_cm7.elf

C:\Users\nxa12829\Desktop\rt1170\boards\evkmimxrt1170\demo_apps\hello_world\cm7\armgcc>IF "" == "" (pause )
Press any key to continue . . .
```

Parent topic:*Run a demo using Arm GCC*

Run an example application This section describes steps to run a demo application using J-Link GDB Server application. To perform this exercise, make sure that either:

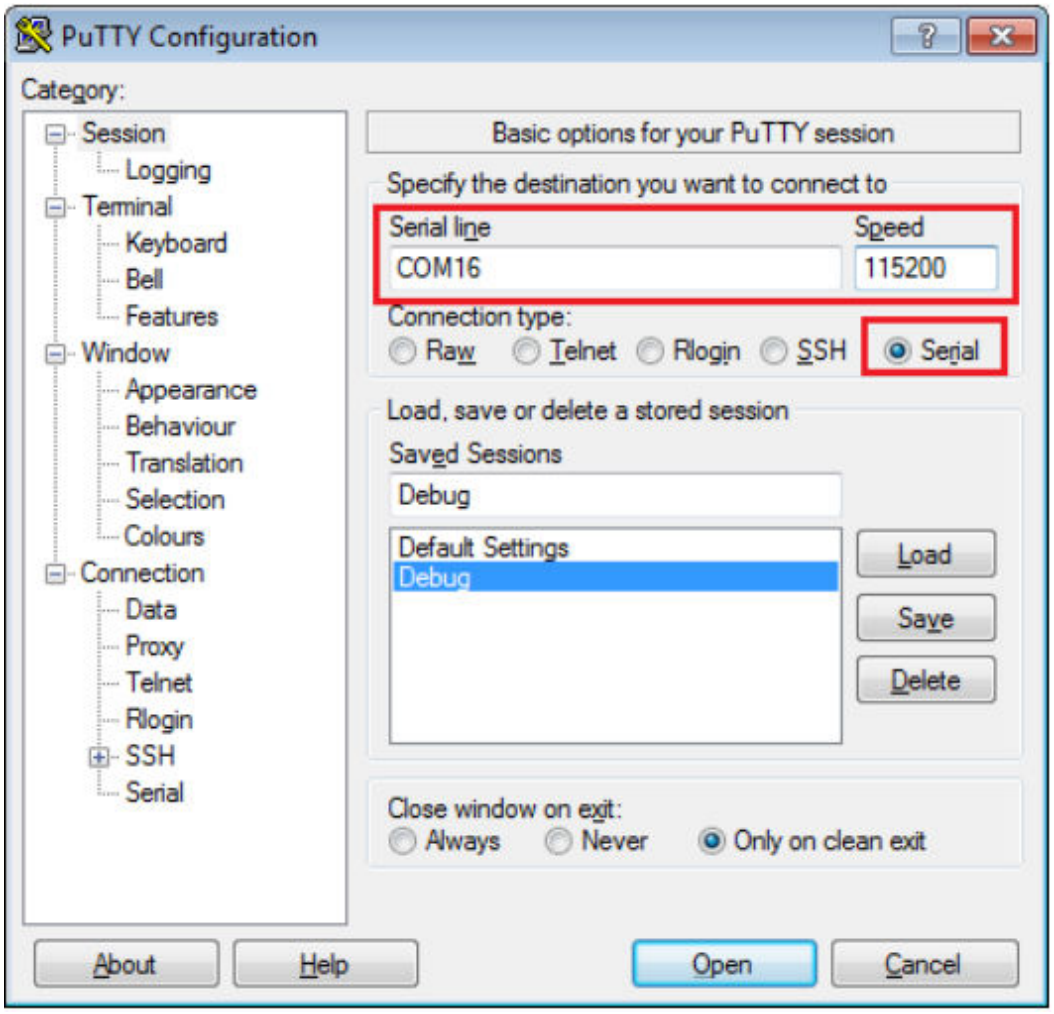
- The OpenSDA interface on your board is programmed with the J-Link OpenSDA firmware. If your board does not support OpenSDA, then a standalone J-Link pod is required.
- You have a standalone J-Link pod that is connected to the debug interface of your board.

Note: Some hardware platforms require hardware modification in order to function correctly with an external debug interface.

After the J-Link interface is configured and connected, follow these steps to download and run the demo applications:

1. This board supports the J-Link debug probe. Before using it, install SEGGER software, which can be downloaded from SEGGER.

2. Connect the development platform to your PC via USB cable between the OpenSDA USB connector and the PC USB connector. If using a standalone J-Link debug pod, also connect it to the SWD/JTAG connector of the board.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see *How to determine COM port*). Configure the terminal with these settings:
   1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATEvariable in the *board.h* file)
   2. No parity
   3. 8 data bits
   4. 1 stop bit

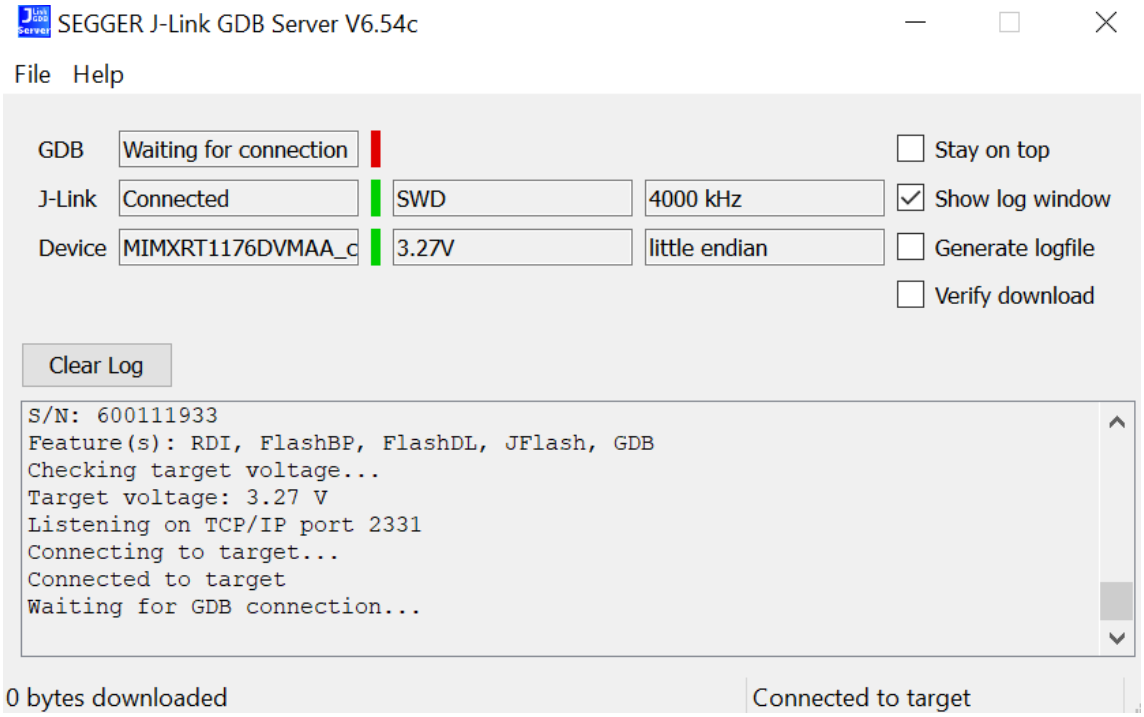


4. Open the J-Link GDB Server application. Go to the SEGGER install folder. For example, *C:\Program Files(x86)\SEGGER\JLink_Vxxx*. Open the command windows. For Debug and Release targets, use the JLinkGDBServer.exe command. For the sdram_debug, sdram_release, flexspi_nor_sdram_debug, and flexspi_nor_sdram_release targets, use the JLinkGDBServer.exe -jlinkscriptfile <install_dir>/ boards/evkbmimxrt1170/ demo_apps/hello_world/cm7/evkbmimxrt1170_connect_cm4_cm7side.jlinkscriptcommand.
5. The target device selection chosen for this example is **MIMXRT1176DVMAA_cm7**.
6. After it is connected, the screen should resemble *Figure 2*.

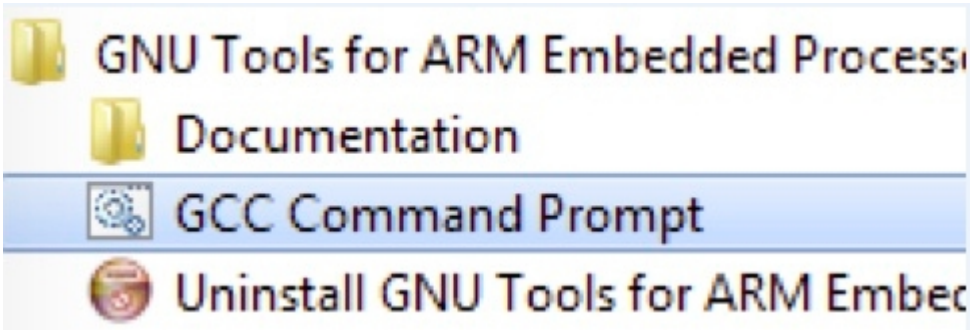
   Note:

   When download the cm4 project, use **MIMXRT1176VDMAA_cm4** as the target device. Use the *evkbmimxrt1170_connect_cm4_cm4side.jlinkscript* file for non-sdram targets and *evkb-*

mimxrt1170_connect_cm4_cm4side_sdram.jlinkscript for sdram targets.



7. If not already running, open a GCC ARM Embedded tool chain command window. To launch the window, from the Windows operating system **Start menu**, go to **Programs**> **GNU Tools ARM Embedded <version>**and select **GCC Command Prompt**.



8. Change to the directory that contains the example application output. The output can be found in using one of these paths, depending on the build target selected:

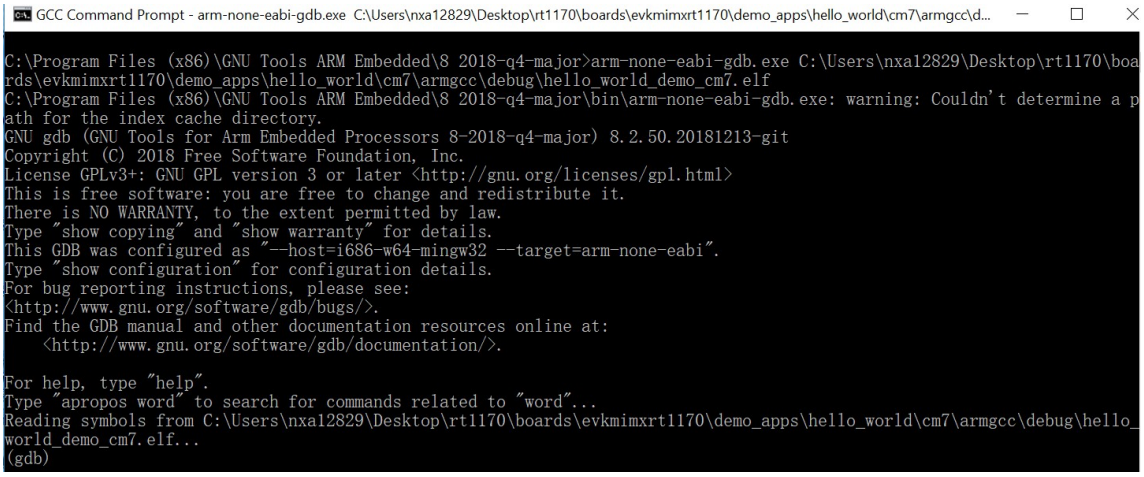
   <install_dir>/boards/<board_name>/<example_type>/<application_name>/cm7/armgcc/debug

   <install_dir>/boards/<board_name>/<example_type>/<application_name>/cm7/armgcc/release

   For this example, the path is:

   <install_dir>/boards/evkbmimxrt1170/demo_apps/hello_world/cm7/armgcc/debug

9. Run the arm-none-eabi-gdb.exe <application_name>.elf. For this example, it is arm-none-eabi-gdb.exe hello_world.elf.

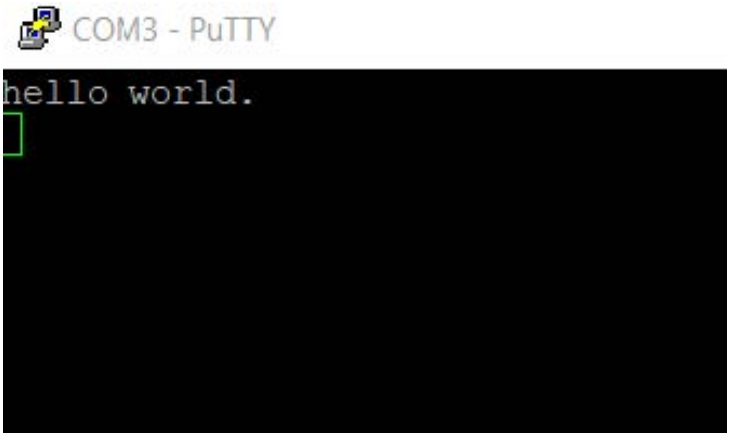


10. Run these commands:

```
target remote localhost:2331
load
```

11. The application is now downloaded and halted at the reset vector. Execute the monitor gocommand to start the demo application.

    The hello_worldapplication is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.



Parent topic:*Run a demo using Arm GCC*

Build a multicore example application This section describes the steps to build and run a dual-core application. The demo application build scripts are located in this folder:

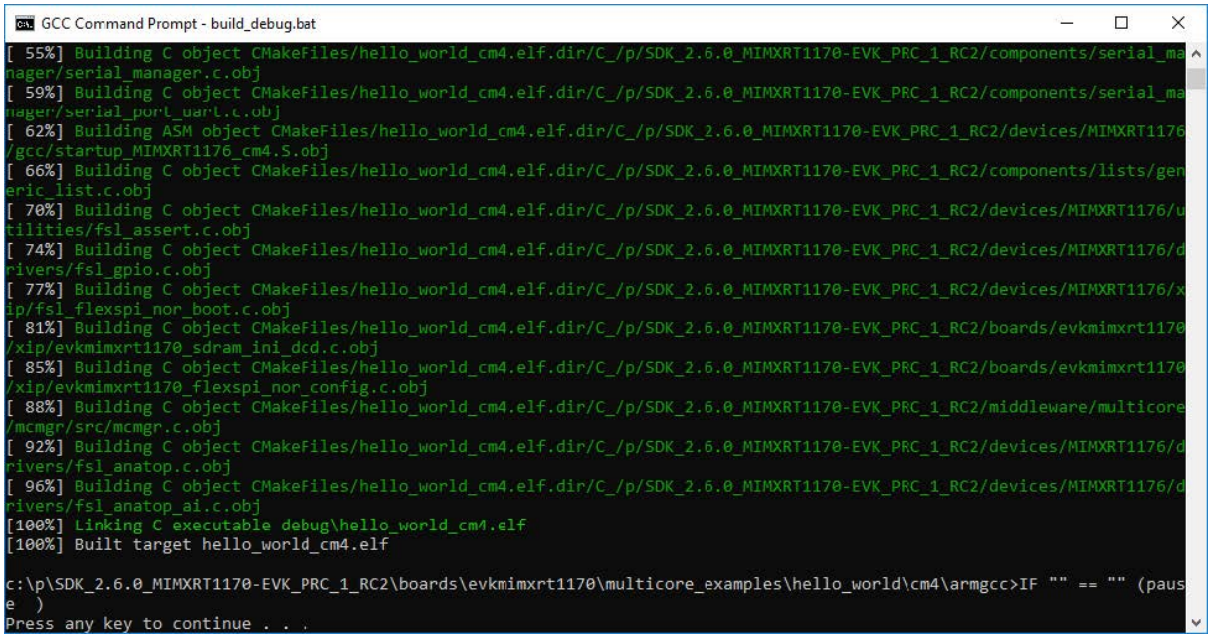
<install_dir>/boards/evkbmimxrt1170/multicore_examples/<application_name>/<core_type>/armgcc

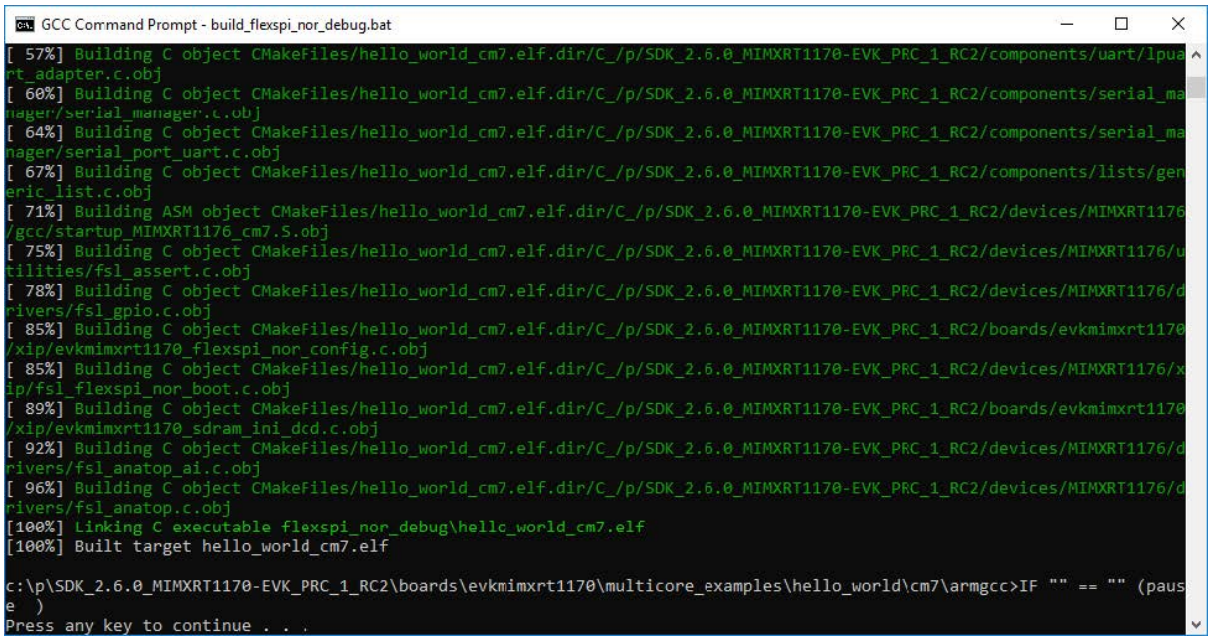
Begin with a simple dual-core version of the Hello World application. The multicore Hello World GCC build scripts are located in this folder:

<install_dir>/boards/evkbmimxrt1170/multicore_examples/hello_world/cm4/armgcc/build_debug.bat

<install_dir>/boards/evkbmimxrt1170/multicore_examples/hello_world/cm7/armgcc/build_flexspi_nor_debug.bat

Build both applications separately following steps for single core examples as described in *Figure 1* and *Figure 2*.





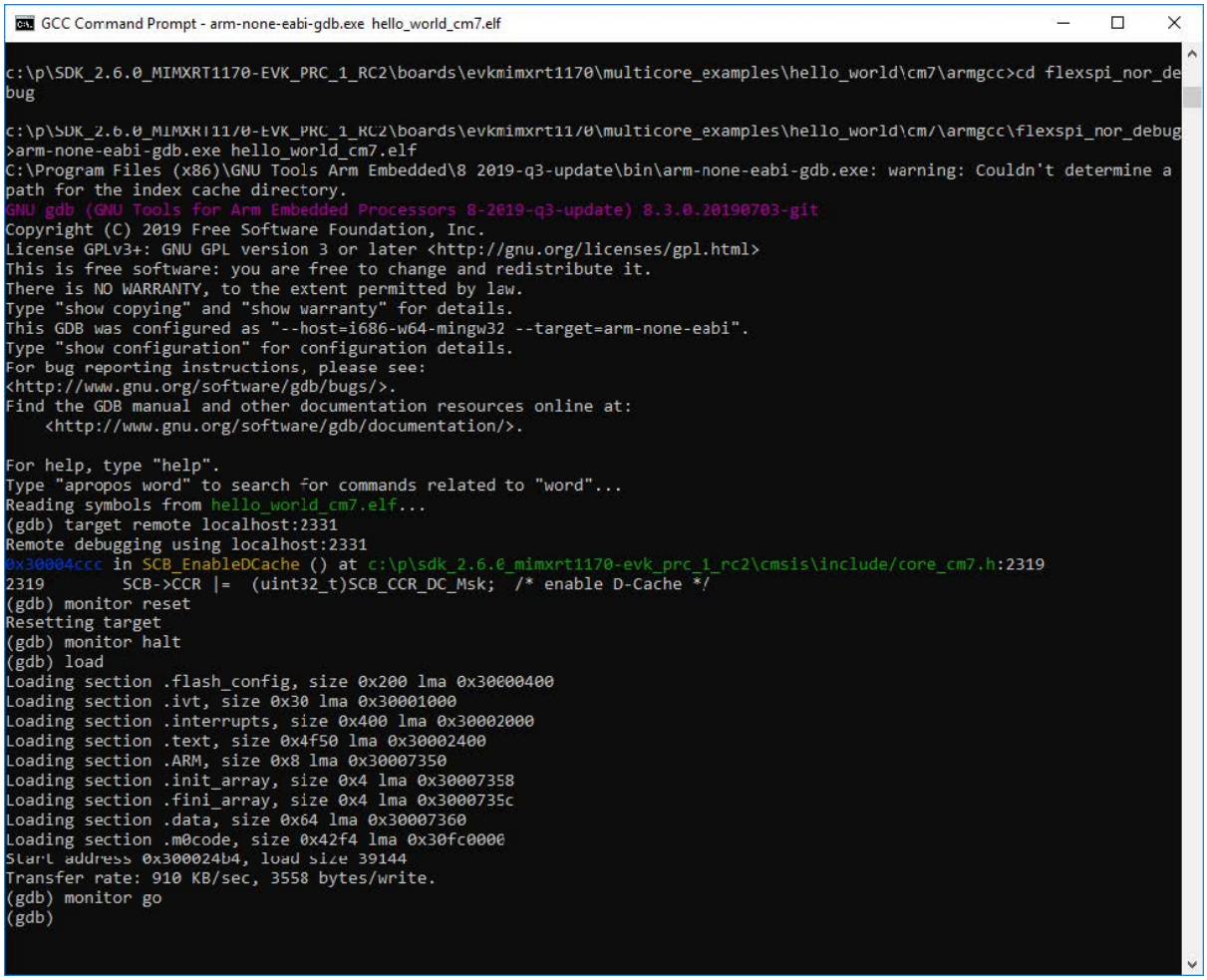
Parent topic:*Run a demo using Arm GCC*

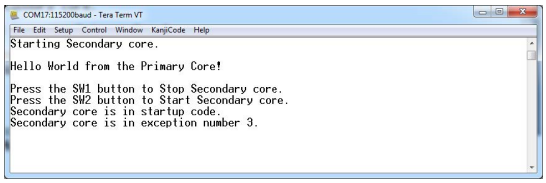
Run a multicore example application When running a multicore application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single-core application, applies, as described in Run an example application.

The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform Steps 1 to 10, as described in Run an example application. These steps are common for both single-core and dual-core applications in Arm GCC.

Both the primary and the auxiliary image is loaded into the SPI flash memory. After execution of the monitor go command, the primary core application is executed. During the primary core code execution, the auxiliary core code is re-allocated from the SPI flash memory to the RAM, and the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and

connections.





Parent topic:*Run a demo using Arm GCC*

MCUXpresso config tools

MCUXpresso Config Tools can help configure the processor and generate initialization code for the on chip peripherals. The tools are able to modify any existing example project, or create a new configuration for the selected board or processor. The generated code is designed to be used with MCUXpresso SDK version 2.x.

Table 1 describes the tools included in the MCUXpresso config tools.

Config tool	Description	Image
Pins tool	For configuration of pin routing and pin electrical properties.	
Clock tool	For system clock configuration	
Peripherals tools	For configuration of other peripherals	
TEE tool	Configures access policies for memory area and peripherals helping to protect and isolate sensitive parts of the application.	
Device Configuration tool	Configures Device Configuration Data (DCD) contained in the program image that the Boot ROM code interprets to setup various on-chip peripherals prior the program launch.	

MCUXpresso Config Tools can be accessed in the following products:

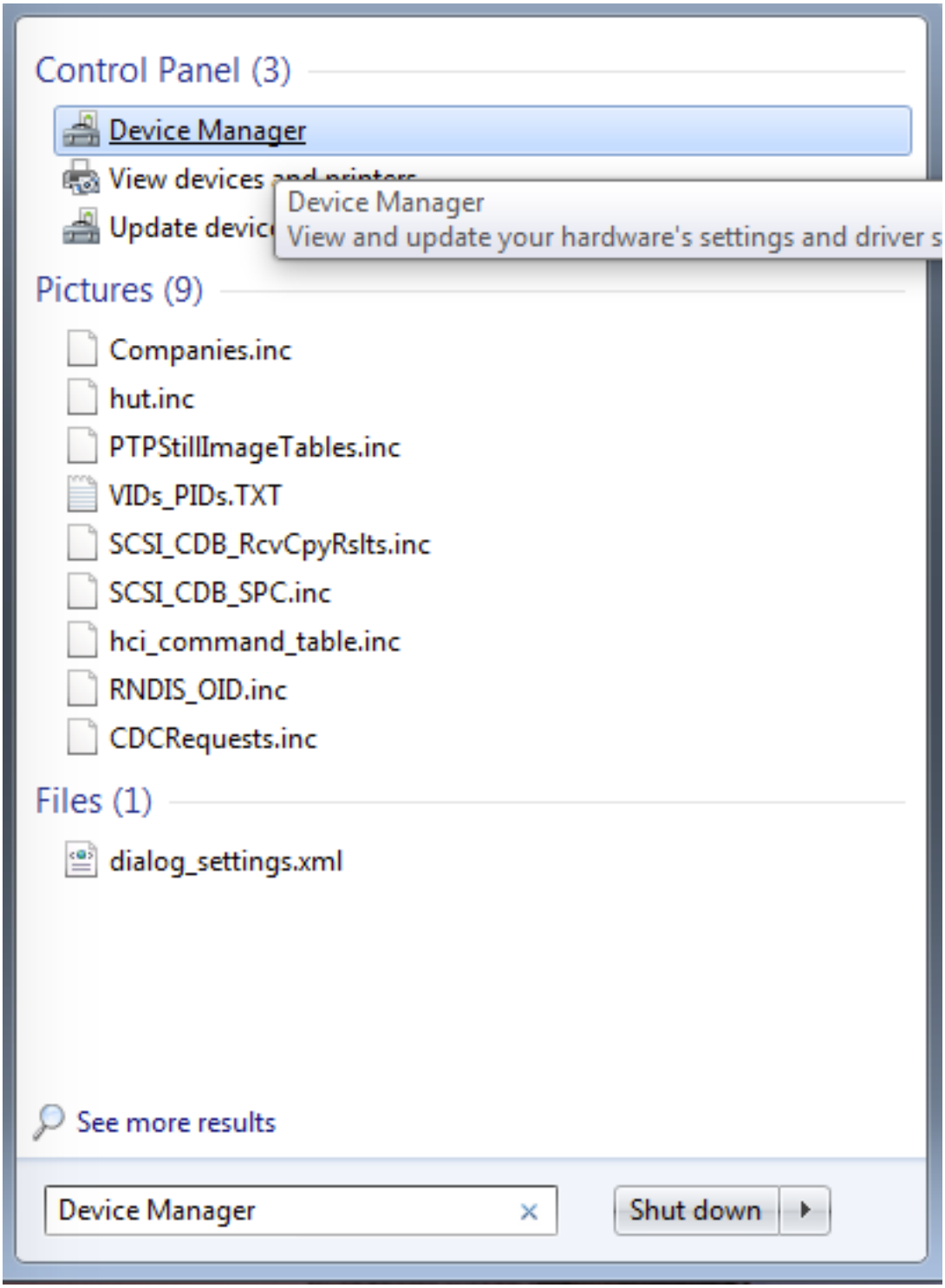
- **Integrated** in the MCUXpresso IDE. Config tools are integrated with both compiler and debugger which makes it the easiest way to begin the development.
- **Standalone version** available for download from MCUXPRESSO. Recommended for customers using IAR Embedded Workbench, Keil MDK µVision, or Arm GCC.
- **Online version** available on MCUXPRESSO. Recommended to do a quick evaluation of the processor or use the tool without installation.

Each version of the product contains a specific *Quick Start Guide* document MCUXpresso IDE Config Tools installation folder that can help start your work.

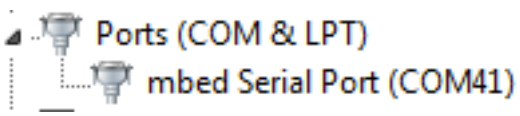
How to determine COM port

This section describes the steps necessary to determine the debug COM port number of your NXP hardware development platform.

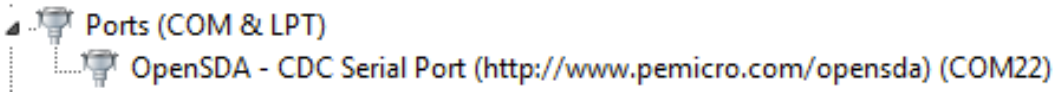
1. To determine the COM port, open the Windows operating system Device Manager. This can be achieved by going to the Windows operating system **Start** menu and typing **Device Manager** in the search bar, as shown in *Figure 1*.



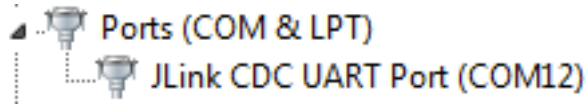
2. In the **Device Manager**, expand the **Ports (COM & LPT)** section to view the available ports. Depending on the NXP board you are using, the COM port can be named differently.
   1. OpenSDA – CMSIS-DAP/mbed/DAPLink interface:

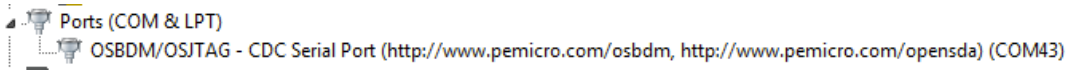
   2. OpenSDA – P&E Micro:



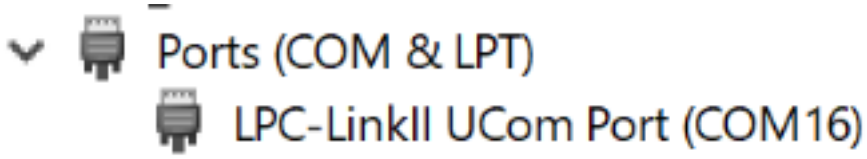
3. OpenSDA – J-Link:



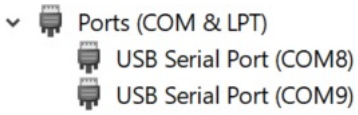
4. P&E Micro OSJTAG:



5. LPC-Link2:



6. FTDI UART:



Default debug interfaces

The MCUXpresso SDK supports various hardware platforms that come loaded with a variety of factory programmed debug interface configurations. *Table 1* lists the hardware platforms supported by the MCUXpresso SDK, their default debug interface, and any version information that helps differentiate a specific interface configuration.

Hardware platform	Default interface	OpenSDA details*1*
EVK-MC56F83000	P&E Micro OSJTAG	N/A
EVK-MIMXRT595	CMSIS-DAP	N/A
EVK-MIMXRT685	CMSIS-DAP	N/A
FRDM-K22F	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.1
FRDM-K28F	DAPLink	OpenSDA v2.1
FRDM-K32L2A4S	CMSIS-DAP	OpenSDA v2.1
FRDM-K32L2B	CMSIS-DAP	OpenSDA v2.1
FRDM-K32W042	CMSIS-DAP	N/A
FRDM-K64F	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.0
FRDM-K66F	J-Link OpenSDA	OpenSDA v2.1
FRDM-K82F	CMSIS-DAP	OpenSDA v2.1
FRDM-KE15Z	DAPLink	OpenSDA v2.1
FRDM-KE16Z	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.2
FRDM-KL02Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL03Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL25Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL26Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL27Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL28Z	P&E Micro OpenSDA	OpenSDA v2.1
FRDM-KL43Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL46Z	P&E Micro OpenSDA	OpenSDA v1.0

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Table 1 – continued from previous page

Hardware platform	Default interface	OpenSDA details*1*
FRDM-KL81Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KL82Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KV10Z	CMSIS-DAP	OpenSDA v2.1
FRDM-KV11Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KV31F	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KW24	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.1
FRDM-KW36	DAPLink	OpenSDA v2.2
FRDM-KW41Z	CMSIS-DAP/DAPLink	OpenSDA v2.1 or greater
Hexiwear	CMSIS-DAP/mbed/DAPLink	OpenSDA v2.0
HVP-KE18F	DAPLink	OpenSDA v2.2
HVP-KV46F150M	P&E Micro OpenSDA	OpenSDA v1
HVP-KV11Z75M	CMSIS-DAP	OpenSDA v2.1
HVP-KV58F	CMSIS-DAP	OpenSDA v2.1
HVP-KV31F120M	P&E Micro OpenSDA	OpenSDA v1
JN5189DK6	CMSIS-DAP	N/A
LPC54018 IoT Module	N/A	N/A
LPCXpresso54018	CMSIS-DAP	N/A
LPCXpresso54102	CMSIS-DAP	N/A
LPCXpresso54114	CMSIS-DAP	N/A
LPCXpresso51U68	CMSIS-DAP	N/A
LPCXpresso54608	CMSIS-DAP	N/A
LPCXpresso54618	CMSIS-DAP	N/A
LPCXpresso54628	CMSIS-DAP	N/A
LPCXpresso54S018M	CMSIS-DAP	N/A
LPCXpresso55s16	CMSIS-DAP	N/A
LPCXpresso55s28	CMSIS-DAP	N/A
LPCXpresso55s69	CMSIS-DAP	N/A
MAPS-KS22	J-Link OpenSDA	OpenSDA v2.0
MIMXRT1170-EVK	CMSIS-DAP	N/A
MIMXRT1170-EVKB	CMSIS-DAP	N/A
TWR-K21D50M	P&E Micro OSJTAG	N/AOpenSDA v2.0
TWR-K21F120M	P&E Micro OSJTAG	N/A
TWR-K22F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K24F120M	CMSIS-DAP/mbed	OpenSDA v2.1
TWR-K60D100M	P&E Micro OSJTAG	N/A
TWR-K64D120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K64F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K80F150M	CMSIS-DAP	OpenSDA v2.1
TWR-K81F150M	CMSIS-DAP	OpenSDA v2.1
TWR-KE18F	DAPLink	OpenSDA v2.1
TWR-KL28Z72M	P&E Micro OpenSDA	OpenSDA v2.1
TWR-KL43Z48M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KL81Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KL82Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KM34Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KM35Z75M	DAPLink	OpenSDA v2.2
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV11Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV31F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV46F150M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV58F220M	CMSIS-DAP	OpenSDA v2.1
TWR-KW24D512	P&E Micro OpenSDA	OpenSDA v1.0

continues on next page

Table 1 – continued from previous page

Hardware platform	Default interface	OpenSDA details*1*
USB-KW24D512	N/A External probe	N/A
USB-KW41Z	CMSIS-DAP\DAPLink	OpenSDA v2.1 or greater

1 The OpenSDA details is not applicable to LPC.

How to add or remove boot header for XIP targets

The MCUXpresso SDK for i.MX RT1170 provides flexspi_nor_debug and flexspi_nor_release targets for each example and/or demo which supports XIP (eXecute-In-Place). These two targets add XIP_BOOT_HEADER to the image by default. Because of this, ROM can boot and run this image directly on external flash.

Macros for the boot leader:

- The following three macros are added in flexspi_nor targets to support XIP, as described in *Table 1*.

  |**XIP_EXTERNAL_FLASH**|1: Exclude the code which changes the clock of FLEXSPI.| |0: Make no changes.| |**XIP_BOOT_HEADER_ENABLE**|1: Add FLEXSPI configuration block, image vector table, boot data, and device configuration data (optional) to the image by default.| |0: Add nothing to the image by default.| |**XIP_BOOT_HEADER_DCD_ENABLE**|1: Add device configuration data to the image.| |0: Do **NOT** add device configuration data to the image.|

- *Table 2* shows the different effect on the built image with a different combination of these macros.

	XIP_BOOT_HEADER_	XIP_BOOT_HEADER_DCD_ENABLE=0
XIP_EXTERNA	XIP_BOOT_HEADE]	- Can be programmed to qspiflash by IDE and can run after POR reset if qspiflash is the boot source.

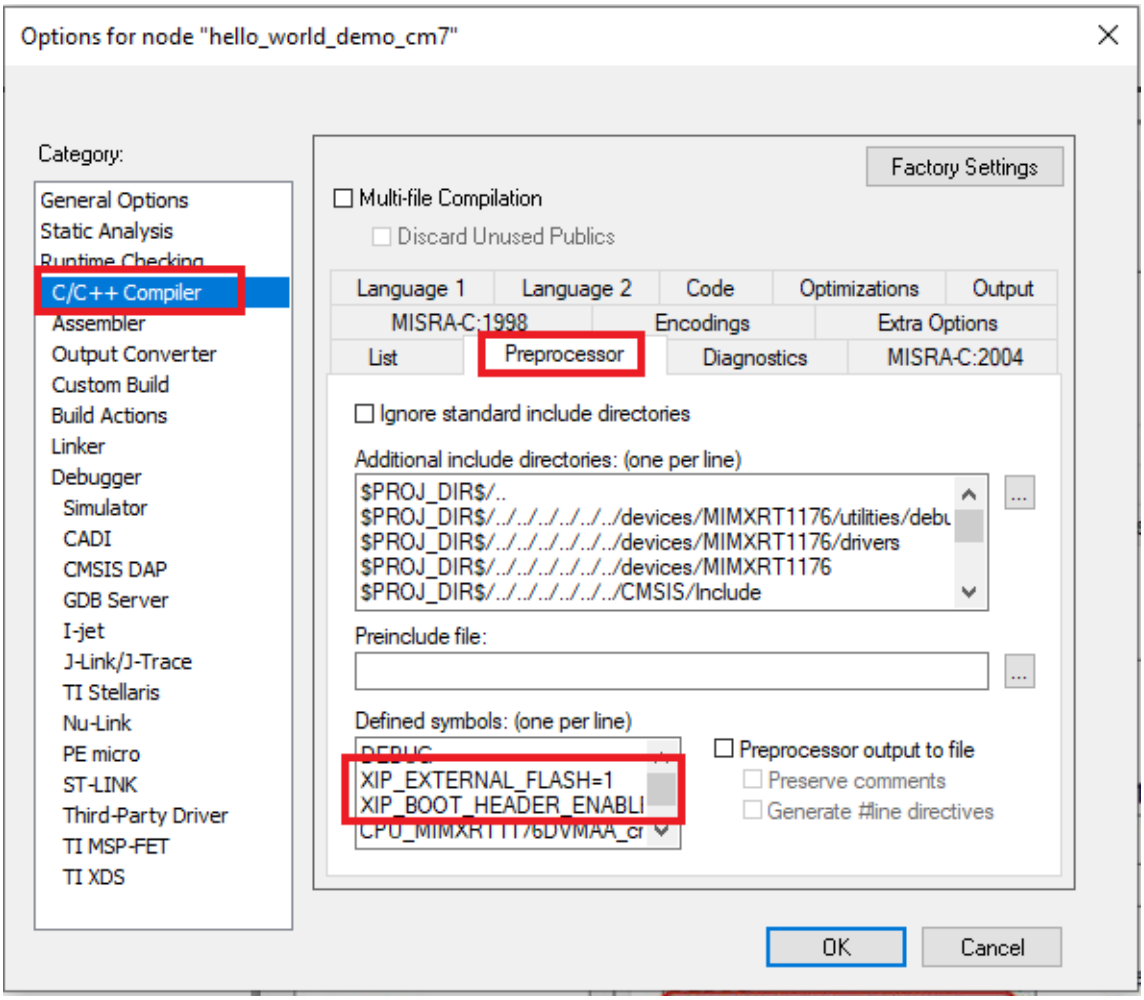
  – SDRAM will be initialized. | - Can be programmed to qspiflash by IDE, and can run after POR reset if qspiflash is the boot source.

  – SDRAM will **NOT** be initialized. | |**XIP_BOOT_HEADER_ENABLE=0**| - **CANNOT** run after POR reset if it is programmed by IDE, even if qspiflash is the boot source. |—| |**XIP_EXTERNAL_FLASH=0**| - This image **CANNOT** complete XIP because when this macro is set to 1, it excludes the code, which changes the clock for FLEXSPI. |

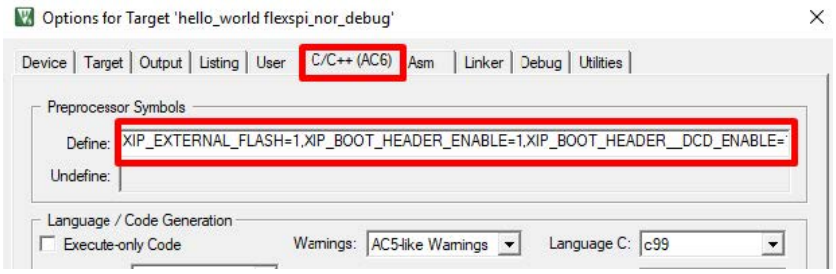
Where to change the macros for each toolchain in MCUXpresso SDK?

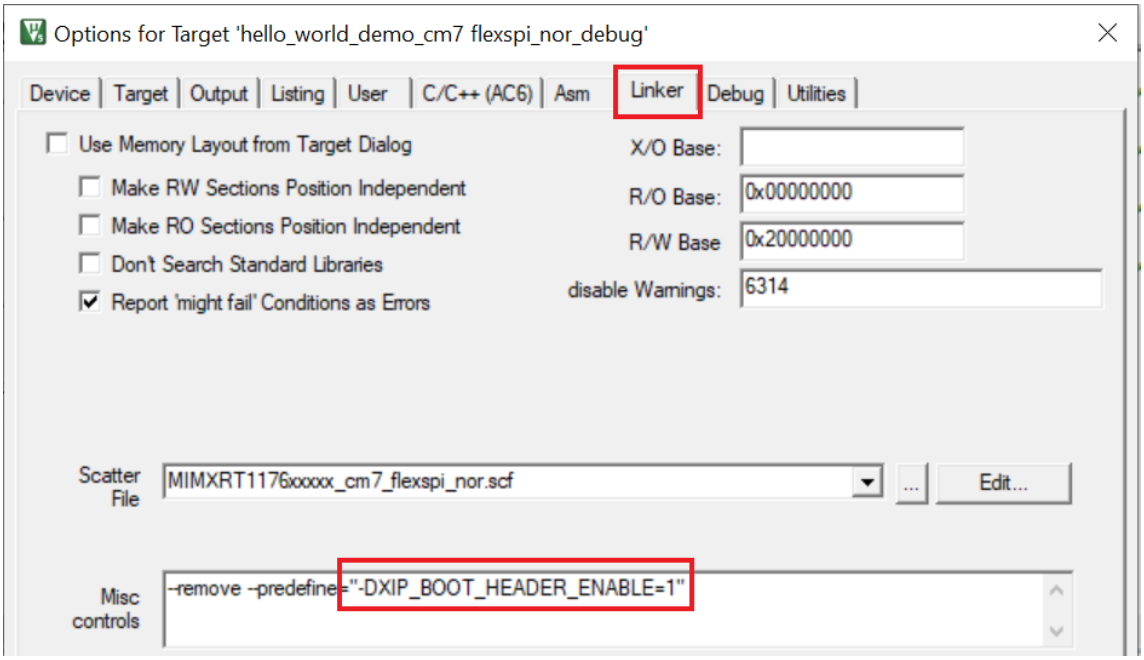
Take hello_world as an example:

- **IAR**


Options for node "hello_world_demo_cm7"
Category:
General Options
Static Analysis
Runtime Checking
C/C++ Compiler
Assembler
Output Converter
Custom Build
Build Actions
Linker
Debugger
Simulator
CADI
CMSIS DAP
GDB Server
I-jet
J-Link/J-Trace
TI Stellaris
Nu-Link
PE micro
ST-LINK
Third-Party Driver
TI MSP-FET
TI XDS
Factory Settings
Multi-file Compilation
Discard Unused Publics
Language 1
Language 2
Code
Optimizations
Output
MISRA-C:1998
Encodings
Extra Options
List
Preprocessor
Diagnostics
MISRA-C:2004
Ignore standard include directories
Additional include directories: (one per line)
$PROJ_DIR$/..
$PROJ_DIR$/../../../../../../devices/MIMXRT1176/utilities/debu
$PROJ_DIR$/../../../../../../devices/MIMXRT1176/drivers
$PROJ_DIR$/../../../../../../devices/MIMXRT1176
$PROJ_DIR$/../../../../../../CMSIS/Include
Preinclude file:
Defined symbols: (one per line)
DEBUG
XIP_EXTERNAL_FLASH=1
XIP_BOOT_HEADER_ENABLI
CPU_MIMXRT1176DVMAA_cr
Preprocessor output to file
Preserve comments
Generate #line directives
OK
Cancel

- **MDK**


Options for Target 'hello_world flexspi_nor_debug'
Device
Target
Output
Listing
User
C/C++ (AC6)
Asm
Linker
Debug
Utilities
Preprocessor Symbols
Define: XIP_EXTERNAL_FLASH=1,XIP_BOOT_HEADER_ENABLE=1,XIP_BOOT_HEADER_DCD_ENABLE=
Undefine:
Language / Code Generation
Execute-only Code
Warnings: AC5-like Warnings
Language C: c99



- **ARMGCC**

  Change the configuration in *CMakeLists.txt*.

```
SET(CMAKE_C_FLAGS_SDRAM_RELEASE "${CMAKE_C_FLAGS_SDRAM_RELEASE} -std=gnu99")

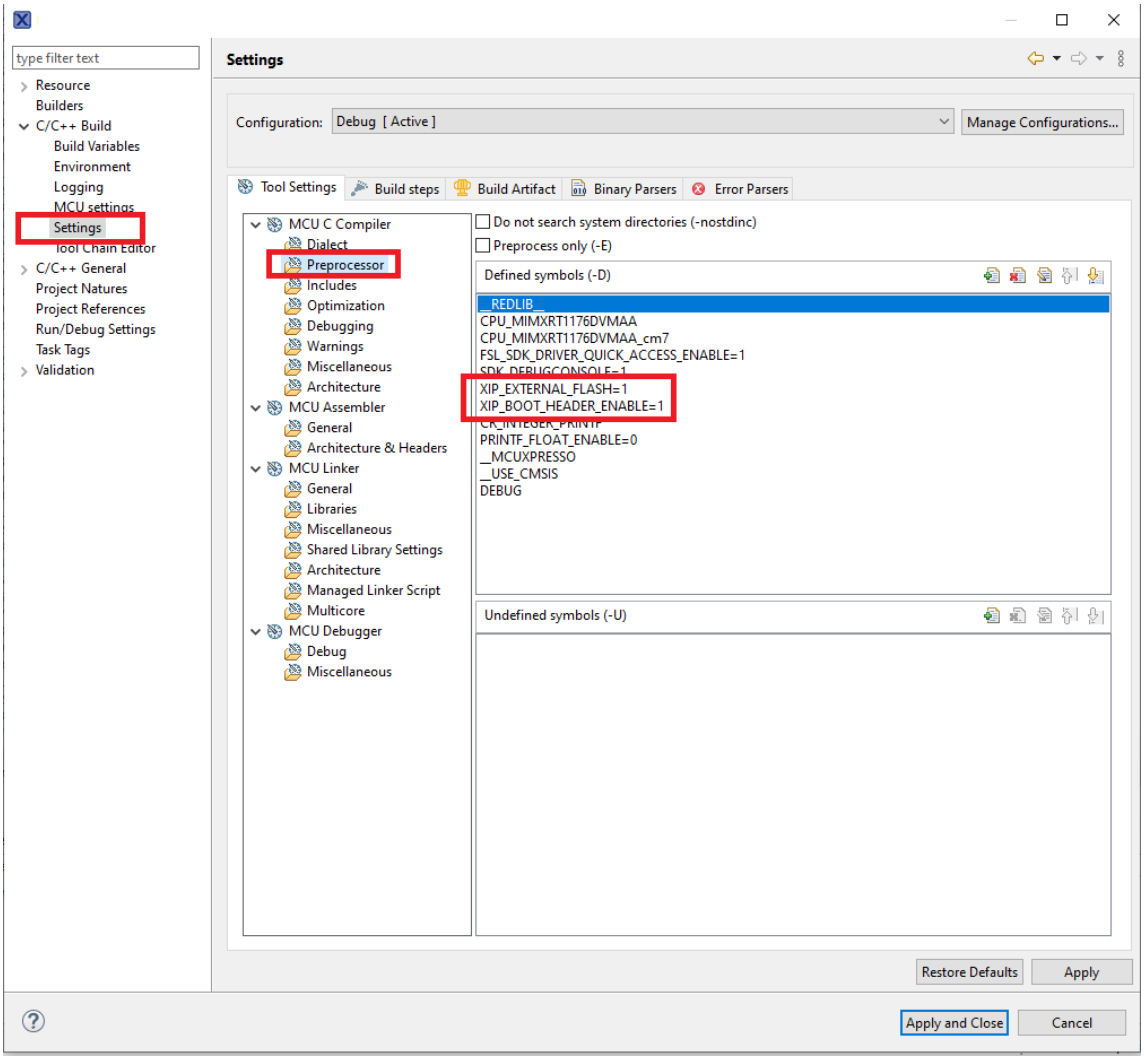
SET(CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG "${CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG} -DXIP_EXTERNAL_FLASH=1")

SET(CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG "${CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG} -DXIP_BOOT_HEADER_ENABLE=1")

SET(CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG "${CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG} -DXIP_BOOT_HEADER_DCD_ENABLE=1")

SET(CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG "${CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG} -DCPU_MIMXRT1052DVL6A")
```

- **MCUX**



1.3 Getting Started with MCUXpresso SDK GitHub

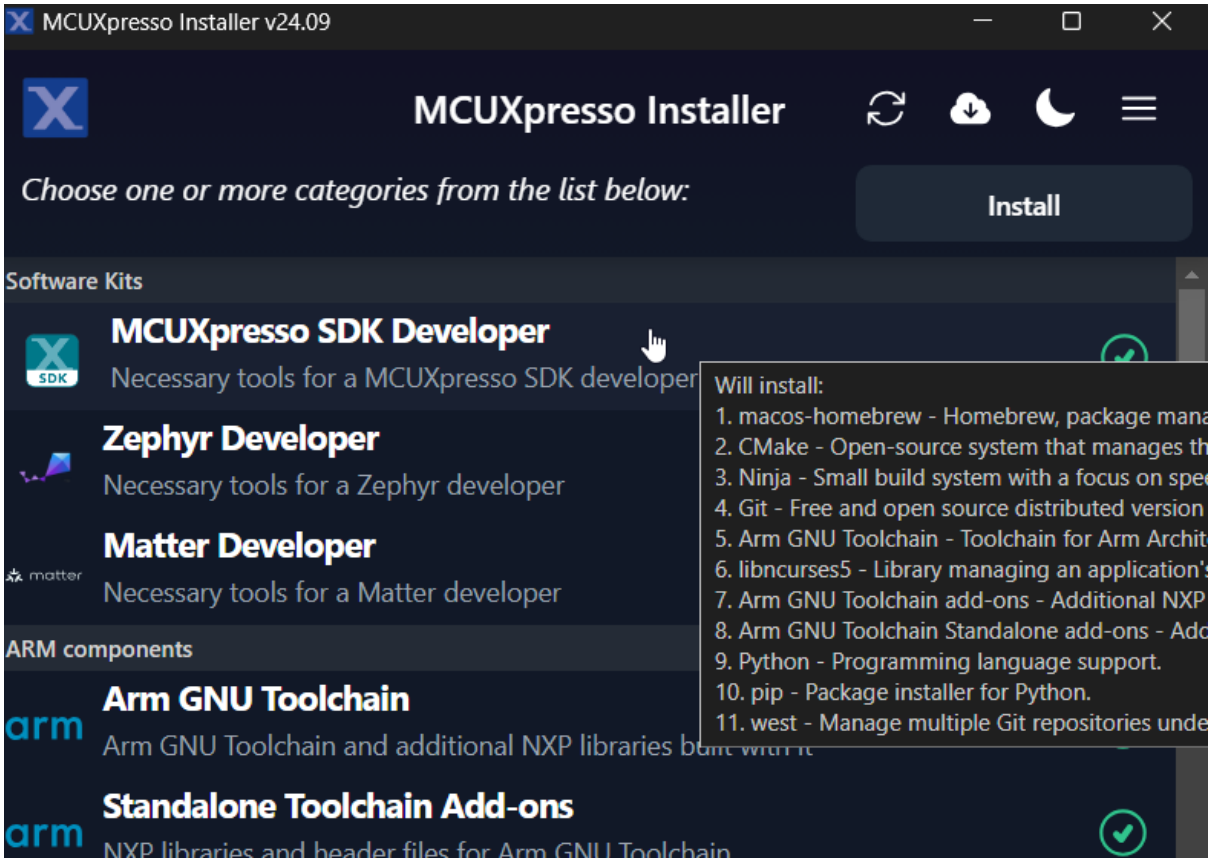
1.3.1 Getting Started with MCUXpresso SDK Repository

Installation

NOTE

If the installation instruction asks/selects whether to have the tool installation path added to the PATH variable, agree/select the choice. This option ensures that the tool can be used in any terminal in any path. *Verify the installation* after each tool installation.

Install Prerequisites with MCUXpresso Installer The MCUXpresso Installer offers a quick and easy way to install the basic tools needed. The MCUXpresso Installer can be obtained from https://github.com/nxp-mcuxpresso/vscode-for-mcux/wiki/Dependency-Installation. The MCUXpresso Installer is an automated installation process, simply select MCUXpresso SDK Developer from the menu and click install. If you prefer to install the basic tools manually, refer to the next section.



Alternative: Manual Installation

Basic tools

Git Git is a free and open source distributed version control system. Git is designed to handle everything from small to large projects with speed and efficiency. To install Git, visit the official Git website. Download the appropriate version(you may use the latest one) for your operating system (Windows, macOS, Linux). Then run the installer and follow the installation instructions.

User `git --version` to check the version if you have a version installed.

Then configure your username and email using the commands:

```
git config --global user.name "Your Name"
git config --global user.email "youremail@example.com"
```

Python Install python 3.10 or latest. Follow the Python Download guide.

Use `python --version` to check the version if you have a version installed.

West Please use the west version equal or greater than 1.2.0

```
# Note: you can add option '--default-timeout=1000' if you meet connection issue. Or you may set a different␣
↪source using option '-i'.
# for example, in China you could try: pip install -U west -i https://pypi.tuna.tsinghua.edu.cn/simple
pip install -U west
```

Build And Configuration System

CMake It is strongly recommended to use CMake version equal or later than 3.30.0. You can get latest CMake distributions from the official CMake download page.

For Windows, you can directly use the .msi installer like cmake-3.31.4-windows-x86_64.msi to install.

For Linux, CMake can be installed using the system package manager or by getting binaries from the official CMake download page.

After installation, you can use `cmake --version` to check the version.

Ninja Please use the ninja version equal or later than 1.12.1.

By default, Windows comes with the Ninja program. If the default Ninja version is too old, you can directly download the ninja binary and register the ninja executor location path into your system path variable to work.

For Linux, you can use your system package manager or you can directly download the ninja binary to work.

After installation, you can use `ninja --version` to check the version.

Kconfig MCUXpresso SDK uses Kconfig python implementation. We customize it based on our needs and integrate it into our build and configuration system. The Kconfiglib sources are placed under `mcuxsdk/scripts/kconfig` folder.

Please make sure *python* environment is setup ready then you can use the Kconfig.

Ruby Our build system supports IDE project generation for iar, mdk, codewarrior and xtensa to provide OOBE from build to debug. This feature is implemented with ruby. You can follow the guide ruby environment setup to setup the ruby environment. Since we provide a built-in portable ruby, it is just a simple one cmd installation.

If you only work with CLI, you can skip this step.

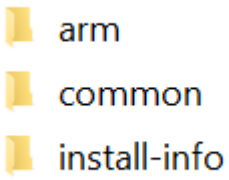
Toolchain MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

Toolchain	Download and Installation Guide	Note
Armgcc	Arm GNU Toolchain Install Guide	ARMGCC is default toolchain
IAR	IAR Installation and Licensing quick reference guide	
MDK	MDK Installation	
Armclang	Installing Arm Compiler for Embedded	
Zephyr	Zephyr SDK	
Codewarrior	NXP CodeWarrior	
Xtensa	Tensilica Tools	
NXP S32Compiler RISC-V Zen-V	NXP Website	

After you have installed the toolchains, register them in the system environment variables. This will allow the west build to recognize them:

Toolchain	Environment Variable	Example	Cmd Line Argument
Armgcc	ARMGCC_DIR	C:\armgcc for windows/usr for Linux. Typically arm-none-eabi-* is installed under /usr/bin	–toolchain armgcc
IAR	IAR_DIR	C:\iar\ewarm-9.60.3 for Windows/opt/iarsystems/bxarm-9.60.3 for Linux	–toolchain iar
MDK	MDK_DIR	C:\Keil_v5 for Windows.MDK IDE is not officially supported with Linux.	–toolchain mdk
Armclang	ARMCLANG_DIR	C:\ArmCompilerforEmbedded6.22 for Windows/opt/ArmCompilerforEmbedded6.21 for Linux	–toolchain mdk
Zephyr	ZEPHYR_SDK	c:\NXP\zephyr-sdk-<version> for windows/opt/zephyr-sdk-<version> for Linux	–toolchain zephyr
CodeWarrior	CW_DIR	C:\Freescale\CW MCU v11.2 for windowsCodeWarrior is not supported with Linux	–toolchain codewarrior
Xtensa	XCC_DIR	C:\xtensa\XtDevTools\install\tools\RI-2023.11-win32\XtensaTools for windows/opt/xtensa/XtDevTools/install/tools/RI-2023.11-Linux/XtensaTools for Linux	–toolchain xtensa
NXP S32Compiler RISC-V Zen-V	RISCVLLVM_DIR	C:\riscv-llvm-win32_b298_b298_2024.08.12 for Windows/opt/riscv-llvm-Linux-x64_b298_b298_2024.08.12 for Linux	–toolchain riscvllvm

- The <toolchain>_DIR is the root installation folder, not the binary location folder. For IAR, it is directory containing following installation folders:



- MDK IDE using armclang toolchain only officially supports Windows. In Linux, please directly use armclang toolchain by setting ARMCLANG_DIR. In Windows, since most Keil users will install MDK IDE instead of standalone armclang toolchain, the MDK_DIR has higher priority than ARMCLANG_DIR.
- For Xtensa toolchain, please set the XTENSA_CORE environment variable. Here's an example list:

Device Core	XTENSA_CORE
RT500 fusion1	nxp_rt500_RI23_11_newlib
RT600 hifi4	nxp_rt600_RI23_11_newlib
RT700 hifi1	rt700_hifi1_RI23_11_nlib
RT700 hifi4	t700_hifi4_RI23_11_nlib
i.MX8ULP fusion1	fusion_nxp02_dsp_prod

- In Windows, the short path is used in environment variables. If any toolchain is using the long path, you can open a command window from the toolchain folder and use below command to get the short path: for %i in (.) do echo %~fsi

Tool installation check Once installed, open a terminal or command prompt and type the associated command to verify the installation.

If you see the version number, you have successfully installed the tool. Else, check whether the tool's installation path is added into the PATH variable. You can add the installation path to the PATH with the commands below:

- Windows: Open command prompt or powershell, run below command to show the user PATH variable.

```
reg query HKEY_CURRENT_USER\Environment /v PATH
```

The tool installation path should be C:\Users\xxx\AppData\Local\Programs\Git\cmd. If the path is not seen in the output from above, append the path value to the PATH variable with the command below:

```
reg add HKEY_CURRENT_USER\Environment /v PATH /d "%PATH%;C:\Users\xxx\AppData\
↪Local\Programs\Git\cmd"
```

Then close the command prompt or powershell and verify the tool command again.

- Linux:
  1. Open the $HOME/.bashrc file using a text editor, such as vim.
  2. Go to the end of the file.
  3. Add the line which appends the tool installation path to the PATH variable and export PATH at the end of the file. For example, export PATH="/Directory1:$PATH".
  4. Save and exit.
  5. Execute the script with source .bashrc or reboot the system to make the changes live. To verify the changes, run echo $PATH.
- macOS:
  1. Open the $HOME/.bash_profile file using a text editor, such as nano.
  2. Go to the end of the file.
  3. Add the line which appends the tool installation path to the PATH variable and export PATH at the end of the file. For example, export PATH="/Directory1:$PATH".
  4. Save and exit.
  5. Execute the script with source .bash_profile or reboot the system to make the changes live. To verify the changes, run echo $PATH.

Get MCUXpresso SDK Repo

Establish SDK Workspace To get the MCUXpresso SDK repository, use the west tool to clone the manifest repository and checkout all the west projects.

```
# Initialize west with the manifest repository
west init -m https://github.com/nxp-mcuxpresso/mcuxsdk-manifests/ mcuxpresso-sdk

# Update the west projects
cd mcuxpresso-sdk
west update

# Allow the usage of west extensions provided by MCUXpresso SDK
west config commands.allow_extensions true
```

Install Python Dependency(If do tool installation manually) To create a Python virtual environment in the west workspace core repo directory mcuxsdk, follow these steps:

1. Navigate to the core directory:

   ```
   cd mcuxsdk
   ```

2. [Optional] Create and activate the virtual environment: If you don't want to use the python virtual environment, skip this step. **We strongly suggest you use venv to avoid conflicts with other projects using python.**

   ```
   python -m venv .venv

   # For Linux/MacOS
   source .venv/bin/activate

   # For Windows
   .\.venv\Scripts\activate
   # If you are using powershell and see the issue that the activate script cannot be run.
   # You may fix the issue by opening the powershell as administrator and run below command:
   powershell Set-ExecutionPolicy RemoteSigned
   # then run above activate command again.
   ```

   Once activated, your shell will be prefixed with (.venv). The virtual environment can be deactivated at any time by running deactivate command.

   Remember to activate the virtual environment every time you start working in this directory. If you are using some modern shell like zsh, there are some powerful plugins to help you auto switch venv among workspaces. For example, zsh-autoswitch-virtualenv.

3. Install the required Python packages:

   ```
   # Note: you can add option '--default-timeout=1000' if you meet connection issue. Or you may set a␣
   ↪different source using option '-i'.
   # for example, in China you could try: pip3 install -r mcuxsdk/scripts/requirements.txt -i https://pypi.
   ↪tuna.tsinghua.edu.cn/simple
   pip install -r scripts/requirements.txt
   ```

Explore Contents

This section helps you build basic understanding of current fundamental project content and guides you how to build and run the provided example project in whole SDK delivery.

Folder View The whole MCUXpresso SDK project, after you have done the west init and west update operations follow the guideline at *Getting Started Guide*, have below folder structure:

Folder	Description
manifests	Manifest repo, contains the manifest file to initialize and update the west workspace.
mcuxsdk	The MCUXpresso SDK source code, examples, middleware integration and script files.

All the projects record in the Manifest repo are checked out to the folder mcuxsdk/, the layout of mcuxsdk folder is shown as below:

Folder	Description
arch	Arch related files such as ARM CMSIS core files, RISC-V files and the build files related to the architecture.
cmake	The cmake modules, files which organize the build system.
components	Software components.
devices	Device support package which categorized by device series. For each device, header file, feature file, startup file and linker files are provided, also device specific drivers are included.
docs	Documentation source and build configuration for this sphinx built online documentation.
drivers	Peripheral drivers.
examples	Various demos and examples, support files on different supported boards. For each board support, there are board configuration files.
middleware	Middleware components integrated into SDK.
rtos	Rtos components integrated into SDK.
scripts	Script files for the west extension command and build system support.
svd	Svd files for devices, this is optional because of large size. Customers run west manifest config group.filter +optional and west update mcux-soc-svd to get this folder.

Examples Project The examples project is part of the whole SDK delivery, and locates in the folder mcuxsdk/examples of west workspace.

Examples files are placed in folder of <example_category>, these examples include (but are not limited to)

- demo_apps: Basic demo set to start using SDK, including hello_world and led_blinky.
- driver_examples: Simple applications that show how to use the peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI transfer using DMA).

Board porting layers are placed in folder of _boards/<board_name> which aims at providing the board specific parts for examples code mentioned above.

Run a demo using MCUXpresso for VS Code

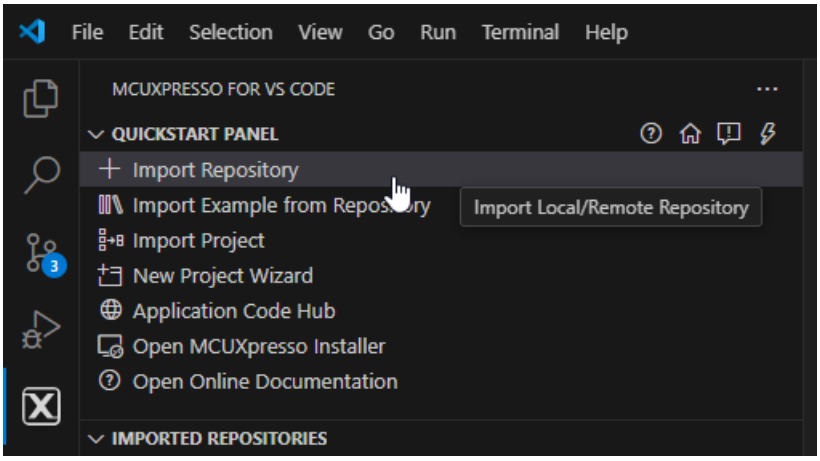
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the hello_world demo application as an example. However, these

steps can be applied to any example application in the MCUXpresso SDK.

Build an example application This section assumes that the user has already obtained the SDK as outlined in *Get MCUXpresso SDK Repo*.

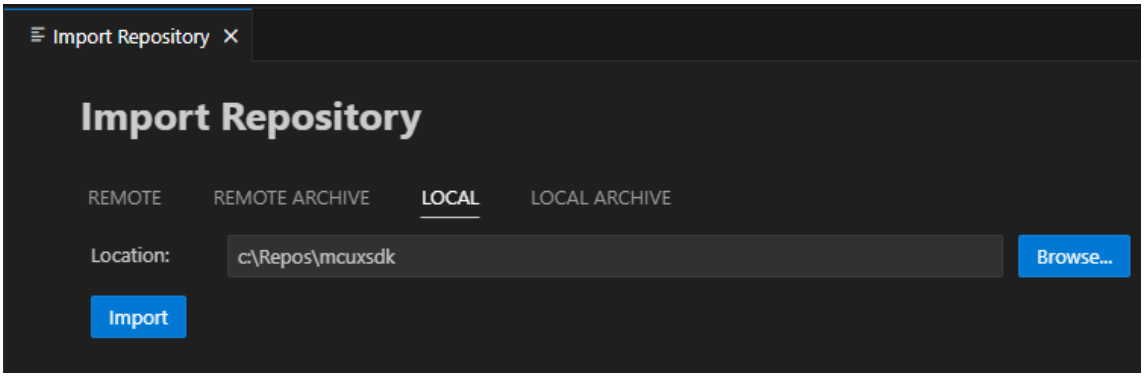
To build an example application:

1. Import the SDK into your workspace. Click **Import Repository** from the **QUICKSTART PANEL**.

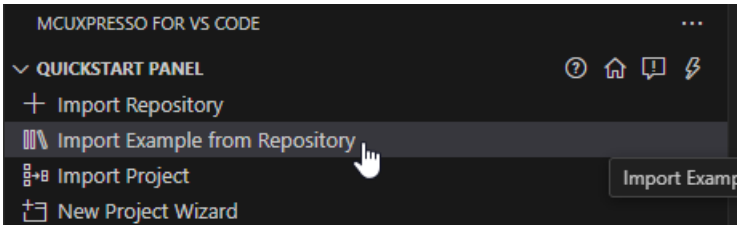


Note: You can import the SDK in several ways. Refer to MCUXpresso for VS Code Wiki for details.

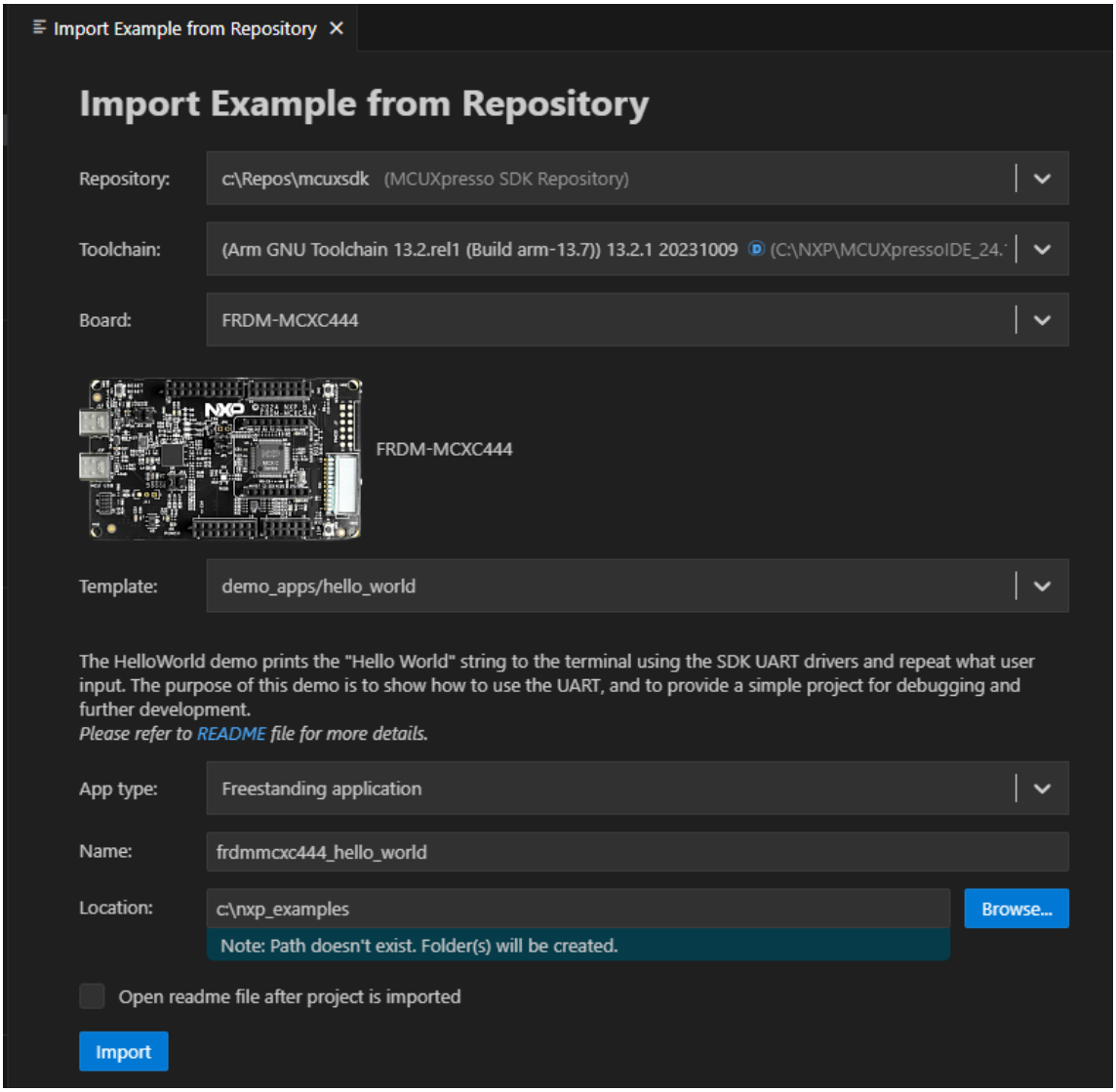
Select **Local** if you've already obtained the SDK as seen in *Get MCUXpresso SDK Repo*. Select your location and click **Import**.



2. Click **Import Example from Repository** from the **QUICKSTART PANEL**.

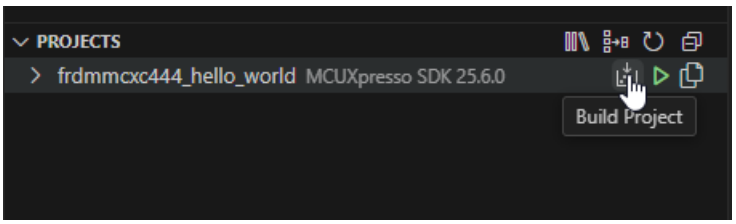


In the dropdown menu, select the MCUXpresso SDK, the Arm GNU Toolchain, your board, template, and application type. Click **Import**.

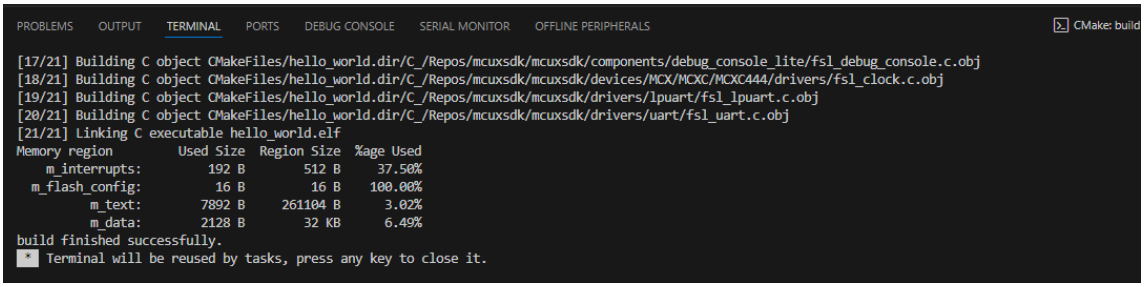


Note: The MCUXpresso SDK projects can be imported as **Repository applications** or **Freestanding applications**. The difference between the two is the import location. Projects imported as Repository examples will be located inside the MCUXpresso SDK, whereas Freestanding examples can be imported to a user-defined location. Select between these by designating your selection in the **App type** dropdown menu.

3. VS Code will prompt you to confirm if the imported files are trusted. Click **Yes**.
4. Navigate to the **PROJECTS** view. Find your project and click the **Build Project** icon.

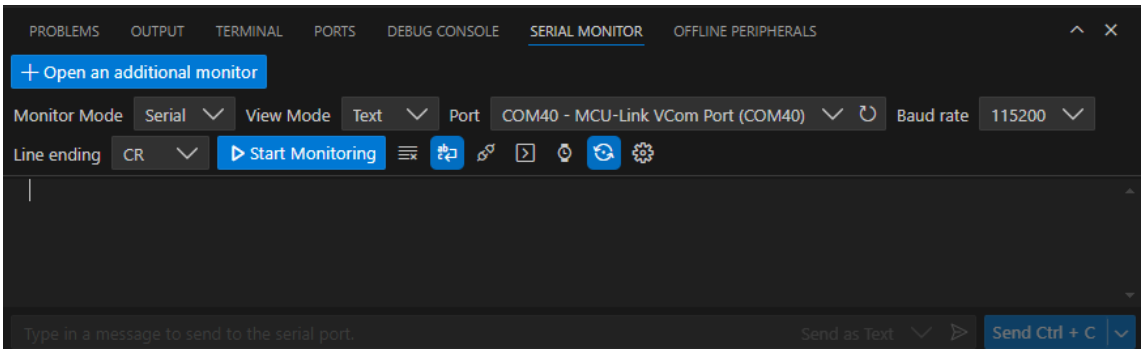


The integrated terminal will open at the bottom and will display the build output.

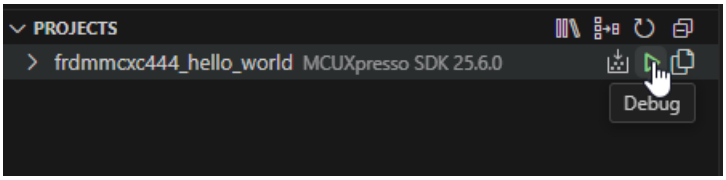


Run an example application **Note:** for full details on MCUXpresso for VS Code debug probe support, see MCUXpresso for VS Code Wiki.

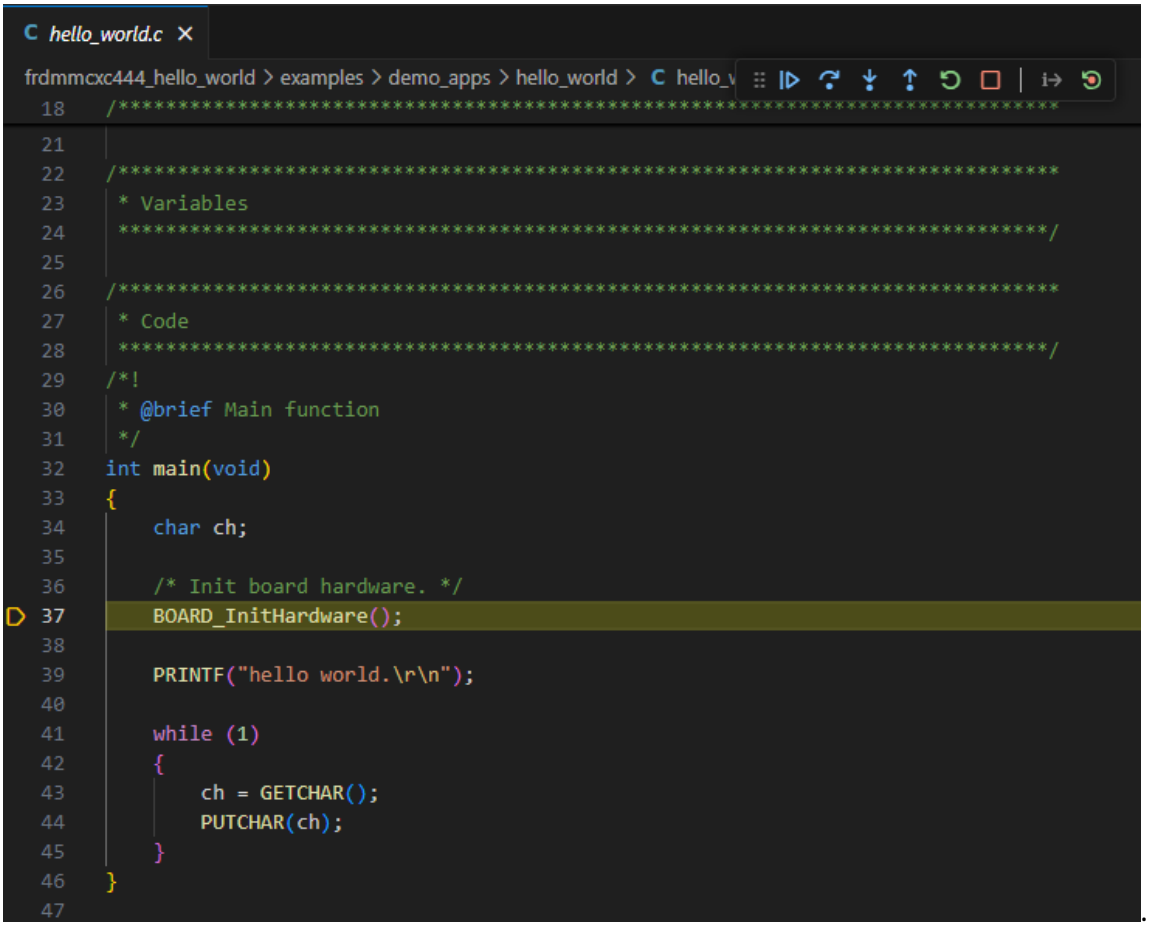
1. Open the **Serial Monitor** from the VS Code's integrated terminal. Select the VCom Port for your device and set the baud rate to 115200.



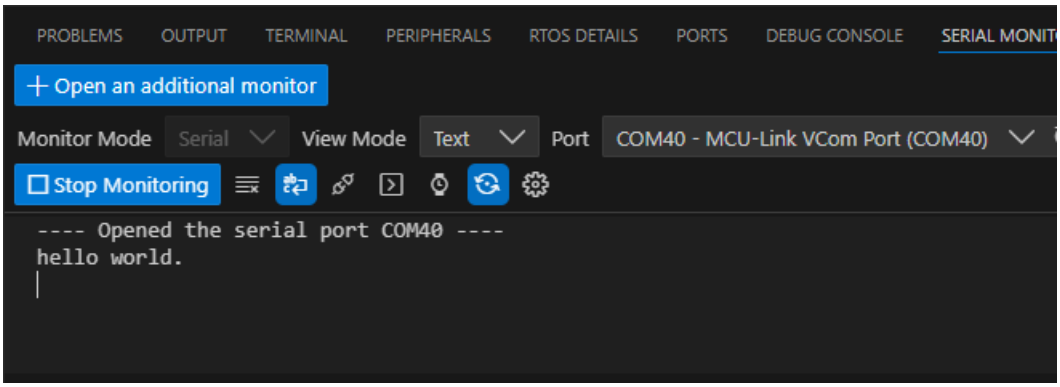
2. Navigate to the **PROJECTS** view and click the play button to initiate a debug session.



The debug session will begin. The debug controls are initially at the top.



3. Click **Continue** on the debug controls to resume execution of the code. Observe the output on the **Serial Monitor**.



Running a demo using ARMGCC CLI/IAR/MDK

Supported Boards Use the west extension west list_project to understand the board support scope for a specified example. All supported build command will be listed in output:

```
west list_project -p examples/demo_apps/hello_world [-t armgcc]

INFO: [  1][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evk9mimx8ulp -Dcore_id=cm33]
INFO: [  2][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbimxrt1050]
INFO: [  3][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
```

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```
↪evkbmimxrt1060]
INFO: [  4][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbmimxrt1170 -Dcore_id=cm4]
INFO: [  5][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbmimxrt1170 -Dcore_id=cm7]
INFO: [  6][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkcmimxrt1060]
INFO: [  7][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkmcimx7ulp]
...
```

The supported toolchains and build targets for an example are decided by the example-self example.yml and board example.yml, please refer Example Toolchains and Targets for more details.

Build the project Use west build -h to see help information for west build command. Compared to zephyr's west build, MCUXpresso SDK's west build command provides following additional options for mcux examples:

- --toolchain: specify the toolchain for this build, default armgcc.
- --config: value for CMAKE_BUILD_TYPE. If not provided, build system will get all the example supported build targets and use the first debug target as the default one. Please refer Example Toolchains and Targets for more details about example supported build targets.

Here are some typical usages for generating a SDK example:

```
# Generate example with default settings, default used device is the mainset MK22F51212
west build -b frdmk22f examples/demo_apps/hello_world

# Just print cmake commands, do not execute it
west build -b frdmk22f examples/demo_apps/hello_world --dry-run

# Generate example with other toolchain like iar, default armgcc
west build -b frdmk22f examples/demo_apps/hello_world --toolchain iar

# Generate example with other config type
west build -b frdmk22f examples/demo_apps/hello_world --config release

# Generate example with other devices with --device
west build -b frdmk22f examples/demo_apps/hello_world --device MK22F12810 --config release
```

For multicore devices, you shall specify the corresponding core id by passing the command line argument -Dcore_id. For example

```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world --toolchain iar -Dcore_id=cm7 --config␣
↪flexspi_nor_debug
```

For shield, please use the --shield to specify the shield to run, like

```
west build -b mimxrt700evk --shield a8974 examples/issdk_examples/sensors/fxls8974cf/fxls8974cf_poll -
↪Dcore_id=cm33_core0
```

Sysbuild(System build) To support multicore project building, we ported Sysbuild from Zephyr. It supports combine multiple projects for compilation. You can build all projects by adding --sysbuild for main application. For example:

```
west build -b evkbmimxrt1170 --sysbuild ./examples/multicore_examples/hello_world/primary -Dcore_
↪id=cm7  --config flexspi_nor_debug --toolchain=armgcc -p always
```

For more details, please refer to System build.

Config a Project Example in MCUXpresso SDK is configured and tested with pre-defined configuration. You can follow steps blow to change the configuration.

1. Run cmake configuration

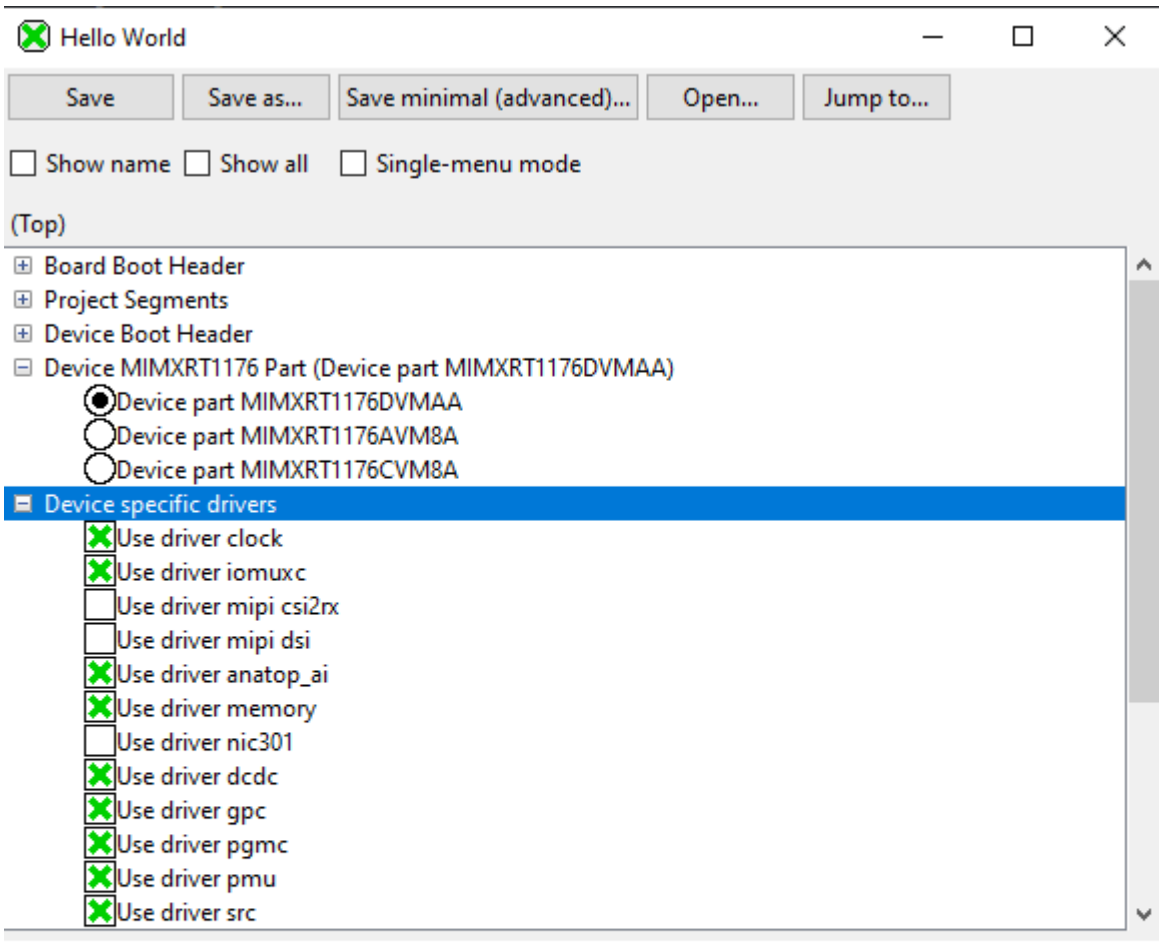
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

Please note the project will be built without --cmake-only parameter.

2. Run guiconfig target

```
west build -t guiconfig
```

Then you will get the Kconfig GUI launched, like




```
Kconfig definition, with parent deps. propagated to 'depends on'
===============================================================

At D:/sdk_next/mcuxsdk\devices\../devices/RT/RT1170/MIMXRT1176\drivers/Kconfig:5
Included via D:/sdk_next/mcuxsdk/examples/demo_apps/hello_world/Kconfig:6 ->
D:/sdk_next/mcuxsdk/Kconfig.mcuxpresso:9 -> D:/sdk_next/mcuxsdk\devices/Kconfig:1
-> D:/sdk_next/mcuxsdk\devices\../devices/RT/RT1170/MIMXRT1176/Kconfig:8
Menu path: (Top)

menu "Device specific drivers"
```

You can reconfigure the project by selecting/deselecting Kconfig options.

After saving and closing the Kconfig GUI, you can directly run west build to build with the new configuration.

Flash ***Note***: Please refer Flash and Debug The Example to enable west flash/debug support.

Flash the hello_world example:

```
west flash -r linkserver
```

Debug Start a gdb interface by following command:

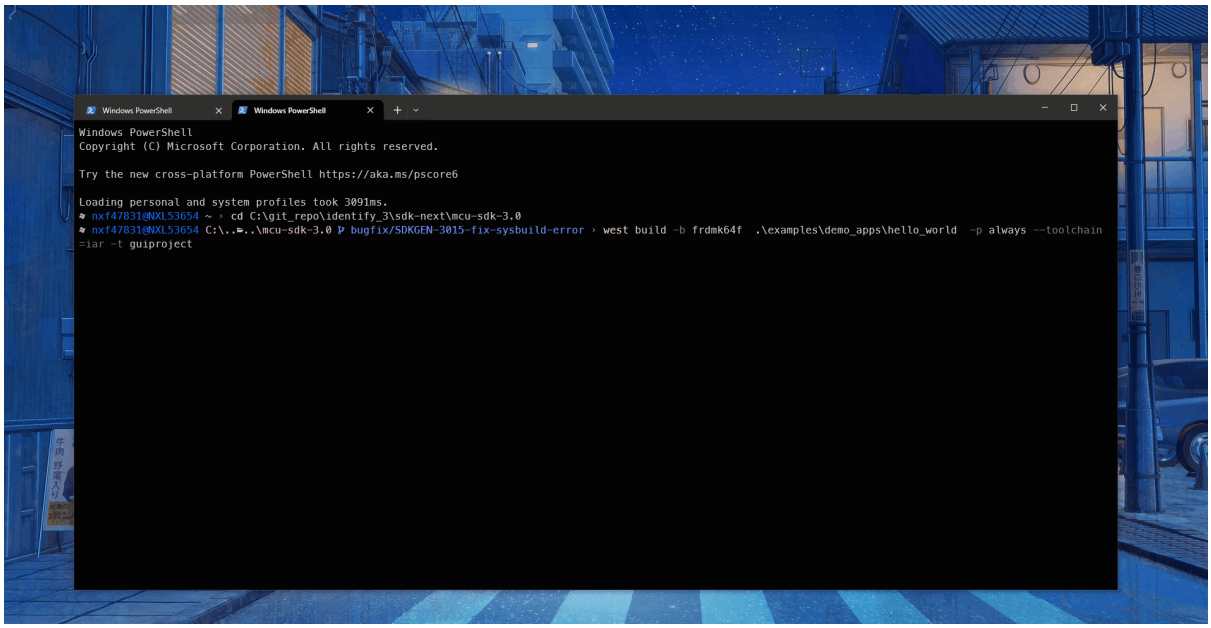
```
west debug -r linkserver
```

Work with IDE Project The above build functionalities are all with CLI. If you want to use the toolchain IDE to work to enjoy the better user experience especially for debugging or you are already used to develop with IDEs like IAR, MDK, Xtensa and CodeWarrior in the embedded world, you can play with our IDE project generation functionality.

This is the cmd to generate the evkbmimxrt1170 hello_world IAR IDE project files.

```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world --toolchain iar -Dcore_id=cm7 --config␣
↪flexspi_nor_debug -p always -t guiproject
```

By default, the IDE project files are generated in mcuxsdk/build/<toolchain> folder, you can open the project file with the IDE tool to work:



Note, please follow the *Installation* to setup the environment especially make sure that *ruby* has been installed.

1.4 Release Notes

1.4.1 MCUXpresso SDK Release Notes

Overview

The MCUXpresso SDK is a comprehensive software enablement package designed to simplify and accelerate application development with Arm Cortex-M-based devices from NXP, including its general purpose, crossover and Bluetooth-enabled MCUs. MCUXpresso SW and Tools for DSC

further extends the SDK support to current 32-bit Digital Signal Controllers. The MCUXpresso SDK includes production-grade software with integrated RTOS (optional), integrated enabling software technologies (stacks and middleware), reference software, and more.

In addition to working seamlessly with the MCUXpresso IDE, the MCUXpresso SDK also supports and provides example projects for various toolchains. The Development tools chapter in the associated Release Notes provides details about toolchain support for your board. Support for the MCUXpresso Config Tools allows easy cloning of existing SDK examples and demos, allowing users to leverage the existing software examples provided by the SDK for their own projects.

Underscoring our commitment to high quality, the MCUXpresso SDK is MISRA compliant and checked with Coverity static analysis tools. For details on MCUXpresso SDK, see MCUXpresso-SDK: Software Development Kit for MCUXpresso.

MCUXpresso SDK

As part of the MCUXpresso software and tools, MCUXpresso SDK is the evolution of Kinetis SDK, includes support for LPC, DSC,PN76, and i.MX System-on-Chip (SoC). The same drivers, APIs, and middleware are still available with support for Kinetis, LPC, DSC, and i.MX silicon. The MCUXpresso SDK adds support for the MCUXpresso IDE, an Eclipse-based toolchain that works with all MCUXpresso SDKs. Easily import your SDK into the new toolchain to access to all of the available components, examples, and demos for your target silicon. In addition to the MCUXpresso IDE, support for the MCUXpresso Config Tools allows easy cloning of existing SDK examples and demos, allowing users to leverage the existing software examples provided by the SDK for their own projects.

In order to maintain compatibility with legacy Freescale code, the filenames and source code in MCUXpresso SDK containing the legacy Freescale prefix FSL has been left as is. The FSL prefix has been redefined as the NXP Foundation Software Library.

Development tools

The MCUXpresso SDK was tested with following development tools. Same versions or above are recommended.

- MCUXpresso IDE, Rev. 25.06.xx
- IAR Embedded Workbench for Arm, version is 9.60.4
- Keil MDK, version is 5.41
- MCUXpresso for VS Code v25.06
- GCC Arm Embedded Toolchain 14.2.x

Supported development systems

This release supports board and devices listed in following table. The board and devices in bold were tested in this release.

Development board	MCU devices
MIMXRT1176-EVK	MIMXRT1171AVM8A, MIMXRT1171AVM8B, MIMXRT1171CVM8A, MIMXRT1171CVM8B, MIMXRT1171DVMAA, MIMXRT1171DVMAB, MIMXRT1172AVM8A, MIMXRT1172AVM8B, MIMXRT1172CVM8A, MIMXRT1172CVM8B, MIMXRT1172DVMAA, MIMXRT1172DVMAB, MIMXRT1173CVM8A, MIMXRT1173CVM8B, MIMXRT1175AVM8A, MIMXRT1175AVM8B, MIMXRT1175CVM8A, MIMXRT1175CVM8B, MIMXRT1175DVMAA, MIMXRT1175DVMAB, MIMXRT1176AVM8A, MIMXRT1176AVM8B, MIMXRT1176CVM8A, MIMXRT1176CVM8B, MIMXRT1176DVMAA, **MIMXRT1176DVMAB**

MCUXpresso SDK release package

The MCUXpresso SDK release package content is aligned with the silicon subfamily it supports. This includes the boards, CMSIS, devices, middleware, and RTOS support.

Device support The device folder contains the whole software enablement available for the specific System-on-Chip (SoC) subfamily. This folder includes clock-specific implementation, device register header files, device register feature header files, and the system configuration source files. Included with the standard SoC support are folders containing peripheral drivers, toolchain support, and a standard debug console. The device-specific header files provide a direct access to the microcontroller peripheral registers. The device header file provides an overall SoC memory mapped register definition. The folder also includes the feature header file for each peripheral on the microcontroller. The toolchain folder contains the startup code and linker files for each supported toolchain. The startup code efficiently transfers the code execution to the main() function.

Board support The boards folder provides the board-specific demo applications, driver examples, and middleware examples.

Demo application and other examples The demo applications demonstrate the usage of the peripheral drivers to achieve a system level solution. Each demo application contains a readme file that describes the operation of the demo and required setup steps. The driver examples demonstrate the capabilities of the peripheral drivers. Each example implements a common use case to help demonstrate the driver functionality.

RTOS

FreeRTOS Real-time operating system for microcontrollers from Amazon

Middleware

CMSIS DSP Library The MCUXpresso SDK is shipped with the standard CMSIS development pack, including the prebuilt libraries.

MCU Boot MCU Boot (formerly KBOOT) NXP/Freescale proprietary loader

wpa_supplicant-rtos NXP Wi-Fi WPA Supplicant

Wireless EdgeFast Bluetooth PAL For more information, see the MCUXpresso SDK EdgeFast Bluetooth Protocol Abstraction Layer User's Guide.

Ethermind BT/BLE Stack nxp_bt_ble_stack

coreHTTP coreHTTP

openvg OpenVG library for devices with graphics acceleration hardware

NXP Wi-Fi The MCUXpresso SDK provides driver for NXP Wi-Fi external modules. The Wi-Fi driver is integrated with LWIP TCPIP stack and demonstrated with several network applications (iperf and AWS IoT).

For more information, see Getting Started with NXP based Wireless Modules and i.MX RT Platform Running on RTOS (document: UM11441).

Secure Element Host Library Secure Element Host Library

VG-Lite GPU Library VGLite library for devices with VGLite graphics hardware acceleration engine

USB Type-C PD Stack See the *MCUXpresso SDK USB Type-C PD Stack User's Guide* (document MCUXSDKUSBPDUG) for more information

USB Host, Device, OTG Stack See the MCUXpresso SDK USB Stack User's Guide (document MCUXSDKUSBSUG) for more information.

TinyCBOR Concise Binary Object Representation (CBOR) Library

Simple Open EtherCAT Master Simple Open EtherCAT Master (SOEM) is an open source EtherCAT master stack that is used to write custom EtherCAT Master applications. For more information on how to use SOEM, see the Getting Started with MCUXpresso SDK for SOEM document.

SDMMC stack The SDMMC software is integrated with MCUXpresso SDK to support SD/MMC/SDIO standard specification. This also includes a host adapter layer for bare-metal/RTOS applications.

PNG decoder An 'embedded-friendly' PNG image decoding library.

PKCS#11 The PKCS#11 standard specifies an application programming interface (API), called "Cryptoki," for devices that hold cryptographic information and perform cryptographic functions. Cryptoki follows a simple object based approach, addressing the goals of technology independence (any kind of device) and resource sharing (multiple applications accessing multiple devices), presenting to applications a common, logical view of the device called a "cryptographic token".

Openh264 H.264 Codec Library

NXP IoT Agent NXP IoT Agent

Motor Control Software (ACIM, BLDC, PMSM) Motor control examples.

Multicore Multicore Software Development Kit

MMCAU The NXP Memory-Mapped Cryptographic Acceleration Unit

MCU Boot Open source MCU Bootloader.

PSA Test Suite Arm Platform Security Architecture Test Suite

mbedTLS mbedtls SSL/TLS library v3.x

NXP PSA CRYPTO DRIVER PSA crypto driver for crypto library integration via driver wrappers

mbedTLS mbedtls SSL/TLS library v2.x

Voice Seeker (no AEC) VoiceSeeker is a multi-microphone voice control audio front-end signal processing solution. VoiceSeeker is not featuring acoustic echo cancellation (AEC).

Voice intelligent technology library Voice Intelligent Technology (VIT) Library provides wake word and voice command engine for voice control

Audio Voice components Audio Voice components for MCU

Maestro Audio Framework for MCU Maestro Audio Framework library for MCU

lwIP The lwIP TCP/IP stack is pre-integrated with MCUXpresso SDK and runs on top of the MCUXpresso SDK Ethernet driver with Ethernet-capable devices/boards.

For details, see the *lwIP TCPIP Stack and MCUXpresso SDK Integration User's Guide* (document MCUXSDKLWIPUG).

lwIP is a small independent implementation of the TCP/IP protocol suite.

eIQ The package contains several example applications using the eIQ TensorFlow Lite for Microcontrollers library.

eIQ machine learning SDK containing:

- Arm CMSIS-NN library (neural network kernels optimized for Cortex-M cores)
- Inference engines:
  - TensorFlow Lite Micro
  - DeepView RT
- Example code for TensorFlow Lite Micro, Glow, and DeepView RT

LVGL LVGL Open Source Graphics Library

llhttp HTTP parser llhttp

LittleFS LittleFS filesystem stack

JPEG library JPEG library

FreeMASTER FreeMASTER communication driver for 32-bit platforms.

File systemFatfs The FatFs file system is integrated with the MCUXpresso SDK and can be used to access either the SD card or the USB memory stick when the SD card driver or the USB Mass Storage Device class implementation is used.

emWin The MCUXpresso SDK is pre-integrated with the SEGGER emWin GUI middleware. The AppWizard provides developers and designers with a flexible tool to create stunning user interface applications, without writing any code.

NAND Flash Management Stack NAND Flash Management Stack

cJSON Ultralightweight JSON parser in ANSI C

AWS IoT Amazon Web Service (AWS) IoT Core SDK.

Release contents

Provides an overview of the MCUXpresso SDK release package contents and locations.

Deliverable	Location
Boards	INSTALL_DIR/boards
Demo Applications	INSTALL_DIR/boards/<board_name>/demo_apps
Driver Examples	INSTALL_DIR/boards/<board_name>/driver_examples
eIQ examples	INSTALL_DIR/boards/<board_name>/eiq_examples
Board Project Template for MCUXpresso IDE NPW	INSTALL_DIR/boards/<board_name>/project_template
Driver, SoC header files, extension header files and feature header files, utilities	INSTALL_DIR/devices/<device_name>
CMSIS drivers	INSTALL_DIR/devices/<device_name>/cmsis_drivers
Peripheral drivers	INSTALL_DIR/devices/<device_name>/drivers
Toolchain linker files and startup code	INSTALL_DIR/devices/<device_name>/<toolchain_nam
Utilities such as debug console	INSTALL_DIR/devices/<device_name>/utilities
Device Project Template for MCUXpresso IDE NPW	INSTALL_DIR/devices/<device_name>/project_templat
CMSIS Arm Cortex-M header files, DSP library source	INSTALL_DIR/CMSIS
Components and board device drivers	INSTALL_DIR/components
RTOS	INSTALL_DIR/rtos
Release Notes, Getting Started Document and other documents	INSTALL_DIR/docs
Tools such as shared cmake files	INSTALL_DIR/tools
Middleware	INSTALL_DIR/middleware

Known issues

This section lists the known issues, limitations, and/or workarounds.

New Project Wizard compile failure

The following components request the user to manually select other components that they depend upon in order to compile.

These components depend on several other components and the New Project Wizard (NPW) is not able to decide which one is needed by the user.

Note: xxx means core variants, such as, cm0plus, cm33, cm4, cm33_nodsp.

Components:issdk_mag3110, issdk_host, systick, gpio_kinetis, gpio_lpc, issdk_mpl3115, sensor_fusion_agm01, sensor_fusion_agm01_lpc, issdk_mma845x, issdk_mma8491q, issdk_mma865x, issdk_mma9553, and CMSIS_RTOS2.CMSIS_RTOS2, and components which include cache driver, such as enet_qos.

Also for low-level adapter components, currently the different types of the same adapter cannot be selected at the same time.

For example, if there are two types of timer adapters, gpt_adapter and pit_adapter, only one can be selected as timer adapter

in one project at a time. Duplicate implementation of the function results in an error.

Note: Most of middleware components have complex dependencies and are not fully supported in new project wizard. Adding a middleware component may result in compile failure.

MCUXpresso IDE limitation

- **Cannot debug cm4 sdram related demos with CMSIS-DAP**

  MCUXpresso IDE does not support initialization of sdram when debugging.

IAR debug limitation

CM4 flash target demos cannot be debugged on IAR with JLINK.

CMSIS PACK new project compile failure

The generated configuration cannot be applied globally. The components, serial_manager_usb_cdc_virtual and serial_manager_usb_cdc_virtual_xxx (xxx means core variants like cm0plus, cm33, cm4, and cm33_nodsp) are unsupported for new project wizard of CMSIS pack and will lead to compile failure if selected while creating new project(s).

Log output may be mixed in shell/hfp example

When multiple tasks print the log, the serial port terminal output has the probability to appear mixed.

LE encryption failure causes connection to fail

There can be a corner case when LE link encryption can fail. This occurs when device under test (DUT); RT Bluetooth controller here, while waiting for the response to LL_SLAVE_FEATURES_REQ, instead receives the LL_ENC_REQ response from a remote device.

This causes deadlock scenario where DUT and remote devices are stuck waiting for response from peer.

Connection disconnects with 7.5 ms connection interval

When wireless example works as a peripheral, the central role with 7. 5 ms connection interval connects to the wireless example. However, when using the 6th/7th/8th central to connect the wireless example, all the previous connections with the previous centrals are disconnected.

When wireless example works as central and the connection interval is 7.5 ms, the 4th peripheral is not scanned.

a2dp sink demo: Noise may occur when phone plays music with other operations

Noise may occur when phone plays music with other operations.

For example:

- Switches the WIFI network of the phone when playing music
- Switches music when playing the online music

Wireless EdgeFast Bluetooth PAL

For more information, see the MCUXpresso SDK EdgeFast Bluetooth Protocol Abstraction Layer User's Guide.

Insufficient heap in ota_demo examples

The ota_demo examples, especially ota_demo_wifi, may run out of heap in the out-of-the-box configuration.

To increase the heap size, change line 62:

```
#define configTOTAL_HEAP_SIZE ( ( size_t ) ( 200 * 1024 ) )
```

Workaround: Therefore, increasing the heap size to 200 KB in FreeRTOSConfig.h is recommended.

Insufficient heap in ota_demo examples

The ota_demo examples, especially ota_demo_wifi, may run out of heap in the out-of-the-box configuration.

To increase the heap size, change line 62:

```
#define configTOTAL_HEAP_SIZE ( ( size_t ) ( 200 * 1024 ) )
```

Workaround: Therefore, increasing the heap size to 200 KB in FreeRTOSConfig.h is recommended.

Fail to set security after building connection with peer device and failed ratio is 1/10

Failed the connection with peer device.

Affected toolchains: GCC ARM, IAR, Keil, MCUXPRESSO IDE

Affected modules: 1XK_M2 1ZM_M2 2EL_M2

Affected platforms: evkmimxrt1180 evkbmimxrt1170 mcxn9xxevk mimxrt685audevk evkbimxrt1050 evkcmimxrt1060 evkmimxrt1040 evkmimxrt685 evkmimxrt595

The wifi_webconfig example can crash while obtaining IP address

This issue can occur during DHCP handshake or other networking activity.

Examples: wifi_webconfig **Affected toolchains:** mdk, mcux **Affected platforms:** evkcmimxrt1060, evkbmimxrt1170

The cmsis_lpi2c_edma_b2b_transfer examples don't work correctly on CM4 core.

Boards cannot transfer data successfully.

Affected toolchains: mcux **Affected platforms:** evkmimxrt1160, evkbmimxrt1170

1.5 ChangeLog

1.5.1 MCUXpresso SDK Changelog

Board Support Files

board

[25.06.00]

- Initial version
  - Added IW610_2LL_USD module support
  - Updated display_support project segment

clock_config

[25.06.00]

- Initial version
  - Updated clock_config.c to align with latest the part number and the clock tool model
  - Changed the default DCDC mode to CCM mode

pin_mux

[25.06.00]

- Initial version
  - Updated pin_mux.c to align with the latest part number
  - Fixed the pad configuration slew rate polarity description

---

ACMP

[2.3.0]

- Improvements
  - Expose C0 register FILTER_CNT bitfield and FPR bitfield to the user.

[2.2.0]

- Improvements
  - Updated feature macros for roundrobin mode, window mode, filter mode, and 3V domain removes.

[2.1.0]

- New Feature
  - Supported the plateforms which don't have hysteresis mode.

[2.0.6]

- Bug Fixes
  - Fixed the wrong comments, the DAC value should range from 0 to 255.

[2.0.5]

- Bug Fixes
  - Fixed the out-of-bounds error of Coverity caused by missing an assert sentence to avoid the return value of ACMP_GetInstance() exceeding the array bounds.
  - Fixed the violations of MISRA C-2012 rules:
    * Rule 10.1, 14.4, 16.4, 17.7.

[2.0.4]

- Bug Fixes
  - Avoided changing w1c bit in ACMP_SetRoundRobinPreState().

[2.0.3]

- New Features
  - Added feature functions for usage of different power domains(1.8 V and 3 V). These functions are first enabled in ULP1. They are about:
    * ACMP_EnableLinkToDAC()
    * ACMP_SetDiscreteModeConfig()
    * ACMP_GetDefaultDiscreteModeConfig()

[2.0.2]

- Other Changes
  - Changed coding style of peripheral base address from “s_acmpBases” to “s_acmpBase”.

[2.0.1]

- Bug Fixes
  - Fixed bug regarding the function “ACMP_SetRoundRobinConfig”. It will not continue execution but returns directly after disabling round robin mode.

ADC_ETC

[2.3.2]

- Improvements
  - Corrected that FSL_FEATURE_ADC_ETC_HAS_NO_TSC1_TRIG should be used instead of FSL_FEATURE_ADC_ETC_HAS_NO_TSC0_TRIG in some places.
  - For ADC_ETC without TSC trigger source, CTRL [bit 30] shall be cleared explicitly.

[2.3.1]

- Improvements
  - Change ADC_ETC default DMA Mode to kADC_ETC_TrigDMAWithPulsedSignal. Generally speaking, DMA transfer requests should only be cleared by DMA ACK, and the CPU should not clear the request source. If some users use option kADC_ETC_TrigDMAWithLatchedSignal, changing the mode to kADC_ETC_TrigDMAWithPulsedSignal also meet their requirements.

[2.3.0]

- Improvements
  - Added blocking way to implement SW trigger.

[2.2.1]

- Improvements
  - Moditied macro “ADC_ETC_DONE2_ERR_IRQ_TRIG0_DONE2_MASK” to “ADC_ETC_DONE2_3_ERR_IRQ_TRIG0_DONE2_MASK” based on the updates of header file.

[2.2.0]

- Improvements
  - Defined two macros to support some devices that do not equipped with TSC trigger.

[2.1.1]

- Bug Fixes
  - Fixed the violation of MISRA-2012 rule.

[2.1.0]

- New Features
  - Supported independent IRQ enable bit in ADC-ETC chain configuration registers.
  - Supported trigger n DONE3 interrupt operations.
- Bug Fixes
  - Fixed the violation of MISRA-2012 rules:
    - Rule 10.1 10.3 10.7 15.5 16.1 16.3 16.4 17.7

[2.0.1]

- New Features
  - Added a control macro to enable/disable the CLOCK code in current driver.

[2.0.0]

- Initial version.

AOI

[2.0.2]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.0.1]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.8, 2.2.

[2.0.0]

- Initial version.

ASRC

[2.1.3]

- Bug Fixes
  - Fixed function did not match the specified channel pair issue.

[2.1.2]

- Improvements
  - Correct feature name in source file by changing FSL_FEATURE_ASRC_PARAMETER_REGISTER_NAME_A to FSL_FEATURE_ASRC_PARAMETER_REGISTER_NAME_ASRPM.
  - Removed the asrc_clock_source_t from driver header file, as SOC header file will provide detail definition.
- Bug Fixes
  - Fixed the ASRC_SetChannelPairConfig/ASRC_ChannelPairEnable functions missing functionality when using channel pair B/C.
  - Fixed violations of the MISRA C-2012 rules 10.7.

[2.1.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1□10.4, 12.2.

[2.1.0]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 14.4, 10.1, 17.7, 11.9, 8.6, 12.2, 11.6.

[2.0.1]

- Improvements
  - Added feature macro FSL_FEATURE_ASRC_PARAMETER_REGISTER_NAME_ASPRM for ASRC parameter register.
- Bug Fixes
  - Fixed the unused build warning in asrc edma driver.

[2.0.0]

- Initial version.

ASRC EDMA Driver

[2.2.0]

- Bug Fixes
  - Fixed the “watermark” and “channel” was defined in struct asrc_p2p_edma_config_t but never used issue.

[2.1.0]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 14.4, 10.1, 17.7, 11.9, 8.6, 12.2, 11.6.

[2.0.1]

- Improvements
  - Added feature macro FSL_FEATURE_ASRC_PARAMETER_REGISTER_NAME_ASPRM for ASRC parameter register.
- Bug Fixes
  - Fixed the unused build warning in asrc edma driver.

[2.0.0]

- Initial version.

CAAM

[2.4.0]

- Add new APIs for native asymmetric operations (RSA, ECC) instead of only accelerating mathematical primitives and support for black keys and blobs for both symmetric and asymmetric operations.

[2.3.2]

- Fix MISRA-2012 issues.

[2.3.1]

- Modified function caam_aes_ccm_check_input_args() to allow payload be empty as is specified in NIST800-38C Section 5.3..

[2.3.0]

- Add support for SHA HMAC.

[2.2.4]

- Fix issue where the outputSize parameter of CAAM_HASH_Finish() has impact on hash calculation.

[2.2.3]

- Fix DCACHE invalidation in CAAM_HASH_Finish().

[2.2.2]

- Modify RNG to not reseed with each request.

[2.2.1]

- Fixed AES-CCM decrypt failing with TAG length bigger than 8 byte.

[2.2.0]

- Added API for Blob functions and CRC

[2.1.6]

- Improve DCACHE handling. Requires CAAM used and cached memory set in write-trough mode.

[2.1.5]

- Support EXTENDED data size for all AES, HASH and RNG operations.
- Support multiple De-Initialization/Initialization of CAAM driver within one POR event.

[2.1.4]

- Fix MISRA-2012 issues.

[2.1.3]

- Fix MISRA-2012 issues.

[2.1.2]

- Add data offset feature to provide support for mirrored (high-speed) memory.

[2.1.1]

- Add DCACHE support.

[2.1.0]

- Add return codes check and handling.

[2.0.3]

- Use MACRO instead of numbers in descriptor.
- Correct descriptor size mask.

[2.0.2]

- Add Data and Instruction Synchronization Barrier in caam_input_ring_set_jobs_added() to make sure that the descriptor will be loaded into CAAM correctly.

[2.0.1]

- Add Job Ring 2 and 3.

[2.0.0]

- Initial version.

CACHE ARMv7-M7

[2.0.4]

- Bug Fixes
  - Fixed doxygen issue.

[2.0.3]

- Improvements
  - Deleted redundancy code about calculating cache clean/invalidate size and address aligns.

[2.0.2]

- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 10.1, 10.3 and 10.4.

[2.0.1]

- Bug Fixes
  - Fixed cache size issue in L2CACHE_GetDefaultConfig API.

[2.0.0]

- Initial version.

CACHE LMEM

[2.1.0]

- Improvements
  - Added new feature macro to support some device do not support PCCCR[ENWRBUF] bit field.

[2.0.6]

- Bug Fixes
  - Fixed doxygen issue.

[2.0.5]

- Improvements
  - Updated the cache enable function, don't enable again when it is already enabled.

[2.0.4]

- Bug Fixes
  - Updated full name for lmem driver.
  - Fixed doxygen issue.

[2.0.3]

- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 10.4 and 14.4.

[2.0.2]

- Improvements
  - Moved CLCR register configuration out of the while loop, it's unnecessary to repeat this operation.

[2.0.1]

- Bug Fixes
  - Fixed the over-4KB-size maintenance issue in invalidate/clean/clean&invalidate by range APIs.

[2.0.0]

- Initial version.

CDOG

[2.1.3]

- Re-design multiple instance IRQs and Clocks
- Add fix for RESTART command errata

[2.1.2]

- Support multiple IRQs
- Fix default CONTROL values

[2.1.1]

- Remove bit CONTROL[CONTROL_CTRL].

[2.1.0]

- Rename CWT to CDOG.

[2.0.2]

- Fix MISRA-2012 issues.

[2.0.1]

- Fix doxygen issues.

[2.0.0]

- Initial version.

COMMON

[2.6.0]

- Bug Fixes
  - Fix CERT-C violations.

[2.5.0]

- New Features
  - Added new APIs InitCriticalSectionMeasurementContext, DisableGlobalIRQEx and EnableGlobalIRQEx so that user can measure the execution time of the protected sections.

[2.4.3]

- Improvements
  - Enable irqs that mount under irqsteer interrupt extender.

[2.4.2]

- Improvements
  - Add the macros to convert peripheral address to secure address or non-secure address.

[2.4.1]

- Improvements
  - Improve for the macro redefinition error when integrated with zephyr.

[2.4.0]

- New Features
  - Added EnableIRQWithPriority, IRQ_SetPriority, and IRQ_ClearPendingIRQ for ARM.
  - Added MSDK_EnableCpuCycleCounter, MSDK_GetCpuCycleCount for ARM.

[2.3.3]

- New Features
  - Added NETC into status group.

[2.3.2]

- Improvements
  - Make driver aarch64 compatible

[2.3.1]

- Bug Fixes
  - Fixed MAKE_VERSION overflow on 16-bit platforms.

[2.3.0]

- Improvements
  - Split the driver to common part and CPU architecture related part.

[2.2.10]

- Bug Fixes
  - Fixed the ATOMIC macros build error in cpp files.

[2.2.9]

- Bug Fixes
  - Fixed MISRA C-2012 issue, 5.6, 5.8, 8.4, 8.5, 8.6, 10.1, 10.4, 17.7, 21.3.
  - Fixed SDK_Malloc issue that not allocate memory with required size.

[2.2.8]

- Improvements
  - Included stddef.h header file for MDK tool chain.
- New Features:
  - Added atomic modification macros.

[2.2.7]

- Other Change
  - Added MECC status group definition.

[2.2.6]

- Other Change
  - Added more status group definition.
- Bug Fixes
  - Undef __VECTOR_TABLE to avoid duplicate definition in cmsis_clang.h

[2.2.5]

- Bug Fixes
  - Fixed MISRA C-2012 rule-15.5.

[2.2.4]

- Bug Fixes
  - Fixed MISRA C-2012 rule-10.4.

[2.2.3]

- New Features
  - Provided better accuracy of SDK_DelayAtLeastUs with DWT, use macro SDK_DELAY_USE_DWT to enable this feature.
  - Modified the Cortex-M7 delay count divisor based on latest tests on RT series boards, this setting lets result be closer to actual delay time.

[2.2.2]

- New Features
  - Added include RTE_Components.h for CMSIS pack RTE.

[2.2.1]

- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 3.1, 10.1, 10.3, 10.4, 11.6, 11.9.

[2.2.0]

- New Features
  - Moved SDK_DelayAtLeastUs function from clock driver to common driver.

[2.1.4]

- New Features
  - Added OTFAD into status group.

[2.1.3]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fixed the rule: rule-10.3.

[2.1.2]

- Improvements
  - Add SUPPRESS_FALL_THROUGH_WARNING() macro for the usage of suppressing fallthrough warning.

[2.1.1]

- Bug Fixes
  - Deleted and optimized repeated macro.

[2.1.0]

- New Features
  - Added IRQ operation for XCC toolchain.
  - Added group IDs for newly supported drivers.

[2.0.2]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fixed the rule: rule-10.4.

[2.0.1]

- Improvements
  - Removed the implementation of LPC8XX Enable/DisableDeepSleepIRQ() function.
  - Added new feature macro switch "FSL_FEATURE_HAS_NO_NONCACHEABLE_SECTION" for specific SoCs which have no noncacheable sections, that helps avoid an unnecessary complex in link file and the startup file.
  - Updated the align(x) to **attribute**(aligned(x)) to support MDK v6 armclang compiler.

[2.0.0]

- Initial version.

CSI

[2.2.0]

- Improvements
  - Update driver to invoke callback whenere there is a full frame received.

[2.1.5]

- Improvements
  - Updated for new CSI register and macro names.

[2.1.4]

- Improvements
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.

[2.1.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 17.7.

[2.1.2]

- Improvements
  - Supported new CSI_Type register naming.

[2.1.1]

- Bug Fixes
  - Fixed IAR build warning Pa082.
  - Fixed violations of the MISRA C-2012 rules 8.4, 10.1, 10.3, 10.4, 10.6, 11.6, 14.4, 17.7.

[2.1.0]

- New Features
  - Added 16-bit and 24-bit data bus support.
- Bug Fixes:
  - Fixed the bug that CSI writes to wrong buffer when empty buffer not submitted in time.

[2.0.3]

- Bug Fixes
  - Fixed wrong circular queue delta calculation.
  - Fixed double buffering capture issue where, when the transfer is ongoing and the device has empty buffer slot, the function CSI_TransferSubmitEmptyBuffer sets the empty buffer to CSI device.

[2.0.2]

- New Features
  - Added fragment mode support.

[2.0.1]

- Improvements
  - Switched DMA output buffer at the first data after each VSYNC. It originally happened when the DMA transfer was done.

[2.0.0]

- Initial version.

DAC12

[2.1.1]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.1.0]

- Improvements
  - Defined the macro “FSL_FEATURE_HAS_NO_ITRM_REGISTER” to distinguish different scenes that ITRM register may not equipped one some devices.

[2.0.1]

- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules:
    - Rule 10.8, 17.7.

[2.0.0]

- Initial version.

DCIC

[2.0.2]

- Bug Fixes
  - Fixed the violations of MISRA 2012 advisory rules.

[2.0.1]

- Bug Fixes
  - Fixed the violations of MISRA 2012 rules: 10.1, 10.4.

[2.0.0]

- Initial version.

DMAMUX

[2.1.2]

- Bug Fixes
  - Add macro FSL_DMAMUX_CHANNEL_NUM to calculat correct DMAMUX channel number when input EDAM channel number.

[2.1.1]

- Improvements
  - Add macro FSL_FEATURE_DMAMUX_CHANNEL_NEEDS_ENDIAN_CONVERT and DMAMUX_CHANNEL_ENDIAN_CONVERTn do channel endian convert.

[2.1.0]

- Improvements
  - Modify the type of parameter source from uint32_t to int32_t in the DMAMUX_SetSource.

[2.0.5]

- Improvements
  - Added feature FSL_FEATURE_DMAMUX_CHCFG_REGISTER_WIDTH for the difference of CHCFG register width.

[2.0.4]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.4.

[2.0.3]

- Bug Fixes
  - Fixed the issue for MISRA-2012 check.
    - Fixed rule 10.4 and rule 10.3.

[2.0.2]

- New Features
  - Added an always-on enable feature to a DMA channel for ULP1 DMAMUX support.

[2.0.1]

- Bug Fixes
  - Fixed the build warning issue by changing the type of parameter source from uint8_t to uint32_t when setting DMA request source in DMAMUX_SetSourceChange.

[2.0.0]

- Initial version.

EDMA

[2.4.5]

- Bug Fixes
  - Fixed memory convert would convert NULL as zero address issue.

[2.4.4]

- Bug Fixes
  - Fixed comments by replacing STCD with TCD
  - Fixed the TCD overwrite issue when submit transfer request in the callback if there is a active TCD in hardware.
  - Fixed violations of MISRA C-2012 rule 10.8,5.6.

[2.4.3]

- Improvements
  - Added FSL_FEATURE_MEMORY_HAS_ADDRESS_OFFSET to convert the address between system mapped address and dma quick access address.
- Bug Fixes
  - Fixed the wrong tcd done count calculated in first TCD interrupt for the non scatter gather case.

[2.4.2]

- Bug Fixes
  - Fixed the wrong tcd done count calculated in first TCD interrupt by correct the initial value of the header.
  - Fixed violations of MISRA C-2012 rule 10.3, 10.4.

[2.4.1]

- Bug Fixes
  - Added clear CITER and BITER registers in EDMA_AbortTransfer to make sure the TCD registers in a correct state for next calling of EDMA_SubmitTransfer.
  - Removed the clear DONE status for ESG not enabled case to aovid DONE bit cleared unexpectedly.

[2.4.0]

- Improvements
  - Added api EDMA_EnableContinuousChannelLinkMode to support continuous link mode.
  - Added apis EDMA_SetMajorOffsetConfig/EDMA_TcdSetMajorOffsetConfig to support major loop address offset feature.
  - Added api EDMA_EnableChannelMinorLoopMapping for minor loop offset feature.
  - Removed the reduntant IRQ Handler in edma driver.

[2.3.2]

- Improvements
  - Fixed HIS ccm issue in function EDMA_PrepareTransferConfig.
  - Fixed violations of MISRA C-2012 rule 11.6, 10.7, 10.3, 18.1.
- Bug Fixes
  - Added ACTIVE & BITER & CITER bitfields to determine the channel status to fixed the issue of the transfer request cannot submit by function EDMA_SubmitTransfer when channel is idle.

[2.3.1]

- Improvements
  - Added source/destination address alignment check.
  - Added driver IRQ handler support for multi DMA instance in one SOC.

[2.3.0]

- Improvements
  - Added new api EDMA_PrepareTransferConfig to allow different configurations of width and offset.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.4, 10.1.

- Fixed the Coverity issue regarding out-of-bounds write.

[2.2.0]

- Improvements
  - Added peripheral-to-peripheral support in EDMA driver.

[2.1.9]

- Bug Fixes
  - Fixed MISRA issue: Rule 10.7 and 10.8 in function EDMA_DisableChannelInterrupts and EDMA_SubmitTransfer.
  - Fixed MISRA issue: Rule 10.7 in function EDMA_EnableAsyncRequest.

[2.1.8]

- Bug Fixes
  - Fixed incorrect channel preemption base address used in EDMA_SetChannelPreemptionConfig API which causes incorrect configuration of the channel preemption register.

[2.1.7]

- Bug Fixes
  - Fixed incorrect transfer size setting.
    - Added 8 bytes transfer configuration and feature for RT series;
    - Added feature to support 16 bytes transfer for Kinetis.
  - Fixed the issue that EDMA_HandleIRQ would go to incorrect branch when TCD was not used and callback function not registered.

[2.1.6]

- Bug Fixes
  - Fixed KW3X MISRA Issue.
    - Rule 14.4, 10.8, 10.4, 10.7, 10.1, 10.3, 13.5, and 13.2.
- Improvements
  - Cleared the IRQ handler unavailable for specific platform with macro FSL_FEATURE_EDMA_MODULE_CHANNEL_IRQ_ENTRY_SHARED_OFFSET.

[2.1.5]

- Improvements
  - Improved EDMA IRQ handler to support half interrupt feature.

[2.1.4]

- Bug Fixes
  - Cleared enabled request, status during EDMA_Init for the case that EDMA is halted before reinitialization.

[2.1.3]

- Bug Fixes
  - Added clear DONE bit in IRQ handler to avoid overwrite TCD issue.
  - Optimized above solution for the case that transfer request occurs in callback.

[2.1.2]

- Improvements
  - Added interface to get next TCD address.
  - Added interface to get the unused TCD number.

[2.1.1]

- Improvements
  - Added documentation for eDMA data flow when scatter/gather is implemented for the EDMA_HandleIRQ API.
  - Updated and corrected some related comments in the EDMA_HandleIRQ API and edma_handle_t struct.

[2.1.0]

- Improvements
  - Changed the EDMA_GetRemainingBytes API into EDMA_GetRemainingMajorLoopCount due to eDMA IP limitation (see API comments/note for further details).

[2.0.5]

- Improvements
  - Added pubweak DriverIRQHandler for K32H844P (16 channels shared).

[2.0.4]

- Improvements
  - Added support for SoCs with multiple eDMA instances.
  - Added pubweak DriverIRQHandler for KL28T DMA1 and MCIMX7U5_M4.

[2.0.3]

- Bug Fixes
  - Fixed the incorrect pubweak IRQHandler name issue, which caused re-definition build errors when client set his/her own IRQHandler, by changing the 32-channel IRQHandler name to DriverIRQHandler.

[2.0.2]

- Bug Fixes
  - Fixed incorrect minorLoopBytes type definition in _edma_transfer_config struct, and defined minorLoopBytes as uint32_t instead of uint16_t.

[2.0.1]

- Bug Fixes
  - Fixed the eDMA callback issue (which did not check valid status) in EDMA_HandleIRQ API.

[2.0.0]

- Initial version.

ELCDIF

[2.1.0]

- New Features
  - Added API ELCDIF_SetPixelComponentOrder to support configure pixel component order.

[2.0.7]

- Bug Fixes
  - Fixed faulty operation of CTRL1 in ELCDIF_RgbModeSetPixelFormat.

[2.0.6]

- Bug Fixes
  - Fixed bug in ELCDIF_RgbModeStop that the API shall return until RUN bit is cleared, so that the RGB mode is properly stopped.

[2.0.5]

- Bug Fixes
  - Fixed the violations of MISRA 2012 advisory rules.

[2.0.4]

- Improvements
  - Increase outstanding transactions for better performance.
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.

[2.0.3]

- Improvements
  - Supported the platforms which don't have PXP handshake feature.
- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 17.7.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 8.4, 10.1, 10.6, 10.7, 10.8, 14.4, 17.7
  - Removed hardcode delay in function ELCDIF_Reset.

[2.0.1]

- Improvements
  - Added the function ELCDIF_RgbModeSetPixelFormat.

[2.0.0]

- Initial version.

ENC

[2.2.1]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.2.0]

- New Features
  - Supported input filter prescaler.

[2.1.0]

- Improvements
  - Supported period measurement function.

[2.0.2]

- Improvements
  - Added feature macro for CTRL2[SABIE] and CTRL2[SABIRQ] bits.

[2.0.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.6, 17.7.

[2.0.0]

- Initial version.

ENET

[2.9.2]

- Bug Fixes
  - RGMII mode is (temporarily) disabled before selecting between 10/100-Mbit/s and 1000-Mbit/s modes of operation. The bit RGMII_EN of RCR register must not be set while changing ECR register's speed bit, otherwise there is a possibility of ENET IP ending in an incorrect state.

[2.9.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 8.4, 10.4.

[2.9.0]

- Bug Fixes
  - Enabled collection of transfer statistics, so the function ENET_GetStatistics does not always return zeroes.
- New Features
  - Added new function ENET_EnableStatistics to enable/disable collection of transfer statistics.
  - Added new function ENET_ResetStatistics to reset transfer statistics.
- Improvements
  - Renamed the function ENET_ResetHareware to ENET_ResetHardware.

[2.8.0]

- New Features
  - Added the function to reset hardware on certain devices.

[2.7.1]

- Bug Fixes
  - Fixed the issue that free wrong buffer address when one frame stores in multiple buffers and memory pool is not enough to allocate these buffers to receive one complete frame.

[2.7.0]

- Improvements
  - Deleted deprecated zero copy Tx/Rx functions and set callback function which can be configured in ENET_Init.
  - Moved the Rx zero copy buffer allocation to Rx BD initialization function to reduce unnecessary looping code.
- Bug Fixes
  - Fixed the issue that predefined Rx buffers which should not be used when enabling Rx zero copy are still be handled by cache operation, it causes hardfault on some platforms.
  - Fixed the issue that zero-copy Rx function doesn't check Rx length of 0 in the BD with EMPTY bit is 0, it may occur in the corner case reported by customer. Not sure how it turns out, consider it as an ENET IP issue and drop this abnormal BD.

[2.6.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 11.6.

[2.6.2]

- Improvements
  - Changed ENET1_MAC0_Rx_Tx_Done0_DriverIRQHandler/ENET1_MAC0_Rx_Tx_Done1_DriverIRQHan to ENET1_MAC0_Rx_Tx_Done1_DriverIRQHandler/ENET1_MAC0_Rx_Tx_Done2_DriverIRQHandler which represent ring 1 and ring 2.

[2.6.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 10.7, 11.6, 11.8.

[2.6.0]

- Improvements
  - Added MDIO access wrapper APIs for ease of use.
  - Fixed the build warning introduced by 64-bit compatibility patch.

[2.5.4]

- Improvements
  - Made the driver compatible with 64-bit platforms.

[2.5.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 11.6.

[2.5.2]

- Improvements
  - Updated the TXIC/RXIC register handling code according to the new header file.

[2.5.1]

- Bug Fixes
  - Fixed document typo.

[2.5.0]

- Bug Fixes
  - Fixed the SendFrame/SendFrameZeroCopy functions issue with scattered buffers.
  - Updated the formula of MDC calculation.
  - Used a feature macro to distinguish the old IP design from the new design, because old IP design always reads a value zero from ATCR->CAPTURE bit. For old IP, driver caculates and wait the necessary delay cycles after setting ATCR->CAPTURE then gets the timestamp value.
- New Features
  - Added new zero copy Tx/Rx function.
  - New zero copy Tx function combines scattered and contiguous Tx buffer in one API, it also supports more Tx featrues which buffer descriptor supports but previous Tx function doesn't support.
  - New zero copy Rx function use dynamic buffer mechanism and simpler interface.
- Improvements
  - Corrected the interrupt handler for PTP timestamp IRQ and PTP1588 event IRQ since platform difference.
  - Added missing IRQ handlers for PTP1588 events on some platforms.
  - Corrected the max Tx frame length verification, it will not depend on a fixed macro. The ENET_FRAME_MAX_FRAMELEN is only an default value for driver, application can configure it. Driver caculates the limitation with the max frame length in register which may takes extended 4 or 8 bytes VLAN tag if VLAN/SVLAN enables.
  - Deleted deprecated Clause 45 read/write legacy APIs.

[2.4.3]

- Improvements
  - Aligned the IRQ handler name with header file.

[2.4.2]

- Bug Fixes
  - Fixed the MISRA issue of speculative out-of-bounds access.

[2.4.1]

- Bug Fixes
  - Fixed the PTP time capture issue.

[2.4.0]

- Improvements
  - Exposed API ENET_ReclaimTxDescriptor for user application to relaim tx descriptors in their application.
  - Added counter to record multicast hash conflict in struct _enet_handle, improved the situation that one multicast group could be left by other conflict multicast address left operation.
  - Improved concurrent usage of relaim and send frame operation.

[2.3.4]

- Bug Fixes
  - Fixed the issue that interrupt handler only checks the interrupt event flag but not checks interrupt mask flag.

[2.3.3]

- Bug Fixes
  - Fixed the issue that some compilers may choose the memcpy with 4-bit aligned address limitation due to the type of address pointer is 'unsigned int *', the data address doesn't have to be 4-bit aligned.

[2.3.2]

- New Features
  - Added the feature that ENET driver can be used in the platform which integrates both 10/100M and 1G ENET IP.
  - Deleted duplicated code about ARM errata 838869 in first/second level IRQ handler.

[2.3.1]

- Improvements
  - Added function pointer checking in IRQ handler to make sure code can be used even it runs into the interrupt when the second level interupt handler is NULL.

[2.3.0]

- Bug Fixes
  - Fixed the issue that clause 45 MDIO read/write API doesn't check the transmission over status between two transmissions.
  - Fixed violations of the MISRA C-2012 rules 2.2,10.3,10.4,10.7,11.6,11.8,13.5,14.4,15.7,17.7.
- New Features
  - Added APIs to support send/receive frame with Zero-Copy.

- Improvements
  - Separated the clock configuration from module configuration when init and deinit.
  - Added functions to set second level interrupt handler.
  - Provided new function to get 1588 timer count without disabling interrupt.
  - Improved timestamp controlling, deleted all old timestamp management APIs and data structures.
  - Merged the single/multiple ring(s) APIs, now these APIs can handle both.
  - Used base and index to control buffer descriptor, aligned with qos and lpc enet driver.

[2.2.6]

- Bug Fixes
  - Updated MII speed formula referring to the manual.

[2.2.5]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.6, 10.7, 11.6, 11.9, 13.5, 14.4, 16.4, 17.7, 21.15, 3.1, 8.4.
  - Changed to use ARRAY_SIZE(s_enetBases) as the array size for s_ENETHandle, fixed the hardfault issue for using some ENET instance when ARRAY_SIZE(s_enetBases) is not same as FSL_FEATURE_SOC_ENET_COUNT.

[2.2.4]

- Improvements
  - Added call to Data Synchronization Barrier instruction before activating Tx/Rx buffer descriptor to ensure previous data update is completed.
  - Improved ENET_TransmitIRQHandler to store timestamps for multiple transmit buffer descriptors.
  - Bug Fixes
  - Fixed the issue that ENET_Ptp1588GetTimer did not handle the timer wrap situation.

[2.2.3]

- Improvements
  - Improved data buffer cache maintenance in the ENET driver.

[2.2.2]

- New Features
  - Added APIs for extended multi-ring support.
  - Added the AVB configure API for extended AVB feature support.

[2.2.1]

- Improvements
  - Changed the input data pointer attribute to const in ENET_SendFrame().

[2.1.1]

- New Features
  - Added the extended MDIO IEEE802.3 Clause 45 MDIO format SMI command APIs.
  - Added the extended interrupt coalescing feature.
- Improvements
  - Combined all storage operations in the ENET_Init to ENET_SetHandler API.

[2.0.1]

- Bug Fixes
  - Used direct transmit busy check when doing data transmit.
- Miscellaneous Changes
  - Updated IRQ handler work flow.
  - Changed the TX/RX interrupt macro from kENET_RxByteInterrupt to kENET_RxBufferInterrupt, from kENET_TxByteInterrupt to kENET_TxBufferInterrupt.
  - Deleted unnecessary parameters in ENET handler.

[2.0.0]

- Initial version.

ENET_QOS

[2.6.5]

- Bug Fixes
  - Fixed ENET_QOS_GetMacAddr address byte order not matching ENET_QOS_SetMacAddr.

[2.6.4]

- Improvements
  - ENET_QOS_SetMII returns success or failure status now (related to i.MX RT1170 errata ERR050539 - ENET_QOS doesn't support RMII 10Mbps mode).
- Bug Fixes
  - Fixed the MISRA C-2012 issue rule 14.3.

[2.6.3]

- Bug Fixes
  - Fixed the issue that ENET_QOS_GetRxFrame, ENET_QOS_ReadFrame and ENET_QOS_DropFrame did not properly restart the receiving once it stopped.

[2.6.2]

- Bug Fixes
  - Fixed the issue that free wrong buffer address when one frame stores in multiple buffers and memory pool is not enough to allocate these buffers to receive one complete frame.

[2.6.1]

- Bug Fixes
  - Fixed the issue that ENET_QOS_ReadFrame doesn't check timestamp available bit before check the context BD bit, it makes software update extra BD. If DMA receives new frame to this BD before software update, software will lose this frame.

[2.6.0]

- New features
  - Added hardware checksum acceleration support.

[2.5.3]

- Bug Fixes
  - Fixed the MISRA issue rule 14.3, 5.3.

[2.5.2]

- Bug Fixes
  - Fixed the issue that ENET_QOS_Init reset the MDIO setting of ENET_QOS_SetSMI.

[2.5.1]

- Improvements
  - Supported RMII mode.

[2.5.0]

- Improvements
  - Added MDIO access wrapper APIs for ease of use.

[2.4.1]

- Improvements
  - Supported cache control.
  - Supported BD address convertion to system address.
  - Make driver aarch64 compatible
- Bug Fixes
  - Fixed the issue that driver internal interface ENET_QOS_DropFrame drops all frames in whole BD ring rather than one frame as design. Impact case: 1. Rx drop occurs in zero copy Rx API ENET_QOS_GetRxFrame. 2. Call ENET_QOS_ReadFrame with data pointer is NULL, driver will drop all Rx frames.

[2.4.0]

- New features
  - Added MDIO IEEE802.3 Clause 45 access support.
  - Added get statistics API to get some statistical data in transfer.
  - Added new APIs to support zero copy Rx.
  - Fixed the MISRA issue rule 8.4, 8.6.

[2.3.0]

- Improvements
  - Added counter to record multicast hash conflict in struct _enet_handle, improved the situation that one multicast group could be left by other conflict multicast address left operation.
- Bug Fixes
  - Updated txDirtyRing maintenance in reclaim and send frame process, allow txDirtyRing to be overwritten.
  - Disabled carrier sensing in full duplex mode configuration in ethernet initialization
  - Fixed 1588 sub-second calculate issue.

[2.2.2]

- Bug Fixes
  - Fixed the issue that ENET_QOS_SetupTxDescriptor didn't handle the DMA access address mapping for SoCs have feature FSL_FEATURE_MEMORY_HAS_ADDRESS_OFFSET.
  - Fixed MISRA 2012 violations detected in examples build.

[2.2.1]

- Bug Fixes
  - Fixed MISRA 2012 violations, fixed doxygen warning.
  - Fixed the issue that cache invalidate to invalid converted memory address in ENET_QOS_ReadFrame for SoCs have feature FSL_FEATURE_MEMORY_HAS_ADDRESS_OFFSET.

[2.2.0]

- Removed the ptp time data ring management, below structures and APIs are removed:
  - structure enet_qos_ptp_time_data_t
  - structure enet_qos_ptp_time_data_ring_t
  - API ENET_QOS_GetRxFrameTime
  - API ENET_QOS_GetTxFrameTime
- Added API for GCL list read and AVB configuration
  - ENET_QOS_EstReadGcl
  - ENET_QOS_AVBConfigure
- Improved driver for PTP system time configuration, timestamp read.
- Added IRQ lock and memory barrier instruction for descriptor operation.
- Fixed MISRA 2012 violations

[2.1.1]

- Bug Fixes
  - Fixed the bug that data pointer is not converted to local memory address in the call to ENET_QOS_Ptp1588ParseFrame.

[2.1.0]

- New feature
  - Update driver to support feature FSL_FEATURE_MEMORY_HAS_ADDRESS_OFFSET which convert buffer address to visible address for DMA.
  - Require user to provide implementation for ENET_QOS_SetSYSControl API, which set the PHY interface and enable clock generation for IP.

[2.0.0]

- Initial version.

EWM

[2.0.4]

- Bug Fixes
  - Fixed CERT INT31-C violations.

[2.0.3]

- Bug Fixes
  - Fixed violation of MISRA C-2012 rules: 10.1, 10.3.

[2.0.2]

- Bug Fixes
  - Fixed violation of MISRA C-2012 rules: 10.3, 10.4.

[2.0.1]

- Bug Fixes
  - Fixed the hard fault in EWM_Deinit.

[2.0.0]

- Initial version.

FLEXCAN

[2.14.1]

- Bug Fixes
  - Fixed register IMASK2-4 IFLAG2-4 HR_TIME_STAMPn access issue on FlexCAN instances with different number of MBs.
  - Fixed bit field MBDSR1-3 access issue on FlexCAN instances with different number of MBs.
- Improvements
  - Unified following API as same parameter and return value type:
    - FLEXCAN_GetMbStatusFlags
    - FLEXCAN_ClearMbStatusFlags
    - FLEXCAN_EnableMbInterrupts
    - FLEXCAN_DisableMbInterrupts

[2.14.0]

- Improvements
  - Support external time tick feature.
  - Support high resolution timestamp feature.
  - Enter Freeze Mode first when enter Disable Mode on some platform.
  - Add feature macro for Pretended Networking because some FlexCAN instance do not have this feature.
  - Add feature macro for enhanced Rx FIFO because some FlexCAN instance do not have this feature.
  - Add new FlexCAN IRQ Handler FLEXCAN_DriverDataIRQHandler and FLEXCAN_DriverEventIRQHandler. Thses IRQ Handlers are used on soc which FlexCAN interrupts are grouped by specific function and assigned to different vector.
  - Update macro FLEXCAN_WAKE_UP_FLAG and FLEXCAN_PNWAKE_UP_FLAG to simplify code.

  - Replace macro FSL_FEATURE_FLEXCAN_HAS_NO_WAKMSK_SUPPORT with FSL_FEATURE_FLEXCAN_HAS_NO_SLFWAK_SUPPORT.
  - Replace macro FSL_FEATURE_FLEXCAN_HAS_NO_WAKSRC_SUPPORT with FSL_FEATURE_FLEXCAN_HAS_GLITCH_FILTER.
- Bug Fixes
  - Fixed wrong interrupt and status flag helper macro in enumeration _flexcan_flags and API FLEXCAN_DisableInterrupts.
  - Fixed interrupt flag helper macro typo issue.
  - Remove flags which will are unassociated with interrupt in macro FLEXCAN_MEMORY_ERROR_INT_FLAG.
  - Remove flags which will are unassociated with interrupt in macro FLEXCAN_ERROR_AND_STATUS_INT_FLAG.
  - Fixed array out-of-bounds access when read enhanced Rx FIFO.

[2.13.1]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.13.0]

- Improvements
  - Support payload endianness selection feature.

[2.12.0]

- Improvements
  - Support automatic Remote Response feature.
  - Add API FLEXCAN_SetRemoteResponseMbConfig() to configure automatic Remote Response mailbox.

[2.11.8]

- Improvements
  - Synchronize flexcan driver update on s32z platform.

[2.11.7]

- Bug Fixes
  - Fixed FLEXCAN_TransferReceiveEnhancedFifoEDMA() compatibility with edma5.

[2.11.6]

- Bug Fixes
  - Fixed ERRATA_9595 FLEXCAN_EnterFreezeMode() may result to bus fault on some platform.

[2.11.5]

- Bug Fixes
  - Fixed flexcan_memset() crash under high optimization compilation.

[2.11.4]

- Improvements
  - Update CANFD max bitrate to 10Mbps on MCXNx3x and MCXNx4x.
  - Release peripheral from reset if necessary in init function.

[2.11.3]

- Bug Fixes
  - Fixed FLEXCAN_TransferReceiveEnhancedFifoEDMA() compile error with DMA3.

[2.11.2]

- Bug Fixes
  - Fixed bug that timestamp in flexcan_handle_t not updated when RX overflow happens.

[2.11.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1.

[2.11.0]

- Bug Fixes
  - Fixed wrong base address argument in FLEXCAN2 IRQ Handler.
- Improvements
  - Add API to determine if the instance supports CAN FD mode at run time.

[2.10.1]

- Bug Fixes
  - Fixed HIS CCM issue.
  - Fixed RTOS issue by adding protection to read-modify-write operations on interrupt enable/disable API.

[2.10.0]

- Improvements
  - Update driver to make it able to support devices which has more than 64 8bytes MBs.
  - Update CAN FD transfer APIs to make them set/get edl bit according to frame content, which can make them compatible with classic CAN.

[2.9.2]

- Bug Fixes
  - Fixed the issue that FLEXCAN_CheckUnhandleInterruptEvents() can't detecting the exist enhanced RX FIFO interrupt status.
  - Fixed the issue that FLEXCAN_ReadPNWakeUpMB() does not return fail even no existing valid wake-up frame.
  - Fixed the issue that FLEXCAN_ReadEnhancedRxFifo() may clear bits other than the data available bit.
  - Fixed violations of the MISRA C-2012 rules 10.4, 10.8.
- Improvements
  - Return kStatus_FLEXCAN_RxFifoDisabled instead of kStatus_Fail when read FIFO fail during IRQ handler.
  - Remove unreachable code from timing calculates APIs.
  - Update Enhanced Rx FIFO handler to make it deal with underflow/overflow status first.

[2.9.1]

- Bug Fixes
  - Fixed the issue that FLEXCAN_TransferReceiveEnhancedFifoBlocking() API clearing Fifo data available flag more than once.
  - Fixed the issue that entering FLEXCAN_SubHandlerForEhancedRxFifo() even if Enhanced Rx fifo interrupts are not enabled.
  - Fixed the issue that FLEXCAN_TransferReceiveEnhancedFifoEDMA() update handle even if previous Rx FIFO receive not finished.
  - Fixed the issue that FLEXCAN_SetEnhancedRxFifoConfig() not configure the ERFCR[NFE] bits to the correct value.
  - Fixed the issue that FLEXCAN_ReceiveFifoEDMACallback() can't differentiate between Rx fifo and enhanced rx fifo.
  - Fixed the issue that FLEXCAN_TransferHandleIRQ() can't report Legacy Rx FIFO warning status.

[2.9.0]

- Improvements
- Add public set bit rate API to make driver easier to use.
- Update Legacy Rx FIFO transfer APIs to make it support received multiple frames during one API call.
- Optimized FLEXCAN_SubHandlerForDataTransfered() API in interrupt handling to reduce the probability of packet loss.

[2.8.7]

- Improvements
- Initialized the EDMA configuration structure in the FLEXCAN EDMA driver.

[2.8.6]

- Bug Fixes
- Fix Coverity overrun issues in fsl_flexcan_edma driver.

[2.8.5]

- Improvements
  - Make driver aarch64 compatible.

[2.8.4]

- Bug Fixes
  - Fixed FlexCan_Errata_6032 to disable all interrupts.

[2.8.3]

- Bug Fixes
  - Fixed an issue with the FLEXCAN_EnableInterrupts and FLEXCAN_DisableInterrupts interrupt enable bits in the CTRL1 register.

[2.8.2]

- Bug Fixes
  - Fixed errors in timing calculations and simplify the calculation process.
  - Fixed issue of CBT and FDCBT register may write failure.

[2.8.1]

- Bug Fixes
  - Fixed the issue of CAN FD three sampling points.
  - Added macro to support the devices that no MCR[SUPV] bit.
  - Remove unnecessary clear WMB operations.

[2.8.0]

- Improvements
  - Update config configuration.
    - Added enableSupervisorMode member to support enable/disable Supervisor mode.
  - Simplified the algorithm in CAN FD improved timing APIs.

[2.7.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.7.

[2.7.0]

- Improvements
  - Update config configuration.
    - Added enablePretendedeNetworking member to support enable/disable Pretended Networking feature.
    - Added enableTransceiverDelayMeasure member to support enable/disable Transceiver Delay MeasurementPretended feature.
    - Added bitRate/bitRateFD member to work as baudRate/baudRateFD member union.
  - Rename all “baud” in code or comments to “bit” to align with the CAN spec.
  - Added Pretended Networking mode related APIs.
    - FLEXCAN_SetPNConfig
    - FLEXCAN_GetPNMatchCount
    - FLEXCAN_ReadPNWakeUpMB
  - Added support for Enhanced Rx FIFO.
  - Removed independent memory error interrupt/status APIs and put all interrupt/status control operation into FLEXCAN_EnableInterrupts/FLEXCAN_DisableInterrupts and FLEXCAN_GetStatusFlags/FLEXCAN_ClearStatusFlags APIs.
  - Update improved timing APIs to make it calculate improved timing according to CiA doc recommended.
    - FLEXCAN_CalculateImprovedTimingValues.
    - FLEXCAN_FDCalculateImprovedTimingValues.
  - Update FLEXCAN_SetBitRate/FLEXCAN_SetFDBitRate to added the use of enhanced timing registers.

[2.6.2]

- Improvements
  - Add CANFD frame data length enumeration.

[2.6.1]

- Bug Fixes
  - Fixed the issue of not fully initializing memory in FLEXCAN_Reset() API.

[2.6.0]

- Improvements
  - Enable CANFD ISO mode in FLEXCAN_FDInit API.
  - Enable the transceiver delay compensation feature when enable FD operation and set bitrate switch.
  - Implementation memory error control in FLEXCAN_Init API.
  - Improve FLEXCAN_FDCalculateImprovedTimingValues API to get same value for FPRESDIV and PRESDIV.
  - Added memory error configuration for user.

        * enableMemoryErrorControl
        * enableNonCorrectableErrorEnterFreeze
    - Added memory error related APIs.
        * FLEXCAN_GetMemoryErrorReportStatus
        * FLEXCAN_GetMemoryErrorStatusFlags
        * FLEXCAN_ClearMemoryErrorStatusFlags
        * FLEXCAN_EnableMemoryErrorInterrupts
        * FLEXCAN_DisableMemoryErrorInterrupts
- Bug Fixes
    - Fixed the issue of sent duff CAN frame after call FLEXCAN_FDInit() API.

[2.5.2]

- Bug Fixes
    - Fixed the code error issue and simplified the algorithm in improved timing APIs.
        * The bit field in CTRL1 register couldn't calculate higher ideal SP, we set it as the lowest one(75%)
            · FLEXCAN_CalculateImprovedTimingValues
            · FLEXCAN_FDCalculateImprovedTimingValues
    - Fixed MISRA-C 2012 Rule 17.7 and 14.4.
- Improvements
    - Pass EsrStatus to callback function when kStatus_FLEXCAN_ErrorStatus is comming.

[2.5.1]

- Bug Fixes
    - Fixed the non-divisible case in improved timing APIs.
        * FLEXCAN_CalculateImprovedTimingValues
        * FLEXCAN_FDCalculateImprovedTimingValues

[2.5.0]

- Bug Fixes
    - MISRA C-2012 issue check.
        * Fixed rules, containing: rule-10.1, rule-10.3, rule-10.4, rule-10.7, rule-10.8, rule-11.8, rule-12.2, rule-13.4, rule-14.4, rule-15.5, rule-15.6, rule-15.7, rule-16.4, rule-17.3, rule-5.8, rule-8.3, rule-8.5.
    - Fixed the issue that API FLEXCAN_SetFDRxMbConfig lacks inactive message buff.
    - Fixed the issue of Pa082 warning.
    - Fixed the issue of dead lock in the function of interruption handler.
    - Fixed the issue of Legacy Rx Fifo EDMA transfer data fail in evkmimxrt1060 and evkmimxrt1064.
    - Fixed the issue of setting CANFD Bit Rate Switch.

  - Fixed the issue of operating unknown pointer risk.
    * when used the pointer "handle->mbFrameBuf[mbIdx]" to update the timestamp in a short-live TX frame, the frame pointer became as unknown, the action of operating it would result in program stack destroyed.
  - Added assert to check current CAN clock source affected by other clock gates in current device.
    * In some chips, CAN clock sources could be selected by CCM. But for some clock sources affected by other clock gates, if user insisted on using that clock source, they had to open these gates at the same time. However, they should take into consideration the power consumption issue at system level. In RT10xx chips, CAN clock source 2 was affected by the clock gate of lpuart1. ERRATA ID: (ERR050235 in CCM).

- Improvements
  - Implementation for new FLEXCAN with ECC feature able to exit Freeze mode.
  - Optimized the function of interruption handler.
  - Added two APIs for FLEXCAN EDMA driver.
    * FLEXCAN_PrepareTransfConfiguration
    * FLEXCAN_StartTransferDatafromRxFIFO
  - Added new API for FLEXCAN driver.
    * FLEXCAN_GetTimeStamp
      · For TX non-blocking API, we wrote the frame into mailbox only, so no need to register TX frame address to the pointer, and the timestamp could be updated into the new global variable handle->timestamp[mbIdx], the FLEXCAN driver provided a new API for user to get it by handle and index number after TX DONE Success.
    * FLEXCAN_EnterFreezeMode
    * FLEXCAN_ExitFreezeMode
  - Added new configuration for user.
    * disableSelfReception
    * enableListenOnlyMode
  - Renamed the two clock source enum macros based on CLKSRC bit field value directly.
    * The CLKSRC bit value had no property about Oscillator or Peripheral type in lots of devices, it acted as two different clock input source only, but the legacy enum macros name contained such property, that misled user to select incorrect CAN clock source.
  - Created two new enum macros for the FLEXCAN driver.
    * kFLEXCAN_ClkSrc0
    * kFLEXCAN_ClkSrc1
  - Deprecated two legacy enum macros for the FLEXCAN driver.
    * kFLEXCAN_ClkSrcOsc
    * kFLEXCAN_ClkSrcPeri
  - Changed the process flow for Remote request frame response..
    * Created a new enum macro for the FLEXCAN driver.
      · kStatus_FLEXCAN_RxRemote

  - Changed the process flow for kFLEXCAN_StateRxRemote state in the interrupt handler.
    * Should the TX frame not register to the pointer of frame handle, interrupt handler would not be able to read the remote response frame from the mail box to ram, so user should read the frame by manual from mail box after a complete remote frame transfer.

[2.4.0]

- Bug Fixes
  - MISRA C-2012 issue check.
    * Fixed rules, containing: rule-12.1, rule-17.7, rule-16.4, rule-11.9, rule-8.4, rule-14.4, rule-10.8, rule-10.4, rule-10.3, rule-10.7, rule-10.1, rule-11.6, rule-13.5, rule-11.3, rule-8.3, rule-12.2 and rule-16.1.
  - Fixed the issue that CANFD transfer data fail when bus baudrate is 30Khz.
  - Fixed the issue that ERR009595 does not folllow the ERRATA document.
  - Fixed code error for ERR006032 work around solution.
  - Fixed the Coverity issue of BAD_SHIFT in FLEXCAN.
  - Fixed the Repo build warning issue for variable without initial.
- Improvements
  - Fixed the run fail issue of FlexCAN RemoteRequest UT Case.
  - Implementation all TX and RX transfering Timestamp used in FlexCAN demos.
  - Fixed the issue of UT Test Fail for CANFD payload size changed from 64BperMB to 8PerMB.
  - Implementation for improved timing API by baud rate.

[2.3.2]

- Improvements
  - Implementation for ERR005959.
  - Implementation for ERR005829.
  - Implementation for ERR006032.

[2.3.1]

- Bug Fixes
  - Added correct handle when kStatus_FLEXCAN_TxSwitchToRx is comming.

[2.3.0]

- Improvements
  - Added self-wakeup support for STOP mode in the interrupt handling.

[2.2.3]

- Bug Fixes
  - Fixed the issue of CANFD data phase's bit rate not set as expected.

[2.2.2]

- Improvements
  - Added a time stamp feature and enable it in the interrupt_transfer example.

[2.2.1]

- Improvements
  - Separated CANFD initialization API.
  - In the interrupt handling, fix the issue that the user cannot use the normal CAN API when with an FD.

[2.2.0]

- Improvements
  - Added FSL_FEATURE_FLEXCAN_HAS_SUPPORT_ENGINE_CLK_SEL_REMOVE feature to support SoCs without CAN Engine Clock selection in FlexCAN module.
  - Added FlexCAN Serial Clock Operation to support i.MX SoCs.

[2.1.0]

- Bug Fixes
  - Corrected the spelling error in the function name FLEXCAN_XXX().
  - Moved Freeze Enable/Disable setting from FLEXCAN_Enter/ExitFreezeMode() to FLEXCAN_Init().
  - Corrected wrong helper macro values.
- Improvements
  - Hid FLEXCAN_Reset() from user.
  - Used NDEBUG macro to wrap FLEXCAN_IsMbOccupied() function instead of DEBUG macro.

[2.0.0]

- Initial version.

FLEXCAN_EDMA

[2.12.0]

- Improvements
  - Support high resolution timestamp feature in enhanced Rx FIFO EDMA.
  - Add feature macro for enhanced Rx FIFO because some FlexCAN instance do not have this feature.
- Bug Fixes
  - Fixed array out-of-bounds access when read enhanced Rx FIFO in EDMA.

[2.11.7]

- Refer FLEXCAN driver change log 2.7.0 to 2.11.7

FLEXIO

[2.3.0]

- Improvements
  - Supported platforms which don't have DOZE mode control.
  - Added more pin control functions.

[2.2.3]

- Improvements
  - Adapter the FLEXIO driver to platforms which don't have system level interrupt controller, such as NVIC.

[2.2.2]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.2.1]

- Improvements
  - Added doxygen index parameter comment in FLEXIO_SetClockMode.

[2.2.0]

- New Features
  - Added new APIs to support FlexIO pin register.

[2.1.0]

- Improvements
  - Added API FLEXIO_SetClockMode to set flexio channel counter and source clock.

[2.0.4]

- Bug Fixes
  - Fixed MISRA 8.4 issues.

[2.0.3]

- Bug Fixes
  - Fixed MISRA 10.4 issues.

[2.0.2]

- Improvements
  - Split FLEXIO component which combines all flexio/flexio_uart/flexio_i2c/flexio_i2s drivers into several components: FlexIO component, flexio_uart component, flexio_i2c_master component, and flexio_i2s component.
- Bug Fixes
  - Fixed MISRA issues
    * Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.

[2.0.1]

- Bug Fixes
  - Fixed the dozen mode configuration error in FLEXIO_Init API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.

FLEXIO_I2C

[2.6.1]

- Bug Fixes
  - Fixed coverity issues

[2.6.0]

- Improvements
  - Supported platforms which don't have DOZE mode control.

[2.5.1]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.5.0]

- Improvements
  - Split some functions, fixed CCM problem in file fsl_flexio_i2c_master.c.

[2.4.0]

- Improvements
  - Added delay of 1 clock cycle in FLEXIO_I2C_MasterTransferRunStateMachine to ensure that bus would be idle before next transfer if master is nacked.
  - Fixed issue that the restart setup time is less than the time in I2C spec by adding delay of 1 clock cycle before restart signal.

[2.3.0]

- Improvements
  - Used 3 timers instead of 2 to support transfer which is more than 14 bytes in single transfer.
  - Improved FLEXIO_I2C_MasterTransferGetCount so that the API can check whether the transfer is still in progress.
- Bug Fixes
  - Fixed MISRA 10.4 issues.

[2.2.0]

- New Features
  - Added timeout mechanism when waiting certain state in transfer API.
  - Added an API for checking bus pin status.
- Bug Fixes
  - Fixed COVERITY issue of useless call in FLEXIO_I2C_MasterTransferRunStateMachine.
  - Fixed MISRA issues
    - Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.
  - Added codes in FLEXIO_I2C_MasterTransferCreateHandle to clear pending NVIC IRQ, disable internal IRQs before enabling NVIC IRQ.
  - Modified code so that during master's nonblocking transfer the start and slave address are sent after interrupts being enabled, in order to avoid potential issue of sending the start and slave address twice.

[2.1.7]

- Bug Fixes
  - Fixed the issue that FLEXIO_I2C_MasterTransferBlocking did not wait for STOP bit sent.
  - Fixed COVERITY issue of useless call in FLEXIO_I2C_MasterTransferRunStateMachine.
  - Fixed the issue that I2C master did not check whether bus was busy before transfer.

[2.1.6]

- Bug Fixes
  - Fixed the issue that I2C Master transfer APIs(blocking/non-blocking) did not support the situation of master transfer with subaddress and transfer data size being zero, which means no data followed the subaddress.

[2.1.5]

- Improvements
  - Unified component full name to FLEXIO I2C Driver.

[2.1.4]

- Bug Fixes
  - The following modifications support FlexIO using multiple instances:
    * Removed FLEXIO_Reset API in module Init APIs.
    * Updated module Deinit APIs to reset the shifter/timer config instead of disabling module/clock.
    * Updated module Enable APIs to only support enable operation.

[2.1.3]

- Improvements
  - Changed the prototype of FLEXIO_I2C_MasterInit to return kStatus_Success if initialized successfully or to return kStatus_InvalidArgument if "(srcClock_Hz / masterConfig->baudRate_Bps) / 2 - 1" exceeds 0xFFU.

[2.1.2]

- Bug Fixes
  - Fixed the FLEXIO I2C issue where the master could not receive data from I2C slave in high baudrate.
  - Fixed the FLEXIO I2C issue where the master could not receive NAK when master sent non-existent addr.
  - Fixed the FLEXIO I2C issue where the master could not get transfer count successfully.
  - Fixed the FLEXIO I2C issue where the master could not receive data successfully when sending data first.
  - Fixed the Dozen mode configuration error in FLEXIO_I2C_MasterInit API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.
  - Fixed the issue that FLEXIO_I2C_MasterTransferBlocking API called FLEXIO_I2C_MasterTransferCreateHandle, which lead to the s_flexioHandle/s_flexioIsr/s_flexioType variable being written. Then, if calling FLEXIO_I2C_MasterTransferBlocking API multiple times, the s_flexioHandle/s_flexioIsr/s_flexioType variable would not be written any more due to it being out of range. This lead to the following situation: NonBlocking transfer APIs could not work due to the fail of register IRQ.

[2.1.1]

- Bug Fixes
  - Implemented the FLEXIO_I2C_MasterTransferBlocking API which is defined in header file but has no implementation in the C file.

[2.1.0]

- New Features
  - Added Transfer prefix in transactional APIs.
  - Added transferSize in handle structure to record the transfer size.

FLEXIO_I2S

[2.2.2]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 12.4.

[2.2.1]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.2.0]

- New Features
  - Added timeout mechanism when waiting certain state in transfer API.
- Bug Fixes
  - Fixed IAR Pa082 warnings.
  - Fixed violations of the MISRA C-2012 rules 10.4, 14.4, 11.8, 11.9, 10.1, 17.7, 11.6, 10.3, 10.7.

[2.1.6]

- Bug Fixes
  - Added reset flexio before flexio i2s init to make sure flexio status is normal.

[2.1.5]

- Bug Fixes
  - Fixed the issue that I2S driver used hard code for bitwidth setting.

[2.1.4]

- Improvements
  - Unified component's full name to FLEXIO I2S (DMA/EDMA) driver.

[2.1.3]

- Bug Fixes
  - The following modifications support FLEXIO using multiple instances:
    - Removed FLEXIO_Reset API in module Init APIs.
    - Updated module Deinit APIs to reset the shifter/timer config instead of disabling module/clock.
    - Updated module Enable APIs to only support enable operation.

[2.1.2]

- New Features
  - Added configure items for all pin polarity and data valid polarity.
  - Added default configure for pin polarity and data valid polarity.

[2.1.1]

- Bug Fixes
  - Fixed FlexIO I2S RX data read error and eDMA address error.
  - Fixed FlexIO I2S slave timer compare setting error.

[2.1.0]

- New Features
  - Added Transfer prefix in transactional APIs.
  - Added transferSize in handle structure to record the transfer size.

FLEXIO_I2S_EDMA

[2.1.9]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 12.4.

[2.1.8]

- Improvements
  - Applied EDMA ERRATA 51327.

FLEXIO_SPI

[2.4.2]

- Bug Fixes
  - Fixed FLEXIO_SPI_MasterTransferBlocking and FLEXIO_SPI_MasterTransferNonBlocking issue in CS continuous mode, the CS might not be continuous.

[2.4.1]

- Bug Fixes
  - Fixed coverity issues

[2.4.0]

- Improvements
  - Supported platforms which don't have DOZE mode control.

[2.3.5]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.3.4]

- Bug Fixes
  - Fixed the txData from void * to const void * in transmit API

[2.3.3]

- Bugfixes
  - Fixed cs-continuous mode.

[2.3.2]

- Improvements
  - Changed FLEXIO_SPI_DUMMYDATA to 0x00.

[2.3.1]

- Bugfixes
  - Fixed IRQ SHIFTBUF overrun issue when one FLEXIO instance used as multiple SPIs.

[2.3.0]

- New Features
  - Supported FLEXIO_SPI slave transfer with continuous master CS signal and CPHA=0.
  - Supported FLEXIO_SPI master transfer with continuous CS signal.
  - Support 32 bit transfer width.
- Bug Fixes
  - Fixed wrong timer compare configuration for dma/edma transfer.
  - Fixed wrong byte order of rx data if transfer width is 16 bit, since the we use shifter buffer bit swapped/byte swapped register to read in received data, so the high byte should be read from the high bits of the register when MSB.

[2.2.1]

- Bug Fixes
  - Fixed bug in FLEXIO_SPI_MasterTransferAbortEDMA that when aborting EDMA transfer EDMA_AbortTransfer should be used rather than EDMA_StopTransfer.

[2.2.0]

- Improvements
  - Added timeout mechanism when waiting certain states in transfer driver.
- Bug Fixes
  - Fixed MISRA 10.4 issues.
  - Added codes in FLEXIO_SPI_MasterTransferCreateHandle and FLEXIO_SPI_SlaveTransferCreateHandle to clear pending NVIC IRQ before enabling NVIC IRQ, to fix issue of pending IRQ interfering the on-going process.

[2.1.3]

- Improvements
  - Unified component full name to FLEXIO SPI(DMA/EDMA) Driver.
- Bug Fixes
  - Fixed MISRA issues
    - Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.

[2.1.2]

- Bug Fixes
  - The following modification support FlexIO using multiple instances:
    - Removed FLEXIO_Reset API in module Init APIs.
    - Updated module Deinit APIs to reset the shifter/timer config instead of disabling module/clock.
    - Updated module Enable APIs to only support enable operation.

[2.1.1]

- Bug Fixes
  - Fixed bug where FLEXIO SPI transfer data is in 16 bit per frame mode with eDMA.
  - Fixed bug when FLEXIO SPI works in eDMA and interrupt mode with 16-bit per frame and Lsbfirst.
  - Fixed the Dozen mode configuration error in FLEXIO_SPI_MasterInit/FLEXIO_SPI_SlaveInit API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.
- Improvements
  - Added #ifndef/#endif to allow users to change the default TX value at compile time.

[2.1.0]

- New Features
  - Added Transfer prefix in transactional APIs.
  - Added transferSize in handle structure to record the transfer size.
- Bug Fixes

  - Fixed the error register address return for 16-bit data write in FLEXIO_SPI_GetTxDataRegisterAddress.
  - Provided independent IRQHandler/transfer APIs for Master and slave to fix the baudrate limit issue.

FLEXIO_UART

[2.6.2]

- Bug Fixes
  - Fixed coverity issues

[2.6.1]

- Improvements
  - Improve baudrate calculation method, to support higher frequency FlexIO clock source.

[2.6.0]

- Improvements
  - Supported platforms which don't have DOZE mode control.

[2.5.1]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.5.0]

- Improvements
  - Added API FLEXIO_UART_FlushShifters to flush UART fifo.

[2.4.0]

- Improvements
  - Use separate data for TX and RX in flexio_uart_transfer_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling FLEXIO_UART_TransferReceiveNonBlocking, the received data count returned by FLEXIO_UART_TransferGetReceiveCount is wrong.

[2.3.0]

- Improvements
  - Added check for baud rate's accuracy that returns kStatus_FLEXIO_UART_BaudrateNotSupport when the best achieved baud rate is not within 3% error of configured baud rate.
- Bug Fixes
  - Added codes in FLEXIO_UART_TransferCreateHandle to clear pending NVIC IRQ before enabling NVIC IRQ, to fix issue of pending IRQ interfering the on-going process.

[2.2.0]

- Improvements
  - Added timeout mechanism when waiting for certain states in transfer driver.
- Bug Fixes
  - Fixed MISRA 10.4 issues.

[2.1.6]

- Bug Fixes
  - Fixed IAR Pa082 warnings.
  - Fixed MISRA issues
    - Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.

[2.1.5]

- Improvements
  - Triggered user callback after all the data in ringbuffer were received in FLEXIO_UART_TransferReceiveNonBlocking.

[2.1.4]

- Improvements
  - Unified component full name to FLEXIO UART(DMA/EDMA) Driver.

[2.1.3]

- Bug Fixes
  - The following modifications support FLEXIO using multiple instances:
    - Removed FLEXIO_Reset API in module Init APIs.
    - Updated module Deinit APIs to reset the shifter/timer configuration instead of disabling module and clock.
    - Updated module Enable APIs to only support enable operation.

[2.1.2]

- Bug Fixes
  - Fixed the transfer count calculation issue in FLEXIO_UART_TransferGetReceiveCount, FLEXIO_UART_TransferGetSendCount, FLEXIO_UART_TransferGetReceiveCountDMA, FLEXIO_UART_TransferGetSendCountDMA, FLEXIO_UART_TransferGetReceiveCountEDMA and FLEXIO_UART_TransferGetSendCountEDMA.
  - Fixed the Dozen mode configuration error in FLEXIO_UART_Init API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.
  - Added code to report errors if the user sets a too-low-baudrate which FLEXIO cannot reach.
  - Disabled FLEXIO_UART receive interrupt instead of all NVICs when reading data from ring buffer. If ring buffer is used, receive nonblocking will disable all NVIC interrupts to protect the ring buffer. This had negative effects on other IPs using interrupt.

[2.1.1]

- Bug Fixes
  - Changed the API name FLEXIO_UART_StopRingBuffer to FLEXIO_UART_TransferStopRingBuffer to align with the definition in C file.

[2.1.0]

- New Features
  - Added Transfer prefix in transactional APIs.
  - Added txSize/rxSize in handle structure to record the transfer size.
- Bug Fixes
  - Added an error handle to handle the situation that data count is zero or data buffer is NULL.

FLEXIO_UART_EDMA

[2.3.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules.

[2.3.0]

- Refer FLEXIO_UART driver change log to 2.3.0

FLEXRAM

[2.3.0]

- New Features
  - Supported platforms which have ECC but no ECC error injection.

[2.2.0]

- New Features
  - Supported flexram ECC error injection function.

[2.1.0]

- New Features
  - Supported flexram ECC function.

[2.0.7]

- Bug Fixes
  - Fixed doxygen issue.

[2.0.6]

- New Features
  - Updated bank configuration and TCM size with GPR16/GPR17/GPR18 into SOC level for different SOC.

[2.0.5]

- New Features
  - Added the magic address feature for OCRAM, DTCM and ITCM.

[2.0.4]

- Bug Fixes
  - Fixed FlexRAM driver's missing extern C around functions in header file.
  - Removed magic address feature from driver.

[2.0.3]

- Bug Fixes
  - Fixed the issue that TCM size configuration was wrong when TCM bank number was not a value power of 2.

[2.0.2]

- Bug Fixes
  - Updated driver due to Reference Manual update.

[2.0.1]

- Bug Fixes
  - Fixed MISRA issue.

[2.0.0]

- Initial version.

FLEXSPI

[2.7.0]

- New Features
  - Added new API to support address remapping.

[2.6.4]

- Improvements
  - Added new macro “FSL_SDK_ENABLE_FLEXSPI_RESET_CONTROL” to support driver level reset control.

[2.6.3]

- Bug Fixes
  - Fixed an issue which cause IPCR1[IPAREN] cleared by mistake.

[2.6.2]

- Bug Fixes
  - Wait Bus IDLE before operation of FLEXSPI_SoftwareReset(), FLEXSPI_TransferBlocking() and FLEXSPI_TransferNonBlocking().

[2.6.1]

- Bug Fixes
  - Updated code of reset peripheral.
  - Updated FLEXSPI_UpdateLUT() to check if input lut address is not in Flexspi AMBA region.
  - Updated FLEXSPI_Init() to check if input AHB buffer size exceeded maximum AHB size.

[2.6.0]

- New Features
  - Added new API to set AHB memory-mapped flash base address.
  - Added support of DLLxCR[REFPHASEGAP] bit field, it is recommended to set it as 0x2 if DLL calibration is enabled.

[2.5.1]

- Bugfixes
  - Fixed handling of W1C bits in the INTR register
  - Removed FIFO resets from FLEXSPI_CheckAndClearError
  - FLEXSPI_TransferBlocking is observing IPCMDDONE and then fetches the final status of the transfer
  - Fixed issue that FLEXSPI2_DriverIRQHandler not defined.

[2.5.0]

- Improvements
  - Supported word un-aligned access for write/read blocking/non-blocking API functions.
  - Fixed dead loop issue in DLL update function when using FRO clock source.
  - Fixed violations of the MISRA C-2012 Rule 10.3.

[2.4.0]

- Improvements
  - Isolated IP command parallel mode and AHB command parallel mode using feature MACRO.
  - Supported new column address shift feature for external memory.

[2.3.5]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 14.2.

[2.3.4]

- Bug Fixes
  - Updated flexspi_config_t structure and FlexSPI_Init to support new feature FSL_FEATURE_FLEXSPI_HAS_NO_MCR0_CONBINATION.

[2.3.3]

- Bug Fixes
  - Removed feature FSL_FEATURE_FLEXSPI_DQS_DELAY_PS for DLL delay setting. Changed to use feature FSL_FEATURE_FLEXSPI_DQS_DELAY_MIN to set slave delay target as 0 for DLL enable and clock frequency higher than 100MHz.

[2.3.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 8.4, 8.5, 10.1, 10.3, 10.4, 11.6 and 14.4.

[2.3.1]

- Bug Fixes
  - Wait for bus to be idle before using it as access to external flash with new setting in FLEXSPI_SetFlashConfig() API.
  - Fixed the potential buffer overread and Tx FIFO overwrite issue in FLEXSPI_WriteBlocking.

[2.3.0]

- New Features
  - Added new API FLEXSPI_UpdateDllValue for users to update DLL value after updating flexspi root clock.
  - Corrected grammatical issues for comments.
  - Added support for new feature FSL_FEATURE_FLEXSPI_DQS_DELAY_PS in DLL configuration.

[2.2.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 10.1, 10.3 and 10.4.
  - Updated _flexspi_command from named enumerator into anonymous enumerator.

[2.2.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 10.1, 10.3, 10.4, 10.8, 11.9, 14.4, 15.7, 16.4, 17.7, 7.3.
  - Fixed IAR build warning Pe167.
  - Fixed the potential buffer overwrite and Rx FIFO overread issue in FLEXSPI_ReadBlocking.

[2.2.0]

- Bug Fixes
  - Fixed flag name typos: kFLEXSPI_IpTxFifoWatermarkEmpltyFlag to kFLEXSPI_IpTxFifoWatermarkEmptyFlag; kFLEXSPI_IpCommandExcutionDoneFlag to kFLEXSPI_IpCommandExecutionDoneFlag.
  - Fixed comments typos such as sequencen->sequence, levle->level.
  - Fixed FLSHCR2[ARDSEQID] field clean issue.
  - Updated flexspi_config_t structure and FlexSPI_Init to support new feature FSL_FEATURE_FLEXSPI_HAS_NO_MCR0_ATDFEN and FSL_FEATURE_FLEXSPI_HAS_NO_MCR0_ARDFEN.
  - Updated flexspi_flags_t structure to support new feature FSL_FEATURE_FLEXSPI_HAS_INTEN_AHBBUSERROREN.

[2.1.1]

- Improvements
  - Defaulted enable prefetch for AHB RX buffer configuration in FLEXSPI_GetDefaultConfig, which is align with the reset value in AHBRXBUFxCR0.
  - Added software workaround for ERR011377 in FLEXSPI_SetFlashConfig; added some delay after DLL lock status set to ensure correct data read/write.

[2.1.0]

- New Features
  - Added new API FLEXSPI_UpdateRxSampleClock for users to update read sample clock source after initialization.
  - Added reset peripheral operation in FLEXSPI_Init if required.

[2.0.5]

- Bug Fixes
  - Fixed FLEXSPI_UpdateLUT cannot do partial update issue.

[2.0.4]

- Bug Fixes
  - Reset flash size to zero for all ports in FLEXSPI_Init; fixed the possible out-of-range flash access with no error reported.

[2.0.3]

- Bug Fixes
  - Fixed AHB receive buffer size configuration issue. The FLEXSPI_AHBRXBUFCR0_BUFSZ field should configure 64 bits size, and currently the AHB receive buffer size is in bytes which means 8-bit, so the correct configuration should be config->ahbConfig.buffer[i].bufferSize / 8.

[2.0.2]

- New Features
  - Supported DQS write mask enable/disable feature during set FLEXSPI configuration.
  - Provided new API FLEXSPI_TransferUpdateSizeEDMA for users to update eDMA transfer size(SSIZE/DSIZE) per DMA transfer.
- Bug Fixes
  - Fixed invalid operation of FLEXSPI_Init to enable AHB bus Read Access to IP RX FIFO.
  - Fixed incorrect operation of FLEXSPI_Init to configure IP TX FIFO watermark.

[2.0.1]

- Bug Fixes
  - Fixed the flag clear issue and AHB read Command index configuration issue in FLEXSPI_SetFlashConfig.
  - Updated FLEXSPI_UpdateLUT function to update LUT table from any index instead of previous command index.
  - Added bus idle wait in FLEXSPI_SetFlashConfig and FLEXSPI_UpdateLUT to ensure bus is idle before any change to FlexSPI controller.
  - Updated interrupt API FLEXSPI_TransferNonBlocking and interrupt handle flow FLEXSPI_TransferHandleIRQ.
  - Updated eDMA API FLEXSPI_TransferEDMA.

[2.0.0]

- Initial version.

FLEXSPI EDMA Driver

[2.3.3]

- Bug Fixes
  - Fixed FLEXSPI_TransferEDMA bug that, the DMA channel not configured correctly when using kFLEXSPI_Read.

[2.3.2]

- Bug Fixes
  - Fixed the bug that internal variable s_edmaPrivateHandle overflows when using FlexSPI2.

[2.0.2]

- New Features
  - Provided new API FLEXSPI_TransferUpdateSizeEDMA for users to update eDMA transfer size(SSIZE/DSIZE) per DMA transfer.

[2.0.0]

- Initial version.

GPIO

[2.0.6]

- Bug Fixes
  - Fixed compile warning: 'GPIO_GetInstance' defined but not used when macro FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL is defined.

[2.0.5]

- Bug Fixes
  - Fixed MISRA C-2012 issue: rule-17.7.

[2.0.4]

- Improvements
  - Updated the GPIO_PinWrite to use atomic operation if possible.
- Bug Fixes
  - Fixed GPIO_PortToggle bug with platforms don't have register DR_TOGGLE.

[2.0.3]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fixed rules, containing: rule-10.3, rule-14.4, and rule-15.5.

[2.0.2]

- Bug Fixes
  - Fixed the bug of enabling wrong GPIO clock gate in initial API. Since some GPIO instances may not have a clock gate enabled, it checks the clock gate number and makes sure the clock gate is valid.

[2.0.1]

- Improvements
  - API interface changes:
    - Refined naming of the API while keeping all original APIs, marking them as deprecated. Original APIs will be removed in next release. The main change is to update the API with prefix of _PinXXX() and _PortXXX().

[2.0.0]

- Initial version.

GPT

[2.0.5]

- Improvements
  - Support workaround for ERR003777. This workaround helps switching the clock sources.

[2.0.4]

- Bug Fixes
  - Fixed compiler warning when built with FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL flag enabled.

[2.0.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 5.3 by customizing function parameter.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 17.7.

[2.0.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.6, 10.8, 17.7.

[2.0.0]

- Initial version.

IEE

[2.1.1]

- Fixed MISRA issues.

[2.1.0]

- Add region lock function IEE_LockRegionConfig() and driver clock control.

[2.0.0]

- Initial version.

IEE_APC

[2.0.2]

- Updated to newer version of implementation in HW.

[2.0.1]

- Fixed MISRA issues.

[2.0.0]

- Initial version.

KEYMGR

[2.0.2]

- Fix MISRA-2012 issues.

[2.0.1]

- Fix MISRA-2012 issues.

[2.0.0]

- Initial version.

KPP

[2.0.1]

- Bug Fixes
  - Fixed the violations of MISRA 2012 rules:
    * Rule 10.3 10.4 10.6 14.4 17.7

[2.0.0]

- Initial version.

LCDIFv2

[2.3.3]

- Other Changes
  - Removed PDI_PARA register operation due to IP change.

[2.3.2]

- Bug Fixes
  - Fixed the violations of MISRA 2012 advisory rules.

[2.3.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.4.

[2.3.0]

- New Features:
  - Added API to calculate global alpha based on desired blended alpha.

[2.2.3]

- Improvements
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.

[2.2.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.2, 10.4, 10.6, 12.2.

[2.2.1]

- Improvements
  - Updated for the new LCDIFV2_Type structure.

[2.2.0]

- Bug Fixes
  - Fixed LCDIFV2_GetPorterDuffConfig issue that does not set color mode correctly.
- Other Changes
  - Removed the store functions.

[2.1.1]

- Bug Fixes
  - Fixed the issue that LCDIFV2_SetLut could not access the last index.

[2.1.0]

- New Features:
  - Added function to get Porter Duff configuration.

[2.0.1]

- Bug Fixes
  - Fixed the issue that register value not reset by LCDIFV2_Deinit and LCDIFV2_Reset.

[2.0.0]

- Initial version.

LPADC

[2.9.3]

- Improvements
  - Add timeout for while loop code.

[2.9.2]

- Improvements
  - Fixed CERT-C issues.

[2.9.1]

- Bug Fixes
  - Fixed incorrect channel B FIFO selection logic.

[2.9.0]

- Bug Fixes
  - Add code to handle the case where GCC[GAIN_CAL] is a signed number.
  - Split LPADC_FinishAutoCalibration function into two functions.
  - Improved LPADC driver.

[2.8.4]

- Bug Fixes
  - Remove function 'LPADC_SetOffsetValue' assert statement, this statement may cause runtime errors in existing code.

[2.8.3]

- Bug Fixes
  - Fixed SDK lpadc driver examples compile issue, move condition 'commandId < ADC_CV_COUNT' to a more appropriate location.

[2.8.2]

- Bug Fixes
  - Fixed the violations of MISRA C-2012 rule 18.1, 10.3, 10.1 and 10.4.

[2.8.1]

- Bug Fixes
  - Fixed LPADC sample mode enum name mistake.

[2.8.0]

- Improvements
  - Release peripheral from reset if necessary in init function.
- Bug Fixes
  - Fixed function LPADC_GetConvResult() issue.
  - Fixed function LPADC_SetConvCommandConfig() bugs.

[2.7.2]

- Improvements
  - Use feature macros instead of header file macros.
- Bug Fixes
  - Fixed the violations of MISRA C-2012 rule 10.1, 10.3, 10.4 and 14.3.

[2.7.1]

- Improvements
  - Corrected descriptions of several functions.
  - Improved function LPADC_GetOffsetValue and LPADC_SetOffsetValue.
  - Revert changes of feature macros for lpadc.
  - Use feature macros instead of header file macros.
- Bug Fixes
  - Fixed the violations of MISRA C-2012 rule 10.8.
  - Fixed the violations of MISRA C-2012 rule 10.1, 10.3, 10.4 and 14.3.

[2.7.0]

- Improvements
  - Added supports of CFG2 register.
  - Removed some useless macros.

[2.6.2]

- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules.
  - Fixed LPADC driver code compile error issue.

[2.6.1]

- Improvements
  - Updated the use of macros in the driver code.

[2.6.0]

- Improvements
  - Added the API LPADC_SetOffset12BitValue() to configure 12bit ADC conversion offset trim value manually.
  - Added the API LPADC_SetOffset16BitValue() to configure 16bit ADC conversion offset trim value manually.
  - Added API to set offset calibration mode.
  - Added configuration of alternate channel.
  - Updated auto calibration API and added calibration value conversion API.
- New feature
  - Added API LPADC_EnableHardwareTriggerCommandSelection() to enable trigger commands controlled by ADC_ETC.
  - Updated LPADC_DoAutoCalibration() to allow doing something else before the ADC initialization to be totally complete. Enhance initialization duration time of the ADC.
  - Added two new APIs to get/set calibration value.

[2.5.2]

- Improvements
  - Added while loop, LPADC_GetConvResult() will return only when the FIFO will not be empty.

[2.5.1]

- Bug Fixes
  - Fixed some typos in Lpadc driver comments.

[2.5.0]

- Improvements
  - Added missing items to enable trigger interrupts.

[2.4.0]

- New features
  - Added APIs to get/clear trigger status flags.

[2.3.0]

- Improvements
  - Removed LPADC_MeasureTemperature() function for the LPADC supports different temperature sensor calculation equations.

[2.2.1]

- Improvements
  - Optimized LPADC_MeasureTemperature() function to support the specific series with flash solidified calibration value.
  - Clean doxygen warnings.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.3, rule 10.8 and rule 17.7.

[2.2.0]

- New Feature
  - Added API LPADC_MeasureTemperature() to get correct temperature from the internal sensor.
- Improvements
  - Separated lpadc_conversion_resolution_mode_t with related feature macro.
- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules:
    - Rule 10.3, 10.4, 10.6, 10.7 and 17.7.

[2.1.1]

- Improvements
  - Updated the gain calibration formula.
  - Used feature to segregate the new item kLPADC_TriggerPriorityPreemptSubsequently.

[2.1.0]

- New Features
  - Added the API LPADC_SetOffsetValue() to support configure offset trim value manually.
  - Added the API LPADC_DoOffsetCalibration() to do offset calibration independently.
- Improvements
  - Improved the usage of macros and removed invalid macros.

[2.0.2]

- Improvements
  - Added support for platforms with 2 FIFOs and different calibration measures.

[2.0.1]

- Bug Fixes
  - Ensured the API LPADC_SetConvCommandConfig configure related registers correctly.

[2.0.0]

- Initial version.

LPI2C

[2.6.1]

- Bug Fixes
  - Fixed coverity issues.

[2.6.0]

- New Feature
  - Added common IRQ handler entry LPI2C_DriverIRQHandler.

[2.5.7]

- Improvements
  - Added support for separated IRQ handlers.

[2.5.6]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.5.5]

- Bug Fixes
  - Fixed LPI2C_SlaveInit() - allow to disable SDA/SCL glitch filter.

[2.5.4]

- Bug Fixes
  - Fixed LPI2C_MasterTransferBlocking() - the return value was sometime affected by call of LPI2C_MasterStop().

[2.5.3]

- Improvements
  - Added handler for LPI2C7 and LPI2C8.

[2.5.2]

- Bug Fixes
  - Fixed ERR051119 to ignore the nak flag when IGNACK=1 in LPI2C_MasterCheckAndClearError.

[2.5.1]

- Bug Fixes
  - Added bus stop incase of bus stall in LPI2C_MasterTransferBlocking.
- Improvements
  - Release peripheral from reset if necessary in init function.

[2.5.0]

- New Features
  - Added new function LPI2C_SlaveEnableAckStall to enable or disable ACKSTALL.

[2.4.1]

- Improvements
  - Before master transfer with transactional APIs, enable master function while disable slave function and vise versa for slave transfer to avoid the one affecting the other.

[2.4.0]

- Improvements
  - Split some functions, fixed CCM problem in file fsl_lpi2c.c.
- Bug Fixes
  - Fixed bug in LPI2C_MasterInit that the MCFGR2's value set in LPI2C_MasterSetBaudRate may be overwritten by mistake.

[2.3.2]

- Improvements
  - Initialized the EDMA configuration structure in the LPI2C EDMA driver.

[2.3.1]

- Improvements
  - Updated LPI2C_GetCyclesForWidth to add the parameter of minimum cycle, because for master SDA/SCL filter, master bus idle/pin low timeout and slave SDA/SCL filter configuration, 0 means disabling the feature and cannot be used.
- Bug Fixes
  - Fixed bug in LPI2C_SlaveTransferHandleIRQ that when restart detect event happens the transfer structure should not be cleared.
  - Fixed bug in LPI2C_RunTransferStateMachine, that when only slave address is transferred or there is still data remaining in tx FIFO the last byte's nack cannot be ignored.
  - Fixed bug in slave filter doze enable, that when FILTDZ is set it means disable rather than enable.
  - Fixed bug in the usage of LPI2C_GetCyclesForWidth. First its return value cannot be used directly to configure the slave FILTSDA, FILTSCL, DATAVD or CLKHOLD, because the real cycle width for them should be FILTSDA+3, FILTSCL+3, FILTSCL+DATAVD+3 and CLKHOLD+3. Second when cycle period is not affected by the prescaler value, prescaler value should be passed as 0 rather than 1.

  - Fixed wrong default setting for LPI2C slave. If enabling the slave tx SCL stall, then the default clock hold time should be set to 250ns according to I2C spec for 100kHz standard mode baudrate.
  - Fixed bug that before pushing command to the tx FIFO the FIFO occupation should be checked first in case FIFO overflow.

[2.3.0]

- New Features
  - Supported reading more than 256 bytes of data in one transfer as master.
  - Added API LPI2C_GetInstance.
- Bug Fixes
  - Fixed bug in LPI2C_MasterTransferAbortEDMA, LPI2C_MasterTransferAbort and LPI2C_MasterTransferHandleIRQ that before sending stop signal whether master is active and whether stop signal has been sent should be checked, to make sure no FIFO error or bus error will be caused.
  - Fixed bug in LPI2C master EDMA transactional layer that the bus error cannot be caught and returned by user callback, by monitoring bus error events in interrupt handler.
  - Fixed bug in LPI2C_GetCyclesForWidth that the parameter used to calculate clock cycle should be 2^prescaler rather than prescaler.
  - Fixed bug in LPI2C_MasterInit that timeout value should be configured after baudrate, since the timeout calculation needs prescaler as parameter which is changed during baudrate configuration.
  - Fixed bug in LPI2C_MasterTransferHandleIRQ and LPI2C_RunTransferStateMachine that when master writes with no stop signal, need to first make sure no data remains in the tx FIFO before finishes the transfer.

[2.2.0]

- Bug Fixes
  - Fixed issue that the SCL high time, start hold time and stop setup time do not meet I2C specification, by changing the configuration of data valid delay, setup hold delay, clock high and low parameters.
  - MISRA C-2012 issue fixed.
    - Fixed rule 8.4, 13.5, 17.7, 20.8.

[2.1.12]

- Bug Fixes
  - Fixed MISRA advisory 15.5 issues.

[2.1.11]

- Bug Fixes
  - Fixed the bug that, during master non-blocking transfer, after the last byte is sent/received, the kLPI2C_MasterNackDetectFlag is expected, so master should not check and clear kLPI2C_MasterNackDetectFlag when remainingBytes is zero, in case FIFO is emptied when stop command has not been sent yet.

  - Fixed the bug that, during non-blocking transfer slave may nack master while master is busy filling tx FIFO, and NDF may not be handled properly.

[2.1.10]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fixed rule 10.3, 14.4, 15.5.
  - Fixed unaligned access issue in LPI2C_RunTransferStateMachine.
  - Fixed uninitialized variable issue in LPI2C_MasterTransferHandleIRQ.
  - Used linked TCD to disable tx and enable rx in read operation to fix the issue that for platform sharing the same DMA request with tx and rx, during LPI2C read operation if interrupt with higher priority happened exactly after command was sent and before tx disabled, potentially both tx and rx could trigger dma and cause trouble.
  - Fixed MISRA issues.
    - Fixed rules 10.1, 10.3, 10.4, 11.6, 11.9, 14.4, 17.7.
  - Fixed the waitTimes variable not re-assignment issue for each byte read.
- New Features
  - Added the IRQHandler for LPI2C5 and LPI2C6 instances.
- Improvements
  - Updated the LPI2C_WAIT_TIMEOUT macro to unified name I2C_RETRY_TIMES.

[2.1.9]

- Bug Fixes
  - Fixed Coverity issue of unchecked return value in I2C_RTOS_Transfer.
  - Fixed Coverity issue of operands did not affect the result in LPI2C_SlaveReceive and LPI2C_SlaveSend.
  - Removed STOP signal wait when NAK detected.
  - Cleared slave repeat start flag before transmission started in LPI2C_SlaveSend/LPI2C_SlaveReceive. The issue was that LPI2C_SlaveSend/LPI2C_SlaveReceive did not handle with the reserved repeat start flag. This caused the next slave to send a break, and the master was always in the receive data status, but could not receive data.

[2.1.8]

- Bug Fixes
  - Fixed the transfer issue with LPI2C_MasterTransferNonBlocking, kLPI2C_TransferNoStopFlag, with the wait transfer done through callback in a way of not doing a blocking transfer.
  - Fixed the issue that STOP signal did not appear in the bus when NAK event occurred.

[2.1.7]

- Bug Fixes
  - Cleared the stopflag before transmission started in LPI2C_SlaveSend/LPI2C_SlaveReceive. The issue was that LPI2C_SlaveSend/LPI2C_SlaveReceive did not handle with the reserved stop flag and caused the next slave to send a break, and the master always stayed in the receive data status but could not receive data.

[2.1.6]

- Bug Fixes
  - Fixed driver MISRA build error and C++ build error in LPI2C_MasterSend and LPI2C_SlaveSend.
  - Reset FIFO in LPI2C Master Transfer functions to avoid any byte still remaining in FIFO during last transfer.
  - Fixed the issue that LPI2C_MasterStop did not return the correct NAK status in the bus for second transfer to the non-existing slave address.

[2.1.5]

- Bug Fixes
  - Extended the Driver IRQ handler to support LPI2C4.
  - Changed to use ARRAY_SIZE(kLpi2cBases) instead of FEATURE COUNT to decide the array size for handle pointer array.

[2.1.4]

- Bug Fixes
  - Fixed the LPI2C_MasterTransferEDMA receive issue when LPI2C shared same request source with TX/RX DMA request. Previously, the API used scatter-gather method, which handled the command transfer first, then the linked TCD which was pre-set with the receive data transfer. The issue was that the TX DMA request and the RX DMA request were both enabled, so when the DMA finished the first command TCD transfer and handled the receive data TCD, the TX DMA request still happened due to empty TX FIFO. The result was that the RX DMA transfer would start without waiting on the expected RX DMA request.
  - Fixed the issue by enabling IntMajor interrupt for the command TCD and checking if there was a linked TCD to disable the TX DMA request in LPI2C_MasterEDMACallback API.

[2.1.3]

- Improvements
  - Added LPI2C_WATI_TIMEOUT macro to allow the user to specify the timeout times for waiting flags in functional API and blocking transfer API.
  - Added LPI2C_MasterTransferBlocking API.

[2.1.2]

- Bug Fixes
  - In LPI2C_SlaveTransferHandleIRQ, reset the slave status to idle when stop flag was detected.

[2.1.1]

- Bug Fixes
  - Disabled the auto-stop feature in eDMA driver. Previously, the auto-stop feature was enabled at transfer when transferring with stop flag. Since transfer was without stop flag and the auto-stop feature was enabled, when starting a new transfer with stop flag, the stop flag would be sent before the new transfer started, causing unsuccesful sending of the start flag, so the transfer could not start.
  - Changed default slave configuration with address stall false.

[2.1.0]

- Improvements
  - API name changed:
    - LPI2C_MasterTransferCreateHandle -> LPI2C_MasterCreateHandle.
    - LPI2C_MasterTransferGetCount -> LPI2C_MasterGetTransferCount.
    - LPI2C_MasterTransferAbort -> LPI2C_MasterAbortTransfer.
    - LPI2C_MasterTransferHandleIRQ -> LPI2C_MasterHandleInterrupt.
    - LPI2C_SlaveTransferCreateHandle -> LPI2C_SlaveCreateHandle.
    - LPI2C_SlaveTransferGetCount -> LPI2C_SlaveGetTransferCount.
    - LPI2C_SlaveTransferAbort -> LPI2C_SlaveAbortTransfer.
    - LPI2C_SlaveTransferHandleIRQ -> LPI2C_SlaveHandleInterrupt.

[2.0.0]

- Initial version.

LPI2C_EDMA

[2.4.4]

- Improvements
  - Added support for 2KB data transfer

[2.4.3]

- Improvements
  - Added support for separated IRQ handlers.

[2.4.2]

- Improvements
  - Add EDMA ext API to accommodate more types of EDMA.

[2.4.1]

- Refer LPI2C driver change log 2.0.0 to 2.4.1

LPSPI

[2.7.1]

- Bug Fixes
  - Workaround for errata ERR050607
  - Workaround for errata ERR010655

[2.7.0]

- New Feature
  - Added common IRQ handler entry LPSPI_DriverIRQHandler.

[2.6.10]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.6.9]

- Bug Fixes
  - Fixed reading of TCR register
  - Workaround for errata ERR050606

[2.6.8]

- Bug Fixes
  - Fixed build error when SPI_RETRY_TIMES is defined to non-zero value.

[2.6.7]

- Bug Fixes
  - Fixed the txData from void * to const void * in transmit API _lpspi_master_handle and _lpspi_slave_handle.

[2.6.6]

- Bug Fixes
  - Added LPSPI register init in LPSPI_MasterInit incase of LPSPI register exist.

[2.6.5]

- Improvements
  - Introduced FSL_FEATURE_LPSPI_HAS_NO_PCSCFG and FSL_FEATURE_LPSPI_HAS_NO_MULTI_WIDTH for conditional compile.
  - Release peripheral from reset if necessary in init function.

[2.6.4]

- Bug Fixes
  - Added LPSPI6_DriverIRQHandler for LPSPI6 instance.

[2.6.3]

- Hot Fixes
  - Added macro switch in function LPSPI_Enable about ERRATA051472.

[2.6.2]

- Bug Fixes
  - Disabled lpspi before LPSPI_MasterSetBaudRate incase of LPSPI opened.

[2.6.1]

- Bug Fixes
  - Fixed return value while calling LPSPI_WaitTxFifoEmpty in function LPSPI_MasterTransferNonBlocking.

[2.6.0]

- Feature
  - Added the new feature of multi-IO SPI .

[2.5.3]

- Bug Fixes
  - Fixed 3-wire txmask of handle vaule reentrant issue.

[2.5.2]

- Bug Fixes
  - Workaround for errata ERR051588 by clearing FIFO after transmit underrun occurs.

[2.5.1]

- Bug Fixes
  - Workaround for errata ERR050456 by resetting the entire module using LPSPIn_CR[RST] bit.

[2.5.0]

- Bug Fixes
  - Workaround for errata ERR011097 to wait the TX FIFO to go empty when writing TCR register and TCR[TXMSK] value is 1.
  - Added API LPSPI_WaitTxFifoEmpty for wait the txfifo to go empty.

[2.4.7]

- Bug Fixes
  - Fixed bug that the SR[REF] would assert if software disabled or enabled the LPSPI module in LPSPI_Enable.

[2.4.6]

- Improvements
  - Moved the configuration of registers for the 3-wire lpspi mode to the LPSPI_MasterInit and LPSPI_SlaveInit function.

[2.4.5]

- Improvements
  - Improved LPSPI_MasterTransferBlocking send performance when frame size is 1-byte.

[2.4.4]

- Bug Fixes
  - Fixed LPSPI_MasterGetDefaultConfig incorrect default inter-transfer delay calculation.

[2.4.3]

- Bug Fixes
  - Fixed bug that the ISR response speed is too slow on some platforms, resulting in the first transmission of overflow, Set proper RX watermarks to reduce the ISR response times.

[2.4.2]

- Bug Fixes
  - Fixed bug that LPSPI_MasterTransferBlocking will modify the parameter txbuff and rxbuff pointer.

[2.4.1]

- Bug Fixes
  - Fixed bug that LPSPI_SlaveTransferNonBlocking can't detect RX error.

[2.4.0]

- Improvements
  - Split some functions, fixed CCM problem in file fsl_lpspi.c.

[2.3.1]

- Improvements
  - Initialized the EDMA configuration structure in the LPSPI EDMA driver.
- Bug Fixes
  - Fixed bug that function LPSPI_MasterTransferBlocking should return after the transfer complete flag is set to make sure the PCS is re-asserted.

[2.3.0]

- New Features
  - Supported the master configuration of sampling the input data using a delayed clock to improve slave setup time.

[2.2.1]

- Bug Fixes
  - Fixed bug in LPSPI_SetPCSContinous when disabling PCS continous mode.

[2.2.0]

- Bug Fixes
  - Fixed bug in 3-wire polling and interrupt transfer that the received data is not correct and the PCS continous mode is not working.

[2.1.0]

- Improvements
  - Improved LPSPI_SlaveTransferHandleIRQ to fill up TX FIFO instead of write one data to TX register which improves the slave transmit performance.
  - Added new functional APIs LPSPI_SelectTransferPCS and LPSPI_SetPCSContinous to support changing PCS selection and PCS continous mode.
- Bug Fixes
  - Fixed bug in non-blocking and EDMA transfer APIs that kStatus_InvalidArgument is returned if user configures 3-wire mode and full-duplex transfer at the same time, but transfer state is already set to kLPSPI_Busy by mistake causing following transfer can not start.
  - Fixed bug when LPSPI slave using EDMA way to transfer, tx should be masked when tx data is null, otherwise in 3-wire mode which tx/rx use the same pin, the received data will be interfered.

[2.0.5]

- Improvements
  - Added timeout mechanism when waiting certain states in transfer driver.
- Bug Fixes
  - Fixed the bug that LPSPI can not transfer large data using EDMA.
  - Fixed MISRA 17.7 issues.
  - Fixed variable overflow issue introduced by MISRA fix.
  - Fixed issue that rxFifoMaxBytes should be calculated according to transfer width rather than FIFO width.
  - Fixed issue that completion flag was not cleared after transfer completed.

[2.0.4]

- Bug Fixes
  - Fixed in LPSPI_MasterTransferBlocking that master rxfifo may overflow in stall condition.
  - Eliminated IAR Pa082 warnings.
  - Fixed MISRA issues.
    - Fixed rules 10.1, 10.3, 10.4, 10.6, 11.9, 14.2, 14.4, 15.7, 17.7.

[2.0.3]

- Bug Fixes
  - Removed LPSPI_Reset from LPSPI_MasterInit and LPSPI_SlaveInit, because this API may glitch the slave select line. If needed, call this function manually.

[2.0.2]

- New Features
  - Added dummy data set up API to allow users to configure the dummy data to be transferred.
  - Enabled the 3-wire mode, SIN and SOUT pins can be configured as input/output pin.

[2.0.1]

- Bug Fixes
  - Fixed the bug that the clock source should be divided by the PRESCALE setting in LPSPI_MasterSetDelayTimes function.
  - Fixed the bug that LPSPI_MasterTransferBlocking function would hang in some corner cases.
- Optimization
  - Added #ifndef/#endif to allow user to change the default TX value at compile time.

[2.0.0]

- Initial version.

LPSPI_EDMA

[2.4.6]

- Improvements
  - Increased transmit FIFO watermark to ensure whole transmit FIFO will be used during data transfer.

[2.4.5]

- Bug Fixes
  - Fixed reading of TCR register
  - Workaround for errata ERR050606

[2.4.4]

- Improvements
  - Add EDMA ext API to accommodate more types of EDMA.

[2.4.3]

- Improvements
  - Supported 32K bytes transmit in DMA, improve the max datasize in LPSPI_MasterTransferEDMALite.

[2.4.2]

- Improvements
  - Added callback status in EDMA_LpspiMasterCallback and EDMA_LpspiSlaveCallback to check transferDone.

[2.4.1]

- Improvements
  - Add the TXMSK wait after TCR setting.

[2.4.0]

- Improvements
  - Separated LPSPI_MasterTransferEDMA functions to LPSPI_MasterTransferPrepareEDMA and LPSPI_MasterTransferEDMALite to optimize the process of transfer.

LPUART

[2.9.1]

- Bug Fixes
  - Fixed coverity issues.

[2.9.0]

- New Feature
  - Added support for swap TXD and RXD pins.
  - Added common IRQ handler entry LPUART_DriverIRQHandler.

[2.8.3]

- Improvements
  - Conditionally compile interrupt handling code to solve the problem of using this driver on CPU cores that do not support interrupts.

[2.8.2]

- Bug Fix
  - Fixed the bug that LPUART_TransferEnable16Bit controled by wrong feature macro.

[2.8.1]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule-5.3, rule-5.8, rule-10.4, rule-11.3, rule-11.8.

[2.8.0]

- Improvements
  - Added support of DATA register for 9bit or 10bit data transmit in write and read API. Such as: LPUART_WriteBlocking16bit, LPUART_ReadBlocking16bit, LPUART_TransferEnable16Bit LPUART_WriteNonBlocking16bit, LPUART_ReadNonBlocking16bit.

[2.7.7]

- Bug Fixes
  - Fixed the bug that baud rate calculation overflow when srcClock_Hz is 528MHz.

[2.7.6]

- Bug Fixes
  - Fixed LPUART_EnableInterrupts and LPUART_DisableInterrupts bug that blocks if the LPUART address doesn't support exclusive access.

[2.7.5]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.7.4]

- Improvements
  - Added support for atomic register accessing in LPUART_EnableInterrupts and LPUART_DisableInterrupts.

[2.7.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 15.7.

[2.7.2]

- Bug Fix
  - Fixed the bug that the OSR calculation error when lupart init and lpuart set baud rate.

[2.7.1]

- Improvements
  - Added support for LPUART_BASE_PTRS_NS in security mode in file fsl_lpuart.c.

[2.7.0]

- Improvements
  - Split some functions, fixed CCM problem in file fsl_lpuart.c.

[2.6.0]

- Bug Fixes
  - Fixed bug that when there are multiple lpuart instance, unable to support different ISR.

[2.5.3]

- Bug Fixes
  - Fixed comments by replacing unused status flags kLPUART_NoiseErrorInRxDataRegFlag and kLPUART_ParityErrorInRxDataRegFlag with kLPUART_NoiseErrorFlag and kLPUART_ParityErrorFlag.

[2.5.2]

- Bug Fixes
  - Fixed bug that when setting watermark for TX or RX FIFO, the value may exceed the maximum limit.
- Improvements
  - Added check in LPUART_TransferDMAHandleIRQ and LPUART_TransferEdmaHandleIRQ to ensure if user enables any interrupts other than transfer complete interrupt, the dma transfer is not terminated by mistake.

[2.5.1]

- Improvements
  - Use separate data for TX and RX in lpuart_transfer_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling LPUART_TransferReceiveNonBlocking, the received data count returned by LPUART_TransferGetReceiveCount is wrong.

[2.5.0]

- Bug Fixes
  - Added missing interrupt enable masks kLPUART_Match1InterruptEnable and kLPUART_Match2InterruptEnable.
  - Fixed bug in LPUART_EnableInterrupts, LPUART_DisableInterrupts and LPUART_GetEnabledInterrupts that the BAUD[LBKDIE] bit field should be soc specific.
  - Fixed bug in LPUART_TransferHandleIRQ that idle line interrupt should be disabled when rx data size is zero.
  - Deleted unused status flags kLPUART_NoiseErrorInRxDataRegFlag and kLPUART_ParityErrorInRxDataRegFlag, since firstly their function are the same as kLPUART_NoiseErrorFlag and kLPUART_ParityErrorFlag, secondly to obtain them one data word must be read out thus interfering with the receiving process.
  - Fixed bug in LPUART_GetStatusFlags that the STAT[LBKDIF], STAT[MA1F] and STAT[MA2F] should be soc specific.
  - Fixed bug in LPUART_ClearStatusFlags that tx/rx FIFO is reset by mistake when clearing flags.
  - Fixed bug in LPUART_TransferHandleIRQ that while clearing idle line flag the other bits should be masked in case other status bits be cleared by accident.
  - Fixed bug of race condition during LPUART transfer using transactional APIs, by disabling and re-enabling the global interrupt before and after critical operations on interrupt enable register.
  - Fixed DMA/eDMA transfer blocking issue by enabling tx idle interrupt after DMA/eDMA transmission finishes.
- New Features
  - Added APIs LPUART_GetRxFifoCount/LPUART_GetTxFifoCount to get rx/tx FIFO data count.
  - Added APIs LPUART_SetRxFifoWatermark/LPUART_SetTxFifoWatermark to set rx/tx FIFO water mark.

[2.4.1]

- Bug Fixes
  - Fixed MISRA advisory 17.7 issues.

[2.4.0]

- New Features
  - Added APIs to configure 9-bit data mode, set slave address and send address.

[2.3.1]

- Bug Fixes
  - Fixed MISRA advisory 15.5 issues.

[2.3.0]

- Improvements
  - Modified LPUART_TransferHandleIRQ so that txState will be set to idle only when all data has been sent out to bus.
  - Modified LPUART_TransferGetSendCount so that this API returns the real byte count that LPUART has sent out rather than the software buffer status.
  - Added timeout mechanism when waiting for certain states in transfer driver.

[2.2.8]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule-10.3, rule-14.4, rule-15.5.
  - Eliminated Pa082 warnings by assigning volatile variables to local variables and using local variables instead.
  - Fixed MISRA issues.
    - Fixed rules 10.1, 10.3, 10.4, 10.8, 14.4, 11.6, 17.7.
- Improvements
  - Added check for kLPUART_TransmissionCompleteFlag in LPUART_WriteBlocking, LPUART_TransferHandleIRQ, LPUART_TransferSendDMACallback and LPUART_SendEDMACallback to ensure all the data would be sent out to bus.
  - Rounded up the calculated sbr value in LPUART_SetBaudRate and LPUART_Init to achieve more acurate baudrate setting. Changed osr from uint32_t to uint8_t since osr's bigest value is 31.
  - Modified LPUART_ReadBlocking so that if more than one receiver errors occur, all status flags will be cleared and the most severe error status will be returned.

[2.2.7]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule-12.1, rule-17.7, rule-14.4, rule-13.3, rule-14.4, rule-10.4, rule-10.8, rule-10.3, rule-10.7, rule-10.1, rule-11.6, rule-13.5, rule-11.3, rule-13.2, rule-8.3.

[2.2.6]

- Bug Fixes
  - Fixed the issue of register's being in repeated reading status while dealing with the IRQ routine.

[2.2.5]

- Bug Fixes
  - Do not set or clear the TIE/RIE bits when using LPUART_EnableTxDMA and LPUART_EnableRxDMA.

[2.2.4]

- Improvements
  - Added hardware flow control function support.
  - Added idle-line-detecting feature in LPUART_TransferNonBlocking function. If an idle line is detected, a callback is triggered with status kStatus_LPUART_IdleLineDetected returned. This feature may be useful when the received Bytes is less than the expected received data size. Before triggering the callback, data in the FIFO (if has FIFO) is read out, and no interrupt will be disabled, except for that the receive data size reaches 0.
  - Enabled the RX FIFO watermark function. With the idle-line-detecting feature enabled, users can set the watermark value to whatever you want (should be less than the RX FIFO size). Data is received and a callback will be triggered when data receive ends.

[2.2.3]

- Improvements
  - Changed parameter type in LPUART_RTOS_Init struct from rtos_lpuart_config to lpuart_rtos_config_t.
- Bug Fixes
  - Disabled LPUART receive interrupt instead of all NVICs when reading data from ring buffer. Otherwise when the ring buffer is used, receive nonblocking method will disable all NVICs to protect the ring buffer. This may has a negative effect on other IPs that are using the interrupt.

[2.2.2]

- Improvements
  - Added software reset feature support.
  - Added software reset API in LPUART_Init.

[2.2.1]

- Improvements
  - Added separate RX/TX IRQ number support.

[2.2.0]

- Improvements
  - Added support of 7 data bits and MSB.

[2.1.1]

- Improvements
  - Removed unnecessary check of event flags and assert in LPUART_RTOS_Receive.
  - Added code to always wait for RX event flag in LPUART_RTOS_Receive.

[2.1.0]

- Improvements
  - Update transactional APIs.

LPUART_EDMA

[2.4.0]

- Refer LPUART driver change log 2.1.0 to 2.4.0

MCM

[2.2.0]

- Improvements
  - Support platforms with less features.

[2.1.0]

- Others
  - Remove byteID from mcm_lmem_fault_attribute_t for document update.

[2.0.0]

- Initial version.

MECC

[2.1.1]

- Bug fixes:
  - Add volatile to variable counter to fix armgcc 13.2.1 -Os optimization issue.

[2.1.0]

- Bug fixes:
  - Removed Ocram1StartAddress, Ocram1EndAddress, Ocram2StartAddress, Ocram2EndAddress in mecc_config_t structure. Use startAddress and endAddress as instead.
  - Removed static function MECC_GetInstance().
- New Features:
  - Added new function MECC_GetPendingFlags().
  - Added new members: enableReadDataWait, enableReadAddrPipeline, enableWriteDataPipeline, enableWriteAddrPipeline in mecc_config_t structure to support pipeline features.

[2.0.2]

- Bug fixes:
  - Fixed MISRA 2012 issue: 10.3, 10.4.

[2.0.1]

- Bug fixes:
  - Fixed MISRA 2012 issue: 10.1, 10.3, 10.4, 10.6.

[2.0.0]

- Initial version.

MIPI CSI2RX

[2.0.4]

- Improvements
  - Updated for new format MIPI_CSI2RX_Type definition.

[2.0.3]

- Bug Fixes
  - Fixed the violations of MISRA 2012 rules: 3.1, 10.3, 10.4, 10.8, 17.7.

[2.0.2]

- Improvements
  - Updated to support MIMX8QX C0 header file.

[2.0.1]

- Improvements
  - Updated to support platforms that don't have dedicated MIPI CSI2RX CSR.
- Bug Fixes
  - Fixed the issue that the register bit PRG_RXHS_SETTLE set to wrong value.

[2.0.0]

- Initial version.

MIPI_DSI

[2.2.5]

- Bug Fixes
  - Fixed issue that VACTIVE setting shall equal to the number of active lines (height), no need to minus 1.

[2.2.4]

- Bug Fixes
  - Updated the DPI setting to use float for coefficient value for more accurate calculation.

[2.2.3]

- Bug Fixes
  - Fixed the DSI_TransferNonBlocking no interrupt issue.
  - Fixed the violations of MISRA 2012 advisory rules.

[2.2.2]

- Bug Fixes
  - Fixed the DPI horizontal timing setting issue.
  - Fixed MISRA issue

[2.2.1]

- Bug Fixes
  - Fixed the bug that runs to hardfault when sending long packet with 4-byte unaligned address.

[2.2.1]

- Improvements
  - Supported long package read.

[2.2.0]

- Improvements
  - Change parameter MIPI_DSI_Type pointer to const type.

[2.1.0]

- Initial version.

MU

[2.2.0]

- New Features
  - Added API MU_GetRxStatusFlags.

[2.1.3]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.1.2]

- Bug Fixes
  - Fixed issue that MU_GetInstance() is defined but never used.

[2.1.1]

- Bug Fixes
  - Fixed general interrupt comment typo.

[2.1.0]

- Improvements
  - Added new enum mu_msg_reg_index_t.

[2.0.7]

- Bug Fixes
  - Fixed MU_GetInterruptsPending bug that can not get general interrupt status.

[2.0.6]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 17.7.

[2.0.5]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 14.4, 15.5.

[2.0.4]

- Improvements
  - Improved for the platforms which don't support reset assert interrupt and get the other core power mode.

[2.0.3]

- Bug fixes
  - MISRA C-2012 issue fixed.
    - Fixed rules, containing: rule-10.3, rule-14.4, rule-15.5.

[2.0.2]

- Improvements
  - Added support for MIMX8MQx.

[2.0.1]

- Improvements
  - Added support for MCIMX7Ux_M4.

[2.0.0]

- Initial version.

OCOTP

[2.1.4]

- Bug fixes
  - Fixed the bug that OCOTP_ReadFuseShadowRegisterExt can't read more than one word.

[2.1.3]

- Bug fixes
  - Fixed MISRA 2012 issue: 8.4, 10.3, 10.4, 14.3.
  - Fixed doxygen warning.

[2.1.2]

- Improvements
  - Updated for new MIMXRT117X header file.

[2.1.1]

- Improvements
  - Updated OCOTP_ReloadShadowRegister to return error status.
  - Added functions OCOTP_ReadFuseShadowRegisterExt and OCOTP_WriteFuseShadowRegisterWithLock.
- Bug fixes
  - Fixed MISRA 2012 rule 10.3 issue.

[2.0.1]

- Bug Fixes
  - Fixed doxygen issues.

[2.0.0]

- Initial version.

OTFAD

[2.1.4]

- Bug fixes
  - Fixed MISRA 2012 issue: 10.1.

[2.1.3]

- Bug fixes
  - Fixed the error that waiting for both FLEXSPI AHB idle and SEQ idle.

[2.1.2]

- Bug fixes
  - Fixed MISRA 2012 issue: 10.4.

[2.1.1]

- Improvements:
  - Hided some bits in CR and SR registers for selected platforms.
  - Fixed doxygen issues.

[2.1.0]

- Improvements:
  - Used boolean type to define 1-bit field concepts.

[2.0.0]

- Initial version.

PDM

[2.9.2]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

[2.9.1]

- Bug Fixes
  - Fixed the issue that the driver still enters the interrupt after disabling clock.

[2.9.0]

- Improvements
- Added feature FSL_FEATURE_PDM_HAS_DECIMATION_FILTER_BYPASS to config CTRL_2[DEC_BYPASS] field.
- Modify code to make the OSR value is not limited to 16.

[2.8.1]

- Improvements
- Added feature FSL_FEATURE_PDM_HAS_NO_DOZEN to handle nonexistent CTRL_1[DOZEN] field.

[2.8.0]

- Improvements
- Added feature FSL_FEATURE_PDM_HAS_NO_HWVAD to remove the support of hadware voice activity detector.
- Added feature FSL_FEATURE_PDM_HAS_NO_FILTER_BUFFER to remove the support of FIR_RDY bitfield in STAT register.

[2.7.4]

- Bug Fixes
  - Fixed driver can not determine the specific float number of clock divider.
  - Fixed PDM_ValidateSrcClockRate calculates PDM channel in wrong method issue.

[2.7.3]

- Improvements
- Added feature FSL_FEATURE_PDM_HAS_NO_VADEF to remove the support of VADEF bit-field in VAD0_STAT register.

[2.7.2]

- Improvements
- Added feature FSL_FEATURE_PDM_HAS_NO_MINIMUM_CLKDIV to decide whether the minimum clock frequency division is required.

[2.7.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 8.4, 10.3, 10.1, 10.4, 14.4

[2.7.0]

- Improvements
  - Added api PDM_EnableHwvadInterruptCallback to support handle hwvad IRQ in PDM driver.
  - Corrected the sample rate configuration for non high quality mode.
  - Added api PDM_SetChannelGain to support adjust the channel gain.

[2.6.0]

- Improvements
  - Added new features FSL_FEATURE_PDM_HAS_STATUS_LOW_FREQ/FSL_FEATURE_PDM_HAS_DC_OUT

[2.5.0]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 8.4, 16.5, 10.4, 10.3, 10.1, 11.9, 17.7, 10.6, 14.4, 11.8, 11.6.

[2.4.1]

- Bug Fixes
  - Fixed MDK 66-D warning in pdm driver.

[2.4.0]

- Improvements
  - Added api PDM_TransferSetChannelConfig/PDM_ReadFifo to support read different width data.
  - Added feature FSL_FEATURE_PDM_HAS_RANGE_CTRL and api PDM_ClearRangeStatus/PDM_GetRangeStatus for range register.
- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 14.4, 10.3, 10.4.

[2.3.0]

- Improvements
  - Enabled envelope/energy voice detect mode by adding apis PDM_SetHwvadInEnvelopeBasedMode/PDM_SetHwvadInEnergyBasedMode.
  - Added feature FSL_FEATURE_PDM_CHANNEL_NUM for different SOC.

[2.2.1]

- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 10.1, 10.3, 10.4, 10.6, 10.7, 11.3, 11.8, 14.4, 17.7, 18.4.
  - Added medium quality mode support in function PDM_SetSampleRateConfig.

[2.2.0]

- Improvements
  - Added api PDM_SetSampleRateConfig to improve user experience and marked api PDM_SetSampleRate as deprecated.

[2.1.1]

- Improvements
- Used new SDMA API SDMA_SetDoneConfig instead of SDMA_EnableSwDone for PDM SDMA driver.

[2.1.0]

- Improvements
  - Added software buffer queue for transactional API.

[2.0.1]

- Improvements
  - Improved HWVAD feature.

[2.0.0]

- Initial version.

PDM_EDMA

[2.6.5]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8.

[2.6.4]

- Improvements
  - Add handling for runtime change of number of linked transfers

[2.6.3]

- Improvements
  - Add EDMA ext API to accommodate more types of EDMA.

[2.6.2]

- Improvements
  - Add macro MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL to let the user decide whether to enable it when calling PDM_TransferReceiveEDMA.

[2.6.1]

- Bug Fixes
  - Fixed violation of MISRA C-2012 Rule 10.3, 10.4.

[2.6.0]

- Improvements
  - Updated api PDM_TransferReceiveEDMA to support channel block interleave transfer.
  - Added new api PDM_TransferSetMultiChannelInterleaveType to support channel interleave type configurations.

[2.5.0]

- Refer PDM driver change log 2.1.0 to 2.5.0

PIT

[2.2.0]

- Bug Fixes
  - According to ERR050763, PIT_LDVAL_STAT register is not reliable in dynamic load mode, so remove the status check in PIT_SetRtiTimerPeriod which added since 2.1.1.
  - Removed not used bit PIT_RTI_TCTRL_CHN_MASK.
- Improvements
  - Added more guide about get RTI load status in PIT_SetRtiTimerPeriod's API comment.
  - Change PIT_RTI_Deinit to inline API.
  - Ensure PIT peripheral clock enabled in PIT_RTI_Init.
- New Features
  - Added PIT_ClearRtiSyncStatus API to clear the RTI_LDVAL_STAT register.

[2.1.1]

- Bug Fixes
  - Enable PIT when using RTI to ensure RTI can work properly in debug mode.
- Improvements
  - Added status check in PIT_SetRtiTimerPeriod to ensure the load value is synchronized into the RTI clock domain.
  - Added note for PIT_RTI_Init to remind users wait RTI sync.

[2.1.0]

- New Features
  - Support RTI (Real Time Interrupt) timer.

[2.0.5]

- Improvements
  - Support workaround for ERR007914. This workaround guarantee the write to MCR register is not ignored.

[2.0.4]

- Bug Fixes
  - Fixed PIT_SetTimerPeriod implementation, the load value trigger should be PIT clock cycles minus 1.

[2.0.3]

- Bug Fixes
  - Clear all status bits for all channels to make sure the status of all TCTRL registers is clean.

[2.0.2]

- Bug Fixes
  - Fixed MISRA-2012 issues.
    - Rule 10.1.

[2.0.1]

- Bug Fixes
  - Cleared timer enable bit for all channels in function PIT_Init() to make sure all channels stay in disable status before setting other configurations.
  - Fixed MISRA-2012 rules.
    - Rule 14.4, rule 10.4.

[2.0.0]

- Initial version.

PUF

[2.2.0]

- Add support for kPUF_KeySlot4.
- Add new PUF_ClearKey() function, that clears a desired PUF internal HW key register.

[2.1.6]

- Changed wait time in PUF_Init(), when initialization fails it will try PUF_Powercycle() with shorter time. If this shorter time will also fail, initialization will be tried with worst case time as before.

[2.1.5]

- Use common SDK delay in puf_wait_usec().

[2.1.4]

- Replace register uint32_t ticksCount with volatile uint32_t ticksCount in puf_wait_usec() to prevent optimization out delay loop.

[2.1.3]

- Fix MISRA C-2012 issue.

[2.1.2]

- Update: Add automatic big to little endian swap for user (pre-shared) keys destinated to secret hardware bus (PUF key index 0).

[2.1.1]

- Fix ARMGCC build warning .

[2.1.0]

- Align driver with PUF SRAM controller registers on LPCXpresso55s16.
- Update initizalition logic .

[2.0.3]

- Fix MISRA C-2012 issue.

[2.0.2]

- New feature:
  - Add PUF configuration structure and support for PUF SRAM controller.
- Improvements:
  - Remove magic constants.

[2.0.1]

- Bug Fixes:
  - Fixed puf_wait_usec function optimization issue.

[2.0.0]

- Initial version.

PWM

[2.9.0]

- Improvements
  - Support PWMX channel output for edge aligned PWM.
  - Forbid submodule 0 counter initialize with master sync and master reload mode.

[2.8.4]

- Improvements
  - Support workaround for ERR051989. This function helps realize no phase delay between submodule 0 and other submodule.

[2.8.3]

- Bug Fixes
  - Fixed MISRA C-2012 Rule 15.7

[2.8.2]

- Bug Fixes
  - Fixed warning conversion from 'int' to 'uint16_t' on API PWM_Init.
  - Fixed warning unused variable 'reg' on API PWM_SetPwmForceOutputToZero.

[2.8.1]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.8.0]

- Improvements
  - Added API PWM_UpdatePwmPeriodAndDutycycle to update the PWM signal's period and dutycycle for a PWM submodule.
  - Added API PWM_SetPeriodRegister and PWM_SetDutycycleRegister to merge duplicate code in API PWM_SetupPwm, PWM_UpdatePwmDutycycleHighAccuracy and PWM_UpdatePwmPeriodAndDutycycle

[2.7.1]

- Improvements
  - Supported UPDATE_MASK bit in MASK register.

[2.7.0]

- Improvements
  - Supported platforms which don't have Capture feature with channel A and B.
  - Supported platforms which don't have Submodule 3.
  - Added assert function in API PWM_SetPhaseDelay to prevent wrong argument.

[2.6.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rules: 10.3.

[2.6.0]

- Improvements
  - Added API PWM_SetPhaseDelay to set the phase delay from the master sync signal of submodule 0.
  - Added API PWM_SetFilterSampleCountthe to set number of consecutive samples that must agree prior to the input filter.
  - Added API PWM_SetFilterSamplePeriod to set set the sampling period of the fault pin input filter.

[2.5.1]

- Bug Fixes
  - Fixed MISRA C-2012 rules: 10.1, 10.3, 10.4 , 10.6 and 10.8.
  - Fixed the issue that PWM_UpdatePwmDutycycle() can't update duty cycle status value correct.

[2.5.0]

- Improvements
  - Added API PWM_SetOouputToIdle to set pwm channel output to idle.
  - Added API PWM_GetPwmChannelState to get the pwm channel output duty cycle value.
  - Added API PWM_SetPwmForceOutputToZero to set the pwm channel output to zero logic.
  - Added API PWM_SetChannelOutput to set the pwm channel output state.
  - Added API PWM_SetClockMode to set the value of the clock prescaler.
  - Added API PWM_SetupPwmPhaseShift to set PWM which a special phase shift and 50% duty cycle.
  - Added API PWM_SetVALxValue/PWM_GetVALxValue to set/get PWM VALs registers values directly.

[2.4.0]

- Improvements
  - Supported the PWM which can't work in wait mode.

[2.3.0]

- Improvements
  - Add PWM output enable&disbale API for SDK.
- Bug Fixes
  - Fixed changing channel B configuration when parameter is kPWM_PWMX and PWMX configuration is not supported yet.

[2.2.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rules: 10.3, 10.4.
- Bug Fixes
  - Fixed the issue that PWM drivers computed VAL1 improperly.
- Improvements
  - Updated calculation accuracy of reloadValue in dutyCycleToReloadValue function.

[2.2.0]

- Improvements
  - Added new enumeration and two APIs to support enabling and disabling one or more PWM output triggers.
  - Added a new function to make the most of 16-bit resolution PWM.
  - Added one API to support updating fault status of PWM output.
  - Added one API to support PWM DMA write request.
  - Added three APIs to support PWM DMA capture read request.
  - Added one API to support get default fault config of PWM.
  - Added one API to support setting PWM fault disable mapping.

[2.1.0]

- Improvements
  - Moved the configuration of fault input filter into a new API to avoid be initialized multiple times.
- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fix rules, containing: rule-10.2, rule-10.3, rule-10.4, rule-10.7, rule-10.8, rule-14.4, rule-16.4.

[2.0.1]

- Bug Fixes
  - Fixed the issue that PWM submodule may be initialized twice in function PWM_SetupPwm().

[2.0.0]

- Initial version.

PXP

[2.7.0]

- New Features
  - Added the PS_LRC setting for V4.
  - Added the PXP_SetPath setting for V4.
  - Fixed the code logic, V4 do not support DATA_PATH_CTRL1.

[2.6.1]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.6.0]

- Bug Fixes
  - Added missing configuration option for fetch engine background value.
  - Fixed bug in PXP_SetStoreEngineConfig that the address increment for store mask is not linear.
  - Added channel aribitration configuration for fetch engine, channel combine for store engine.
  - Fixed wrong method of obtaining the store mask address.
  - Fixed wrong method of configuring flag shift mask/width which can only be written in word boundary.
  - Fixed wrong configurations of block store and pitch in PXP_SetStoreEngineConfig.
  - Fixed wrong method of obtaining cfaValue address and calculating word count.
  - Fixed the channel word order cannot be updated when configuring the second channel.
  - Fixed bugs in PXP_SetHistogramConfig of wrong method to obtain the store mask address and wrong access of 32-bit registers.

[2.5.0]

- New Features
  - Added new API PXP_GetPorterDuffConfigExt for flexible Porter-Duff configuration.
  - Added enumerations for new AS/PS pixel formats for certain SoCs.

[2.4.1]

- New Features
  - Added API PXP_ResetControl to reset the PXP and the control register to initialized state.

[2.4.0]

- New Features
  - Added the API PXP_BuildRect of building a solid rectangle of given pixel value.
  - Added the interrupt enable/disable and status mask for V3.
  - Added API PXP_EnableProcessEngine to enable/disable process engines for V3.
  - Added API PXP_SetHistogramSize to re-configure the histogram size for each update.
  - Updated PXP_WfeaInit and PXP_SetWfeaConfig according to header file's update of WFE related registers.
  - Updated PXP_WfeaInit to support handshake with upstream dither store engine and added API PXP_WfeaEnableDitherHandshake to enable/disable the feature.
  - Added API PXP_GetLutUsage to get the occupied LUT list.
  - Updated APIs to support alpha blending engine1.
  - Added the API PXP_MemCopy to support all memory size copy.
- Bug Fixes
  - Fixed wrong naming for mux16.

  - Fixed wrong naming for enumerations in pxp_scanline_burst_t.
  - Fixed bug in PXP_GetHistogramMatchResult since there are 2 histograms engines rather than 1.
  - Fixed bug in PXP_SetFetchEngineConfig that the fetch size should not be minus one coding.

[2.3.0]

- New Features
  - Added the configuration of fetch engine, store engine, pre-dither engine and histogram block.

[2.2.2]

- Improvements
  - Disable alpha surface (AS) in PXP_Init.

[2.2.1]

- Improvements
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.

[2.2.0]

- Bug Fixes
  - Fixed Porter Duff configuration error.

[2.1.0]

- New Features
  - Added Porter Duff support.
  - Added APIs PXP_StartMemCopy and PXP_StartPictureCopy.
  - Added API PXP_SetProcessSurfaceYUVFormat.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 10.8, 11.6, 12.2.

[2.0.1]

- Bug Fixes
  - Fixed the rotate function issue for i.MX 6ULL.

[2.0.0]

- Initial version.

QTMR

[2.2.2]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rules: 10.1, 10.8.

[2.2.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rules: 10.1, 10.8.

[2.2.0]

- Improvements
  - Added API QTMR_SetPwmOutputToIdle to set the generated pwm signal to the configured idle value.
  - Added API QTMR_GetPwmOutputStatus to return the output status of the generated pwm signal.
  - Added API QTMR_GetPwmChannelStatus to return the channel dutycycle value.
  - Added API QTMR_SetPwmClockMode to set clock mode change peripheral clock frequency.
- Bug Fixes
  - Fixed the issue that pwm duty cycle could not be 0 and 100.

[2.1.0]

- Bug Fixes
  - Fixed the issue QTMR_SetTimerPeriod needs to decrement down count by 1, and added new APIs to configure the LOAD register, COMP register.

[2.0.2]

- Bug Fixes
  - Fixed the issue introduced by previous code correction for improving the output signal accuracy.

[2.0.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rules: 10.1, 10.3, 11.5, 11.9.
- Improvements
  - Improved the output signal accuracy.

[2.0.0]

- Initial version.

RDC

[2.2.0]

- New Features
  - Added APIs to get memory region or peripheral access policy for specific domain.

[2.1.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.6.

[2.1.0]

- Improvements
  - Enhanced to support memory region larger than 32-bit address.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 11.3, 11.8, 17.7.

[2.0.1]

- Bug Fixes:
  - Added __DSB after new configuration is set to ensure the new configuration takes effect.

[2.0.0]

- Initial version.

RDC_SEMA42

[2.0.4]

- Improvements
  - Changed to implement RDC_SEMAPHORE_Lock base on RDC_SEMAPHORE_TryLock.

[2.0.3]

- Improvements:
  - Supported the RDC_SEMAPHORE_Type structure whose gate registers are defined as an array.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 10.8, 14.3, 14.4, 18.1.

[2.0.1]

- Improvements:
  - Added support for the platforms that don't have dedicated RDC_SEMA42 clock gate.

[2.0.0]

- Initial version.

RTWDOG

[2.1.4]

- Bug Fixes
  - Fixed CERT INT30-C, INT31-C issue.
  - Make API RTWDOG_CountToMesec return 0 if result overflow.

[2.1.3]

- Improvements
  - Waited the over status after CS register operation in case next CS operation causes problem.

[2.1.2]

- Bug Fixes
  - Fixed doxygen issue.

[2.1.1]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - Fixed rules, containing: rule-10.3, rule-10.8, rule-11.9, rule-14.4, rule-15.5.

[2.1.0]

- Improvements
  - Added an API to enable or disable the window mode.
  - Added an API to convert a raw count value to millisecond.
  - Used AT_QUICKACCESS_SECTION_CODE macro to decorate RTWDOG_Init, and copied this function from flash to QUICKACCESS section.

[2.0.1]

- Bug Fixes
  - Fixed bug in the RTWDOG_Init; added check for register's unlock status when configuring the RTWDOG in RTWDOG_init.

[2.0.0]

- Initial version.

SAI

[2.4.7]

- Added conditional support for bit clock swap feature
- Added common IRQ handler entry SAI_DriverIRQHandler.

[2.4.6]

- Bug Fixes
  - Fixed the IAR build warning.

[2.4.5]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

[2.4.4]

- Bug Fixes
  - Fixed enumeration sai_fifo_combine_t - add RX configuration.

[2.4.3]

- Bug Fixes
  - Fixed enumeration sai_fifo_combine_t value configuration issue.

[2.4.2]

- Improvements
  - Release peripheral from reset if necessary in init function.

[2.4.1]

- Bug Fixes
  - Fixed bitWidth incorrectly assigned issue.

[2.4.0]

- Improvements
  - Removed deprecated APIs.

[2.3.8]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.4.

[2.3.7]

- Improvements
  - Change feature “FSL_FEATURE_SAI_FIFO_COUNT” to “FSL_FEATURE_SAI_HAS_FIFO”.
  - Added feature “FSL_FEATURE_SAI_FIFO_COUNTn(x)” to align SAI fifo count function with IP in function

[2.3.6]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 5.6.

[2.3.5]

- Improvements
  - Make driver to be aarch64 compatible.

[2.3.4]

- Bug Fixes
  - Corrected the fifo combine feature macro used in driver.

[2.3.3]

- Bug Fixes
  - Added bit clock polarity configuration when sai act as slave.
  - Fixed out of bound access coverity issue.
  - Fixed violations of MISRA C-2012 rule 10.3, 10.4.

[2.3.2]

- Bug Fixes
  - Corrected the frame sync configuration when sai act as slave.

[2.3.1]

- Bug Fixes
  - Corrected the peripheral name in function SAI0_DriverIRQHandler.
  - Fixed violations of MISRA C-2012 rule 17.7.

[2.3.0]

- Bug Fixes
  - Fixed the build error caused by the SOC has no fifo feature.

[2.2.3]

- Bug Fixes
  - Corrected the peripheral name in function SAI0_DriverIRQHandler.

[2.2.2]

- Bug Fixes
  - Fixed the issue of MISRA 2004 rule 9.3.
  - Fixed sign-compare warning.
  - Fixed the PA082 build warning.
  - Fixed sign-compare warning.
  - Fixed violations of MISRA C-2012 rule 10.3,17.7,10.4,8.4,10.7,10.8,14.4,17.7,11.6,10.1,10.6,8.4,14.3,16.4,18
  - Allow to reset Rx or Tx FIFO pointers only when Rx or Tx is disabled.
- Improvements
  - Added 24bit raw audio data width support in sai sdma driver.
  - Disabled the interrupt/DMA request in the SAI_Init to avoid generates unexpected sai FIFO requests.

[2.2.1]

- Improvements
  - Added mclk post divider support in function SAI_SetMasterClockDivider.
  - Removed useless configuration code in SAI_RxSetSerialDataConfig.
- Bug Fixes
  - Fixed the SAI SDMA driver build issue caused by the wrong structure member name used in the function SAI_TransferRxSetConfigSDMA/SAI_TransferTxSetConfigSDMA.
  - Fixed BAD BIT SHIFT OPERATION issue caused by the FSL_FEATURE_SAI_CHANNEL_COUNTn.
  - Applied ERR05144: not set FCONT = 1 when TMR > 0, otherwise the TX may not work.

[2.2.0]

- Improvements
  - Added new APIs for parameters collection and simplified user interfaces:
    - SAI_Init
    - SAI_SetMasterClockConfig
    - SAI_TxSetBitClockRate
    - SAI_TxSetSerialDataConfig
    - SAI_TxSetFrameSyncConfig
    - SAI_TxSetFifoConfig
    - SAI_TxSetBitclockConfig
    - SAI_TxSetConfig
    - SAI_TxSetTransferConfig

        * SAI_RxSetBitClockRate
        * SAI_RxSetSerialDataConfig
        * SAI_RxSetFrameSyncConfig
        * SAI_RxSetFifoConfig
        * SAI_RxSetBitclockConfig
        * SAI_RXSetConfig
        * SAI_RxSetTransferConfig
        * SAI_GetClassicI2SConfig
        * SAI_GetLeftJustifiedConfig
        * SAI_GetRightJustifiedConfig
        * SAI_GetTDMConfig

[2.1.9]

- Improvements
  - Improved SAI driver comment for clock polarity.
  - Added enumeration for SAI for sample inputs on different edges.
  - Changed FSL_FEATURE_SAI_CHANNEL_COUNT to FSL_FEATURE_SAI_CHANNEL_COUNTn(base) for the difference between the different SAI instances.
- Added new APIs:
  - SAI_TxSetBitClockDirection
  - SAI_RxSetBitClockDirection
  - SAI_RxSetFrameSyncDirection
  - SAI_TxSetFrameSyncDirection

[2.1.8]

- Improvements
  - Added feature macro test for the sync mode2 and mode 3.
  - Added feature macro test for masterClockHz in sai_transfer_format_t.

[2.1.7]

- Improvements
  - Added feature macro test for the mclkSource member in sai_config_t.
  - Changed “FSL_FEATURE_SAI5_SAI6_SHARE_IRQ” to “FSL_FEATURE_SAI_SAI5_SAI6_SHARE_IRQ”.
  - Added #ifndef #endif check for SAI_XFER_QUEUE_SIZE to allow redefinition.
- Bug Fixes
  - Fixed build error caused by feature macro test for mclkSource.

[2.1.6]

- Improvements
  - Added feature macro test for mclkSourceClockHz check.
  - Added bit clock source name for general devices.
- Bug Fixes
  - Fixed incorrect channel numbers setting while calling RX/TX set format together.

[2.1.5]

- Bug Fixes
  - Corrected SAI3 driver IRQ handler name.
  - Added I2S4/5/6 IRQ handler.
  - Added base in handler structure to support different instances sharing one IRQ number.
- New Features
  - Updated SAI driver for MCR bit MICS.
  - Added 192 KHZ/384 KHZ in the sample rate enumeration.
  - Added multi FIFO interrupt/SDMA transfer support for TX/RX.
  - Added an API to read/write multi FIFO data in a blocking method.
  - Added bclk bypass support when bclk is same with mclk.

[2.1.4]

- New Features
  - Added an API to enable/disable auto FIFO error recovery in platforms that support this feature.
  - Added an API to set data packing feature in platforms which support this feature.

[2.1.3]

- New Features
  - Added feature to make I2S frame sync length configurable according to bitWidth.

[2.1.2]

- Bug Fixes
  - Added 24-bit support for SAI eDMA transfer. All data shall be 32 bits for send/receive, as eDMA cannot directly handle 3-Byte transfer.

[2.1.1]

- Improvements
  - Reduced code size while not using transactional API.

[2.1.0]

- Improvements
  - API name changes:
    * SAI_GetSendRemainingBytes -> SAI_GetSentCount.
    * SAI_GetReceiveRemainingBytes -> SAI_GetReceivedCount.
    * All names of transactional APIs were added with “Transfer” prefix.
    * All transactional APIs use base and handle as input parameter.
    * Unified the parameter names.
- Bug Fixes
  - Fixed WLC bug while reading TCSR/RCSR registers.
  - Fixed MOE enable flow issue. Moved MOE enable after MICS settings in SAI_TxInit/SAI_RxInit.

[2.0.0]

- Initial version.

SAI_EDMA

[2.7.3]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

[2.7.2]

- Improvements
  - Add macros MCUX_SDK_SAI_EDMA_TX_ENABLE_INTERNAL and MCUX_SDK_SAI_EDMA_RX_ENABLE_INTERNAL to let the user decide whether to enable SAI when calling SAI_TransferSendEDMA/SAI_TransferReceiveEDMA.

[2.7.1]

- Improvements
  - Add EDMA ext API to accommodate more types of EDMA.

[2.7.0]

- Improvements
  - Updated api SAI_TransferReceiveEDMA to support voice channel block interleave transfer.
  - Updated api SAI_TransferSendEDMA to support voice channel block interleave transfer.
  - Added new api SAI_TransferSetInterleaveType to support channel interleave type configurations.

[2.6.0]

- Improvements
  - Removed deprecated APIs.

[2.5.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 20.7.

[2.5.0]

- Improvements
  - Added new api SAI_TransferSendLoopEDMA/SAI_TransferReceiveLoopEDMA to support loop transfer.
  - Added multi sai channel transfer support.

[2.4.0]

- Improvements
  - Added new api SAI_TransferGetValidTransferSlotsEDMA which can be used to get valid transfer slot count in the sai edma transfer queue.
  - Deprecated the api SAI_TransferRxSetFormatEDMA and SAI_TransferTxSetFormatEDMA.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.3,10.4.

[2.3.2]

- Refer SAI driver change log 2.1.0 to 2.3.2

SEMA4

[2.2.0]

- New Features
  - Added SEMA4_BUSY_POLL_COUNT parameter to prevent infinite polling loops in SEMA4 operations.
  - Added timeout mechanism to all polling loops in SEMA4 driver code.
- Improvements
  - Updated SEMA4_Lock function to return status_t instead of void for better error handling.
  - Enhanced documentation to clarify timeout behavior and return values.

[2.1.0]

- Improvements
  - Changed mask parameter type in SEMA4_EnableGateNotifyInterrupt() and SEMA4_DisableGateNotifyInterrupt() functions to avoid casting from unsigned long to unsigned short in the code when modifying the 16bits CPINE register.

[2.0.3]

- Improvements
  - Changed to implement SEMA4_Lock base on SEMA4_TryLock.

[2.0.2]

- Improvements:
  - Supported the SEMA4_Type structure whose gate registers are defined as an array.

[2.0.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 15.5, 18.1, 18.4.

[2.0.0]

- Initial version.

SEMC

[2.7.1]

- Bug Fixes
  - Fixed the wrong write operation to INTR register. The INTR register is a W1C register, so the right write operation is write directly to it to clear.

[2.7.0]

- Improvements
  - Add new autofreshTimes parameter in semc_sdram_config_t.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.4.

[2.6.0]

- Bug Fixes
  - Fixed the SEMC SRAM function bug that some configuration options can't be set.
  - Correct legacy SEMC SRAM function feature macros.
- Improvements
  - Add new SEMC SRAM function feature macros.

[2.5.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 14.3.
  - Fixed SEMC_ConfigureDBI bug that RDX not set correctly.

[2.5.0]

- Bug Fixes
  - Fixed definitions of bitfields of BMCR0 and BMCR1 - wrong field order and incorrect semantical naming
  - The fix alters the driver API regarding configuration of AXI bus queue reordering

[2.4.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 5.6.

[2.4.2]

- Improvements
  - Deleted meaningless parameter in memory size conversion function.

[2.4.1]

- Bug Fixes
  - Fixed PSRAM A8 configuration issue, which should be 0x06U for PSRAM while pix mux bit width is 0x04U, based on different pix mux bit width.

[2.4.0]

- Improvements
  - Improved nor and sram timing configuration on sync mode.

[2.3.1]

- Bug Fixes
  - Updated refresh timer period(RT) timing setting, which updated into (RT+1)*(Prescaler period) for SDRAM.
  - Supported new DBI control register 2 to configure CSX interval time(CEITV).
  - Fixed violations of the MISRA C-2012 Rule 10.8.
  - Fixed doxygen warning.

[2.3.0]

- New Features
  - Limited burst length as 1 according to ERR050577, Auto-refresh command may possibly fail to be triggered during long time back-to-back write (or read) when SDRAM controller's burst length is greater than 1.
  - Supported 8 bits column address for SDRAM.

[2.2.1]

- New Features
  - Added queue weight control, which can control queue a/b is working or not.
  - Updated NAND FLASH configuration API which disables and enables SEMC between configure control registers.
  - Added ONFI parameter Integrity CRC check for SEMC flash component.

[2.2.0]

- New Features
  - Supported up to 4 PSRAM CS.
  - Added programmable delay line for DQS.
  - Added ready/wait feature for SRAM in asynchronous mode.

[2.1.0]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.
  - Updated parameter type from uint16_t into uint32_t for send IP command API.

[2.0.4]

- Bug Fixes
  - Fixed the SEMC queueA and queueB weight configuration issue.
  - Fixed the wrong configuration of DBICR1 register in SEMC_ConfigureDBI.

[2.0.3]

- Bug Fixes
  - Added feature macro to control WDS&WDH bit setting for NOR synchronous transfer.

[2.0.2]

- Bug Fixes
  - Changed SEMC NAND configuration structure and verify SEMC NAND related APIs.
  - Added extended SEMC clock enable.

[2.0.1]

- Bug Fixes
  - Fixed data size mask configure in SEMC_ConfigureIPCommand API.
  - Updated the command mode in IP command type.

[2.0.0]

- Initial version.

SMARTCARD

[2.3.0]

- New features:
  - Added support for USIM

[2.2.2]

- Bug fix:
  - Fixed MISRA C-2012 rule 10.4.

[2.2.1]

- Bug fix:
  - Fixed IAR warnings Pa082 in smartcard_emvsim
  - Fixed MISRA issues
  - Fixed rules 10.1, 10.3, 10.4, 10.6, 10.7, 10.8, 14.4, 16.1, 16.3, 16.4, 17.7

[2.2.0]

- New features:
  - Updated to use RX/TX FIFO

[2.1.2]

- Provided time delay function which works in microseconds.
- Bug fix:
  - Changed event to semaphore in RTOS driver (KPSDK-11634).
  - Added check if de-initialized variables are not null iSMARTCARD_RTOS_Deinit() (KPSDK-8788).
  - Changed deactivation sequence iSMARTCARD_PHY_TDA8035_Deactivate() to properly stop the clockPOSCR-35).
  - Fixed timing issue with VSEL0/1 signals in smartcard TDA803driver (KPSDK-10160)

[2.1.1]

- New features:
  - Added default phy interface selection into smartcard RTOS drivers (KPSDK-9063).
  - Replaced smartcard_phy_ncn8025 driver by smartcard_phy_tda8035.
- Bug fix:
  - Fixed protocol timers activation sequences in smartcard_emvsim and smartcard_phy_tda8035 drivers during emvl1 pre-certification tests (KPSDK-9170, KPSDK-9556).

[2.1.0]

- Initial version.

SNVS_HP

[2.3.2]

- Make SNVS_HP_RTC_Init()/SNVS_HP_RTC_Deinit more transparent. Use function SNVS_HP_Init()/SNVS_HP_Deinit() instead of copy of this code in SNVS_HP_RTC_XXX() function.

[2.3.1]

- Fixed problem in SNVS_HP_RTC_Init(), which is clearing bits that should stay intact.

[2.3.0]

- Re-map Security Violation for RT11xx specific violations.

[2.2.0]

- Fixed doxygen issues.
- Add SNVS HP Set locks.

[2.1.4]

- Fix MISRA issues.

[2.1.3]

- Fixed IAR Pa082 warnings.

[2.1.2]

- Fixed problem with initialization of the periodic interrupt frequency.
- Fixed problem with SNVS entering into fail state when HAB enters closed mode.

[2.1.1]

- Added APIs for HP security violation status flags.

[2.1.0]

- Added APIs for High Assurance Counter (HAC), Zeroizable Master Key (ZMK) and Software Security Violation.

[2.0.0]

- Initial version.

SNVS_LP

[2.4.6]

- Fix a bug in SNVS_LP_EnableRxActiveTamper() where assignments to base->LPATRC2R were done wrongly to LPATRC1R.

[2.4.5]

- Fix a bug in SNVS_LP_EnableRxActiveTamper() where assignments to base->LPATRC1R would overwrite previously set bits.

[2.4.4]

- Make SNVS_LP_SRTC_Init()/SNVS_LP_SRTC_Deinit more transparent. Use function SNVS_LP_Init()/SNVS_LP_Deinit() instead of copy of this code in SNVS_LP_SRTC_XXX() function.

[2.4.3]

- Fixed problem in SNVS_LP_SRTC_Init(), which is clearing bits that should stay intact.

[2.4.2]

- Updated driver to match with new device header files.

[2.4.1]

- Fixed MISRA issues.

[2.4.0]

- Fix backward compatibility with version 2.2.x.

[2.3.0]

- Add active pin, clock, voltage and temperature tamper features.

[2.2.0]

- Fixed doxygen issues.
- Add Transition SNVS SSM state to Trusted/Non-secure from Check state.

[2.1.2]

- Fix MISRA issues.

[2.1.1]

- Fix IAR Pa082 warning.

[2.1.0]

- Added APIs for Zeroizable Master Key (ZMK) and Monotonic Counter (MC).

[2.0.0]

- Initial version.

SPDIF

[2.0.7]

- Improvements
  - Add feature macro FSL_FEATURE_SPDIF_HAS_NO_SIC_REGISTER to handle nonexistent SIC register.

[2.0.6]

- Bug Fixes
  - Fixed the Q/U channel interrupt enabled unexpectly while Q/U transfer pointer is NULL.

[2.0.5]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.3.

[2.0.4]

- Bug Fixes
  - Added udata/qdata buffer address validation in driver IRQ handler to ensure that NULL pointer dereferences do not occur.

[2.0.3]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.

[2.0.2]

- Bug Fixes
  - Corrected operator used for size value assertion in SPDIF_ReadBlocking/SPDIF_WriteBlocking.

[2.0.1]

- Bug Fixes
  - Corrected the feature macro name used to define s_edmaPrivateHandle.

[2.0.0]

- Initial version.

SPDIF DMA Driver

[2.0.8]

- Improvements
  - Add EDMA ext API to accommodate more types of EDMA.

[2.0.7]

- Bug Fixes
  - Fixed the incompatibility issue with edma4 driver.

[2.0.6]

- Bug Fixes
  - Add feature macro to determine whether to use the API MEMORY_ConvertMemoryMapAddress to translate TCD addresses for DLAST_SGA.

[2.0.5]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.3.

[2.0.4]

- Bug Fixes
  - Added udata/qdata buffer address validation in driver IRQ handler to ensure that NULL pointer dereferences do not occur.

[2.0.3]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.

[2.0.2]

- Bug Fixes
  - Corrected operator used for size value assertion in SPDIF_ReadBlocking/SPDIF_WriteBlocking.

[2.0.1]

- Bug Fixes
  - Corrected the feature macro name used to define s_edmaPrivateHandle.

[2.0.0]

- Initial version.

SSARC

[2.1.0]

- Improvements
  - Updated the structure ssarc_descriptor_config_t, make it more friendly to users.

[2.0.0]

- Initial version.

TEMPSENSOR

[2.1.2]

- Bug Fixes
  - Fixed the bug of incorrect default value of temperature sensor registers in initialization state.

[2.1.1]

- Improvements
  - CTRL0 register fields are not needed for customer, they are trim registers for the IP that are determined during calibration.

[2.1.0]

- Improvements
  - Supported directly access to TEMPSENSOR registers.

[2.0.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 Rule 10.1, 10.3, 10.4, 10.8.

[2.0.2]

- Bug Fixes
  - Fixed bug that FINISH flag not cleared after temperature read out.

[2.0.1]

- Improvements
  - Updated temperature calculation formula, to get more accurate result with high or low temperature..

[2.0.0]

- Initial version.

USDHC

[2.8.5]

- Improvements
  - Enable the driver to be AARCH64 compatible.

[2.8.4]

- Improvements
  - Add feature macro FSL_FEATURE_USDHC_HAS_NO_VS18.

[2.8.3]

- Improvements
  - Improved api USDHC_EnableAutoTuningForCmdAndData to adapt to new bit field name for USDHC_VEND_SPEC2 register.

[2.8.2]

- Improvements
  - Added feature macro FSL_FEATURE_USDHC_HAS_NO_VOLTAGE_SELECT.

[2.8.1]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.9.

[2.8.0]

- Improvements
  - Fixed the mmc boot transfer failed issue which is caused by the Dma complete interrupt not enabled.
  - Marked api USDHC_AdjustDelayForManualTuning as deprecated and added new api USDHC_SetTuingDelay/USDHC_GetTuningDelayStatus.
  - Improved the manual tuning flow accroding to specification.
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.
  - Fixed violations of MISRA C-2012 rule 10.4.

[2.7.0]

- Improvements
  - Added api USDHC_TransferScatterGatherADMANonBlocking to support scatter gather transfer.
  - Added feature FSL_FEATURE_USDHC_REGISTER_HOST_CTRL_CAP_HAS_NO_RETUNING_TIME_COUNT for re-tuning time counter field in HOST_CTRL_CAP register.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.9, 10.1, 10.3, 10.4, 8.4.

[2.6.0]

- Improvements
  - Added api USDHC_SetStandardTuningCounter to support adjust tuning counter of Standard tuning.

[2.5.1]

- Improvements
  - Used different status code for command and data interrupt callback.
  - Added cache line invalidate for receive buffer in driver IRQ handler to fix CM7 speculative access issue.

[2.5.0]

- Improvements
  - Added new api USDHC_SetStrobeDllOverride for HS400 strobe dll override mode delay taps configurations.
  - Corrected the STROBE DLL configurations sequence.

[2.4.0]

- Improvements
  - Added feature macro for read/write burst length.
    - Disabled redundant interrupt per different transfer request.

    * Disabled interrupt and reset command/data pointer in handle when transfer completes.

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.9, 15.7, 4.7, 16.4, 10.1, 10.3, 10.4, 11.3, 14.4, 10.6, 17.7, 16.1, 16.3.
  - Fixed PA082 build warning.
  - Fixed logically dead code Coverity issue.

[2.3.0]

- Improvements
  - Added USDHC_SetDataConfig API to support manual tuning.
  - Removed the limitaion that source clock must be bigger than the target in function USDHC_SetSdClock by using source clock frequency as target directly.
  - Added peripheral reset in USDHC_Init function.
  - Added tuning reset support in function USDHC_Reset function.

[2.2.8]

- Bug Fixes
  - Fixed out-of bounds write in function USDHC_ReceiveCommandResponse.

[2.2.7]

- Improvements
  - Added API USDHC_GetEnabledInterruptStatusFlags and used in USDHC_TransferHandleIRQ.
  - Removed useless member interruptFlags in usdhc_handle_t.

[2.2.6]

- Improvements
  - Added address align check for ADMA descriptor table address.
  - Changed USDHC_ADMA1_DESCRIPTOR_MAX_LENGTH_PER_ENTRY to (65536-4096) to make sure the data address is 4KB align for a transfer which need more than one ADMA1 descriptor.

[2.2.5]

- Bug Fixes
  - Fixed MDK 66-D warning.

[2.2.4]

- Bug Fixes
  - Fixed issue that real clock frequency wss mismatched with target clock frequency, which was caused by an incorrect prescaler calculation.
- New Features
  - Added control macro to enable/disable the CLOCK code in current driver.

[2.2.3]

- Bug Fixes
  - Fixed issue where AMDA did not disable with DMAEN clear.
- Improvements
  - Improved set clock function to check the output frequency range.
  - Dynamic set SDCLKFS during DDR enable or disable.

[2.2.2]

- Improvements
  - Improved read transfer cache maintain operation, combined clean, and invalidated them into one function.

[2.2.1]

- Bug Fixes
  - Disabled the invalidate cache operation for tuning.

[2.2.0]

- Improvements
  - Improved USDHC to support MMC boot feature.

[2.1.3]

- Bug Fixes
  - Fixed MISRA issue.

[2.1.2]

- Bug Fixes
  - Fixed Coverity issue.
  - Added base address and userData parameter for all callback functions.

[2.1.1]

- Improvements
  - Added cache maintain operation.
  - Added timeout status check for the DATA transfer which ignore error.
  - Added feature macro for SDR50/SDR104 mode.
  - Removed useless IRQ handler from different platforms.

[2.1.0]

- Improvements
  - Integrated tuning into transfer function.
  - Added strobe DLL feature.
  - Added enableAutoCommand23 in data structure.
  - Removed enable card clock function because the controller would handle the clock on/off.

[2.0.0]

- Initial version.

WDOG

[2.2.0]

- Bug Fixes
  - Fixed the wrong behavior of workMode.enableWait, workMode.enableStop, workMode.enableDebug in configuration structure wdog_config_t. When set the items to true, WDOG will continues working in those modes.

[2.1.1]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.1, 10.3, 10.4, 10.6, 10.7 and 11.9.
  - Fixed the issue of the inseparable process interrupted by other interrupt source.
    - WDOG_Init
    - WDOG_Refresh

[2.1.0]

- New Features
  - Added new API “WDOG_TriggerSystemSoftwareReset()” to allow users to reset the system by software.
  - Added new API “WDOG_TriggerSoftwareSignal()” to allow users to trigger a WDOG_B signal by software.
  - Removed the parameter “softwareAssertion” and “softwareResetSignal” out of the wdog_config_t structure.

  - Added new parameter “enableTimeOutAssert” to the wdog_config_t structure. With this parameter enabled, when the WDOG timeout occurs, a WDOG_B signal will be asserted. This signal can be routed to external pin of the chip. Note that WDOG_B signal remains asserted until a power-on reset (POR) occurs.

[2.0.1]

- New Features
  - Added control macro to enable/disable the CLOCK code in current driver.

[2.0.0]

- Initial version.

XBARA

[2.0.6]

- Bug Fixes
  - Fixed typo in kXBARA_RequestInterruptEnalbe item.

[2.0.5]

- Bug Fixes
  - Fixed IAR build warning Pa082.
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.6, 10.7, 10.8, 12.1, 18.1, 20.7.

[2.0.4]

- Improvements
  - Optimized XBARA_SetOutputSignalConfig.

[2.0.3]

- Bug Fixes
  - Corrected configuration for function XBAR_SetOutputSignalConfig.

[2.0.2]

- Other Changes
  - Changed array clock name.

[2.0.1]

- Bug Fixes
  - Fixed w1c bits for XBARA_SetOutputSignalConfig function.

[2.0.0]

- Initial version.

XBARB

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 12.2, 10.7

[2.0.1]

- Bug Fixes
  - Corrected XBARB_SetSignalsConnection function.
- Other Changes
  - Changed array clock name.

[2.0.0]

- Initial version.

XECC

[2.0.0]

- Initial version.

XRDC2

[2.0.3]

- Bug Fixes
  - Fixed the bug that domain access policy is set to the incorrect domain ID.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.8, 12.2, 14.1.

[2.0.1]

- Improvements
  - Updated for new header file.

[2.0.0]

- Initial version.

1.6 Driver API Reference Manual

This section provides a link to the Driver API RM, detailing available drivers and their usage to help you integrate hardware efficiently.

MIMXRT1176

1.7 Middleware Documentation

Find links to detailed middleware documentation for key components. While not all onboard middleware is covered, this serves as a useful reference for configuration and development.

1.7.1 VG-Lite GPU Library

VGLite Graphics Driver

1.7.2 Multicore

Multicore SDK

1.7.3 MCU Boot

mcuboot_opensource

1.7.4 Audio Voice components

Audio Voice Components

1.7.5 Maestro Audio Framework for MCU

Maestro Audio Framework

1.7.6 eIQ

eIQ

1.7.7 FreeMASTER

freemaster

1.7.8 AWS IoT

AWS IoT

1.7.9 NXP Wi-Fi

Wi-Fi, Bluetooth, 802.15.4

1.7.10 FreeRTOS

FreeRTOS

1.7.11 Wireless EdgeFast Bluetooth PAL

EdgeFast Bluetooth

1.7.12 lwIP

lwIP

1.7.13 File systemFatfs

fatfs

Chapter 2

MIMXRT1176

2.1 ACMP: Analog Comparator Driver

void ACMP_Init(CMP_Type *base, const *acmp_config_t* *config)

Initializes the ACMP.

The default configuration can be got by calling ACMP_GetDefaultConfig().

Parameters

- base – ACMP peripheral base address.
- config – Pointer to ACMP configuration structure.

void ACMP_Deinit(CMP_Type *base)

Deinitializes the ACMP.

Parameters

- base – ACMP peripheral base address.

void ACMP_GetDefaultConfig(*acmp_config_t* *config)

Gets the default configuration for ACMP.

This function initializes the user configuration structure to default value. The default value are:

Example:

```
config->enableHighSpeed = false;
config->enableInvertOutput = false;
config->useUnfilteredOutput = false;
config->enablePinOut = false;
config->enableHysteresisBothDirections = false;
config->hysteresisMode = kACMP_hysteresisMode0;
```

Parameters

- config – Pointer to ACMP configuration structure.

void ACMP_Enable(CMP_Type *base, bool enable)

Enables or disables the ACMP.

Parameters

- base – ACMP peripheral base address.
- enable – True to enable the ACMP.

void ACMP_EnableLinkToDAC(CMP_Type *base, bool enable)

Enables the link from CMP to DAC enable.

When this bit is set, the DAC enable/disable is controlled by the bit CMP_C0[EN] instead of CMP_C1[DACEN].

Parameters

- base – ACMP peripheral base address.
- enable – Enable the feature or not.

void ACMP_SetChannelConfig(CMP_Type *base, const *acmp_channel_config_t* *config)

Sets the channel configuration.

Note that the plus/minus mux's setting is only valid when the positive/negative port's input isn't from DAC but from channel mux.

Example:

```
acmp_channel_config_t configStruct = {0};
configStruct.positivePortInput = kACMP_PortInputFromDAC;
configStruct.negativePortInput = kACMP_PortInputFromMux;
configStruct.minusMuxInput = 1U;
ACMP_SetChannelConfig(CMP0, &configStruct);
```

Parameters

- base – ACMP peripheral base address.
- config – Pointer to channel configuration structure.

void ACMP_EnableDMA(CMP_Type *base, bool enable)

Enables or disables DMA.

Parameters

- base – ACMP peripheral base address.
- enable – True to enable DMA.

void ACMP_EnableWindowMode(CMP_Type *base, bool enable)

Enables or disables window mode.

Parameters

- base – ACMP peripheral base address.
- enable – True to enable window mode.

void ACMP_SetFilterConfig(CMP_Type *base, const *acmp_filter_config_t* *config)

Configures the filter.

The filter can be enabled when the filter count is bigger than 1, the filter period is greater than 0 and the sample clock is from divided bus clock or the filter is bigger than 1 and the sample clock is from external clock. Detailed usage can be got from the reference manual.

Example:

```
acmp_filter_config_t configStruct = {0};
configStruct.filterCount = 5U;
configStruct.filterPeriod = 200U;
configStruct.enableSample = false;
ACMP_SetFilterConfig(CMP0, &configStruct);
```

Parameters

- base – ACMP peripheral base address.

- config – Pointer to filter configuration structure.

void ACMP_SetDACConfig(CMP_Type *base, const *acmp_dac_config_t* *config)

Configures the internal DAC.

Example:

```
acmp_dac_config_t configStruct = {0};
configStruct.referenceVoltageSource = kACMP_VrefSourceVin1;
configStruct.DACValue = 20U;
configStruct.enableOutput = false;
configStruct.workMode = kACMP_DACWorkLowSpeedMode;
ACMP_SetDACConfig(CMP0, &configStruct);
```

Parameters

- base – ACMP peripheral base address.
- config – Pointer to DAC configuration structure. "NULL" is for disabling the feature.

void ACMP_SetRoundRobinConfig(CMP_Type *base, const *acmp_round_robin_config_t* *config)

Configures the round robin mode.

Example:

```
acmp_round_robin_config_t configStruct = {0};
configStruct.fixedPort = kACMP_FixedPlusPort;
configStruct.fixedChannelNumber = 3U;
configStruct.checkerChannelMask = 0xF7U;
configStruct.sampleClockCount = 0U;
configStruct.delayModulus = 0U;
ACMP_SetRoundRobinConfig(CMP0, &configStruct);
```

Parameters

- base – ACMP peripheral base address.
- config – Pointer to round robin mode configuration structure. "NULL" is for disabling the feature.

void ACMP_SetRoundRobinPreState(CMP_Type *base, uint32_t mask)

Defines the pre-set state of channels in round robin mode.

Note: The pre-state has different circuit with get-round-robin-result in the SOC even though they are same bits. So get-round-robin-result can't return the same value as the value are set by pre-state.

Parameters

- base – ACMP peripheral base address.
- mask – Mask of round robin channel index. Available range is channel0:0x01 to channel7:0x80.

static inline uint32_t ACMP_GetRoundRobinStatusFlags(CMP_Type *base)

Gets the channel input changed flags in round robin mode.

Parameters

- base – ACMP peripheral base address.

Returns

Mask of channel input changed asserted flags. Available range is channel0:0x01 to channel7:0x80.

void ACMP_ClearRoundRobinStatusFlags(CMP_Type *base, uint32_t mask)

Clears the channel input changed flags in round robin mode.

Parameters

- base – ACMP peripheral base address.
- mask – Mask of channel index. Available range is channel0:0x01 to channel7:0x80.

static inline uint32_t ACMP_GetRoundRobinResult(CMP_Type *base)

Gets the round robin result.

Note that the set-pre-state has different circuit with get-round-robin-result in the SOC even though they are same bits. So ACMP_GetRoundRobinResult() can't return the same value as the value are set by ACMP_SetRoundRobinPreState.

Parameters

- base – ACMP peripheral base address.

Returns

Mask of round robin channel result. Available range is channel0:0x01 to channel7:0x80.

void ACMP_EnableInterrupts(CMP_Type *base, uint32_t mask)

Enables interrupts.

Parameters

- base – ACMP peripheral base address.
- mask – Interrupts mask. See "_acmp_interrupt_enable".

void ACMP_DisableInterrupts(CMP_Type *base, uint32_t mask)

Disables interrupts.

Parameters

- base – ACMP peripheral base address.
- mask – Interrupts mask. See "_acmp_interrupt_enable".

uint32_t ACMP_GetStatusFlags(CMP_Type *base)

Gets status flags.

Parameters

- base – ACMP peripheral base address.

Returns

Status flags asserted mask. See "_acmp_status_flags".

void ACMP_ClearStatusFlags(CMP_Type *base, uint32_t mask)

Clears status flags.

Parameters

- base – ACMP peripheral base address.
- mask – Status flags mask. See "_acmp_status_flags".

void ACMP_SetDiscreteModeConfig(CMP_Type *base, const *acmp_discrete_mode_config_t* *config)

Configure the discrete mode.

Configure the discrete mode when supporting 3V domain with 1.8V core.

Parameters

- base – ACMP peripheral base address.
- config – Pointer to configuration structure. See "acmp_discrete_mode_config_t".

void ACMP_GetDefaultDiscreteModeConfig(*acmp_discrete_mode_config_t* *config)

Get the default configuration for discrete mode setting.

Parameters

- config – Pointer to configuration structure to be restored with the setting values.

FSL_ACMP_DRIVER_VERSION

ACMP driver version 2.3.0.

enum _acmp_interrupt_enable

Interrupt enable/disable mask.

Values:

enumerator kACMP_OutputRisingInterruptEnable

Enable the interrupt when comparator outputs rising.

enumerator kACMP_OutputFallingInterruptEnable

Enable the interrupt when comparator outputs falling.

enumerator kACMP_RoundRobinInterruptEnable

Enable the Round-Robin interrupt.

enum _acmp_status_flags

Status flag mask.

Values:

enumerator kACMP_OutputRisingEventFlag

Rising-edge on compare output has occurred.

enumerator kACMP_OutputFallingEventFlag

Falling-edge on compare output has occurred.

enumerator kACMP_OutputAssertEventFlag

Return the current value of the analog comparator output.

enum _acmp_offset_mode

Comparator hard block offset control.

If OFFSET level is 1, then there is no hysteresis in the case of positive port input crossing negative port input in the positive direction (or negative port input crossing positive port input in the negative direction). Hysteresis still exists for positive port input crossing negative port input in the falling direction. If OFFSET level is 0, then the hysteresis selected by acmp_hysteresis_mode_t is valid for both directions.

Values:

enumerator kACMP_OffsetLevel0

The comparator hard block output has level 0 offset internally.

enumerator kACMP_OffsetLevel1

The comparator hard block output has level 1 offset internally.

enum _acmp_hysteresis_mode

Comparator hard block hysteresis control.

See chip data sheet to get the actual hysteresis value with each level.

Values:

enumerator kACMP_HysteresisLevel0
Offset is level 0 and Hysteresis is level 0.

enumerator kACMP_HysteresisLevel1
Offset is level 0 and Hysteresis is level 1.

enumerator kACMP_HysteresisLevel2
Offset is level 0 and Hysteresis is level 2.

enumerator kACMP_HysteresisLevel3
Offset is level 0 and Hysteresis is level 3.

enum _acmp_reference_voltage_source
CMP Voltage Reference source.

Values:

enumerator kACMP_VrefSourceVin1
Vin1 is selected as resistor ladder network supply reference Vin.

enumerator kACMP_VrefSourceVin2
Vin2 is selected as resistor ladder network supply reference Vin.

enum _acmp_port_input
Port input source.

Values:

enumerator kACMP_PortInputFromDAC
Port input from the 8-bit DAC output.

enumerator kACMP_PortInputFromMux
Port input from the analog 8-1 mux.

enum _acmp_fixed_port
Fixed mux port.

Values:

enumerator kACMP_FixedPlusPort
Only the inputs to the Minus port are swept in each round.

enumerator kACMP_FixedMinusPort
Only the inputs to the Plus port are swept in each round.

enum _acmp_dac_work_mode
Internal DAC's work mode.

Values:

enumerator kACMP_DACWorkLowSpeedMode
DAC is selected to work in low speed and low power mode.

enumerator kACMP_DACWorkHighSpeedMode
DAC is selected to work in high speed high power mode.

typedef enum *_acmp_offset_mode* acmp_offset_mode_t
Comparator hard block offset control.

If OFFSET level is 1, then there is no hysteresis in the case of positive port input crossing negative port input in the positive direction (or negative port input crossing positive port input in the negative direction). Hysteresis still exists for positive port input crossing negative port input in the falling direction. If OFFSET level is 0, then the hysteresis selected by acmp_hysteresis_mode_t is valid for both directions.

typedef enum *_acmp_hysteresis_mode* acmp_hysteresis_mode_t
Comparator hard block hysteresis control.

See chip data sheet to get the actual hysteresis value with each level.

typedef enum *_acmp_reference_voltage_source* acmp_reference_voltage_source_t
CMP Voltage Reference source.

typedef enum *_acmp_port_input* acmp_port_input_t
Port input source.

typedef enum *_acmp_fixed_port* acmp_fixed_port_t
Fixed mux port.

typedef enum *_acmp_dac_work_mode* acmp_dac_work_mode_t
Internal DAC's work mode.

typedef struct *_acmp_config* acmp_config_t
Configuration for ACMP.

typedef struct *_acmp_channel_config* acmp_channel_config_t
Configuration for channel.

The comparator's port can be input from channel mux or DAC. If port input is from channel mux, detailed channel number for the mux should be configured.

typedef struct *_acmp_filter_config* acmp_filter_config_t
Configuration for filter.

typedef struct *_acmp_dac_config* acmp_dac_config_t
Configuration for DAC.

typedef struct *_acmp_round_robin_config* acmp_round_robin_config_t
Configuration for round robin mode.

typedef struct *_acmp_discrete_mode_config* acmp_discrete_mode_config_t
Configuration for discrete mode.

CMP_C0_CFx_MASK
The mask of status flags cleared by writing 1.

CMP_C1_CHNn_MASK

CMP_C2_CHnF_MASK

struct acmp_config
#include <fsl_acmp.h> Configuration for ACMP.

Public Members

acmp_offset_mode_t offsetMode
Offset mode.

acmp_hysteresis_mode_t hysteresisMode
Hysteresis mode.

bool enableHighSpeed
Enable High Speed (HS) comparison mode.

bool enableInvertOutput
Enable inverted comparator output.

bool useUnfilteredOutput

Set compare output(COUT) to equal COUTA(true) or COUT(false).

bool enablePinOut

The comparator output is available on the associated pin.

struct _acmp_channel_config

#include <fsl_acmp.h> Configuration for channel.

The comparator's port can be input from channel mux or DAC. If port input is from channel mux, detailed channel number for the mux should be configured.

Public Members

acmp_port_input_t positivePortInput

Input source of the comparator's positive port.

uint32_t plusMuxInput

Plus mux input channel(0~7).

acmp_port_input_t negativePortInput

Input source of the comparator's negative port.

uint32_t minusMuxInput

Minus mux input channel(0~7).

struct _acmp_filter_config

#include <fsl_acmp.h> Configuration for filter.

Public Members

bool enableSample

Using external SAMPLE as sampling clock input, or using divided bus clock.

uint32_t filterCount

Filter Sample Count. Available range is 1-7, 0 would cause the filter disabled.

uint32_t filterPeriod

Filter Sample Period. The divider to bus clock. Available range is 0-255.

struct _acmp_dac_config

#include <fsl_acmp.h> Configuration for DAC.

Public Members

acmp_reference_voltage_source_t referenceVoltageSource

Supply voltage reference source.

uint32_t DACValue

Value for DAC Output Voltage. Available range is 0-255.

bool enableOutput

Enable the DAC output.

struct _acmp_round_robin_config

#include <fsl_acmp.h> Configuration for round robin mode.

Public Members

acmp_fixed_port_t fixedPort
Fixed mux port.

uint32_t fixedChannelNumber
Indicates which channel is fixed in the fixed mux port.

uint32_t checkerChannelMask
Mask of checker channel index. Available range is channel0:0x01 to channel7:0x80 for round-robin checker.

uint32_t sampleClockCount
Specifies how many round-robin clock cycles(0~3) later the sample takes place.

uint32_t delayModulus
Comparator and DAC initialization delay modulus.

struct _acmp_discrete_mode_config
#include <fsl_acmp.h> Configuration for discrete mode.

Public Members

bool enablePositiveChannelDiscreteMode
Positive Channel Continuous Mode Enable. By default, the continuous mode is used.

bool enableNegativeChannelDiscreteMode
Negative Channel Continuous Mode Enable. By default, the continuous mode is used.

2.2 ADC_ETC: ADC External Trigger Control

void ADC_ETC_Init(ADC_ETC_Type *base, const *adc_etc_config_t* *config)
Initialize the ADC_ETC module.

Parameters

- base – ADC_ETC peripheral base address.
- config – Pointer to “adc_etc_config_t” structure.

void ADC_ETC_Deinit(ADC_ETC_Type *base)
De-Initialize the ADC_ETC module.

Parameters

- base – ADC_ETC peripheral base address.

void ADC_ETC_GetDefaultConfig(*adc_etc_config_t* *config)
Gets an available pre-defined settings for the ADC_ETC’s configuration. This function initializes the ADC_ETC’s configuration structure with available settings. The default values are:

```
config->enableTSCBypass = true;
config->enableTSC0Trigger = false;
config->enableTSC1Trigger = false;
config->TSC0triggerPriority = 0U;
config->TSC1triggerPriority = 0U;
config->clockPreDivider = 0U;
config->XBARtriggerMask = 0U;
```

Parameters

- config – Pointer to “adc_etc_config_t” structure.

void ADC_ETC_SetTriggerConfig(ADC_ETC_Type *base, uint32_t triggerGroup, const *adc_etc_trigger_config_t* *config)

Set the external XBAR trigger configuration.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index.
- config – Pointer to “adc_etc_trigger_config_t” structure.

void ADC_ETC_SetTriggerChainConfig(ADC_ETC_Type *base, uint32_t triggerGroup, uint32_t chainGroup, const *adc_etc_trigger_chain_config_t* *config)

Set the external XBAR trigger chain configuration. For example, if triggerGroup is set to 0U and chainGroup is set to 1U, which means Trigger0 source’s chain1 would be configurated.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.
- chainGroup – Trigger chain group index. Available number is 0~7.
- config – Pointer to “adc_etc_trigger_chain_config_t” structure.

uint32_t ADC_ETC_GetInterruptStatusFlags(ADC_ETC_Type *base, *adc_etc_external_trigger_source_t* sourceIndex)

Gets the interrupt status flags of external XBAR and TSC triggers.

Parameters

- base – ADC_ETC peripheral base address.
- sourceIndex – trigger source index.

Returns

Status flags mask of trigger. Refer to “_adc_etc_status_flag_mask”.

void ADC_ETC_ClearInterruptStatusFlags(ADC_ETC_Type *base, *adc_etc_external_trigger_source_t* sourceIndex, uint32_t mask)

Clears the ADC_ETC’s interrupt status falgs.

Parameters

- base – ADC_ETC peripheral base address.
- sourceIndex – trigger source index.
- mask – Status flags mask of trigger. Refer to “_adc_etc_status_flag_mask”.

static inline void ADC_ETC_EnableDMA(ADC_ETC_Type *base, uint32_t triggerGroup)

Enable the DMA corresponding to each trigger source.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.

static inline void ADC_ETC_DisableDMA(ADC_ETC_Type *base, uint32_t triggerGroup)

Disable the DMA corresponding to each trigger sources.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.

static inline uint32_t ADC_ETC_GetDMAStatusFlags(ADC_ETC_Type *base)

Get the DMA request status falgs. Only external XBAR sources support DMA request.

Parameters

- base – ADC_ETC peripheral base address.

Returns

Mask of external XBAR tirgger's DMA request asserted flags. Available range is trigger0:0x01 to trigger7:0x80.

static inline void ADC_ETC_ClearDMAStatusFlags(ADC_ETC_Type *base, uint32_t mask)

Clear the DMA request status falgs. Only external XBAR sources support DMA request.

Parameters

- base – ADC_ETC peripheral base address.
- mask – Mask of external XBAR tirgger's DMA request asserted flags. Available range is trigger0:0x01 to trigger7:0x80.

static inline void ADC_ETC_DoSoftwareReset(ADC_ETC_Type *base, bool enable)

When enable, all logical will be reset.

Parameters

- base – ADC_ETC peripheral base address.
- enable – Enable/Disable the software reset.

static inline void ADC_ETC_DoSoftwareTrigger(ADC_ETC_Type *base, uint32_t triggerGroup)

Do software trigger corresponding to each XBAR trigger sources. Each XBAR trigger sources can be configured as HW or SW trigger mode. In hardware trigger mode, trigger source is from XBAR. In software mode, trigger source is from software tigger. TSC trigger sources can only work in hardware trigger mode.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.

static inline void ADC_ETC_DoSoftwareTriggerBlocking(ADC_ETC_Type *base, uint32_t triggerGroup)

Do software trigger corresponding to each XBAR trigger sources.

Note: This function provides a workaround implementation for ERR052412 by using blocking way to implement SW trigger.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.

uint32_t ADC_ETC_GetADCConversionValue(ADC_ETC_Type *base, uint32_t triggerGroup, uint32_t chainGroup)

Get ADC conversion result from external XBAR sources. For example, if triggerGroup is set to 0U and chainGroup is set to 1U, which means the API would return Trigger0 source's chain1 conversion result.

Parameters

- base – ADC_ETC peripheral base address.
- triggerGroup – Trigger group index. Available number is 0~7.
- chainGroup – Trigger chain group index. Available number is 0~7.

Returns

ADC conversion result value.

enum _adc_etc_status_flag_mask

ADC_ETC customized status flags mask.

Values:

enumerator kADC_ETC_Done0StatusFlagMask

enumerator kADC_ETC_Done1StatusFlagMask

enumerator kADC_ETC_Done2StatusFlagMask

enumerator kADC_ETC_Done3StatusFlagMask

enumerator kADC_ETC_ErrorStatusFlagMask

enum _adc_etc_external_trigger_source

External triggers sources.

Values:

enumerator kADC_ETC_Trg0TriggerSource

enumerator kADC_ETC_Trg1TriggerSource

enumerator kADC_ETC_Trg2TriggerSource

enumerator kADC_ETC_Trg3TriggerSource

enumerator kADC_ETC_Trg4TriggerSource

enumerator kADC_ETC_Trg5TriggerSource

enumerator kADC_ETC_Trg6TriggerSource

enumerator kADC_ETC_Trg7TriggerSource

enumerator kADC_ETC_TSC0TriggerSource

enumerator kADC_ETC_TSC1TriggerSource

enum _adc_etc_interrupt_enable

Interrupt enable/disable mask.

Values:

enumerator kADC_ETC_Done0InterruptEnable

enumerator kADC_ETC_Done1InterruptEnable

enumerator kADC_ETC_Done2InterruptEnable

enumerator kADC_ETC_Done3InterruptEnable

enum _adc_etc_dma_mode_selection
DMA mode selection.

Values:

enumerator kADC_ETC_TrigDMAWithLatchedSignal

enumerator kADC_ETC_TrigDMAWithPulsedSignal

typedef enum *_adc_etc_external_trigger_source* adc_etc_external_trigger_source_t
External triggers sources.

typedef enum *_adc_etc_interrupt_enable* adc_etc_interrupt_enable_t
Interrupt enable/disable mask.

typedef enum *_adc_etc_dma_mode_selection* adc_etc_dma_mode_selection_t
DMA mode selection.

typedef struct *_adc_etc_config* adc_etc_config_t
ADC_ETC configuration.

typedef struct *_adc_etc_trigger_chain_config* adc_etc_trigger_chain_config_t
ADC_ETC trigger chain configuration.

typedef struct *_adc_etc_trigger_config* adc_etc_trigger_config_t
ADC_ETC trigger configuration.

FSL_ADC_ETC_DRIVER_VERSION
ADC_ETC driver version.

Version 2.3.2.

ADC_ETC_DMA_CTRL_TRGn_REQ_MASK
The mask of status flags cleared by writing 1.

struct _adc_etc_config
#include <fsl_adc_etc.h> ADC_ETC configuration.

struct _adc_etc_trigger_chain_config
#include <fsl_adc_etc.h> ADC_ETC trigger chain configuration.

struct _adc_etc_trigger_config
#include <fsl_adc_etc.h> ADC_ETC trigger configuration.

2.3 Anatop_ai

enum _anatop_ai_itf
Anatop AI ITF enumeration.

Values:

enumerator kAI_Itf_Ldo
LDO ITF.

enumerator kAI_Itf_1g
1G PLL ITF.

enumerator kAI_Itf_Audio
Audio PLL ITF.

enumerator kAI_Itf_Video
Video PLL ITF.

enumerator kAI_Itf_400m
400M OSC ITF.

enumerator kAI_Itf_Temp
Temperature Sensor ITF.

enumerator kAI_Itf_Bandgap
Bandgap ITF.

enum _anatop_ai_reg
The enumeration of ANATOP AI Register.

Values:

enumerator kAI_PHY_LDO_CTRL0
PHY LDO CTRL0 Register.

enumerator kAI_PHY_LDO_CTRL0_SET
PHY LDO CTRL0 Set Register.

enumerator kAI_PHY_LDO_CTRL0_CLR
PHY LDO CTRL0 Clr Register.

enumerator kAI_PHY_LDO_CTRL0_TOG
PHY LDO CTRL0 TOG Register.

enumerator kAI_PHY_LDO_STAT0
PHY LDO STAT0 Register.

enumerator kAI_PHY_LDO_STAT0_SET
PHY LDO STAT0 Set Register.

enumerator kAI_PHY_LDO_STAT0_CLR
PHY LDO STAT0 Clr Register.

enumerator kAI_PHY_LDO_STAT0_TOG
PHY LDO STAT0 Tog Register.

enumerator kAI_BANDGAP_CTRL0
BANDGAP CTRL0 Register.

enumerator kAI_BANDGAP_STAT0
BANDGAP STAT0 Register.

enumerator kAI_RCOSC400M_CTRL0
RC OSC 400M CTRL0 Register.

enumerator kAI_RCOSC400M_CTRL0_SET
RC OSC 400M CTRL0 SET Register.

enumerator kAI_RCOSC400M_CTRL0_CLR
RC OSC 400M CTRL0 CLR Register.

enumerator kAI_RCOSC400M_CTRL0_TOG
RC OSC 400M CTRL0 TOG Register.

enumerator kAI_RCOSC400M_CTRL1
RC OSC 400M CTRL1 Register.

enumerator kAI_RCOSC400M_CTRL1_SET
RC OSC 400M CTRL1 SET Register.

enumerator kAI_RCOSC400M_CTRL1_CLR
RC OSC 400M CTRL1 CLR Register.

enumerator kAI_RCOSC400M_CTRL1_TOG
RC OSC 400M CTRL1 TOG Register.

enumerator kAI_RCOSC400M_CTRL2
RC OSC 400M CTRL2 Register.

enumerator kAI_RCOSC400M_CTRL2_SET
RC OSC 400M CTRL2 SET Register.

enumerator kAI_RCOSC400M_CTRL2_CLR
RC OSC 400M CTRL2 CLR Register.

enumerator kAI_RCOSC400M_CTRL2_TOG
RC OSC 400M CTRL2 TOG Register.

enumerator kAI_RCOSC400M_CTRL3
RC OSC 400M CTRL3 Register.

enumerator kAI_RCOSC400M_CTRL3_SET
RC OSC 400M CTRL3 SET Register.

enumerator kAI_RCOSC400M_CTRL3_CLR
RC OSC 400M CTRL3 CLR Register.

enumerator kAI_RCOSC400M_CTRL3_TOG
RC OSC 400M CTRL3 TOG Register.

enumerator kAI_RCOSC400M_STAT0
RC OSC 400M STAT0 Register.

enumerator kAI_RCOSC400M_STAT0_SET
RC OSC 400M STAT0 SET Register.

enumerator kAI_RCOSC400M_STAT0_CLR
RC OSC 400M STAT0 CLR Register.

enumerator kAI_RCOSC400M_STAT0_TOG
RC OSC 400M STAT0 TOG Register.

enumerator kAI_RCOSC400M_STAT1
RC OSC 400M STAT1 Register.

enumerator kAI_RCOSC400M_STAT1_SET
RC OSC 400M STAT1 SET Register.

enumerator kAI_RCOSC400M_STAT1_CLR
RC OSC 400M STAT1 CLR Register.

enumerator kAI_RCOSC400M_STAT1_TOG
RC OSC 400M STAT1 TOG Register.

enumerator kAI_RCOSC400M_STAT2
RC OSC 400M STAT2 Register.

enumerator kAI_RCOSC400M_STAT2_SET
RC OSC 400M STAT2 SET Register.

enumerator kAI_RCOSC400M_STAT2_CLR
RC OSC 400M STAT2 CLR Register.

enumerator kAI_RCOSC400M_STAT2_TOG
RC OSC 400M STAT2 TOG Register.

enumerator kAI_PLL1G_CTRL0
1G PLL CTRL0 Register.

enumerator kAI_PLL1G_CTRL0_SET
1G PLL CTRL0 SET Register.

enumerator kAI_PLL1G_CTRL0_CLR
1G PLL CTRL0 CLR Register.

enumerator kAI_PLL1G_CTRL1
1G PLL CTRL1 Register.

enumerator kAI_PLL1G_CTRL1_SET
1G PLL CTRL1 SET Register.

enumerator kAI_PLL1G_CTRL1_CLR
1G PLL CTRL1 CLR Register.

enumerator kAI_PLL1G_CTRL2
1G PLL CTRL2 Register.

enumerator kAI_PLL1G_CTRL2_SET
1G PLL CTRL2 SET Register.

enumerator kAI_PLL1G_CTRL2_CLR
1G PLL CTRL2 CLR Register.

enumerator kAI_PLL1G_CTRL3
1G PLL CTRL3 Register.

enumerator kAI_PLL1G_CTRL3_SET
1G PLL CTRL3 SET Register.

enumerator kAI_PLL1G_CTRL3_CLR
1G PLL CTRL3 CLR Register.

enumerator kAI_PLLAUDIO_CTRL0
AUDIO PLL CTRL0 Register.

enumerator kAI_PLLAUDIO_CTRL0_SET
AUDIO PLL CTRL0 SET Register.

enumerator kAI_PLLAUDIO_CTRL0_CLR
AUDIO PLL CTRL0 CLR Register.

enumerator kAI_PLLAUDIO_CTRL1
AUDIO PLL CTRL1 Register.

enumerator kAI_PLLAUDIO_CTRL1_SET
AUDIO PLL CTRL1 SET Register.

enumerator kAI_PLLAUDIO_CTRL1_CLR
AUDIO PLL CTRL1 CLR Register.

enumerator kAI_PLLAUDIO_CTRL2
AUDIO PLL CTRL2 Register.

enumerator kAI_PLLAUDIO_CTRL2_SET
AUDIO PLL CTRL2 SET Register.

enumerator kAI_PLLAUDIO_CTRL2_CLR
AUDIO PLL CTRL2 CLR Register.

enumerator kAI_PLLAUDIO_CTRL3
AUDIO PLL CTRL3 Register.

enumerator kAI_PLLAUDIO_CTRL3_SET
AUDIO PLL CTRL3 SET Register.

enumerator kAI_PLLAUDIO_CTRL3_CLR
AUDIO PLL CTRL3 CLR Register.

enumerator kAI_PLLVIDEO_CTRL0
VIDEO PLL CTRL0 Register.

enumerator kAI_PLLVIDEO_CTRL0_SET
VIDEO PLL CTRL0 SET Register.

enumerator kAI_PLLVIDEO_CTRL0_CLR
VIDEO PLL CTRL0 CLR Register.

enumerator kAI_PLLVIDEO_CTRL1
VIDEO PLL CTRL1 Register.

enumerator kAI_PLLVIDEO_CTRL1_SET
VIDEO PLL CTRL1 SET Register.

enumerator kAI_PLLVIDEO_CTRL1_CLR
VIDEO PLL CTRL1 CLR Register.

enumerator kAI_PLLVIDEO_CTRL2
VIDEO PLL CTRL2 Register.

enumerator kAI_PLLVIDEO_CTRL2_SET
VIDEO PLL CTRL2 SET Register.

enumerator kAI_PLLVIDEO_CTRL2_CLR
VIDEO PLL CTRL2 CLR Register.

enumerator kAI_PLLVIDEO_CTRL3
VIDEO PLL CTRL3 Register.

enumerator kAI_PLLVIDEO_CTRL3_SET
VIDEO PLL CTRL3 SET Register.

enumerator kAI_PLLVIDEO_CTRL3_CLR
VIDEO PLL CTRL3 CLR Register.

typedef enum *_anatop_ai_itf* anatop_ai_itf_t
Anatop AI ITF enumeration.

typedef enum *_anatop_ai_reg* anatop_ai_reg_t
The enumeration of ANATOP AI Register.

FSL_ANATOP_AI_DRIVER_VERSION
Anatop AI driver version 1.0.0.

AI_PHY_LDO_CTRL0_LINREG_EN(**x**)

AI_PHY_LDO_CTRL0_LINREG_EN_MASK

AI_PHY_LDO_CTRL0_LINREG_EN_SHIFT

AI_PHY_LDO_CTRL0_PWRUPLOAD_DIS(x)

LINREG_EN - LinReg master enable LinReg master enable. Setting this bit will enable the regular

AI_PHY_LDO_CTRL0_PWRUPLOAD_DIS_MASK

AI_PHY_LDO_CTRL0_PWRUPLOAD_DIS_SHIFT

AI_PHY_LDO_CTRL0_LIMIT_EN(x)

LINREG_PWRUPLOAD_DIS - LinReg power-up load disable 0b0..Internal pull-down enabled 0b1..Internal pull-down disabled

AI_PHY_LDO_CTRL0_LIMIT_EN_MASK

AI_PHY_LDO_CTRL0_LIMIT_EN_SHIFT

AI_PHY_LDO_CTRL0_OUTPUT_TRG(x)

LINREG_LIMIT_EN - LinReg current limit enable LinReg current-limit enable. Setting this bit will enable the current-limiter in the regulator

AI_PHY_LDO_CTRL0_OUTPUT_TRG_MASK

AI_PHY_LDO_CTRL0_OUTPUT_TRG_SHIFT

AI_PHY_LDO_CTRL0_PHY_ISO_B(x)

LINREG_OUTPUT_TRG - LinReg output voltage target setting 0b00000..Set output voltage to x.xV 0b10000..Set output voltage to 1.0V 0b11111..Set output voltage to x.xV

AI_PHY_LDO_CTRL0_PHY_ISO_B_MASK

AI_PHY_LDO_CTRL0_PHY_ISO_B_SHIFT

AI_BANDGAP_CTRL0_REFTOP_PWD(x)

AI_BANDGAP_CTRL0_REFTOP_PWD_MASK

AI_BANDGAP_CTRL0_REFTOP_PWD_SHIFT

AI_BANDGAP_CTRL0_REFTOP_LINREGREF_PWD(x)

REFTOP_PWD - This bit fully powers down the bandgap module. Setting this bit high will disable reference output currents and voltages from the bandgap and will affect functionality and validity of the voltage detectors.

AI_BANDGAP_CTRL0_REFTOP_LINREGREF_PWD_MASK

AI_BANDGAP_CTRL0_REFTOP_LINREGREF_PWD_SHIFT

AI_BANDGAP_CTRL0_REFTOP_PWDVBGUP(x)

REFOP_LINREGREF_PWD - This bit powers down only the voltage reference output section of the bandgap. Setting this bit high will affect functionality and validity of the voltage detectors.

AI_BANDGAP_CTRL0_REFTOP_PWDVBGUP_MASK

AI_BANDGAP_CTRL0_REFTOP_PWDVBGUP_SHIFT

AI_BANDGAP_CTRL0_REFTOP_LOWPOWER(x)

REFTOP_PWDVBGUP - This bit powers down the VBGUP detector of the bandgap without affecting any additional functionality.

AI_BANDGAP_CTRL0_REFTOP_LOWPOWER_MASK

AI_BANDGAP_CTRL0_REFTOP_LOWPOWER_SHIFT

AI_BANDGAP_CTRL0_REFTOP_SELFBIASOFF(x)

REFTOP_LOWPOWER - This bit enables the low-power operation of the bandgap by cutting the bias currents in half to the main amplifiers. This will save power but could affect the accuracy of the output voltages and currents.

AI_BANDGAP_CTRL0_REFTOP_SELFBIASOFF_MASK

AI_BANDGAP_CTRL0_REFTOP_SELFBIASOFF_SHIFT

AI_BANDGAP_CTRL0_REFTOP_VBGADJ(x)

REFTOP_SELFBIASOFF - Control bit to disable the self-bias circuit in the bandgap. The self-bias circuit is used by the bandgap during startup. This bit should be set high after the bandgap has stabilized and is necessary for best noise performance of modules using the outputs of the bandgap. It is expected that this control bit be set low any time that either the bandgap is fully powered-down or the 1.8V supply is removed.

AI_BANDGAP_CTRL0_REFTOP_VBGADJ_MASK

AI_BANDGAP_CTRL0_REFTOP_VBGADJ_SHIFT

AI_BANDGAP_CTRL0_REFTOP_IBZTCADJ(x)

REFTOP_VBGADJ - These bits allow the output VBG voltage of the bandgap to be trimmed 000 : nominal 001 : +10mV 010 : +20mV 011 : +30mV 100 : -10mV 101 : -20mV 110 : -30mV 111 : -40mV

AI_BANDGAP_CTRL0_REFTOP_IBZTCADJ_MASK

AI_BANDGAP_CTRL0_REFTOP_IBZTCADJ_SHIFT

AI_RCOSC400M_CTRL0_REF_CLK_DIV(x)

AI_RCOSC400M_CTRL0_REF_CLK_DIV_MASK

AI_RCOSC400M_CTRL0_REF_CLK_DIV_SHIFT

AI_PLL1G_CTRL0_HOLD_RING_OFF(x)

AI_PLL1G_CTRL0_HOLD_RING_OFF_MASK

AI_PLL1G_CTRL0_HOLD_RING_OFF_SHIFT

AI_PLL1G_CTRL0_POWER_UP(x)

AI_PLL1G_CTRL0_POWER_UP_MASK

AI_PLL1G_CTRL0_POWER_UP_SHIFT

AI_PLL1G_CTRL0_ENABLE(x)

AI_PLL1G_CTRL0_ENABLE_MASK

AI_PLL1G_CTRL0_ENABLE_SHIFT

AI_PLL1G_CTRL0_BYPASS(x)

AI_PLL1G_CTRL0_BYPASS_MASK

AI_PLL1G_CTRL0_BYPASS_SHIFT

AI_PLL1G_CTRL0_PLL_REG_EN(x)

AI_PLL1G_CTRL0_PLL_REG_EN_MASK

AI_PLL1G_CTRL0_PLL_REG_EN_SHIFT

AI_PLLAUDIO_CTRL0_HOLD_RING_OFF(x)

AI_PLLAUDIO_CTRL0_HOLD_RING_OFF_MASK

AI_PLLAUDIO_CTRL0_HOLD_RING_OFF_SHIFT

AI_PLLAUDIO_CTRL0_POWER_UP(x)

AI_PLLAUDIO_CTRL0_POWER_UP_MASK

AI_PLLAUDIO_CTRL0_POWER_UP_SHIFT

AI_PLLAUDIO_CTRL0_ENABLE(x)

AI_PLLAUDIO_CTRL0_ENABLE_MASK

AI_PLLAUDIO_CTRL0_ENABLE_SHIFT

AI_PLLAUDIO_CTRL0_BYPASS(x)

AI_PLLAUDIO_CTRL0_BYPASS_MASK

AI_PLLAUDIO_CTRL0_BYPASS_SHIFT

AI_PLLAUDIO_CTRL0_PLL_REG_EN(x)

AI_PLLAUDIO_CTRL0_PLL_REG_EN_MASK

AI_PLLAUDIO_CTRL0_PLL_REG_EN_SHIFT

AI_PLLVIDEO_CTRL0_HOLD_RING_OFF(x)

AI_PLLVIDEO_CTRL0_HOLD_RING_OFF_MASK

AI_PLLVIDEO_CTRL0_HOLD_RING_OFF_SHIFT

AI_PLLVIDEO_CTRL0_POWER_UP(x)

AI_PLLVIDEO_CTRL0_POWER_UP_MASK

AI_PLLVIDEO_CTRL0_POWER_UP_SHIFT

AI_PLLVIDEO_CTRL0_ENABLE(x)

AI_PLLVIDEO_CTRL0_ENABLE_MASK

AI_PLLVIDEO_CTRL0_ENABLE_SHIFT

AI_PLLVIDEO_CTRL0_BYPASS(x)

AI_PLLVIDEO_CTRL0_BYPASS_MASK

AI_PLLVIDEO_CTRL0_BYPASS_SHIFT

AI_PLLVIDEO_CTRL0_PLL_REG_EN(x)

AI_PLLVIDEO_CTRL0_PLL_REG_EN_MASK

AI_PLLVIDEO_CTRL0_PLL_REG_EN_SHIFT

AI_PHY_LDO_STAT0_LINREG_STAT(x)

AI_PHY_LDO_STAT0_LINREG_STAT_MASK

AI_PHY_LDO_STAT0_LINREG_STAT_SHIFT

AI_BANDGAP_STAT0_REFTOP_VBGUP(x)

AI_BANDGAP_STAT0_REFTOP_VBGUP_MASK

AI_BANDGAP_STAT0_REFTOP_VBGUP_SHIFT

AI_RCOSC400M_STAT0_CLK1M_ERR(x)

AI_RCOSC400M_STAT0_CLK1M_ERR_MASK

AI_RCOSC400M_STAT0_CLK1M_ERR_SHIFT

AI_RCOSC400M_CTRL1_HYST_MINUS(x)

AI_RCOSC400M_CTRL1_HYST_MINUS_MASK

AI_RCOSC400M_CTRL1_HYST_MINUS_SHIFT

AI_RCOSC400M_CTRL1_HYST_PLUS(x)

AI_RCOSC400M_CTRL1_HYST_PLUS_MASK

AI_RCOSC400M_CTRL1_HYST_PLUS_SHIFT

AI_RCOSC400M_CTRL1_TARGET_COUNT(x)

AI_RCOSC400M_CTRL1_TARGET_COUNT_MASK

AI_RCOSC400M_CTRL1_TARGET_COUNT_SHIFT

AI_RCOSC400M_CTRL2_TUNE_BYP(x)

AI_RCOSC400M_CTRL2_TUNE_BYP_MASK

AI_RCOSC400M_CTRL2_TUNE_BYP_SHIFT

AI_RCOSC400M_CTRL2_TUNE_EN(x)

AI_RCOSC400M_CTRL2_TUNE_EN_MASK

AI_RCOSC400M_CTRL2_TUNE_EN_SHIFT

AI_RCOSC400M_CTRL2_TUNE_START(x)

AI_RCOSC400M_CTRL2_TUNE_START_MASK

AI_RCOSC400M_CTRL2_TUNE_START_SHIFT

AI_RCOSC400M_CTRL2_OSC_TUNE_VAL(x)

AI_RCOSC400M_CTRL2_OSC_TUNE_VAL_MASK

AI_RCOSC400M_CTRL2_OSC_TUNE_VAL_SHIFT

AI_RCOSC400M_CTRL3_CLR_ERR(x)

AI_RCOSC400M_CTRL3_CLR_ERR_MASK

AI_RCOSC400M_CTRL3_CLR_ERR_SHIFT

AI_RCOSC400M_CTRL3_EN_1M_CLK(x)

AI_RCOSC400M_CTRL3_EN_1M_CLK_MASK

AI_RCOSC400M_CTRL3_EN_1M_CLK_SHIFT

AI_RCOSC400M_CTRL3_MUX_1M_CLK(x)

AI_RCOSC400M_CTRL3_MUX_1M_CLK_MASK

AI_RCOSC400M_CTRL3_MUX_1M_CLK_SHIFT

AI_RCOSC400M_CTRL3_COUNT_1M_CLK(x)

AI_RCOSC400M_CTRL3_COUNT_1M_CLK_MASK

AI_RCOSC400M_CTRL3_COUNT_1M_CLK_SHIFT

AI_RCOSC400M_STAT1_CURR_COUNT_VAL(x)

AI_RCOSC400M_STAT1_CURR_COUNT_VAL_MASK

AI_RCOSC400M_STAT1_CURR_COUNT_VAL_SHIFT

AI_RCOSC400M_STAT2_CURR_OSC_TUNE_VAL(x)

AI_RCOSC400M_STAT2_CURR_OSC_TUNE_VAL_MASK

AI_RCOSC400M_STAT2_CURR_OSC_TUNE_VAL_SHIFT

2.4 AOI: Crossbar AND/OR/INVERT Driver

void AOI_Init(AOI_Type *base)

Initializes an AOI instance for operation.

This function un-gates the AOI clock.

Parameters

- base – AOI peripheral address.

void AOI_Deinit(AOI_Type *base)

Deinitializes an AOI instance for operation.

This function shutdowns AOI module.

Parameters

- base – AOI peripheral address.

void AOI_GetEventLogicConfig(AOI_Type *base, *aoi_event_t* event, *aoi_event_config_t* *config)

Gets the Boolean evaluation associated.

This function returns the Boolean evaluation associated.

Example:

```
aoi_event_config_t demoEventLogicStruct;

AOI_GetEventLogicConfig(AOI, kAOI_Event0, &demoEventLogicStruct);
```

Parameters

- base – AOI peripheral address.
- event – Index of the event which will be set of type aoi_event_t.
- config – Selected input configuration .

void AOI_SetEventLogicConfig(AOI_Type *base, *aoi_event_t* event, const *aoi_event_config_t* *eventConfig)

Configures an AOI event.

This function configures an AOI event according to the aoiEventConfig structure. This function configures all inputs (A, B, C, and D) of all product terms (0, 1, 2, and 3) of a desired event.

Example:

```
aoi_event_config_t demoEventLogicStruct;

demoEventLogicStruct.PT0AC = kAOI_InvInputSignal;
demoEventLogicStruct.PT0BC = kAOI_InputSignal;
demoEventLogicStruct.PT0CC = kAOI_LogicOne;
demoEventLogicStruct.PT0DC = kAOI_LogicOne;

demoEventLogicStruct.PT1AC = kAOI_LogicZero;
demoEventLogicStruct.PT1BC = kAOI_LogicOne;
demoEventLogicStruct.PT1CC = kAOI_LogicOne;
demoEventLogicStruct.PT1DC = kAOI_LogicOne;

demoEventLogicStruct.PT2AC = kAOI_LogicZero;
demoEventLogicStruct.PT2BC = kAOI_LogicOne;
demoEventLogicStruct.PT2CC = kAOI_LogicOne;
demoEventLogicStruct.PT2DC = kAOI_LogicOne;

demoEventLogicStruct.PT3AC = kAOI_LogicZero;
demoEventLogicStruct.PT3BC = kAOI_LogicOne;
demoEventLogicStruct.PT3CC = kAOI_LogicOne;
demoEventLogicStruct.PT3DC = kAOI_LogicOne;

AOI_SetEventLogicConfig(AOI, kAOI_Event0, demoEventLogicStruct);
```

Parameters

- base – AOI peripheral address.
- event – Event which will be configured of type aoi_event_t.
- eventConfig – Pointer to type aoi_event_config_t structure. The user is responsible for filling out the members of this structure and passing the pointer to this function.

FSL_AOI_DRIVER_VERSION

Version 2.0.2.

enum _aoi_input_config

AOI input configurations.

The selection item represents the Boolean evaluations.

Values:

enumerator kAOI_LogicZero

Forces the input to logical zero.

enumerator kAOI_InputSignal

Passes the input signal.

enumerator kAOI_InvInputSignal

Inverts the input signal.

enumerator kAOI_LogicOne

Forces the input to logical one.

enum __aoi__event

AOI event indexes, where an event is the collection of the four product terms (0, 1, 2, and 3) and the four signal inputs (A, B, C, and D).

Values:

enumerator kAOI_Event0

Event 0 index

enumerator kAOI_Event1

Event 1 index

enumerator kAOI_Event2

Event 2 index

enumerator kAOI_Event3

Event 3 index

typedef enum *_aoi_input_config* aoi__input__config__t

AOI input configurations.

The selection item represents the Boolean evaluations.

typedef enum *_aoi_event* aoi__event__t

AOI event indexes, where an event is the collection of the four product terms (0, 1, 2, and 3) and the four signal inputs (A, B, C, and D).

typedef struct *_aoi_event_config* aoi__event__config__t

AOI event configuration structure.

Defines structure _aoi_event_config and use the AOI_SetEventLogicConfig() function to make whole event configuration.

AOI

AOI peripheral address

struct __aoi__event__config

#include <fsl_aoi.h> AOI event configuration structure.

Defines structure _aoi_event_config and use the AOI_SetEventLogicConfig() function to make whole event configuration.

Public Members

aoi_input_config_t PT0AC

Product term 0 input A

aoi_input_config_t PT0BC

Product term 0 input B

aoi_input_config_t PT0CC

Product term 0 input C

aoi_input_config_t PT0DC

Product term 0 input D

aoi_input_config_t PT1AC

Product term 1 input A

aoi_input_config_t PT1BC
Product term 1 input B

aoi_input_config_t PT1CC
Product term 1 input C

aoi_input_config_t PT1DC
Product term 1 input D

aoi_input_config_t PT2AC
Product term 2 input A

aoi_input_config_t PT2BC
Product term 2 input B

aoi_input_config_t PT2CC
Product term 2 input C

aoi_input_config_t PT2DC
Product term 2 input D

aoi_input_config_t PT3AC
Product term 3 input A

aoi_input_config_t PT3BC
Product term 3 input B

aoi_input_config_t PT3CC
Product term 3 input C

aoi_input_config_t PT3DC
Product term 3 input D

2.5 ASRC: Asynchronous sample rate converter

2.6 ASRC Driver

uint32_t ASRC_GetInstance(ASRC_Type *base)
Get instance number of the ASRC peripheral.

Parameters

- base – ASRC base pointer.

void ASRC_Init(ASRC_Type *base, uint32_t asrcPeripheralClock_Hz)
brief Initializes the asrc peripheral.

This API gates the asrc clock. The asrc module can't operate unless ASRC_Init is called to enable the clock.

param base asrc base pointer. param asrcPeripheralClock_Hz peripheral clock of ASRC.

void ASRC_Deinit(ASRC_Type *base)
De-initializes the ASRC peripheral.

This API gates the ASRC clock and disable ASRC module. The ASRC module can't operate unless ASRC_Init

Parameters

- base – ASRC base pointer.

void ASRC_SoftwareReset(ASRC_Type *base)

Do software reset .

This software reset bit is self-clear bit, it will generate a software reset signal inside ASRC. After 9 cycles of the ASRC processing clock, this reset process will stop and this bit will cleared automatically.

Parameters

- base – ASRC base pointer

status_t ASRC_SetChannelPairConfig(ASRC_Type *base, *asrc_channel_pair_t* channelPair, *asrc_channel_pair_config_t* *config, uint32_t inputSampleRate, uint32_t outputSampleRate)

ASRC configure channel pair.

Parameters

- base – ASRC base pointer.
- channelPair – index of channel pair, reference _asrc_channel_pair.
- config – ASRC channel pair configuration pointer.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

uint32_t ASRC_GetOutSamplesSize(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t inSampleRate, uint32_t outSampleRate, uint32_t inSamplesize)

Get output sample buffer size.

Note: This API is depends on the ASRC output configuration, should be called after the ASRC_SetChannelPairConfig.

Parameters

- base – asrc base pointer.
- channelPair – ASRC channel pair number.
- inSampleRate – input sample rate.
- outSampleRate – output sample rate.
- inSamplesize – input sampleS size.

Return values

output – buffer size in byte.

uint32_t ASRC_MapSamplesWidth(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t *inWidth, uint32_t *outWidth)

Map register sample width to real sample width.

Note: This API is depends on the ASRC configuration, should be called after the ASRC_SetChannelPairConfig.

Parameters

- base – asrc base pointer.
- channelPair – asrc channel pair index.

- inWidth – ASRC channel pair number.
- outWidth – input sample rate.

Return values
input – sample mask value.

uint32_t ASRC_GetRemainFifoSamples(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t *buffer, uint32_t outSampleWidth, uint32_t remainSamples)

Get left samples in fifo.

Parameters

- base – asrc base pointer.
- channelPair – ASRC channel pair number.
- buffer – input sample numbers.
- outSampleWidth – output sample width.
- remainSamples – output sample rate.

Return values
remain – samples number.

static inline void ASRC_ModuleEnable(ASRC_Type *base, bool enable)

ASRC module enable.

Parameters

- base – ASRC base pointer.
- enable – true is enable, false is disable

static inline void ASRC_ChannelPairEnable(ASRC_Type *base, *asrc_channel_pair_t* channelPair, bool enable)

ASRC enable channel pair.

Parameters

- base – ASRC base pointer.
- channelPair – channel pair mask value, reference _asrc_channel_pair_mask.
- enable – true is enable, false is disable.

static inline void ASRC_EnableInterrupt(ASRC_Type *base, uint32_t mask)

ASRC interrupt enable This function enable the ASRC interrupt with the provided mask.

Parameters

- base – ASRC peripheral base address.
- mask – The interrupts to enable. Logical OR of _asrc_interrupt_mask.

static inline void ASRC_DisableInterrupt(ASRC_Type *base, uint32_t mask)

ASRC interrupt disable This function disable the ASRC interrupt with the provided mask.

Parameters

- base – ASRC peripheral base address.
- mask – The interrupts to disable. Logical OR of _asrc_interrupt_mask.

static inline uint32_t ASRC_GetStatus(ASRC_Type *base)

Gets the ASRC status flag state.

Parameters

- base – ASRC base pointer

Returns

ASRC Tx status flag value. Use the Status Mask to get the status value needed.

static inline bool ASRC_GetChannelPairInitialStatus(ASRC_Type *base, *asrc_channel_pair_t* channel)

Gets the ASRC channel pair initialization state.

Parameters

- base – ASRC base pointer
- channel – ASRC channel pair.

Returns

ASRC Tx status flag value. Use the Status Mask to get the status value needed.

static inline uint32_t ASRC_GetChannelPairFifoStatus(ASRC_Type *base, *asrc_channel_pair_t* channelPair)

Gets the ASRC channel A fifo a status flag state.

Parameters

- base – ASRC base pointer
- channelPair – ASRC channel pair.

Returns

ASRC channel pair a fifo status flag value. Use the Status Mask to get the status value needed.

static inline void ASRC_ChannelPairWriteData(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t data)

Writes data into ASRC channel pair FIFO. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.
- data – Data needs to be written.

static inline uint32_t ASRC_ChannelPairReadData(ASRC_Type *base, *asrc_channel_pair_t* channelPair)

Read data from ASRC channel pair FIFO. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.

Return values

value – read from fifo.

static inline uint32_t ASRC_GetInputDataRegisterAddress(ASRC_Type *base, *asrc_channel_pair_t* channelPair)

Get input data fifo address. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.

- channelPair – ASRC channel pair.

static inline uint32_t ASRC_GetOutputDataRegisterAddress(ASRC_Type *base, *asrc_channel_pair_t* channelPair)

Get output data fifo address. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.

status_t ASRC_SetIdealRatioConfig(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t inputSampleRate, uint32_t outputSampleRate)

ASRC configure ideal ratio. The ideal ratio should be used when input clock source is not avalible.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

status_t ASRC_TransferSetChannelPairConfig(ASRC_Type *base, *asrc_handle_t* *handle, *asrc_channel_pair_config_t* *config, uint32_t inputSampleRate, uint32_t outputSampleRate)

ASRC configure channel pair.

Parameters

- base – ASRC base pointer.
- handle – ASRC transactional handle pointer.
- config – ASRC channel pair configuration pointer.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

void ASRC_TransferCreateHandle(ASRC_Type *base, *asrc_handle_t* *handle, *asrc_channel_pair_t* channelPair, *asrc_transfer_callback_t* inCallback, *asrc_transfer_callback_t* outCallback, void *userData)

Initializes the ASRC handle.

This function initializes the handle for the ASRC transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – ASRC base pointer
- handle – ASRC handle pointer.
- channelPair – ASRC channel pair.
- inCallback – Pointer to the user callback function.
- outCallback – Pointer to the user callback function.
- userData – User parameter passed to the callback function

status_t ASRC_TransferNonBlocking(ASRC_Type *base, *asrc_handle_t* *handle, *asrc_transfer_t* *xfer)

Performs an interrupt non-blocking convert on asrc.

Note: This API returns immediately after the transfer initiates, application should check the wait and check the callback status.

Parameters

- base – asrc base pointer.
- handle – Pointer to the asrc_handle_t structure which stores the transfer state.
- xfer – Pointer to the ASRC_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_ASRCBusy – Previous receive still not finished.

status_t ASRC_TransferBlocking(ASRC_Type *base, *asrc_channel_pair_t* channelPair, *asrc_transfer_t* *xfer)

Performs an blocking convert on asrc.

Note: This API returns immediately after the convert finished.

Parameters

- base – asrc base pointer.
- channelPair – channel pair index.
- xfer – Pointer to the ASRC_transfer_t structure.

Return values

kStatus_Success – Successfully started the data receive.

status_t ASRC_TransferGetConvertedCount(ASRC_Type *base, *asrc_handle_t* *handle, size_t *count)

Get converted byte count.

Parameters

- base – ASRC base pointer.
- handle – Pointer to the asrc_handle_t structure which stores the transfer state.
- count – Bytes count sent.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_ASRCIdle – There is not a non-blocking transaction currently in progress.

void ASRC_TransferAbortConvert(ASRC_Type *base, *asrc_handle_t* *handle)

Aborts the current convert.

Note: This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – ASRC base pointer.
- handle – Pointer to the asrc_handle_t structure which stores the transfer state.

void ASRC_TransferTerminateConvert(ASRC_Type *base, *asrc_handle_t* *handle)

Terminate all ASRC convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call ASRC_TransferAbortConvert.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferHandleIRQ(ASRC_Type *base, *asrc_handle_t* *handle)

ASRC convert interrupt handler.

Parameters

- base – ASRC base pointer.
- handle – Pointer to the asrc_handle_t structure.

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Version 2.1.3

ASRC return status .

Values:

enumerator kStatus_ASRCIdle

ASRC is idle.

enumerator kStatus_ASRCInIdle

ASRC in is idle.

enumerator kStatus_ASRCOutIdle

ASRC out is idle.

enumerator kStatus_ASRCBusy

ASRC is busy.

enumerator kStatus_ASRCInvalidArgument

ASRC invalid argument.

enumerator kStatus_ASRCClockConfigureFailed

ASRC clock configure failed

enumerator kStatus_ASRCChannelPairConfigureFailed

ASRC clock configure failed

enumerator kStatus_ASRCConvertError

ASRC clock configure failed

enumerator kStatus_ASRCNotSupport
ASRC not support

enumerator kStatus_ASRCQueueFull
ASRC queue is full

enumerator kStatus_ASRCOutQueueIdle
ASRC out queue is idle

enumerator kStatus_ASRCInQueueIdle
ASRC in queue is idle

enum _asrc_channel_pair
ASRC channel pair mask.

Values:

enumerator kASRC_ChannelPairA
channel pair A value

enumerator kASRC_ChannelPairB
channel pair B value

enumerator kASRC_ChannelPairC
channel pair C value

ASRC support sample rate .

Values:

enumerator kASRC_SampleRate_8000HZ
asrc sample rate 8KHZ

enumerator kASRC_SampleRate_11025HZ
asrc sample rate 11.025KHZ

enumerator kASRC_SampleRate_12000HZ
asrc sample rate 12KHZ

enumerator kASRC_SampleRate_16000HZ
asrc sample rate 16KHZ

enumerator kASRC_SampleRate_22050HZ
asrc sample rate 22.05KHZ

enumerator kASRC_SampleRate_24000HZ
asrc sample rate 24KHZ

enumerator kASRC_SampleRate_30000HZ
asrc sample rate 30KHZ

enumerator kASRC_SampleRate_32000HZ
asrc sample rate 32KHZ

enumerator kASRC_SampleRate_44100HZ
asrc sample rate 44.1KHZ

enumerator kASRC_SampleRate_48000HZ
asrc sample rate 48KHZ

enumerator kASRC_SampleRate_64000HZ
asrc sample rate 64KHZ

enumerator kASRC_SampleRate_88200HZ
asrc sample rate 88.2KHZ

enumerator kASRC_SampleRate_96000HZ
asrc sample rate 96KHZ

enumerator kASRC_SampleRate_128000HZ
asrc sample rate 128KHZ

enumerator kASRC_SampleRate_176400HZ
asrc sample rate 176.4KHZ

enumerator kASRC_SampleRate_192000HZ
asrc sample rate 192KHZ

The ASRC interrupt enable flag .

Values:

enumerator kASRC_FPInWaitStateInterruptEnable
FP in wait state mask

enumerator kASRC_OverLoadInterruptMask
overload interrupt mask

enumerator kASRC_DataOutputCInterruptMask
data output c interrupt mask

enumerator kASRC_DataOutputBInterruptMask
data output b interrupt mask

enumerator kASRC_DataOutputAInterruptMask
data output a interrupt mask

enumerator kASRC_DataInputCInterruptMask
data input c interrupt mask

enumerator kASRC_DataInputBInterruptMask
data input b interrupt mask

enumerator kASRC_DataInputAInterruptMask
data input a interrupt mask

The ASRC interrupt status .

Values:

enumerator kASRC_StatusDSLCounterReady
DSL counter

enumerator kASRC_StatusTaskQueueOverLoad
task queue overload

enumerator kASRC_StatusPairCOutputOverLoad
pair c output overload

enumerator kASRC_StatusPairBOutputOverLoad
pair b output overload

enumerator kASRC_StatusPairAOutputOverLoad
pair a output overload

enumerator kASRC_StatusPairCInputOverLoad
pair c input overload

enumerator kASRC_StatusPairBInputOverLoad
pair b input overload

enumerator kASRC_StatusPairAInputOverLoad
pair a input overload

enumerator kASRC_StatusPairCOutputOverflow
pair c output overflow

enumerator kASRC_StatusPairBOutputOverflow
pair b output overflow

enumerator kASRC_StatusPairAOutputOverflow
pair a output overflow

enumerator kASRC_StatusPairCInputUnderflow
pair c input underflow

enumerator kASRC_StatusPairBInputUnderflow
pair b input under flow

enumerator kASRC_StatusPairAInputUnderflow
pair a input underflow

enumerator kASRC_StatusFPInWaitState
FP in wait state

enumerator kASRC_StatusOverloadError
overload error

enumerator kASRC_StatusInputError
input error status

enumerator kASRC_StatusOutputError
output error status

enumerator kASRC_StatusPairCOutputReady
pair c output ready

enumerator kASRC_StatusPairBOutputReady
pair b output ready

enumerator kASRC_StatusPairAOutputReady
pair a output ready

enumerator kASRC_StatusPairCInputReady
pair c input ready

enumerator kASRC_StatusPairBInputReady
pair b input ready

enumerator kASRC_StatusPairAInputReady
pair a input ready

enumerator kASRC_StatusPairAInterrupt
pair A interrupt

enumerator kASRC_StatusPairBInterrupt
pair B interrupt

enumerator kASRC_StatusPairCInterrupt
pair C interrupt

ASRC channel pair status .

Values:

enumerator kASRC_OutputFifoNearFull
channel pair output fifo near full

enumerator kASRC_InputFifoNearEmpty
channel pair input fifo near empty

enum _asrc_ratio
ASRC ideal ratio.

Values:

enumerator kASRC_RatioNotUsed
ideal ratio not used

enumerator kASRC_RatioUseInternalMeasured
ideal ratio use internal measure ratio, can be used for real time streaming audio

enumerator kASRC_RatioUseIdealRatio
ideal ratio use manual configure ratio, can be used for the non-real time streaming audio

enum _asrc_audio_channel
Number of channels in audio data.

Values:

enumerator kASRC_ChannelsNumber1
channel number is 1

enumerator kASRC_ChannelsNumber2
channel number is 2

enumerator kASRC_ChannelsNumber3
channel number is 3

enumerator kASRC_ChannelsNumber4
channel number is 4

enumerator kASRC_ChannelsNumber5
channel number is 5

enumerator kASRC_ChannelsNumber6
channel number is 6

enumerator kASRC_ChannelsNumber7
channel number is 7

enumerator kASRC_ChannelsNumber8
channel number is 8

enumerator kASRC_ChannelsNumber9
channel number is 9

enumerator kASRC_ChannelsNumber10
channel number is 10

enum _asrc_data_width
data width

Values:

enumerator kASRC_DataWidth24Bit
data width 24bit

enumerator kASRC_DataWidth16Bit
data width 16bit

enumerator kASRC_DataWidth8Bit
data width 8bit

enum _asrc_data_align
data alignment

Values:

enumerator kASRC_DataAlignMSB
data alignment MSB

enumerator kASRC_DataAlignLSB
data alignment LSB

enum _asrc_sign_extension
sign extension

Values:

enumerator kASRC_NoSignExtension
no sign extension

enumerator kASRC_SignExtension
sign extension

typedef enum *_asrc_channel_pair* asrc_channel_pair_t
ASRC channel pair mask.

typedef enum *_asrc_ratio* asrc_ratio_t
ASRC ideal ratio.

typedef enum *_asrc_audio_channel* asrc_audio_channel_t
Number of channels in audio data.

typedef enum *_asrc_data_width* asrc_data_width_t
data width

typedef enum *_asrc_data_align* asrc_data_align_t
data alignment

typedef enum *_asrc_sign_extension* asrc_sign_extension_t
sign extension

typedef struct *_asrc_channel_pair_config* asrc_channel_pair_config_t
asrc channel pair configuation

typedef struct *_asrc_transfer* asrc_transfer_t
SAI transfer structure.

typedef struct *_asrc_handle* asrc_handle_t
asrc handler

typedef void (*asrc_transfer_callback_t)(ASRC_Type *base, *asrc_handle_t* *handle, *status_t* status, void *userData)

ASRC transfer callback prototype.

typedef struct *_asrc_in_handle* asrc_in_handle_t

asrc in handler

typedef struct *_asrc_out_handle* asrc_out_handle_t

output handler

ASRC_XFER_QUEUE_SIZE

ASRC transfer queue size, user can refine it according to use case.

FSL_ASRC_CHANNEL_PAIR_COUNT

ASRC channel pair count.

FSL_ASRC_CHANNEL_PAIR_FIFO_DEPTH

ASRC FIFO depth.

ASRC_ASRCTR_AT_MASK(index)

ASRC register access macro.

ASRC_ASRCTR_RATIO_MASK(index)

ASRC_ASRCTR_RATIO(ratio, index)

ASRC_ASRIER_INPUT_INTERRUPT_MASK(index)

ASRC_ASRIER_OUTPUTPUT_INTERRUPT_MASK(index)

ASRC_ASRCNCR_CHANNEL_COUNTER_MASK(index)

ASRC_ASRCNCR_CHANNEL_COUNTER(counter, index)

ASRC_ASRCFG_PRE_MODE_MASK(index)

ASRC_ASRCFG_PRE_MODE(mode, index)

ASRC_ASRCFG_POST_MODE_MASK(index)

ASRC_ASRCFG_POST_MODE(mode, index)

ASRC_ASRCFG_INIT_DONE_MASK(index)

ASRC_ASRCSR_INPUT_CLOCK_SOURCE_MASK(index)

ASRC_ASRCSR_INPUT_CLOCK_SOURCE(source, index)

ASRC_ASRCSR_OUTPUT_CLOCK_SOURCE_MASK(index)

ASRC_ASRCSR_OUTPUT_CLOCK_SOURCE(source, index)

ASRC_ASRCDR_INPUT_PRESCALER_MASK(index)

ASRC_ASRCDR_INPUT_PRESCALER(prescaler, index)

ASRC_ASRCDR_INPUT_DIVIDER_MASK(index)

ASRC_ASRCDR_INPUT_DIVIDER(divider, index)

ASRC_ASRCDR_OUTPUT_PRESCALER_MASK(index)

ASRC_ASRCDR_OUTPUT_PRESCALER(prescaler, index)

ASRC_ASRCDR_OUTPUT_DIVIDER_MASK(index)

ASRC_ASRCDR_OUTPUT_DIVIDER(divider, index)

ASCR_ASRCDR_OUTPUT_CLOCK_DIVIDER_PRESCALER(value, index)

ASCR_ASRCDR_INPUT_CLOCK_DIVIDER_PRESCALER(value, index)

ASRC_IDEAL_RATIO_HIGH(base, index)

ASRC_IDEAL_RATIO_LOW(base, index)

ASRC_ASRMCR(base, index)

ASRC_ASRMCR1(base, index)

ASRC_ASRDI(base, index)

ASRC_ASRDO(base, index)

ASRC_ASRDI_ADDR(base, index)

ASRC_ASRDO_ADDR(base, index)

ASRC_ASRFST_ADDR(base, index)

ASRC_GET_CHANNEL_COUNTER(base, index)

struct _asrc_channel_pair_config

#include <fsl_asrc.h> asrc channel pair configuation

Public Members

asrc_audio_channel_t audioDataChannels

audio data channel numbers

asrc_clock_source_t inClockSource

input clock source, reference the clock source definition in SOC header file

uint32_t inSourceClock_Hz

input source clock frequency

asrc_clock_source_t outClockSource

output clock source, reference the clock source definition in SOC header file

uint32_t outSourceClock_Hz

output source clock frequency

asrc_ratio_t sampleRateRatio

sample rate ratio type

asrc_data_width_t inDataWidth

input data width

asrc_data_align_t inDataAlign

input data alignment

asrc_data_width_t outDataWidth

output data width

asrc_data_align_t outDataAlign

output data alignment

asrc_sign_extension_t outSignExtension
output extension

uint8_t outFifoThreshold
output fifo threshold

uint8_t inFifoThreshold
input fifo threshold

bool bufStallWhenFifoEmptyFull
stall Pair A conversion in case of Buffer near empty full condition

struct __asrc__transfer
#include <fsl_asrc.h> SAI transfer structure.

Public Members

void *inData
Data address to convert.

size_t inDataSize
input data size.

void *outData
Data address to store converted data

size_t outDataSize
output data size.

struct __asrc__in__handle
#include <fsl_asrc.h> asrc in handler

Public Members

asrc_transfer_callback_t callback
Callback function called at convert complete

uint32_t sampleWidth
data width

uint32_t sampleMask
data mask

uint32_t fifoThreshold
fifo threshold

uint8_t *asrcQueue[(4U)]
Transfer queue storing queued transfer

size_t transferSamples[(4U)]
Data bytes need to convert

volatile uint8_t queueUser
Index for user to queue transfer

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

struct __asrc__out__handle
#include <fsl_asrc.h> output handler

Public Members

asrc_transfer_callback_t callback
Callback function called at convert complete

uint32_t sampleWidth
data width

uint32_t fifoThreshold
fifo threshold

uint8_t *asrcQueue[(4U)]
Transfer queue storing queued transfer

size_t transferSamples[(4U)]
Data bytes need to convert

volatile uint8_t queueUser
Index for user to queue transfer

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

struct _asrc_handle
#include <fsl_asrc.h> ASRC handle structure.

Public Members

ASRC_Type *base
base address

uint32_t state
Transfer status

void *userData
Callback parameter passed to callback function

asrc_audio_channel_t audioDataChannels
audio channel number

asrc_channel_pair_t channelPair
channel pair mask

asrc_in_handle_t in
asrc input handler

asrc_out_handle_t out
asrc output handler

2.7 ASRC EDMA Driver

void ASRC_TransferInCreateHandleEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle, *asrc_channel_pair_t* channelPair, *asrc_edma_callback_t* callback, *edma_handle_t* *inDmaHandle, const *asrc_p2p_edma_config_t* *periphConfig, void *userData)

Initializes the ASRC IN eDMA handle.

This function initializes the ASRC DMA handle, which can be used for other ASRC transactional APIs. Usually, for a specified ASRC channel pair, call this API once to get the initialized handle.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair
- handle – ASRC eDMA handle pointer.
- callback – Pointer to user callback function.
- inDmaHandle – DMA handler for ASRC in.
- periphConfig – peripheral configuration.
- userData – User parameter passed to the callback function.

void ASRC_TransferOutCreateHandleEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle, *asrc_channel_pair_t* channelPair, *asrc_edma_callback_t* callback, *edma_handle_t* *outDmaHandle, const *asrc_p2p_edma_config_t* *periphConfig, void *userData)

Initializes the ASRC OUT eDMA handle.

This function initializes the ASRC DMA handle, which can be used for other ASRC transactional APIs. Usually, for a specified ASRC channel pair, call this API once to get the initialized handle.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair
- handle – ASRC eDMA handle pointer.
- callback – Pointer to user callback function.
- outDmaHandle – DMA handler for ASRC out.
- periphConfig – peripheral configuration.
- userData – User parameter passed to the callback function.

status_t ASRC_TransferSetChannelPairConfigEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle, *asrc_channel_pair_config_t* *asrcConfig, uint32_t inSampleRate, uint32_t outSampleRate)

Configures the ASRC P2P channel pair.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.
- asrcConfig – asrc configurations.
- inSampleRate – ASRC input sample rate.
- outSampleRate – ASRC output sample rate.

uint32_t ASRC_GetOutSamplesSizeEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle, uint32_t inSampleRate, uint32_t outSampleRate, uint32_t inSamplesize)

Get output sample buffer size can be transferred by edma.

Note: This API is depends on the ASRC output configuration, should be called after the ASRC_TransferSetChannelPairConfigEDMA.

Parameters

- base – asrc base pointer.
- handle – ASRC channel pair edma handle.
- inSampleRate – input sample rate.
- outSampleRate – output sample rate.
- inSamplesize – input sampleS size.

Return values

output – buffer size in byte.

status_t ASRC_TransferEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle, *asrc_transfer_t* *xfer)

Performs a non-blocking ASRC m2m convert using EDMA.

Note: This interface returns immediately after the transfer initiates.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- kStatus_Success – Start a ASRC eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_ASRCQueueFull – ASRC EDMA driver queue is full.

void ASRC_TransferInAbortEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Aborts a ASRC IN transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call ASRC_TransferTerminalP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferOutAbortEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Aborts a ASRC OUT transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call ASRC_TransferTerminalP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferInTerminalEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Terminate In ASRC Convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call ASRC_TransferAbortPP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferOutTerminalEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Terminate Out ASRC Convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call ASRC_TransferAbortPP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

FSL_ASRC_EDMA_DRIVER_VERSION

Version 2.2.0

typedef struct *_asrc_edma_handle* asrc_edma_handle_t

typedef void (*asrc_edma_callback_t)(ASRC_Type *base, *asrc_edma_handle_t* *handle, *status_t* status, void *userData)

ASRC eDMA transfer callback function for finish and error.

typedef void (*asrc_start_peripheral_t)(bool start)

ASRC trigger peripheral function pointer.

typedef struct *_asrc_p2p_edma_config* asrc_p2p_edma_config_t

destination peripheral configuration

typedef struct *_asrc_in_edma_handle* asrc_in_edma_handle_t

@ brief asrc in edma handler

typedef struct *_asrc_out_edma_handle* asrc_out_edma_handle_t

@ brief asrc out edma handler

ASRC_XFER_IN_QUEUE_SIZE

ASRC IN edma QUEUE size.

<

ASRC_XFER_OUT_QUEUE_SIZE

struct _asrc_p2p_edma_config

#include <fsl_asrc_edma.h> destination peripheral configuration

Public Members

asrc_start_peripheral_t startPeripheral

trigger peripheral start

struct _asrc_in_edma_handle

#include <fsl_asrc_edma.h> @ brief asrc in edma handler

Public Members

edma_handle_t *inDmaHandle

DMA handler for ASRC in

uint8_t tcd[(4U + 1U) * sizeof(*edma_tcd_t*)]

TCD pool for eDMA send.

uint32_t sampleWidth

input data width

uint32_t fifoThreshold

ASRC input fifo threshold

uint32_t *asrcQueue[4U]

Transfer queue storing queued transfer.

size_t transferSize[4U]

Data bytes need to transfer

volatile uint8_t queueUser

Index for user to queue transfer.

volatile uint8_t queueDriver

Index for driver to get the transfer data and size

uint32_t state

Internal state for ASRC eDMA transfer

const *asrc_p2p_edma_config_t* *peripheralConfig

peripheral configuration pointer

struct _asrc_out_edma_handle

#include <fsl_asrc_edma.h> @ brief asrc out edma handler

Public Members

edma_handle_t *outDmaHandle

DMA handler for ASRC out

uint8_t tcd[(((4U) * 2U) + 1U) * sizeof(*edma_tcd_t*)]

TCD pool for eDMA send.

uint32_t sampleWidth

output data width

uint32_t fifoThreshold

ASRC output fifo threshold

uint32_t *asrcQueue[((4U) * 2U)]

Transfer queue storing queued transfer.

size_t transferSize[((4U) * 2U)]

Data bytes need to transfer

volatile uint8_t queueUser

Index for user to queue transfer.

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

uint32_t state
Internal state for ASRC eDMA transfer

const *asrc_p2p_edma_config_t* *peripheralConfig
peripheral configuration pointer

struct _asrc_edma_handle
#include <fsl_asrc_edma.h> ASRC DMA transfer handle.

Public Members

asrc_in_edma_handle_t in
asrc in handler

asrc_out_edma_handle_t out
asrc out handler

asrc_channel_pair_t channelPair
channel pair

void *userData
User callback parameter

asrc_edma_callback_t callback
Callback for users while transfer finish or error occurs

2.8 CAAM: Cryptographic Acceleration and Assurance Module

FSL_CAAM_DRIVER_VERSION
CAAM driver version.

Current version: 2.4.0

Change log:

- Version 2.0.0
  - Initial version
- Version 2.0.1
  - Add Job Ring 2 and 3.
- Version 2.0.2
  - Add Data and Instruction Synchronization Barrier in caam_input_ring_set_jobs_added() to make sure that the descriptor will be loaded into CAAM correctly.
- Version 2.0.3
  - Use MACRO instead of numbers in descriptor.
  - Correct descriptor size mask.
- Version 2.1.0
  - Add return codes check and handling.
- Version 2.1.1

  - Add DCACHE support.
- Version 2.1.2
  - Add data offset feature to provide support for mirrored (high-speed) memory.
- Version 2.1.3
  - Fix MISRA-2012 issues.
- Version 2.1.4
  - Fix MISRA-2012 issues.
- Version 2.1.5
  - Support EXTENDED data size for all AES, HASH and RNG operations.
  - Support multiple De-Initialization/Initialization of CAAM driver within one POR event.
- Version 2.1.6
  - Improve DCACHE handling. Requires CAAM used and cached memory set in write-trough mode.
- Version 2.2.0
  - Added API for Blob functions and CRC
- Version 2.2.1
  - Fixed AES-CCM decrypt failing with TAG length bigger than 8 byte.
- Version 2.2.2
  - Modify RNG to not reseed with each request.
- Version 2.2.3
  - Fix DCACHE invalidation in CAAM_HASH_Finish().
- Version 2.2.4
  - Fix issue where the outputSize parameter of CAAM_HASH_Finish() has impact on hash calculation.
- Version 2.3.0
  - Add support for SHA HMAC.
- Version 2.3.1
  - Modified function caam_aes_ccm_check_input_args() to allow payload be empty as is specified in NIST800-38C Section 5.3.
- Version 2.3.2
  - Fix MISRA-2012 issues.
- Version 2.4.0
  - Add new APIs for native asymmetric operations (RSA, ECC) instead of only accelerating mathematical primitives and support for black keys and blobs for both symmetric and asymmetric operations.

CAAM status return codes.

Values:

enumerator kStatus_CAAM_Again

Non-blocking function shall be called again.

enumerator kStatus_CAAM_DataOverflow
Input data too big.

enum _caam_job_ring_t
CAAM job ring selection.

Values:

enumerator kCAAM_JobRing0
CAAM Job ring 0

enumerator kCAAM_JobRing1
CAAM Job ring 1

enumerator kCAAM_JobRing2
CAAM Job ring 2

enumerator kCAAM_JobRing3
CAAM Job ring 3

enum _caam_wait_mode
CAAM driver wait mechanism.

Values:

enumerator kCAAM_Blocking
CAAM_Wait blocking mode

enumerator kCAAM_Nonblocking
CAAM Wait non-blocking mode

enum _caam_rng_sample_mode
CAAM RNG sample mode. Used by caam_config_t.

Values:

enumerator kCAAM_RNG_SampleModeVonNeumann
Use von Neumann data in both Entropy shifter and Statistical Checker.

enumerator kCAAM_RNG_SampleModeRaw
Use raw data into both Entropy shifter and Statistical Checker.

enumerator kCAAM_RNG_SampleModeVonNeumannRaw
Use von Neumann data in Entropy shifter. Use raw data into Statistical Checker.

enum _caam_rng_ring_osc_div
CAAM RNG ring oscillator divide. Used by caam_config_t.

Values:

enumerator kCAAM_RNG_RingOscDiv0
Ring oscillator with no divide

enumerator kCAAM_RNG_RingOscDiv2
Ring oscillator divided-by-2.

enumerator kCAAM_RNG_RingOscDiv4
Ring oscillator divided-by-4.

enumerator kCAAM_RNG_RingOscDiv8
Ring oscillator divided-by-8.

enum _caam_priblob

CAAM Private Blob. Used by caam_config_t.

Values:

enumerator kCAAM_PrivSecureBootBlobs

Private secure boot software blobs.

enumerator kCAAM_PrivProvisioningBlobsType1

Private Provisioning Type 1 blobs.

enumerator kCAAM_PrivProvisioningBlobsType2

Private Provisioning Type 2 blobs.

enumerator kCAAM_NormalOperationBlobs

Normal operation blobs.

enum _caam_ext_key_xfr_source

CAAM External Key Transfer command SRC (The source from which the key will be obtained)

Values:

enumerator kCAAM_ExtKeyXfr_KeyRegisterClass1

The Class 1 Key Register is the source.

enumerator kCAAM_ExtKeyXfr_KeyRegisterClass2

The Class 2 Key Register is the source.

enumerator kCAAM_ExtKeyXfr_PkhaRamE

The PKHA E RAM is the source.

enum _caam_ecc_ecdsel

Values:

enumerator kCAAM_ECDSEL_P_192

enumerator kCAAM_ECDSEL_P_224

enumerator kCAAM_ECDSEL_P_256

enumerator kCAAM_ECDSEL_P_384

enumerator kCAAM_ECDSEL_P_521

enumerator kCAAM_ECDSEL_brainpoolP160r1

enumerator kCAAM_ECDSEL_brainpoolP160t1

enumerator kCAAM_ECDSEL_brainpoolP192r1

enumerator kCAAM_ECDSEL_brainpoolP192t1

enumerator kCAAM_ECDSEL_brainpoolP224r1

enumerator kCAAM_ECDSEL_brainpoolP224t1

enumerator kCAAM_ECDSEL_brainpoolP256r1

enumerator kCAAM_ECDSEL_brainpoolP256t1

enumerator kCAAM_ECDSEL_brainpoolP320r1

enumerator kCAAM_ECDSEL_brainpoolP320t1

enumerator kCAAM_ECDSEL_brainpoolP384r1

enumerator kCAAM_ECDSEL_brainpoolP384t1

enumerator kCAAM_ECDSEL_brainpoolP512r1

enumerator kCAAM_ECDSEL_brainpoolP512t1

enumerator kCAAM_ECDSEL_prime192v2

enumerator kCAAM_ECDSEL_prime192v3

enumerator kCAAM_ECDSEL_prime239v1

enumerator kCAAM_ECDSEL_prime239v2

enumerator kCAAM_ECDSEL_prime239v3

enumerator kCAAM_ECDSEL_secp112r1

enumerator kCAAM_ECDSEL_wtls8

enumerator kCAAM_ECDSEL_wtls9

enumerator kCAAM_ECDSEL_secp160k1

enumerator kCAAM_ECDSEL_secp160r1

enumerator kCAAM_ECDSEL_secp160r2

enumerator kCAAM_ECDSEL_secp192k1

enumerator kCAAM_ECDSEL_secp224k1

enumerator kCAAM_ECDSEL_secp256k1

enumerator kCAAM_ECDSEL_B_163

enumerator kCAAM_ECDSEL_B_233

enumerator kCAAM_ECDSEL_B_283

enumerator kCAAM_ECDSEL_B_409

enumerator kCAAM_ECDSEL_B_571

enumerator kCAAM_ECDSEL_K_163

enumerator kCAAM_ECDSEL_K_233

enumerator kCAAM_ECDSEL_K_283

enumerator kCAAM_ECDSEL_K_409

enumerator kCAAM_ECDSEL_K_571

enumerator kCAAM_ECDSEL_wtls1

enumerator kCAAM_ECDSEL_sect113r1

enumerator kCAAM_ECDSEL_c2pnb163v1

enumerator kCAAM_ECDSEL_c2pnb163v2

enumerator kCAAM_ECDSEL_c2pnb163v3

enumerator kCAAM_ECDSEL_sect163r1

enumerator kCAAM_ECDSEL_sect193r1

enumerator kCAAM_ECDSEL_sect193r2

enumerator kCAAM_ECDSEL_sect239k1

typedef struct *_caam_job_callback* caam_job_callback_t

CAAM callback function.

typedef enum *_caam_job_ring_t* caam_job_ring_t

CAAM job ring selection.

typedef struct *_caam_handle_t* caam_handle_t

CAAM handle Specifies jobRing and optionally the user callback function. The user callback functions is invoked only if jobRing interrupt has been enabled by the user. By default the jobRing interrupt is disabled (default job complete test is polling CAAM output ring).

typedef enum *_caam_wait_mode* caam_wait_mode_t

CAAM driver wait mechanism.

typedef uint32_t caam_desc_aes_ecb_t[64]

Memory buffer to hold CAAM descriptor for AESA ECB job.

typedef uint32_t caam_desc_aes_cbc_t[64]

Memory buffer to hold CAAM descriptor for AESA CBC job.

typedef uint32_t caam_desc_aes_ctr_t[64]

Memory buffer to hold CAAM descriptor for AESA CTR job.

typedef uint32_t caam_desc_aes_ccm_t[64]

Memory buffer to hold CAAM descriptor for AESA CCM job.

typedef uint32_t caam_desc_aes_gcm_t[64]

Memory buffer to hold CAAM descriptor for AESA GCM job.

typedef uint32_t caam_desc_hash_t[64]

Memory buffer to hold CAAM descriptor for MDHA job or AESA CMAC job.

typedef uint32_t caam_desc_rng_t[64]

Memory buffer to hold CAAM descriptor for RNG jobs.

typedef uint32_t caam_desc_cipher_des_t[64]

Memory buffer to hold CAAM descriptor for DESA jobs.

typedef uint32_t caam_desc_pkha_t[64]

Memory buffer to hold CAAM descriptor for PKHA jobs.

typedef uint32_t caam_desc_pkha_ecc_t[64]

Memory buffer to hold CAAM descriptor for PKHA ECC jobs.

typedef uint32_t caam_desc_key_black_t[64]

Memory buffer to hold CAAM descriptor for performing key blackening jobs.

typedef uint32_t caam_desc_gen_enc_blob_t[64]

Memory buffer to hold CAAM descriptor for performing generating dek blob jobs.

typedef uint32_t caam_desc_gen_dep_blob_t[64]

typedef uint32_t caam_desc_rsa_t[64]

Memory buffer to hold CAAM descriptor for performing generating dek blob jobs.

typedef uint32_t caam_desc_ecc_t[64]

Memory buffer to hold CAAM descriptor for performing generating dek blob jobs.

typedef struct *_caam_job_ring_interface* caam_job_ring_interface_t

typedef enum *_caam_rng_sample_mode* caam_rng_sample_mode_t

CAAM RNG sample mode. Used by caam_config_t.

typedef enum *_caam_rng_ring_osc_div* caam_rng_ring_osc_div_t

CAAM RNG ring oscillator divide. Used by caam_config_t.

typedef enum *_caam_priblob* caam_priblob_t

CAAM Private Blob. Used by caam_config_t.

typedef struct *_caam_config* caam_config_t

CAAM configuration structure.

typedef enum *_caam_ext_key_xfr_source* caam_ext_key_xfr_source_t

CAAM External Key Transfer command SRC (The source from which the key will be obtained)

typedef enum *_caam_ecc_ecdsel* caam_ecc_ecdsel_t

status_t CAAM_Init(CAAM_Type *base, const *caam_config_t* *config)

Initializes the CAAM driver.

This function initializes the CAAM driver, including CAAM's internal RNG.

Parameters

- base – CAAM peripheral base address
- config – Pointer to configuration structure.

Returns

kStatus_Success the CAAM Init has completed with zero termination status word

Returns

kStatus_Fail the CAAM Init has completed with non-zero termination status word

status_t CAAM_Deinit(CAAM_Type *base)

Deinitializes the CAAM driver. This function deinitializes the CAAM driver.

Parameters

- base – CAAM peripheral base address

Returns

kStatus_Success the CAAM Deinit has completed with zero termination status word

Returns

kStatus_Fail the CAAM Deinit has completed with non-zero termination status word

void CAAM_GetDefaultConfig(*caam_config_t* *config)

Gets the default configuration structure.

This function initializes the CAAM configuration structure to a default value. The default values are as follows. caamConfig->rngSampleMode = kCAAM_RNG_SampleModeVonNeumann; caamConfig->rngRingOscDiv = kCAAM_RNG_RingOscDiv4;

Parameters

- config – **[out]** Pointer to configuration structure.

status_t CAAM_Wait(CAAM_Type *base, *caam_handle_t* *handle, uint32_t *descriptor, *caam_wait_mode_t* mode)

Wait for a CAAM job to complete.

This function polls CAAM output ring for a specific job.

The CAAM job ring is specified by the jobRing field in the caam_handle_t structure. The job to be waited is specified by it's descriptor address.

This function has two modes, determined by the mode argument. In blocking mode, the function polls the specified jobRing until the descriptor is available in the CAAM output job ring. In non-blocking mode, it polls the output ring once and returns status immediately.

The function can be called from multiple threads or interrupt service routines, as internally it uses global critical section (global interrupt disable enable) to protect it's operation against concurrent accesses. The global interrupt is disabled only when the descriptor is found in the output ring, for a very short time, to remove the descriptor from the output ring safely.

Parameters

- base – CAAM peripheral base address
- handle – Data structure with CAAM jobRing used for this request
- descriptor –
- mode – Blocking and non-blocking mode. Zero is blocking. Non-zero is non-blocking.

Returns
kStatus_Success the CAAM job has completed with zero job termination status word

Returns
kStatus_Fail the CAAM job has completed with non-zero job termination status word

Returns
kStatus_Again In non-blocking mode, the job is not ready in the CAAM Output Ring

status_t CAAM_ExternalKeyTransfer(CAAM_Type *base, *caam_handle_t* *handle, *caam_ext_key_xfr_source_t* keySource, size_t keySize)

External Key Transfer.

This function loads the given key source to an CAAM external destination via a private interface, such as Inline Encryption Engine IEE Private Key bus.

The CAAM job ring is specified by the jobRing field in the caam_handle_t structure.

This function is blocking.

Parameters

- base – CAAM peripheral base address
- handle – Data structure with CAAM jobRing used for this request.
- keySource – The source from which the key will be obtained.
- keySize – Size of the key in bytes.

Returns
kStatus_Success the CAAM job has completed with zero job termination status word

Returns
kStatus_Fail the CAAM job has completed with non-zero job termination status word

struct _caam_job_callback

#include <fsl_caam.h> CAAM callback function.

Public Members

void (*JobCompleted)(void *userData)
CAAM Job complete callback

struct _caam_handle_t

#include <fsl_caam.h> CAAM handle Specifies jobRing and optionally the user callback function. The user callback functions is invoked only if jobRing interrupt has been enabled by the user. By default the jobRing interrupt is disabled (default job complete test is polling CAAM output ring).

Public Members

caam_job_callback_t callback
Callback function

void *userData
Parameter for CAAM job complete callback

struct _caam_job_ring_interface

#include <fsl_caam.h>

struct _caam_config

#include <fsl_caam.h> CAAM configuration structure.

Public Members

caam_rng_sample_mode_t rngSampleMode
RTMCTL Sample Mode.

caam_rng_ring_osc_div_t rngRingOscDiv
RTMCTL Oscillator Divide.

bool scfgrLockTrngProgramMode
SCFGR Lock TRNG Program Mode.

bool scfgrEnableRandomDataBuffer
SCFGR Enable random data buffer.

bool scfgrRandomRngStateHandle0
SCFGR Random Number Generator State Handle 0.

bool scfgrRandomDpaResistance
SCFGR Random Differential Power Analysis Resistance.

caam_priblob_t scfgrPriblob
SCFGR Private Blob.

2.9 CAAM AES driver

status_t CAAM_AES_EncryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *key, size_t keySize)

Encrypts AES using the ECB block mode.

Encrypts AES using the ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns

Status from encrypt operation

status_t CAAM_AES_DecryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *key, size_t keySize)

Decrypts AES using ECB block mode.

Decrypts AES using ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key.
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns

Status from decrypt operation

status_t CAAM_AES_EncryptEcbExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Encrypts AES using the ECB block mode using black key.

Encrypts AES using the ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt

- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns
Status from encrypt operation

status_t CAAM_AES_DecryptEcbExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Decrypts AES using ECB block mode using black key.

Decrypts AES using ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key.
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns
Status from decrypt operation

status_t CAAM_AES_EncryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[16], const uint8_t *key, size_t keySize)

Encrypts AES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns
Status from encrypt operation

status_t CAAM_AES_DecryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[16], const uint8_t *key, size_t keySize)

Decrypts AES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns

Status from decrypt operation

status_t CAAM_AES_EncryptCbcExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[16], const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Encrypts AES using CBC block mode using black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns

Status from encrypt operation

status_t CAAM_AES_DecryptCbcExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[16], const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Decrypts AES using CBC block mode using black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

- blackKeyType – Type of black key

Returns
Status from decrypt operation

status_t CAAM_AES_CryptCtr(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *input, uint8_t *output, size_t size, uint8_t counter[16], const uint8_t *key, size_t keySize, uint8_t counterlast[16], size_t *szLeft)

Encrypts or decrypts AES using CTR block mode.

Encrypts or decrypts AES using CTR block mode. AES CTR mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- input – Input data for CTR block mode
- output – **[out]** Output data for CTR block mode
- size – Size of input and output data in bytes
- counter – **[inout]** Input counter (updates on return)
- key – Input key to use for forward AES cipher
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- counterlast – **[out]** Output cipher of last counter, for chained CTR calls. NULL can be passed if chained calls are not used.
- szLeft – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.

Returns
Status from encrypt operation

status_t CAAM_AES_CryptCtrExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *input, uint8_t *output, size_t size, uint8_t counter[16], const uint8_t *key, size_t keySize, uint8_t counterlast[16], size_t *szLeft, *caam_key_type_t* blackKeyType)

Encrypts or decrypts AES using CTR block mode using black key.

Encrypts or decrypts AES using CTR block mode. AES CTR mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- input – Input data for CTR block mode
- output – **[out]** Output data for CTR block mode
- size – Size of input and output data in bytes
- counter – **[inout]** Input counter (updates on return)

- key – Input key to use for forward AES cipher
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- counterlast – **[out]** Output cipher of last counter, for chained CTR calls. NULL can be passed if chained calls are not used.
- szLeft – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.
- blackKeyType – Type of black key

Returns

Status from encrypt operation

status_t CAAM_AES_EncryptTagCcm(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize)

Encrypts AES and tags using CCM block mode.

Encrypts AES and optionally tags using CCM block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes. Zero means authentication only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication skipped).
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Generated output tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.

Returns

Status from encrypt operation

status_t CAAM_AES_DecryptTagCcm(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize)

Decrypts AES and authenticates using CCM block mode.

Decrypts AES and optionally authenticates using CCM block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.

- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes. Zero means authentication data only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication data skipped).
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Received tag. Set to NULL to skip tag processing.
- tagSize – Input size of the received tag to compare with the computed tag, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.

Returns

Status from decrypt operation

status_t CAAM_AES_EncryptTagCcmExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Encrypts AES and tags using CCM block mode using black key.

Encrypts AES and optionally tags using CCM block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes. Zero means authentication only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication skipped).
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Generated output tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.
- blackKeyType – Type of black key

Returns
Status from encrypt operation

status_t CAAM_AES_DecryptTagCcmExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Decrypts AES and authenticates using CCM block mode using black key.

Decrypts AES and optionally authenticates using CCM block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes. Zero means authentication data only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication data skipped).
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Received tag. Set to NULL to skip tag processing.
- tagSize – Input size of the received tag to compare with the computed tag, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.
- blackKeyType – Type of black key

Returns
Status from decrypt operation

status_t CAAM_AES_EncryptTagGcm(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize)

Encrypts AES and tags using GCM block mode.

Encrypts AES and optionally tags using GCM block mode. If plaintext is NULL, only the GHASH is calculated and output in the 'tag' field.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes
- iv – Input initial vector

- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Output hash tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4,8,12,13,14,15 or 16.

Returns

Status from encrypt operation

status_t CAAM_AES_DecryptTagGcm(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize)

Decrypts AES and authenticates using GCM block mode.

Decrypts AES and optionally authenticates using GCM block mode. If ciphertext is NULL, only the GHASH is calculated and compared with the received GHASH in 'tag' field.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Input hash tag to compare. Set to NULL to skip tag processing.
- tagSize – Input size of the tag, in bytes. Must be 4, 8, 12, 13, 14, 15, or 16.

Returns

Status from decrypt operation

status_t CAAM_AES_EncryptTagGcmExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Encrypts AES and tags using GCM block mode using black key.

Encrypts AES and optionally tags using GCM block mode. If plaintext is NULL, only the GHASH is calculated and output in the 'tag' field. Uses black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Output hash tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4,8,12,13,14,15 or 16.
- blackenKeyType – Type of black key

Returns

Status from encrypt operation

status_t CAAM_AES_DecryptTagGcmExtended(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Decrypts AES and authenticates using GCM block mode using black key.

Decrypts AES and optionally authenticates using GCM block mode. If ciphertext is NULL, only the GHASH is calculated and compared with the received GHASH in 'tag' field. Uses black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Input hash tag to compare. Set to NULL to skip tag processing.
- tagSize – Input size of the tag, in bytes. Must be 4, 8, 12, 13, 14, 15, or 16.
- blackenKeyType – Type of black key

Returns
Status from decrypt operation

CAAM_AES_BLOCK_SIZE
AES block size in bytes

2.10 CAAM Key Blankening driver

size_t CAAM_BLACK_KeyBlackenSize(*caam_fifost_type_t* fifostType, size_t dataSize)
Return size of blacken key based on encryption type and data to encrypt size.

Parameters

- fifostType – Type of AES-CBC or AEC-CCM to encrypt plaintext
- dataSize – Size of data to be encrypted

Returns
size_t Size of blacken key.

status_t CAAM_BLACK_GetKeyBlacken(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *data, size_t dataSize, *caam_fifost_type_t* fifostType, uint8_t *blackdata)
Construct a black key.

This function constructs a job descriptor capable of performing a key blackening operation on a plaintext secure memory resident object.

Parameters

- base – CAAM peripheral base address
- handle – jobRing used for this request
- data – Pointer address uses to pointed the plaintext.
- dataSize – Size of the buffer pointed by the data parameter
- fifostType – Type of AES-CBC or AEC-CCM to encrypt plaintext
- blackdata – **[out]** Pointer address uses to pointed the black key

Returns
Status of the request

2.11 CAAM Blob driver

enum _caam_fifost_type
CAAM FIFOST types.

Values:

enumerator kCAAM_FIFOST_Type_Ecb_Jkek
Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_FIFOST_Type_Ecb_Tkek
Key Register, encrypted using AES-ECB with the trusted descriptor key encryption key.

enumerator kCAAM_FIFOST_Type_Ccm_Jkek
Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enumerator kCAAM_FIFOST_Type_Ccm_Tkek
Key register, encrypted using AES-CCM with the trusted descriptor key encryption key.

enum _caam_desc_type
CAAM descriptor types.

Values:

enumerator kCAAM_Descriptor_Type_Ecb_Jkek
Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_Descriptor_Type_Ecb_Tkek
Key Register, encrypted using AES-ECB with the trusted descriptor key encryption key.

enumerator kCAAM_Descriptor_Type_Ccm_Jkek
Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enumerator kCAAM_Descriptor_Type_Ccm_Tkek
Key register, encrypted using AES-CCM with the trusted descriptor key encryption key.

enum _caam_key_type
CAAM key types.

Values:

enumerator kCAAM_Key_Type_None

enumerator kCAAM_Key_Type_Ecb_Jkek
Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_Key_Type_Ecb_Tkek
Key Register, encrypted using AES-ECB with the trusted descriptor key encryption key.

enumerator kCAAM_Key_Type_Ccm_Jkek
Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enumerator kCAAM_Key_Type_Ccm_Tkek
Key register, encrypted using AES-CCM with the trusted descriptor key encryption key.

enum _caam_ecc_encryption_type
CAAM ecc encryption types.

Values:

enumerator kCAAM_Ecc_Encryption_Type_None

enumerator kCAAM_Ecc_Encryption_Type_Ecb_Jkek
Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_Ecc_Encryption_Type_Ccm_Jkek
Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enum _caam_rsa_key_type
CAAM rsa key encryption types.

Values:

enumerator kCAAM_Rsa_Key_Type_None

enumerator kCAAM_Rsa_Key_Type_Ecb_Jkek
Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_Rsa_Key_Type_Ccm_Jkek
Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enum _caam_rsa_encryption_type

CAAM rsa encryption types.

Values:

enumerator kCAAM_Rsa_Encryption_Type_None

enumerator kCAAM_Rsa_Encryption_Type_Ecb_Jkek

Key Register, encrypted using AES-ECB with the job descriptor key encryption key.

enumerator kCAAM_Rsa_Encryption_Type_Ecb_Tkek

Key Register, encrypted using AES-ECB with the trusted descriptor key encryption key.

enumerator kCAAM_Rsa_Encryption_Type_Ccm_Jkek

Key Register, encrypted using AES-CCM with the job descriptor key encryption key.

enumerator kCAAM_Rsa_Encryption_Type_Ccm_Tkek

Key register, encrypted using AES-CCM with the trusted descriptor key encryption key.

enum _caam_rsa_format_type

Values:

enumerator kCAAM_Rsa_Format_Type_None

No formatting

enumerator kCAAM_Rsa_Format_Type_PKCS1

EME-PKCS1-v1_5 encryption decoding function

typedef enum *_caam_fifost_type* caam_fifost_type_t

CAAM FIFOST types.

typedef enum *_caam_desc_type* caam_desc_type_t

CAAM descriptor types.

typedef enum *_caam_key_type* caam_key_type_t

CAAM key types.

typedef enum *_caam_ecc_encryption_type* caam_ecc_encryption_type_t

CAAM ecc encryption types.

typedef enum *_caam_rsa_key_type* caam_rsa_key_type_t

CAAM rsa key encryption types.

typedef enum *_caam_rsa_encryption_type* caam_rsa_encryption_type_t

CAAM rsa encryption types.

typedef enum *_caam_rsa_format_type* caam_rsa_format_type_t

status_t CAAM_RedBlob_Encapsule(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *keyModifier, size_t keyModifierSize, const uint8_t *data, size_t dataSize, uint8_t *blob_data)

Construct a encrypted Red Blob.

This function constructs a job descriptor capable of performing a encrypted blob operation on a plaintext object.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- keyModifier – Address of the random key modifier generated by RNG
- keyModifierSize – Size of keyModifier buffer in bytes

- data – Data adress
- dataSize – Size of the buffer pointed by the data parameter
- blob_data – **[out]** Output blob data adress

Returns
Status of the request

status_t CAAM_RedBlob_Decapsule(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *keyModifier, size_t keyModifierSize, const uint8_t *blob_data, uint8_t *data, size_t dataSize)

Decrypt red blob.

This function constructs a job descriptor capable of performing decrypting red blob .

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- keyModifier – Address of the random key modifier generated by RNG
- keyModifierSize – Size of keyModifier buffer in bytes
- blob_data – Address of blob data
- data – **[out]** Output data adress.
- dataSize – Size of the buffer pointed by the data parameter in bytes

Returns
Status of the request

status_t CAAM_BlackBlob_Encapsule(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *keyModifier, size_t keyModifierSize, const uint8_t *data, size_t dataSize, uint8_t *blob_data, *caam_desc_type_t* blackKeyType)

Construct a encrypted Black Blob.

This function constructs a job descriptor capable of performing a encrypted blob operation on a plaintext object.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- keyModifier – Address of the random key modifier generated by RNG
- keyModifierSize – Size of keyModifier buffer in bytes
- data – Data adress
- dataSize – Size of the buffer pointed by the data parameter
- blob_data – **[out]** Output blob data adress
- blackKeyType – Type of black key see enum caam_desc_type_t for more info

Returns
Status of the request

status_t CAAM_BlackBlob_Decapsule(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *keyModifier, size_t keyModifierSize, const uint8_t *blob_data, uint8_t *data, size_t dataSize, *caam_desc_type_t* blackKeyType)

Construct a decrypted black blob.

This function constructs a job descriptor capable of performing decrypting black blob.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- keyModifier – Address of the random key modifier generated by RNG
- keyModifierSize – Size of keyModifier buffer in bytes
- blob_data – Address of blob data
- data – **[out]** Output data adress.
- dataSize – Size of the buffer pointed by the data parameter in bytes
- blackKeyType – Type of black key see enum caam_desc_type_t for more info

Returns

Status of the request

2.12 CAAM CRC driver

status_t CAAM_CRC_Init(CAAM_Type *base, *caam_handle_t* *handle, *caam_hash_ctx_t* *ctx, caam_crc_algo_t algo, const uint8_t *polynomial, size_t polynomialSize, caam_aai_crc_alg_t mode)

Initialize CRC context.

This function initializes the CRC context. polynomial shall be supplied if the underlaying algoritm is kCAAM_CrcCUSTPOLY. polynomial shall be NULL if the underlaying algoritm is kCAAM_CrcIEEE or kCAAM_CrciSCSI.

This functions is used to initialize the context for CAAM_CRC API

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- ctx – **[out]** Output crc context
- algo – Underlaying algorithm to use for CRC computation
- polynomial – CRC polynomial (NULL if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- polynomialSize – Size of polynomial in bytes (0u if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- mode – Specify how CRC engine manipulates its input and output data

Returns

Status of initialization

status_t CAAM_CRC_Update(*caam_hash_ctx_t* *ctx, const uint8_t *input, size_t inputSize)

Add data to current CRC.

Add data to current CRC. This can be called repeatedly. The functions blocks. If it returns kStatus_Success, the running CRC has been updated (CAAM has processed the input data), so the memory at input pointer can be released back to system. The context is updated with the running CRC and with all necessary information to support possible context switch.

Parameters

- ctx – **[inout]** CRC context
- input – Input data
- inputSize – Size of input data in bytes

Returns
Status of the crc update operation

status_t CAAM_CRC_Finish(*caam_hash_ctx_t* *ctx, uint8_t *output, size_t *outputSize)

Finalize CRC.

Outputs the final CRC (computed by CAAM_CRC_Update()) and erases the context.

Parameters

- ctx – **[inout]** Input crc context
- output – **[out]** Output crc data
- outputSize – **[out]** Output parameter storing the size of the output crc in bytes

Returns
Status of the crc finish operation

status_t CAAM_CRC(CAAM_Type *base, *caam_handle_t* *handle, caam_crc_algo_t algo, caam_aai_crc_alg_t mode, const uint8_t *input, size_t inputSize, const uint8_t *polynomial, size_t polynomialSize, uint8_t *output, size_t *outputSize)

Create CRC on given data.

Perform CRC in one function call.

Polynomial shall be supplied if underlaying algorithm is kCAAM_CrcCUSTPOLY. Polynomial shall be NULL if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI.

The function is blocking.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- algo – Underlaying algorithm to use for crc computation.
- mode – Specify how CRC engine manipulates its input and output data.
- input – Input data
- inputSize – Size of input data in bytes
- polynomial – CRC polynomial (NULL if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- polynomialSize – Size of input polynomial in bytes (0U if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- output – **[out]** Output crc data
- outputSize – **[out]** Output parameter storing the size of the output crc in bytes

Returns
Status of the one call crc operation.

status_t CAAM_CRC_NonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_hash_t* descriptor, caam_crc_algo_t algo, caam_aai_crc_alg_t mode, const uint8_t *input, size_t inputSize, const uint8_t *polynomial, size_t polynomialSize, uint8_t *output, size_t *outputSize)

Create CRC on given data.

Perform CRC in one function call.

Polynomial shall be supplied if underlaying algorithm is kCAAM_CrcCUSTPOLY. Polynomial shall be NULL if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI.

The function is non-blocking. The request is scheduled at CAAM.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- descriptor – **[out]** Memory for the CAAM descriptor.
- algo – Underlaying algorithm to use for crc computation.
- mode – Specify how CRC engine manipulates its input and output data.
- input – Input data
- inputSize – Size of input data in bytes
- polynomial – CRC polynomial (NULL if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- polynomialSize – Size of input polynomial in bytes (0U if underlaying algorithm is kCAAM_CrcIEEE or kCAAM_CrciSCSI)
- output – **[out]** Output crc data
- outputSize – **[out]** Output parameter storing the size of the output crc in bytes

Returns

Status of the one call crc operation.

2.13 CAAM DES driver

status_t CAAM_DES_EncryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key[8U])

Encrypts DES using ECB block mode.

Encrypts DES using ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key – Input key to use for encryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_DecryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key[8U])

Decrypts DES using ECB block mode.

Decrypts DES using ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key – Input key to use for decryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_EncryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using CBC block mode.

Encrypts DES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Ouput ciphertext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key – Input key to use for encryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_DecryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using CBC block mode.

Decrypts DES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input data in bytes

- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key – Input key to use for decryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_EncryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using CFB block mode.

Encrypts DES using CFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- size – Size of input data in bytes
- iv – Input initial block.
- key – Input key to use for encryption
- ciphertext – **[out]** Output ciphertext

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_DecryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using CFB block mode.

Decrypts DES using CFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key – Input key to use for decryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_EncryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using OFB block mode.

Encrypts DES using OFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.

- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key – Input key to use for encryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES_DecryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using OFB block mode.

Decrypts DES using OFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key – Input key to use for decryption

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES2_EncryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using ECB block mode with two keys.

Encrypts triple DES using ECB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES2_DecryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using ECB block mode with two keys.

Decrypts triple DES using ECB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES2_EncryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using CBC block mode with two keys.

Encrypts triple DES using CBC block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES2_DecryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using CBC block mode with two keys.

Decrypts triple DES using CBC block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes

- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES2_EncryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using CFB block mode with two keys.

Encrypts triple DES using CFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES2_DecryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using CFB block mode with two keys.

Decrypts triple DES using CFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES2_EncryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using OFB block mode with two keys.

Encrypts triple DES using OFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES2_DecryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using OFB block mode with two keys.

Decrypts triple DES using OFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES3_EncryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using ECB block mode with three keys.

Encrypts triple DES using ECB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

- key3 – Third input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES3_DecryptEcb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using ECB block mode with three keys.

Decrypts triple DES using ECB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES3_EncryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using CBC block mode with three keys.

Encrypts triple DES using CBC block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from encrypt/decrypt operation

status_t CAAM_DES3_DecryptCbc(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using CBC block mode with three keys.

Decrypts triple DES using CBC block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES3_EncryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using CFB block mode with three keys.

Encrypts triple DES using CFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and ouput data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES3_DecryptCfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using CFB block mode with three keys.

Decrypts triple DES using CFB block mode with three keys.

Parameters

- base – CAAM peripheral base address

- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES3_EncryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using OFB block mode with three keys.

Encrypts triple DES using OFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from encrypt/decrypt operation

status_t CAAM_DES3_DecryptOfb(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using OFB block mode with three keys.

Decrypts triple DES using OFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes

- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from encrypt/decrypt operation

CAAM_DES_KEY_SIZE
CAAM DES key size - 64 bits.

CAAM_DES_IV_SIZE
CAAM DES IV size - 8 bytes.

CAAM_BLACKEN_ECB_SIZE(x)
CAAM blacken key size for ECB encryption.

CAAM_BLACKEN_CCM_SIZE(x)
CAAM blacken key size for CCM encryption.

CAAM_DSA_PUBLIC_KEY_LENGTH(domain)
CAAM DSA public key length for EC domain.

CAAM_ECC_PUBLIC_KEY_LENGTH(domain)
CAAM ECC public key length for EC domain.

CAAM_ECC_PRIVATE_KEY_LENGTH(domain)
CAAM ECC private key length for EC domain.

CAAM_ECC_SECOND_SIGN_BUFFER_SIZE(domain)
CAAM blacken key size for ECB encryption.

The second part of key size and buffer length needed for compution may differ.

2.14 Caam_driver_ecc

size_t CAAM_ECC_PrivateKeySize(*caam_ecc_encryption_type_t* encryptKeyType, *caam_ecc_ecdsel_t* ecdsel)

Return size of private key based on encryption type and ecliptic curve domain.

Parameters

- encryptKeyType – Type of key encryption.
- ecdsel – Elliptic curve domain selection

Returns
size_t Size of private key.

status_t CAAM_ECC_KeyPair(CAAM_Type *base, *caam_handle_t* *handle, *caam_ecc_ecdsel_t* ecdsel, *caam_ecc_encryption_type_t* encryptKeyType, uint8_t *privKey, uint8_t *pubKey)

Generates public and private key for ECC.

The buffer size of privKey can be determined using CAAM_ECC_PRIVATE_KEY_LENGTH. The buffer size of pubKey can be determined using CAAM_ECC_PUBLIC_KEY_LENGTH. For encrypted privKey, the buffer size can be determined using CAAM_BLACKEN_ECB_SIZE or CAAM_BLACKEN_CCM_SIZE macros.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- ecdsel – Elliptic curve domain selection
- encryptKeyType – Type of key encryption
- privKey – **[out]** Private key
- pubKey – **[out]** Public key

Returns
Operation status.

status_t CAAM_ECC_Sign(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *privKey, const uint8_t *data, size_t dataSize, *caam_ecc_ecdsel_t* ecdsel, *caam_ecc_encryption_type_t* encryptKeyType, uint8_t *signFirst, uint8_t *signSecond)

Generates signature using ECC.

The buffer size of signFirst can be determined using CAAM_ECC_PRIVATE_KEY_LENGTH. ! The buffer size of signSecond can be determined using CAAM_ECC_SECOND_SIGN_BUFFER_SIZE.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- privKey – Private key
- data – Hashed data
- dataSize – Hashed data length
- ecdsel – Elliptic curve domain selection
- encryptKeyType – Type of key encryption
- signFirst – **[out]** First part of the signature
- signSecond – **[out]** Second part of the signature

Returns
Operation status.

status_t CAAM_ECC_VerifyPublicKey(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *pubKey, const uint8_t *data, size_t dataSize, const uint8_t *signFirst, const uint8_t *signSecond, *caam_ecc_ecdsel_t* ecdsel, uint8_t *tmp)

Verify ECC signature using public key.

The buffer size of tmp can be determined using CAAM_ECC_PUBLIC_KEY_LENGTH.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- pubKey – Public key
- data – Hashed data
- dataSize – Hashed data length
- signFirst – First part of the signature
- signSecond – Second part of the signature

- ecdsel – Elliptic curve domain selection
- tmp – **[inout]** Temporary storage for intermediate results

Returns
Operation status.

status_t CAAM_ECC_VerifyPrivateKey(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *privKey, const uint8_t *data, size_t dataSize, const uint8_t *signFirst, const uint8_t *signSecond, *caam_ecc_ecdsel_t* ecdsel, *caam_ecc_encryption_type_t* encryptKeyType)

Verify ECC signature using private key.

Faster that verifying using public key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- privKey – Private key
- data – Hashed data
- dataSize – Hashed data length
- signFirst – First part of the signature
- signSecond – Second part of the signature
- ecdsel – Elliptic curve domain selection
- encryptKeyType – Type of key encryption

Returns
Operation status.

2.15 CAAM HASH driver

enum _caam_hash_algo_t

Supported cryptographic block cipher functions for HASH creation.

Values:

enumerator kCAAM_XcbcMac
XCBC-MAC (AES engine)

enumerator kCAAM_Cmac
CMAC (AES engine)

enumerator kCAAM_Sha1
SHA_1 (MDHA engine)

enumerator kCAAM_Sha224
SHA_224 (MDHA engine)

enumerator kCAAM_Sha256
SHA_256 (MDHA engine)

enumerator kCAAM_Sha384
SHA_384 (MDHA engine)

enumerator kCAAM_Sha512
SHA_512 (MDHA engine)

enumerator kCAAM_HmacSha1
HMAC_SHA_1 (MDHA engine)

enumerator kCAAM_HmacSha224
HMAC_SHA_224 (MDHA engine)

enumerator kCAAM_HmacSha256
HMAC_SHA_256 (MDHA engine)

enumerator kCAAM_HmacSha384
HMAC_SHA_384 (MDHA engine)

enumerator kCAAM_HmacSha512
HMAC_SHA_512 (MDHA engine)

typedef enum *_caam_hash_algo_t* caam_hash_algo_t
Supported cryptographic block cipher functions for HASH creation.

typedef uint32_t caam_hash_ctx_t[83]
Storage type used to save hash context.

status_t CAAM_HASH_Init(CAAM_Type *base, *caam_handle_t* *handle, *caam_hash_ctx_t* *ctx, *caam_hash_algo_t* algo, const uint8_t *key, size_t keySize)
Initialize HASH context.

This function initializes the HASH. Key shall be supplied if the underlaying algoritm is AES XCBC-MAC or CMAC. Key shall be NULL if the underlaying algoritm is SHA.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For MDHA the key length argument is ignored.

This functions is used to initialize the context for both blocking and non-blocking CAAM_HASH API. For blocking CAAM HASH API, the HASH context contains all information required for context switch, such as running hash or MAC. For non-blocking CAAM HASH API, the HASH context is used to hold SGT. Therefore, the HASH context cannot be shared between blocking and non-blocking HASH API. With one HASH context, either use only blocking HASH API or only non-blocking HASH API.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- ctx – **[out]** Output hash context
- algo – Underlaying algorithm to use for hash computation.
- key – Input key (NULL if underlaying algorithm is SHA)
- keySize – Size of input key in bytes

Returns
Status of initialization

status_t CAAM_HASH_Update(*caam_hash_ctx_t* *ctx, const uint8_t *input, size_t inputSize)
Add data to current HASH.

Add data to current HASH. This can be called repeatedly with an arbitrary amount of data to be hashed. The functions blocks. If it returns kStatus_Success, the running hash or mac has been updated (CAAM has processed the input data), so the memory at input pointer can be released back to system. The context is updated with the running hash or mac and with all necessary information to support possible context switch.

Parameters

- ctx – **[inout]** HASH context
- input – Input data
- inputSize – Size of input data in bytes

Returns
Status of the hash update operation

status_t CAAM_HASH_Finish(*caam_hash_ctx_t* *ctx, uint8_t *output, size_t *outputSize)

Finalize hashing.

Outputs the final hash (computed by CAAM_HASH_Update()) and erases the context.

Parameters

- ctx – **[inout]** Input hash context
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

Returns
Status of the hash finish operation

status_t CAAM_HASH(CAAM_Type *base, *caam_handle_t* *handle, *caam_hash_algo_t* algo, const uint8_t *input, size_t inputSize, const uint8_t *key, size_t keySize, uint8_t *output, size_t *outputSize)

Create HASH on given data.

Perform the full keyed XCBC-MAC/CMAC or SHA in one function call.

Key shall be supplied if the underlaying algoritm is AES XCBC-MAC or CMAC. Key shall be NULL if the underlaying algoritm is SHA.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For MDHA the key length argument is ignored.

The function is blocking.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- algo – Underlaying algorithm to use for hash computation.
- input – Input data
- inputSize – Size of input data in bytes
- key – Input key (NULL if underlaying algorithm is SHA)
- keySize – Size of input key in bytes
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

Returns
Status of the one call hash operation.

CAAM_SHA_BLOCK_SIZE

CAAM HASH Context size.

up to SHA-512 block size

CAAM_HASH_BLOCK_SIZE
: CAAM hash block size

CAAM_HASH_CTX_SIZE
: CAAM HASH Context size.

2.16 Caam_driver_hmac

status_t CAAM_HMAC_Init(CAAM_Type *base, *caam_handle_t* *handle, *caam_hash_ctx_t* *ctx, *caam_hash_algo_t* algo, const uint8_t *key, size_t keySize)

Initialize HMAC context.

This function initializes the HMAC.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For MDHA the key length argument is ignored.

This functions is used to initialize the context for both blocking and non-blocking CAAM_HMAC API.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- ctx – **[out]** Output HMAC context
- algo – Underlaying algorithm to use for HMAC computation.
- key – Input key
- keySize – Size of input key in bytes

Returns

Status of initialization

status_t CAAM_HMAC(CAAM_Type *base, *caam_handle_t* *handle, *caam_hash_algo_t* algo, const uint8_t *input, size_t inputSize, const uint8_t *key, size_t keySize, uint8_t *output, size_t *outputSize)

Create Message Authentication Code (MAC) on given data.

Perform the full keyed XCBC-MAC/CMAC, or HMAC-SHA in one function call.

Key shall be supplied if the underlaying algoritm is AES XCBC-MAC, CMAC, or SHA HMAC.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For HMAC, the key can have any size.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- algo – Underlaying algorithm to use for MAC computation.
- input – Input data
- inputSize – Size of input data in bytes
- key – Input key
- keySize – Size of input key in bytes
- output – **[out]** Output MAC data

- outputSize – **[out]** Output parameter storing the size of the output MAC in bytes

Returns
Status of the one call hash operation.

2.17 CAAM PKHA driver

enum _caam_pkha_timing_t
Use of timing equalized version of a PKHA function.

Values:

enumerator kCAAM_PKHA_NoTimingEqualized
Normal version of a PKHA operation

enumerator kCAAM_PKHA_TimingEqualized
Timing-equalized version of a PKHA operation

enum _caam_pkha_f2m_t
Integer vs binary polynomial arithmetic selection.

Values:

enumerator kCAAM_PKHA_IntegerArith
Use integer arithmetic

enumerator kCAAM_PKHA_F2mArith
Use binary polynomial arithmetic

enum _caam_pkha_montgomery_form_t
Montgomery or normal PKHA input format.

Values:

enumerator kCAAM_PKHA_NormalValue
PKHA number is normal integer

enumerator kCAAM_PKHA_MontgomeryFormat
PKHA number is in montgomery format

typedef struct *_caam_pkha_ecc_point_t* caam_pkha_ecc_point_t
PKHA ECC point structure

typedef enum *_caam_pkha_timing_t* caam_pkha_timing_t
Use of timing equalized version of a PKHA function.

typedef enum *_caam_pkha_f2m_t* caam_pkha_f2m_t
Integer vs binary polynomial arithmetic selection.

typedef enum *_caam_pkha_montgomery_form_t* caam_pkha_montgomery_form_t
Montgomery or normal PKHA input format.

int CAAM_PKHA_CompareBigNum(const uint8_t *a, size_t sizeA, const uint8_t *b, size_t sizeB)

status_t CAAM_PKHA_NormalToMontgomery(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *N, size_t sizeN, uint8_t *A, size_t *sizeA, uint8_t *B, size_t *sizeB, uint8_t *R2, size_t *sizeR2, *caam_pkha_timing_t* equalTime, *caam_pkha_f2m_t* arithType)

Converts from integer to Montgomery format.

This function computes R2 mod N and optionally converts A or B into Montgomery format of A or B.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- N – modulus
- sizeN – size of N in bytes
- A – **[inout]** The first input in non-Montgomery format. Output Montgomery format of the first input.
- sizeA – **[inout]** pointer to size variable. On input it holds size of input A in bytes. On output it holds size of Montgomery format of A in bytes.
- B – **[inout]** Second input in non-Montgomery format. Output Montgomery format of the second input.
- sizeB – **[inout]** pointer to size variable. On input it holds size of input B in bytes. On output it holds size of Montgomery format of B in bytes.
- R2 – **[out]** Output Montgomery factor R2 mod N.
- sizeR2 – **[out]** pointer to size variable. On output it holds size of Montgomery factor R2 mod N in bytes.
- equalTime – Run the function time equalized or no timing equalization.
- arithType – Type of arithmetic to perform (integer or F2m)

Returns

Operation status.

status_t CAAM_PKHA_MontgomeryToNormal(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *N, size_t sizeN, uint8_t *A, size_t *sizeA, uint8_t *B, size_t *sizeB, *caam_pkha_timing_t* equalTime, *caam_pkha_f2m_t* arithType)

Converts from Montgomery format to int.

This function converts Montgomery format of A or B into int A or B.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- N – modulus.
- sizeN – size of N modulus in bytes.
- A – **[inout]** Input first number in Montgomery format. Output is non-Montgomery format.
- sizeA – **[inout]** pointer to size variable. On input it holds size of the input A in bytes. On output it holds size of non-Montgomery A in bytes.
- B – **[inout]** Input first number in Montgomery format. Output is non-Montgomery format.
- sizeB – **[inout]** pointer to size variable. On input it holds size of the input B in bytes. On output it holds size of non-Montgomery B in bytes.
- equalTime – Run the function time equalized or no timing equalization.

- arithType – Type of arithmetic to perform (integer or F2m)

Returns
Operation status.

status_t CAAM_PKHA_ModAdd(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *B, size_t sizeB, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType)

Performs modular addition - (A + B) mod N.

This function performs modular addition of (A + B) mod N, with either integer or binary polynomial (F2m) inputs. In the F2m form, this function is equivalent to a bitwise XOR and it is functionally the same as subtraction.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus.
- sizeN – Size of N in bytes.
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

Returns
Operation status.

status_t CAAM_PKHA_ModSub1(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *B, size_t sizeB, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize)

Performs modular subtraction - (A - B) mod N.

This function performs modular subtraction of (A - B) mod N with integer inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes

Returns
Operation status.

status_t CAAM_PKHA_ModSub2(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *B, size_t sizeB, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize)

Performs modular subtraction - (B - A) mod N.

This function performs modular subtraction of (B - A) mod N, with integer inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes

Returns
Operation status.

status_t CAAM_PKHA_ModMul(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *B, size_t sizeB, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType, *caam_pkha_montgomery_form_t* montIn, *caam_pkha_montgomery_form_t* montOut, *caam_pkha_timing_t* equalTime)

Performs modular multiplication - (A x B) mod N.

This function performs modular multiplication with either integer or binary polynomial (F2m) inputs. It can optionally specify whether inputs and/or outputs will be in Montgomery form or not.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus.
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)
- montIn – Format of inputs

- montOut – Format of output
- equalTime – Run the function time equalized or no timing equalization. This argument is ignored for F2m modular multiplication.

Returns
Operation status.

status_t CAAM_PKHA_ModExp(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *N, size_t sizeN, const uint8_t *E, size_t sizeE, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType, *caam_pkha_montgomery_form_t* montIn, *caam_pkha_timing_t* equalTime)

Performs modular exponentiation - (A^E) mod N.

This function performs modular exponentiation with either integer or binary polynomial (F2m) inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- E – exponent
- sizeE – Size of E in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- montIn – Format of A input (normal or Montgomery)
- arithType – Type of arithmetic to perform (integer or F2m)
- equalTime – Run the function time equalized or no timing equalization.

Returns
Operation status.

status_t CAAM_PKHA_ModRed(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType)

Performs modular reduction - (A) mod N.

This function performs modular reduction with either integer or binary polynomial (F2m) inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation

- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

Returns
Operation status.

status_t CAAM_PKHA_ModInv(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType)

Performs modular inversion - (A^-1) mod N.

This function performs modular inversion with either integer or binary polynomial (F2m) inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

Returns
Operation status.

status_t CAAM_PKHA_ModR2(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType)

Computes integer Montgomery factor R^2 mod N.

This function computes a constant to assist in converting operands into the Montgomery residue system representation.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

Returns
Operation status.

status_t CAAM_PKHA_ModGcd(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *N, size_t sizeN, uint8_t *result, size_t *resultSize, *caam_pkha_f2m_t* arithType)

Calculates the greatest common divisor - GCD (A, N).

This function calculates the greatest common divisor of two inputs with either integer or binary polynomial (F2m) inputs.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – first value (must be smaller than or equal to N)
- sizeA – Size of A in bytes
- N – second value (must be non-zero)
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

Returns

Operation status.

status_t CAAM_PKHA_PrimalityTest(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *A, size_t sizeA, const uint8_t *B, size_t sizeB, const uint8_t *N, size_t sizeN, bool *res)

Executes Miller-Rabin primality test.

This function calculates whether or not a candidate prime number is likely to be a prime.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- A – initial random seed
- sizeA – Size of A in bytes
- B – number of trial runs
- sizeB – Size of B in bytes
- N – candidate prime integer
- sizeN – Size of N in bytes
- res – **[out]** True if the value is likely prime or false otherwise

Returns

Operation status.

status_t CAAM_PKHA_ECC_PointAdd(CAAM_Type *base, *caam_handle_t* *handle, const *caam_pkha_ecc_point_t* *A, const *caam_pkha_ecc_point_t* *B, const uint8_t *N, const uint8_t *R2modN, const uint8_t *aCurveParam, const uint8_t *bCurveParam, size_t size, *caam_pkha_f2m_t* arithType, *caam_pkha_ecc_point_t* *result)

Adds elliptic curve points - A + B.

This function performs ECC point addition over a prime field (Fp) or binary field (F2m) using affine coordinates.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.

- A – Left-hand point
- B – Right-hand point
- N – Prime modulus of the field
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAAM_PKHA_ModR2() function).
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (constant)
- size – Size in bytes of curve points and parameters
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

Returns
Operation status.

status_t CAAM_PKHA_ECC_PointDouble(CAAM_Type *base, *caam_handle_t* *handle, const *caam_pkha_ecc_point_t* *B, const uint8_t *N, const uint8_t *aCurveParam, const uint8_t *bCurveParam, size_t size, *caam_pkha_f2m_t* arithType, *caam_pkha_ecc_point_t* *result)

Doubles elliptic curve points - B + B.

This function performs ECC point doubling over a prime field (Fp) or binary field (F2m) using affine coordinates.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- B – Point to double
- N – Prime modulus of the field
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (constant)
- size – Size in bytes of curve points and parameters
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

Returns
Operation status.

status_t CAAM_PKHA_ECC_PointMul(CAAM_Type *base, *caam_handle_t* *handle, const *caam_pkha_ecc_point_t* *A, const uint8_t *E, size_t sizeE, const uint8_t *N, const uint8_t *R2modN, const uint8_t *aCurveParam, const uint8_t *bCurveParam, size_t size, *caam_pkha_timing_t* equalTime, *caam_pkha_f2m_t* arithType, *caam_pkha_ecc_point_t* *result)

Multiplies an elliptic curve point by a scalar - E x (A0, A1).

This function performs ECC point multiplication to multiply an ECC point by a scalar integer multiplier over a prime field (Fp) or a binary field (F2m).

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.

- A – Point as multiplicand
- E – Scalar multiple
- sizeE – The size of E, in bytes
- N – Modulus, a prime number for the Fp field or Irreducible polynomial for F2m field.
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAAM_PKHA_ModR2() function).
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (C parameter for operation over F2m).
- size – Size in bytes of curve points and parameters
- equalTime – Run the function time equalized or no timing equalization.
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

Returns
Operation status.

struct __caam_pkha_ecc_point_t
#include <fsl_caam.h> PKHA ECC point structure

Public Members

uint8_t *X
X coordinate (affine)

uint8_t *Y
Y coordinate (affine)

2.18 CAAM RNG driver

enum __caam_rng_state_handle
CAAM RNG state handle.

Values:

enumerator kCAAM_RngStateHandle0
CAAM RNG state handle 0

enumerator kCAAM_RngStateHandle1
CAAM RNG state handle 1

enum __caam_rng_random_type
Type of random data to generate.

Values:

enumerator kCAAM_RngDataAny
CAAM RNG any random data bytes

enumerator kCAAM_RngDataOddParity
CAAM RNG odd parity random data bytes

enumerator kCAAM_RngDataNonZero
CAAM RNG non zero random data bytes

typedef enum *_caam_rng_state_handle* caam_rng_state_handle_t
CAAM RNG state handle.

typedef enum *_caam_rng_random_type* caam_rng_random_type_t
Type of random data to generate.

typedef uint32_t caam_rng_generic256_t[256 / sizeof(uint32_t)]
256-bit value used as optional additional entropy input

typedef struct *_caam_rng_user_config* caam_rng_config_t
CAAM RNG configuration.

status_t CAAM_RNG_GetDefaultConfig(*caam_rng_config_t* *config)
Initializes user configuration structure to default.

This function initializes the configure structure to default value. the default value are:

```
config->autoReseedInterval = 0;
config->personalString = NULL;
```

Parameters

- config – User configuration structure.

Returns
status of the request

status_t CAAM_RNG_Init(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_state_handle_t* stateHandle, const *caam_rng_config_t* *config)
Instantiate the CAAM RNG state handle.

This function instantiates CAAM RNG state handle. The function is blocking and returns after CAAM has processed the request.

Parameters

- base – CAAM peripheral base address
- handle – CAAM jobRing used for this request
- stateHandle – RNG state handle to instantiate
- config – Pointer to configuration structure.

Returns
Status of the request

status_t CAAM_RNG_Deinit(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_state_handle_t* stateHandle)
Uninstantiate the CAAM RNG state handle.

This function uninstantiates CAAM RNG state handle. The function is blocking and returns after CAAM has processed the request.

Parameters

- base – CAAM peripheral base address
- handle – jobRing used for this request.
- stateHandle – RNG state handle to uninstantiate

Returns
Status of the request

status_t CAAM_RNG_GenerateSecureKey(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_generic256_t* additionalEntropy)

Generate Secure Key.

This function generates random data writes it to Secure Key registers. The function is blocking and returns after CAAM has processed the request. RNG state handle 0 is always used.

Parameters

- base – CAAM peripheral base address
- handle – jobRing used for this request
- additionalEntropy – NULL or Pointer to optional 256-bit additional entropy.

Returns

Status of the request

status_t CAAM_RNG_Reseed(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_state_handle_t* stateHandle, *caam_rng_generic256_t* additionalEntropy)

Reseed the CAAM RNG state handle.

This function reseeds the CAAM RNG state handle. For a state handle in nondeterministic mode, the DRNG is seeded with 384 bits of entropy from the TRNG and an optional 256-bit additional input from the descriptor via the Class 1 Context Register.

The function is blocking and returns after CAAM has processed the request.

Parameters

- base – CAAM peripheral base address
- handle – jobRing used for this request
- stateHandle – RNG state handle to reseed
- additionalEntropy – NULL or Pointer to optional 256-bit additional entropy.

Returns

Status of the request

status_t CAAM_RNG_GetRandomData(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_state_handle_t* stateHandle, uint8_t *data, size_t dataSize, *caam_rng_random_type_t* dataType, *caam_rng_generic256_t* additionalEntropy)

Get random data.

This function gets random data from CAAM RNG.

The function is blocking and returns after CAAM has generated the requested data or an error occurred.

Parameters

- base – CAAM peripheral base address
- handle – jobRing used for this request
- stateHandle – RNG state handle used to generate random data
- data – **[out]** Pointer address used to store random data
- dataSize – Size of the buffer pointed by the data parameter
- dataType – Type of random data to be generated
- additionalEntropy – NULL or Pointer to optional 256-bit additional entropy.

Returns

Status of the request

struct __caam_rng_user_config

#include <fsl_caam.h> CAAM RNG configuration.

Public Members

uint32_t autoReseedInterval

Automatic reseed internal. If set to zero, CAAM RNG will use hardware default interval of 10.000.000 generate requests.

caam_rng_generic256_t *personalString

NULL or pointer to optional personalization string

2.19 Caam_driver_rsa

size_t CAAM_RSA_PrivateExponentSize(*caam_rsa_key_type_t* prvKeyType, uint32_t privExponentSize)

Return size for private key buffer based on encryption type and ecliptic curve domain.

Parameters

- prvKeyType – Type of private key
- privExponentSize – Expected length of private exponent without encryption padding.

Returns

size_t Size for private key buffer.

status_t CAAM_RSA_KeyPair(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *primeP, const uint8_t *primeQ, uint32_t primesSize, const uint8_t *pubExponent, uint32_t pubExponentSize, *caam_rsa_key_type_t* prvKeyType, uint8_t *modulus, uint32_t modulusSize, uint8_t *privExponent, size_t *privExponentSize)

Generates RSA key.

Generates modulus N and private exponent D give prime numbers P and Q and public exponent E. Public key is {E,N}. Private key is {D,N}.

! privExponentSize value may differ for different P abd Q with same bit length. For encrypted privExponent, the buffer size can be determined using CAAM_BLACKEN_ECB_SIZE or CAAM_BLACKEN_CCM_SIZE macros.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- primeP – Prime number P
- primeQ – Prime number Q
- primesSize – Byte length of primeP or primeQ (primeP and primeQ must have the same byte length)
- pubExponent – Public exponent E
- pubExponentSize – Byte length of pubExponent
- prvKeyType – Type of private key
- modulus – **[out]** Buffer for calculated modulus N
- modulusSize – Byte length of modulus buffer

- privExponent – **[out]** Buffer for calculated private exponent D
- privExponentSize – **[out]** Byte length of calculated private exponent.

Returns
Operation status.

status_t CAAM_RSA_Encrypt(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *plainText, uint32_t plainTextSize, const uint8_t *modulus, uint32_t modulusSize, const uint8_t *pubExponent, uint32_t pubExponentSize, *caam_rsa_encryption_type_t* dataOutType, *caam_rsa_format_type_t* format, uint8_t *cipherText)

Performs the RSA public key primitive.

Performs the RSA public key primitive which can be used when encrypting a secret or verifying a signature.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plainText – Input data
- plainTextize – Byte length of the input data
- modulus – Modulus N
- modulusSize – Byte length of modulus
- pubExponent – Public exponent E
- pubExponentSize – Byte length of pubExponent
- dataOutType – Type of encryption of output data
- cipherText – **[out]** Buffer for RSA encrypted data

Returns
Operation status

status_t CAAM_RSA_Decrypt(CAAM_Type *base, *caam_handle_t* *handle, const uint8_t *cipherText, const uint8_t *modulus, uint32_t modulusSize, const uint8_t *privExponent, uint32_t privExponentSize, *caam_rsa_encryption_type_t* prvKeyType, *caam_rsa_encryption_type_t* dataOutType, *caam_rsa_format_type_t* format, uint8_t *plainText, size_t *rsaDecSize)

Performs the RSA private key primitive.

Performs the RSA private key primitive which can be used when decrypting a secret or creating a siganture.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- cipherText – Input data
- modulus – Moulus N
- modulusSize – Byte length of modulus
- privExponent – Private exponent D
- privExponentSize – Byte length of privExponent
- prvKeyType – Type of private key encryption

- dataOutType – Type of encryption of output data
- plainText – **[out]** Buffer for RSA encrypted data
- rsaDecSize – **[out]** Returned output size

Returns
Operation status

2.20 CAAM Blocking APIs

2.21 CAAM Non-blocking APIs

2.22 CAAM Non-blocking AES driver

status_t CAAM_AES_EncryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ecb_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *key, size_t keySize)

Encrypts AES using the ECB block mode.

Puts AES ECB encrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns
Status from job descriptor push

status_t CAAM_AES_DecryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ecb_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *key, size_t keySize)

Decrypts AES using ECB block mode.

Puts AES ECB decrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.

- key – Input key.
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns
Status from job descriptor push

status_t CAAM_AES_EncryptEcbNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ecb_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Encrypts AES using the ECB block mode using black key.

Puts AES ECB encrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- plaintext – Input plain text to encrypt
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns
Status from job descriptor push

status_t CAAM_AES_DecryptEcbNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ecb_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Decrypts AES using ECB block mode using black key.

Puts AES ECB decrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- key – Input key.
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns
Status from job descriptor push

status_t CAAM_AES_EncryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_cbc_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, const uint8_t *key, size_t keySize)

Encrypts AES using CBC block mode.

Puts AES CBC encrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns
Status from job descriptor push

status_t CAAM_AES_DecryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_cbc_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, const uint8_t *key, size_t keySize)

Decrypts AES using CBC block mode.

Puts AES CBC decrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns
Status from job descriptor push

status_t CAAM_AES_EncryptCbcNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_cbc_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Encrypts AES using CBC block mode using black key.

Puts AES CBC encrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns

Status from job descriptor push

status_t CAAM_AES_DecryptCbcNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_cbc_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, const uint8_t *key, size_t keySize, *caam_key_type_t* blackKeyType)

Decrypts AES using CBC block mode using black key.

Puts AES CBC decrypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- blackKeyType – Type of black key

Returns

Status from job descriptor push

status_t CAAM_AES_CryptCtrNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ctr_t* descriptor, const uint8_t *input, uint8_t *output, size_t size, uint8_t *counter, const uint8_t *key, size_t keySize, uint8_t *counterlast, size_t *szLeft)

Encrypts or decrypts AES using CTR block mode.

Encrypts or decrypts AES using CTR block mode. AES CTR mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Puts AES CTR crypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- input – Input data for CTR block mode
- output – **[out]** Output data for CTR block mode
- size – Size of input and output data in bytes
- counter – **[inout]** Input counter (updates on return)
- key – Input key to use for forward AES cipher
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- counterlast – **[out]** Output cipher of last counter, for chained CTR calls. NULL can be passed if chained calls are not used.
- szLeft – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.

Returns

Status from job descriptor push

status_t CAAM_AES_CryptCtrNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ctr_t* descriptor, const uint8_t *input, uint8_t *output, size_t size, uint8_t *counter, const uint8_t *key, size_t keySize, uint8_t *counterlast, size_t *szLeft, *caam_key_type_t* blackKeyType)

Encrypts or decrypts AES using CTR block mode using black key.

Encrypts or decrypts AES using CTR block mode. AES CTR mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Puts AES CTR crypt descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- input – Input data for CTR block mode
- output – **[out]** Output data for CTR block mode
- size – Size of input and output data in bytes
- counter – **[inout]** Input counter (updates on return)

- key – Input key to use for forward AES cipher
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- counterlast – **[out]** Output cipher of last counter, for chained CTR calls. NULL can be passed if chained calls are not used.
- szLeft – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.
- blackKeyType – Type of black key

Returns

Status from job descriptor push

status_t CAAM_AES_EncryptTagCcmNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ccm_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize)

Encrypts AES and tags using CCM block mode.

Puts AES CCM encrypt and tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes. Zero means authentication only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication skipped).
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Generated output tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.

Returns

Status from job descriptor push

status_t CAAM_AES_DecryptTagCcmNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ccm_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize)

Decrypts AES and authenticates using CCM block mode.

Puts AES CCM decrypt and check tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes. Zero means authentication data only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication data skipped).
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Received tag. Set to NULL to skip tag processing.
- tagSize – Input size of the received tag to compare with the computed tag, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.

Returns

Status from job descriptor push

status_t CAAM_AES_EncryptTagCcmNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ccm_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Encrypts AES and tags using CCM block mode using black key.

Puts AES CCM encrypt and tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes. Zero means authentication only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.

- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication skipped).
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Generated output tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.
- blackKeyType – Type of black key

Returns
Status from job descriptor push

status_t CAAM_AES_DecryptTagCcmNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_ccm_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Decrypts AES and authenticates using CCM block mode using black key.

Puts AES CCM decrypt and check tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes. Zero means authentication data only.
- iv – Nonce
- ivSize – Length of the Nonce in bytes. Must be 7, 8, 9, 10, 11, 12, or 13.
- aad – Input additional authentication data. Can be NULL if aadSize is zero.
- aadSize – Input size in bytes of AAD. Zero means data mode only (authentication data skipped).
- key – Input key to use for decryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Received tag. Set to NULL to skip tag processing.
- tagSize – Input size of the received tag to compare with the computed tag, in bytes. Must be 4, 6, 8, 10, 12, 14, or 16.
- blackKeyType – Type of black key

Returns
Status from job descriptor push

status_t CAAM_AES_EncryptTagGcmNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_gcm_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize)

Encrypts AES and tags using GCM block mode.

Encrypts AES and optionally tags using GCM block mode. If plaintext is NULL, only the GHASH is calculated and output in the 'tag' field. Puts AES GCM encrypt and tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Output hash tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4,8,12,13,14,15 or 16.

Returns

Status from job descriptor push

status_t CAAM_AES_DecryptTagGcmNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_gcm_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize)

Decrypts AES and authenticates using GCM block mode.

Decrypts AES and optionally authenticates using GCM block mode. If ciphertext is NULL, only the GHASH is calculated and compared with the received GHASH in 'tag' field. Puts AES GCM decrypt and check tag descriptor to CAAM input job ring.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt

- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Input hash tag to compare. Set to NULL to skip tag processing.
- tagSize – Input size of the tag, in bytes. Must be 4, 8, 12, 13, 14, 15, or 16.

Returns

Status from job descriptor push

status_t CAAM_AES_EncryptTagGcmNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_gcm_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Encrypts AES and tags using GCM block mode using black key.

Encrypts AES and optionally tags using GCM block mode. If plaintext is NULL, only the GHASH is calculated and output in the 'tag' field. Puts AES GCM encrypt and tag descriptor to CAAM input job ring. Uses black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – **[out]** Output hash tag. Set to NULL to skip tag processing.
- tagSize – Input size of the tag to generate, in bytes. Must be 4,8,12,13,14,15 or 16.
- blackenKeyType – Type of black key

Returns
Status from job descriptor push

status_t CAAM_AES_DecryptTagGcmNonBlockingExtended(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_aes_gcm_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad, size_t aadSize, const uint8_t *key, size_t keySize, const uint8_t *tag, size_t tagSize, *caam_key_type_t* blackKeyType)

Decrypts AES and authenticates using GCM block mode using black key.

Decrypts AES and optionally authenticates using GCM block mode. If ciphertext is NULL, only the GHASH is calculated and compared with the received GHASH in 'tag' field. Puts AES GCM decrypt and check tag descriptor to CAAM input job ring. Uses black key.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** Memory for the CAAM descriptor.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text.
- size – Size of input and output data in bytes
- iv – Input initial vector
- ivSize – Size of the IV
- aad – Input additional authentication data
- aadSize – Input size in bytes of AAD
- key – Input key to use for encryption
- keySize – Size of the input key, in bytes. Must be 16, 24, or 32.
- tag – Input hash tag to compare. Set to NULL to skip tag processing.
- tagSize – Input size of the tag, in bytes. Must be 4, 8, 12, 13, 14, 15, or 16.
- blackenKeyType – Type of black key

Returns
Status from job descriptor push

2.23 CAAM Non-blocking DES driver

status_t CAAM_DES_EncryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key[8U])

Encrypts DES using ECB block mode.

Encrypts DES using ECB block mode.

Parameters

- base – CAAM peripheral base address

- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key – Input key to use for encryption

Returns
Status from descriptor push

status_t CAAM_DES_DecryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key[8U])

Decrypts DES using ECB block mode.

Decrypts DES using ECB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key – Input key to use for decryption

Returns
Status from descriptor push

status_t CAAM_DES_EncryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using CBC block mode.

Encrypts DES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Ouput ciphertext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key – Input key to use for encryption

Returns
Status from descriptor push

status_t CAAM_DES_DecryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using CBC block mode.

Decrypts DES using CBC block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key – Input key to use for decryption

Returns

Status from descriptor push

status_t CAAM_DES_EncryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using CFB block mode.

Encrypts DES using CFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- size – Size of input data in bytes
- iv – Input initial block.
- key – Input key to use for encryption
- ciphertext – **[out]** Output ciphertext

Returns

Status from descriptor push

status_t CAAM_DES_DecryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using CFB block mode.

Decrypts DES using CFB block mode.

Parameters

- base – CAAM peripheral base address

- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key – Input key to use for decryption

Returns
Status from descriptor push

status_t CAAM_DES_EncryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Encrypts DES using OFB block mode.

Encrypts DES using OFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key – Input key to use for encryption

Returns
Status from descriptor push

status_t CAAM_DES_DecryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key[8U])

Decrypts DES using OFB block mode.

Decrypts DES using OFB block mode.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.

- key – Input key to use for decryption

Returns
Status from descriptor push

status_t CAAM_DES2_EncryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using ECB block mode with two keys.

Encrypts triple DES using ECB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES2_DecryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using ECB block mode with two keys.

Decrypts triple DES using ECB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES2_EncryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using CBC block mode with two keys.

Encrypts triple DES using CBC block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES2_DecryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using CBC block mode with two keys.

Decrypts triple DES using CBC block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES2_EncryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using CFB block mode with two keys.

Encrypts triple DES using CFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.

- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES2_DecryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using CFB block mode with two keys.

Decrypts triple DES using CFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES2_EncryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Encrypts triple DES using OFB block mode with two keys.

Encrypts triple DES using OFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes

- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES2_DecryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U])

Decrypts triple DES using OFB block mode with two keys.

Decrypts triple DES using OFB block mode with two keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES3_EncryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using ECB block mode with three keys.

Encrypts triple DES using ECB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES3_DecryptEcbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using ECB block mode with three keys.

Decrypts triple DES using ECB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes. Must be multiple of 8 bytes.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES3_EncryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using CBC block mode with three keys.

Encrypts triple DES using CBC block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns
Status from descriptor push

status_t CAAM_DES3_DecryptCbcNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using CBC block mode with three keys.

Decrypts triple DES using CBC block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input initial vector to combine with the first plaintext block. The iv does not need to be secret, but it must be unpredictable.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES3_EncryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using CFB block mode with three keys.

Encrypts triple DES using CFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and ouput data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES3_DecryptCfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using CFB block mode with three keys.

Decrypts triple DES using CFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input data in bytes
- iv – Input initial block.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES3_EncryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Encrypts triple DES using OFB block mode with three keys.

Encrypts triple DES using OFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- plaintext – Input plaintext to encrypt
- ciphertext – **[out]** Output ciphertext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from descriptor push

status_t CAAM_DES3_DecryptOfbNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_cipher_des_t* descriptor, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[8], const uint8_t key1[8U], const uint8_t key2[8U], const uint8_t key3[8U])

Decrypts triple DES using OFB block mode with three keys.

Decrypts triple DES using OFB block mode with three keys.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request. Specifies jobRing.
- descriptor – **[out]** memory for CAAM commands
- ciphertext – Input ciphertext to decrypt
- plaintext – **[out]** Output plaintext
- size – Size of input and output data in bytes
- iv – Input unique input vector. The OFB mode requires that the IV be unique for each execution of the mode under the given key.
- key1 – First input key for key bundle
- key2 – Second input key for key bundle
- key3 – Third input key for key bundle

Returns

Status from descriptor push

2.24 CAAM Non-blocking HASH driver

status_t CAAM_HASH_UpdateNonBlocking(*caam_hash_ctx_t* *ctx, const uint8_t *input, size_t inputSize)

Add input address and size to input data table.

Add data input pointer to a table maintained internally in the context. Each call of this function creates one entry in the table. The entry consists of the input pointer and inputSize. All entries created by one or multiple calls of this function can be processed in one call to CAAM_HASH_FinishNonBlocking() function. Individual entries can point to non-continuous data in the memory. The processing will occur in the order in which the CAAM_HASH_UpdateNonBlocking() have been called.

Memory pointers will be later accessed by CAAM (at time of CAAM_HASH_FinishNonBlocking()), so the memory must stay valid until CAAM_HASH_FinishNonBlocking() has been called and CAAM completes the processing.

Parameters

- ctx – **[inout]** HASH context
- input – Input data
- inputSize – Size of input data in bytes

Returns

Status of the hash update operation

status_t CAAM_HASH_FinishNonBlocking(*caam_hash_ctx_t* *ctx, *caam_desc_hash_t* descriptor, uint8_t *output, size_t *outputSize)

Finalize hashing.

The actual algorithm is computed with all input data, the memory pointers are accessed by CAAM after the function returns. The input data chunks have been specified by prior calls to CAAM_HASH_UpdateNonBlocking(). The function schedules the request at CAAM, then returns. After a while, when the CAAM completes processing of the input data chunks, the result is written to the output[] array, outputSize is written and the context is cleared.

Parameters

- ctx – **[inout]** Input hash context
- descriptor – **[out]** Memory for the CAAM descriptor.
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

Returns

Status of the hash finish operation

status_t CAAM_HASH_NonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_hash_t* descriptor, *caam_hash_algo_t* algo, const uint8_t *input, size_t inputSize, const uint8_t *key, size_t keySize, uint8_t *output, size_t *outputSize)

Create HASH on given data.

Perform the full keyed XCBC-MAC/CMAC or SHA in one function call.

Key shall be supplied if the underlaying algoritm is AES XCBC-MAC or CMAC. Key shall be NULL if the underlaying algoritm is SHA.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For MDHA the key length argument is ignored.

The function is non-blocking. The request is scheduled at CAAM.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- descriptor – **[out]** Memory for the CAAM descriptor.
- algo – Underlaying algorithm to use for hash computation.
- input – Input data
- inputSize – Size of input data in bytes
- key – Input key (NULL if underlaying algorithm is SHA)
- keySize – Size of input key in bytes
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

Returns

Status of the one call hash operation.

2.25 Caam_nonblocking_driver_hmac

status_t CAAM_HMAC_NonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_desc_hash_t* descriptor, *caam_hash_algo_t* algo, const uint8_t *input, size_t inputSize, const uint8_t *key, size_t keySize, uint8_t *output, size_t *outputSize)

Create Message Authentication Code (MAC) on given data.

Perform the full keyed XCBC-MAC/CMAC, or HMAC-SHA in one function call.

Key shall be supplied if the underlaying algoritm is AES XCBC-MAC, CMAC, or SHA HMAC.

For XCBC-MAC, the key length must be 16. For CMAC, the key length can be the AES key lengths supported by AES engine. For HMAC, the key can have any size, however the function will block if the supplied key is bigger than the block size of the underlying hashing algorithm (e.g. >64 bytes for SHA256).

The function is not blocking with the exception of supplying large key sizes. In that case the function will block until the large key is hashed down with the supplied hashing algorithm (as per FIPS 198-1), after which operation is resumed to calling non-blocking HMAC.

Parameters

- base – CAAM peripheral base address
- handle – Handle used for this request.
- descriptor – **[out]** Memory for the CAAM descriptor.
- algo – Underlaying algorithm to use for MAC computation.
- input – Input data
- inputSize – Size of input data in bytes
- key – Input key
- keySize – Size of input key in bytes
- output – **[out]** Output MAC data
- outputSize – **[out]** Output parameter storing the size of the output MAC in bytes

Returns

Status of the one call hash operation.

2.26 CAAM Non-blocking RNG driver

status_t CAAM_RNG_GetRandomDataNonBlocking(CAAM_Type *base, *caam_handle_t* *handle, *caam_rng_state_handle_t* stateHandle, *caam_desc_rng_t* descriptor, void *data, size_t dataSize, *caam_rng_random_type_t* dataType, *caam_rng_generic256_t* additionalEntropy)

Request random data.

This function schedules the request for random data from CAAM RNG. Memory at memory pointers will be accessed by CAAM shortly after this function returns, according to actual CAAM schedule.

Parameters

- base – CAAM peripheral base address

- handle – RNG handle used for this request
- stateHandle – RNG state handle used to generate random data
- descriptor – **[out]** memory for CAAM commands
- data – **[out]** Pointer address used to store random data
- dataSize – Size of the buffer pointed by the data parameter, in bytes.
- dataType – Type of random data to be generated.
- additionalEntropy – NULL or Pointer to optional 256-bit additional entropy.

Returns
status of the request

2.27 CACHE: ARMV7-M7 CACHE Memory Controller

static inline void L1CACHE_EnableICache(void)
Enables cortex-m7 L1 instruction cache.

static inline void L1CACHE_DisableICache(void)
Disables cortex-m7 L1 instruction cache.

static inline void L1CACHE_InvalidateICache(void)
Invalidate cortex-m7 L1 instruction cache.

void L1CACHE_InvalidateICacheByRange(uint32_t address, uint32_t size_byte)
Invalidate cortex-m7 L1 instruction cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1ICACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 I-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be invalidated.
- size_byte – The memory size.

static inline void L1CACHE_EnableDCache(void)
Enables cortex-m7 L1 data cache.

static inline void L1CACHE_DisableDCache(void)
Disables cortex-m7 L1 data cache.

static inline void L1CACHE_InvalidateDCache(void)
Invalidates cortex-m7 L1 data cache.

static inline void L1CACHE_CleanDCache(void)
Cleans cortex-m7 L1 data cache.

static inline void L1CACHE_CleanInvalidateDCache(void)
Cleans and Invalidates cortex-m7 L1 data cache.

static inline void L1CACHE_InvalidateDCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be invalidated.
- size_byte – The memory size.

static inline void L1CACHE_CleanDCacheByRange(uint32_t address, uint32_t size_byte)

Cleans cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be cleaned.
- size_byte – The memory size.

static inline void L1CACHE_CleanInvalidateDCacheByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be clean and invalidated.
- size_byte – The memory size.

void ICACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)

Invalidates all instruction caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)

Invalidates all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)

Cleans all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned.

void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned and invalidated.

FSL_CACHE_DRIVER_VERSION

cache driver version 2.0.4.

2.28 CACHE: LMEM CACHE Memory Controller

void L1CACHE_EnableCodeCache(void)

Enables the processor code bus cache.

void L1CACHE_DisableCodeCache(void)

Disables the processor code bus cache.

void L1CACHE_InvalidateCodeCache(void)

Invalidates the processor code bus cache.

void L1CACHE_InvalidateCodeCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates processor code bus cache by range.

Note: Address and size should be aligned to "L1CODCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1CODEBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be invalidated.

void L1CACHE_CleanCodeCache(void)

Cleans the processor code bus cache.

void L1CACHE_CleanCodeCacheByRange(uint32_t address, uint32_t size_byte)

Cleans processor code bus cache by range.

Note: Address and size should be aligned to "L1CODEBUSCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1CODEBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be cleaned.

void L1CACHE_CleanInvalidateCodeCache(void)

Cleans and invalidates the processor code bus cache.

void L1CACHE_CleanInvalidateCodeCacheByRange(uint32_t address, uint32_t size_byte)

Cleans and invalidate processor code bus cache by range.

Note: Address and size should be aligned to "L1CODEBUSCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1CODEBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be Cleaned and Invalidated.

static inline void L1CACHE_EnableCodeCacheWriteBuffer(bool enable)

Enables/disables the processor code bus write buffer.

Parameters

- enable – The enable or disable flag. true - enable the code bus write buffer. false - disable the code bus write buffer.

void L1CACHE_EnableSystemCache(void)

Enables the processor system bus cache.

void L1CACHE_DisableSystemCache(void)

Disables the processor system bus cache.

void L1CACHE_InvalidateSystemCache(void)

Invalidates the processor system bus cache.

void L1CACHE_InvalidateSystemCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates processor system bus cache by range.

Note: Address and size should be aligned to "L1SYSTEMBUSCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1SYSTEMBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be invalidated.

void L1CACHE_CleanSystemCache(void)

Cleans the processor system bus cache.

void L1CACHE_CleanSystemCacheByRange(uint32_t address, uint32_t size_byte)

Cleans processor system bus cache by range.

Note: Address and size should be aligned to "L1SYSTEMBUSCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1SYSTEMBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be cleaned.

void L1CACHE_CleanInvalidateSystemCache(void)

Cleans and invalidates the processor system bus cache.

void L1CACHE_CleanInvalidateSystemCacheByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates processor system bus cache by range.

Note: Address and size should be aligned to "L1SYSTEMBUSCACHE_LINESIZE_BYTE". The startAddr here will be forced to align to L1SYSTEMBUSCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be Clean and Invalidated.

static inline void L1CACHE_EnableSystemCacheWriteBuffer(bool enable)

Enables/disables the processor system bus write buffer.

Parameters

- enable – The enable or disable flag. true - enable the code bus write buffer. false - disable the code bus write buffer.

void L1CACHE_InvalidateICacheByRange(uint32_t address, uint32_t size_byte)

Invalidates cortex-m4 L1 instrument cache by range.

Note: The start address and size_byte should be 16-Byte(FSL_FEATURE_L1ICACHE_LINESIZE_BYTE) aligned.

Parameters

- address – The start address of the memory to be invalidated.
- size_byte – The memory size.

static inline void L1CACHE_InvalidateDCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates cortex-m4 L1 data cache by range.

Note: The start address and size_byte should be 16-Byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned.

Parameters

- address – The start address of the memory to be invalidated.
- size_byte – The memory size.

void L1CACHE_CleanDCacheByRange(uint32_t address, uint32_t size_byte)

Cleans cortex-m4 L1 data cache by range.

Note: The start address and size_byte should be 16-Byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned.

Parameters

- address – The start address of the memory to be cleaned.
- size_byte – The memory size.

void L1CACHE_CleanInvalidateDCacheByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates cortex-m4 L1 data cache by range.

Note: The start address and size_byte should be 16-Byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned.

Parameters

- address – The start address of the memory to be clean and invalidated.

- size_byte – The memory size.

static inline void ICACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)

Invalidates instruction cache by range.

Note: Address and size should be aligned to 16-Byte due to the cache operation unit FSL_FEATURE_L1ICACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

static inline void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)

Invalidates data cache by range.

Note: Address and size should be aligned to 16-Byte due to the cache operation unit FSL_FEATURE_L1DCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

static inline void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)

Clean data cache by range.

Note: Address and size should be aligned to 16-Byte due to the cache operation unit FSL_FEATURE_L1DCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned.

static inline void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates data cache by range.

Note: Address and size should be aligned to 16-Byte due to the cache operation unit FSL_FEATURE_L1DCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be Cleaned and Invalidated.

FSL_CACHE_DRIVER_VERSION
cache driver version.

L1CODEBUSCACHE_LINESIZE_BYTE
code bus cache line size is equal to system bus line size, so the unified I/D cache line size equals too.

The code bus CACHE line size is 16B = 128b.

L1SYSTEMBUSCACHE_LINESIZE_BYTE
The system bus CACHE line size is 16B = 128b.

2.29 CDOG

status_t CDOG_Init(CDOG_Type *base, *cdog_config_t* *conf)
Initialize CDOG.

This function initializes CDOG block and setting.

Parameters

- base – CDOG peripheral base address
- conf – CDOG configuration structure

Returns
Status of the init operation

void CDOG_Deinit(CDOG_Type *base)
Deinitialize CDOG.

This function deinitializes CDOG secure counter.

Parameters

- base – CDOG peripheral base address

void CDOG_GetDefaultConfig(*cdog_config_t* *conf)
Sets the default configuration of CDOG.

This function initialize CDOG config structure to default values.

Parameters

- conf – CDOG configuration structure

void CDOG_Stop(CDOG_Type *base, uint32_t stop)
Stops secure counter and instruction timer.

This function stops instruction timer and secure counter. This also change state od CDOG to IDLE.

Parameters

- base – CDOG peripheral base address
- stop – expected value which will be compared with value of secure counter

void CDOG_Start(CDOG_Type *base, uint32_t reload, uint32_t start)
Sets secure counter and instruction timer values.

This function sets value in RELOAD and START registers for instruction timer and secure counter

Parameters

- base – CDOG peripheral base address

- reload – reload value
- start – start value

void CDOG_Check(CDOG_Type *base, uint32_t check)

Checks secure counter.

This function compares stop value in handler with secure counter value by writting to RELOAD refister.

Parameters

- base – CDOG peripheral base address
- check – expected (stop) value

void CDOG_Set(CDOG_Type *base, uint32_t stop, uint32_t reload, uint32_t start)

Sets secure counter and instruction timer values.

This function sets value in STOP, RELOAD and START registers for instruction timer and secure counter.

Parameters

- base – CDOG peripheral base address
- stop – expected value which will be compared with value of secure counter
- reload – reload value for instruction timer
- start – start value for secure timer

void CDOG_Add(CDOG_Type *base, uint32_t add)

Add value to secure counter.

This function add specified value to secure counter.

Parameters

- base – CDOG peripheral base address.
- add – Value to be added.

void CDOG_Add1(CDOG_Type *base)

Add 1 to secure counter.

This function add 1 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Add16(CDOG_Type *base)

Add 16 to secure counter.

This function add 16 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Add256(CDOG_Type *base)

Add 256 to secure counter.

This function add 256 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub(CDOG_Type *base, uint32_t sub)

brief Substract value to secure counter

This function substract specified value to secure counter.

param base CDOG peripheral base address. param sub Value to be substracted.

void CDOG_Sub1(CDOG_Type *base)

Substract 1 from secure counter.

This function substract specified 1 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub16(CDOG_Type *base)

Substract 16 from secure counter.

This function substract specified 16 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub256(CDOG_Type *base)

Substract 256 from secure counter.

This function substract specified 256 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_WritePersistent(CDOG_Type *base, uint32_t value)

Set the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.
- value – The value to be written.

uint32_t CDOG_ReadPersistent(CDOG_Type *base)

Get the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.

Returns

The persistent word.

FSL_CDOG_DRIVER_VERSION

Defines CDOG driver version 2.1.3.

Change log:

- Version 2.1.3
  - Re-design multiple instance IRQs and Clocks
  - Add fix for RESTART command errata
- Version 2.1.2
  - Support multiple IRQs
  - Fix default CONTROL values
- Version 2.1.1

- Remove bit CONTROL[CONTROL_CTRL]

- Version 2.1.0
  - Rename CWT to CDOG
- Version 2.0.2
  - Fix MISRA-2012 issues
- Version 2.0.1
  - Fix doxygen issues
- Version 2.0.0
  - initial version

enum ___cdog__debug__Action__ctrl__enum

Values:

enumerator kCDOG__DebugHaltCtrl__Run

enumerator kCDOG__DebugHaltCtrl__Pause

enum ___cdog__irq__pause__ctrl__enum

Values:

enumerator kCDOG__IrqPauseCtrl__Run

enumerator kCDOG__IrqPauseCtrl__Pause

enum ___cdog__fault__ctrl__enum

Values:

enumerator kCDOG__FaultCtrl__EnableReset

enumerator kCDOG__FaultCtrl__EnableInterrupt

enumerator kCDOG__FaultCtrl__NoAction

enum ___code__lock__ctrl__enum

Values:

enumerator kCDOG__LockCtrl__Lock

enumerator kCDOG__LockCtrl__Unlock

typedef uint32_t secure__counter__t

SC__ADD(add)

SC__ADD1

SC__ADD16

SC__ADD256

SC__SUB(sub)

SC__SUB1

SC__SUB16

SC__SUB256

SC__CHECK(val)

struct cdog__config__t

#include <fsl_cdog.h>

2.30 Clock Driver

enum _clock_lpcg

Clock LPCG index.

Values:

enumerator kCLOCK_M7

Clock LPCG M7.

enumerator kCLOCK_M4

Clock LPCG M4.

enumerator kCLOCK_Sim_M7

Clock LPCG SIM M7.

enumerator kCLOCK_Sim_M

Clock LPCG SIM M4.

enumerator kCLOCK_Sim_Disp

Clock LPCG SIM DISP.

enumerator kCLOCK_Sim_Per

Clock LPCG SIM PER.

enumerator kCLOCK_Sim_Lpsr

Clock LPCG SIM LPSR.

enumerator kCLOCK_Anadig

Clock LPCG Anadig.

enumerator kCLOCK_Dcdc

Clock LPCG DCDC.

enumerator kCLOCK_Src

Clock LPCG SRC.

enumerator kCLOCK_Ccm

Clock LPCG CCM.

enumerator kCLOCK_Gpc

Clock LPCG GPC.

enumerator kCLOCK_Ssarc

Clock LPCG SSARC.

enumerator kCLOCK_Sim_R

Clock LPCG SIM_R.

enumerator kCLOCK_Wdog1

Clock LPCG WDOG1.

enumerator kCLOCK_Wdog2

Clock LPCG WDOG2.

enumerator kCLOCK_Wdog3

Clock LPCG WDOG3.

enumerator kCLOCK_Wdog4

Clock LPCG WDOG4.

enumerator kCLOCK_Ewm0

Clock LPCG EWM0.

enumerator kCLOCK_Sema
Clock LPCG SEMA.

enumerator kCLOCK_Mu_A
Clock LPCG MU_A.

enumerator kCLOCK_Mu_B
Clock LPCG MU_B.

enumerator kCLOCK_Edma
Clock LPCG EDMA.

enumerator kCLOCK_Edma_Lpsr
Clock LPCG EDMA_LPSR.

enumerator kCLOCK_Romcp
Clock LPCG ROMCP.

enumerator kCLOCK_Ocram
Clock LPCG OCRAM.

enumerator kCLOCK_Flexram
Clock LPCG FLEXRAM.

enumerator kCLOCK_Lmem
Clock LPCG Lmem.

enumerator kCLOCK_Flexspi1
Clock LPCG Flexspi1.

enumerator kCLOCK_Flexspi2
Clock LPCG Flexspi2.

enumerator kCLOCK_Rdc
Clock LPCG RDC.

enumerator kCLOCK_M7_Xrdc
Clock LPCG M7 XRDC.

enumerator kCLOCK_M4_Xrdc
Clock LPCG M4 XRDC.

enumerator kCLOCK_Semc
Clock LPCG SEMC.

enumerator kCLOCK_Xecc
Clock LPCG XECC.

enumerator kCLOCK_Iee
Clock LPCG IEE.

enumerator kCLOCK_Key_Manager
Clock LPCG KEY_MANAGER.

enumerator kCLOCK_Puf
Clock LPCG PUF.

enumerator kCLOCK_Ocotp
Clock LPCG OSOTP.

enumerator kCLOCK_Snvs_Hp
Clock LPCG SNVS_HP.

enumerator kCLOCK_Snvs
Clock LPCG SNVS.

enumerator kCLOCK_Caam
Clock LPCG Caam.

enumerator kCLOCK_Jtag_Mux
Clock LPCG JTAG_MUX.

enumerator kCLOCK_Cstrace
Clock LPCG CSTRACE.

enumerator kCLOCK_Xbar1
Clock LPCG XBAR1.

enumerator kCLOCK_Xbar2
Clock LPCG XBAR2.

enumerator kCLOCK_Xbar3
Clock LPCG XBAR3.

enumerator kCLOCK_Aoi1
Clock LPCG AOI1.

enumerator kCLOCK_Aoi2
Clock LPCG AOI2.

enumerator kCLOCK_Adc_Etc
Clock LPCG ADC_ETC.

enumerator kCLOCK_Iomuxc
Clock LPCG IOMUXC.

enumerator kCLOCK_Iomuxc_Lpsr
Clock LPCG IOMUXC_LPSR.

enumerator kCLOCK_Gpio
Clock LPCG GPIO.

enumerator kCLOCK_Kpp
Clock LPCG KPP.

enumerator kCLOCK_Flexio1
Clock LPCG FLEXIO1.

enumerator kCLOCK_Flexio2
Clock LPCG FLEXIO2.

enumerator kCLOCK_Lpadc1
Clock LPCG LPADC1.

enumerator kCLOCK_Lpadc2
Clock LPCG LPADC2.

enumerator kCLOCK_Dac
Clock LPCG DAC.

enumerator kCLOCK_Acmp1
Clock LPCG ACMP1.

enumerator kCLOCK_Acmp2
Clock LPCG ACMP2.

enumerator kCLOCK_Acmp3
Clock LPCG ACMP3.

enumerator kCLOCK_Acmp4
Clock LPCG ACMP4.

enumerator kCLOCK_Pit1
Clock LPCG PIT1.

enumerator kCLOCK_Pit2
Clock LPCG PIT2.

enumerator kCLOCK_Gpt1
Clock LPCG GPT1.

enumerator kCLOCK_Gpt2
Clock LPCG GPT2.

enumerator kCLOCK_Gpt3
Clock LPCG GPT3.

enumerator kCLOCK_Gpt4
Clock LPCG GPT4.

enumerator kCLOCK_Gpt5
Clock LPCG GPT5.

enumerator kCLOCK_Gpt6
Clock LPCG GPT6.

enumerator kCLOCK_Qtimer1
Clock LPCG QTIMER1.

enumerator kCLOCK_Qtimer2
Clock LPCG QTIMER2.

enumerator kCLOCK_Qtimer3
Clock LPCG QTIMER3.

enumerator kCLOCK_Qtimer4
Clock LPCG QTIMER4.

enumerator kCLOCK_Enc1
Clock LPCG Enc1.

enumerator kCLOCK_Enc2
Clock LPCG Enc2.

enumerator kCLOCK_Enc3
Clock LPCG Enc3.

enumerator kCLOCK_Enc4
Clock LPCG Enc4.

enumerator kCLOCK_Hrtimer
Clock LPCG Hrtimer.

enumerator kCLOCK_Pwm1
Clock LPCG PWM1.

enumerator kCLOCK_Pwm2
Clock LPCG PWM2.

enumerator kCLOCK_Pwm3
Clock LPCG PWM3.

enumerator kCLOCK_Pwm4
Clock LPCG PWM4.

enumerator kCLOCK_Can1
Clock LPCG CAN1.

enumerator kCLOCK_Can2
Clock LPCG CAN2.

enumerator kCLOCK_Can3
Clock LPCG CAN3.

enumerator kCLOCK_Lpuart1
Clock LPCG LPUART1.

enumerator kCLOCK_Lpuart2
Clock LPCG LPUART2.

enumerator kCLOCK_Lpuart3
Clock LPCG LPUART3.

enumerator kCLOCK_Lpuart4
Clock LPCG LPUART4.

enumerator kCLOCK_Lpuart5
Clock LPCG LPUART5.

enumerator kCLOCK_Lpuart6
Clock LPCG LPUART6.

enumerator kCLOCK_Lpuart7
Clock LPCG LPUART7.

enumerator kCLOCK_Lpuart8
Clock LPCG LPUART8.

enumerator kCLOCK_Lpuart9
Clock LPCG LPUART9.

enumerator kCLOCK_Lpuart10
Clock LPCG LPUART10.

enumerator kCLOCK_Lpuart11
Clock LPCG LPUART11.

enumerator kCLOCK_Lpuart12
Clock LPCG LPUART12.

enumerator kCLOCK_Lpi2c1
Clock LPCG LPI2C1.

enumerator kCLOCK_Lpi2c2
Clock LPCG LPI2C2.

enumerator kCLOCK_Lpi2c3
Clock LPCG LPI2C3.

enumerator kCLOCK_Lpi2c4
Clock LPCG LPI2C4.

enumerator kCLOCK_Lpi2c5
Clock LPCG LPI2C5.

enumerator kCLOCK_Lpi2c6
Clock LPCG LPI2C6.

enumerator kCLOCK_Lpspi1
Clock LPCG LPSPI1.

enumerator kCLOCK_Lpspi2
Clock LPCG LPSPI2.

enumerator kCLOCK_Lpspi3
Clock LPCG LPSPI3.

enumerator kCLOCK_Lpspi4
Clock LPCG LPSPI4.

enumerator kCLOCK_Lpspi5
Clock LPCG LPSPI5.

enumerator kCLOCK_Lpspi6
Clock LPCG LPSPI6.

enumerator kCLOCK_Sim1
Clock LPCG SIM1.

enumerator kCLOCK_Sim2
Clock LPCG SIM2.

enumerator kCLOCK_Enet
Clock LPCG ENET.

enumerator kCLOCK_Enet_1g
Clock LPCG ENET 1G.

enumerator kCLOCK_Enet_Qos
Clock LPCG ENET QOS.

enumerator kCLOCK_Usb
Clock LPCG USB.

enumerator kCLOCK_Cdog
Clock LPCG CDOG.

enumerator kCLOCK_Usdhc1
Clock LPCG USDHC1.

enumerator kCLOCK_Usdhc2
Clock LPCG USDHC2.

enumerator kCLOCK_Asrc
Clock LPCG ASRC.

enumerator kCLOCK_Mqs
Clock LPCG MQS.

enumerator kCLOCK_Pdm
Clock LPCG PDM.

enumerator kCLOCK_Spdif
Clock LPCG SPDIF.

enumerator kCLOCK_Sai1
Clock LPCG SAI1.

enumerator kCLOCK_Sai2
Clock LPCG SAI2.

enumerator kCLOCK_Sai3
Clock LPCG SAI3.

enumerator kCLOCK_Sai4
Clock LPCG SAI4.

enumerator kCLOCK_Pxp
Clock LPCG PXP.

enumerator kCLOCK_Gpu2d
Clock LPCG GPU2D.

enumerator kCLOCK_Lcdif
Clock LPCG LCDIF.

enumerator kCLOCK_Lcdifv2
Clock LPCG LCDIFV2.

enumerator kCLOCK_Mipi_Dsi
Clock LPCG MIPI DSI.

enumerator kCLOCK_Mipi_Csi
Clock LPCG MIPI CSI.

enumerator kCLOCK_Csi
Clock LPCG CSI.

enumerator kCLOCK_Dcic_Mipi
Clock LPCG DCIC MIPI.

enumerator kCLOCK_Dcic_Lcd
Clock LPCG DCIC LCD.

enumerator kCLOCK_Video_Mux
Clock LPCG VIDEO MUX.

enumerator kCLOCK_Uniq_Edt_I
Clock LPCG Uniq_Edt_I.

enumerator kCLOCK_IpInvalid
Invalid value.

enum _clock_name
Clock name.

Values:

enumerator kCLOCK_OscRc16M
16MHz RC Oscillator.

enumerator kCLOCK_OscRc48M
48MHz RC Oscillator.

enumerator kCLOCK_OscRc48MDiv2
48MHz RC Oscillator Div2.

enumerator kCLOCK_OscRc400M
400MHz RC Oscillator.

enumerator kCLOCK_Osc24M
24MHz Oscillator.

enumerator kCLOCK_Osc24MOut
48MHz Oscillator Out.

enumerator kCLOCK_ArmPll
ARM PLL.

enumerator kCLOCK_ArmPllOut
ARM PLL Out.

enumerator kCLOCK_SysPll2
SYS PLL2.

enumerator kCLOCK_SysPll2Out
SYS PLL2 OUT.

enumerator kCLOCK_SysPll2Pfd0
SYS PLL2 PFD0.

enumerator kCLOCK_SysPll2Pfd1
SYS PLL2 PFD1.

enumerator kCLOCK_SysPll2Pfd2
SYS PLL2 PFD2.

enumerator kCLOCK_SysPll2Pfd3
SYS PLL2 PFD3.

enumerator kCLOCK_SysPll3
SYS PLL3.

enumerator kCLOCK_SysPll3Out
SYS PLL3 OUT.

enumerator kCLOCK_SysPll3Div2
SYS PLL3 DIV2

enumerator kCLOCK_SysPll3Pfd0
SYS PLL3 PFD0.

enumerator kCLOCK_SysPll3Pfd1
SYS PLL3 PFD1

enumerator kCLOCK_SysPll3Pfd2
SYS PLL3 PFD2

enumerator kCLOCK_SysPll3Pfd3
SYS PLL3 PFD3

enumerator kCLOCK_SysPll1
SYS PLL1.

enumerator kCLOCK_SysPll1Out
SYS PLL1 OUT.

enumerator kCLOCK_SysPll1Div2
SYS PLL1 DIV2.

enumerator kCLOCK_SysPll1Div5
SYS PLL1 DIV5.

enumerator kCLOCK_AudioPll
SYS AUDIO PLL.

enumerator kCLOCK_AudioPllOut
SYS AUDIO PLL OUT.

enumerator kCLOCK_VideoPll
SYS VIDEO PLL.

enumerator kCLOCK_VideoPllOut
SYS VIDEO PLL OUT.

enumerator kCLOCK_CpuClk
SYS CPU CLK.

enumerator kCLOCK_CoreSysClk
SYS CORE SYS CLK.

enum _clock_root
Root clock index.

Values:

enumerator kCLOCK_Root_M7
CLOCK Root M7.

enumerator kCLOCK_Root_M4
CLOCK Root M4.

enumerator kCLOCK_Root_Bus
CLOCK Root Bus.

enumerator kCLOCK_Root_Bus_Lpsr
CLOCK Root Bus Lpsr.

enumerator kCLOCK_Root_Semc
CLOCK Root Semc.

enumerator kCLOCK_Root_Cssys
CLOCK Root Cssys.

enumerator kCLOCK_Root_Cstrace
CLOCK Root Cstrace.

enumerator kCLOCK_Root_M4_Systick
CLOCK Root M4 Systick.

enumerator kCLOCK_Root_M7_Systick
CLOCK Root M7 Systick.

enumerator kCLOCK_Root_Adc1
CLOCK Root Adc1.

enumerator kCLOCK_Root_Adc2
CLOCK Root Adc2.

enumerator kCLOCK_Root_Acmp
CLOCK Root Acmp.

enumerator kCLOCK_Root_Flexio1
CLOCK Root Flexio1.

enumerator kCLOCK_Root_Flexio2
CLOCK Root Flexio2.

enumerator kCLOCK_Root_Gpt1
CLOCK Root Gpt1.

enumerator kCLOCK_Root_Gpt2
CLOCK Root Gpt2.

enumerator kCLOCK_Root_Gpt3
CLOCK Root Gpt3.

enumerator kCLOCK_Root_Gpt4
CLOCK Root Gpt4.

enumerator kCLOCK_Root_Gpt5
CLOCK Root Gpt5.

enumerator kCLOCK_Root_Gpt6
CLOCK Root Gpt6.

enumerator kCLOCK_Root_Flexspi1
CLOCK Root Flexspi1.

enumerator kCLOCK_Root_Flexspi2
CLOCK Root Flexspi2.

enumerator kCLOCK_Root_Can1
CLOCK Root Can1.

enumerator kCLOCK_Root_Can2
CLOCK Root Can2.

enumerator kCLOCK_Root_Can3
CLOCK Root Can3.

enumerator kCLOCK_Root_Lpuart1
CLOCK Root Lpuart1.

enumerator kCLOCK_Root_Lpuart2
CLOCK Root Lpuart2.

enumerator kCLOCK_Root_Lpuart3
CLOCK Root Lpuart3.

enumerator kCLOCK_Root_Lpuart4
CLOCK Root Lpuart4.

enumerator kCLOCK_Root_Lpuart5
CLOCK Root Lpuart5.

enumerator kCLOCK_Root_Lpuart6
CLOCK Root Lpuart6.

enumerator kCLOCK_Root_Lpuart7
CLOCK Root Lpuart7.

enumerator kCLOCK_Root_Lpuart8
CLOCK Root Lpuart8.

enumerator kCLOCK_Root_Lpuart9
CLOCK Root Lpuart9.

enumerator kCLOCK_Root_Lpuart10
CLOCK Root Lpuart10.

enumerator kCLOCK_Root_Lpuart11
CLOCK Root Lpuart11.

enumerator kCLOCK_Root_Lpuart12
CLOCK Root Lpuart12.

enumerator kCLOCK_Root_Lpi2c1
CLOCK Root Lpi2c1.

enumerator kCLOCK_Root_Lpi2c2
CLOCK Root Lpi2c2.

enumerator kCLOCK_Root_Lpi2c3
CLOCK Root Lpi2c3.

enumerator kCLOCK_Root_Lpi2c4
CLOCK Root Lpi2c4.

enumerator kCLOCK_Root_Lpi2c5
CLOCK Root Lpi2c5.

enumerator kCLOCK_Root_Lpi2c6
CLOCK Root Lpi2c6.

enumerator kCLOCK_Root_Lpspi1
CLOCK Root Lpspi1.

enumerator kCLOCK_Root_Lpspi2
CLOCK Root Lpspi2.

enumerator kCLOCK_Root_Lpspi3
CLOCK Root Lpspi3.

enumerator kCLOCK_Root_Lpspi4
CLOCK Root Lpspi4.

enumerator kCLOCK_Root_Lpspi5
CLOCK Root Lpspi5.

enumerator kCLOCK_Root_Lpspi6
CLOCK Root Lpspi6.

enumerator kCLOCK_Root_Emv1
CLOCK Root Emv1.

enumerator kCLOCK_Root_Emv2
CLOCK Root Emv2.

enumerator kCLOCK_Root_Enet1
CLOCK Root Enet1.

enumerator kCLOCK_Root_Enet2
CLOCK Root Enet2.

enumerator kCLOCK_Root_Enet_Qos
CLOCK Root Enet Qos.

enumerator kCLOCK_Root_Enet_25m
CLOCK Root Enet 25M.

enumerator kCLOCK_Root_Enet_Timer1
CLOCK Root Enet Timer1.

enumerator kCLOCK_Root_Enet_Timer2
CLOCK Root Enet Timer2.

enumerator kCLOCK_Root_Enet_Timer3
CLOCK Root Enet Timer3.

enumerator kCLOCK_Root_Usdhc1
CLOCK Root Usdhc1.

enumerator kCLOCK_Root_Usdhc2
CLOCK Root Usdhc2.

enumerator kCLOCK_Root_Asrc
CLOCK Root Asrc.

enumerator kCLOCK_Root_Mqs
CLOCK Root Mqs.

enumerator kCLOCK_Root_Mic
CLOCK Root MIC.

enumerator kCLOCK_Root_Spdif
CLOCK Root Spdif

enumerator kCLOCK_Root_Sai1
CLOCK Root Sai1.

enumerator kCLOCK_Root_Sai2
CLOCK Root Sai2.

enumerator kCLOCK_Root_Sai3
CLOCK Root Sai3.

enumerator kCLOCK_Root_Sai4
CLOCK Root Sai4.

enumerator kCLOCK_Root_Gc355
CLOCK Root Gc355.

enumerator kCLOCK_Root_Lcdif
CLOCK Root Lcdif.

enumerator kCLOCK_Root_Lcdifv2
CLOCK Root Lcdifv2.

enumerator kCLOCK_Root_Mipi_Ref
CLOCK Root Mipi Ref.

enumerator kCLOCK_Root_Mipi_Esc
CLOCK Root Mipi Esc.

enumerator kCLOCK_Root_Csi2
CLOCK Root Csi2.

enumerator kCLOCK_Root_Csi2_Esc
CLOCK Root Csi2 Esc.

enumerator kCLOCK_Root_Csi2_Ui
CLOCK Root Csi2 Ui.

enumerator kCLOCK_Root_Csi
CLOCK Root Csi.

enumerator kCLOCK_Root_Cko1
CLOCK Root CKo1.

enumerator kCLOCK_Root_Cko2
CLOCK Root CKo2.

enum _clock_root_mux_source
The enumerator of clock roots' clock source mux value.

Values:

enumerator kCLOCK_M7_ClockRoot_MuxOscRc48MDiv2
M7 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_M7_ClockRoot_MuxOsc24MOut
M7 mux from MuxOsc24MOut.

enumerator kCLOCK_M7_ClockRoot_MuxOscRc400M
M7 mux from MuxOscRc400M.

enumerator kCLOCK_M7_ClockRoot_MuxOscRc16M
M7 mux from MuxOscRc16M.

enumerator kCLOCK_M7_ClockRoot_MuxArmPllOut
M7 mux from MuxArmPllOut.

enumerator kCLOCK_M7_ClockRoot_MuxSysPll1Out
M7 mux from MuxSysPll1Out.

enumerator kCLOCK_M7_ClockRoot_MuxSysPll3Out
M7 mux from MuxSysPll3Out.

enumerator kCLOCK_M7_ClockRoot_MuxVideoPllOut
M7 mux from MuxVideoPllOut.

enumerator kCLOCK_M4_ClockRoot_MuxOscRc48MDiv2
M4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_M4_ClockRoot_MuxOsc24MOut
M4 mux from MuxOsc24MOut.

enumerator kCLOCK_M4_ClockRoot_MuxOscRc400M
M4 mux from MuxOscRc400M.

enumerator kCLOCK_M4_ClockRoot_MuxOscRc16M
M4 mux from MuxOscRc16M.

enumerator kCLOCK_M4_ClockRoot_MuxSysPll3Pfd3
M4 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_M4_ClockRoot_MuxSysPll3Out
M4 mux from MuxSysPll3Out.

enumerator kCLOCK_M4_ClockRoot_MuxSysPll2Out
M4 mux from MuxSysPll2Out.

enumerator kCLOCK_M4_ClockRoot_MuxSysPll1Div5
M4 mux from MuxSysPll1Div5.

enumerator kCLOCK_BUS_ClockRoot_MuxOscRc48MDiv2
BUS mux from MuxOscRc48MDiv2.

enumerator kCLOCK_BUS_ClockRoot_MuxOsc24MOut
BUS mux from MuxOsc24MOut.

enumerator kCLOCK_BUS_ClockRoot_MuxOscRc400M
BUS mux from MuxOscRc400M.

enumerator kCLOCK_BUS_ClockRoot_MuxOscRc16M
BUS mux from MuxOscRc16M.

enumerator kCLOCK_BUS_ClockRoot_MuxSysPll3Out
BUS mux from MuxSysPll3Out.

enumerator kCLOCK_BUS_ClockRoot_MuxSysPll1Div5
BUS mux from MuxSysPll1Div5.

enumerator kCLOCK_BUS_ClockRoot_MuxSysPll2Out
BUS mux from MuxSysPll2Out.

enumerator kCLOCK_BUS_ClockRoot_MuxSysPll2Pfd3
BUS mux from MuxSysPll2Pfd3.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxOscRc48MDiv2
BUS_LPSR mux from MuxOscRc48MDiv2.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxOsc24MOut
BUS_LPSR mux from MuxOsc24MOut.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxOscRc400M
BUS_LPSR mux from MuxOscRc400M.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxOscRc16M
BUS_LPSR mux from MuxOscRc16M.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxSysPll3Pfd3
BUS_LPSR mux from MuxSysPll3Pfd3.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxSysPll3Out
BUS_LPSR mux from MuxSysPll3Out.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxSysPll2Out
BUS_LPSR mux from MuxSysPll2Out.

enumerator kCLOCK_BUS_LPSR_ClockRoot_MuxSysPll1Div5
BUS_LPSR mux from MuxSysPll1Div5.

enumerator kCLOCK_SEMC_ClockRoot_MuxOscRc48MDiv2
SEMC mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SEMC_ClockRoot_MuxOsc24MOut
SEMC mux from MuxOsc24MOut.

enumerator kCLOCK_SEMC_ClockRoot_MuxOscRc400M
SEMC mux from MuxOscRc400M.

enumerator kCLOCK_SEMC_ClockRoot_MuxOscRc16M
SEMC mux from MuxOscRc16M.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll1Div5
SEMC mux from MuxSysPll1Div5.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll2Out
SEMC mux from MuxSysPll2Out.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll2Pfd1
SEMC mux from MuxSysPll2Pfd1.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll3Pfd0
SEMC mux from MuxSysPll3Pfd0.

enumerator kCLOCK_CSSYS_ClockRoot_MuxOscRc48MDiv2
CSSYS mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSSYS_ClockRoot_MuxOsc24MOut
CSSYS mux from MuxOsc24MOut.

enumerator kCLOCK_CSSYS_ClockRoot_MuxOscRc400M
CSSYS mux from MuxOscRc400M.

enumerator kCLOCK_CSSYS_ClockRoot_MuxOscRc16M
CSSYS mux from MuxOscRc16M.

enumerator kCLOCK_CSSYS_ClockRoot_MuxSysPll3Div2
CSSYS mux from MuxSysPll3Div2.

enumerator kCLOCK_CSSYS_ClockRoot_MuxSysPll1Div5
CSSYS mux from MuxSysPll1Div5.

enumerator kCLOCK_CSSYS_ClockRoot_MuxSysPll2Out
CSSYS mux from MuxSysPll2Out.

enumerator kCLOCK_CSSYS_ClockRoot_MuxSysPll2Pfd3
CSSYS mux from MuxSysPll2Pfd3.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxOscRc48MDiv2
CSTRACE mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxOsc24MOut
CSTRACE mux from MuxOsc24MOut.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxOscRc400M
CSTRACE mux from MuxOscRc400M.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxOscRc16M
CSTRACE mux from MuxOscRc16M.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxSysPll3Div2
CSTRACE mux from MuxSysPll3Div2.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxSysPll1Div5
CSTRACE mux from MuxSysPll1Div5.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxSysPll2Pfd1
CSTRACE mux from MuxSysPll2Pfd1.

enumerator kCLOCK_CSTRACE_ClockRoot_MuxSysPll2Out
CSTRACE mux from MuxSysPll2Out.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxOscRc48MDiv2
M4_SYSTICK mux from MuxOscRc48MDiv2.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxOsc24MOut
M4_SYSTICK mux from MuxOsc24MOut.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxOscRc400M
M4_SYSTICK mux from MuxOscRc400M.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxOscRc16M
M4_SYSTICK mux from MuxOscRc16M.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxSysPll3Pfd3
M4_SYSTICK mux from MuxSysPll3Pfd3.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxSysPll3Out
M4_SYSTICK mux from MuxSysPll3Out.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxSysPll2Pfd0
M4_SYSTICK mux from MuxSysPll2Pfd0.

enumerator kCLOCK_M4_SYSTICK_ClockRoot_MuxSysPll1Div5
M4_SYSTICK mux from MuxSysPll1Div5.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOscRc48MDiv2
M7_SYSTICK mux from MuxOscRc48MDiv2.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOsc24MOut
M7_SYSTICK mux from MuxOsc24MOut.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOscRc400M
M7_SYSTICK mux from MuxOscRc400M.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOscRc16M
M7_SYSTICK mux from MuxOscRc16M.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxSysPll2Out
M7_SYSTICK mux from MuxSysPll2Out.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxSysPll3Div2
M7_SYSTICK mux from MuxSysPll3Div2.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxSysPll1Div5
M7_SYSTICK mux from MuxSysPll1Div5.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxSysPll2Pfd0
M7_SYSTICK mux from MuxSysPll2Pfd0.

enumerator kCLOCK_ADC1_ClockRoot_MuxOscRc48MDiv2
ADC1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ADC1_ClockRoot_MuxOsc24MOut
ADC1 mux from MuxOsc24MOut.

enumerator kCLOCK_ADC1_ClockRoot_MuxOscRc400M
ADC1 mux from MuxOscRc400M.

enumerator kCLOCK_ADC1_ClockRoot_MuxOscRc16M
ADC1 mux from MuxOscRc16M.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll3Div2
ADC1 mux from MuxSysPll3Div2.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll1Div5
ADC1 mux from MuxSysPll1Div5.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll2Out
ADC1 mux from MuxSysPll2Out.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll2Pfd3
ADC1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_ADC2_ClockRoot_MuxOscRc48MDiv2
ADC2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ADC2_ClockRoot_MuxOsc24MOut
ADC2 mux from MuxOsc24MOut.

enumerator kCLOCK_ADC2_ClockRoot_MuxOscRc400M
ADC2 mux from MuxOscRc400M.

enumerator kCLOCK_ADC2_ClockRoot_MuxOscRc16M
ADC2 mux from MuxOscRc16M.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll3Div2
ADC2 mux from MuxSysPll3Div2.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll1Div5
ADC2 mux from MuxSysPll1Div5.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll2Out
ADC2 mux from MuxSysPll2Out.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll2Pfd3
ADC2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_ACMP_ClockRoot_MuxOscRc48MDiv2
ACMP mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ACMP_ClockRoot_MuxOsc24MOut
ACMP mux from MuxOsc24MOut.

enumerator kCLOCK_ACMP_ClockRoot_MuxOscRc400M
ACMP mux from MuxOscRc400M.

enumerator kCLOCK_ACMP_ClockRoot_MuxOscRc16M
ACMP mux from MuxOscRc16M.

enumerator kCLOCK_ACMP_ClockRoot_MuxSysPll3Out
ACMP mux from MuxSysPll3Out.

enumerator kCLOCK_ACMP_ClockRoot_MuxSysPll1Div5
ACMP mux from MuxSysPll1Div5.

enumerator kCLOCK_ACMP_ClockRoot_MuxAudioPllOut
ACMP mux from MuxAudioPllOut.

enumerator kCLOCK_ACMP_ClockRoot_MuxSysPll2Pfd3
ACMP mux from MuxSysPll2Pfd3.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOscRc48MDiv2
FLEXIO1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOsc24MOut
FLEXIO1 mux from MuxOsc24MOut.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOscRc400M
FLEXIO1 mux from MuxOscRc400M.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOscRc16M
FLEXIO1 mux from MuxOscRc16M.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll3Div2
FLEXIO1 mux from MuxSysPll3Div2.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll1Div5
FLEXIO1 mux from MuxSysPll1Div5.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll2Out
FLEXIO1 mux from MuxSysPll2Out.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll2Pfd3
FLEXIO1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOscRc48MDiv2
FLEXIO2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOsc24MOut
FLEXIO2 mux from MuxOsc24MOut.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOscRc400M
FLEXIO2 mux from MuxOscRc400M.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOscRc16M
FLEXIO2 mux from MuxOscRc16M.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll3Div2
FLEXIO2 mux from MuxSysPll3Div2.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll1Div5
FLEXIO2 mux from MuxSysPll1Div5.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll2Out
FLEXIO2 mux from MuxSysPll2Out.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll2Pfd3
FLEXIO2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_GPT1_ClockRoot_MuxOscRc48MDiv2
GPT1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT1_ClockRoot_MuxOsc24MOut
GPT1 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT1_ClockRoot_MuxOscRc400M
GPT1 mux from MuxOscRc400M.

enumerator kCLOCK_GPT1_ClockRoot_MuxOscRc16M
GPT1 mux from MuxOscRc16M.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll3Div2
GPT1 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll1Div5
GPT1 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll3Pfd2
GPT1 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll3Pfd3
GPT1 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_GPT2_ClockRoot_MuxOscRc48MDiv2
GPT2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT2_ClockRoot_MuxOsc24MOut
GPT2 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT2_ClockRoot_MuxOscRc400M
GPT2 mux from MuxOscRc400M.

enumerator kCLOCK_GPT2_ClockRoot_MuxOscRc16M
GPT2 mux from MuxOscRc16M.

enumerator kCLOCK_GPT2_ClockRoot_MuxSysPll3Div2
GPT2 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT2_ClockRoot_MuxSysPll1Div5
GPT2 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT2_ClockRoot_MuxAudioPllOut
GPT2 mux from MuxAudioPllOut.

enumerator kCLOCK_GPT2_ClockRoot_MuxVideoPllOut
GPT2 mux from MuxVideoPllOut.

enumerator kCLOCK_GPT3_ClockRoot_MuxOscRc48MDiv2
GPT3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT3_ClockRoot_MuxOsc24MOut
GPT3 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT3_ClockRoot_MuxOscRc400M
GPT3 mux from MuxOscRc400M.

enumerator kCLOCK_GPT3_ClockRoot_MuxOscRc16M
GPT3 mux from MuxOscRc16M.

enumerator kCLOCK_GPT3_ClockRoot_MuxSysPll3Div2
GPT3 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT3_ClockRoot_MuxSysPll1Div5
GPT3 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT3_ClockRoot_MuxAudioPllOut
GPT3 mux from MuxAudioPllOut.

enumerator kCLOCK_GPT3_ClockRoot_MuxVideoPllOut
GPT3 mux from MuxVideoPllOut.

enumerator kCLOCK_GPT4_ClockRoot_MuxOscRc48MDiv2
GPT4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT4_ClockRoot_MuxOsc24MOut
GPT4 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT4_ClockRoot_MuxOscRc400M
GPT4 mux from MuxOscRc400M.

enumerator kCLOCK_GPT4_ClockRoot_MuxOscRc16M
GPT4 mux from MuxOscRc16M.

enumerator kCLOCK_GPT4_ClockRoot_MuxSysPll3Div2
GPT4 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT4_ClockRoot_MuxSysPll1Div5
GPT4 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT4_ClockRoot_MuxSysPll3Pfd2
GPT4 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_GPT4_ClockRoot_MuxSysPll3Pfd3
GPT4 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_GPT5_ClockRoot_MuxOscRc48MDiv2
GPT5 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT5_ClockRoot_MuxOsc24MOut
GPT5 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT5_ClockRoot_MuxOscRc400M
GPT5 mux from MuxOscRc400M.

enumerator kCLOCK_GPT5_ClockRoot_MuxOscRc16M
GPT5 mux from MuxOscRc16M.

enumerator kCLOCK_GPT5_ClockRoot_MuxSysPll3Div2
GPT5 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT5_ClockRoot_MuxSysPll1Div5
GPT5 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT5_ClockRoot_MuxSysPll3Pfd2
GPT5 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_GPT5_ClockRoot_MuxSysPll3Pfd3
GPT5 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_GPT6_ClockRoot_MuxOscRc48MDiv2
GPT6 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GPT6_ClockRoot_MuxOsc24MOut
GPT6 mux from MuxOsc24MOut.

enumerator kCLOCK_GPT6_ClockRoot_MuxOscRc400M
GPT6 mux from MuxOscRc400M.

enumerator kCLOCK_GPT6_ClockRoot_MuxOscRc16M
GPT6 mux from MuxOscRc16M.

enumerator kCLOCK_GPT6_ClockRoot_MuxSysPll3Div2
GPT6 mux from MuxSysPll3Div2.

enumerator kCLOCK_GPT6_ClockRoot_MuxSysPll1Div5
GPT6 mux from MuxSysPll1Div5.

enumerator kCLOCK_GPT6_ClockRoot_MuxSysPll3Pfd2
GPT6 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_GPT6_ClockRoot_MuxSysPll3Pfd3
GPT6 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOscRc48MDiv2
FLEXSPI1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOsc24MOut
FLEXSPI1 mux from MuxOsc24MOut.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOscRc400M
FLEXSPI1 mux from MuxOscRc400M.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOscRc16M
FLEXSPI1 mux from MuxOscRc16M.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll3Pfd0
FLEXSPI1 mux from MuxSysPll3Pfd0.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll2Out
FLEXSPI1 mux from MuxSysPll2Out.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll2Pfd2
FLEXSPI1 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll3Out
FLEXSPI1 mux from MuxSysPll3Out.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOscRc48MDiv2
FLEXSPI2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOsc24MOut
FLEXSPI2 mux from MuxOsc24MOut.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOscRc400M
FLEXSPI2 mux from MuxOscRc400M.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOscRc16M
FLEXSPI2 mux from MuxOscRc16M.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll3Pfd0
FLEXSPI2 mux from MuxSysPll3Pfd0.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll2Out
FLEXSPI2 mux from MuxSysPll2Out.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll2Pfd2
FLEXSPI2 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll3Out
FLEXSPI2 mux from MuxSysPll3Out.

enumerator kCLOCK_CAN1_ClockRoot_MuxOscRc48MDiv2
CAN1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CAN1_ClockRoot_MuxOsc24MOut
CAN1 mux from MuxOsc24MOut.

enumerator kCLOCK_CAN1_ClockRoot_MuxOscRc400M
CAN1 mux from MuxOscRc400M.

enumerator kCLOCK_CAN1_ClockRoot_MuxOscRc16M
CAN1 mux from MuxOscRc16M.

enumerator kCLOCK_CAN1_ClockRoot_MuxSysPll3Div2
CAN1 mux from MuxSysPll3Div2.

enumerator kCLOCK_CAN1_ClockRoot_MuxSysPll1Div5
CAN1 mux from MuxSysPll1Div5.

enumerator kCLOCK_CAN1_ClockRoot_MuxSysPll2Out
CAN1 mux from MuxSysPll2Out.

enumerator kCLOCK_CAN1_ClockRoot_MuxSysPll2Pfd3
CAN1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_CAN2_ClockRoot_MuxOscRc48MDiv2
CAN2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CAN2_ClockRoot_MuxOsc24MOut
CAN2 mux from MuxOsc24MOut.

enumerator kCLOCK_CAN2_ClockRoot_MuxOscRc400M
CAN2 mux from MuxOscRc400M.

enumerator kCLOCK_CAN2_ClockRoot_MuxOscRc16M
CAN2 mux from MuxOscRc16M.

enumerator kCLOCK_CAN2_ClockRoot_MuxSysPll3Div2
CAN2 mux from MuxSysPll3Div2.

enumerator kCLOCK_CAN2_ClockRoot_MuxSysPll1Div5
CAN2 mux from MuxSysPll1Div5.

enumerator kCLOCK_CAN2_ClockRoot_MuxSysPll2Out
CAN2 mux from MuxSysPll2Out.

enumerator kCLOCK_CAN2_ClockRoot_MuxSysPll2Pfd3
CAN2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_CAN3_ClockRoot_MuxOscRc48MDiv2
CAN3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CAN3_ClockRoot_MuxOsc24MOut
CAN3 mux from MuxOsc24MOut.

enumerator kCLOCK_CAN3_ClockRoot_MuxOscRc400M
CAN3 mux from MuxOscRc400M.

enumerator kCLOCK_CAN3_ClockRoot_MuxOscRc16M
CAN3 mux from MuxOscRc16M.

enumerator kCLOCK_CAN3_ClockRoot_MuxSysPll3Pfd3
CAN3 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_CAN3_ClockRoot_MuxSysPll3Out
CAN3 mux from MuxSysPll3Out.

enumerator kCLOCK_CAN3_ClockRoot_MuxSysPll2Pfd3
CAN3 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_CAN3_ClockRoot_MuxSysPll1Div5
CAN3 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART1_ClockRoot_MuxOscRc48MDiv2
LPUART1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART1_ClockRoot_MuxOsc24MOut
LPUART1 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART1_ClockRoot_MuxOscRc400M
LPUART1 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART1_ClockRoot_MuxOscRc16M
LPUART1 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART1_ClockRoot_MuxSysPll3Div2
LPUART1 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART1_ClockRoot_MuxSysPll1Div5
LPUART1 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART1_ClockRoot_MuxSysPll2Out
LPUART1 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART1_ClockRoot_MuxSysPll2Pfd3
LPUART1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART2_ClockRoot_MuxOscRc48MDiv2
LPUART2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART2_ClockRoot_MuxOsc24MOut
LPUART2 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART2_ClockRoot_MuxOscRc400M
LPUART2 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART2_ClockRoot_MuxOscRc16M
LPUART2 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART2_ClockRoot_MuxSysPll3Div2
LPUART2 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART2_ClockRoot_MuxSysPll1Div5
LPUART2 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART2_ClockRoot_MuxSysPll2Out
LPUART2 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART2_ClockRoot_MuxSysPll2Pfd3
LPUART2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART3_ClockRoot_MuxOscRc48MDiv2
LPUART3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART3_ClockRoot_MuxOsc24MOut
LPUART3 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART3_ClockRoot_MuxOscRc400M
LPUART3 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART3_ClockRoot_MuxOscRc16M
LPUART3 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART3_ClockRoot_MuxSysPll3Div2
LPUART3 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART3_ClockRoot_MuxSysPll1Div5
LPUART3 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART3_ClockRoot_MuxSysPll2Out
LPUART3 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART3_ClockRoot_MuxSysPll2Pfd3
LPUART3 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART4_ClockRoot_MuxOscRc48MDiv2
LPUART4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART4_ClockRoot_MuxOsc24MOut
LPUART4 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART4_ClockRoot_MuxOscRc400M
LPUART4 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART4_ClockRoot_MuxOscRc16M
LPUART4 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART4_ClockRoot_MuxSysPll3Div2
LPUART4 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART4_ClockRoot_MuxSysPll1Div5
LPUART4 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART4_ClockRoot_MuxSysPll2Out
LPUART4 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART4_ClockRoot_MuxSysPll2Pfd3
LPUART4 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART5_ClockRoot_MuxOscRc48MDiv2
LPUART5 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART5_ClockRoot_MuxOsc24MOut
LPUART5 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART5_ClockRoot_MuxOscRc400M
LPUART5 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART5_ClockRoot_MuxOscRc16M
LPUART5 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART5_ClockRoot_MuxSysPll3Div2
LPUART5 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART5_ClockRoot_MuxSysPll1Div5
LPUART5 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART5_ClockRoot_MuxSysPll2Out
LPUART5 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART5_ClockRoot_MuxSysPll2Pfd3
LPUART5 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART6_ClockRoot_MuxOscRc48MDiv2
LPUART6 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART6_ClockRoot_MuxOsc24MOut
LPUART6 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART6_ClockRoot_MuxOscRc400M
LPUART6 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART6_ClockRoot_MuxOscRc16M
LPUART6 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART6_ClockRoot_MuxSysPll3Div2
LPUART6 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART6_ClockRoot_MuxSysPll1Div5
LPUART6 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART6_ClockRoot_MuxSysPll2Out
LPUART6 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART6_ClockRoot_MuxSysPll2Pfd3
LPUART6 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART7_ClockRoot_MuxOscRc48MDiv2
LPUART7 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART7_ClockRoot_MuxOsc24MOut
LPUART7 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART7_ClockRoot_MuxOscRc400M
LPUART7 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART7_ClockRoot_MuxOscRc16M
LPUART7 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART7_ClockRoot_MuxSysPll3Div2
LPUART7 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART7_ClockRoot_MuxSysPll1Div5
LPUART7 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART7_ClockRoot_MuxSysPll2Out
LPUART7 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART7_ClockRoot_MuxSysPll2Pfd3
LPUART7 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART8_ClockRoot_MuxOscRc48MDiv2
LPUART8 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART8_ClockRoot_MuxOsc24MOut
LPUART8 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART8_ClockRoot_MuxOscRc400M
LPUART8 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART8_ClockRoot_MuxOscRc16M
LPUART8 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART8_ClockRoot_MuxSysPll3Div2
LPUART8 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART8_ClockRoot_MuxSysPll1Div5
LPUART8 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART8_ClockRoot_MuxSysPll2Out
LPUART8 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART8_ClockRoot_MuxSysPll2Pfd3
LPUART8 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART9_ClockRoot_MuxOscRc48MDiv2
LPUART9 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART9_ClockRoot_MuxOsc24MOut
LPUART9 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART9_ClockRoot_MuxOscRc400M
LPUART9 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART9_ClockRoot_MuxOscRc16M
LPUART9 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART9_ClockRoot_MuxSysPll3Div2
LPUART9 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART9_ClockRoot_MuxSysPll1Div5
LPUART9 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART9_ClockRoot_MuxSysPll2Out
LPUART9 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART9_ClockRoot_MuxSysPll2Pfd3
LPUART9 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART10_ClockRoot_MuxOscRc48MDiv2
LPUART10 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART10_ClockRoot_MuxOsc24MOut
LPUART10 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART10_ClockRoot_MuxOscRc400M
LPUART10 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART10_ClockRoot_MuxOscRc16M
LPUART10 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART10_ClockRoot_MuxSysPll3Div2
LPUART10 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPUART10_ClockRoot_MuxSysPll1Div5
LPUART10 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART10_ClockRoot_MuxSysPll2Out
LPUART10 mux from MuxSysPll2Out.

enumerator kCLOCK_LPUART10_ClockRoot_MuxSysPll2Pfd3
LPUART10 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART11_ClockRoot_MuxOscRc48MDiv2
LPUART11 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART11_ClockRoot_MuxOsc24MOut
LPUART11 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART11_ClockRoot_MuxOscRc400M
LPUART11 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART11_ClockRoot_MuxOscRc16M
LPUART11 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART11_ClockRoot_MuxSysPll3Pfd3
LPUART11 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPUART11_ClockRoot_MuxSysPll3Out
LPUART11 mux from MuxSysPll3Out.

enumerator kCLOCK_LPUART11_ClockRoot_MuxSysPll2Pfd3
LPUART11 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART11_ClockRoot_MuxSysPll1Div5
LPUART11 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPUART12_ClockRoot_MuxOscRc48MDiv2
LPUART12 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPUART12_ClockRoot_MuxOsc24MOut
LPUART12 mux from MuxOsc24MOut.

enumerator kCLOCK_LPUART12_ClockRoot_MuxOscRc400M
LPUART12 mux from MuxOscRc400M.

enumerator kCLOCK_LPUART12_ClockRoot_MuxOscRc16M
LPUART12 mux from MuxOscRc16M.

enumerator kCLOCK_LPUART12_ClockRoot_MuxSysPll3Pfd3
LPUART12 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPUART12_ClockRoot_MuxSysPll3Out
LPUART12 mux from MuxSysPll3Out.

enumerator kCLOCK_LPUART12_ClockRoot_MuxSysPll2Pfd3
LPUART12 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPUART12_ClockRoot_MuxSysPll1Div5
LPUART12 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxOscRc48MDiv2
LPI2C1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxOsc24MOut
LPI2C1 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxOscRc400M
LPI2C1 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxOscRc16M
LPI2C1 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxSysPll3Div2
LPI2C1 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxSysPll1Div5
LPI2C1 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxSysPll2Out
LPI2C1 mux from MuxSysPll2Out.

enumerator kCLOCK_LPI2C1_ClockRoot_MuxSysPll2Pfd3
LPI2C1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxOscRc48MDiv2
LPI2C2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxOsc24MOut
LPI2C2 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxOscRc400M
LPI2C2 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxOscRc16M
LPI2C2 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxSysPll3Div2
LPI2C2 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxSysPll1Div5
LPI2C2 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxSysPll2Out
LPI2C2 mux from MuxSysPll2Out.

enumerator kCLOCK_LPI2C2_ClockRoot_MuxSysPll2Pfd3
LPI2C2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxOscRc48MDiv2
LPI2C3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxOsc24MOut
LPI2C3 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxOscRc400M
LPI2C3 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxOscRc16M
LPI2C3 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxSysPll3Div2
LPI2C3 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxSysPll1Div5
LPI2C3 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxSysPll2Out
LPI2C3 mux from MuxSysPll2Out.

enumerator kCLOCK_LPI2C3_ClockRoot_MuxSysPll2Pfd3
LPI2C3 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxOscRc48MDiv2
LPI2C4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxOsc24MOut
LPI2C4 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxOscRc400M
LPI2C4 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxOscRc16M
LPI2C4 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxSysPll3Div2
LPI2C4 mux from MuxSysPll3Div2.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxSysPll1Div5
LPI2C4 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxSysPll2Out
LPI2C4 mux from MuxSysPll2Out.

enumerator kCLOCK_LPI2C4_ClockRoot_MuxSysPll2Pfd3
LPI2C4 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxOscRc48MDiv2
LPI2C5 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxOsc24MOut
LPI2C5 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxOscRc400M
LPI2C5 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxOscRc16M
LPI2C5 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxSysPll3Pfd3
LPI2C5 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxSysPll3Out
LPI2C5 mux from MuxSysPll3Out.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxSysPll2Pfd3
LPI2C5 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C5_ClockRoot_MuxSysPll1Div5
LPI2C5 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxOscRc48MDiv2
LPI2C6 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxOsc24MOut
LPI2C6 mux from MuxOsc24MOut.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxOscRc400M
LPI2C6 mux from MuxOscRc400M.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxOscRc16M
LPI2C6 mux from MuxOscRc16M.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxSysPll3Pfd3
LPI2C6 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxSysPll3Out
LPI2C6 mux from MuxSysPll3Out.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxSysPll2Pfd3
LPI2C6 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPI2C6_ClockRoot_MuxSysPll1Div5
LPI2C6 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxOscRc48MDiv2
LPSPI1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxOsc24MOut
LPSPI1 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxOscRc400M
LPSPI1 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxOscRc16M
LPSPI1 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxSysPll3Pfd2
LPSPI1 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxSysPll1Div5
LPSPI1 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxSysPll2Out
LPSPI1 mux from MuxSysPll2Out.

enumerator kCLOCK_LPSPI1_ClockRoot_MuxSysPll2Pfd3
LPSPI1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxOscRc48MDiv2
LPSPI2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxOsc24MOut
LPSPI2 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxOscRc400M
LPSPI2 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxOscRc16M
LPSPI2 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxSysPll3Pfd2
LPSPI2 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxSysPll1Div5
LPSPI2 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxSysPll2Out
LPSPI2 mux from MuxSysPll2Out.

enumerator kCLOCK_LPSPI2_ClockRoot_MuxSysPll2Pfd3
LPSPI2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxOscRc48MDiv2
LPSPI3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxOsc24MOut
LPSPI3 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxOscRc400M
LPSPI3 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxOscRc16M
LPSPI3 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxSysPll3Pfd2
LPSPI3 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxSysPll1Div5
LPSPI3 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxSysPll2Out
LPSPI3 mux from MuxSysPll2Out.

enumerator kCLOCK_LPSPI3_ClockRoot_MuxSysPll2Pfd3
LPSPI3 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxOscRc48MDiv2
LPSPI4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxOsc24MOut
LPSPI4 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxOscRc400M
LPSPI4 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxOscRc16M
LPSPI4 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxSysPll3Pfd2
LPSPI4 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxSysPll1Div5
LPSPI4 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxSysPll2Out
LPSPI4 mux from MuxSysPll2Out.

enumerator kCLOCK_LPSPI4_ClockRoot_MuxSysPll2Pfd3
LPSPI4 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxOscRc48MDiv2
LPSPI5 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxOsc24MOut
LPSPI5 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxOscRc400M
LPSPI5 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxOscRc16M
LPSPI5 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxSysPll3Pfd3
LPSPI5 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxSysPll3Out
LPSPI5 mux from MuxSysPll3Out.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxSysPll3Pfd2
LPSPI5 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI5_ClockRoot_MuxSysPll1Div5
LPSPI5 mux from MuxSysPll1Div5.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxOscRc48MDiv2
LPSPI6 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxOsc24MOut
LPSPI6 mux from MuxOsc24MOut.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxOscRc400M
LPSPI6 mux from MuxOscRc400M.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxOscRc16M
LPSPI6 mux from MuxOscRc16M.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxSysPll3Pfd3
LPSPI6 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxSysPll3Out
LPSPI6 mux from MuxSysPll3Out.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxSysPll3Pfd2
LPSPI6 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_LPSPI6_ClockRoot_MuxSysPll1Div5
LPSPI6 mux from MuxSysPll1Div5.

enumerator kCLOCK_EMV1_ClockRoot_MuxOscRc48MDiv2
EMV1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_EMV1_ClockRoot_MuxOsc24MOut
EMV1 mux from MuxOsc24MOut.

enumerator kCLOCK_EMV1_ClockRoot_MuxOscRc400M
EMV1 mux from MuxOscRc400M.

enumerator kCLOCK_EMV1_ClockRoot_MuxOscRc16M
EMV1 mux from MuxOscRc16M.

enumerator kCLOCK_EMV1_ClockRoot_MuxSysPll3Div2
EMV1 mux from MuxSysPll3Div2.

enumerator kCLOCK_EMV1_ClockRoot_MuxSysPll1Div5
EMV1 mux from MuxSysPll1Div5.

enumerator kCLOCK_EMV1_ClockRoot_MuxSysPll2Out
EMV1 mux from MuxSysPll2Out.

enumerator kCLOCK_EMV1_ClockRoot_MuxSysPll2Pfd3
EMV1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_EMV2_ClockRoot_MuxOscRc48MDiv2
EMV2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_EMV2_ClockRoot_MuxOsc24MOut
EMV2 mux from MuxOsc24MOut.

enumerator kCLOCK_EMV2_ClockRoot_MuxOscRc400M
EMV2 mux from MuxOscRc400M.

enumerator kCLOCK_EMV2_ClockRoot_MuxOscRc16M
EMV2 mux from MuxOscRc16M.

enumerator kCLOCK_EMV2_ClockRoot_MuxSysPll3Div2
EMV2 mux from MuxSysPll3Div2.

enumerator kCLOCK_EMV2_ClockRoot_MuxSysPll1Div5
EMV2 mux from MuxSysPll1Div5.

enumerator kCLOCK_EMV2_ClockRoot_MuxSysPll2Out
EMV2 mux from MuxSysPll2Out.

enumerator kCLOCK_EMV2_ClockRoot_MuxSysPll2Pfd3
EMV2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_ENET1_ClockRoot_MuxOscRc48MDiv2
ENET1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET1_ClockRoot_MuxOsc24MOut
ENET1 mux from MuxOsc24MOut.

enumerator kCLOCK_ENET1_ClockRoot_MuxOscRc400M
ENET1 mux from MuxOscRc400M.

enumerator kCLOCK_ENET1_ClockRoot_MuxOscRc16M
ENET1 mux from MuxOscRc16M.

enumerator kCLOCK_ENET1_ClockRoot_MuxSysPll1Div2
ENET1 mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET1_ClockRoot_MuxAudioPllOut
ENET1 mux from MuxAudioPllOut.

enumerator kCLOCK_ENET1_ClockRoot_MuxSysPll1Div5
ENET1 mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET1_ClockRoot_MuxSysPll2Pfd1
ENET1 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET2_ClockRoot_MuxOscRc48MDiv2
ENET2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET2_ClockRoot_MuxOsc24MOut
ENET2 mux from MuxOsc24MOut.

enumerator kCLOCK_ENET2_ClockRoot_MuxOscRc400M
ENET2 mux from MuxOscRc400M.

enumerator kCLOCK_ENET2_ClockRoot_MuxOscRc16M
ENET2 mux from MuxOscRc16M.

enumerator kCLOCK_ENET2_ClockRoot_MuxSysPll1Div2
ENET2 mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET2_ClockRoot_MuxAudioPllOut
ENET2 mux from MuxAudioPllOut.

enumerator kCLOCK_ENET2_ClockRoot_MuxSysPll1Div5
ENET2 mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET2_ClockRoot_MuxSysPll2Pfd1
ENET2 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxOscRc48MDiv2
ENET_QOS mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxOsc24MOut
ENET_QOS mux from MuxOsc24MOut.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxOscRc400M
ENET_QOS mux from MuxOscRc400M.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxOscRc16M
ENET_QOS mux from MuxOscRc16M.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxSysPll1Div2
ENET_QOS mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxAudioPllOut
ENET_QOS mux from MuxAudioPllOut.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxSysPll1Div5
ENET_QOS mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET_QOS_ClockRoot_MuxSysPll2Pfd1
ENET_QOS mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxOscRc48MDiv2
ENET_25M mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxOsc24MOut
ENET_25M mux from MuxOsc24MOut.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxOscRc400M
ENET_25M mux from MuxOscRc400M.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxOscRc16M
ENET_25M mux from MuxOscRc16M.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxSysPll1Div2
ENET_25M mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxAudioPllOut
ENET_25M mux from MuxAudioPllOut.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxSysPll1Div5
ENET_25M mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET_25M_ClockRoot_MuxSysPll2Pfd1
ENET_25M mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxOscRc48MDiv2
ENET_TIMER1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxOsc24MOut
ENET_TIMER1 mux from MuxOsc24MOut.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxOscRc400M
ENET_TIMER1 mux from MuxOscRc400M.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxOscRc16M
ENET_TIMER1 mux from MuxOscRc16M.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxSysPll1Div2
ENET_TIMER1 mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxAudioPllOut
ENET_TIMER1 mux from MuxAudioPllOut.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxSysPll1Div5
ENET_TIMER1 mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET_TIMER1_ClockRoot_MuxSysPll2Pfd1
ENET_TIMER1 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxOscRc48MDiv2
ENET_TIMER2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxOsc24MOut
ENET_TIMER2 mux from MuxOsc24MOut.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxOscRc400M
ENET_TIMER2 mux from MuxOscRc400M.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxOscRc16M
ENET_TIMER2 mux from MuxOscRc16M.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxSysPll1Div2
ENET_TIMER2 mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxAudioPllOut
ENET_TIMER2 mux from MuxAudioPllOut.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxSysPll1Div5
ENET_TIMER2 mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET_TIMER2_ClockRoot_MuxSysPll2Pfd1
ENET_TIMER2 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxOscRc48MDiv2
ENET_TIMER3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxOsc24MOut
ENET_TIMER3 mux from MuxOsc24MOut.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxOscRc400M
ENET_TIMER3 mux from MuxOscRc400M.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxOscRc16M
ENET_TIMER3 mux from MuxOscRc16M.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxSysPll1Div2
ENET_TIMER3 mux from MuxSysPll1Div2.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxAudioPllOut
ENET_TIMER3 mux from MuxAudioPllOut.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxSysPll1Div5
ENET_TIMER3 mux from MuxSysPll1Div5.

enumerator kCLOCK_ENET_TIMER3_ClockRoot_MuxSysPll2Pfd1
ENET_TIMER3 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOscRc48MDiv2
USDHC1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOsc24MOut
USDHC1 mux from MuxOsc24MOut.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOscRc400M
USDHC1 mux from MuxOscRc400M.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOscRc16M
USDHC1 mux from MuxOscRc16M.

enumerator kCLOCK_USDHC1_ClockRoot_MuxSysPll2Pfd2
USDHC1 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_USDHC1_ClockRoot_MuxSysPll2Pfd0
USDHC1 mux from MuxSysPll2Pfd0.

enumerator kCLOCK_USDHC1_ClockRoot_MuxSysPll1Div5
USDHC1 mux from MuxSysPll1Div5.

enumerator kCLOCK_USDHC1_ClockRoot_MuxArmPllOut
USDHC1 mux from MuxArmPllOut.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOscRc48MDiv2
USDHC2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOsc24MOut
USDHC2 mux from MuxOsc24MOut.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOscRc400M
USDHC2 mux from MuxOscRc400M.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOscRc16M
USDHC2 mux from MuxOscRc16M.

enumerator kCLOCK_USDHC2_ClockRoot_MuxSysPll2Pfd2
USDHC2 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_USDHC2_ClockRoot_MuxSysPll2Pfd0
USDHC2 mux from MuxSysPll2Pfd0.

enumerator kCLOCK_USDHC2_ClockRoot_MuxSysPll1Div5
USDHC2 mux from MuxSysPll1Div5.

enumerator kCLOCK_USDHC2_ClockRoot_MuxArmPllOut
USDHC2 mux from MuxArmPllOut.

enumerator kCLOCK_ASRC_ClockRoot_MuxOscRc48MDiv2
ASRC mux from MuxOscRc48MDiv2.

enumerator kCLOCK_ASRC_ClockRoot_MuxOsc24MOut
ASRC mux from MuxOsc24MOut.

enumerator kCLOCK_ASRC_ClockRoot_MuxOscRc400M
ASRC mux from MuxOscRc400M.

enumerator kCLOCK_ASRC_ClockRoot_MuxOscRc16M
ASRC mux from MuxOscRc16M.

enumerator kCLOCK_ASRC_ClockRoot_MuxSysPll1Div5
ASRC mux from MuxSysPll1Div5.

enumerator kCLOCK_ASRC_ClockRoot_MuxSysPll3Div2
ASRC mux from MuxSysPll3Div2.

enumerator kCLOCK_ASRC_ClockRoot_MuxAudioPllOut
ASRC mux from MuxAudioPllOut.

enumerator kCLOCK_ASRC_ClockRoot_MuxSysPll2Pfd3
ASRC mux from MuxSysPll2Pfd3.

enumerator kCLOCK_MQS_ClockRoot_MuxOscRc48MDiv2
MQS mux from MuxOscRc48MDiv2.

enumerator kCLOCK_MQS_ClockRoot_MuxOsc24MOut
MQS mux from MuxOsc24MOut.

enumerator kCLOCK_MQS_ClockRoot_MuxOscRc400M
MQS mux from MuxOscRc400M.

enumerator kCLOCK_MQS_ClockRoot_MuxOscRc16M
MQS mux from MuxOscRc16M.

enumerator kCLOCK_MQS_ClockRoot_MuxSysPll1Div5
MQS mux from MuxSysPll1Div5.

enumerator kCLOCK_MQS_ClockRoot_MuxSysPll3Div2
MQS mux from MuxSysPll3Div2.

enumerator kCLOCK_MQS_ClockRoot_MuxAudioPllOut
MQS mux from MuxAudioPllOut.

enumerator kCLOCK_MQS_ClockRoot_MuxSysPll2Pfd3
MQS mux from MuxSysPll2Pfd3.

enumerator kCLOCK_MIC_ClockRoot_MuxOscRc48MDiv2
MIC mux from MuxOscRc48MDiv2.

enumerator kCLOCK_MIC_ClockRoot_MuxOsc24MOut
MIC mux from MuxOsc24MOut.

enumerator kCLOCK_MIC_ClockRoot_MuxOscRc400M
MIC mux from MuxOscRc400M.

enumerator kCLOCK_MIC_ClockRoot_MuxOscRc16M
MIC mux from MuxOscRc16M.

enumerator kCLOCK_MIC_ClockRoot_MuxSysPll3Pfd3
MIC mux from MuxSysPll3Pfd3.

enumerator kCLOCK_MIC_ClockRoot_MuxSysPll3Out
MIC mux from MuxSysPll3Out.

enumerator kCLOCK_MIC_ClockRoot_MuxAudioPllOut
MIC mux from MuxAudioPllOut.

enumerator kCLOCK_MIC_ClockRoot_MuxSysPll1Div5
MIC mux from MuxSysPll1Div5.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOscRc48MDiv2
SPDIF mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOsc24MOut
SPDIF mux from MuxOsc24MOut.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOscRc400M
SPDIF mux from MuxOscRc400M.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOscRc16M
SPDIF mux from MuxOscRc16M.

enumerator kCLOCK_SPDIF_ClockRoot_MuxAudioPllOut
SPDIF mux from MuxAudioPllOut.

enumerator kCLOCK_SPDIF_ClockRoot_MuxSysPll3Out
SPDIF mux from MuxSysPll3Out.

enumerator kCLOCK_SPDIF_ClockRoot_MuxSysPll3Pfd2
SPDIF mux from MuxSysPll3Pfd2.

enumerator kCLOCK_SPDIF_ClockRoot_MuxSysPll2Pfd3
SPDIF mux from MuxSysPll2Pfd3.

enumerator kCLOCK_SAI1_ClockRoot_MuxOscRc48MDiv2
SAI1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SAI1_ClockRoot_MuxOsc24MOut
SAI1 mux from MuxOsc24MOut.

enumerator kCLOCK_SAI1_ClockRoot_MuxOscRc400M
SAI1 mux from MuxOscRc400M.

enumerator kCLOCK_SAI1_ClockRoot_MuxOscRc16M
SAI1 mux from MuxOscRc16M.

enumerator kCLOCK_SAI1_ClockRoot_MuxAudioPllOut
SAI1 mux from MuxAudioPllOut.

enumerator kCLOCK_SAI1_ClockRoot_MuxSysPll3Pfd2
SAI1 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_SAI1_ClockRoot_MuxSysPll1Div5
SAI1 mux from MuxSysPll1Div5.

enumerator kCLOCK_SAI1_ClockRoot_MuxSysPll2Pfd3
SAI1 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_SAI2_ClockRoot_MuxOscRc48MDiv2
SAI2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SAI2_ClockRoot_MuxOsc24MOut
SAI2 mux from MuxOsc24MOut.

enumerator kCLOCK_SAI2_ClockRoot_MuxOscRc400M
SAI2 mux from MuxOscRc400M.

enumerator kCLOCK_SAI2_ClockRoot_MuxOscRc16M
SAI2 mux from MuxOscRc16M.

enumerator kCLOCK_SAI2_ClockRoot_MuxAudioPllOut
SAI2 mux from MuxAudioPllOut.

enumerator kCLOCK_SAI2_ClockRoot_MuxSysPll3Pfd2
SAI2 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_SAI2_ClockRoot_MuxSysPll1Div5
SAI2 mux from MuxSysPll1Div5.

enumerator kCLOCK_SAI2_ClockRoot_MuxSysPll2Pfd3
SAI2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_SAI3_ClockRoot_MuxOscRc48MDiv2
SAI3 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SAI3_ClockRoot_MuxOsc24MOut
SAI3 mux from MuxOsc24MOut.

enumerator kCLOCK_SAI3_ClockRoot_MuxOscRc400M
SAI3 mux from MuxOscRc400M.

enumerator kCLOCK_SAI3_ClockRoot_MuxOscRc16M
SAI3 mux from MuxOscRc16M.

enumerator kCLOCK_SAI3_ClockRoot_MuxAudioPllOut
SAI3 mux from MuxAudioPllOut.

enumerator kCLOCK_SAI3_ClockRoot_MuxSysPll3Pfd2
SAI3 mux from MuxSysPll3Pfd2.

enumerator kCLOCK_SAI3_ClockRoot_MuxSysPll1Div5
SAI3 mux from MuxSysPll1Div5.

enumerator kCLOCK_SAI3_ClockRoot_MuxSysPll2Pfd3
SAI3 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_SAI4_ClockRoot_MuxOscRc48MDiv2
SAI4 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_SAI4_ClockRoot_MuxOsc24MOut
SAI4 mux from MuxOsc24MOut.

enumerator kCLOCK_SAI4_ClockRoot_MuxOscRc400M
SAI4 mux from MuxOscRc400M.

enumerator kCLOCK_SAI4_ClockRoot_MuxOscRc16M
SAI4 mux from MuxOscRc16M.

enumerator kCLOCK_SAI4_ClockRoot_MuxSysPll3Pfd3
SAI4 mux from MuxSysPll3Pfd3.

enumerator kCLOCK_SAI4_ClockRoot_MuxSysPll3Out
SAI4 mux from MuxSysPll3Out.

enumerator kCLOCK_SAI4_ClockRoot_MuxAudioPllOut
SAI4 mux from MuxAudioPllOut.

enumerator kCLOCK_SAI4_ClockRoot_MuxSysPll1Div5
SAI4 mux from MuxSysPll1Div5.

enumerator kCLOCK_GC355_ClockRoot_MuxOscRc48MDiv2
GC355 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_GC355_ClockRoot_MuxOsc24MOut
GC355 mux from MuxOsc24MOut.

enumerator kCLOCK_GC355_ClockRoot_MuxOscRc400M
GC355 mux from MuxOscRc400M.

enumerator kCLOCK_GC355_ClockRoot_MuxOscRc16M
GC355 mux from MuxOscRc16M.

enumerator kCLOCK_GC355_ClockRoot_MuxSysPll2Out
GC355 mux from MuxSysPll2Out.

enumerator kCLOCK_GC355_ClockRoot_MuxSysPll2Pfd1
GC355 mux from MuxSysPll2Pfd1.

enumerator kCLOCK_GC355_ClockRoot_MuxSysPll3Out
GC355 mux from MuxSysPll3Out.

enumerator kCLOCK_GC355_ClockRoot_MuxVideoPllOut
GC355 mux from MuxVideoPllOut.

enumerator kCLOCK_LCDIF_ClockRoot_MuxOscRc48MDiv2
LCDIF mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LCDIF_ClockRoot_MuxOsc24MOut
LCDIF mux from MuxOsc24MOut.

enumerator kCLOCK_LCDIF_ClockRoot_MuxOscRc400M
LCDIF mux from MuxOscRc400M.

enumerator kCLOCK_LCDIF_ClockRoot_MuxOscRc16M
LCDIF mux from MuxOscRc16M.

enumerator kCLOCK_LCDIF_ClockRoot_MuxSysPll2Out
LCDIF mux from MuxSysPll2Out.

enumerator kCLOCK_LCDIF_ClockRoot_MuxSysPll2Pfd2
LCDIF mux from MuxSysPll2Pfd2.

enumerator kCLOCK_LCDIF_ClockRoot_MuxSysPll3Pfd0
LCDIF mux from MuxSysPll3Pfd0.

enumerator kCLOCK_LCDIF_ClockRoot_MuxVideoPllOut
LCDIF mux from MuxVideoPllOut.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxOscRc48MDiv2
LCDIFV2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxOsc24MOut
LCDIFV2 mux from MuxOsc24MOut.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxOscRc400M
LCDIFV2 mux from MuxOscRc400M.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxOscRc16M
LCDIFV2 mux from MuxOscRc16M.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxSysPll2Out
LCDIFV2 mux from MuxSysPll2Out.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxSysPll2Pfd2
LCDIFV2 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxSysPll3Pfd0
LCDIFV2 mux from MuxSysPll3Pfd0.

enumerator kCLOCK_LCDIFV2_ClockRoot_MuxVideoPllOut
LCDIFV2 mux from MuxVideoPllOut.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxOscRc48MDiv2
MIPI_REF mux from MuxOscRc48MDiv2.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxOsc24MOut
MIPI_REF mux from MuxOsc24MOut.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxOscRc400M
MIPI_REF mux from MuxOscRc400M.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxOscRc16M
MIPI_REF mux from MuxOscRc16M.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxSysPll2Out
MIPI_REF mux from MuxSysPll2Out.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxSysPll2Pfd0
MIPI_REF mux from MuxSysPll2Pfd0.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxSysPll3Pfd0
MIPI_REF mux from MuxSysPll3Pfd0.

enumerator kCLOCK_MIPI_REF_ClockRoot_MuxVideoPllOut
MIPI_REF mux from MuxVideoPllOut.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxOscRc48MDiv2
MIPI_ESC mux from MuxOscRc48MDiv2.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxOsc24MOut
MIPI_ESC mux from MuxOsc24MOut.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxOscRc400M
MIPI_ESC mux from MuxOscRc400M.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxOscRc16M
MIPI_ESC mux from MuxOscRc16M.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxSysPll2Out
MIPI_ESC mux from MuxSysPll2Out.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxSysPll2Pfd0
MIPI_ESC mux from MuxSysPll2Pfd0.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxSysPll3Pfd0
MIPI_ESC mux from MuxSysPll3Pfd0.

enumerator kCLOCK_MIPI_ESC_ClockRoot_MuxVideoPllOut
MIPI_ESC mux from MuxVideoPllOut.

enumerator kCLOCK_CSI2_ClockRoot_MuxOscRc48MDiv2
CSI2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSI2_ClockRoot_MuxOsc24MOut
CSI2 mux from MuxOsc24MOut.

enumerator kCLOCK_CSI2_ClockRoot_MuxOscRc400M
CSI2 mux from MuxOscRc400M.

enumerator kCLOCK_CSI2_ClockRoot_MuxOscRc16M
CSI2 mux from MuxOscRc16M.

enumerator kCLOCK_CSI2_ClockRoot_MuxSysPll2Pfd2
CSI2 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_CSI2_ClockRoot_MuxSysPll3Out
CSI2 mux from MuxSysPll3Out.

enumerator kCLOCK_CSI2_ClockRoot_MuxSysPll2Pfd0
CSI2 mux from MuxSysPll2Pfd0.

enumerator kCLOCK_CSI2_ClockRoot_MuxVideoPllOut
CSI2 mux from MuxVideoPllOut.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxOscRc48MDiv2
CSI2_ESC mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxOsc24MOut
CSI2_ESC mux from MuxOsc24MOut.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxOscRc400M
CSI2_ESC mux from MuxOscRc400M.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxOscRc16M
CSI2_ESC mux from MuxOscRc16M.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxSysPll2Pfd2
CSI2_ESC mux from MuxSysPll2Pfd2.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxSysPll3Out
CSI2_ESC mux from MuxSysPll3Out.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxSysPll2Pfd0
CSI2_ESC mux from MuxSysPll2Pfd0.

enumerator kCLOCK_CSI2_ESC_ClockRoot_MuxVideoPllOut
CSI2_ESC mux from MuxVideoPllOut.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxOscRc48MDiv2
CSI2_UI mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxOsc24MOut
CSI2_UI mux from MuxOsc24MOut.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxOscRc400M
CSI2_UI mux from MuxOscRc400M.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxOscRc16M
CSI2_UI mux from MuxOscRc16M.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxSysPll2Pfd2
CSI2_UI mux from MuxSysPll2Pfd2.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxSysPll3Out
CSI2_UI mux from MuxSysPll3Out.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxSysPll2Pfd0
CSI2_UI mux from MuxSysPll2Pfd0.

enumerator kCLOCK_CSI2_UI_ClockRoot_MuxVideoPllOut
CSI2_UI mux from MuxVideoPllOut.

enumerator kCLOCK_CSI_ClockRoot_MuxOscRc48MDiv2
CSI mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CSI_ClockRoot_MuxOsc24MOut
CSI mux from MuxOsc24MOut.

enumerator kCLOCK_CSI_ClockRoot_MuxOscRc400M
CSI mux from MuxOscRc400M.

enumerator kCLOCK_CSI_ClockRoot_MuxOscRc16M
CSI mux from MuxOscRc16M.

enumerator kCLOCK_CSI_ClockRoot_MuxSysPll2Pfd2
CSI mux from MuxSysPll2Pfd2.

enumerator kCLOCK_CSI_ClockRoot_MuxSysPll3Out
CSI mux from MuxSysPll3Out.

enumerator kCLOCK_CSI_ClockRoot_MuxSysPll3Pfd1
CSI mux from MuxSysPll3Pfd1.

enumerator kCLOCK_CSI_ClockRoot_MuxVideoPllOut
CSI mux from MuxVideoPllOut.

enumerator kCLOCK_CKO1_ClockRoot_MuxOscRc48MDiv2
CKO1 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CKO1_ClockRoot_MuxOsc24MOut
CKO1 mux from MuxOsc24MOut.

enumerator kCLOCK_CKO1_ClockRoot_MuxOscRc400M
CKO1 mux from MuxOscRc400M.

enumerator kCLOCK_CKO1_ClockRoot_MuxOscRc16M
CKO1 mux from MuxOscRc16M.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll2Pfd2
CKO1 mux from MuxSysPll2Pfd2.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll2Out
CKO1 mux from MuxSysPll2Out.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll3Pfd1
CKO1 mux from MuxSysPll3Pfd1.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll1Div5
CKO1 mux from MuxSysPll1Div5.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc48MDiv2
CKO2 mux from MuxOscRc48MDiv2.

enumerator kCLOCK_CKO2_ClockRoot_MuxOsc24MOut
CKO2 mux from MuxOsc24MOut.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc400M
CKO2 mux from MuxOscRc400M.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc16M
CKO2 mux from MuxOscRc16M.

enumerator kCLOCK_CKO2_ClockRoot_MuxSysPll2Pfd3
CKO2 mux from MuxSysPll2Pfd3.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc48M
CKO2 mux from MuxOscRc48M.

enumerator kCLOCK_CKO2_ClockRoot_MuxSysPll3Pfd1
CKO2 mux from MuxSysPll3Pfd1.

enumerator kCLOCK_CKO2_ClockRoot_MuxAudioPllOut
CKO2 mux from MuxAudioPllOut.

enum _clock_group
Clock group enumeration.

Values:

enumerator kCLOCK_Group_FlexRAM
FlexRAM clock group.

enumerator kCLOCK_Group_MipiDsi
Mipi Dsi clock group.

enumerator kCLOCK_Group_Last
Last clock group.

enum _clock_osc
OSC 24M sorce select.

Values:

enumerator kCLOCK_RcOsc
On chip OSC.

enumerator kCLOCK_XtalOsc
24M Xtal OSC

enum _clock_gate_value
Clock gate value.

Values:

enumerator kCLOCK_Off
Clock is off.

enumerator kCLOCK_On
Clock is on

enum _clock_mode_t
System clock mode.

Values:

enumerator kCLOCK_ModeRun
Remain in run mode.

enumerator kCLOCK_ModeWait
Transfer to wait mode.

enumerator kCLOCK_ModeStop
Transfer to stop mode.

enum _clock_usb_src
USB clock source definition.

Values:

enumerator kCLOCK_Usb480M
Use 480M.

enumerator kCLOCK_UsbSrcUnused
Used when the function does not care the clock source.

enum _clock_usb_phy_src
Source of the USB HS PHY.

Values:

enumerator kCLOCK_Usbphy480M
Use 480M.

enum _clock_pll_clk_src
PLL clock source, bypass cloco source also.

Values:

enumerator kCLOCK_PllClkSrc24M
Pll clock source 24M

enumerator kCLOCK_PllSrcClkPN
Pll clock source CLK1_P and CLK1_N

enum _clock_pll_post_div
PLL post divider enumeration.

Values:

enumerator kCLOCK_PllPostDiv2
Divide by 2.

enumerator kCLOCK_PllPostDiv4
Divide by 4.

enumerator kCLOCK_PllPostDiv8
Divide by 8.

enumerator kCLOCK_PllPostDiv1
Divide by 1.

enum _clock_pll
PLL name.

Values:

enumerator kCLOCK_PllArm
ARM PLL.

enumerator kCLOCK_PllSys1
SYS1 PLL, it has a dedicated frequency of 1GHz.

enumerator kCLOCK_PllSys2
SYS2 PLL, it has a dedicated frequency of 528MHz.

enumerator kCLOCK_PllSys3
SYS3 PLL, it has a dedicated frequency of 480MHz.

enumerator kCLOCK_PllAudio
Audio PLL.

enumerator kCLOCK_PllVideo
Video PLL.

enumerator kCLOCK_PllInvalid
Invalid value.

enum _clock_pfd
PLL PFD name.

Values:

enumerator kCLOCK_Pfd0
PLL PFD0

enumerator kCLOCK_Pfd1
PLL PFD1

enumerator kCLOCK_Pfd2
PLL PFD2

enumerator kCLOCK_Pfd3
PLL PFD3

enum _clock_control_mode
The enumeration of control mode.

Values:

enumerator kCLOCK_SoftwareMode
Software control mode.

enumerator kCLOCK_GpcMode
GPC control mode.

enum _clock_24MOsc_mode
The enumeration of 24MHz crystal oscillator mode.

Values:

enumerator kCLOCK_24MOscHighGainMode
24MHz crystal oscillator work as high gain mode.

enumerator kCLOCK_24MOscBypassMode
24MHz crystal oscillator work as bypass mode.

enumerator kCLOCK_24MOscLowPowerMode
24MHz crystal oscillator work as low power mode.

enum _clock_16MOsc_source
The enumeration of 16MHz RC oscillator clock source.

Values:

enumerator kCLOCK_16MOscSourceFrom16MOsc
Source from 16MHz RC oscialltor.

enumerator kCLOCK_16MOscSourceFrom24MOsc
Source from 24MHz crystal oscillator.

enum _clock_1MHzOut_behavior
The enumeration of 1MHz output clock behavior, including disabling 1MHz output, enabling locked 1MHz clock output, and enabling free-running 1MHz clock output.

Values:

enumerator kCLOCK_1MHzOutDisable
Disable 1MHz output clock.

enumerator kCLOCK_1MHzOutEnableLocked1Mhz
Enable 1MHz output clock, and select locked 1MHz to output.

enumerator kCLOCK_1MHzOutEnableFreeRunning1Mhz
Enable 1MHZ output clock, and select free-running 1MHz to output.

enum _clock_level
The clock dependence level.

Values:

enumerator kCLOCK_Level0
Not needed in any mode.

enumerator kCLOCK_Level1
Needed in RUN mode.

enumerator kCLOCK_Level2
Needed in RUN and WAIT mode.

enumerator kCLOCK_Level3
Needed in RUN, WAIT and STOP mode.

enumerator kCLOCK_Level4
Always on in any mode.

typedef enum *_clock_lpcg* clock_lpcg_t
Clock LPCG index.

typedef enum *_clock_name* clock_name_t
Clock name.

typedef enum *_clock_root* clock_root_t
Root clock index.

typedef enum *_clock_root_mux_source* clock_root_mux_source_t
The enumerator of clock roots' clock source mux value.

typedef enum *_clock_group* clock_group_t
Clock group enumeration.

typedef struct *_clock_group_config* clock_group_config_t
The structure used to configure clock group.

typedef enum *_clock_osc* clock_osc_t
OSC 24M sorce select.

typedef enum *_clock_gate_value* clock_gate_value_t
Clock gate value.

typedef enum *_clock_mode_t* clock_mode_t
System clock mode.

typedef enum *_clock_usb_src* clock_usb_src_t
USB clock source definition.

typedef enum *_clock_usb_phy_src* clock_usb_phy_src_t
Source of the USB HS PHY.

typedef enum *_clock_pll_post_div* clock_pll_post_div_t
PLL post divider enumeration.

typedef struct *_clock_arm_pll_config* clock_arm_pll_config_t
PLL configuration for ARM.

The output clock frequency is:

Fout=Fin*loopDivider /(2 * postDivider).

Fin is always 24MHz.

typedef struct *_clock_usb_pll_config* clock_usb_pll_config_t
PLL configuration for USB.

typedef struct *_clock_pll_ss_config* clock_pll_ss_config_t
Spread specturm configure Pll.

typedef struct *_clock_sys_pll2_config* clock_sys_pll2_config_t
PLL configure for Sys Pll2.

typedef struct *_clock_sys_pll1_config* clock_sys_pll1_config_t
PLL configure for Sys Pll1.

typedef struct *_clock_audio_pll_config* clock_av_pll_config_t
PLL configuration for AUDIO and VIDEO.

typedef struct *_clock_audio_pll_config* clock_audio_pll_config_t

typedef struct *_clock_audio_pll_config* clock_video_pll_config_t

typedef struct *_clock_audio_pll_gpc_config* clock_audio_pll_gpc_config_t
PLL configuration fro AUDIO PLL, SYSTEM PLL1 and VIDEO PLL.

typedef struct *_clock_audio_pll_gpc_config* clock_video_pll_gpc_config_t

typedef struct *_clock_audio_pll_gpc_config* clock_sys_pll1_gpc_config_t

typedef struct *_clock_enet_pll_config* clock_enet_pll_config_t
PLL configuration for ENET.

typedef struct *_clock_root_config_t* clock_root_config_t
Clock root configuration.

typedef struct *_clock_root_setpoint_config_t* clock_root_setpoint_config_t
Clock root configuration in SetPoint Mode.

typedef enum *_clock_pll* clock_pll_t
PLL name.

typedef enum *_clock_pfd* clock_pfd_t
PLL PFD name.

typedef enum *_clock_control_mode* clock_control_mode_t
The enumeration of control mode.

typedef enum *_clock_24MOsc_mode* clock_24MOsc_mode_t

The enumeration of 24MHz crystal oscillator mode.

typedef enum *_clock_16MOsc_source* clock_16MOsc_source_t

The enumeration of 16MHz RC oscillator clock source.

typedef enum *_clock_1MHzOut_behavior* clock_1MHzOut_behavior_t

The enumeration of 1MHz output clock behavior, including disabling 1MHz output, enabling locked 1MHz clock output, and enabling free-running 1MHz clock output.

typedef enum *_clock_level* clock_level_t

The clock dependence level.

const *clock_name_t* s_clockSourceName[][8]

static inline void CLOCK_SetRootClockMux(*clock_root_t* root, uint8_t src)

Set CCM Root Clock MUX node to certain value.

Parameters

- root – Which root clock node to set, see clock_root_t.
- src – Clock mux value to set, different mux has different value range. See clock_root_mux_source_t.

static inline uint32_t CLOCK_GetRootClockMux(*clock_root_t* root)

Get CCM Root Clock MUX value.

Parameters

- root – Which root clock node to get, see clock_root_t.

Returns

Clock mux value.

static inline *clock_name_t* CLOCK_GetRootClockSource(*clock_root_t* root, uint32_t src)

Get CCM Root Clock Source.

Parameters

- root – Which root clock node to get, see clock_root_t.
- src – Clock mux value to get, see clock_root_mux_source_t.

Returns

Clock source

static inline void CLOCK_SetRootClockDiv(*clock_root_t* root, uint32_t div)

Set CCM Root Clock DIV certain value.

Parameters

- root – Which root clock to set, see clock_root_t.
- div – Clock div value to set range is 1-256, different divider has different value range.

static inline uint32_t CLOCK_GetRootClockDiv(*clock_root_t* root)

Get CCM DIV node value.

Parameters

- root – Which root clock node to get, see clock_root_t.

Returns

divider set for this root

static inline void CLOCK_PowerOffRootClock(*clock_root_t* root)

Power Off Root Clock.

Parameters

- root – Which root clock node to set, see clock_root_t.

static inline void CLOCK_PowerOnRootClock(*clock_root_t* root)

Power On Root Clock.

Parameters

- root – Which root clock node to set, see clock_root_t.

static inline void CLOCK_SetRootClock(*clock_root_t* root, const *clock_root_config_t* *config)

Configure Root Clock.

Parameters

- root – Which root clock node to set, see clock_root_t.
- config – root clock config, see clock_root_config_t

static inline void CLOCK_ControlGate(*clock_lpcg_t* name, *clock_gate_value_t* value)

Control the clock gate for specific IP.

Note: This API will not have any effect when this clock is in CPULPM or SetPoint Mode

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Parameters

- name – Which clock to enable, see clock_lpcg_t.
- value – Clock gate value to set, see clock_gate_value_t.

static inline void CLOCK_EnableClock(*clock_lpcg_t* name)

Enable the clock for specific IP.

Parameters

- name – Which clock to enable, see clock_lpcg_t.

static inline void CLOCK_DisableClock(*clock_lpcg_t* name)

Disable the clock for specific IP.

Parameters

- name – Which clock to disable, see clock_lpcg_t.

void CLOCK_SetGroupConfig(*clock_group_t* group, const *clock_group_config_t* *config)

Set the clock group configuration.

Parameters

- group – Which group to configure, see clock_group_t.
- config – Configuration to set.

uint32_t CLOCK_GetFreq(*clock_name_t* name)

Gets the clock frequency for a specific clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in clock_name_t.

Parameters

- name – Clock names defined in clock_name_t

Returns
Clock frequency value in hertz

static inline uint32_t CLOCK_GetRootClockFreq(*clock_root_t* root)

Gets the clock frequency for a specific root clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in clock_root_t.

Parameters

- root – Clock names defined in clock_root_t

Returns
Clock frequency value in hertz

static inline uint32_t CLOCK_GetM7Freq(void)

Get the CCM CPU/core/system frequency.

Returns
Clock frequency; If the clock is invalid, returns 0.

static inline uint32_t CLOCK_GetM4Freq(void)

Get the CCM CPU/core/system frequency.

Returns
Clock frequency; If the clock is invalid, returns 0.

static inline bool CLOCK_IsPllBypassed(*clock_pll_t* pll)

Check if PLL is bypassed.

Parameters

- pll – PLL control name (see clock_pll_t enumeration)

Returns
PLL bypass status.

- true: The PLL is bypassed.
- false: The PLL is not bypassed.

static inline bool CLOCK_IsPllEnabled(*clock_pll_t* pll)

Check if PLL is enabled.

Parameters

- pll – PLL control name (see clock_pll_t enumeration)

Returns
PLL bypass status.

- true: The PLL is enabled.
- false: The PLL is not enabled.

FSL_CLOCK_DRIVER_VERSION

CLOCK driver version.

SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY

CCSR_OFFSET

CCM registers offset.

CBCDR_OFFSET

CBCMR_OFFSET

CSCMR1_OFFSET

CSCMR2_OFFSET

CSCDR1_OFFSET

CDCDR_OFFSET

CSCDR2_OFFSET

CSCDR3_OFFSET

CACRR_OFFSET

CS1CDR_OFFSET

CS2CDR_OFFSET

ARM_PLL_OFFSET
: CCM Analog registers offset.

PLL_SYS_OFFSET

PLL_USB1_OFFSET

PLL_AUDIO_OFFSET

PLL_VIDEO_OFFSET

PLL_ENET_OFFSET

PLL_USB2_OFFSET

CCM_TUPLE(reg, shift, mask, busyShift)

CCM_TUPLE_REG(base, tuple)

CCM_TUPLE_SHIFT(tuple)

CCM_TUPLE_MASK(tuple)

CCM_TUPLE_BUSY_SHIFT(tuple)

CCM_BUSY_WAIT

CCM_ANALOG_TUPLE(reg, shift)
: CCM ANALOG tuple macros to map corresponding registers and bit fields.

CCM_ANALOG_TUPLE_SHIFT(tuple)

CCM_ANALOG_TUPLE_REG_OFF(base, tuple, off)

CCM_ANALOG_TUPLE_REG(base, tuple)

SYS_PLL1_FREQ
: SYS_PLL_FREQ frequency in Hz.

SYS_PLL2_MFI

SYS_PLL2_FREQ

SYS_PLL3_MFI

SYS_PLL3_FREQ

XTAL_FREQ

LPADC_CLOCKS
: Clock gate name array for ADC.

ADC_ETC_CLOCKS
: Clock gate name array for ADC.

AOI_CLOCKS
: Clock gate name array for AOI.

DCDC_CLOCKS
: Clock gate name array for DCDC.

  Clock ip name array for DCDC.

DCDC_CLOCKS
: Clock gate name array for DCDC.

  Clock ip name array for DCDC.

SRC_CLOCKS
: Clock gate name array for SRC.

GPC_CLOCKS
: Clock gate name array for GPC.

SSARC_CLOCKS
: Clock gate name array for SSARC.

WDOG_CLOCKS
: Clock gate name array for WDOG.

EWM_CLOCKS
: Clock gate name array for EWM.

SEMA_CLOCKS
: Clock gate name array for Sema.

MU_CLOCKS
: Clock gate name array for MU.

EDMA_CLOCKS
: Clock gate name array for EDMA.

FLEXRAM_CLOCKS
: Clock gate name array for FLEXRAM.

LMEM_CLOCKS
: Clock gate name array for LMEM.

FLEXSPI_CLOCKS
: Clock gate name array for FLEXSPI.

RDC_CLOCKS
: Clock gate name array for RDC.

SEMC_CLOCKS
: Clock ip name array for SEMC.

XECC_CLOCKS
: Clock ip name array for XECC.

IEE_CLOCKS
: Clock ip name array for IEE.

KEYMANAGER_CLOCKS
: Clock ip name array for KEY_MANAGER.

PUF_CLOCKS
: Clock ip name array for PUF.

OCOTP_CLOCKS
: Clock ip name array for OCOTP.

CAAM_CLOCKS
: Clock ip name array for CAAM.

XBAR_CLOCKS
: Clock ip name array for XBAR.

IOMUXC_CLOCKS
: Clock ip name array for IOMUXC.

GPIO_CLOCKS
: Clock ip name array for GPIO.

KPP_CLOCKS
: Clock ip name array for KPP.

FLEXIO_CLOCKS
: Clock ip name array for FLEXIO.

DAC_CLOCKS
: Clock ip name array for DAC.

CMP_CLOCKS
: Clock ip name array for CMP.

PIT_CLOCKS
: Clock ip name array for PIT.

GPT_CLOCKS
: Clock ip name array for GPT.

TMR_CLOCKS
: Clock ip name array for QTIMER.

ENC_CLOCKS
: Clock ip name array for ENC.

PWM_CLOCKS
: Clock ip name array for PWM.

FLEXCAN_CLOCKS
: Clock ip name array for FLEXCAN.

LPUART_CLOCKS
: Clock ip name array for LPUART.

LPI2C_CLOCKS
: Clock ip name array for LPI2C.

LPSPI_CLOCKS
: Clock ip name array for LPSPI.

EMVSIM_CLOCKS
: Clock ip name array for EMVSIM.

ENET_CLOCKS
: Clock ip name array for ENET.

ENETQOS_CLOCKS
: Clock ip name array for ENET_QOS.

USB_CLOCKS
: Clock ip name array for USB.

CDOG_CLOCKS
: Clock ip name array for CDOG.

USDHC_CLOCKS
: Clock ip name array for USDHC.

ASRC_CLOCKS
: Clock ip name array for ASRC.

MQS_CLOCKS
: Clock ip name array for MQS.

PDM_CLOCKS
: Clock ip name array for PDM.

SPDIF_CLOCKS
: Clock ip name array for SPDIF.

SAI_CLOCKS
: Clock ip name array for SAI.

PXP_CLOCKS
: Clock ip name array for PXP.

GPU2D_CLOCKS
: Clock ip name array for GPU2d.

LCDIF_CLOCKS
: Clock ip name array for LCDIF.

LCDIFV2_CLOCKS
: Clock ip name array for LCDIFV2.

MIPI_DSI_HOST_CLOCKS
: Clock ip name array for MIPI_DSI.

MIPI_CSI2RX_CLOCKS
: Clock ip name array for MIPI_CSI.

CSI_CLOCKS
: Clock ip name array for CSI.

DCIC_CLOCKS
: Clock ip name array for DCIC.

DMAMUX_CLOCKS
: Clock ip name array for DMAMUX_CLOCKS.

XBARA_CLOCKS
: Clock ip name array for XBARA.

XBARB_CLOCKS
: Clock ip name array for XBARB.

CCM_OBS_M7_CLK_ROOT

CCM_OBS_M4_CLK_ROOT

CCM_OBS_BUS_CLK_ROOT

CCM_OBS_BUS_LPSR_CLK_ROOT

CCM_OBS_SEMC_CLK_ROOT

CCM_OBS_CSSYS_CLK_ROOT

CCM_OBS_CSTRACE_CLK_ROOT

CCM_OBS_M4_SYSTICK_CLK_ROOT

CCM_OBS_M7_SYSTICK_CLK_ROOT

CCM_OBS_ADC1_CLK_ROOT

CCM_OBS_ADC2_CLK_ROOT

CCM_OBS_ACMP_CLK_ROOT

CCM_OBS_FLEXIO1_CLK_ROOT

CCM_OBS_FLEXIO2_CLK_ROOT

CCM_OBS_GPT1_CLK_ROOT

CCM_OBS_GPT2_CLK_ROOT

CCM_OBS_GPT3_CLK_ROOT

CCM_OBS_GPT4_CLK_ROOT

CCM_OBS_GPT5_CLK_ROOT

CCM_OBS_GPT6_CLK_ROOT

CCM_OBS_FLEXSPI1_CLK_ROOT

CCM_OBS_FLEXSPI2_CLK_ROOT

CCM_OBS_CAN1_CLK_ROOT

CCM_OBS_CAN2_CLK_ROOT

CCM_OBS_CAN3_CLK_ROOT

CCM_OBS_LPUART1_CLK_ROOT

CCM_OBS_LPUART2_CLK_ROOT

CCM_OBS_LPUART3_CLK_ROOT

CCM_OBS_LPUART4_CLK_ROOT

CCM_OBS_LPUART5_CLK_ROOT

CCM_OBS_LPUART6_CLK_ROOT

CCM_OBS_LPUART7_CLK_ROOT

CCM_OBS_LPUART8_CLK_ROOT

CCM_OBS_LPUART9_CLK_ROOT

CCM_OBS_LPUART10_CLK_ROOT

CCM_OBS_LPUART11_CLK_ROOT

CCM_OBS_LPUART12_CLK_ROOT

CCM_OBS_LPI2C1_CLK_ROOT

CCM_OBS_LPI2C2_CLK_ROOT

CCM_OBS_LPI2C3_CLK_ROOT

CCM_OBS_LPI2C4_CLK_ROOT

CCM_OBS_LPI2C5_CLK_ROOT

CCM_OBS_LPI2C6_CLK_ROOT

CCM_OBS_LPSPI1_CLK_ROOT

CCM_OBS_LPSPI2_CLK_ROOT

CCM_OBS_LPSPI3_CLK_ROOT

CCM_OBS_LPSPI4_CLK_ROOT

CCM_OBS_LPSPI5_CLK_ROOT

CCM_OBS_LPSPI6_CLK_ROOT

CCM_OBS_EMV1_CLK_ROOT

CCM_OBS_EMV2_CLK_ROOT

CCM_OBS_ENET1_CLK_ROOT

CCM_OBS_ENET2_CLK_ROOT

CCM_OBS_ENET_QOS_CLK_ROOT

CCM_OBS_ENET_25M_CLK_ROOT

CCM_OBS_ENET_TIMER1_CLK_ROOT

CCM_OBS_ENET_TIMER2_CLK_ROOT

CCM_OBS_ENET_TIMER3_CLK_ROOT

CCM_OBS_USDHC1_CLK_ROOT

CCM_OBS_USDHC2_CLK_ROOT

CCM_OBS_ASRC_CLK_ROOT

CCM_OBS_MQS_CLK_ROOT

CCM_OBS_MIC_CLK_ROOT

CCM_OBS_SPDIF_CLK_ROOT

CCM_OBS_SAI1_CLK_ROOT

CCM_OBS_SAI2_CLK_ROOT

CCM_OBS_SAI3_CLK_ROOT

CCM_OBS_SAI4_CLK_ROOT

CCM_OBS_GC355_CLK_ROOT

CCM_OBS_LCDIF_CLK_ROOT

CCM_OBS_LCDIFV2_CLK_ROOT

CCM_OBS_MIPI_REF_CLK_ROOT

CCM_OBS_MIPI_ESC_CLK_ROOT

CCM_OBS_CSI2_CLK_ROOT

CCM_OBS_CSI2_ESC_CLK_ROOT

CCM_OBS_CSI2_UI_CLK_ROOT

CCM_OBS_CSI_CLK_ROOT

CCM_OBS_CCM_CKO1_CLK_ROOT

CCM_OBS_CCM_CKO2_CLK_ROOT

CCM_OBS_CM7_CORE_STCLKEN

CCM_OBS_CCM_FLEXRAM_CLK_ROOT

CCM_OBS_MIPI_DSI_TXESC

CCM_OBS_MIPI_DSI_RXESC

CCM_OBS_OSC_RC_16M

CCM_OBS_OSC_RC_48M

CCM_OBS_OSC_RC_48M_DIV2

CCM_OBS_OSC_RC_400M

CCM_OBS_OSC_24M_OUT

CCM_OBS_ARM_PLL_OUT

CCM_OBS_SYS_PLL2_OUT

CCM_OBS_SYS_PLL2_PFD0

CCM_OBS_SYS_PLL2_PFD1

CCM_OBS_SYS_PLL2_PFD2

CCM_OBS_SYS_PLL2_PFD3

CCM_OBS_SYS_PLL3_OUT

CCM_OBS_SYS_PLL3_DIV2

CCM_OBS_SYS_PLL3_PFD0

CCM_OBS_SYS_PLL3_PFD1

CCM_OBS_SYS_PLL3_PFD2

CCM_OBS_SYS_PLL3_PFD3

CCM_OBS_SYS_PLL1_OUT

CCM_OBS_SYS_PLL1_DIV2

CCM_OBS_SYS_PLL1_DIV5

CCM_OBS_PLL_AUDIO_OUT

CCM_OBS_PLL_VIDEO_OUT

CCM_OBS_DIV

clock_ip_name_t

CLOCK_GetCpuClkFreq

CLOCK_GetCoreSysClkFreq

For compatible with other platforms without CCM.

PLL_PFD_COUNT

static inline uint32_t CLOCK_GetRtcFreq(void)

Gets the RTC clock frequency.

Returns

Clock frequency; If the clock is invalid, returns 0.

static inline void CLOCK_OSC_SetOsc48MControlMode(*clock_control_mode_t* controlMode)

Set the control mode of 48MHz RC oscillator.

Parameters

- controlMode – The control mode to be set, please refer to clock_control_mode_t.

static inline void CLOCK_OSC_EnableOsc48M(bool enable)

Enable/disable 48MHz RC oscillator.

Parameters

- enable – Used to enable or disable the 48MHz RC oscillator.
  - **true** Enable the 48MHz RC oscillator.
  - **false** Dissable the 48MHz RC oscillator.

static inline void CLOCK_OSC_SetOsc48MDiv2ControlMode(*clock_control_mode_t* controlMode)

Set the control mode of the 24MHz clock sourced from 48MHz RC oscillator.

Parameters

- controlMode – The control mode to be set, please refer to clock_control_mode_t.

static inline void CLOCK_OSC_EnableOsc48MDiv2(bool enable)

Enable/disable the 24MHz clock sourced from 48MHz RC oscillator.

Note: The 48MHz RC oscillator must be enabled before enabling this 24MHz clock.

Parameters

- enable – Used to enable/disable the 24MHz clock sourced from 48MHz RC oscillator.
  - **true** Enable the 24MHz clock sourced from 48MHz.
  - **false** Disable the 24MHz clock sourced from 48MHz.

static inline void CLOCK_OSC_SetOsc24MControlMode(*clock_control_mode_t* controlMode)

Set the control mode of 24MHz crystal oscillator.

Parameters

- controlMode – The control mode to be set, please refer to clock_control_mode_t.

void CLOCK_OSC_EnableOsc24M(void)

Enable OSC 24Mhz.

This function enables OSC 24Mhz.

static inline void CLOCK_OSC_GateOsc24M(bool enableGate)

Gate/ungate the 24MHz crystal oscillator output.

Note: Gating the 24MHz crystal oscillator can save power.

Parameters

- enableGate – Used to gate/ungate the 24MHz crystal oscillator.
  - **true** Gate the 24MHz crystal oscillator to save power.
  - **false** Ungate the 24MHz crystal oscillator.

void CLOCK_OSC_SetOsc24MWorkMode(*clock_24MOsc_mode_t* workMode)

Set the work mode of 24MHz crystal oscillator, the available modes are high gian mode, low power mode, and bypass mode.

Parameters

- workMode – The work mode of 24MHz crystal oscillator, please refer to clock_24MOsc_mode_t for details.

static inline void CLOCK_OSC_SetOscRc400MControlMode(*clock_control_mode_t* controlMode)

Set the control mode of 400MHz RC oscillator.

Parameters

- controlMode – The control mode to be set, please refer to clock_control_mode_t.

void CLOCK_OSC_EnableOscRc400M(void)

Enable OSC RC 400Mhz.

This function enables OSC RC 400Mhz.

static inline void CLOCK_OSC_GateOscRc400M(bool enableGate)

Gate/ungate 400MHz RC oscillator.

Parameters

- enableGate – Used to gate/ungate 400MHz RC oscillator.
  - **true** Gate the 400MHz RC oscillator.
  - **false** Ungate the 400MHz RC oscillator.

void CLOCK_OSC_TrimOscRc400M(bool enable, bool bypass, uint16_t trim)

Trims OSC RC 400MHz.

Parameters

- enable – Used to enable trim function.
- bypass – Bypass the trim function.
- trim – Trim value.

void CLOCK_OSC_SetOscRc400MRefClkDiv(uint8_t divValue)

Set the divide value for ref_clk to generate slow clock.

Note: slow_clk = ref_clk / (divValue + 1), and the recommand divide value is 24.

Parameters

- divValue – The divide value to be set, the available range is 0~63.

void CLOCK_OSC_SetOscRc400MFastClkCount(uint16_t targetCount)

Set the target count for the fast clock.

Parameters

- targetCount – The desired target for the fast clock, should be the number of clock cycles of the fast_clk per divided ref_clk.

void CLOCK_OSC_SetOscRc400MHysteresisValue(uint8_t negHysteresis, uint8_t posHysteresis)

Set the negative and positive hysteresis value for the tuned clock.

Note: The hysteresis value should be set after the clock is tuned.

Parameters

- negHysteresis – The negative hysteresis value for the turned clock, this value in number of clock cycles of the fast clock
- posHysteresis – The positive hysteresis value for the turned clock, this value in number of clock cycles of the fast clock

void CLOCK_OSC_BypassOscRc400MTuneLogic(bool enableBypass)

Bypass/un-bypass the tune logic.

Parameters

- enableBypass – Used to control whether to bypass the turn logic.
  - **true** Bypass the tune logic and use the programmed oscillator frequency to run the oscillator. Function CLOCK_OSC_SetOscRc400MTuneValue() can be used to set oscillator frequency.
  - **false** Use the output of tune logic to run the oscillator.

void CLOCK_OSC_EnableOscRc400MTuneLogic(bool enable)

Start/Stop the tune logic.

Parameters

- enable – Used to start or stop the tune logic.
  - **true** Start tuning
  - **false** Stop tuning and reset the tuning logic.

void CLOCK_OSC_FreezeOscRc400MTuneValue(bool enableFreeze)

Freeze/Unfreeze the tuning value.

Parameters

- enableFreeze – Used to control whether to freeze the tune value.
  - **true** Freeze the tune at the current tuned value and the oscillator runs at tje frozen tune value.
  - **false** Unfreezes and continues the tune operation.

void CLOCK_OSC_SetOscRc400MTuneValue(uint8_t tuneValue)

Set the 400MHz RC oscillator tune value when the tune logic is disabled.

Parameters

- tuneValue – The tune value to determine the frequency of Oscillator.

void CLOCK_OSC_Set1MHzOutputBehavior(*clock_1MHzOut_behavior_t* behavior)

Set the behavior of the 1MHz output clock, such as disable the 1MHz clock output, enable the free-running 1MHz clock output, enable the locked 1MHz clock output.

Note: The 1MHz clock is divided from 400M RC Oscillator.

Parameters

- behavior – The behavior of 1MHz output clock, please refer to clock_1MHzOut_behavior_t for details.

void CLOCK_OSC_SetLocked1MHzCount(uint16_t count)

Set the count for the locked 1MHz clock out.

Parameters

- count – Used to set the desired target for the locked 1MHz clock out, the value in number of clock cycles of the fast clock per divided ref_clk.

bool CLOCK_OSC_CheckLocked1MHzErrorFlag(void)

Check the error flag for locked 1MHz clock out.

Returns

The error flag for locked 1MHz clock out.

- **true** The count value has been reached within one diviced ref clock period
- **false** No effect.

void CLOCK_OSC_ClearLocked1MHzErrorFlag(void)

Clear the error flag for locked 1MHz clock out.

uint16_t CLOCK_OSC_GetCurrentOscRc400MFastClockCount(void)

Get current count for the fast clock during the tune process.

Returns

The current count for the fast clock.

uint8_t CLOCK_OSC_GetCurrentOscRc400MTuneValue(void)

Get current tune value used by oscillator during tune process.

Returns

The current tune value.

static inline void CLOCK_OSC_SetOsc16MControlMode(*clock_control_mode_t* controlMode)

Set the control mode of 16MHz crystal oscillator.

Parameters

- controlMode – The control mode to be set, please refer to clock_control_mode_t.

void CLOCK_OSC_SetOsc16MConfig(*clock_16MOsc_source_t* source, bool enablePowerSave, bool enableClockOut)

Configure the 16MHz oscillator.

Parameters

- source – Used to select the source for 16MHz RC oscillator, please refer to clock_16MOsc_source_t.
- enablePowerSave – Enable/disable power save mode function at 16MHz OSC.
  - **true** Enable power save mode function at 16MHz osc.
  - **false** Disable power save mode function at 16MHz osc.
- enableClockOut – Enable/Disable clock output for 16MHz RCOSC.
  - **true** Enable clock output for 16MHz RCOSC.
  - **false** Disable clock output for 16MHz RCOSC.

void CLOCK_InitArmPll(const *clock_arm_pll_config_t* *config)

Initialize the ARM PLL.

This function initialize the ARM PLL with specific settings

Parameters

- config – configuration to set to PLL.

status_t CLOCK_CalcArmPllFreq(*clock_arm_pll_config_t* *config, uint32_t freqInMhz)

Calculate corresponding config values per given frequency.

This function calculates config valudes per given frequency for Arm PLL

Parameters

- config – pll config structure
- freqInMhz – target frequency

status_t CLOCK_InitArmPllWithFreq(uint32_t freqInMhz)

Initializes the Arm PLL with Specific Frequency (in Mhz).

This function initializes the Arm PLL with specific frequency

Parameters

- freqInMhz – target frequency

void CLOCK_DeinitArmPll(void)

De-initialize the ARM PLL.

void CLOCK_CalcPllSpreadSpectrum(uint32_t factor, uint32_t range, uint32_t mod, *clock_pll_ss_config_t* *ss)

Calculate spread spectrum step and stop.

This function calculate spread spectrum step and stop according to given parameters. For integer PLL (syspll2) the factor is mfd, while for other fractional PLLs (audio/video/syspll1), the factor is denominator.

Parameters

- factor – factor to calculate step/stop
- range – spread spectrum range
- mod – spread spectrum modulation frequency
- ss – calculated spread spectrum values

void CLOCK_InitSysPll1(const *clock_sys_pll1_config_t* *config)

Initialize the System PLL1.

This function initializes the System PLL1 with specific settings

Parameters

- config – Configuration to set to PLL1.

void CLOCK_DeinitSysPll1(void)

De-initialize the System PLL1.

void CLOCK_GPC_SetSysPll1OutputFreq(const *clock_sys_pll1_gpc_config_t* *config)

Set System PLL1 output frequency in GPC mode.

Parameters

- config – Pointer to System PLL1 configure structure.

void CLOCK_InitSysPll2(const *clock_sys_pll2_config_t* *config)

Initialize the System PLL2.

This function initializes the System PLL2 with specific settings

Parameters

- config – Configuration to configure spread spectrum. This parameter can be NULL, if no need to enabled spread spectrum

void CLOCK_DeinitSysPll2(void)

De-initialize the System PLL2.

bool CLOCK_IsSysPll2PfdEnabled(*clock_pfd_t* pfd)

Check if Sys PLL2 PFD is enabled.

Note: Only useful in software control mode.

Parameters

- pfd – PFD control name

Returns

PFD bypass status.

- true: power on.
- false: power off.

void CLOCK_InitSysPll3(void)

Initialize the System PLL3.

This function initializes the System PLL3 with specific settings

void CLOCK_DeinitSysPll3(void)

De-initialize the System PLL3.

bool CLOCK_IsSysPll3PfdEnabled(*clock_pfd_t* pfd)

Check if Sys PLL3 PFD is enabled.

Note: Only useful in software control mode.

Parameters

- pfd – PFD control name

Returns

PFD bypass status.

- true: power on.
- false: power off.

void CLOCK_SetPllBypass(*clock_pll_t* pll, bool bypass)

PLL bypass setting.

Parameters

- pll – PLL control name (see clock_pll_t enumeration)
- bypass – Bypass the PLL.
  - true: Bypass the PLL.
  - false:Not bypass the PLL.

status_t CLOCK_CalcAvPllFreq(*clock_av_pll_config_t* *config, uint32_t freqInMhz)

Calculate corresponding config values per given frequency.

This function calculates config valudes per given frequency for Audio/Video PLL.

Parameters

- config – pll config structure
- freqInMhz – target frequency

status_t CLOCK_InitAudioPllWithFreq(uint32_t freqInMhz, bool ssEnable, uint32_t ssRange, uint32_t ssMod)

Initializes the Audio PLL with Specific Frequency (in Mhz).

This function initializes the Audio PLL with specific frequency

Parameters

- freqInMhz – target frequency
- ssEnable – enable spread spectrum or not
- ssRange – range spread spectrum range
- ssMod – spread spectrum modulation frequency

void CLOCK_InitAudioPll(const *clock_audio_pll_config_t* *config)

Initializes the Audio PLL.

This function initializes the Audio PLL with specific settings

Parameters

- config – Configuration to set to PLL.

void CLOCK_DeinitAudioPll(void)

De-initialize the Audio PLL.

void CLOCK_GPC_SetAudioPllOutputFreq(const *clock_audio_pll_gpc_config_t* *config)

Set Audio PLL output frequency in GPC mode.

Parameters

- config – Pointer to clock_audio_pll_gpc_config_t structure.

status_t CLOCK_InitVideoPllWithFreq(uint32_t freqInMhz, bool ssEnable, uint32_t ssRange, uint32_t ssMod)

Initializes the Video PLL with Specific Frequency (in Mhz).

This function initializes the Video PLL with specific frequency

Parameters

- freqInMhz – target frequency
- ssEnable – enable spread spectrum or not
- ssRange – range spread spectrum range
- ssMod – spread spectrum modulation frequency

void CLOCK_InitVideoPll(const *clock_video_pll_config_t* *config)

Initialize the video PLL.

This function configures the Video PLL with specific settings

Parameters

- config – configuration to set to PLL.

void CLOCK_DeinitVideoPll(void)

De-initialize the Video PLL.

void CLOCK_GPC_SetVideoPllOutputFreq(const *clock_video_pll_gpc_config_t* *config)

Set Video PLL output frequency in GPC mode.

Parameters

- config – Pointer to Vidoe PLL configure structure.

uint32_t CLOCK_GetPllFreq(*clock_pll_t* pll)

Get current PLL output frequency.

This function get current output frequency of specific PLL

Parameters

- pll – pll name to get frequency.

Returns

The PLL output frequency in hertz.

void CLOCK_InitPfd(*clock_pll_t* pll, *clock_pfd_t* pfd, uint8_t frac)

Initialize PLL PFD.

This function initializes the System PLL PFD. During new value setting, the clock output is disabled to prevent glitch.

Note: It is recommended that PFD settings are kept between 12-35.

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – Which PFD clock to enable.

- frac – The PFD FRAC value.

void CLOCK_DeinitPfd(*clock_pll_t* pll, *clock_pfd_t* pfd)

De-initialize selected PLL PFD.

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – Which PFD clock to enable.

uint32_t CLOCK_GetPfdFreq(*clock_pll_t* pll, *clock_pfd_t* pfd)

Get current PFD output frequency.

This function get current output frequency of specific System PLL PFD

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – pfd name to get frequency.

Returns

The PFD output frequency in hertz.

uint32_t CLOCK_GetFreqFromObs(uint32_t obsSigIndex, uint32_t obsIndex)

bool CLOCK_EnableUsbhs0Clock(*clock_usb_src_t* src, uint32_t freq)

Enable USB HS clock.

This function only enables the access to USB HS prepheral, upper layer should first call the CLOCK_EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

- src – USB HS does not care about the clock source, here must be kCLOCK_UsbSrcUnused.
- freq – USB HS does not care about the clock source, so this parameter is ignored.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

bool CLOCK_EnableUsbhs1Clock(*clock_usb_src_t* src, uint32_t freq)

Enable USB HS clock.

This function only enables the access to USB HS prepheral, upper layer should first call the CLOCK_EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

- src – USB HS does not care about the clock source, here must be kCLOCK_UsbSrcUnused.
- freq – USB HS does not care about the clock source, so this parameter is ignored.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

bool CLOCK_EnableUsbhs0PhyPllClock(*clock_usb_phy_src_t* src, uint32_t freq)

Enable USB HS PHY PLL clock.

This function enables the internal 480MHz USB PHY PLL clock.

Parameters

- src – USB HS PHY PLL clock source.
- freq – The frequency specified by src.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

void CLOCK_DisableUsbhs0PhyPllClock(void)

Disable USB HS PHY PLL clock.

This function disables USB HS PHY PLL clock.

bool CLOCK_EnableUsbhs1PhyPllClock(*clock_usb_phy_src_t* src, uint32_t freq)

Enable USB HS PHY PLL clock.

This function enables the internal 480MHz USB PHY PLL clock.

Parameters

- src – USB HS PHY PLL clock source.
- freq – The frequency specified by src.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

void CLOCK_DisableUsbhs1PhyPllClock(void)

Disable USB HS PHY PLL clock.

This function disables USB HS PHY PLL clock.

static inline void CLOCK_OSCPLL_LockControlMode(*clock_name_t* name)

Lock low power and access control mode for this clock.

Note: When this bit is set, bits 16-20 can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.

static inline void CLOCK_OSCPLL_LockWhiteList(*clock_name_t* name)

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.

static inline void CLOCK_OSCPLL_SetWhiteList(*clock_name_t* name, uint8_t domainId)

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.
- domainId – Domains that on the whitelist can change this clock.

static inline bool CLOCK_OSCPLL_IsSetPointImplemented(*clock_name_t* name)

Check whether this clock implement SetPoint control scheme.

Parameters

- name – Clock source name, see clock_name_t.

Returns

Clock source SetPoint implement status.

- true: SetPoint is implemented.
- false: SetPoint is not implemented.

static inline void CLOCK_OSCPLL_ControlByUnassignedMode(*clock_name_t* name)

Set this clock works in Unassigned Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.

void CLOCK_OSCPLL_ControlBySetPointMode(*clock_name_t* name, uint16_t spValue, uint16_t stbyValue)

Set this clock works in SetPoint control Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.
- spValue – Bit0~Bit15 hold value for Setpoint 0~16 respectively. A bitfield value of 0 implies clock will be shutdown in this Setpoint. A bitfield value of 1 implies clock will be turn on in this Setpoint.
- stbyValue – Bit0~Bit15 hold value for Setpoint 0~16 standby. A bitfield value of 0 implies clock will be shutdown during standby. A bitfield value of 1 represent clock will keep Setpoint setting during standby.

void CLOCK_OSCPLL_ControlByCpuLowPowerMode(*clock_name_t* name, uint8_t domainId, *clock_level_t* level0, *clock_level_t* level1)

Set this clock works in CPU Low Power Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.
- domainId – Domains that on the whitelist can change this clock.

- level1 (level0,) – Depend level of this clock.

static inline void CLOCK_OSCPLL_SetCurrentClockLevel(*clock_name_t* name, *clock_level_t* level)

Set clock depend level for current accessing domain.

Note: This setting only take effects in CPU Low Power Mode.

Parameters

- name – Clock source name, see clock_name_t.
- level – Depend level of this clock.

static inline void CLOCK_OSCPLL_ControlByDomainMode(*clock_name_t* name, uint8_t domainId)

Set this clock works in Domain Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.
- domainId – Domains that on the whitelist can change this clock.

static inline void CLOCK_ROOT_LockControlMode(*clock_root_t* name)

Lock low power and access control mode for this clock.

Note: When this bit is set, bits 16-20 can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.

static inline void CLOCK_ROOT_LockWhiteList(*clock_root_t* name)

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.

static inline void CLOCK_ROOT_SetWhiteList(*clock_root_t* name, uint8_t domainId)

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.

- domainId – Domains that on the whitelist can change this clock.

static inline bool CLOCK_ROOT_IsSetPointImplemented(*clock_root_t* name)

Check whether this clock implement SetPoint control scheme.

Parameters

- name – Clock root name, see clock_root_t.

Returns

Clock root SetPoint implement status.

- true: SetPoint is implemented.
- false: SetPoint is not implemented.

static inline void CLOCK_ROOT_ControlByUnassignedMode(*clock_root_t* name)

Set this clock works in Unassigned Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.

static inline void CLOCK_ROOT_ConfigSetPoint(*clock_root_t* name, uint16_t spIndex, const *clock_root_setpoint_config_t* *config)

Configure one SetPoint for this clock.

Note: SetPoint value could only be changed in Unassigend Mode.

Parameters

- name – Which clock root to set, see clock_root_t.
- spIndex – Which SetPoint of this clock root to set.
- config – SetPoint config, see clock_root_setpoint_config_t

static inline void CLOCK_ROOT_EnableSetPointControl(*clock_root_t* name)

Enable SetPoint control for this clock root.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.

void CLOCK_ROOT_ControlBySetPointMode(*clock_root_t* name, const *clock_root_setpoint_config_t* *spTable)

Set this clock works in SetPoint controlled Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.
- spTable – Point to the array that stores clock root settings for each setpoint. Note that the pointed array must have 16 elements.

static inline void CLOCK_ROOT_ControlByDomainMode(*clock_root_t* name, uint8_t domainId)

Set this clock works in CPU Low Power Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock root name, see clock_root_t.
- domainId – Domains that on the whitelist can change this clock.

static inline void CLOCK_LPCG_LockControlMode(*clock_lpcg_t* name)

Lock low power and access control mode for this clock.

Note: When this bit is set, bits 16-20 can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.

static inline void CLOCK_LPCG_LockWhiteList(*clock_lpcg_t* name)

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.

static inline void CLOCK_LPCG_SetWhiteList(*clock_lpcg_t* name, uint8_t domainId)

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.
- domainId – Domains that on the whitelist can change this clock.

static inline bool CLOCK_LPCG_IsSetPointImplemented(*clock_lpcg_t* name)

Check whether this clock implement SetPoint control scheme.

Parameters

- name – Clock gate name, see clock_lpcg_t.

Returns

Clock gate SetPoint implement status.

- true: SetPoint is implemented.

- false: SetPoint is not implemented.

static inline void CLOCK_LPCG_ControlByUnassignedMode(*clock_lpcg_t* name)

Set this clock works in Unassigned Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.

void CLOCK_LPCG_ControlBySetPointMode(*clock_lpcg_t* name, uint16_t spValue, uint16_t stbyValue)

Set this clock works in SetPoint control Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.
- spValue – Bit0~Bit15 hold value for Setpoint 0~16 respectively. A bitfield value of 0 implies clock will be shutdown in this Setpoint. A bitfield value of 1 implies clock will be turn on in this Setpoint.
- stbyValue – Bit0~Bit15 hold value for Setpoint 0~16 standby. A bitfield value of 0 implies clock will be shutdown during standby. A bitfield value of 1 represent clock will keep Setpoint setting during standby.

void CLOCK_LPCG_ControlByCpuLowPowerMode(*clock_lpcg_t* name, uint8_t domainId, *clock_level_t* level0, *clock_level_t* level1)

Set this clock works in CPU Low Power Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.
- domainId – Domains that on the whitelist can change this clock.
- level1 (level0,) – Depend level of this clock.

static inline void CLOCK_LPCG_SetCurrentClockLevel(*clock_lpcg_t* name, *clock_level_t* level)

Set clock depend level for current accessing domain.

Note: This setting only take effects in CPU Low Power Mode.

Parameters

- name – Clock gate name, see clock_lpcg_t.
- level – Depend level of this clock.

static inline void CLOCK_LPCG_ControlByDomainMode(*clock_lpcg_t* name, uint8_t domainId)

Set this clock works in Domain Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock gate name, see clock_lpcg_t.
- domainId – Domains that on the whitelist can change this clock.

bool clockOff

Turn off the clock.

uint16_t resetDiv

resetDiv + 1 should be common multiple of all dividers, valid range 0 ~ 255.

uint8_t div0

Divide root clock by div0 + 1, valid range: 0 ~ 15.

clock_pll_post_div_t postDivider

Post divider.

uint32_t loopDivider

PLL loop divider. Valid range: 104-208.

uint8_t loopDivider

PLL loop divider. 0 - Fout=Fref*20; 1 - Fout=Fref*22

uint8_t src

Pll clock source, reference _clock_pll_clk_src

uint16_t stop

Spread spectrum stop value to get frequency change.

uint16_t step

Spread spectrum step value to get frequency change step.

uint32_t mfd

Denominator of spread spectrum

clock_pll_ss_config_t *ss

Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable

Enable spread spectrum flag

bool pllDiv2En

Enable Sys Pll1 divide-by-2 clock or not.

bool pllDiv5En

Enable Sys Pll1 divide-by-5 clock or not.

clock_pll_ss_config_t *ss

Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable

Enable spread spectrum flag

uint8_t loopDivider
: PLL loop divider. Valid range for DIV_SELECT divider value: 27~54.

uint8_t postDivider
: Divider after the PLL, 0x0=divided by 1, 0x1=divided by 2, 0x2=divided by 4, 0x3=divided by 8, 0x4=divided by 16, 0x5=divided by 32.

uint32_t numerator
: 30 bit numerator of fractional loop divider.

uint32_t denominator
: 30 bit denominator of fractional loop divider

clock_pll_ss_config_t *ss
: Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable
: Enable spread spectrum flag

uint8_t loopDivider
: PLL loop divider.

uint32_t numerator
: 30 bit numerator of fractional loop divider.

uint32_t denominator
: 30 bit denominator of fractional loop divider

clock_pll_ss_config_t *ss
: Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable
: Enable spread spectrum flag

bool enableClkOutput
: Power on and enable PLL clock output for ENET0 (ref_enetpll0).

bool enableClkOutput25M
: Power on and enable PLL clock output for ENET2 (ref_enetpll2).

uint8_t loopDivider
: Controls the frequency of the ENET0 reference clock. b00 25MHz b01 50MHz b10 100MHz (not 50% duty cycle) b11 125MHz

uint8_t src
: Pll clock source, reference _clock_pll_clk_src

bool enableClkOutput1
: Power on and enable PLL clock output for ENET1 (ref_enetpll1).

uint8_t loopDivider1
: Controls the frequency of the ENET1 reference clock. b00 25MHz b01 50MHz b10 100MHz (not 50% duty cycle) b11 125MHz

bool clockOff

uint8_t mux
: See clock_root_mux_source_t for details.

uint8_t div
: it's the actual divider

uint8_t grade

Indicate speed grade for each SetPoint

bool clockOff

uint8_t mux

See clock_root_mux_source_t for details.

uint8_t div

it's the actual divider

FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL

Configure whether driver controls clock.

When set to 0, peripheral drivers will enable clock in initialize function and disable clock in de-initialize function. When set to 1, peripheral driver will not control the clock, application could control the clock out of the driver.

Note: All drivers share this feature switcher. If it is set to 1, application should handle clock enable and disable for all drivers.

---

struct _clock_group_config

#include <fsl_clock.h> The structure used to configure clock group.

struct _clock_arm_pll_config

#include <fsl_clock.h> PLL configuration for ARM.

The output clock frequency is:

Fout=Fin*loopDivider /(2 * postDivider).

Fin is always 24MHz.

struct _clock_usb_pll_config

#include <fsl_clock.h> PLL configuration for USB.

struct _clock_pll_ss_config

#include <fsl_clock.h> Spread specturm configure Pll.

struct _clock_sys_pll2_config

#include <fsl_clock.h> PLL configure for Sys Pll2.

struct _clock_sys_pll1_config

#include <fsl_clock.h> PLL configure for Sys Pll1.

struct _clock_audio_pll_config

#include <fsl_clock.h> PLL configuration for AUDIO and VIDEO.

struct _clock_audio_pll_gpc_config

#include <fsl_clock.h> PLL configuration fro AUDIO PLL, SYSTEM PLL1 and VIDEO PLL.

struct _clock_enet_pll_config

#include <fsl_clock.h> PLL configuration for ENET.

struct _clock_root_config_t

#include <fsl_clock.h> Clock root configuration.

struct _clock_root_setpoint_config_t

#include <fsl_clock.h> Clock root configuration in SetPoint Mode.

2.31 MIPI CSI2 RX: MIPI CSI2 RX Driver

FSL_CSI2RX_DRIVER_VERSION
CSI2RX driver version.

enum _csi2rx_data_lane
CSI2RX data lanes.

Values:

enumerator kCSI2RX_DataLane0
Data lane 0.

enumerator kCSI2RX_DataLane1
Data lane 1.

enumerator kCSI2RX_DataLane2
Data lane 2.

enumerator kCSI2RX_DataLane3
Data lane 3.

enum _csi2rx_payload
CSI2RX payload type.

Values:

enumerator kCSI2RX_PayloadGroup0Null
NULL.

enumerator kCSI2RX_PayloadGroup0Blank
Blank.

enumerator kCSI2RX_PayloadGroup0Embedded
Embedded.

enumerator kCSI2RX_PayloadGroup0YUV420_8Bit
Legacy YUV420 8 bit.

enumerator kCSI2RX_PayloadGroup0YUV422_8Bit
YUV422 8 bit.

enumerator kCSI2RX_PayloadGroup0YUV422_10Bit
YUV422 10 bit.

enumerator kCSI2RX_PayloadGroup0RGB444
RGB444.

enumerator kCSI2RX_PayloadGroup0RGB555
RGB555.

enumerator kCSI2RX_PayloadGroup0RGB565
RGB565.

enumerator kCSI2RX_PayloadGroup0RGB666
RGB666.

enumerator kCSI2RX_PayloadGroup0RGB888
RGB888.

enumerator kCSI2RX_PayloadGroup0Raw6
Raw 6.

enumerator kCSI2RX_PayloadGroup0Raw7
Raw 7.

enumerator kCSI2RX_PayloadGroup0Raw8
Raw 8.

enumerator kCSI2RX_PayloadGroup0Raw10
Raw 10.

enumerator kCSI2RX_PayloadGroup0Raw12
Raw 12.

enumerator kCSI2RX_PayloadGroup0Raw14
Raw 14.

enumerator kCSI2RX_PayloadGroup1UserDefined1
User defined 8-bit data type 1, 0x30.

enumerator kCSI2RX_PayloadGroup1UserDefined2
User defined 8-bit data type 2, 0x31.

enumerator kCSI2RX_PayloadGroup1UserDefined3
User defined 8-bit data type 3, 0x32.

enumerator kCSI2RX_PayloadGroup1UserDefined4
User defined 8-bit data type 4, 0x33.

enumerator kCSI2RX_PayloadGroup1UserDefined5
User defined 8-bit data type 5, 0x34.

enumerator kCSI2RX_PayloadGroup1UserDefined6
User defined 8-bit data type 6, 0x35.

enumerator kCSI2RX_PayloadGroup1UserDefined7
User defined 8-bit data type 7, 0x36.

enumerator kCSI2RX_PayloadGroup1UserDefined8
User defined 8-bit data type 8, 0x37.

enum __csi2rx_bit_error
MIPI CSI2RX bit errors.

Values:

enumerator kCSI2RX_BitErrorEccTwoBit
ECC two bit error has occurred.

enumerator kCSI2RX_BitErrorEccOneBit
ECC one bit error has occurred.

enum __csi2rx_ppi_error
MIPI CSI2RX PPI error types.

Values:

enumerator kCSI2RX_PpiErrorSotHs
CSI2RX DPHY PPI error ErrSotHS.

enumerator kCSI2RX_PpiErrorSotSyncHs
CSI2RX DPHY PPI error ErrSotSync_HS.

enumerator kCSI2RX_PpiErrorEsc
CSI2RX DPHY PPI error ErrEsc.

enumerator kCSI2RX_PpiErrorSyncEsc
CSI2RX DPHY PPI error ErrSyncEsc.

enumerator kCSI2RX_PpiErrorControl
CSI2RX DPHY PPI error ErrControl.

enum _csi2rx_interrupt
MIPI CSI2RX interrupt.

Values:

enumerator kCSI2RX_InterruptCrcError

enumerator kCSI2RX_InterruptEccOneBitError

enumerator kCSI2RX_InterruptEccTwoBitError

enumerator kCSI2RX_InterruptUlpsStatusChange

enumerator kCSI2RX_InterruptErrorSotHs

enumerator kCSI2RX_InterruptErrorSotSyncHs

enumerator kCSI2RX_InterruptErrorEsc

enumerator kCSI2RX_InterruptErrorSyncEsc

enumerator kCSI2RX_InterruptErrorControl

enum _csi2rx_ulps_status
MIPI CSI2RX D-PHY ULPS state.

Values:

enumerator kCSI2RX_ClockLaneUlps
Clock lane is in ULPS state.

enumerator kCSI2RX_DataLane0Ulps
Data lane 0 is in ULPS state.

enumerator kCSI2RX_DataLane1Ulps
Data lane 1 is in ULPS state.

enumerator kCSI2RX_DataLane2Ulps
Data lane 2 is in ULPS state.

enumerator kCSI2RX_DataLane3Ulps
Data lane 3 is in ULPS state.

enumerator kCSI2RX_ClockLaneMark
Clock lane is in mark state.

enumerator kCSI2RX_DataLane0Mark
Data lane 0 is in mark state.

enumerator kCSI2RX_DataLane1Mark
Data lane 1 is in mark state.

enumerator kCSI2RX_DataLane2Mark
Data lane 2 is in mark state.

enumerator kCSI2RX_DataLane3Mark
Data lane 3 is in mark state.

typedef struct *_csi2rx_config* csi2rx_config_t

CSI2RX configuration.

typedef enum *_csi2rx_ppi_error* csi2rx_ppi_error_t

MIPI CSI2RX PPI error types.

void CSI2RX_Init(MIPI_CSI2RX_Type *base, const *csi2rx_config_t* *config)

Enables and configures the CSI2RX peripheral module.

Parameters

- base – CSI2RX peripheral address.
- config – CSI2RX module configuration structure.

void CSI2RX_Deinit(MIPI_CSI2RX_Type *base)

Disables the CSI2RX peripheral module.

Parameters

- base – CSI2RX peripheral address.

static inline uint32_t CSI2RX_GetBitError(MIPI_CSI2RX_Type *base)

Gets the MIPI CSI2RX bit error status.

This function gets the RX bit error status, the return value could be compared with _csi2rx_bit_error. If one bit ECC error detected, the return value could be passed to the function CSI2RX_GetEccBitErrorPosition to get the position of the ECC error bit.

Example:

```
uint32_t bitError;
uint32_t bitErrorPosition;

bitError = CSI2RX_GetBitError(MIPI_CSI2RX);

if (kCSI2RX_BitErrorEccTwoBit & bitError)
{
    Two bits error;
}
else if (kCSI2RX_BitErrorEccOneBit & bitError)
{
    One bits error;
    bitErrorPosition = CSI2RX_GetEccBitErrorPosition(bitError);
}
```

Parameters

- base – CSI2RX peripheral address.

Returns

The RX bit error status.

static inline uint32_t CSI2RX_GetEccBitErrorPosition(uint32_t bitError)

Get ECC one bit error bit position.

If CSI2RX_GetBitError detects ECC one bit error, this function could extract the error bit position from the return value of CSI2RX_GetBitError.

Parameters

- bitError – The bit error returned by CSI2RX_GetBitError.

Returns

The position of error bit.

static inline uint32_t CSI2RX_GetUlpsStatus(MIPI_CSI2RX_Type *base)

Gets the MIPI CSI2RX D-PHY ULPS status.

Example to check whether data lane 0 is in ULPS status.

```
uint32_t status = CSI2RX_GetUlpsStatus(MIPI_CSI2RX);

if (kCSI2RX_DataLane0Ulps & status)
{
    Data lane 0 is in ULPS status.
}
```

Parameters

- base – CSI2RX peripheral address.

Returns

The MIPI CSI2RX D-PHY ULPS status, it is OR'ed value or _csi2rx_ulps_status.

static inline uint32_t CSI2RX_GetPpiErrorDataLanes(MIPI_CSI2RX_Type *base, *csi2rx_ppi_error_t* errorType)

Gets the MIPI CSI2RX D-PHY PPI error lanes.

This function checks the PPI error occurred on which data lanes, the returned value is OR'ed value of csi2rx_ppi_error_t. For example, if the ErrSotHS is detected, to check the ErrSotHS occurred on which data lanes, use like this:

```
uint32_t errorDataLanes = CSI2RX_GetPpiErrorDataLanes(MIPI_CSI2RX, kCSI2RX_
↪PpiErrorSotHs);

if (kCSI2RX_DataLane0 & errorDataLanes)
{
    ErrSotHS occurred on data lane 0.
}

if (kCSI2RX_DataLane1 & errorDataLanes)
{
    ErrSotHS occurred on data lane 1.
}
```

Parameters

- base – CSI2RX peripheral address.
- errorType – What kind of error to check.

Returns

The data lane mask that error errorType occurred.

static inline void CSI2RX_EnableInterrupts(MIPI_CSI2RX_Type *base, uint32_t mask)

Enable the MIPI CSI2RX interrupts.

This function enables the MIPI CSI2RX interrupts. The interrupts to enable are passed in as an OR'ed value of _csi2rx_interrupt. For example, to enable one bit and two bit ECC error interrupts, use like this:

```
CSI2RX_EnableInterrupts(MIPI_CSI2RX, kCSI2RX_InterruptEccOneBitError | kCSI2RX_
↪InterruptEccTwoBitError);
```

Parameters

- base – CSI2RX peripheral address.
- mask – OR'ed value of _csi2rx_interrupt.

static inline void CSI2RX_DisableInterrupts(MIPI_CSI2RX_Type *base, uint32_t mask)

Disable the MIPI CSI2RX interrupts.

This function disables the MIPI CSI2RX interrupts. The interrupts to disable are passed in as an OR'ed value of _csi2rx_interrupt. For example, to disable one bit and two bit ECC error interrupts, use like this:

```
CSI2RX_DisableInterrupts(MIPI_CSI2RX, kCSI2RX_InterruptEccOneBitError | kCSI2RX_
↪InterruptEccTwoBitError);
```

Parameters

- base – CSI2RX peripheral address.
- mask – OR'ed value of _csi2rx_interrupt.

static inline uint32_t CSI2RX_GetInterruptStatus(MIPI_CSI2RX_Type *base)

Get the MIPI CSI2RX interrupt status.

This function returns the MIPI CSI2RX interrupts status as an OR'ed value of _csi2rx_interrupt.

Parameters

- base – CSI2RX peripheral address.

Returns

OR'ed value of _csi2rx_interrupt.

CSI2RX_REG_CFG_NUM_LANES(base)

CSI2RX_REG_CFG_DISABLE_DATA_LANES(base)

CSI2RX_REG_BIT_ERR(base)

CSI2RX_REG_IRQ_STATUS(base)

CSI2RX_REG_IRQ_MASK(base)

CSI2RX_REG_ULPS_STATUS(base)

CSI2RX_REG_PPI_ERRSOT_HS(base)

CSI2RX_REG_PPI_ERRSOTSYNC_HS(base)

CSI2RX_REG_PPI_ERRESC(base)

CSI2RX_REG_PPI_ERRSYNCESC(base)

CSI2RX_REG_PPI_ERRCONTROL(base)

CSI2RX_REG_CFG_DISABLE_PAYLOAD_0(base)

CSI2RX_REG_CFG_DISABLE_PAYLOAD_1(base)

CSI2RX_REG_CFG_IGNORE_VC(base)

CSI2RX_REG_CFG_VID_VC(base)

CSI2RX_REG_CFG_VID_P_FIFO_SEND_LEVEL(base)

CSI2RX_REG_CFG_VID_VSYNC(base)

CSI2RX_REG_CFG_VID_HSYNC_FP(base)

CSI2RX_REG_CFG_VID_HSYNC(base)

CSI2RX_REG_CFG_VID_HSYNC_BP(base)

MIPI_CSI2RX_CSI2RX_CFG_NUM_LANES_csi2rx_cfg_num_lanes_MASK

MIPI_CSI2RX_CSI2RX_IRQ_MASK_csi2rx_irq_mask_MASK

struct _csi2rx_config

#include <fsl_mipi_csi2rx.h> CSI2RX configuration.

Public Members

uint8_t laneNum

Number of active lanes used for receiving data.

uint8_t tHsSettle_EscClk

Number of rx_clk_esc clock periods for T_HS_SETTLE. The T_HS_SETTLE should be in the range of 85ns + 6UI to 145ns + 10UI.

2.32 CSI: CMOS Sensor Interface

status_t CSI_Init(CSI_Type *base, const *csi_config_t* *config)

Initialize the CSI.

This function enables the CSI peripheral clock, and resets the CSI registers.

Parameters

- base – CSI peripheral base address.
- config – Pointer to the configuration structure.

Return values

- kStatus_Success – Initialize successfully.
- kStatus_InvalidArgument – Initialize failed because of invalid argument.

void CSI_Deinit(CSI_Type *base)

De-initialize the CSI.

This function disables the CSI peripheral clock.

Parameters

- base – CSI peripheral base address.

void CSI_Reset(CSI_Type *base)

Reset the CSI.

This function resets the CSI peripheral registers to default status.

Parameters

- base – CSI peripheral base address.

void CSI_GetDefaultConfig(*csi_config_t* *config)

Get the default configuration for to initialize the CSI.

The default configuration value is:

```
config->width = 320U;
config->height = 240U;
config->polarityFlags = kCSI_HsyncActiveHigh | kCSI_DataLatchOnRisingEdge;
config->bytesPerPixel = 2U;
config->linePitch_Bytes = 320U * 2U;
config->workMode = kCSI_GatedClockMode;
config->dataBus = kCSI_DataBus8Bit;
config->useExtVsync = true;
```

Parameters

- config – Pointer to the CSI configuration.

void CSI_ClearFifo(CSI_Type *base, *csi_fifo_t* fifo)

Clear the CSI FIFO.

This function clears the CSI FIFO.

Parameters

- base – CSI peripheral base address.
- fifo – The FIFO to clear.

void CSI_ReflashFifoDma(CSI_Type *base, *csi_fifo_t* fifo)

Reflash the CSI FIFO DMA.

This function reflashes the CSI FIFO DMA.

For RXFIFO, there are two frame buffers. When the CSI module started, it saves the frames to frame buffer 0 then frame buffer 1, the two buffers will be written by turns. After reflash DMA using this function, the CSI is reset to save frame to buffer 0.

Parameters

- base – CSI peripheral base address.
- fifo – The FIFO DMA to reflash.

void CSI_EnableFifoDmaRequest(CSI_Type *base, *csi_fifo_t* fifo, bool enable)

Enable or disable the CSI FIFO DMA request.

Parameters

- base – CSI peripheral base address.
- fifo – The FIFO DMA reques to enable or disable.
- enable – True to enable, false to disable.

static inline void CSI_Start(CSI_Type *base)

Start to receive data.

Parameters

- base – CSI peripheral base address.

static inline void CSI_Stop(CSI_Type *base)

Stop to receiving data.

Parameters

- base – CSI peripheral base address.

void CSI_SetRxBufferAddr(CSI_Type *base, uint8_t index, uint32_t addr)

Set the RX frame buffer address.

Parameters

- base – CSI peripheral base address.
- index – Buffer index.
- addr – Frame buffer address to set.

void CSI_EnableInterrupts(CSI_Type *base, uint32_t mask)

Enables CSI interrupt requests.

Parameters

- base – CSI peripheral base address.
- mask – The interrupts to enable, pass in as OR'ed value of _csi_interrupt_enable.

void CSI_DisableInterrupts(CSI_Type *base, uint32_t mask)

Disable CSI interrupt requests.

Parameters

- base – CSI peripheral base address.
- mask – The interrupts to disable, pass in as OR'ed value of _csi_interrupt_enable.

static inline uint32_t CSI_GetStatusFlags(CSI_Type *base)

Gets the CSI status flags.

Parameters

- base – CSI peripheral base address.

Returns

status flag, it is OR'ed value of _csi_flags.

static inline void CSI_ClearStatusFlags(CSI_Type *base, uint32_t statusMask)

Clears the CSI status flag.

The flags to clear are passed in as OR'ed value of _csi_flags. The following flags are cleared automatically by hardware:

- kCSI_RxFifoFullFlag,
- kCSI_StatFifoFullFlag,
- kCSI_Field0PresentFlag,
- kCSI_Field1PresentFlag,
- kCSI_RxFifoDataReadyFlag,

Parameters

- base – CSI peripheral base address.
- statusMask – The status flags mask, OR'ed value of _csi_flags.

status_t CSI_TransferCreateHandle(CSI_Type *base, *csi_handle_t* *handle, *csi_transfer_callback_t* callback, void *userData)

Initializes the CSI handle.

This function initializes CSI handle, it should be called before any other CSI transactional functions.

Parameters

- base – CSI peripheral base address.

- handle – Pointer to the handle structure.
- callback – Callback function for CSI transfer.
- userData – Callback function parameter.

Return values

kStatus_Success – Handle created successfully.

status_t CSI_TransferStart(CSI_Type *base, *csi_handle_t* *handle)

Start the transfer using transactional functions.

When the empty frame buffers have been submit to CSI driver using function CSI_TransferSubmitEmptyBuffer, user could call this function to start the transfer. The incoming frame will be saved to the empty frame buffer, and user could be optionally notified through callback function.

Parameters

- base – CSI peripheral base address.
- handle – Pointer to the handle structure.

Return values

- kStatus_Success – Started successfully.
- kStatus_CSI_NoEmptyBuffer – Could not start because no empty frame buffer in queue.

status_t CSI_TransferStop(CSI_Type *base, *csi_handle_t* *handle)

Stop the transfer using transactional functions.

The driver does not clean the full frame buffers in queue. In other words, after calling this function, user still could get the full frame buffers in queue using function CSI_TransferGetFullBuffer.

Parameters

- base – CSI peripheral base address.
- handle – Pointer to the handle structure.

Return values

kStatus_Success – Stoped successfully.

status_t CSI_TransferSubmitEmptyBuffer(CSI_Type *base, *csi_handle_t* *handle, uint32_t frameBuffer)

Submit empty frame buffer to queue.

This function could be called before CSI_TransferStart or after CSI_TransferStart. If there is no room in queue to store the empty frame buffer, this function returns error.

Parameters

- base – CSI peripheral base address.
- handle – Pointer to the handle structure.
- frameBuffer – Empty frame buffer to submit.

Return values

- kStatus_Success – Started successfully.
- kStatus_CSI_QueueFull – Could not submit because there is no room in queue.

status_t CSI_TransferGetFullBuffer(CSI_Type *base, *csi_handle_t* *handle, uint32_t *frameBuffer)

Get one full frame buffer from queue.

After the transfer started using function CSI_TransferStart, the incoming frames will be saved to the empty frame buffers in queue. This function gets the full-filled frame buffer from the queue. If there is no full frame buffer in queue, this function returns error.

Parameters

- base – CSI peripheral base address.
- handle – Pointer to the handle structure.
- frameBuffer – Full frame buffer.

Return values

- kStatus_Success – Started successfully.
- kStatus_CSI_NoFullBuffer – There is no full frame buffer in queue.

void CSI_TransferHandleIRQ(CSI_Type *base, *csi_handle_t* *handle)

CSI IRQ handle function.

This function handles the CSI IRQ request to work with CSI driver transactional APIs.

Parameters

- base – CSI peripheral base address.
- handle – CSI handle pointer.

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Error codes for the CSI driver.

Values:

enumerator kStatus_CSI_NoEmptyBuffer

No empty frame buffer in queue to load to CSI.

enumerator kStatus_CSI_NoFullBuffer

No full frame buffer in queue to read out.

enumerator kStatus_CSI_QueueFull

Queue is full, no room to save new empty buffer.

enumerator kStatus_CSI_FrameDone

New frame received and saved to queue.

enum _csi_work_mode

CSI work mode.

The CCIR656 interlace mode is not supported currently.

Values:

enumerator kCSI_GatedClockMode

HSYNC, VSYNC, and PIXCLK signals are used.

enumerator kCSI_NonGatedClockMode

VSYNC, and PIXCLK signals are used.

enumerator kCSI_CCIR656ProgressiveMode

CCIR656 progressive mode.

enum _csi_data_bus

CSI data bus witdh.

Values:

enumerator kCSI_DataBus8Bit

8-bit data bus.

enumerator kCSI_DataBus16Bit

16-bit data bus.

enumerator kCSI_DataBus24Bit

24-bit data bus.

enum _csi_polarity_flags

CSI signal polarity.

Values:

enumerator kCSI_HsyncActiveLow

HSYNC is active low.

enumerator kCSI_HsyncActiveHigh

HSYNC is active high.

enumerator kCSI_DataLatchOnRisingEdge

Pixel data latched at rising edge of pixel clock.

enumerator kCSI_DataLatchOnFallingEdge

Pixel data latched at falling edge of pixel clock.

enumerator kCSI_VsyncActiveHigh

VSYNC is active high.

enumerator kCSI_VsyncActiveLow

VSYNC is active low.

enum _csi_fifo

The CSI FIFO, used for FIFO operation.

Values:

enumerator kCSI_RxFifo

RXFIFO.

enumerator kCSI_StatFifo

STAT FIFO.

enumerator kCSI_AllFifo

Both RXFIFO and STAT FIFO.

enum _csi_interrupt_enable

CSI feature interrupt source.

Values:

enumerator kCSI_EndOfFrameInterruptEnable

End of frame interrupt enable.

enumerator kCSI_ChangeOfFieldInterruptEnable

Change of field interrupt enable.

enumerator kCSI_StatFifoOverrunInterruptEnable

STAT FIFO overrun interrupt enable.

enumerator kCSI_RxFifoOverrunInterruptEnable
RXFIFO overrun interrupt enable.

enumerator kCSI_StatFifoDmaDoneInterruptEnable
STAT FIFO DMA done interrupt enable.

enumerator kCSI_StatFifoFullInterruptEnable
STAT FIFO full interrupt enable.

enumerator kCSI_RxBuffer1DmaDoneInterruptEnable
RX frame buffer 1 DMA transfer done.

enumerator kCSI_RxBuffer0DmaDoneInterruptEnable
RX frame buffer 0 DMA transfer done.

enumerator kCSI_RxFifoFullInterruptEnable
RXFIFO full interrupt enable.

enumerator kCSI_StartOfFrameInterruptEnable
Start of frame (SOF) interrupt enable.

enumerator kCSI_EccErrorInterruptEnable
ECC error detection interrupt enable.

enumerator kCSI_AhbResErrorInterruptEnable
AHB response Error interrupt enable.

enumerator kCSI_BaseAddrChangeErrorInterruptEnable
The DMA output buffer base address changes before DMA completed.

enumerator kCSI_Field0DoneInterruptEnable
Field 0 done interrupt enable.

enumerator kCSI_Field1DoneInterruptEnable
Field 1 done interrupt enable.

enum _csi_flags
CSI status flags.

The following status register flags can be cleared:

- kCSI_EccErrorFlag
- kCSI_AhbResErrorFlag
- kCSI_ChangeOfFieldFlag
- kCSI_StartOfFrameFlag
- kCSI_EndOfFrameFlag
- kCSI_RxBuffer1DmaDoneFlag
- kCSI_RxBuffer0DmaDoneFlag
- kCSI_StatFifoDmaDoneFlag
- kCSI_StatFifoOverrunFlag
- kCSI_RxFifoOverrunFlag
- kCSI_Field0DoneFlag
- kCSI_Field1DoneFlag
- kCSI_BaseAddrChangeErrorFlag

Values:

enumerator kCSI_RxFifoDataReadyFlag
RXFIFO data ready.

enumerator kCSI_EccErrorFlag
ECC error detected.

enumerator kCSI_AhbResErrorFlag
Hresponse (AHB bus response) Error.

enumerator kCSI_ChangeOfFieldFlag
Change of field.

enumerator kCSI_Field0PresentFlag
Field 0 present in CCIR mode.

enumerator kCSI_Field1PresentFlag
Field 1 present in CCIR mode.

enumerator kCSI_StartOfFrameFlag
Start of frame (SOF) detected.

enumerator kCSI_EndOfFrameFlag
End of frame (EOF) detected.

enumerator kCSI_RxFifoFullFlag
RXFIFO full (Number of data reaches trigger level).

enumerator kCSI_RxBuffer1DmaDoneFlag
RX frame buffer 1 DMA transfer done.

enumerator kCSI_RxBuffer0DmaDoneFlag
RX frame buffer 0 DMA transfer done.

enumerator kCSI_StatFifoFullFlag
STAT FIFO full (Reach trigger level).

enumerator kCSI_StatFifoDmaDoneFlag
STAT FIFO DMA transfer done.

enumerator kCSI_StatFifoOverrunFlag
STAT FIFO overrun.

enumerator kCSI_RxFifoOverrunFlag
RXFIFO overrun.

enumerator kCSI_Field0DoneFlag
Field 0 transfer done.

enumerator kCSI_Field1DoneFlag
Field 1 transfer done.

enumerator kCSI_BaseAddrChangeErrorFlag
The DMA output buffer base address changes before DMA completed.

typedef enum *_csi_work_mode* csi_work_mode_t
CSI work mode.

The CCIR656 interlace mode is not supported currently.

typedef enum *_csi_data_bus* csi_data_bus_t
CSI data bus witdh.

typedef struct *_csi_config* csi_config_t

Configuration to initialize the CSI module.

typedef enum *_csi_fifo* csi_fifo_t

The CSI FIFO, used for FIFO operation.

typedef struct *_csi_handle* csi_handle_t

typedef void (*csi_transfer_callback_t)(CSI_Type *base, *csi_handle_t* *handle, *status_t* status, void *userData)

CSI transfer callback function.

When a new frame is received and saved to the frame buffer queue, the callback is called and the pass the status kStatus_CSI_FrameDone to upper layer.

CSI_REG_CR1(base)

CSI_REG_CR2(base)

CSI_REG_CR3(base)

CSI_REG_CR18(base)

CSI_REG_SR(base)

CSI_REG_DMASA_FB1(base)

CSI_REG_DMASA_FB2(base)

CSI_REG_IMAG_PARA(base)

CSI_REG_FBUF_PARA(base)

CSI_DRIVER_QUEUE_SIZE

Size of the frame buffer queue used in CSI transactional function.

CSI_DRIVER_FRAG_MODE

Enable fragment capture function or not.

CSI_CR1_INT_EN_MASK

CSI_CR3_INT_EN_MASK

CSI_CR18_INT_EN_MASK

struct _csi_config

#include <fsl_csi.h> Configuration to initialize the CSI module.

Public Members

uint16_t width

Pixels of the input frame.

uint16_t height

Lines of the input frame.

uint32_t polarityFlags

Timing signal polarity flags, OR'ed value of _csi_polarity_flags.

uint8_t bytesPerPixel
Bytes per pixel, valid values are:
- 2: Used for RGB565, YUV422, and so on.
- 4: Used for XRGB8888, XYUV444, and so on.

uint16_t linePitch_Bytes
Frame buffer line pitch, must be 8-byte aligned.

csi_work_mode_t workMode
CSI work mode.

csi_data_bus_t dataBus
Data bus width.

bool useExtVsync
In CCIR656 progressive mode, set true to use external VSYNC signal, set false to use internal VSYNC signal decoded from SOF.

struct buf_queue_t
#include <fsl_csi.h>

struct _csi_handle
#include <fsl_csi.h> CSI handle structure.

Please see the user guide for the details of the CSI driver queue mechanism.

Public Members

volatile uint8_t activeBufferNum
How many frame buffers are in progress currently.

volatile uint8_t dmaDoneBufferIdx
Index of the current full-filled framebuffer.

volatile bool transferStarted
User has called CSI_TransferStart to start frame receiving.

csi_transfer_callback_t callback
Callback function.

void *userData
CSI callback function parameter.

2.33 DAC12: 12-bit Digital-to-Analog Converter Driver

void DAC12_GetHardwareInfo(DAC_Type *base, *dac12_hardware_info_t* *info)
Get hardware information about this module.

Parameters
- base – DAC12 peripheral base address.
- info – Pointer to info structure, see to dac12_hardware_info_t.

void DAC12_Init(DAC_Type *base, const *dac12_config_t* *config)
Initialize the DAC12 module.

Parameters
- base – DAC12 peripheral base address.

- config – Pointer to configuration structure, see to dac12_config_t.

void DAC12_GetDefaultConfig(*dac12_config_t* *config)

Initializes the DAC12 user configuration structure.

This function initializes the user configuration structure to a default value. The default values are:

```
config->fifoWatermarkLevel = 0U;
config->fifoWorkMode = kDAC12_FIFODisabled;
config->referenceVoltageSource = kDAC12_ReferenceVoltageSourceAlt1;
config->fifoTriggerMode = kDAC12_FIFOTriggerByHardwareMode;
config->referenceCurrentSource = kDAC12_ReferenceCurrentSourceAlt0;
config->speedMode = kDAC12_SpeedLowMode;
config->speedMode = false;
config->currentReferenceInternalTrimValue = 0x4;
```

Parameters

- config – Pointer to the configuration structure. See "dac12_config_t".

void DAC12_Deinit(DAC_Type *base)

De-initialize the DAC12 module.

Parameters

- base – DAC12 peripheral base address.

static inline void DAC12_Enable(DAC_Type *base, bool enable)

Enable the DAC12's converter or not.

Parameters

- base – DAC12 peripheral base address.
- enable – Enable the DAC12's converter or not.

static inline void DAC12_ResetConfig(DAC_Type *base)

Reset all internal logic and registers.

Parameters

- base – DAC12 peripheral base address.

static inline void DAC12_ResetFIFO(DAC_Type *base)

Reset the FIFO pointers.

FIFO pointers should only be reset when the DAC12 is disabled. This function can be used to configure both pointers to the same address to reset the FIFO as empty.

Parameters

- base – DAC12 peripheral base address.

static inline uint32_t DAC12_GetStatusFlags(DAC_Type *base)

Get status flags.

Parameters

- base – DAC12 peripheral base address.

Returns

Mask of current status flags. See to _dac12_status_flags.

static inline void DAC12_ClearStatusFlags(DAC_Type *base, uint32_t flags)

Clear status flags.

Note: Not all the flags can be cleared by this API. Several flags need special condition to clear them according to target chip's reference manual document.

Parameters

- base – DAC12 peripheral base address.
- flags – Mask of status flags to be cleared. See to _dac12_status_flags.

static inline void DAC12_EnableInterrupts(DAC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – DAC12 peripheral base address.
- mask – Mask value of interrupts to be enabled. See to _dac12_interrupt_enable.

static inline void DAC12_DisableInterrupts(DAC_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – DAC12 peripheral base address.
- mask – Mask value of interrupts to be disabled. See to _dac12_interrupt_enable.

static inline void DAC12_EnableDMA(DAC_Type *base, bool enable)

Enable DMA or not.

When DMA is enabled, the DMA request will be generated by original interrupts. The interrupts will not be presented on this module at the same time.

static inline void DAC12_SetData(DAC_Type *base, uint32_t value)

Set data into the entry of FIFO buffer.

When the DAC FIFO is disabled, and the one entry buffer is enabled, the DAC converts the data in the buffer to analog output voltage. Any write to the DATA register will replace the data in the buffer and push data to analog conversion without trigger support. When the DAC FIFO is enabled. Writing data would increase the write pointer of FIFO. Also, the data would be restored into the FIFO buffer.

Parameters

- base – DAC12 peripheral base address.
- value – Setting value into FIFO buffer.

static inline void DAC12_DoSoftwareTrigger(DAC_Type *base)

Do trigger the FIFO by software.

When the DAC FIFO is enabled, and software trigger is used. Doing trigger would increase the read pointer, and the data in the entry pointed by read pointer would be converted as new output.

Parameters

- base – DAC12 peripheral base address.

static inline uint32_t DAC12_GetFIFOReadPointer(DAC_Type *base)

Get the current read pointer of FIFO.

Parameters

- base – DAC12 peripheral base address.

Returns

Read pointer index of FIFO buffer.

static inline uint32_t DAC12_GetFIFOWritePointer(DAC_Type *base)

Get the current write pointer of FIFO.

Parameters

- base – DAC12 peripheral base address.

Returns

Write pointer index of FIFO buffer

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enum _dac12_status_flags

DAC12 flags.

Values:

enumerator kDAC12_OverflowFlag

FIFO overflow status flag, which indicates that more data has been written into FIFO than it can hold.

enumerator kDAC12_UnderflowFlag

FIFO underflow status flag, which means that there is a new trigger after the FIFO is nearly empty.

enumerator kDAC12_WatermarkFlag

FIFO wartermark status flag, which indicates the remaining FIFO data is less than the watermark setting.

enumerator kDAC12_NearlyEmptyFlag

FIFO nearly empty flag, which means there is only one data remaining in FIFO.

enumerator kDAC12_FullFlag

FIFO full status flag, which means that the FIFO read pointer equals the write pointer, as the write pointer increase.

enum _dac12_interrupt_enable

DAC12 interrupts.

Values:

enumerator kDAC12_UnderOrOverflowInterruptEnable

Underflow and overflow interrupt enable.

enumerator kDAC12_WatermarkInterruptEnable

Watermark interrupt enable.

enumerator kDAC12_NearlyEmptyInterruptEnable

Nearly empty interrupt enable.

enumerator kDAC12_FullInterruptEnable

Full interrupt enable.

enum _dac12_fifo_size_info

DAC12 FIFO size information provided by hardware.

Values:

enumerator kDAC12_FIFOSize2

FIFO depth is 2.

enumerator kDAC12_FIFOSize4

FIFO depth is 4.

enumerator kDAC12_FIFOSize8
FIFO depth is 8.

enumerator kDAC12_FIFOSize16
FIFO depth is 16.

enumerator kDAC12_FIFOSize32
FIFO depth is 32.

enumerator kDAC12_FIFOSize64
FIFO depth is 64.

enumerator kDAC12_FIFOSize128
FIFO depth is 128.

enumerator kDAC12_FIFOSize256
FIFO depth is 256.

enum _dac12_fifo_work_mode
DAC12 FIFO work mode.

Values:

enumerator kDAC12_FIFODisabled
FIFO disabled and only one level buffer is enabled. Any data written from this buffer goes to conversion.

enumerator kDAC12_FIFOWorkAsNormalMode
Data will first read from FIFO to buffer then go to conversion.

enumerator kDAC12_FIFOWorkAsSwingMode
In Swing mode, the FIFO must be set up to be full. In Swing back mode, a trigger changes the read pointer to make it swing between the FIFO Full and Nearly Empty state. That is, the trigger increases the read pointer till FIFO is nearly empty and decreases the read pointer till the FIFO is full.

enum _dac12_reference_voltage_source
DAC12 reference voltage source.

Values:

enumerator kDAC12_ReferenceVoltageSourceAlt1
The DAC selects DACREF_1 as the reference voltage.

enumerator kDAC12_ReferenceVoltageSourceAlt2
The DAC selects DACREF_2 as the reference voltage.

enum _dac12_fifo_trigger_mode
DAC12 FIFO trigger mode.

Values:

enumerator kDAC12_FIFOTriggerByHardwareMode
Buffer would be triggered by hardware.

enumerator kDAC12_FIFOTriggerBySoftwareMode
Buffer would be triggered by software.

enum _dac12_reference_current_source
DAC internal reference current source.

Analog module needs reference current to keep working . Such reference current can generated by IP itself, or by on-chip PMC's "reference part". If no current reference be selected, analog module can't working normally ,even when other register can still

be assigned, DAC would waste current but no function. To make the DAC work, either kDAC12_ReferenceCurrentSourceAltx should be selected.

Values:

enumerator kDAC12_ReferenceCurrentSourceDisabled

None of reference current source is enabled.

enumerator kDAC12_ReferenceCurrentSourceAlt0

Use the internal reference current generated by the module itself.

enumerator kDAC12_ReferenceCurrentSourceAlt1

Use the ZTC(Zero Temperature Coefficient) reference current generated by on-chip power management module.

enumerator kDAC12_ReferenceCurrentSourceAlt2

Use the PTAT(Proportional To Absolution Temperature) reference current generated by power management module.

enum _dac12_speed_mode

DAC analog buffer speed mode for conversion.

Values:

enumerator kDAC12_SpeedLowMode

Low speed mode.

enumerator kDAC12_SpeedMiddleMode

Middle speed mode.

enumerator kDAC12_SpeedHighMode

High speed mode.

typedef enum *_dac12_fifo_size_info* dac12_fifo_size_info_t

DAC12 FIFO size information provided by hardware.

typedef enum *_dac12_fifo_work_mode* dac12_fifo_work_mode_t

DAC12 FIFO work mode.

typedef enum *_dac12_reference_voltage_source* dac12_reference_voltage_source_t

DAC12 reference voltage source.

typedef enum *_dac12_fifo_trigger_mode* dac12_fifo_trigger_mode_t

DAC12 FIFO trigger mode.

typedef enum *_dac12_reference_current_source* dac12_reference_current_source_t

DAC internal reference current source.

Analog module needs reference current to keep working . Such reference current can generated by IP itself, or by on-chip PMC's "reference part". If no current reference be selected, analog module can't working normally ,even when other register can still be assigned, DAC would waste current but no function. To make the DAC work, either kDAC12_ReferenceCurrentSourceAltx should be selected.

typedef enum *_dac12_speed_mode* dac12_speed_mode_t

DAC analog buffer speed mode for conversion.

typedef struct *_dac12_hardware_info* dac12_hardware_info_t

DAC12 hardware information.

DAC12_CR_W1C_FLAGS_MASK

Define "write 1 to clear" flags.

DAC12_CR_ALL_FLAGS_MASK

Define all the flag bits in DACx_CR register.

struct _dac12_hardware_info

#include <fsl_dac12.h> DAC12 hardware information.

Public Members

dac12_fifo_size_info_t fifoSizeInfo

The number of words in this device's DAC buffer.

struct dac12_config_t

#include <fsl_dac12.h> DAC12 module configuration.

Actually, the most fields are for FIFO buffer.

Public Members

uint32_t fifoWatermarkLevel

FIFO's watermark, the max value can be the hardware FIFO size.

dac12_fifo_work_mode_t fifoWorkMode

FIFI's work mode about pointers.

dac12_reference_voltage_source_t referenceVoltageSource

Select the reference voltage source.

dac12_reference_current_source_t referenceCurrentSource

Select the trigger mode for FIFO. Select the reference current source.

dac12_speed_mode_t speedMode

Select the speed mode for conversion.

bool enableAnalogBuffer

Enable analog buffer for high drive.

2.34 Dcdc_soc

void DCDC_Init(DCDC_Type *base, const *dcdc_config_t* *config)

Initializes the basic resource of DCDC module, such as control mode, etc.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to the dcdc_config_t structure.

void DCDC_Deinit(DCDC_Type *base)

De-initializes the DCDC module.

Parameters

- base – DCDC peripheral base address.

void DCDC_GetDefaultConfig(*dcdc_config_t* *config)

Gets the default setting for DCDC, such as control mode, etc.

This function initializes the user configuration structure to a default value. The default values are:

```
config->controlMode                  = kDCDC_StaticControl;
config->trimInputMode                = kDCDC_SampleTrimInput;
config->enableDcdcTimeout            = false;
config->enableSwitchingConverterOutput = false;
```

Parameters

- config – Pointer to configuration structure. See to dcdc_config_t.

static inline void DCDC_EnterLowPowerModeViaStandbyRequest(DCDC_Type *base, bool enable)

Makes the DCDC enter into low power mode for GPC standby request or not.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
  - **true** Makes DCDC enter into low power mode for GPC standby mode.

static inline void DCDC_EnterLowPowerMode(DCDC_Type *base, bool enable)

Makes DCDC enter into low power mode or not, before entering low power mode must disable stepping for VDD1P8 and VDD1P0.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
  - **true** Makes DCDC enter into low power mode.

static inline void DCDC_EnterStandbyMode(DCDC_Type *base, bool enable)

Makes DCDC enter into standby mode or not.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
  - **true** Makes DCDC enter into standby mode.

static inline void DCDC_SetVDD1P0StandbyModeTargetVoltage(DCDC_Type *base, *dcdc_standby_mode_1P0_target_vol_t* targetVoltage)

Sets the target value(ranges from 0.625V to 1.4V) of VDD1P0 in standby mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- targetVoltage – The target value of VDD1P0 in standby mode, see dcdc_standby_mode_1P0_target_vol_t.

static inline uint16_t DCDC_GetVDD1P0StandbyModeTargetVoltage(DCDC_Type *base)

Gets the target value of VDD1P0 in standby mode, the result takes “mV” as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P0’s voltage value in standby mode and the unit is “mV”.

static inline void DCDC_SetVDD1P8StandbyModeTargetVoltage(DCDC_Type *base, *dcdc_standby_mode_1P8_target_vol_t* targetVoltage)

Sets the target value(ranges from 1.525V to 2.3V) of VDD1P8 in standby mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- targetVoltage – The target value of VDD1P8 in standby mode, see dcdc_standby_mode_1P8_target_vol_t.

static inline uint16_t DCDC_GetVDD1P8StandbyModeTargetVoltage(DCDC_Type *base)

Gets the target value of VDD1P8 in standby mode, the result takes "mV" as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P8's voltage value in standby mode and the unit is "mV".

static inline void DCDC_SetVDD1P0BuckModeTargetVoltage(DCDC_Type *base, *dcdc_buck_mode_1P0_target_vol_t* targetVoltage)

Sets the target value(ranges from 0.6V to 1.375V) of VDD1P0 in buck mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- targetVoltage – The target value of VDD1P0 in buck mode, see dcdc_buck_mode_1P0_target_vol_t.

static inline uint16_t DCDC_GetVDD1P0BuckModeTargetVoltage(DCDC_Type *base)

Gets the target value of VDD1P0 in buck mode, the result takes "mV" as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P0's voltage value in buck mode and the unit is "mV".

static inline void DCDC_SetVDD1P8BuckModeTargetVoltage(DCDC_Type *base, *dcdc_buck_mode_1P8_target_vol_t* targetVoltage)

Sets the target value(ranges from 1.5V to 2.275V) of VDD1P8 in buck mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- targetVoltage – The target value of VDD1P8 in buck mode, see dcdc_buck_mode_1P8_target_vol_t.

static inline uint16_t DCDC_GetVDD1P8BuckModeTargetVoltage(DCDC_Type *base)

Gets the target value of VDD1P8 in buck mode, the result takes "mV" as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P8's voltage value in buck mode and the unit is "mV".

static inline void DCDC_EnableVDD1P0TargetVoltageStepping(DCDC_Type *base, bool enable)

Enables/Disables stepping for VDD1P0, before entering low power modes the stepping for VDD1P0 must be disabled.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
  - **true** Enables stepping for VDD1P0.
  - **false** Disables stepping for VDD1P0.

static inline void DCDC_EnableVDD1P8TargetVoltageStepping(DCDC_Type *base, bool enable)

Enables/Disables stepping for VDD1P8, before entering low power modes the stepping for VDD1P8 must be disabled.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
  - **true** Enables stepping for VDD1P8.
  - **false** Disables stepping for VDD1P8.

void DCDC_GetDefaultDetectionConfig(*dcdc_detection_config_t* *config)

Gets the default setting for detection configuration.

The default configuration are set according to responding registers' setting when powered on. They are:

```
config->enableXtalokDetection = false;
config->powerDownOverVoltageVdd1P8Detection = true;
config->powerDownOverVoltageVdd1P0Detection = true;
config->powerDownLowVoltageDetection  = false;
config->powerDownOverCurrentDetection = true;
config->powerDownPeakCurrentDetection = true;
config->powerDownZeroCrossDetection   = true;
config->OverCurrentThreshold          = kDCDC_OverCurrentThresholdAlt0;
config->PeakCurrentThreshold          = kDCDC_PeakCurrentThresholdAlt0;
```

Parameters

- config – Pointer to configuration structure. See to dcdc_detection_config_t.

void DCDC_SetDetectionConfig(DCDC_Type *base, const *dcdc_detection_config_t* *config)

Configures the DCDC detection.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to dcdc_detection_config_t.

static inline void DCDC_EnableOutputRangeComparator(DCDC_Type *base, bool enable)

Enables/Disables the output range comparator.

The output range comparator is disabled by default.

Parameters

- base – DCDC peripheral base address.
- enable – Enable the feature or not.
  - **true** Enable the output range comparator.

– **false** Disable the output range comparator.

void DCDC_SetClockSource(DCDC_Type *base, *dcdc_clock_source_t* clockSource)

Configures the DCDC clock source.

Parameters

- base – DCDC peripheral base address.
- clockSource – Clock source for DCDC. See to dcdc_clock_source_t.

void DCDC_GetDefaultLowPowerConfig(*dcdc_low_power_config_t* *config)

Gets the default setting for low power configuration.

The default configuration are set according to responding registers' setting when powered on. They are:

```
config->enableAdjustHystereticValue = false;
```

Parameters

- config – Pointer to configuration structure. See to dcdc_low_power_config_t.

void DCDC_SetLowPowerConfig(DCDC_Type *base, const *dcdc_low_power_config_t* *config)

Configures the DCDC low power.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to dcdc_low_power_config_t.

static inline void DCDC_SetBandgapVoltageTrimValue(DCDC_Type *base, uint32_t trimValue)

Sets the bangap trim value(0~31) to trim bandgap voltage.

Parameters

- base – DCDC peripheral base address.
- trimValue – The bangap trim value. Available range is 0U-31U.

void DCDC_GetDefaultLoopControlConfig(*dcdc_loop_control_config_t* *config)

Gets the default setting for loop control configuration.

The default configuration are set according to responding registers' setting when powered on. They are:

```
config->enableCommonHysteresis = false;
config->enableCommonThresholdDetection = false;
config->enableInvertHysteresisSign = false;
config->enableRCThresholdDetection = false;
config->enableRCScaleCircuit = 0U;
config->complementFeedForwardStep = 0U;
config->controlParameterMagnitude = 2U;
config->integralProportionalRatio = 2U;
```

Parameters

- config – Pointer to configuration structure. See to dcdc_loop_control_config_t.

void DCDC_SetLoopControlConfig(DCDC_Type *base, const *dcdc_loop_control_config_t* *config)

Configures the DCDC loop control.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to dcdc_loop_control_config_t.

void DCDC_SetMinPowerConfig(DCDC_Type *base, const *dcdc_min_power_config_t* *config)

Configures for the min power.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to dcdc_min_power_config_t.

static inline void DCDC_SetLPComparatorBiasValue(DCDC_Type *base, *dcdc_comparator_current_bias_t* biasValue)

Sets the current bias of low power comparator.

Parameters

- base – DCDC peripheral base address.
- biasValue – The current bias of low power comparator. Refer to dcdc_comparator_current_bias_t.

void DCDC_SetInternalRegulatorConfig(DCDC_Type *base, const *dcdc_internal_regulator_config_t* *config)

Configures the DCDC internal regulator.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to dcdc_internal_regulator_config_t.

static inline void DCDC_EnableAdjustDelay(DCDC_Type *base, bool enable)

Adjusts delay to reduce ground noise.

Parameters

- base – DCDC peripheral base address.
- enable – Enable the feature or not.

static inline void DCDC_EnableImproveTransition(DCDC_Type *base, bool enable)

Enables/Disables to improve the transition from heavy load to light load.

Note: It is valid while zero cross detection is enabled. If ouput exceeds the threshold, DCDC would return CCM from DCM.

Parameters

- base – DCDC peripheral base address.
- enable – Enable the feature or not.

void DCDC_SetPointInit(DCDC_Type *base, const *dcdc_setpoint_config_t* *config)

Initializes DCDC module when the control mode selected as setpoint mode.

Note: The function should be invoked in the initial step to config the DCDC via setpoint control mode.

Parameters

- base – DCDC peripheral base address.
- config – The pointer to the structure dcdc_setpoint_config_t.

static inline void DCDC_SetPointDeinit(DCDC_Type *base, uint32_t setpointMap)

Disable DCDC module when the control mode selected as setpoint mode.

Parameters

- base – DCDC peripheral base address.
- setpointMap – The map of the setpoint to disable the DCDC module, Should be the OR'ed value of _dcdc_setpoint_map.

static inline uint32_t DCDC_GetStatusFlags(DCDC_Type *base)

Get DCDC status flags.

Parameters

- base – peripheral base address.

Returns

Mask of asserted status flags. See to _dcdc_status_flags.

void DCDC_BootIntoDCM(DCDC_Type *base)

Boots DCDC into DCM(discontinous conduction mode).

```
pwd_zcd=0x0;
DM_CTRL = 1'b1;
pwd_cmp_offset=0x0;
dcdc_loopctrl_en_rcscale=0x3 or 0x5;
DCM_set_ctrl=1'b1;
```

Parameters

- base – DCDC peripheral base address.

void DCDC_BootIntoCCM(DCDC_Type *base)

Boots DCDC into CCM(continous conduction mode).

```
pwd_zcd=0x1;
pwd_cmp_offset=0x0;
dcdc_loopctrl_en_rcscale=0x3;
```

Parameters

- base – DCDC peripheral base address.

enum _dcdc_status_flags

The enumeration of DCDC status flags.

Values:

enumerator kDCDC_AlreadySettledStatusFlag

Indicate DCDC status. 1'b1: DCDC already settled 1'b0: DCDC is settling.

enum _dcdc_setpoint_map

System setpoints enumeration.

Values:

enumerator kDCDC_SetPoint0

Set point 0.

enumerator kDCDC_SetPoint1
Set point 1.

enumerator kDCDC_SetPoint2
Set point 2.

enumerator kDCDC_SetPoint3
Set point 3.

enumerator kDCDC_SetPoint4
Set point 4.

enumerator kDCDC_SetPoint5
Set point 5.

enumerator kDCDC_SetPoint6
Set point 6.

enumerator kDCDC_SetPoint7
Set point 7.

enumerator kDCDC_SetPoint8
Set point 8.

enumerator kDCDC_SetPoint9
Set point 9.

enumerator kDCDC_SetPoint10
Set point 10.

enumerator kDCDC_SetPoint11
Set point 11.

enumerator kDCDC_SetPoint12
Set point 12.

enumerator kDCDC_SetPoint13
Set point 13.

enumerator kDCDC_SetPoint14
Set point 14.

enumerator kDCDC_SetPoint15
Set point 15.

enum _dcdc_control_mode
DCDC control mode, including setpoint control mode and static control mode.

Values:

enumerator kDCDC_StaticControl
Static control.

enumerator kDCDC_SetPointControl
Controlled by GPC set points.

enum _dcdc_trim_input_mode
DCDC trim input mode, including sample trim input and hold trim input.

Values:

enumerator kDCDC_SampleTrimInput
Sample trim input.

enumerator kDCDC_HoldTrimInput
Hold trim input.

enum _dcdc_standby_mode_1P0_target_vol
The enumeration VDD1P0's target voltage value in standby mode.

Values:

enumerator kDCDC_1P0StbyTarget0P625V
In standby mode, the target voltage value of VDD1P0 is 0.625V.

enumerator kDCDC_1P0StbyTarget0P65V
In standby mode, the target voltage value of VDD1P0 is 0.65V.

enumerator kDCDC_1P0StbyTarget0P675V
In standby mode, the target voltage value of VDD1P0 is 0.675V.

enumerator kDCDC_1P0StbyTarget0P7V
In standby mode, the target voltage value of VDD1P0 is 0.7V.

enumerator kDCDC_1P0StbyTarget0P725V
In standby mode, the target voltage value of VDD1P0 is 0.725V.

enumerator kDCDC_1P0StbyTarget0P75V
In standby mode, the target voltage value of VDD1P0 is 0.75V.

enumerator kDCDC_1P0StbyTarget0P775V
In standby mode, the target voltage value of VDD1P0 is 0.775V.

enumerator kDCDC_1P0StbyTarget0P8V
In standby mode, the target voltage value of VDD1P0 is 0.8V.

enumerator kDCDC_1P0StbyTarget0P825V
In standby mode, the target voltage value of VDD1P0 is 0.825V.

enumerator kDCDC_1P0StbyTarget0P85V
In standby mode, the target voltage value of VDD1P0 is 0.85V.

enumerator kDCDC_1P0StbyTarget0P875V
In standby mode, the target voltage value of VDD1P0 is 0.875V.

enumerator kDCDC_1P0StbyTarget0P9V
In standby mode, the target voltage value of VDD1P0 is 0.9V.

enumerator kDCDC_1P0StbyTarget0P925V
In standby mode, the target voltage value of VDD1P0 is 0.925V.

enumerator kDCDC_1P0StbyTarget0P95V
In standby mode, the target voltage value of VDD1P0 is 0.95V.

enumerator kDCDC_1P0StbyTarget0P975V
In standby mode, the target voltage value of VDD1P0 is 0.975V.

enumerator kDCDC_1P0StbyTarget1P0V
In standby mode, the target voltage value of VDD1P0 is 1.0V.

enumerator kDCDC_1P0StbyTarget1P025V
In standby mode, the target voltage value of VDD1P0 is 1.025V.

enumerator kDCDC_1P0StbyTarget1P05V
In standby mode, the target voltage value of VDD1P0 is 1.05V.

enumerator kDCDC_1P0StbyTarget1P075V
In standby mode, the target voltage value of VDD1P0 is 1.075V.

enumerator kDCDC_1P0StbyTarget1P1V
In standby mode, the target voltage value of VDD1P0 is 1.1V.

enumerator kDCDC_1P0StbyTarget1P125V
In standby mode, the target voltage value of VDD1P0 is 1.125V.

enumerator kDCDC_1P0StbyTarget1P15V
In standby mode, the target voltage value of VDD1P0 is 1.15V.

enumerator kDCDC_1P0StbyTarget1P175V
In standby mode, the target voltage value of VDD1P0 is 1.175V.

enumerator kDCDC_1P0StbyTarget1P2V
In standby mode, the target voltage value of VDD1P0 is 1.2V.

enumerator kDCDC_1P0StbyTarget1P225V
In standby mode, the target voltage value of VDD1P0 is 1.225V.

enumerator kDCDC_1P0StbyTarget1P25V
In standby mode, the target voltage value of VDD1P0 is 1.25V.

enumerator kDCDC_1P0StbyTarget1P275V
In standby mode, the target voltage value of VDD1P0 is 1.275V.

enumerator kDCDC_1P0StbyTarget1P3V
In standby mode, the target voltage value of VDD1P0 is 1.3V.

enumerator kDCDC_1P0StbyTarget1P325V
In standby mode, the target voltage value of VDD1P0 is 1.325V.

enumerator kDCDC_1P0StbyTarget1P35V
In standby mode, the target voltage value of VDD1P0 is 1.35V.

enumerator kDCDC_1P0StbyTarget1P375V
In standby mode, the target voltage value of VDD1P0 is 1.375V.

enumerator kDCDC_1P0StbyTarget1P4V
In standby mode, The target voltage value of VDD1P0 is 1.4V

enum _dcdc_standby_mode_1P8_target_vol
The enumeration VDD1P8's target voltage value in standby mode.

Values:

enumerator kDCDC_1P8StbyTarget1P525V
In standby mode, the target voltage value of VDD1P8 is 1.525V.

enumerator kDCDC_1P8StbyTarget1P55V
In standby mode, the target voltage value of VDD1P8 is 1.55V.

enumerator kDCDC_1P8StbyTarget1P575V
In standby mode, the target voltage value of VDD1P8 is 1.575V.

enumerator kDCDC_1P8StbyTarget1P6V
In standby mode, the target voltage value of VDD1P8 is 1.6V.

enumerator kDCDC_1P8StbyTarget1P625V
In standby mode, the target voltage value of VDD1P8 is 1.625V.

enumerator kDCDC_1P8StbyTarget1P65V
In standby mode, the target voltage value of VDD1P8 is 1.65V.

enumerator kDCDC_1P8StbyTarget1P675V
In standby mode, the target voltage value of VDD1P8 is 1.675V.

enumerator kDCDC_1P8StbyTarget1P7V
In standby mode, the target voltage value of VDD1P8 is 1.7V.

enumerator kDCDC_1P8StbyTarget1P725V
In standby mode, the target voltage value of VDD1P8 is 1.725V.

enumerator kDCDC_1P8StbyTarget1P75V
In standby mode, the target voltage value of VDD1P8 is 1.75V.

enumerator kDCDC_1P8StbyTarget1P775V
In standby mode, the target voltage value of VDD1P8 is 1.775V.

enumerator kDCDC_1P8StbyTarget1P8V
In standby mode, the target voltage value of VDD1P8 is 1.8V.

enumerator kDCDC_1P8StbyTarget1P825V
In standby mode, the target voltage value of VDD1P8 is 1.825V.

enumerator kDCDC_1P8StbyTarget1P85V
In standby mode, the target voltage value of VDD1P8 is 1.85V.

enumerator kDCDC_1P8StbyTarget1P875V
In standby mode, the target voltage value of VDD1P8 is 1.875V.

enumerator kDCDC_1P8StbyTarget1P9V
In standby mode, the target voltage value of VDD1P8 is 1.9V.

enumerator kDCDC_1P8StbyTarget1P925V
In standby mode, the target voltage value of VDD1P8 is 1.925V.

enumerator kDCDC_1P8StbyTarget1P95V
In standby mode, the target voltage value of VDD1P8 is 1.95V.

enumerator kDCDC_1P8StbyTarget1P975V
In standby mode, the target voltage value of VDD1P8 is 1.975V.

enumerator kDCDC_1P8StbyTarget2P0V
In standby mode, the target voltage value of VDD1P8 is 2.0V.

enumerator kDCDC_1P8StbyTarget2P025V
In standby mode, the target voltage value of VDD1P8 is 2.025V.

enumerator kDCDC_1P8StbyTarget2P05V
In standby mode, the target voltage value of VDD1P8 is 2.05V.

enumerator kDCDC_1P8StbyTarget2P075V
In standby mode, the target voltage value of VDD1P8 is 2.075V.

enumerator kDCDC_1P8StbyTarget2P1V
In standby mode, the target voltage value of VDD1P8 is 2.1V.

enumerator kDCDC_1P8StbyTarget2P125V
In standby mode, the target voltage value of VDD1P8 is 2.125V.

enumerator kDCDC_1P8StbyTarget2P15V
In standby mode, the target voltage value of VDD1P8 is 2.15V.

enumerator kDCDC_1P8StbyTarget2P175V
In standby mode, the target voltage value of VDD1P8 is 2.175V.

enumerator kDCDC_1P8StbyTarget2P2V
In standby mode, the target voltage value of VDD1P8 is 2.2V.

enumerator kDCDC_1P8StbyTarget2P225V
In standby mode, the target voltage value of VDD1P8 is 2.225V.

enumerator kDCDC_1P8StbyTarget2P25V
In standby mode, the target voltage value of VDD1P8 is 2.25V.

enumerator kDCDC_1P8StbyTarget2P275V
In standby mode, the target voltage value of VDD1P8 is 2.275V.

enumerator kDCDC_1P8StbyTarget2P3V
In standby mode, the target voltage value is 2.3V.

enum _dcdc_buck_mode_1P0_target_vol
The enumeration VDD1P0's target voltage value in buck mode.

Values:

enumerator kDCDC_1P0BuckTarget0P6V
In buck mode, the target voltage value of VDD1P0 is 0.6V.

enumerator kDCDC_1P0BuckTarget0P625V
In buck mode, the target voltage value of VDD1P0 is 0.625V.

enumerator kDCDC_1P0BuckTarget0P65V
In buck mode, the target voltage value of VDD1P0 is 0.65V.

enumerator kDCDC_1P0BuckTarget0P675V
In buck mode, the target voltage value of VDD1P0 is 0.675V.

enumerator kDCDC_1P0BuckTarget0P7V
In buck mode, the target voltage value of VDD1P0 is 0.7V.

enumerator kDCDC_1P0BuckTarget0P725V
In buck mode, the target voltage value of VDD1P0 is 0.725V.

enumerator kDCDC_1P0BuckTarget0P75V
In buck mode, the target voltage value of VDD1P0 is 0.75V.

enumerator kDCDC_1P0BuckTarget0P775V
In buck mode, the target voltage value of VDD1P0 is 0.775V.

enumerator kDCDC_1P0BuckTarget0P8V
In buck mode, the target voltage value of VDD1P0 is 0.8V.

enumerator kDCDC_1P0BuckTarget0P825V
In buck mode, the target voltage value of VDD1P0 is 0.825V.

enumerator kDCDC_1P0BuckTarget0P85V
In buck mode, the target voltage value of VDD1P0 is 0.85V.

enumerator kDCDC_1P0BuckTarget0P875V
In buck mode, the target voltage value of VDD1P0 is 0.875V.

enumerator kDCDC_1P0BuckTarget0P9V
In buck mode, the target voltage value of VDD1P0 is 0.9V.

enumerator kDCDC_1P0BuckTarget0P925V
In buck mode, the target voltage value of VDD1P0 is 0.925V.

enumerator kDCDC_1P0BuckTarget0P95V
In buck mode, the target voltage value of VDD1P0 is 0.95V.

enumerator kDCDC_1P0BuckTarget0P975V
In buck mode, the target voltage value of VDD1P0 is 0.975V.

enumerator kDCDC_1P0BuckTarget1P0V
In buck mode, the target voltage value of VDD1P0 is 1.0V.

enumerator kDCDC_1P0BuckTarget1P025V
In buck mode, the target voltage value of VDD1P0 is 1.025V.

enumerator kDCDC_1P0BuckTarget1P05V
In buck mode, the target voltage value of VDD1P0 is 1.05V.

enumerator kDCDC_1P0BuckTarget1P075V
In buck mode, the target voltage value of VDD1P0 is 1.075V.

enumerator kDCDC_1P0BuckTarget1P1V
In buck mode, the target voltage value of VDD1P0 is 1.1V.

enumerator kDCDC_1P0BuckTarget1P125V
In buck mode, the target voltage value of VDD1P0 is 1.125V.

enumerator kDCDC_1P0BuckTarget1P15V
In buck mode, the target voltage value of VDD1P0 is 1.15V.

enumerator kDCDC_1P0BuckTarget1P175V
In buck mode, the target voltage value of VDD1P0 is 1.175V.

enumerator kDCDC_1P0BuckTarget1P2V
In buck mode, the target voltage value of VDD1P0 is 1.2V.

enumerator kDCDC_1P0BuckTarget1P225V
In buck mode, the target voltage value of VDD1P0 is 1.225V.

enumerator kDCDC_1P0BuckTarget1P25V
In buck mode, the target voltage value of VDD1P0 is 1.25V.

enumerator kDCDC_1P0BuckTarget1P275V
In buck mode, the target voltage value of VDD1P0 is 1.275V.

enumerator kDCDC_1P0BuckTarget1P3V
In buck mode, the target voltage value of VDD1P0 is 1.3V.

enumerator kDCDC_1P0BuckTarget1P325V
In buck mode, the target voltage value of VDD1P0 is 1.325V.

enumerator kDCDC_1P0BuckTarget1P35V
In buck mode, the target voltage value of VDD1P0 is 1.35V.

enumerator kDCDC_1P0BuckTarget1P375V
In buck mode, the target voltage value of VDD1P0 is 1.375V.

enum __dcdc_buck_mode_1P8_target_vol
The enumeration VDD1P8's target voltage value in buck mode.

Values:

enumerator kDCDC_1P8BuckTarget1P5V
In buck mode, the target voltage value of VDD1P0 is 1.5V.

enumerator kDCDC_1P8BuckTarget1P525V
In buck mode, the target voltage value of VDD1P0 is 1.525V.

enumerator kDCDC_1P8BuckTarget1P55V
In buck mode, the target voltage value of VDD1P0 is 1.55V.

enumerator kDCDC_1P8BuckTarget1P575V
In buck mode, the target voltage value of VDD1P0 is 1.575V.

enumerator kDCDC_1P8BuckTarget1P6V
In buck mode, the target voltage value of VDD1P0 is 1.6V.

enumerator kDCDC_1P8BuckTarget1P625V
In buck mode, the target voltage value of VDD1P0 is 1.625V.

enumerator kDCDC_1P8BuckTarget1P65V
In buck mode, the target voltage value of VDD1P0 is 1.65V.

enumerator kDCDC_1P8BuckTarget1P675V
In buck mode, the target voltage value of VDD1P0 is 1.675V.

enumerator kDCDC_1P8BuckTarget1P7V
In buck mode, the target voltage value of VDD1P0 is 1.7V.

enumerator kDCDC_1P8BuckTarget1P725V
In buck mode, the target voltage value of VDD1P0 is 1.725V.

enumerator kDCDC_1P8BuckTarget1P75V
In buck mode, the target voltage value of VDD1P0 is 1.75V.

enumerator kDCDC_1P8BuckTarget1P775V
In buck mode, the target voltage value of VDD1P0 is 1.775V.

enumerator kDCDC_1P8BuckTarget1P8V
In buck mode, the target voltage value of VDD1P0 is 1.8V.

enumerator kDCDC_1P8BuckTarget1P825V
In buck mode, the target voltage value of VDD1P0 is 1.825V.

enumerator kDCDC_1P8BuckTarget1P85V
In buck mode, the target voltage value of VDD1P0 is 1.85V.

enumerator kDCDC_1P8BuckTarget1P875V
In buck mode, the target voltage value of VDD1P0 is 1.875V.

enumerator kDCDC_1P8BuckTarget1P9V
In buck mode, the target voltage value of VDD1P0 is 1.9V.

enumerator kDCDC_1P8BuckTarget1P925V
In buck mode, the target voltage value of VDD1P0 is 1.925V.

enumerator kDCDC_1P8BuckTarget1P95V
In buck mode, the target voltage value of VDD1P0 is 1.95V.

enumerator kDCDC_1P8BuckTarget1P975V
In buck mode, the target voltage value of VDD1P0 is 1.975V.

enumerator kDCDC_1P8BuckTarget2P0V
In buck mode, the target voltage value of VDD1P0 is 2.0V.

enumerator kDCDC_1P8BuckTarget2P025V
In buck mode, the target voltage value of VDD1P0 is 2.025V.

enumerator kDCDC_1P8BuckTarget2P05V
In buck mode, the target voltage value of VDD1P0 is 2.05V.

enumerator kDCDC_1P8BuckTarget2P075V
In buck mode, the target voltage value of VDD1P0 is 2.075V.

enumerator kDCDC_1P8BuckTarget2P1V
In buck mode, the target voltage value of VDD1P0 is 2.1V.

enumerator kDCDC_1P8BuckTarget2P125V
In buck mode, the target voltage value of VDD1P0 is 2.125V.

enumerator kDCDC_1P8BuckTarget2P15V
In buck mode, the target voltage value of VDD1P0 is 2.15V.

enumerator kDCDC_1P8BuckTarget2P175V
In buck mode, the target voltage value of VDD1P0 is 2.175V.

enumerator kDCDC_1P8BuckTarget2P2V
In buck mode, the target voltage value of VDD1P0 is 2.2V.

enumerator kDCDC_1P8BuckTarget2P225V
In buck mode, the target voltage value of VDD1P0 is 2.225V.

enumerator kDCDC_1P8BuckTarget2P25V
In buck mode, the target voltage value of VDD1P0 is 2.25V.

enumerator kDCDC_1P8BuckTarget2P275V
In buck mode, the target voltage value of VDD1P0 is 2.275V.

enum _dcdc_comparator_current_bias
The current bias of low power comparator.

Values:

enumerator kDCDC_ComparatorCurrentBias50nA
The current bias of low power comparator is 50nA.

enumerator kDCDC_ComparatorCurrentBias100nA
The current bias of low power comparator is 100nA.

enumerator kDCDC_ComparatorCurrentBias200nA
The current bias of low power comparator is 200nA.

enumerator kDCDC_ComparatorCurrentBias400nA
The current bias of low power comparator is 400nA.

enum _dcdc_peak_current_threshold
The threshold if peak current detection.

Values:

enumerator kDCDC_PeakCurrentRunMode250mALPMode1P5A
Over peak current threshold in low power mode is 250mA, in run mode is 1.5A

enumerator kDCDC_PeakCurrentRunMode200mALPMode1P5A
Over peak current threshold in low power mode is 200mA, in run mode is 1.5A

enumerator kDCDC_PeakCurrentRunMode250mALPMode2A
Over peak current threshold in low power mode is 250mA, in run mode is 2A

enumerator kDCDC_PeakCurrentRunMode200mALPMode2A
Over peak current threshold in low power mode is 200mA, in run mode is 2A

enum _dcdc_clock_source
Oscillator clock option.

Values:

enumerator kDCDC_ClockAutoSwitch
Automatic clock switch from internal oscillator to external clock.

enumerator kDCDC_ClockInternalOsc
Use internal oscillator.

enumerator kDCDC_ClockExternalOsc
Use external 24M crystal oscillator.

enum _dcdc_voltage_output_sel
Voltage output option.

Values:

enumerator kDCDC_VoltageOutput1P8
1.8V output.

enumerator kDCDC_VoltageOutput1P0
1.0V output.

typedef enum *_dcdc_control_mode* dcdc_control_mode_t
DCDC control mode, including setpoint control mode and static control mode.

typedef enum *_dcdc_trim_input_mode* dcdc_trim_input_mode_t
DCDC trim input mode, including sample trim input and hold trim input.

typedef enum *_dcdc_standby_mode_1P0_target_vol* dcdc_standby_mode_1P0_target_vol_t
The enumeration VDD1P0's target voltage value in standby mode.

typedef enum *_dcdc_standby_mode_1P8_target_vol* dcdc_standby_mode_1P8_target_vol_t
The enumeration VDD1P8's target voltage value in standby mode.

typedef enum *_dcdc_buck_mode_1P0_target_vol* dcdc_buck_mode_1P0_target_vol_t
The enumeration VDD1P0's target voltage value in buck mode.

typedef enum *_dcdc_buck_mode_1P8_target_vol* dcdc_buck_mode_1P8_target_vol_t
The enumeration VDD1P8's target voltage value in buck mode.

typedef enum *_dcdc_comparator_current_bias* dcdc_comparator_current_bias_t
The current bias of low power comparator.

typedef enum *_dcdc_peak_current_threshold* dcdc_peak_current_threshold_t
The threshold if peak current detection.

typedef enum *_dcdc_clock_source* dcdc_clock_source_t
Oscillator clock option.

typedef enum *_dcdc_voltage_output_sel* dcdc_voltage_output_sel_t
Voltage output option.

typedef struct *_dcdc_config* dcdc_config_t
Configuration for DCDC.

typedef struct *_dcdc_min_power_config* dcdc_min_power_config_t
Configuration for min power setting.

typedef struct *_dcdc_detection_config* dcdc_detection_config_t
Configuration for DCDC detection.

typedef struct *_dcdc_loop_control_config* dcdc_loop_control_config_t
Configuration for the loop control.

typedef struct *_dcdc_internal_regulator_config* dcdc_internal_regulator_config_t
Configuration for DCDC internal regulator.

typedef struct *_dcdc_low_power_config* dcdc_low_power_config_t
Configuration for DCDC low power.

typedef struct *_dcdc_setpoint_config* dcdc_setpoint_config_t
DCDC configuration in set point mode.

FSL_DCDC_DRIVER_VERSION
DCDC driver version.

Version 2.1.2.

STANDBY_MODE_VDD1P0_TARGET_VOLTAGE
The array of VDD1P0 target voltage in standby mode.

STANDBY_MODE_VDD1P8_TARGET_VOLTAGE
The array of VDD1P8 target voltage in standby mode.

BUCK_MODE_VDD1P0_TARGET_VOLTAGE
The array of VDD1P0 target voltage in buck mode.

BUCK_MODE_VDD1P8_TARGET_VOLTAGE
The array of VDD1P8 target voltage in buck mode.

struct _dcdc_config
#include <fsl_dcdc.h> Configuration for DCDC.

Public Members

dcdc_control_mode_t controlMode
DCDC control mode.

dcdc_trim_input_mode_t trimInputMode
Hold trim input.

bool enableDcdcTimeout
Enable internal count for DCDC_OK timeout.

bool enableSwitchingConverterOutput
Enable the VDDIO switching converter output.

struct _dcdc_min_power_config
#include <fsl_dcdc.h> Configuration for min power setting.

Public Members

bool enableUseHalfFreqForContinuous
Set DCDC clock to half frequency for the continuous mode.

struct _dcdc_detection_config
#include <fsl_dcdc.h> Configuration for DCDC detection.

Public Members

bool enableXtalokDetection
: Enable xtalok detection circuit.

bool powerDownOverVoltageVdd1P8Detection
: Power down over-voltage detection comparator for VDD1P8.

bool powerDownOverVoltageVdd1P0Detection
: Power down over-voltage detection comparator for VDD1P0.

bool powerDownLowVoltageDetection
: Power down low-voltage detection comparator.

bool powerDownOverCurrentDetection
: Power down over-current detection.

bool powerDownPeakCurrentDetection
: Power down peak-current detection.

bool powerDownZeroCrossDetection
: Power down the zero cross detection function for discontinuous conductor mode.

dcdc_peak_current_threshold_t PeakCurrentThreshold
: The threshold of peak current detection.

struct __dcdc_loop_control_config
: *#include <fsl_dcdc.h>* Configuration for the loop control.

Public Members

bool enableCommonHysteresis
: Enable hysteresis in switching converter common mode analog comparators. This feature will improve transient supply ripple and efficiency.

bool enableCommonThresholdDetection
: Increase the threshold detection for common mode analog comparator.

bool enableDifferentialHysteresis
: Enable hysteresis in switching converter differential mode analog comparators. This feature will improve transient supply ripple and efficiency.

bool enableDifferentialThresholdDetection
: Increase the threshold detection for differential mode analog comparators.

bool enableInvertHysteresisSign
: Invert the sign of the hysteresis in DC-DC analog comparators.

bool enableRCThresholdDetection
: Increase the threshold detection for RC scale circuit.

uint32_t enableRCScaleCircuit
: Available range is 0~7. Enable analog circuit of DC-DC converter to respond faster under transient load conditions.

uint32_t complementFeedForwardStep
: Available range is 0~7. Two's complement feed forward step in duty cycle in the switching DC-DC converter. Each time this field makes a transition from 0x0, the loop filter of the DC-DC converter is stepped once by a value proportional to the change. This can be used to force a certain control loop behavior, such as improving response under known heavy load transients.

uint32_t controlParameterMagnitude

Available range is 0~15. Magnitude of proportional control parameter in the switching DC-DC converter control loop.

uint32_t integralProportionalRatio

Available range is 0~3.Ratio of integral control parameter to proportional control parameter in the switching DC-DC converter, and can be used to optimize efficiency and loop response.

struct _dcdc_internal_regulator_config

#include <fsl_dcdc.h> Configuration for DCDC internal regulator.

Public Members

uint32_t feedbackPoint

Available range is 0~3. Select the feedback point of the internal regulator.

struct _dcdc_low_power_config

#include <fsl_dcdc.h> Configuration for DCDC low power.

Public Members

bool enableAdjustHystereticValue

Adjust hysteretic value in low power from 12.5mV to 25mV.

struct _dcdc_setpoint_config

#include <fsl_dcdc.h> DCDC configuration in set point mode.

Public Members

uint32_t enableDCDCMap

The setpoint map that enable the DCDC module. Should be the OR'ed value of _dcdc_setpoint_map.

uint32_t enableDigLogicMap

The setpoint map that enable the DCDC dig logic. Should be the OR'ed value of _dcdc_setpoint_map.

uint32_t lowpowerMap

The setpoint map that enable the DCDC Low powermode. Should be the OR'ed value of _dcdc_setpoint_map.

uint32_t standbyMap

The setpoint map that enable the DCDC standby mode. Should be the OR'ed value of _dcdc_setpoint_map.

uint32_t standbyLowpowerMap

The setpoint map that enable the DCDC low power mode, when the related setpoint is in standby mode. Please refer to _dcdc_setpoint_map.

dcdc_buck_mode_1P8_target_vol_t *buckVDD1P8TargetVoltage

Point to the array that store the target voltage level of VDD1P8 in buck mode, please refer to dcdc_buck_mode_1P8_target_vol_t. Note that the pointed array must have 16 elements.

dcdc_buck_mode_1P0_target_vol_t *buckVDD1P0TargetVoltage

Point to the array that store the target voltage level of VDD1P0 in buck mode, please refer to dcdc_buck_mode_1P0_target_vol_t. Note that the pointed array must have 16 elements.

dcdc_standby_mode_1P8_target_vol_t *standbyVDD1P8TargetVoltage

Point to the array that store the target voltage level of VDD1P8 in standby mode, please refer to dcdc_standby_mode_1P8_target_vol_t. Note that the pointed array must have 16 elements.

dcdc_standby_mode_1P0_target_vol_t *standbyVDD1P0TargetVoltage

Point to the array that store the target voltage level of VDD1P0 in standby mode, please refer to dcdc_standby_mode_1P0_target_vol_t. Note that the pointed array must have 16 elements.

2.35 DCIC: Display Content Integrity Checker

2.36 DCIC

void DCIC_Init(DCIC_Type *base, const *dcic_config_t* *config)

Initializes the DCIC.

This function resets DCIC registers to default value, then set the configurations. This function does not start the DCIC to work, application should call DCIC_DisableRegion to configure regions, then call DCIC_Enable to start the DCIC to work.

Parameters

- base – DCIC peripheral base address.
- config – Pointer to the configuration.

void DCIC_Deinit(DCIC_Type *base)

Deinitialize the DCIC.

Disable the DCIC functions.

Parameters

- base – DCIC peripheral base address.

void DCIC_GetDefaultConfig(*dcic_config_t* *config)

Get the default configuration to initialize DCIC.

The default configuration is:

```
config->polarityFlags = kDCIC_VsyncActiveLow | kDCIC_HsyncActiveLow |
                        kDCIC_DataEnableActiveLow | kDCIC_DriveDataOnFallingClkEdge;
config->enableExternalSignal = false;
config->enableInterrupts = 0;
```

Parameters

- config – Pointer to the configuration.

static inline void DCIC_Enable(DCIC_Type *base, bool enable)

Enable or disable the DCIC module.

Parameters

- base – DCIC peripheral base address.

- enable – Use true to enable, false to disable.

static inline uint32_t DCIC_GetStatusFlags(DCIC_Type *base)

Get status flags.

The flag kDCIC_ErrorInterruptStatus is asserted if any region mismatch flag asserted.

base DCIC peripheral base address.

Returns

Masks of asserted status flags, _DCIC_status_flags.

static inline void DCIC_ClearStatusFlags(DCIC_Type *base, uint32_t mask)

Clear status flags.

The flag kDCIC_ErrorInterruptStatus should be cleared by clearing all asserted region mismatch flags.

base DCIC peripheral base address.

mask Mask of status values that would be cleared, _DCIC_status_flags.

static inline void DCIC_LockInterruptEnabledStatus(DCIC_Type *base)

Lock the interrupt enabled status.

Once this function is called, the interrupt enabled status could not be changed until reset.

Parameters

- base – DCIC peripheral base address.

static inline void DCIC_EnableInterrupts(DCIC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – DCIC peripheral base address.
- mask – Mask of interrupt events that would be enabled. See to "_dcic_interrupt_enable_t".

static inline void DCIC_DisableInterrupts(DCIC_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – DCIC peripheral base address.
- mask – Mask of interrupt events that would be disabled. See to "_dcic_interrupt_enable_t".

void DCIC_EnableRegion(DCIC_Type *base, uint8_t regionIdx, const *dcic_region_config_t* *config)

Enable the region of interest (ROI) with configuration.

Enable the ROI with configuration. To change the configuration except reference CRC value, the region should be disabled first by DCIC_DisableRegion, then call this function again. The reference CRC value could be changed by DCIC_SetRegionRefCrc without disabling the region. If the configuration is locked, only the reference CRC value could be changed, the region size and position, enable status could not be changed until reset.

Parameters

- base – DCIC peripheral base address.
- regionIdx – Region index, from 0 to (DCIC_REGION_COUNT - 1).
- config – Pointer to the configuration.

static inline void DCIC_DisableRegion(DCIC_Type *base, uint8_t regionIdx)

Disable the region of interest (ROI).

Parameters

- base – DCIC peripheral base address.
- regionIdx – Region index, from 0 to (DCIC_REGION_COUNT - 1).

static inline void DCIC_SetRegionRefCrc(DCIC_Type *base, uint8_t regionIdx, uint32_t crc)

Set the reference CRC of interest (ROI).

Parameters

- base – DCIC peripheral base address.
- regionIdx – Region index, from 0 to (DCIC_REGION_COUNT - 1).
- crc – The reference CRC value.

static inline uint32_t DCIC_GetRegionCalculatedCrc(DCIC_Type *base, uint8_t regionIdx)

Get the DCIC calculated CRC.

Parameters

- base – DCIC peripheral base address.
- regionIdx – Region index, from 0 to (DCIC_REGION_COUNT - 1).

Returns

The calculated CRC value.

static inline void DCIC_EnableMismatchExternalSignal(DCIC_Type *base, bool enable)

Enable or disable output the mismatch external signal.

The mismatch status can be output to external pins. If enabled:

- If kDCIC_ErrorInterruptStatus asserted, the output signal frequency is DCIC clock / 16.
- If kDCIC_ErrorInterruptStatus not asserted, the output signal frequency is DCIC clock / 4.
- If integrity check is disabled, the signal is idle.

Parameters

- base – DCIC peripheral base address.
- enable – Use true to enable, false to disable.

enum _DCIC_polarity_flags

DCIC display signal polarity flags .

Values:

enumerator kDCIC_VsyncActiveHigh

VSYNC active high.

enumerator kDCIC_HsyncActiveHigh

HSYNC active high.

enumerator kDCIC_DataEnableActiveHigh

Data enable line active high.

enumerator kDCIC_DriveDataOnFallingClkEdge

Output data on rising clock edge, capture data on falling clock edge.

enumerator kDCIC_VsyncActiveLow

VSYNC active low.

enumerator kDCIC_HsyncActiveLow
HSYNC active low.

enumerator kDCIC_DataEnableActiveLow
Data enable line active low.

enumerator kDCIC_DriveDataOnRisingClkEdge
Output data on falling clock edge, capture data on rising clock edge.

enum _DCIC_status_flags
Status flags. .

Values:

enumerator kDCIC_FunctionalInterruptStatus
Asserted when match results ready.

enumerator kDCIC_ErrorInterruptStatus
Asserted when there is a signature mismatch.

enumerator kDCIC_Region0MismatchStatus
Region 0 CRC32 value mismatch.

enumerator kDCIC_Region1MismatchStatus
Region 1 CRC32 value mismatch.

enumerator kDCIC_Region2MismatchStatus
Region 2 CRC32 value mismatch.

enumerator kDCIC_Region3MismatchStatus
Region 3 CRC32 value mismatch.

enumerator kDCIC_Region4MismatchStatus
Region 4 CRC32 value mismatch.

enumerator kDCIC_Region5MismatchStatus
Region 5 CRC32 value mismatch.

enumerator kDCIC_Region6MismatchStatus
Region 6 CRC32 value mismatch.

enumerator kDCIC_Region7MismatchStatus
Region 7 CRC32 value mismatch.

enumerator kDCIC_Region8MismatchStatus
Region 8 CRC32 value mismatch.

enumerator kDCIC_Region9MismatchStatus
Region 9 CRC32 value mismatch.

enumerator kDCIC_Region10MismatchStatus
Region 10 CRC32 value mismatch.

enumerator kDCIC_Region11MismatchStatus
Region 11 CRC32 value mismatch.

enumerator kDCIC_Region12MismatchStatus
Region 12 CRC32 value mismatch.

enumerator kDCIC_Region13MismatchStatus
Region 13 CRC32 value mismatch.

enumerator kDCIC_Region14MismatchStatus
Region 14 CRC32 value mismatch.

enumerator kDCIC_Region15MismatchStatus
Region 15 CRC32 value mismatch.

enum _dcic_interrupt_enable
Interrupts. .

Values:

enumerator kDCIC_FunctionalInterruptEnable
Interrupt when match results ready.

enumerator kDCIC_ErrorInterruptEnable
Interrupt when there is a signature mismatch.

typedef struct *_dcic_config* dcic_config_t
DCIC configuration.

typedef struct *_dcic_region_config* dcic_region_config_t
Region of interest (ROI) configuration.

DCIC_REGION_COUNT

FSL_DCIC_DRIVER_VERSION
DCIC driver version.

DCIC_CRC32_POLYNOMIAL
CRC32 calculation polynomial.

DCIC_CRC32_INIT_VALUE
CRC32 calculation initialize value.

DCIC_REGION_MISMATCH_STATUS(region)
ROI CRC32 value mismatch status.

struct _dcic_config
#include <fsl_dcic.h> DCIC configuration.

Public Members

bool enableExternalSignal
Enable the mismatch external signal. When enabled, the mismatch status could be monitored from the extern pin.

uint8_t polarityFlags
Display signal polarity, logical OR'ed of _DCIC_polarity_flags.

uint32_t enableInterrupts
Interrupts to enable, should be OR'ed of _dcic_interrupt_enable.

struct _dcic_region_config
#include <fsl_dcic.h> Region of interest (ROI) configuration.

Public Members

bool lock
Lock the region configuration except reference CRC32 value setting.

uint16_t upperLeftX
: X of upper left corner. Range: 0 to 2^13-1.

uint16_t upperLeftY
: Y of upper left corner. Range: 0 to 2^12-1.

uint16_t lowerRightX
: X of lower right corner. Range: 0 to 2^13-1.

uint16_t lowerRightY
: Y of lower right corner. Range: 0 to 2^12-1.

uint32_t refCrc
: Reference CRC32 value.

2.37 DMAMUX: Direct Memory Access Multiplexer Driver

void DMAMUX_Init(DMAMUX_Type *base)
: Initializes the DMAMUX peripheral.

  This function ungates the DMAMUX clock.

  Parameters

  - base – DMAMUX peripheral base address.

void DMAMUX_Deinit(DMAMUX_Type *base)
: Deinitializes the DMAMUX peripheral.

  This function gates the DMAMUX clock.

  Parameters

  - base – DMAMUX peripheral base address.

static inline void DMAMUX_EnableChannel(DMAMUX_Type *base, uint32_t channel)
: Enables the DMAMUX channel.

  This function enables the DMAMUX channel.

  Parameters

  - base – DMAMUX peripheral base address.
  - channel – DMAMUX channel number.

static inline void DMAMUX_DisableChannel(DMAMUX_Type *base, uint32_t channel)
: Disables the DMAMUX channel.

  This function disables the DMAMUX channel.

  Note: The user must disable the DMAMUX channel before configuring it.

  Parameters

  - base – DMAMUX peripheral base address.
  - channel – DMAMUX channel number.

static inline void DMAMUX_SetSource(DMAMUX_Type *base, uint32_t channel, int32_t source)

Configures the DMAMUX channel source.

Parameters

- base – DMAMUX peripheral base address.
- channel – DMAMUX channel number.
- source – Channel source, which is used to trigger the DMA transfer.User need to use the dma_request_source_t type as the input parameter.

static inline void DMAMUX_EnablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)

Enables the DMAMUX period trigger.

This function enables the DMAMUX period trigger feature.

Parameters

- base – DMAMUX peripheral base address.
- channel – DMAMUX channel number.

static inline void DMAMUX_DisablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)

Disables the DMAMUX period trigger.

This function disables the DMAMUX period trigger.

Parameters

- base – DMAMUX peripheral base address.
- channel – DMAMUX channel number.

static inline void DMAMUX_EnableAlwaysOn(DMAMUX_Type *base, uint32_t channel, bool enable)

Enables the DMA channel to be always ON.

This function enables the DMAMUX channel always ON feature.

Parameters

- base – DMAMUX peripheral base address.
- channel – DMAMUX channel number.
- enable – Switcher of the always ON feature. “true” means enabled, “false” means disabled.

FSL_DMAMUX_DRIVER_VERSION

DMAMUX driver version 2.1.1.

2.38 eDMA: Enhanced Direct Memory Access (eDMA) Controller Driver

void EDMA_Init(DMA_Type *base, const *edma_config_t* *config)

Initializes the eDMA peripheral.

This function ungates the eDMA clock and configures the eDMA peripheral according to the configuration structure. All emda enabled request will be cleared in this function.

Note: This function enables the minor loop map feature.

Parameters

- base – eDMA peripheral base address.
- config – A pointer to the configuration structure, see "edma_config_t".

void EDMA_Deinit(DMA_Type *base)

Deinitializes the eDMA peripheral.

This function gates the eDMA clock.

Parameters

- base – eDMA peripheral base address.

void EDMA_InstallTCD(DMA_Type *base, uint32_t channel, *edma_tcd_t* *tcd)

Push content of TCD structure into hardware TCD register.

Parameters

- base – EDMA peripheral base address.
- channel – EDMA channel number.
- tcd – Point to TCD structure.

void EDMA_GetDefaultConfig(*edma_config_t* *config)

Gets the eDMA default configuration structure.

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
config.enableContinuousLinkMode = false;
config.enableHaltOnError = true;
config.enableRoundRobinArbitration = false;
config.enableDebugMode = false;
```

Parameters

- config – A pointer to the eDMA configuration structure.

static inline void EDMA_EnableContinuousChannelLinkMode(DMA_Type *base, bool enable)

Enable/Disable continuous channel link mode.

Note: Do not use continuous link mode with a channel linking to itself if there is only one minor loop iteration per service request, for example, if the channel's NBYTES value is the same as either the source or destination size. The same data transfer profile can be achieved by simply increasing the NBYTES value, which provides more efficient, faster processing.

Parameters

- base – EDMA peripheral base address.
- enable – true is enable, false is disable.

static inline void EDMA_EnableMinorLoopMapping(DMA_Type *base, bool enable)

Enable/Disable minor loop mapping.

The TCDn.word2 is redefined to include individual enable fields, an offset field, and the NBYTES field.

Parameters

- base – EDMA peripheral base address.
- enable – true is enable, false is disable.

void EDMA_ResetChannel(DMA_Type *base, uint32_t channel)

Sets all TCD registers to default values.

This function sets TCD registers for this channel to default values.

Note: This function must not be called while the channel transfer is ongoing or it causes unpredictable results.

Note: This function enables the auto stop request feature.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.

void EDMA_SetTransferConfig(DMA_Type *base, uint32_t channel, const *edma_transfer_config_t* *config, *edma_tcd_t* *nextTcd)

Configures the eDMA transfer attribute.

This function configures the transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the TCD address. Example:

```
edma_transfer_t config;
edma_tcd_t tcd;
config.srcAddr = ..;
config.destAddr = ..;
...
EDMA_SetTransferConfig(DMA0, channel, &config, &stcd);
```

Note: If nextTcd is not NULL, it means scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the eDMA_ResetChannel.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- config – Pointer to eDMA transfer configuration structure.
- nextTcd – Point to TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

void EDMA_SetMinorOffsetConfig(DMA_Type *base, uint32_t channel, const *edma_minor_offset_config_t* *config)

Configures the eDMA minor offset feature.

The minor offset means that the signed-extended value is added to the source address or destination address after each minor loop.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- config – A pointer to the minor offset configuration structure.

void EDMA_SetChannelPreemptionConfig(DMA_Type *base, uint32_t channel, const *edma_channel_Preemption_config_t* *config)

Configures the eDMA channel preemption feature.

This function configures the channel preemption attribute and the priority of the channel.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number
- config – A pointer to the channel preemption configuration structure.

void EDMA_SetChannelLink(DMA_Type *base, uint32_t channel, *edma_channel_link_type_t* linkType, uint32_t linkedChannel)

Sets the channel link for the eDMA transfer.

This function configures either the minor link or the major link mode. The minor link means that the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

Note: Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- linkType – A channel link type, which can be one of the following:
  - kEDMA_LinkNone
  - kEDMA_MinorLink
  - kEDMA_MajorLink
- linkedChannel – The linked channel number.

void EDMA_SetBandWidth(DMA_Type *base, uint32_t channel, *edma_bandwidth_t* bandWidth)

Sets the bandwidth for the eDMA transfer.

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- bandWidth – A bandwidth setting, which can be one of the following:
  - kEDMABandwidthStallNone
  - kEDMABandwidthStall4Cycle
  - kEDMABandwidthStall8Cycle

void EDMA_SetModulo(DMA_Type *base, uint32_t channel, *edma_modulo_t* srcModulo, *edma_modulo_t* destModulo)

Sets the source modulo and the destination modulo for the eDMA transfer.

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- srcModulo – A source modulo value.
- destModulo – A destination modulo value.

static inline void EDMA_EnableAsyncRequest(DMA_Type *base, uint32_t channel, bool enable)

Enables an async request for the eDMA transfer.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- enable – The command to enable (true) or disable (false).

static inline void EDMA_EnableAutoStopRequest(DMA_Type *base, uint32_t channel, bool enable)

Enables an auto stop request for the eDMA transfer.

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- enable – The command to enable (true) or disable (false).

void EDMA_EnableChannelInterrupts(DMA_Type *base, uint32_t channel, uint32_t mask)

Enables the interrupt source for the eDMA transfer.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- mask – The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type.

void EDMA_DisableChannelInterrupts(DMA_Type *base, uint32_t channel, uint32_t mask)

Disables the interrupt source for the eDMA transfer.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- mask – The mask of the interrupt source to be set. Use the defined edma_interrupt_enable_t type.

void EDMA_SetMajorOffsetConfig(DMA_Type *base, uint32_t channel, int32_t sourceOffset, int32_t destOffset)

Configures the eDMA channel TCD major offset feature.

Adjustment value added to the source address at the completion of the major iteration count

Parameters

- base – eDMA peripheral base address.
- channel – edma channel number.
- sourceOffset – source address offset will be applied to source address after major loop done.
- destOffset – destination address offset will be applied to source address after major loop done.

void EDMA_TcdReset(*edma_tcd_t* *tcd)

Sets all fields to default values for the TCD structure.

This function sets all fields for this TCD structure to default value.

Note: This function enables the auto stop request feature.

Parameters

- tcd – Pointer to the TCD structure.

void EDMA_TcdSetTransferConfig(*edma_tcd_t* *tcd, const *edma_transfer_config_t* *config, *edma_tcd_t* *nextTcd)

Configures the eDMA TCD transfer attribute.

The TCD is a transfer control descriptor. The content of the TCD is the same as the hardware TCD registers. The TCD is used in the scatter-gather mode. This function configures the TCD transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the next TCD address. Example:

```
edma_transfer_t config = {
...
}
edma_tcd_t tcd __aligned(32);
edma_tcd_t nextTcd __aligned(32);
EDMA_TcdSetTransferConfig(&tcd, &config, &nextTcd);
```

Note: TCD address should be 32 bytes aligned or it causes an eDMA error.

Note: If the nextTcd is not NULL, the scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the EDMA_TcdReset.

Parameters

- tcd – Pointer to the TCD structure.
- config – Pointer to eDMA transfer configuration structure.
- nextTcd – Pointer to the next TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

void EDMA_TcdSetMinorOffsetConfig(*edma_tcd_t* *tcd, const *edma_minor_offset_config_t* *config)

Configures the eDMA TCD minor offset feature.

A minor offset is a signed-extended value added to the source address or a destination address after each minor loop.

Parameters

- tcd – A point to the TCD structure.
- config – A pointer to the minor offset configuration structure.

void EDMA_TcdSetChannelLink(*edma_tcd_t* *tcd, *edma_channel_link_type_t* linkType, uint32_t linkedChannel)

Sets the channel link for the eDMA TCD.

This function configures either a minor link or a major link. The minor link means the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

Note: Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

Parameters

- tcd – Point to the TCD structure.
- linkType – Channel link type, it can be one of:
  - kEDMA_LinkNone
  - kEDMA_MinorLink
  - kEDMA_MajorLink
- linkedChannel – The linked channel number.

static inline void EDMA_TcdSetBandWidth(*edma_tcd_t* *tcd, *edma_bandwidth_t* bandWidth)

Sets the bandwidth for the eDMA TCD.

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

Parameters

- tcd – A pointer to the TCD structure.
- bandWidth – A bandwidth setting, which can be one of the following:
  - kEDMABandwidthStallNone
  - kEDMABandwidthStall4Cycle
  - kEDMABandwidthStall8Cycle

void EDMA_TcdSetModulo(*edma_tcd_t* *tcd, *edma_modulo_t* srcModulo, *edma_modulo_t* destModulo)

Sets the source modulo and the destination modulo for the eDMA TCD.

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

Parameters

- tcd – A pointer to the TCD structure.
- srcModulo – A source modulo value.
- destModulo – A destination modulo value.

static inline void EDMA_TcdEnableAutoStopRequest(*edma_tcd_t* *tcd, bool enable)

Sets the auto stop request for the eDMA TCD.

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

Parameters

- tcd – A pointer to the TCD structure.
- enable – The command to enable (true) or disable (false).

void EDMA_TcdEnableInterrupts(*edma_tcd_t* *tcd, uint32_t mask)

Enables the interrupt source for the eDMA TCD.

Parameters

- tcd – Point to the TCD structure.
- mask – The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type.

void EDMA_TcdDisableInterrupts(*edma_tcd_t* *tcd, uint32_t mask)

Disables the interrupt source for the eDMA TCD.

Parameters

- tcd – Point to the TCD structure.
- mask – The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type.

void EDMA_TcdSetMajorOffsetConfig(*edma_tcd_t* *tcd, int32_t sourceOffset, int32_t destOffset)

Configures the eDMA TCD major offset feature.

Adjustment value added to the source address at the completion of the major iteration count

Parameters

- tcd – A point to the TCD structure.
- sourceOffset – source address offset wiil be applied to source address after major loop done.
- destOffset – destination address offset will be applied to source address after major loop done.

static inline void EDMA_EnableChannelRequest(DMA_Type *base, uint32_t channel)

Enables the eDMA hardware channel request.

This function enables the hardware channel request.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.

static inline void EDMA_DisableChannelRequest(DMA_Type *base, uint32_t channel)

Disables the eDMA hardware channel request.

This function disables the hardware channel request.

Parameters

- base – eDMA peripheral base address.

- channel – eDMA channel number.

static inline void EDMA_TriggerChannelStart(DMA_Type *base, uint32_t channel)

Starts the eDMA transfer by using the software trigger.

This function starts a minor loop transfer.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.

uint32_t EDMA_GetRemainingMajorLoopCount(DMA_Type *base, uint32_t channel)

Gets the remaining major loop count from the eDMA current channel TCD.

This function checks the TCD (Task Control Descriptor) status for a specified eDMA channel and returns the number of major loop count that has not finished.

Note: 1. This function can only be used to get unfinished major loop count of transfer without the next TCD, or it might be inaccuracy.

a. The unfinished/remaining transfer bytes cannot be obtained directly from registers while the channel is running. Because to calculate the remaining bytes, the initial NBYTES configured in DMA_TCDn_NBYTES_MLNO register is needed while the eDMA IP does not support getting it while a channel is active. In another word, the NBYTES value reading is always the actual (decrementing) NBYTES value the dma_engine is working with while a channel is running. Consequently, to get the remaining transfer bytes, a software-saved initial value of NBYTES (for example copied before enabling the channel) is needed. The formula to calculate it is shown below: RemainingBytes = RemainingMajorLoopCount * NBYTES(initially configured)

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.

Returns

Major loop count which has not been transferred yet for the current TCD.

static inline uint32_t EDMA_GetErrorStatusFlags(DMA_Type *base)

Gets the eDMA channel error status flags.

Parameters

- base – eDMA peripheral base address.

Returns

The mask of error status flags. Users need to use the _edma_error_status_flags type to decode the return variables.

uint32_t EDMA_GetChannelStatusFlags(DMA_Type *base, uint32_t channel)

Gets the eDMA channel status flags.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.

Returns

The mask of channel status flags. Users need to use the _edma_channel_status_flags type to decode the return variables.

void EDMA_ClearChannelStatusFlags(DMA_Type *base, uint32_t channel, uint32_t mask)

Clears the eDMA channel status flags.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- mask – The mask of channel status to be cleared. Users need to use the defined _edma_channel_status_flags type.

void EDMA_CreateHandle(*edma_handle_t* *handle, DMA_Type *base, uint32_t channel)

Creates the eDMA handle.

This function is called if using the transactional API for eDMA. This function initializes the internal state of the eDMA handle.

Parameters

- handle – eDMA handle pointer. The eDMA handle stores callback function and parameters.
- base – eDMA peripheral base address.
- channel – eDMA channel number.

void EDMA_InstallTCDMemory(*edma_handle_t* *handle, *edma_tcd_t* *tcdPool, uint32_t tcdSize)

Installs the TCDs memory pool into the eDMA handle.

This function is called after the EDMA_CreateHandle to use scatter/gather feature. This function shall only be used while users need to use scatter gather mode. Scatter gather mode enables EDMA to load a new transfer control block (tcd) in hardware, and automatically reconfigure that DMA channel for a new transfer. Users need to prepare tcd memory and also configure tcds using interface EDMA_SubmitTransfer.

Parameters

- handle – eDMA handle pointer.
- tcdPool – A memory pool to store TCDs. It must be 32 bytes aligned.
- tcdSize – The number of TCD slots.

void EDMA_SetCallback(*edma_handle_t* *handle, *edma_callback* callback, void *userData)

Installs a callback function for the eDMA transfer.

This callback is called in the eDMA IRQ handler. Use the callback to do something after the current major loop transfer completes. This function will be called every time one tcd finished transfer.

Parameters

- handle – eDMA handle pointer.
- callback – eDMA callback function pointer.
- userData – A parameter for the callback function.

void EDMA_PrepareTransferConfig(*edma_transfer_config_t* *config, void *srcAddr, uint32_t srcWidth, int16_t srcOffset, void *destAddr, uint32_t destWidth, int16_t destOffset, uint32_t bytesEachRequest, uint32_t transferBytes)

Prepares the eDMA transfer structure configurations.

This function prepares the transfer configuration structure according to the user input.

Note: The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

Parameters

- config – The user configuration structure of type edma_transfer_t.
- srcAddr – eDMA transfer source address.
- srcWidth – eDMA transfer source address width(bytes).
- srcOffset – source address offset.
- destAddr – eDMA transfer destination address.
- destWidth – eDMA transfer destination address width(bytes).
- destOffset – destination address offset.
- bytesEachRequest – eDMA transfer bytes per channel request.
- transferBytes – eDMA transfer bytes to be transferred.

void EDMA_PrepareTransfer(*edma_transfer_config_t* *config, void *srcAddr, uint32_t srcWidth, void *destAddr, uint32_t destWidth, uint32_t bytesEachRequest, uint32_t transferBytes, *edma_transfer_type_t* transferType)

Prepares the eDMA transfer structure.

This function prepares the transfer configuration structure according to the user input.

Note: The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

Parameters

- config – The user configuration structure of type edma_transfer_t.
- srcAddr – eDMA transfer source address.
- srcWidth – eDMA transfer source address width(bytes).
- destAddr – eDMA transfer destination address.
- destWidth – eDMA transfer destination address width(bytes).
- bytesEachRequest – eDMA transfer bytes per channel request.
- transferBytes – eDMA transfer bytes to be transferred.
- transferType – eDMA transfer type.

status_t EDMA_SubmitTransfer(*edma_handle_t* *handle, const *edma_transfer_config_t* *config)

Submits the eDMA transfer request.

This function submits the eDMA transfer request according to the transfer configuration structure. In scatter gather mode, call this function will add a configured tcd to the circular list of tcd pool. The tcd pools is setup by call function EDMA_InstallTCDMemory before.

Parameters

- handle – eDMA handle pointer.
- config – Pointer to eDMA transfer configuration structure.

Return values

- kStatus_EDMA_Success – It means submit transfer request succeed.
- kStatus_EDMA_QueueFull – It means TCD queue is full. Submit transfer request is not allowed.
- kStatus_EDMA_Busy – It means the given channel is busy, need to submit request later.

void EDMA_StartTransfer(*edma_handle_t* *handle)

eDMA starts transfer.

This function enables the channel request. Users can call this function after submitting the transfer request or before submitting the transfer request.

Parameters

- handle – eDMA handle pointer.

void EDMA_StopTransfer(*edma_handle_t* *handle)

eDMA stops transfer.

This function disables the channel request to pause the transfer. Users can call EDMA_StartTransfer() again to resume the transfer.

Parameters

- handle – eDMA handle pointer.

void EDMA_AbortTransfer(*edma_handle_t* *handle)

eDMA aborts transfer.

This function disables the channel request and clear transfer status bits. Users can submit another transfer after calling this API.

Parameters

- handle – DMA handle pointer.

static inline uint32_t EDMA_GetUnusedTCDNumber(*edma_handle_t* *handle)

Get unused TCD slot number.

This function gets current tcd index which is run. If the TCD pool pointer is NULL, it will return 0.

Parameters

- handle – DMA handle pointer.

Returns

The unused tcd slot number.

static inline uint32_t EDMA_GetNextTCDAddress(*edma_handle_t* *handle)

Get the next tcd address.

This function gets the next tcd address. If this is last TCD, return 0.

Parameters

- handle – DMA handle pointer.

Returns

The next TCD address.

void EDMA_HandleIRQ(*edma_handle_t* *handle)

eDMA IRQ handler for the current major loop transfer completion.

This function clears the channel major interrupt flag and calls the callback function if it is not NULL.

Note: For the case using TCD queue, when the major iteration count is exhausted, additional operations are performed. These include the final address adjustments and reloading of the BITER field into the CITER. Assertion of an optional interrupt request also occurs at this time, as does a possible fetch of a new TCD from memory using the scatter/gather address pointer included in the descriptor (if scatter/gather is enabled).

For instance, when the time interrupt of TCD[0] happens, the TCD[1] has already been loaded into the eDMA engine. As sga and sga_index are calculated based on the DLAST_SGA bitfield lies in the TCD_CSR register, the sga_index in this case should be 2 (DLAST_SGA of TCD[1] stores the address of TCD[2]). Thus, the "tcdUsed" updated should be (tcdUsed - 2U) which indicates the number of TCDs can be loaded in the memory pool (because TCD[0] and TCD[1] have been loaded into the eDMA engine at this point already.).

For the last two continuous ISRs in a scatter/gather process, they both load the last TCD (The last ISR does not load a new TCD) from the memory pool to the eDMA engine when major loop completes. Therefore, ensure that the header and tcdUsed updated are identical for them. tcdUsed are both 0 in this case as no TCD to be loaded.

See the "eDMA basic data flow" in the eDMA Functional description section of the Reference Manual for further details.

Parameters

- handle – eDMA handle pointer.

FSL_EDMA_DRIVER_VERSION

eDMA driver version

Version 2.4.5.

enum _edma_transfer_size

eDMA transfer configuration

Values:

enumerator kEDMA_TransferSize1Bytes

Source/Destination data transfer size is 1 byte every time

enumerator kEDMA_TransferSize2Bytes

Source/Destination data transfer size is 2 bytes every time

enumerator kEDMA_TransferSize4Bytes

Source/Destination data transfer size is 4 bytes every time

enumerator kEDMA_TransferSize8Bytes

Source/Destination data transfer size is 8 bytes every time

enumerator kEDMA_TransferSize16Bytes

Source/Destination data transfer size is 16 bytes every time

enumerator kEDMA_TransferSize32Bytes

Source/Destination data transfer size is 32 bytes every time

enum _edma_modulo

eDMA modulo configuration

Values:

enumerator kEDMA_ModuloDisable

Disable modulo

enumerator kEDMA_Modulo2bytes

Circular buffer size is 2 bytes.

enumerator kEDMA_Modulo4bytes
Circular buffer size is 4 bytes.

enumerator kEDMA_Modulo8bytes
Circular buffer size is 8 bytes.

enumerator kEDMA_Modulo16bytes
Circular buffer size is 16 bytes.

enumerator kEDMA_Modulo32bytes
Circular buffer size is 32 bytes.

enumerator kEDMA_Modulo64bytes
Circular buffer size is 64 bytes.

enumerator kEDMA_Modulo128bytes
Circular buffer size is 128 bytes.

enumerator kEDMA_Modulo256bytes
Circular buffer size is 256 bytes.

enumerator kEDMA_Modulo512bytes
Circular buffer size is 512 bytes.

enumerator kEDMA_Modulo1Kbytes
Circular buffer size is 1 K bytes.

enumerator kEDMA_Modulo2Kbytes
Circular buffer size is 2 K bytes.

enumerator kEDMA_Modulo4Kbytes
Circular buffer size is 4 K bytes.

enumerator kEDMA_Modulo8Kbytes
Circular buffer size is 8 K bytes.

enumerator kEDMA_Modulo16Kbytes
Circular buffer size is 16 K bytes.

enumerator kEDMA_Modulo32Kbytes
Circular buffer size is 32 K bytes.

enumerator kEDMA_Modulo64Kbytes
Circular buffer size is 64 K bytes.

enumerator kEDMA_Modulo128Kbytes
Circular buffer size is 128 K bytes.

enumerator kEDMA_Modulo256Kbytes
Circular buffer size is 256 K bytes.

enumerator kEDMA_Modulo512Kbytes
Circular buffer size is 512 K bytes.

enumerator kEDMA_Modulo1Mbytes
Circular buffer size is 1 M bytes.

enumerator kEDMA_Modulo2Mbytes
Circular buffer size is 2 M bytes.

enumerator kEDMA_Modulo4Mbytes
Circular buffer size is 4 M bytes.

enumerator kEDMA_Modulo8Mbytes
Circular buffer size is 8 M bytes.

enumerator kEDMA_Modulo16Mbytes
Circular buffer size is 16 M bytes.

enumerator kEDMA_Modulo32Mbytes
Circular buffer size is 32 M bytes.

enumerator kEDMA_Modulo64Mbytes
Circular buffer size is 64 M bytes.

enumerator kEDMA_Modulo128Mbytes
Circular buffer size is 128 M bytes.

enumerator kEDMA_Modulo256Mbytes
Circular buffer size is 256 M bytes.

enumerator kEDMA_Modulo512Mbytes
Circular buffer size is 512 M bytes.

enumerator kEDMA_Modulo1Gbytes
Circular buffer size is 1 G bytes.

enumerator kEDMA_Modulo2Gbytes
Circular buffer size is 2 G bytes.

enum _edma_bandwidth
Bandwidth control.

Values:

enumerator kEDMA_BandwidthStallNone
No eDMA engine stalls.

enumerator kEDMA_BandwidthStall4Cycle
eDMA engine stalls for 4 cycles after each read/write.

enumerator kEDMA_BandwidthStall8Cycle
eDMA engine stalls for 8 cycles after each read/write.

enum _edma_channel_link_type
Channel link type.

Values:

enumerator kEDMA_LinkNone
No channel link

enumerator kEDMA_MinorLink
Channel link after each minor loop

enumerator kEDMA_MajorLink
Channel link while major loop count exhausted

_edma_channel_status_flags eDMA channel status flags.

Values:

enumerator kEDMA_DoneFlag
DONE flag, set while transfer finished, CITER value exhausted

enumerator kEDMA_ErrorFlag
eDMA error flag, an error occurred in a transfer

enumerator kEDMA_InterruptFlag
eDMA interrupt flag, set while an interrupt occurred of this channel

_edma_error_status_flags eDMA channel error status flags.

Values:

enumerator kEDMA_DestinationBusErrorFlag
Bus error on destination address

enumerator kEDMA_SourceBusErrorFlag
Bus error on the source address

enumerator kEDMA_ScatterGatherErrorFlag
Error on the Scatter/Gather address, not 32byte aligned.

enumerator kEDMA_NbytesErrorFlag
NBYTES/CITER configuration error

enumerator kEDMA_DestinationOffsetErrorFlag
Destination offset not aligned with destination size

enumerator kEDMA_DestinationAddressErrorFlag
Destination address not aligned with destination size

enumerator kEDMA_SourceOffsetErrorFlag
Source offset not aligned with source size

enumerator kEDMA_SourceAddressErrorFlag
Source address not aligned with source size

enumerator kEDMA_ErrorChannelFlag
Error channel number of the cancelled channel number

enumerator kEDMA_ChannelPriorityErrorFlag
Channel priority is not unique.

enumerator kEDMA_TransferCanceledFlag
Transfer cancelled

enumerator kEDMA_ValidFlag
No error occurred, this bit is 0. Otherwise, it is 1.

enum _edma_interrupt_enable
eDMA interrupt source

Values:

enumerator kEDMA_ErrorInterruptEnable
Enable interrupt while channel error occurs.

enumerator kEDMA_MajorInterruptEnable
Enable interrupt while major count exhausted.

enumerator kEDMA_HalfInterruptEnable
Enable interrupt while major count to half value.

enum _edma_transfer_type
eDMA transfer type

Values:

enumerator kEDMA_MemoryToMemory
Transfer from memory to memory

enumerator kEDMA_PeripheralToMemory
Transfer from peripheral to memory

enumerator kEDMA_MemoryToPeripheral
Transfer from memory to peripheral

enumerator kEDMA_PeripheralToPeripheral
Transfer from Peripheral to peripheral

_edma_transfer_status eDMA transfer status

Values:

enumerator kStatus_EDMA_QueueFull
TCD queue is full.

enumerator kStatus_EDMA_Busy
Channel is busy and can't handle the transfer request.

typedef enum *_edma_transfer_size* edma_transfer_size_t
eDMA transfer configuration

typedef enum *_edma_modulo* edma_modulo_t
eDMA modulo configuration

typedef enum *_edma_bandwidth* edma_bandwidth_t
Bandwidth control.

typedef enum *_edma_channel_link_type* edma_channel_link_type_t
Channel link type.

typedef enum *_edma_interrupt_enable* edma_interrupt_enable_t
eDMA interrupt source

typedef enum *_edma_transfer_type* edma_transfer_type_t
eDMA transfer type

typedef struct *_edma_config* edma_config_t
eDMA global configuration structure.

typedef struct *_edma_transfer_config* edma_transfer_config_t
eDMA transfer configuration

This structure configures the source/destination transfer attribute.

typedef struct *_edma_channel_Preemption_config* edma_channel_Preemption_config_t
eDMA channel priority configuration

typedef struct *_edma_minor_offset_config* edma_minor_offset_config_t
eDMA minor offset configuration

typedef struct *_edma_tcd* edma_tcd_t
eDMA TCD.

This structure is same as TCD register which is described in reference manual, and is used to configure the scatter/gather feature as a next hardware TCD.

typedef void (*edma_callback)(struct *_edma_handle* *handle, void *userData, bool transferDone, uint32_t tcds)

Define callback function for eDMA.

This callback function is called in the EDMA interrupt handle. In normal mode, run into callback function means the transfer users need is done. In scatter gather mode, run into callback function means a transfer control block (tcd) is finished. Not all transfer finished, users can get the finished tcd numbers using interface EDMA_GetUnusedTCDNumber.

Param handle
EDMA handle pointer, users shall not touch the values inside.

Param userData
The callback user parameter pointer. Users can use this parameter to involve things users need to change in EDMA callback function.

Param transferDone
If the current loaded transfer done. In normal mode it means if all transfer done. In scatter gather mode, this parameter shows is the current transfer block in EDMA register is done. As the load of core is different, it will be different if the new tcd loaded into EDMA registers while this callback called. If true, it always means new tcd still not loaded into registers, while false means new tcd already loaded into registers.

Param tcds
How many tcds are done from the last callback. This parameter only used in scatter gather mode. It tells user how many tcds are finished between the last callback and this.

typedef struct *_edma_handle* edma_handle_t

eDMA transfer handle structure

DMA_DCHPRI_INDEX(channel)

Compute the offset unit from DCHPRI3.

struct _edma_config

#include <fsl_edma.h> eDMA global configuration structure.

Public Members

bool enableContinuousLinkMode

Enable (true) continuous link mode. Upon minor loop completion, the channel activates again if that channel has a minor loop channel link enabled and the link channel is itself.

bool enableHaltOnError

Enable (true) transfer halt on error. Any error causes the HALT bit to set. Subsequently, all service requests are ignored until the HALT bit is cleared.

bool enableRoundRobinArbitration

Enable (true) round robin channel arbitration method or fixed priority arbitration is used for channel selection

bool enableDebugMode

Enable(true) eDMA debug mode. When in debug mode, the eDMA stalls the start of a new channel. Executing channels are allowed to complete.

struct _edma_transfer_config

#include <fsl_edma.h> eDMA transfer configuration

This structure configures the source/destination transfer attribute.

Public Members

uint32_t srcAddr
: Source data address.

uint32_t destAddr
: Destination data address.

edma_transfer_size_t srcTransferSize
: Source data transfer size.

edma_transfer_size_t destTransferSize
: Destination data transfer size.

int16_t srcOffset
: Sign-extended offset applied to the current source address to form the next-state value as each source read is completed.

int16_t destOffset
: Sign-extended offset applied to the current destination address to form the next-state value as each destination write is completed.

uint32_t minorLoopBytes
: Bytes to transfer in a minor loop

uint32_t majorLoopCounts
: Major loop iteration count.

struct __edma__channel__Preemption__config
: *#include <fsl_edma.h>* eDMA channel priority configuration

Public Members

bool enableChannelPreemption
: If true: a channel can be suspended by other channel with higher priority

bool enablePreemptAbility
: If true: a channel can suspend other channel with low priority

uint8_t channelPriority
: Channel priority

struct __edma__minor__offset__config
: *#include <fsl_edma.h>* eDMA minor offset configuration

Public Members

bool enableSrcMinorOffset
: Enable(true) or Disable(false) source minor loop offset.

bool enableDestMinorOffset
: Enable(true) or Disable(false) destination minor loop offset.

uint32_t minorOffset
: Offset for a minor loop mapping.

struct __edma__tcd
: *#include <fsl_edma.h>* eDMA TCD.

  This structure is same as TCD register which is described in reference manual, and is used to configure the scatter/gather feature as a next hardware TCD.

Public Members

___IO uint32_t SADDR
SADDR register, used to save source address

___IO uint16_t SOFF
SOFF register, save offset bytes every transfer

___IO uint16_t ATTR
ATTR register, source/destination transfer size and modulo

___IO uint32_t NBYTES
Nbytes register, minor loop length in bytes

___IO uint32_t SLAST
SLAST register

___IO uint32_t DADDR
DADDR register, used for destination address

___IO uint16_t DOFF
DOFF register, used for destination offset

___IO uint16_t CITER
CITER register, current minor loop numbers, for unfinished minor loop.

___IO uint32_t DLAST_SGA
DLASTSGA register, next tcd address used in scatter-gather mode

___IO uint16_t CSR
CSR register, for TCD control status

___IO uint16_t BITER
BITER register, begin minor loop count.

struct _edma_handle
#include <fsl_edma.h> eDMA transfer handle structure

Public Members

edma_callback callback
Callback function for major count exhausted.

void *userData
Callback function parameter.

DMA_Type *base
eDMA peripheral base address.

edma_tcd_t *tcdPool
Pointer to memory stored TCDs.

uint8_t channel
eDMA channel number.

volatile int8_t header
The first TCD index. Should point to the next TCD to be loaded into the eDMA engine.

volatile int8_t tail
The last TCD index. Should point to the next TCD to be stored into the memory pool.

volatile int8_t tcdUsed

The number of used TCD slots. Should reflect the number of TCDs can be used/loaded in the memory.

volatile int8_t tcdSize

The total number of TCD slots in the queue.

uint8_t flags

The status of the current channel.

2.39 eLCDIF: Enhanced LCD Interface

void ELCDIF_RgbModeInit(LCDIF_Type *base, const *elcdif_rgb_mode_config_t* *config)

Initializes the eLCDIF to work in RGB mode (DOTCLK mode).

This function ungates the eLCDIF clock and configures the eLCDIF peripheral according to the configuration structure.

Parameters

- base – eLCDIF peripheral base address.
- config – Pointer to the configuration structure.

void ELCDIF_RgbModeGetDefaultConfig(*elcdif_rgb_mode_config_t* *config)

Gets the eLCDIF default configuration structure for RGB (DOTCLK) mode.

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
config->panelWidth = 480U;
config->panelHeight = 272U;
config->hsw = 41;
config->hfp = 4;
config->hbp = 8;
config->vsw = 10;
config->vfp = 4;
config->vbp = 2;
config->polarityFlags = kELCDIF_VsyncActiveLow |
                        kELCDIF_HsyncActiveLow |
                        kELCDIF_DataEnableActiveLow |
                        kELCDIF_DriveDataOnFallingClkEdge;
config->bufferAddr = 0U;
config->pixelFormat = kELCDIF_PixelFormatRGB888;
config->dataBus = kELCDIF_DataBus24Bit;
```

Parameters

- config – Pointer to the eLCDIF configuration structure.

void ELCDIF_Deinit(LCDIF_Type *base)

Deinitializes the eLCDIF peripheral.

Parameters

- base – eLCDIF peripheral base address.

void ELCDIF_RgbModeSetPixelFormat(LCDIF_Type *base, *elcdif_pixel_format_t* pixelFormat)

Set the pixel format in RGB (DOTCLK) mode.

Parameters

- base – eLCDIF peripheral base address.

- pixelFormat – The pixel format.

static inline void ELCDIF_RgbModeStart(LCDIF_Type *base)

Start to display in RGB (DOTCLK) mode.

Parameters

- base – eLCDIF peripheral base address.

void ELCDIF_RgbModeStop(LCDIF_Type *base)

Stop display in RGB (DOTCLK) mode and wait until finished.

Parameters

- base – eLCDIF peripheral base address.

static inline void ELCDIF_SetNextBufferAddr(LCDIF_Type *base, uint32_t bufferAddr)

Set the next frame buffer address to display.

Parameters

- base – eLCDIF peripheral base address.
- bufferAddr – The frame buffer address to set.

void ELCDIF_Reset(LCDIF_Type *base)

Reset the eLCDIF peripheral.

Parameters

- base – eLCDIF peripheral base address.

void ELCDIF_SetPixelComponentOrder(LCDIF_Type *base, *elcdif_pixel_component_order_t* order)

Set the order of the RGB components of each pixel in lines.

Parameters

- base – eLCDIF peripheral base address.
- order – The pixel component order

static inline uint32_t ELCDIF_GetCrcValue(const LCDIF_Type *base)

Get the CRC value of the frame sent out.

When a frame is sent complete (the interrupt kELCDIF_CurFrameDone assert), this function can be used to get the CRC value of the frame sent.

Note: The CRC value is dependent on the LCD_DATABUS_WIDTH.

Parameters

- base – eLCDIF peripheral base address.

Returns

The CRC value.

static inline uint32_t ELCDIF_GetBusMasterErrorAddr(const LCDIF_Type *base)

Get the bus master error virtual address.

When bus master error occurs (the interrupt kELCDIF_BusMasterError assert), this function can get the virtual address at which the AXI master received an error response from the slave.

Parameters

- base – eLCDIF peripheral base address.

Returns
The error virtual address.

static inline uint32_t ELCDIF_GetStatus(const LCDIF_Type *base)

Get the eLCDIF status.

The status flags are returned as a mask value, application could check the corresponding bit. Example:

```
uint32_t statusFlags;
statusFlags = ELCDIF_GetStatus(LCDIF);

if (kELCDIF_LFifoFull & statusFlags)
{
}

if (kELCDIF_TxFifoEmpty & statusFlags)
{
}
```

Parameters

- base – eLCDIF peripheral base address.

Returns
The mask value of status flags, it is OR'ed value of _elcdif_status_flags.

static inline uint32_t ELCDIF_GetLFifoCount(const LCDIF_Type *base)

Get current count in Latency buffer (LFIFO).

Parameters

- base – eLCDIF peripheral base address.

Returns
The LFIFO current count

static inline void ELCDIF_EnableInterrupts(LCDIF_Type *base, uint32_t mask)

Enables eLCDIF interrupt requests.

Parameters

- base – eLCDIF peripheral base address.
- mask – interrupt source, OR'ed value of _elcdif_interrupt_enable.

static inline void ELCDIF_DisableInterrupts(LCDIF_Type *base, uint32_t mask)

Disables eLCDIF interrupt requests.

Parameters

- base – eLCDIF peripheral base address.
- mask – interrupt source, OR'ed value of _elcdif_interrupt_enable.

static inline uint32_t ELCDIF_GetInterruptStatus(const LCDIF_Type *base)

Get eLCDIF interrupt peding status.

Parameters

- base – eLCDIF peripheral base address.

Returns
Interrupt pending status, OR'ed value of _elcdif_interrupt_flags.

static inline void ELCDIF_ClearInterruptStatus(LCDIF_Type *base, uint32_t mask)

Clear eLCDIF interrupt peding status.

Parameters

- base – eLCDIF peripheral base address.
- mask – of the flags to clear, OR'ed value of _elcdif_interrupt_flags.

static inline void ELCDIF_EnableLut(LCDIF_Type *base, bool enable)

Enable or disable the LUT.

Parameters

- base – eLCDIF peripheral base address.
- enable – True to enable, false to disable.

status_t ELCDIF_UpdateLut(LCDIF_Type *base, *elcdif_lut_t* lut, uint16_t startIndex, const uint32_t *lutData, uint16_t count)

Load the LUT value.

This function loads the LUT value to the specific LUT memory, user can specify the start entry index.

Parameters

- base – eLCDIF peripheral base address.
- lut – Which LUT to load.
- startIndex – The start index of the LUT entry to update.
- lutData – The LUT data to load.
- count – Count of lutData.

Return values

- kStatus_Success – Initialization success.
- kStatus_InvalidArgument – Wrong argument.

FSL_ELCDIF_DRIVER_VERSION

eLCDIF driver version

enum _elcdif_polarity_flags

eLCDIF signal polarity flags

Values:

enumerator kELCDIF_VsyncActiveLow

VSYNC active low.

enumerator kELCDIF_HsyncActiveLow

HSYNC active low.

enumerator kELCDIF_DataEnableActiveLow

Data enable line active low.

enumerator kELCDIF_DriveDataOnFallingClkEdge

Drive data on falling clock edge, capture data on rising clock edge.

enumerator kELCDIF_VsyncActiveHigh

VSYNC active high.

enumerator kELCDIF_HsyncActiveHigh

HSYNC active high.

enumerator kELCDIF_DataEnableActiveHigh
Data enable line active high.

enumerator kELCDIF_DriveDataOnRisingClkEdge
Drive data on falling clock edge, capture data on rising clock edge.

enum _elcdif_interrupt_enable
The eLCDIF interrupts to enable.

Values:

enumerator kELCDIF_BusMasterErrorInterruptEnable
Bus master error interrupt.

enumerator kELCDIF_TxFifoOverflowInterruptEnable
TXFIFO overflow interrupt.

enumerator kELCDIF_TxFifoUnderflowInterruptEnable
TXFIFO underflow interrupt.

enumerator kELCDIF_CurFrameDoneInterruptEnable
Interrupt when hardware enters vertical blanking state.

enumerator kELCDIF_VsyncEdgeInterruptEnable
Interrupt when hardware encounters VSYNC edge.

enum _elcdif_interrupt_flags
The eLCDIF interrupt status flags.

Values:

enumerator kELCDIF_BusMasterError
Bus master error interrupt.

enumerator kELCDIF_TxFifoOverflow
TXFIFO overflow interrupt.

enumerator kELCDIF_TxFifoUnderflow
TXFIFO underflow interrupt.

enumerator kELCDIF_CurFrameDone
Interrupt when hardware enters vertical blanking state.

enumerator kELCDIF_VsyncEdge
Interrupt when hardware encounters VSYNC edge.

enum _elcdif_status_flags
eLCDIF status flags

Values:

enumerator kELCDIF_LFifoFull
LFIFO full.

enumerator kELCDIF_LFifoEmpty
LFIFO empty.

enumerator kELCDIF_TxFifoFull
TXFIFO full.

enumerator kELCDIF_TxFifoEmpty
TXFIFO empty.

enum _elcdif_pixel_format

The pixel format.

This enumerator should be defined together with the array s_pixelFormatReg. To support new pixel format, enhance this enumerator and s_pixelFormatReg.

Values:

enumerator kELCDIF_PixelFormatRAW8

RAW 8 bit, four data use 32 bits.

enumerator kELCDIF_PixelFormatRGB565

RGB565, two pixel use 32 bits.

enumerator kELCDIF_PixelFormatRGB666

RGB666 unpacked, one pixel uses 32 bits, high byte unused, upper 2 bits of other bytes unused.

enumerator kELCDIF_PixelFormatXRGB8888

XRGB8888 unpacked, one pixel uses 32 bits, high byte unused.

enumerator kELCDIF_PixelFormatRGB888

RGB888 packed, one pixel uses 24 bits.

enum _elcdif_lcd_data_bus

The LCD data bus type.

Values:

enumerator kELCDIF_DataBus8Bit

8-bit data bus.

enumerator kELCDIF_DataBus16Bit

16-bit data bus, support RGB565.

enumerator kELCDIF_DataBus18Bit

18-bit data bus, support RGB666.

enumerator kELCDIF_DataBus24Bit

24-bit data bus, support RGB888.

enum _elcdif_as_pixel_format

eLCDIF alpha surface pixel format.

Values:

enumerator kELCDIF_AsPixelFormatARGB8888

32-bit pixels with alpha.

enumerator kELCDIF_AsPixelFormatRGB888

32-bit pixels without alpha (unpacked 24-bit format)

enumerator kELCDIF_AsPixelFormatARGB1555

16-bit pixels with alpha.

enumerator kELCDIF_AsPixelFormatARGB4444

16-bit pixels with alpha.

enumerator kELCDIF_AsPixelFormatRGB555

16-bit pixels without alpha.

enumerator kELCDIF_AsPixelFormatRGB444

16-bit pixels without alpha.

enumerator kELCDIF_AsPixelFormatRGB565
16-bit pixels without alpha.

enum _elcdif_alpha_mode
eLCDIF alpha mode during blending.

Values:

enumerator kELCDIF_AlphaEmbedded
The alpha surface pixel alpha value will be used for blend.

enumerator kELCDIF_AlphaOverride
The user defined alpha value will be used for blend directly.

enumerator kELCDIF_AlphaMultiply
The alpha surface pixel alpha value scaled the user defined alpha value will be used for blend, for example, pixel alpha set set to 200, user defined alpha set to 100, then the reault alpha is 200 * 100 / 255.

enumerator kELCDIF_AlphaRop
Raster operation.

enum _elcdif_rop_mode
eLCDIF ROP mode during blending.

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

Values:

enumerator kELCDIF_RopMaskAs
AS AND PS.

enumerator kELCDIF_RopMaskNotAs
nAS AND PS.

enumerator kELCDIF_RopMaskAsNot
AS AND nPS.

enumerator kELCDIF_RopMergeAs
AS OR PS.

enumerator kELCDIF_RopMergeNotAs
nAS OR PS.

enumerator kELCDIF_RopMergeAsNot
AS OR nPS.

enumerator kELCDIF_RopNotCopyAs
nAS.

enumerator kELCDIF_RopNot
nPS.

enumerator kELCDIF_RopNotMaskAs
AS NAND PS.

enumerator kELCDIF_RopNotMergeAs
AS NOR PS.

enumerator kELCDIF_RopXorAs
AS XOR PS.

enumerator kELCDIF_RopNotXorAs
AS XNOR PS.

enum _elcdif_lut
eLCDIF LUT

The Lookup Table (LUT) is used to expand the 8 bits pixel to 24 bits pixel before output to external displayer.

There are two 256x24 bits LUT memory in LCDIF, the LSB of frame buffer address determins which memory to use.

Values:

enumerator kELCDIF_Lut0
LUT 0.

enumerator kELCDIF_Lut1
LUT 1.

enum _elcdif_pixel_component_order
eLCDIF pixel component order.

Values:

enumerator kELCDIF_PixelComponentOrderRGB
Input order RGB.

enumerator kELCDIF_PixelComponentOrderRBG
Input order RBG.

enumerator kELCDIF_PixelComponentOrderGBR
Input order GBR.

enumerator kELCDIF_PixelComponentOrderGRB
Input order GRB.

enumerator kELCDIF_PixelComponentOrderBRG
Input order BRG.

enumerator kELCDIF_PixelComponentOrderBGR
Input order BGR.

typedef enum *_elcdif_pixel_format* elcdif_pixel_format_t
The pixel format.

This enumerator should be defined together with the array s_pixelFormatReg. To support new pixel format, enhance this enumerator and s_pixelFormatReg.

typedef enum *_elcdif_lcd_data_bus* elcdif_lcd_data_bus_t
The LCD data bus type.

typedef struct *_elcdif_pixel_format_reg* elcdif_pixel_format_reg_t
The register value when using different pixel format.

These register bits control the pixel format:

- CTRL[DATA_FORMAT_24_BIT]
- CTRL[DATA_FORMAT_18_BIT]

- CTRL[DATA_FORMAT_16_BIT]
- CTRL[WORD_LENGTH]
- CTRL1[BYTE_PACKING_FORMAT]

typedef struct *_elcdif_rgb_mode_config* elcdif_rgb_mode_config_t

eLCDIF configure structure for RGB mode (DOTCLK mode).

typedef enum *_elcdif_as_pixel_format* elcdif_as_pixel_format_t

eLCDIF alpha surface pixel format.

typedef struct *_elcdif_as_buffer_config* elcdif_as_buffer_config_t

eLCDIF alpha surface buffer configuration.

typedef enum *_elcdif_alpha_mode* elcdif_alpha_mode_t

eLCDIF alpha mode during blending.

typedef enum *_elcdif_rop_mode* elcdif_rop_mode_t

eLCDIF ROP mode during blending.

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

typedef struct *_elcdif_as_blend_config* elcdif_as_blend_config_t

eLCDIF alpha surface blending configuration.

typedef enum *_elcdif_lut* elcdif_lut_t

eLCDIF LUT

The Lookup Table (LUT) is used to expand the 8 bits pixel to 24 bits pixel before output to external displayer.

There are two 256x24 bits LUT memory in LCDIF, the LSB of frame buffer address determins which memory to use.

typedef enum *_elcdif_pixel_component_order* elcdif_pixel_component_order_t

eLCDIF pixel component order.

ELCDIF_CTRL1_IRQ_MASK

ELCDIF_CTRL1_IRQ_EN_MASK

ELCDIF_AS_CTRL_IRQ_MASK

ELCDIF_AS_CTRL_IRQ_EN_MASK

FSL_FEATURE_LCDIF_HAS_PXP_HANDSHAKE

ELCDIF_ADDR_CPU_2_IP(addr)

ELCDIF_LUT_ENTRY_NUM

struct elcdif_pixel_format_reg

#include <fsl_elcdif.h> The register value when using different pixel format.

These register bits control the pixel format:

- CTRL[DATA_FORMAT_24_BIT]
- CTRL[DATA_FORMAT_18_BIT]

- CTRL[DATA_FORMAT_16_BIT]
- CTRL[WORD_LENGTH]
- CTRL1[BYTE_PACKING_FORMAT]

Public Members

uint32_t regCtrl
: Value of register CTRL.

uint32_t regCtrl1
: Value of register CTRL1.

struct __elcdif_rgb_mode_config
: *#include <fsl_elcdif.h>* eLCDIF configure structure for RGB mode (DOTCLK mode).

Public Members

uint16_t panelWidth
: Display panel width, pixels per line.

uint16_t panelHeight
: Display panel height, how many lines per panel.

uint8_t hsw
: HSYNC pulse width.

uint8_t hfp
: Horizontal front porch.

uint8_t hbp
: Horizontal back porch.

uint8_t vsw
: VSYNC pulse width.

uint8_t vfp
: Vrtical front porch.

uint8_t vbp
: Vertical back porch.

uint32_t polarityFlags
: OR'ed value of _elcdif_polarity_flags, used to contol the signal polarity.

uint32_t bufferAddr
: Frame buffer address.

elcdif_pixel_format_t pixelFormat
: Pixel format.

elcdif_lcd_data_bus_t dataBus
: LCD data bus.

struct __elcdif_as_buffer_config
: *#include <fsl_elcdif.h>* eLCDIF alpha surface buffer configuration.

Public Members

uint32_t bufferAddr
: Buffer address.

elcdif_as_pixel_format_t pixelFormat
: Pixel format.

struct __elcdif_as_blend_config
: *#include <fsl_elcdif.h>* eLCDIF alpha surface blending configuration.

Public Members

uint8_t alpha
: User defined alpha value, only used when alphaMode is kELCDIF_AlphaOverride or kELCDIF_AlphaRop.

bool invertAlpha
: Set true to invert the alpha.

elcdif_alpha_mode_t alphaMode
: Alpha mode.

elcdif_rop_mode_t ropMode
: ROP mode, only valid when alphaMode is kELCDIF_AlphaRop.

2.40 ENC: Quadrature Encoder/Decoder

void ENC_Init(ENC_Type *base, const *enc_config_t* *config)
: Initialization for the ENC module.

  This function is to make the initialization for the ENC module. It should be called firstly before any operation to the ENC with the operations like:

  - Enable the clock for ENC module.
  - Configure the ENC's working attributes.

  Parameters

  - base – ENC peripheral base address.
  - config – Pointer to configuration structure. See to "enc_config_t".

void ENC_Deinit(ENC_Type *base)
: De-initialization for the ENC module.

  This function is to make the de-initialization for the ENC module. It could be called when ENC is no longer used with the operations like:

  - Disable the clock for ENC module.

  Parameters

  - base – ENC peripheral base address.

void ENC_GetDefaultConfig(*enc_config_t* *config)
: Get an available pre-defined settings for ENC's configuration.

  This function initializes the ENC configuration structure with an available settings, the default value are:

```
config->enableReverseDirection                = false;
config->decoderWorkMode                       = kENC_DecoderWorkAsNormalMode;
config->HOMETriggerMode                       = kENC_HOMETriggerDisabled;
config->INDEXTriggerMode                      = kENC_INDEXTriggerDisabled;
config->enableTRIGGERClearPositionCounter     = false;
config->enableTRIGGERClearHoldPositionCounter = false;
config->enableWatchdog                        = false;
config->watchdogTimeoutValue                  = 0U;
config->filterCount                           = 0U;
config->filterSamplePeriod                    = 0U;
config->positionMatchMode                     = kENC_
↪POSMATCHOnPositionCounterEqualToComapreValue;
config->positionCompareValue                  = 0xFFFFFFFFU;
config->revolutionCountCondition              = kENC_RevolutionCountOnINDEXPulse;
config->enableModuloCountMode                 = false;
config->positionModulusValue                  = 0U;
config->positionInitialValue                  = 0U;
config->prescalerValue                        = kENC_ClockDiv1;
config->enablePeriodMeasurementFunction       = true;
```

Parameters

- config – Pointer to a variable of configuration structure. See to "enc_config_t".

void ENC_DoSoftwareLoadInitialPositionValue(ENC_Type *base)

Load the initial position value to position counter.

This function is to transfer the initial position value (UINIT and LINIT) contents to position counter (UPOS and LPOS), so that to provide the consistent operation the position counter registers.

Parameters

- base – ENC peripheral base address.

void ENC_SetSelfTestConfig(ENC_Type *base, const *enc_self_test_config_t* *config)

Enable and configure the self test function.

This function is to enable and configuration the self test function. It controls and sets the frequency of a quadrature signal generator. It provides a quadrature test signal to the inputs of the quadrature decoder module. It is a factory test feature; however, it may be useful to customers' software development and testing.

Parameters

- base – ENC peripheral base address.
- config – Pointer to configuration structure. See to "enc_self_test_config_t". Pass "NULL" to disable.

void ENC_EnableWatchdog(ENC_Type *base, bool enable)

Enable watchdog for ENC module.

Parameters

- base – ENC peripheral base address
- enable – Enables or disables the watchdog

void ENC_SetInitialPositionValue(ENC_Type *base, uint32_t value)

Set initial position value for ENC module.

Parameters

- base – ENC peripheral base address

- value – Positive initial value

uint32_t ENC_GetStatusFlags(ENC_Type *base)

Get the status flags.

Parameters

- base – ENC peripheral base address.

Returns

Mask value of status flags. For available mask, see to "_enc_status_flags".

void ENC_ClearStatusFlags(ENC_Type *base, uint32_t mask)

Clear the status flags.

Parameters

- base – ENC peripheral base address.
- mask – Mask value of status flags to be cleared. For available mask, see to "_enc_status_flags".

static inline uint16_t ENC_GetSignalStatusFlags(ENC_Type *base)

Get the signals' real-time status.

Parameters

- base – ENC peripheral base address.

Returns

Mask value of signals' real-time status. For available mask, see to "_enc_signal_status_flags"

void ENC_EnableInterrupts(ENC_Type *base, uint32_t mask)

Enable the interrupts.

Parameters

- base – ENC peripheral base address.
- mask – Mask value of interrupts to be enabled. For available mask, see to "_enc_interrupt_enable".

void ENC_DisableInterrupts(ENC_Type *base, uint32_t mask)

Disable the interrupts.

Parameters

- base – ENC peripheral base address.
- mask – Mask value of interrupts to be disabled. For available mask, see to "_enc_interrupt_enable".

uint32_t ENC_GetEnabledInterrupts(ENC_Type *base)

Get the enabled interrupts' flags.

Parameters

- base – ENC peripheral base address.

Returns

Mask value of enabled interrupts.

uint32_t ENC_GetPositionValue(ENC_Type *base)

Get the current position counter's value.

Parameters

- base – ENC peripheral base address.

Returns
Current position counter's value.

uint32_t ENC_GetHoldPositionValue(ENC_Type *base)

Get the hold position counter's value.

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

Parameters

- base – ENC peripheral base address.

Returns
Hold position counter's value.

static inline uint16_t ENC_GetPositionDifferenceValue(ENC_Type *base)

Get the position difference counter's value.

Parameters

- base – ENC peripheral base address.

Returns
The position difference counter's value.

static inline uint16_t ENC_GetHoldPositionDifferenceValue(ENC_Type *base)

Get the hold position difference counter's value.

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

Parameters

- base – ENC peripheral base address.

Returns
Hold position difference counter's value.

static inline uint16_t ENC_GetRevolutionValue(ENC_Type *base)

Get the position revolution counter's value.

Parameters

- base – ENC peripheral base address.

Returns
The position revolution counter's value.

static inline uint16_t ENC_GetHoldRevolutionValue(ENC_Type *base)

Get the hold position revolution counter's value.

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

Parameters

- base – ENC peripheral base address.

Returns
Hold position revolution counter's value.

static inline uint16_t ENC_GetLastEdgeTimeValue(ENC_Type *base)

Get the last edge time value.

Parameters

- base – ENC peripheral base address.

Returns
The last edge time hold value.

static inline uint16_t ENC_GetHoldLastEdgeTimeValue(ENC_Type *base)

Get the last edge time hold value.

Parameters

- base – ENC peripheral base address.

Returns
The last edge time hold value.

static inline uint16_t ENC_GetPositionDifferencePeriodValue(ENC_Type *base)

Get the position difference period value.

Parameters

- base – ENC peripheral base address.

Returns
The position difference period hold value.

static inline uint16_t ENC_GetPositionDifferencePeriodBufferValue(ENC_Type *base)

Get the position difference period buffer value.

Parameters

- base – ENC peripheral base address.

Returns
The position difference period hold value.

static inline uint16_t ENC_GetHoldPositionDifferencePeriodValue(ENC_Type *base)

Get the position difference period hold value.

Parameters

- base – ENC peripheral base address.

Returns
The position difference period hold value.

enum _enc_interrupt_enable

Interrupt enable/disable mask.

Values:

enumerator kENC_HOMETransitionInterruptEnable
HOME interrupt enable.

enumerator kENC_INDEXPulseInterruptEnable
INDEX pulse interrupt enable.

enumerator kENC_WatchdogTimeoutInterruptEnable
Watchdog timeout interrupt enable.

enumerator kENC_PositionCompareInerruptEnable
Position compare interrupt enable.

enumerator kENC_PositionRollOverInterruptEnable
Roll-over interrupt enable.

enumerator kENC_PositionRollUnderInterruptEnable
Roll-under interrupt enable.

enum _enc_status_flags

Status flag mask.

These flags indicate the counter's events.

Values:

enumerator kENC_HOMETransitionFlag
HOME signal transition interrupt request.

enumerator kENC_INDEXPulseFlag
INDEX Pulse Interrupt Request.

enumerator kENC_WatchdogTimeoutFlag
Watchdog timeout interrupt request.

enumerator kENC_PositionCompareFlag
Position compare interrupt request.

enumerator kENC_PositionRollOverFlag
Roll-over interrupt request.

enumerator kENC_PositionRollUnderFlag
Roll-under interrupt request.

enumerator kENC_LastCountDirectionFlag
Last count was in the up direction, or the down direction.

enum _enc_signal_status_flags

Signal status flag mask.

These flags indicate the counter's signal.

Values:

enumerator kENC_RawHOMEStatusFlag
Raw HOME input.

enumerator kENC_RawINDEXStatusFlag
Raw INDEX input.

enumerator kENC_RawPHBStatusFlag
Raw PHASEB input.

enumerator kENC_RawPHAEXStatusFlag
Raw PHASEA input.

enumerator kENC_FilteredHOMEStatusFlag
The filtered version of HOME input.

enumerator kENC_FilteredINDEXStatusFlag
The filtered version of INDEX input.

enumerator kENC_FilteredPHBStatusFlag
The filtered version of PHASEB input.

enumerator kENC_FilteredPHAStatusFlag
The filtered version of PHASEA input.

enum _enc_home_trigger_mode

Define HOME signal's trigger mode.

The ENC would count the trigger from HOME signal line.

Values:

enumerator kENC_HOMETriggerDisabled
HOME signal's trigger is disabled.

enumerator kENC_HOMETriggerOnRisingEdge
Use positive going edge-to-trigger initialization of position counters.

enumerator kENC_HOMETriggerOnFallingEdge
Use negative going edge-to-trigger initialization of position counters.

enum _enc_index_trigger_mode
Define INDEX signal's trigger mode.

The ENC would count the trigger from INDEX signal line.

Values:

enumerator kENC_INDEXTriggerDisabled
INDEX signal's trigger is disabled.

enumerator kENC_INDEXTriggerOnRisingEdge
Use positive going edge-to-trigger initialization of position counters.

enumerator kENC_INDEXTriggerOnFallingEdge
Use negative going edge-to-trigger initialization of position counters.

enum _enc_decoder_work_mode
Define type for decoder work mode.

The normal work mode uses the standard quadrature decoder with PHASEA and PHASEB. When in signal phase count mode, a positive transition of the PHASEA input generates a count signal while the PHASEB input and the reverse direction control the counter direction. If the reverse direction is not enabled, PHASEB = 0 means counting up and PHASEB = 1 means counting down. Otherwise, the direction is reversed.

Values:

enumerator kENC_DecoderWorkAsNormalMode
Use standard quadrature decoder with PHASEA and PHASEB.

enumerator kENC_DecoderWorkAsSignalPhaseCountMode
PHASEA input generates a count signal while PHASEB input control the direction.

enum _enc_position_match_mode
Define type for the condition of POSMATCH pulses.

Values:

enumerator kENC_POSMATCHOnPositionCounterEqualToComapreValue
POSMATCH pulses when a match occurs between the position counters (POS) and the compare value (COMP).

enumerator kENC_POSMATCHOnReadingAnyPositionCounter
POSMATCH pulses when any position counter register is read.

enum _enc_revolution_count_condition
Define type for determining how the revolution counter (REV) is incremented/decremented.

Values:

enumerator kENC_RevolutionCountOnINDEXPulse
Use INDEX pulse to increment/decrement revolution counter.

enumerator kENC_RevolutionCountOnRollOverModulus
Use modulus counting roll-over/under to increment/decrement revolution counter.

enum _enc_self_test_direction
Define type for direction of self test generated signal.

Values:

enumerator kENC_SelfTestDirectionPositive
Self test generates the signal in positive direction.

enumerator kENC_SelfTestDirectionNegative
Self test generates the signal in negative direction.

enum _enc_prescaler
Define prescaler value for clock in CTRL3.

The clock is prescaled by a value of 2^PRSC which means that the prescaler logic can divide the clock by a minimum of 1 and a maximum of 32,768.

Values:

enumerator kENC_ClockDiv1

enumerator kENC_ClockDiv2

enumerator kENC_ClockDiv4

enumerator kENC_ClockDiv8

enumerator kENC_ClockDiv16

enumerator kENC_ClockDiv32

enumerator kENC_ClockDiv64

enumerator kENC_ClockDiv128

enumerator kENC_ClockDiv256

enumerator kENC_ClockDiv512

enumerator kENC_ClockDiv1024

enumerator kENC_ClockDiv2048

enumerator kENC_ClockDiv4096

enumerator kENC_ClockDiv8192

enumerator kENC_ClockDiv16384

enumerator kENC_ClockDiv32768

enum _enc_filter_prescaler
Define input filter prescaler value.

The input filter prescaler value is to prescale the IPBus clock. (Frequency of FILT clock) = (Frequency of IPBus clock) / 2^FILT_PRSC.

Values:

enumerator kENC_FilterPrescalerDiv1
Input filter prescaler is 1.

enumerator kENC_FilterPrescalerDiv2
Input filter prescaler is 2.

enumerator kENC_FilterPrescalerDiv4
Input filter prescaler is 4.

enumerator kENC_FilterPrescalerDiv8
Input filter prescaler is 8.

enumerator kENC_FilterPrescalerDiv16
Input filter prescaler is 16.

enumerator kENC_FilterPrescalerDiv32
Input filter prescaler is 32.

enumerator kENC_FilterPrescalerDiv64
Input filter prescaler is 64.

enumerator kENC_FilterPrescalerDiv128
Input filter prescaler is 128.

typedef enum *_enc_home_trigger_mode* enc_home_trigger_mode_t
Define HOME signal's trigger mode.

The ENC would count the trigger from HOME signal line.

typedef enum *_enc_index_trigger_mode* enc_index_trigger_mode_t
Define INDEX signal's trigger mode.

The ENC would count the trigger from INDEX signal line.

typedef enum *_enc_decoder_work_mode* enc_decoder_work_mode_t
Define type for decoder work mode.

The normal work mode uses the standard quadrature decoder with PHASEA and PHASEB. When in signal phase count mode, a positive transition of the PHASEA input generates a count signal while the PHASEB input and the reverse direction control the counter direction. If the reverse direction is not enabled, PHASEB = 0 means counting up and PHASEB = 1 means counting down. Otherwise, the direction is reversed.

typedef enum *_enc_position_match_mode* enc_position_match_mode_t
Define type for the condition of POSMATCH pulses.

typedef enum *_enc_revolution_count_condition* enc_revolution_count_condition_t
Define type for determining how the revolution counter (REV) is incremented/decremented.

typedef enum *_enc_self_test_direction* enc_self_test_direction_t
Define type for direction of self test generated signal.

typedef enum *_enc_prescaler* enc_prescaler_t
Define prescaler value for clock in CTRL3.

The clock is prescaled by a value of 2^PRSC which means that the prescaler logic can divide the clock by a minimum of 1 and a maximum of 32,768.

typedef enum *_enc_filter_prescaler* enc_filter_prescaler_t
Define input filter prescaler value.

The input filter prescaler value is to prescale the IPBus clock. (Frequency of FILT clock) = (Frequency of IPBus clock) / 2^FILT_PRSC.

typedef struct *_enc_config* enc_config_t
Define user configuration structure for ENC module.

typedef struct *_enc_self_test_config* enc_self_test_config_t

Define configuration structure for self test module.

The self test module provides a quadrature test signal to the inputs of the quadrature decoder module. This is a factory test feature. It is also useful to customers' software development and testing.

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struct _enc_config

#include <fsl_enc.h> Define user configuration structure for ENC module.

Public Members

bool enableReverseDirection

Enable reverse direction counting.

enc_decoder_work_mode_t decoderWorkMode

Enable signal phase count mode.

enc_home_trigger_mode_t HOMETriggerMode

Enable HOME to initialize position counters.

enc_index_trigger_mode_t INDEXTriggerMode

Enable INDEX to initialize position counters.

bool enableTRIGGERClearPositionCounter

Clear POSD, REV, UPOS and LPOS on rising edge of TRIGGER, or not.

bool enableTRIGGERClearHoldPositionCounter

Enable update of hold registers on rising edge of TRIGGER, or not.

bool enableWatchdog

Enable the watchdog to detect if the target is moving or not.

uint16_t watchdogTimeoutValue

Watchdog timeout count value. It stores the timeout count for the quadrature decoder module watchdog timer. This field is only available when "enableWatchdog" = true. The available value is a 16-bit unsigned number.

enc_filter_prescaler_t filterPrescaler

Input filter prescaler.

uint16_t filterCount

Input Filter Sample Count. This value should be chosen to reduce the probability of noisy samples causing an incorrect transition to be recognized. The value represent the number of consecutive samples that must agree prior to the input filter accepting an input transition. A value of 0x0 represents 3 samples. A value of 0x7 represents 10 samples. The Available range is 0 - 7.

uint16_t filterSamplePeriod

Input Filter Sample Period. This value should be set such that the sampling period is larger than the period of the expected noise. This value represents the sampling period (in IPBus clock cycles) of the decoder input signals. The available range is 0 - 255.

enc_position_match_mode_t positionMatchMode

The condition of POSMATCH pulses.

uint32_t positionCompareValue

Position compare value. The available value is a 32-bit number.

enc_revolution_count_condition_t revolutionCountCondition

Revolution Counter Modulus Enable.

bool enableModuloCountMode

Enable Modulo Counting.

uint32_t positionModulusValue

Position modulus value. This value would be available only when "enableModuloCountMode" = true. The available value is a 32-bit number.

uint32_t positionInitialValue

Position initial value. The available value is a 32-bit number.

bool enablePeriodMeasurementFunction

Enable period measurement function.

enc_prescaler_t prescalerValue

The value of prescaler.

struct _enc_self_test_config

#include <fsl_enc.h> Define configuration structure for self test module.

The self test module provides a quadrature test signal to the inputs of the quadrature decoder module. This is a factory test feature. It is also useful to customers' software development and testing.

Public Members

enc_self_test_direction_t signalDirection

Direction of self test generated signal.

uint16_t signalCount

Hold the number of quadrature advances to generate. The available range is 0 - 255.

uint16_t signalPeriod

Hold the period of quadrature phase in IPBus clock cycles. The available range is 0 - 31.

2.41 ENET: Ethernet MAC Driver

void ENET_GetDefaultConfig(*enet_config_t* *config)

Gets the ENET default configuration structure.

The purpose of this API is to get the default ENET MAC controller configure structure for ENET_Init(). User may use the initialized structure unchanged in ENET_Init(), or modify some fields of the structure before calling ENET_Init(). Example:

```
enet_config_t config;
ENET_GetDefaultConfig(&config);
```

Parameters

- config – The ENET mac controller configuration structure pointer.

status_t ENET_Up(ENET_Type *base, *enet_handle_t* *handle, const *enet_config_t* *config, const *enet_buffer_config_t* *bufferConfig, uint8_t *macAddr, uint32_t srcClock_Hz)

Initializes the ENET module.

This function initializes the module with the ENET configuration.

Note: ENET has two buffer descriptors legacy buffer descriptors and enhanced IEEE 1588 buffer descriptors. The legacy descriptor is used by default. To use the IEEE 1588 feature, use the enhanced IEEE 1588 buffer descriptor by defining "ENET_ENHANCEDBUFFERDESCRIPTOR_MODE" and calling ENET_Ptp1588Configure() to configure the 1588 feature and related buffers after calling ENET_Up().

Parameters

- base – ENET peripheral base address.
- handle – ENET handler pointer.
- config – ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.
- bufferConfig – ENET buffer configuration structure pointer. The buffer configuration should be prepared for ENET Initialization. It is the start address of "ringNum" enet_buffer_config structures. To support added multi-ring features in some soc and compatible with the previous enet driver version. For single ring supported, this bufferConfig is a buffer configure structure pointer, for multi-ring supported and used case, this bufferConfig pointer should be a buffer configure structure array pointer.
- macAddr – ENET mac address of Ethernet device. This MAC address should be provided.
- srcClock_Hz – The internal module clock source for MII clock.

Return values

- kStatus_Success – Succeed to initialize the ethernet driver.
- kStatus_ENET_InitMemoryFail – Init fails since buffer memory is not enough.

status_t ENET_Init(ENET_Type *base, *enet_handle_t* *handle, const *enet_config_t* *config, const *enet_buffer_config_t* *bufferConfig, uint8_t *macAddr, uint32_t srcClock_Hz)

Initializes the ENET module.

This function ungates the module clock and initializes it with the ENET configuration.

Note: ENET has two buffer descriptors legacy buffer descriptors and enhanced IEEE 1588 buffer descriptors. The legacy descriptor is used by default. To use the IEEE 1588 feature, use the enhanced IEEE 1588 buffer descriptor by defining "ENET_ENHANCEDBUFFERDESCRIPTOR_MODE" and calling ENET_Ptp1588Configure() to configure the 1588 feature and related buffers after calling ENET_Init().

Parameters

- base – ENET peripheral base address.
- handle – ENET handler pointer.
- config – ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used

directly. It is also possible to verify the Mac configuration using other methods.

- bufferConfig – ENET buffer configuration structure pointer. The buffer configuration should be prepared for ENET Initialization. It is the start address of "ringNum" enet_buffer_config structures. To support added multi-ring features in some soc and compatible with the previous enet driver version. For single ring supported, this bufferConfig is a buffer configure structure pointer, for multi-ring supported and used case, this bufferConfig pointer should be a buffer configure structure array pointer.
- macAddr – ENET mac address of Ethernet device. This MAC address should be provided.
- srcClock_Hz – The internal module clock source for MII clock.

Return values

- kStatus_Success – Succeed to initialize the ethernet driver.
- kStatus_ENET_InitMemoryFail – Init fails since buffer memory is not enough.

void ENET_Down(ENET_Type *base)

Stops the ENET module.

This function disables the ENET module.

Parameters

- base – ENET peripheral base address.

void ENET_Deinit(ENET_Type *base)

Deinitializes the ENET module.

This function gates the module clock, clears ENET interrupts, and disables the ENET module.

Parameters

- base – ENET peripheral base address.

static inline void ENET_Reset(ENET_Type *base)

Resets the ENET module.

This function restores the ENET module to reset state. Note that this function sets all registers to reset state. As a result, the ENET module can't work after calling this function.

Parameters

- base – ENET peripheral base address.

void ENET_SetMII(ENET_Type *base, *enet_mii_speed_t* speed, *enet_mii_duplex_t* duplex)

Sets the ENET MII speed and duplex.

This API is provided to dynamically change the speed and dulpex for MAC.

Parameters

- base – ENET peripheral base address.
- speed – The speed of the RMII mode.
- duplex – The duplex of the RMII mode.

void ENET_SetSMI(ENET_Type *base, uint32_t srcClock_Hz, bool isPreambleDisabled)

Sets the ENET SMI(serial management interface)- MII management interface.

Parameters

- base – ENET peripheral base address.
- srcClock_Hz – This is the ENET module clock frequency. See clock distribution.
- isPreambleDisabled – The preamble disable flag.
  - true Enables the preamble.
  - false Disables the preamble.

static inline bool ENET_GetSMI(ENET_Type *base)

Gets the ENET SMI- MII management interface configuration.

This API is used to get the SMI configuration to check whether the MII management interface has been set.

Parameters

- base – ENET peripheral base address.

Returns

The SMI setup status true or false.

static inline uint32_t ENET_ReadSMIData(ENET_Type *base)

Reads data from the PHY register through an SMI interface.

Parameters

- base – ENET peripheral base address.

Returns

The data read from PHY

static inline void ENET_StartSMIWrite(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, *enet_mii_write_t* operation, uint16_t data)

Sends the MDIO IEEE802.3 Clause 22 format write command.

After calling this function, need to check whether the transmission is over then do next MDIO operation. For ease of use, encapsulated ENET_MDIOWrite() can be called. For customized requirements, implement with combining separated APIs.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address. Range from 0 ~ 31.
- regAddr – The PHY register address. Range from 0 ~ 31.
- operation – The write operation.
- data – The data written to PHY.

static inline void ENET_StartSMIRead(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, *enet_mii_read_t* operation)

Sends the MDIO IEEE802.3 Clause 22 format read command.

After calling this function, need to check whether the transmission is over then do next MDIO operation. For ease of use, encapsulated ENET_MDIORead() can be called. For customized requirements, implement with combining separated APIs.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address. Range from 0 ~ 31.
- regAddr – The PHY register address. Range from 0 ~ 31.
- operation – The read operation.

status_t ENET_MDIOWrite(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

MDIO write with IEEE802.3 Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address. Range from 0 ~ 31.
- regAddr – The PHY register. Range from 0 ~ 31.
- data – The data written to PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

status_t ENET_MDIORead(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t *pData)

MDIO read with IEEE802.3 Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address. Range from 0 ~ 31.
- regAddr – The PHY register. Range from 0 ~ 31.
- pData – The data read from PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

static inline void ENET_StartExtC45SMIWriteReg(ENET_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr)

Sends the MDIO IEEE802.3 Clause 45 format write register command.

After calling this function, need to check whether the transmission is over then do next MDIO operation. For ease of use, encapsulated ENET_MDIOC45Write()/ENET_MDIOC45Read() can be called. For customized requirements, implement with combining separated APIs.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.

static inline void ENET_StartExtC45SMIWriteData(ENET_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t data)

Sends the MDIO IEEE802.3 Clause 45 format write data command.

After calling this function, need to check whether the transmission is over then do next MDIO operation. For ease of use, encapsulated ENET_MDIOC45Write() can be called. For customized requirements, implement with combining separated APIs.

Parameters

- base – ENET peripheral base address.

- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- data – The data written to PHY.

static inline void ENET_StartExtC45SMIReadData(ENET_Type *base, uint8_t portAddr, uint8_t devAddr)

Sends the MDIO IEEE802.3 Clause 45 format read data command.

After calling this function, need to check whether the transmission is over then do next MDIO operation. For ease of use, encapsulated ENET_MDIOC45Read() can be called. For customized requirements, implement with combining separated APIs.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.

status_t ENET_MDIOC45Write(ENET_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t data)

MDIO write with IEEE802.3 Clause 45 format.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.
- data – The data written to PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

status_t ENET_MDIOC45Read(ENET_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t *pData)

MDIO read with IEEE802.3 Clause 45 format.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.
- pData – The data read from PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

static inline void ENET_SetRGMIIClockDelay(ENET_Type *base, bool txEnabled, bool rxEnabled)

Control the usage of the delayed tx/rx RGMII clock.

Parameters

- base – ENET peripheral base address.
- txEnabled – Enable or disable to generate the delayed version of RGMII_TXC.
- rxEnabled – Enable or disable to use the delayed version of RGMII_RXC.

void ENET_SetMacAddr(ENET_Type *base, uint8_t *macAddr)

Sets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

void ENET_GetMacAddr(ENET_Type *base, uint8_t *macAddr)

Gets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

void ENET_AddMulticastGroup(ENET_Type *base, uint8_t *address)

Adds the ENET device to a multicast group.

Parameters

- base – ENET peripheral base address.
- address – The six-byte multicast group address which is provided by application.

void ENET_LeaveMulticastGroup(ENET_Type *base, uint8_t *address)

Moves the ENET device from a multicast group.

Parameters

- base – ENET peripheral base address.
- address – The six-byte multicast group address which is provided by application.

static inline void ENET_ActiveRead(ENET_Type *base)

Activates frame reception for multiple rings.

This function is to active the enet read process.

Note: This must be called after the MAC configuration and state are ready. It must be called after the ENET_Init(). This should be called when the frame reception is required.

Parameters

- base – ENET peripheral base address.

static inline void ENET_EnableSleepMode(ENET_Type *base, bool enable)

Enables/disables the MAC to enter sleep mode. This function is used to set the MAC enter sleep mode. When entering sleep mode, the magic frame wakeup interrupt should be enabled to wake up MAC from the sleep mode and reset it to normal mode.

Parameters

- base – ENET peripheral base address.

- enable – True enable sleep mode, false disable sleep mode.

static inline void ENET_GetAccelFunction(ENET_Type *base, uint32_t *txAccelOption, uint32_t *rxAccelOption)

Gets ENET transmit and receive accelerator functions from MAC controller.

Parameters

- base – ENET peripheral base address.
- txAccelOption – The transmit accelerator option. The "enet_tx_accelerator_t" is recommended to be used to as the mask to get the exact the accelerator option.
- rxAccelOption – The receive accelerator option. The "enet_rx_accelerator_t" is recommended to be used to as the mask to get the exact the accelerator option.

static inline void ENET_EnableInterrupts(ENET_Type *base, uint32_t mask)

Enables the ENET interrupt.

This function enables the ENET interrupt according to the provided mask. The mask is a logical OR of enumeration members. See enet_interrupt_enable_t. For example, to enable the TX frame interrupt and RX frame interrupt, do the following.

```
ENET_EnableInterrupts(ENET, kENET_TxFrameInterrupt | kENET_RxFrameInterrupt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to enable. This is a logical OR of the enumeration enet_interrupt_enable_t.

static inline void ENET_DisableInterrupts(ENET_Type *base, uint32_t mask)

Disables the ENET interrupt.

This function disables the ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See enet_interrupt_enable_t. For example, to disable the TX frame interrupt and RX frame interrupt, do the following.

```
ENET_DisableInterrupts(ENET, kENET_TxFrameInterrupt | kENET_RxFrameInterrupt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to disable. This is a logical OR of the enumeration enet_interrupt_enable_t.

static inline uint32_t ENET_GetInterruptStatus(ENET_Type *base)

Gets the ENET interrupt status flag.

Parameters

- base – ENET peripheral base address.

Returns

The event status of the interrupt source. This is the logical OR of members of the enumeration enet_interrupt_enable_t.

static inline void ENET_ClearInterruptStatus(ENET_Type *base, uint32_t mask)

Clears the ENET interrupt events status flag.

This function clears enabled ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See the enet_interrupt_enable_t. For example, to clear the TX frame interrupt and RX frame interrupt, do the following.

```
ENET_ClearInterruptStatus(ENET, kENET_TxFrameInterrupt | kENET_RxFrameInterrupt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupt source to be cleared. This is the logical OR of members of the enumeration enet_interrupt_enable_t.

void ENET_SetRxISRHandler(ENET_Type *base, *enet_isr_t* ISRHandler)

Set the second level Rx IRQ handler.

Parameters

- base – ENET peripheral base address.
- ISRHandler – The handler to install.

void ENET_SetTxISRHandler(ENET_Type *base, *enet_isr_t* ISRHandler)

Set the second level Tx IRQ handler.

Parameters

- base – ENET peripheral base address.
- ISRHandler – The handler to install.

void ENET_SetErrISRHandler(ENET_Type *base, *enet_isr_t* ISRHandler)

Set the second level Err IRQ handler.

Parameters

- base – ENET peripheral base address.
- ISRHandler – The handler to install.

void ENET_GetRxErrBeforeReadFrame(*enet_handle_t* *handle, *enet_data_error_stats_t* *eErrorStatic, uint8_t ringId)

Gets the error statistics of a received frame for ENET specified ring.

This API must be called after the ENET_GetRxFrameSize and before the ENET_ReadFrame(). If the ENET_GetRxFrameSize returns kStatus_ENET_RxFrameError, the ENET_GetRxErrBeforeReadFrame can be used to get the exact error statistics. This is an example.

```
status = ENET_GetRxFrameSize(&g_handle, &length, 0);
if (status == kStatus_ENET_RxFrameError)
{
    Comments: Get the error information of the received frame.
    ENET_GetRxErrBeforeReadFrame(&g_handle, &eErrStatic, 0);
    Comments: update the receive buffer.
    ENET_ReadFrame(EXAMPLE_ENET, &g_handle, NULL, 0);
}
```

Parameters

- handle – The ENET handler structure pointer. This is the same handler pointer used in the ENET_Init.
- eErrorStatic – The error statistics structure pointer.
- ringId – The ring index, range from 0 ~ (FSL_FEATURE_ENET_INSTANCE_QUEUEn(x) - 1).

void ENET_EnableStatistics(ENET_Type *base, bool enable)

Enables/disables collection of transfer statistics.

Note that this function does not reset any of the already collected data, use the function ENET_ResetStatistics to clear the transfer statistics if needed.

Parameters

- base – ENET peripheral base address.
- enable – True enable statistics collection, false disable statistics collection.

void ENET_GetStatistics(ENET_Type *base, *enet_transfer_stats_t* *statistics)

Gets transfer statistics.

Copies the actual value of hardware counters into the provided structure. Calling this function does not reset the counters in hardware.

Parameters

- base – ENET peripheral base address.
- statistics – The statistics structure pointer.

void ENET_ResetStatistics(ENET_Type *base)

Resets transfer statistics.

Sets the value of hardware transfer counters to zero.

Parameters

- base – ENET peripheral base address.

status_t ENET_GetRxFrameSize(*enet_handle_t* *handle, uint32_t *length, uint8_t ringId)

Gets the size of the read frame for specified ring.

This function gets a received frame size from the ENET buffer descriptors.

Note: The FCS of the frame is automatically removed by MAC and the size is the length without the FCS. After calling ENET_GetRxFrameSize, ENET_ReadFrame() should be called to receive frame and update the BD if the result is not "kStatus_ENET_RxFrameEmpty".

Parameters

- handle – The ENET handler structure. This is the same handler pointer used in the ENET_Init.
- length – The length of the valid frame received.
- ringId – The ring index or ring number.

Return values

- kStatus_ENET_RxFrameEmpty – No frame received. Should not call ENET_ReadFrame to read frame.
- kStatus_ENET_RxFrameError – Data error happens. ENET_ReadFrame should be called with NULL data and NULL length to update the receive buffers.
- kStatus_Success – Receive a frame Successfully then the ENET_ReadFrame should be called with the right data buffer and the captured data length input.

status_t ENET_ReadFrame(ENET_Type *base, *enet_handle_t* *handle, uint8_t *data, uint32_t length, uint8_t ringId, uint32_t *ts)

Reads a frame from the ENET device. This function reads a frame (both the data and the length) from the ENET buffer descriptors. User can get timestamp through ts pointer if the ts is not NULL.

Note: It doesn't store the timestamp in the receive timestamp queue. The ENET_GetRxFrameSize should be used to get the size of the prepared data buffer. This API uses memcpy to copy data from DMA buffer to application buffer, 4 bytes aligned data buffer in 32 bits platforms provided by user may let compiler use optimization instruction to reduce time consumption. This is an example:

```
uint32_t length;
enet_handle_t g_handle;
Comments: Get the received frame size firstly.
status = ENET_GetRxFrameSize(&g_handle, &length, 0);
if (length != 0)
{
    Comments: Allocate memory here with the size of "length"
    uint8_t *data = memory allocate interface;
    if (!data)
    {
        ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0, NULL);
        Comments: Add the console warning log.
    }
    else
    {
        status = ENET_ReadFrame(ENET, &g_handle, data, length, 0, NULL);
        Comments: Call stack input API to deliver the data to stack
    }
}
else if (status == kStatus_ENET_RxFrameError)
{
    Comments: Update the received buffer when a error frame is received.
    ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0, NULL);
}
```

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler structure. This is the same handler pointer used in the ENET_Init.
- data – The data buffer provided by user to store the frame which memory size should be at least "length".
- length – The size of the data buffer which is still the length of the received frame.
- ringId – The ring index or ring number.
- ts – The timestamp address to store received timestamp.

Returns

The execute status, successful or failure.

status_t ENET_SendFrame(ENET_Type *base, *enet_handle_t* *handle, const uint8_t *data, uint32_t length, uint8_t ringId, bool tsFlag, void *context)

Transmits an ENET frame for specified ring.

Note: The CRC is automatically appended to the data. Input the data to send without the CRC. This API uses memcpy to copy data from DMA buffer to application buffer, 4 bytes aligned data buffer in 32 bits platforms provided by user may let compiler use optimization instruction to reduce time consumption.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- data – The data buffer provided by user to send.
- length – The length of the data to send.
- ringId – The ring index or ring number.
- tsFlag – Timestamp enable flag.
- context – Used by user to handle some events after transmit over.

Return values

- kStatus_Success – Send frame succeed.
- kStatus_ENET_TxFrameBusy – Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with kStatus_ENET_TxFrameBusy.

status_t ENET_SetTxReclaim(*enet_handle_t* *handle, bool isEnable, uint8_t ringId)

Enable or disable tx descriptors reclaim mechanism.

Note: This function must be called when no pending send frame action. Set enable if you want to reclaim context or timestamp in interrupt.

Parameters

- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- isEnable – Enable or disable flag.
- ringId – The ring index or ring number.

Return values

- kStatus_Success – Succeed to enable/disable Tx reclaim.
- kStatus_Fail – Fail to enable/disable Tx reclaim.

void ENET_ReclaimTxDescriptor(ENET_Type *base, *enet_handle_t* *handle, uint8_t ringId)

Reclaim tx descriptors. This function is used to update the tx descriptor status and store the tx timestamp when the 1588 feature is enabled. This is called by the transmit interupt IRQ handler after the complete of a frame transmission.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- ringId – The ring index or ring number.

status_t ENET_GetRxFrame(ENET_Type *base, *enet_handle_t* *handle, *enet_rx_frame_struct_t* *rxFrame, uint8_t ringId)

Receives one frame in specified BD ring with zero copy.

This function uses the user-defined allocation and free callbacks. Every time application gets one frame through this function, driver stores the buffer address(es) in enet_buffer_struct_t and allocate new buffer(s) for the BD(s). If there's no memory buffer in the pool, this function drops current one frame to keep the Rx frame in BD ring is as fresh as possible.

Note: Application must provide a memory pool including at least BD number + n buffers in order for this function to work properly, because each BD must always take one buffer while driver is running, then other extra n buffer(s) can be taken by application. Here n is the ceil(max_frame_length(set by RCR) / bd_rx_size(set by MRBR)). Application must also provide an array structure in rxFrame->rxBuffArray with n index to receive one complete frame in any case.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- rxFrame – The received frame information structure provided by user.
- ringId – The ring index or ring number.

Return values

- kStatus_Success – Succeed to get one frame and allocate new memory for Rx buffer.
- kStatus_ENET_RxFrameEmpty – There's no Rx frame in the BD.
- kStatus_ENET_RxFrameError – There's issue in this receiving.
- kStatus_ENET_RxFrameDrop – There's no new buffer memory for BD, drop this frame.

status_t ENET_StartTxFrame(ENET_Type *base, *enet_handle_t* *handle, *enet_tx_frame_struct_t* *txFrame, uint8_t ringId)

Sends one frame in specified BD ring with zero copy.

This function supports scattered buffer transmit, user needs to provide the buffer array.

Note: Tx reclaim should be enabled to ensure the Tx buffer ownership can be given back to application after Tx is over.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- txFrame – The Tx frame structure.
- ringId – The ring index or ring number.

Return values

- kStatus_Success – Succeed to send one frame.

- kStatus_ENET_TxFrameBusy – The BD is not ready for Tx or the reclaim operation still not finishs.
- kStatus_ENET_TxFrameOverLen – The Tx frame length is over max ethernet frame length.

void ENET_TransmitIRQHandler(ENET_Type *base, *enet_handle_t* *handle)

The transmit IRQ handler.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer.

void ENET_ReceiveIRQHandler(ENET_Type *base, *enet_handle_t* *handle)

The receive IRQ handler.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer.

void ENET_ErrorIRQHandler(ENET_Type *base, *enet_handle_t* *handle)

Some special IRQ handler including the error, mii, wakeup irq handler.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer.

void ENET_Ptp1588IRQHandler(ENET_Type *base)

the common IRQ handler for the 1588 irq handler.

This is used for the 1588 timer interrupt.

Parameters

- base – ENET peripheral base address.

void ENET_CommonFrame0IRQHandler(ENET_Type *base)

the common IRQ handler for the tx/rx/error etc irq handler.

This is used for the combined tx/rx/error interrupt for single/mutli-ring (frame 0).

Parameters

- base – ENET peripheral base address.

FSL_ENET_DRIVER_VERSION

Defines the driver version.

ENET_BUFFDESCRIPTOR_RX_EMPTY_MASK

Empty bit mask.

ENET_BUFFDESCRIPTOR_RX_SOFTOWNER1_MASK

Software owner one mask.

ENET_BUFFDESCRIPTOR_RX_WRAP_MASK

Next buffer descriptor is the start address.

ENET_BUFFDESCRIPTOR_RX_SOFTOWNER2_Mask

Software owner two mask.

ENET_BUFFDESCRIPTOR_RX_LAST_MASK

Last BD of the frame mask.

ENET_BUFFDESCRIPTOR_RX_MISS_MASK
: Received because of the promiscuous mode.

ENET_BUFFDESCRIPTOR_RX_BROADCAST_MASK
: Broadcast packet mask.

ENET_BUFFDESCRIPTOR_RX_MULTICAST_MASK
: Multicast packet mask.

ENET_BUFFDESCRIPTOR_RX_LENVLIOLATE_MASK
: Length violation mask.

ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK
: Non-octet aligned frame mask.

ENET_BUFFDESCRIPTOR_RX_CRC_MASK
: CRC error mask.

ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK
: FIFO overrun mask.

ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK
: Frame is truncated mask.

ENET_BUFFDESCRIPTOR_TX_READY_MASK
: Ready bit mask.

ENET_BUFFDESCRIPTOR_TX_SOFTOWENER1_MASK
: Software owner one mask.

ENET_BUFFDESCRIPTOR_TX_WRAP_MASK
: Wrap buffer descriptor mask.

ENET_BUFFDESCRIPTOR_TX_SOFTOWENER2_MASK
: Software owner two mask.

ENET_BUFFDESCRIPTOR_TX_LAST_MASK
: Last BD of the frame mask.

ENET_BUFFDESCRIPTOR_TX_TRANMITCRC_MASK
: Transmit CRC mask.

ENET_FRAME_MAX_FRAMELEN
: Default maximum Ethernet frame size without VLAN tag.

ENET_FRAME_VLAN_TAGLEN
: Ethernet single VLAN tag size.

ENET_FRAME_CRC_LEN
: CRC size in a frame.

ENET_FRAME_TX_LEN_LIMITATION(x)

ENET_FIFO_MIN_RX_FULL
: ENET minimum receive FIFO full.

ENET_RX_MIN_BUFFERSIZE
: ENET minimum buffer size.

ENET_PHY_MAXADDRESS
: Maximum PHY address.

ENET_TX_INTERRUPT
Enet Tx interrupt flag.

ENET_RX_INTERRUPT
Enet Rx interrupt flag.

ENET_TS_INTERRUPT
Enet timestamp interrupt flag.

ENET_ERR_INTERRUPT
Enet error interrupt flag.

Defines the status return codes for transaction.

Values:

enumerator kStatus_ENET_InitMemoryFail
Init fails since buffer memory is not enough.

enumerator kStatus_ENET_RxFrameError
A frame received but data error happen.

enumerator kStatus_ENET_RxFrameFail
Failed to receive a frame.

enumerator kStatus_ENET_RxFrameEmpty
No frame arrive.

enumerator kStatus_ENET_RxFrameDrop
Rx frame is dropped since no buffer memory.

enumerator kStatus_ENET_TxFrameOverLen
Tx frame over length.

enumerator kStatus_ENET_TxFrameBusy
Tx buffer descriptors are under process.

enumerator kStatus_ENET_TxFrameFail
Transmit frame fail.

enum _enet_mii_mode
Defines the MII/RMII/RGMII mode for data interface between the MAC and the PHY.

Values:

enumerator kENET_MiiMode
MII mode for data interface.

enumerator kENET_RmiiMode
RMII mode for data interface.

enumerator kENET_RgmiiMode
RGMII mode for data interface.

enum _enet_mii_speed
Defines the 10/100/1000 Mbps speed for the MII data interface.

Notice: “kENET_MiiSpeed1000M” only supported when mii mode is “kENET_RgmiiMode”.

Values:

enumerator kENET_MiiSpeed10M
Speed 10 Mbps.

enumerator kENET_MiiSpeed100M
Speed 100 Mbps.

enumerator kENET_MiiSpeed1000M
Speed 1000M bps.

enum _enet_mii_duplex
Defines the half or full duplex for the MII data interface.

Values:

enumerator kENET_MiiHalfDuplex
Half duplex mode.

enumerator kENET_MiiFullDuplex
Full duplex mode.

enum _enet_mii_write
Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

Values:

enumerator kENET_MiiWriteNoCompliant
Write frame operation, but not MII-compliant.

enumerator kENET_MiiWriteValidFrame
Write frame operation for a valid MII management frame.

enum _enet_mii_read
Defines the read operation for the MII management frame.

Values:

enumerator kENET_MiiReadValidFrame
Read frame operation for a valid MII management frame.

enumerator kENET_MiiReadNoCompliant
Read frame operation, but not MII-compliant.

enum _enet_mii_extend_opcode
Define the MII opcode for extended MDIO_CLAUSES_45 Frame.

Values:

enumerator kENET_MiiAddrWrite_C45
Address Write operation.

enumerator kENET_MiiWriteFrame_C45
Write frame operation for a valid MII management frame.

enumerator kENET_MiiReadFrame_C45
Read frame operation for a valid MII management frame.

enum _enet_special_control_flag
Defines a special configuration for ENET MAC controller.

These control flags are provided for special user requirements. Normally, these control flags are unused for ENET initialization. For special requirements, set the flags to macSpecialConfig in the enet_config_t. The kENET_ControlStoreAndFwdDisable is used to disable the FIFO store and forward. FIFO store and forward means that the FIFO read/send is started when a complete frame is stored in TX/RX FIFO. If this flag is set, configure rxFifoFullThreshold and txFifoWatermark in the enet_config_t.

Values:

enumerator kENET_ControlFlowControlEnable
Enable ENET flow control: pause frame.

enumerator kENET_ControlRxPayloadCheckEnable
Enable ENET receive payload length check.

enumerator kENET_ControlRxPadRemoveEnable
Padding is removed from received frames.

enumerator kENET_ControlRxBroadCastRejectEnable
Enable broadcast frame reject.

enumerator kENET_ControlMacAddrInsert
Enable MAC address insert.

enumerator kENET_ControlStoreAndFwdDisable
Enable FIFO store and forward.

enumerator kENET_ControlSMIPreambleDisable
Enable SMI preamble.

enumerator kENET_ControlPromiscuousEnable
Enable promiscuous mode.

enumerator kENET_ControlMIILoopEnable
Enable ENET MII loop back.

enumerator kENET_ControlVLANTagEnable
Enable normal VLAN (single vlan tag).

enumerator kENET_ControlSVLANEnable
Enable S-VLAN.

enumerator kENET_ControlVLANUseSecondTag
Enable extracting the second vlan tag for further processing.

enum _enet_interrupt_enable
List of interrupts supported by the peripheral. This enumeration uses one-bit encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

Values:

enumerator kENET_BabrInterrupt
Babbling receive error interrupt source

enumerator kENET_BabtInterrupt
Babbling transmit error interrupt source

enumerator kENET_GraceStopInterrupt
Graceful stop complete interrupt source

enumerator kENET_TxFrameInterrupt
TX FRAME interrupt source

enumerator kENET_TxBufferInterrupt
TX BUFFER interrupt source

enumerator kENET_RxFrameInterrupt
RX FRAME interrupt source

enumerator kENET_RxBufferInterrupt
RX BUFFER interrupt source

enumerator kENET_MiiInterrupt
MII interrupt source

enumerator kENET_EBusERInterrupt
Ethernet bus error interrupt source

enumerator kENET_LateCollisionInterrupt
Late collision interrupt source

enumerator kENET_RetryLimitInterrupt
Collision Retry Limit interrupt source

enumerator kENET_UnderrunInterrupt
Transmit FIFO underrun interrupt source

enumerator kENET_PayloadRxInterrupt
Payload Receive error interrupt source

enumerator kENET_WakeupInterrupt
WAKEUP interrupt source

enumerator kENET_TsAvailInterrupt
TS AVAIL interrupt source for PTP

enumerator kENET_TsTimerInterrupt
TS WRAP interrupt source for PTP

enum _enet_event
Defines the common interrupt event for callback use.

Values:

enumerator kENET_RxEvent
Receive event.

enumerator kENET_TxEvent
Transmit event.

enumerator kENET_ErrEvent
Error event: BABR/BABT/EBERR/LC/RL/UN/PLR .

enumerator kENET_WakeUpEvent
Wake up from sleep mode event.

enumerator kENET_TimeStampEvent
Time stamp event.

enumerator kENET_TimeStampAvailEvent
Time stamp available event.

enum _enet_idle_slope
Defines certain idle slope for bandwidth fraction.

Values:

enumerator kENET_IdleSlope1
The bandwidth fraction is about 0.002.

enumerator kENET_IdleSlope2
The bandwidth fraction is about 0.003.

enumerator kENET_IdleSlope4
The bandwidth fraction is about 0.008.

enumerator kENET_IdleSlope8
The bandwidth fraction is about 0.02.

enumerator kENET_IdleSlope16
The bandwidth fraction is about 0.03.

enumerator kENET_IdleSlope32
The bandwidth fraction is about 0.06.

enumerator kENET_IdleSlope64
The bandwidth fraction is about 0.11.

enumerator kENET_IdleSlope128
The bandwidth fraction is about 0.20.

enumerator kENET_IdleSlope256
The bandwidth fraction is about 0.33.

enumerator kENET_IdleSlope384
The bandwidth fraction is about 0.43.

enumerator kENET_IdleSlope512
The bandwidth fraction is about 0.50.

enumerator kENET_IdleSlope640
The bandwidth fraction is about 0.56.

enumerator kENET_IdleSlope768
The bandwidth fraction is about 0.60.

enumerator kENET_IdleSlope896
The bandwidth fraction is about 0.64.

enumerator kENET_IdleSlope1024
The bandwidth fraction is about 0.67.

enumerator kENET_IdleSlope1152
The bandwidth fraction is about 0.69.

enumerator kENET_IdleSlope1280
The bandwidth fraction is about 0.71.

enumerator kENET_IdleSlope1408
The bandwidth fraction is about 0.73.

enumerator kENET_IdleSlope1536
The bandwidth fraction is about 0.75.

enum _enet_tx_accelerator
Defines the transmit accelerator configuration.

Note that the hardware does not insert ICMPv6 protocol checksums as mentioned in errata ERR052152.

Values:

enumerator kENET_TxAccelIsShift16Enabled
Transmit FIFO shift-16.

enumerator kENET_TxAccelIpCheckEnabled
Insert IP header checksum.

enumerator kENET_TxAccelProtoCheckEnabled
Insert protocol checksum (TCP, UDP, ICMPv4).

enum _enet_rx_accelerator

Defines the receive accelerator configuration.

Note that the hardware does not validate ICMPv6 protocol checksums as mentioned in errata ERR052152.

Values:

enumerator kENET_RxAccelPadRemoveEnabled

Padding removal for short IP frames.

enumerator kENET_RxAccelIpCheckEnabled

Discard with wrong IP header checksum.

enumerator kENET_RxAccelProtoCheckEnabled

Discard with wrong protocol checksum (TCP, UDP, ICMPv4).

enumerator kENET_RxAccelMacCheckEnabled

Discard with Mac layer errors.

enumerator kENET_RxAccelisShift16Enabled

Receive FIFO shift-16.

typedef enum *_enet_mii_mode* enet_mii_mode_t

Defines the MII/RMII/RGMII mode for data interface between the MAC and the PHY.

typedef enum *_enet_mii_speed* enet_mii_speed_t

Defines the 10/100/1000 Mbps speed for the MII data interface.

Notice: "kENET_MiiSpeed1000M" only supported when mii mode is "kENET_RgmiiMode".

typedef enum *_enet_mii_duplex* enet_mii_duplex_t

Defines the half or full duplex for the MII data interface.

typedef enum *_enet_mii_write* enet_mii_write_t

Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

typedef enum *_enet_mii_read* enet_mii_read_t

Defines the read operation for the MII management frame.

typedef enum *_enet_mii_extend_opcode* enet_mii_extend_opcode

Define the MII opcode for extended MDIO_CLAUSES_45 Frame.

typedef enum *_enet_special_control_flag* enet_special_control_flag_t

Defines a special configuration for ENET MAC controller.

These control flags are provided for special user requirements. Normally, these control flags are unused for ENET initialization. For special requirements, set the flags to macSpecialConfig in the enet_config_t. The kENET_ControlStoreAndFwdDisable is used to disable the FIFO store and forward. FIFO store and forward means that the FIFO read/send is started when a complete frame is stored in TX/RX FIFO. If this flag is set, configure rxFifoFullThreshold and txFifoWatermark in the enet_config_t.

typedef enum *_enet_interrupt_enable* enet_interrupt_enable_t

List of interrupts supported by the peripheral. This enumeration uses one-bit encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

typedef enum *_enet_event* enet_event_t

Defines the common interrupt event for callback use.

typedef enum *_enet_idle_slope* enet_idle_slope_t

Defines certain idle slope for bandwidth fraction.

typedef enum *_enet_tx_accelerator* enet_tx_accelerator_t

Defines the transmit accelerator configuration.

Note that the hardware does not insert ICMPv6 protocol checksums as mentioned in errata ERR052152.

typedef enum *_enet_rx_accelerator* enet_rx_accelerator_t

Defines the receive accelerator configuration.

Note that the hardware does not validate ICMPv6 protocol checksums as mentioned in errata ERR052152.

typedef struct *_enet_rx_bd_struct* enet_rx_bd_struct_t

Defines the receive buffer descriptor structure for the little endian system.

typedef struct *_enet_tx_bd_struct* enet_tx_bd_struct_t

Defines the enhanced transmit buffer descriptor structure for the little endian system.

typedef struct *_enet_data_error_stats* enet_data_error_stats_t

Defines the ENET data error statistics structure.

typedef struct *_enet_rx_frame_error* enet_rx_frame_error_t

Defines the Rx frame error structure.

typedef struct *_enet_transfer_stats* enet_transfer_stats_t

Defines the ENET transfer statistics structure.

typedef struct *enet_frame_info* enet_frame_info_t

Defines the frame info structure.

typedef struct *_enet_tx_dirty_ring* enet_tx_dirty_ring_t

Defines the ENET transmit dirty addresses ring/queue structure.

typedef void *(*enet_rx_alloc_callback_t)(ENET_Type *base, void *userData, uint8_t ringId)

Defines the ENET Rx memory buffer alloc function pointer.

typedef void (*enet_rx_free_callback_t)(ENET_Type *base, void *buffer, void *userData, uint8_t ringId)

Defines the ENET Rx memory buffer free function pointer.

typedef struct *_enet_buffer_config* enet_buffer_config_t

Defines the receive buffer descriptor configuration structure.

Note that for the internal DMA requirements, the buffers have a corresponding alignment requirements.

a. The aligned receive and transmit buffer size must be evenly divisible by ENET_BUFF_ALIGNMENT. when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of “ENET_BUFF_ALIGNMENT” and the cache line size.

b. The aligned transmit and receive buffer descriptor start address must be at least 64 bit aligned. However, it’s recommended to be evenly divisible by ENET_BUFF_ALIGNMENT. buffer descriptors should be put in non-cacheable region when cache is enabled.

c. The aligned transmit and receive data buffer start address must be evenly divisible by ENET_BUFF_ALIGNMENT. Receive buffers should be continuous with the total size equal to “rxBdNumber * rxBuffSizeAlign”. Transmit buffers should be continuous with the total size equal to “txBdNumber * txBuffSizeAlign”. when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of “ENET_BUFF_ALIGNMENT” and the cache line size.

typedef struct *_enet_intcoalesce_config* enet_intcoalesce_config_t

Defines the interrupt coalescing configure structure.

typedef struct *_enet_avb_config* enet_avb_config_t

Defines the ENET AVB Configure structure.

This is used for to configure the extended ring 1 and ring 2.

a. The classification match format is (CMP3 « 12) | (CMP2 « 8) | (CMP1 « 4) | CMP0. composed of four 3-bit compared VLAN priority field cmp0~cmp3, cm0 ~ cmp3 are used in parallel.

If CMP1,2,3 are not unused, please set them to the same value as CMP0.

a. The idleSlope is used to calculate the Band Width fraction, BW fraction = 1 / (1 + 512/idleSlope). For avb configuration, the BW fraction of Class 1 and Class 2 combined must not exceed 0.75.

typedef struct *_enet_handle* enet_handle_t

typedef void (*enet_callback_t)(ENET_Type *base, *enet_handle_t* *handle, *enet_event_t* event, *enet_frame_info_t* *frameInfo, void *userData)

ENET callback function.

typedef struct *_enet_config* enet_config_t

Defines the basic configuration structure for the ENET device.

Note:

a. macSpecialConfig is used for a special control configuration, A logical OR of "enet_special_control_flag_t". For a special configuration for MAC, set this parameter to 0.

b. txWatermark is used for a cut-through operation. It is in steps of 64 bytes: 0/1 - 64 bytes written to TX FIFO before transmission of a frame begins. 2 - 128 bytes written to TX FIFO .... 3 - 192 bytes written to TX FIFO .... The maximum of txWatermark is 0x2F - 4032 bytes written to TX FIFO .... txWatermark allows minimizing the transmit latency to set the txWatermark to 0 or 1 or for larger bus access latency 3 or larger due to contention for the system bus.

c. rxFifoFullThreshold is similar to the txWatermark for cut-through operation in RX. It is in 64-bit words. The minimum is ENET_FIFO_MIN_RX_FULL and the maximum is 0xFF. If the end of the frame is stored in FIFO and the frame size if smaller than the txWatermark, the frame is still transmitted. The rule is the same for rxFifoFullThreshold in the receive direction.

d. When "kENET_ControlFlowControlEnable" is set in the macSpecialConfig, ensure that the pauseDuration, rxFifoEmptyThreshold, and rxFifoStatEmptyThreshold are set for flow control enabled case.

e. When "kENET_ControlStoreAndFwdDisabled" is set in the macSpecialConfig, ensure that the rxFifoFullThreshold and txFifoWatermark are set for store and forward disable.

f. The rxAccelerConfig and txAccelerConfig default setting with 0 - accelerator are disabled. The "enet_tx_accelerator_t" and "enet_rx_accelerator_t" are recommended to be used to enable the transmit and receive accelerator. After the accelerators are enabled, the store and forward feature should be enabled. As a result, kENET_ControlStoreAndFwdDisabled should not be set.

g. The intCoalesceCfg can be used in the rx or tx enabled cases to decrese the CPU loading.

typedef struct *_enet_tx_bd_ring* enet_tx_bd_ring_t

Defines the ENET transmit buffer descriptor ring/queue structure.

typedef struct *_enet_rx_bd_ring* enet_rx_bd_ring_t
Defines the ENET receive buffer descriptor ring/queue structure.

typedef struct *_enet_buffer_struct* enet_buffer_struct_t

typedef struct *_enet_rx_frame_attribute_struct* enet_rx_frame_attribute_t

typedef struct *_enet_rx_frame_struct* enet_rx_frame_struct_t

typedef struct *_enet_tx_frame_struct* enet_tx_frame_struct_t

typedef void (*enet_isr_t)(ENET_Type *base, *enet_handle_t* *handle)
Define interrupt IRQ handler.

const *clock_ip_name_t* s_enetClock[]
Pointers to enet clocks for each instance.

const *clock_ip_name_t* s_enetExtraClock[]

uint32_t ENET_GetInstance(ENET_Type *base)
Get the ENET instance from peripheral base address.

Parameters

- base – ENET peripheral base address.

Returns
ENET instance.

ENET_BUFFDESCRIPTOR_RX_ERR_MASK
Defines the receive error status flag mask.

struct _enet_rx_bd_struct
#include <fsl_enet.h> Defines the receive buffer descriptor structure for the little endian system.

Public Members

uint16_t length
Buffer descriptor data length.

uint16_t control
Buffer descriptor control and status.

uint32_t buffer
Data buffer pointer.

struct _enet_tx_bd_struct
#include <fsl_enet.h> Defines the enhanced transmit buffer descriptor structure for the little endian system.

Public Members

uint16_t length
Buffer descriptor data length.

uint16_t control
Buffer descriptor control and status.

uint32_t buffer
Data buffer pointer.

struct _enet_data_error_stats

#include <fsl_enet.h> Defines the ENET data error statistics structure.

Public Members

uint32_t statsRxLenGreaterErr

Receive length greater than RCR[MAX_FL].

uint32_t statsRxAlignErr

Receive non-octet alignment/

uint32_t statsRxFcsErr

Receive CRC error.

uint32_t statsRxOverRunErr

Receive over run.

uint32_t statsRxTruncateErr

Receive truncate.

struct _enet_rx_frame_error

#include <fsl_enet.h> Defines the Rx frame error structure.

Public Members

bool statsRxTruncateErr

Receive truncate.

bool statsRxOverRunErr

Receive over run.

bool statsRxFcsErr

Receive CRC error.

bool statsRxAlignErr

Receive non-octet alignment.

bool statsRxLenGreaterErr

Receive length greater than RCR[MAX_FL].

struct _enet_transfer_stats

#include <fsl_enet.h> Defines the ENET transfer statistics structure.

Public Members

uint32_t statsRxFrameCount

Rx frame number.

uint32_t statsRxFrameOk

Good Rx frame number.

uint32_t statsRxCrcErr

Rx frame number with CRC error.

uint32_t statsRxAlignErr

Rx frame number with alignment error.

uint32_t statsRxDropInvalidSFD

Dropped frame number due to invalid SFD.

uint32_t statsRxFifoOverflowErr
: Rx FIFO overflow count.

uint32_t statsTxFrameCount
: Tx frame number.

uint32_t statsTxFrameOk
: Good Tx frame number.

uint32_t statsTxCrcAlignErr
: The transmit frame is error.

uint32_t statsTxFifoUnderRunErr
: Tx FIFO underrun count.

struct enet_frame_info
: *#include <fsl_enet.h>* Defines the frame info structure.

Public Members

void *context
: User specified data

struct _enet_tx_dirty_ring
: *#include <fsl_enet.h>* Defines the ENET transmit dirty addresses ring/queue structure.

Public Members

enet_frame_info_t *txDirtyBase
: Dirty buffer descriptor base address pointer.

uint16_t txGenIdx
: tx generate index.

uint16_t txConsumIdx
: tx consume index.

uint16_t txRingLen
: tx ring length.

bool isFull
: tx ring is full flag.

struct _enet_buffer_config
: *#include <fsl_enet.h>* Defines the receive buffer descriptor configuration structure.

  Note that for the internal DMA requirements, the buffers have a corresponding alignment requirements.

  a. The aligned receive and transmit buffer size must be evenly divisible by ENET_BUFF_ALIGNMENT. when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of “ENET_BUFF_ALIGNMENT” and the cache line size.

  b. The aligned transmit and receive buffer descriptor start address must be at least 64 bit aligned. However, it’s recommended to be evenly divisible by ENET_BUFF_ALIGNMENT. buffer descriptors should be put in non-cacheable region when cache is enabled.

c. The aligned transmit and receive data buffer start address must be evenly divisible by ENET_BUFF_ALIGNMENT. Receive buffers should be continuous with the total size equal to “rxBdNumber * rxBuffSizeAlign”. Transmit buffers should be continuous with the total size equal to “txBdNumber * txBuffSizeAlign”. when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of “ENET_BUFF_ALIGNMENT” and the cache line size.

Public Members

uint16_t rxBdNumber
: Receive buffer descriptor number.

uint16_t txBdNumber
: Transmit buffer descriptor number.

uint16_t rxBuffSizeAlign
: Aligned receive data buffer size.

uint16_t txBuffSizeAlign
: Aligned transmit data buffer size.

volatile *enet_rx_bd_struct_t* *rxBdStartAddrAlign
: Aligned receive buffer descriptor start address: should be non-cacheable.

volatile *enet_tx_bd_struct_t* *txBdStartAddrAlign
: Aligned transmit buffer descriptor start address: should be non-cacheable.

uint8_t *rxBufferAlign
: Receive data buffer start address.

uint8_t *txBufferAlign
: Transmit data buffer start address.

bool rxMaintainEnable
: Receive buffer cache maintain.

bool txMaintainEnable
: Transmit buffer cache maintain.

enet_frame_info_t *txFrameInfo
: Transmit frame information start address.

struct __enet_intcoalesce_config
: *#include <fsl_enet.h>* Defines the interrupt coalescing configure structure.

Public Members

uint8_t txCoalesceFrameCount[1]
: Transmit interrupt coalescing frame count threshold.

uint16_t txCoalesceTimeCount[1]
: Transmit interrupt coalescing timer count threshold.

uint8_t rxCoalesceFrameCount[1]
: Receive interrupt coalescing frame count threshold.

uint16_t rxCoalesceTimeCount[1]
: Receive interrupt coalescing timer count threshold.

struct _enet_avb_config

#include <fsl_enet.h> Defines the ENET AVB Configure structure.

This is used for to configure the extended ring 1 and ring 2.

a. The classification match format is (CMP3 « 12) | (CMP2 « 8) | (CMP1 « 4) | CMP0. composed of four 3-bit compared VLAN priority field cmp0~cmp3, cm0 ~ cmp3 are used in parallel.

If CMP1,2,3 are not unused, please set them to the same value as CMP0.

a. The idleSlope is used to calculate the Band Width fraction, BW fraction = 1 / (1 + 512/idleSlope). For avb configuration, the BW fraction of Class 1 and Class 2 combined must not exceed 0.75.

Public Members

uint16_t rxClassifyMatch[1 - 1]

The classification match value for the ring.

enet_idle_slope_t idleSlope[1 - 1]

The idle slope for certian bandwidth fraction.

struct _enet_config

#include <fsl_enet.h> Defines the basic configuration structure for the ENET device.

Note:

a. macSpecialConfig is used for a special control configuration, A logical OR of "enet_special_control_flag_t". For a special configuration for MAC, set this parameter to 0.

b. txWatermark is used for a cut-through operation. It is in steps of 64 bytes: 0/1 - 64 bytes written to TX FIFO before transmission of a frame begins. 2 - 128 bytes written to TX FIFO .... 3 - 192 bytes written to TX FIFO .... The maximum of txWatermark is 0x2F - 4032 bytes written to TX FIFO .... txWatermark allows minimizing the transmit latency to set the txWatermark to 0 or 1 or for larger bus access latency 3 or larger due to contention for the system bus.

c. rxFifoFullThreshold is similar to the txWatermark for cut-through operation in RX. It is in 64-bit words. The minimum is ENET_FIFO_MIN_RX_FULL and the maximum is 0xFF. If the end of the frame is stored in FIFO and the frame size if smaller than the txWatermark, the frame is still transmitted. The rule is the same for rxFifoFullThreshold in the receive direction.

d. When "kENET_ControlFlowControlEnable" is set in the macSpecialConfig, ensure that the pauseDuration, rxFifoEmptyThreshold, and rxFifoStatEmptyThreshold are set for flow control enabled case.

e. When "kENET_ControlStoreAndFwdDisabled" is set in the macSpecialConfig, ensure that the rxFifoFullThreshold and txFifoWatermark are set for store and forward disable.

f. The rxAccelerConfig and txAccelerConfig default setting with 0 - accelerator are disabled. The "enet_tx_accelerator_t" and "enet_rx_accelerator_t" are recommended to be used to enable the transmit and receive accelerator. After the accelerators are enabled, the store and forward feature should be enabled. As a result, kENET_ControlStoreAndFwdDisabled should not be set.

g. The intCoalesceCfg can be used in the rx or tx enabled cases to decrese the CPU loading.

Public Members

uint32_t macSpecialConfig
: Mac special configuration. A logical OR of “enet_special_control_flag_t”.

uint32_t interrupt
: Mac interrupt source. A logical OR of “enet_interrupt_enable_t”.

uint16_t rxMaxFrameLen
: Receive maximum frame length.

enet_mii_mode_t miiMode
: MII mode.

enet_mii_speed_t miiSpeed
: MII Speed.

enet_mii_duplex_t miiDuplex
: MII duplex.

uint8_t rxAccelerConfig
: Receive accelerator, A logical OR of “enet_rx_accelerator_t”.

uint8_t txAccelerConfig
: Transmit accelerator, A logical OR of “enet_rx_accelerator_t”.

uint16_t pauseDuration
: For flow control enabled case: Pause duration.

uint8_t rxFifoEmptyThreshold
: For flow control enabled case: when RX FIFO level reaches this value, it makes MAC generate XOFF pause frame.

uint8_t rxFifoStatEmptyThreshold
: For flow control enabled case: number of frames in the receive FIFO, independent of size, that can be accept. If the limit is reached, reception continues and a pause frame is triggered.

uint8_t rxFifoFullThreshold
: For store and forward disable case, the data required in RX FIFO to notify the MAC receive ready status.

uint8_t txFifoWatermark
: For store and forward disable case, the data required in TX FIFO before a frame transmit start.

enet_intcoalesce_config_t *intCoalesceCfg
: If the interrupt coalsecence is not required in the ring n(0,1,2), please set to NULL.

uint8_t ringNum
: Number of used rings. default with 1 — single ring.

enet_rx_alloc_callback_t rxBuffAlloc
: Callback function to alloc memory, must be provided for zero-copy Rx.

enet_rx_free_callback_t rxBuffFree
: Callback function to free memory, must be provided for zero-copy Rx.

enet_callback_t callback
: General callback function.

void *userData
: Callback function parameter.

struct _enet_tx_bd_ring

#include <fsl_enet.h> Defines the ENET transmit buffer descriptor ring/queue structure.

Public Members

volatile *enet_tx_bd_struct_t* *txBdBase

Buffer descriptor base address pointer.

uint16_t txGenIdx

The current available transmit buffer descriptor pointer.

uint16_t txConsumIdx

Transmit consume index.

volatile uint16_t txDescUsed

Transmit descriptor used number.

uint16_t txRingLen

Transmit ring length.

struct _enet_rx_bd_ring

#include <fsl_enet.h> Defines the ENET receive buffer descriptor ring/queue structure.

Public Members

volatile *enet_rx_bd_struct_t* *rxBdBase

Buffer descriptor base address pointer.

uint16_t rxGenIdx

The current available receive buffer descriptor pointer.

uint16_t rxRingLen

Receive ring length.

struct _enet_handle

#include <fsl_enet.h> Defines the ENET handler structure.

Public Members

enet_rx_bd_ring_t rxBdRing[1]

Receive buffer descriptor.

enet_tx_bd_ring_t txBdRing[1]

Transmit buffer descriptor.

uint16_t rxBuffSizeAlign[1]

Receive buffer size alignment.

uint16_t txBuffSizeAlign[1]

Transmit buffer size alignment.

bool rxMaintainEnable[1]

Receive buffer cache maintain.

bool txMaintainEnable[1]

Transmit buffer cache maintain.

uint8_t ringNum

Number of used rings.

enet_callback_t callback
Callback function.

void *userData
Callback function parameter.

enet_tx_dirty_ring_t txDirtyRing[1]
Ring to store tx frame information.

bool txReclaimEnable[1]
Tx reclaim enable flag.

enet_rx_alloc_callback_t rxBuffAlloc
Callback function to alloc memory for zero copy Rx.

enet_rx_free_callback_t rxBuffFree
Callback function to free memory for zero copy Rx.

uint8_t multicastCount[64]
Multicast collisions counter

uint32_t enetClock
The clock of enet peripheral, to caculate core cycles for PTP timestamp.

uint32_t tsDelayCount
The count of core cycles for PTP timestamp capture delay.

struct __enet_buffer_struct
#include <fsl_enet.h>

Public Members

void *buffer
The buffer store the whole or partial frame.

uint16_t length
The byte length of this buffer.

struct __enet_rx_frame_attribute_struct
#include <fsl_enet.h>

Public Members

bool promiscuous
This frame is received because of promiscuous mode.

struct __enet_rx_frame_struct
#include <fsl_enet.h>

Public Members

enet_buffer_struct_t *rxBuffArray
Rx frame buffer structure.

uint16_t totLen
Rx frame total length.

enet_rx_frame_attribute_t rxAttribute
Rx frame attribute structure.

enet_rx_frame_error_t rxFrameError
Rx frame error.

struct _enet_tx_frame_struct
#include <fsl_enet.h>

Public Members

enet_buffer_struct_t *txBuffArray
Tx frame buffer structure.

uint32_t txBuffNum
Buffer number of this Tx frame.

void *context
Driver reclaims and gives it in Tx over callback, usually store network packet header.

2.42 EQOS-TSN: Ethernet QoS with TSN Driver

2.43 Enet_qos_qos

void ENET_QOS_GetDefaultConfig(*enet_qos_config_t* *config)
Gets the ENET default configuration structure.

The purpose of this API is to get the default ENET configure structure for ENET_QOS_Init(). User may use the initialized structure unchanged in ENET_QOS_Init(), or modify some fields of the structure before calling ENET_QOS_Init(). Example:

```
enet_qos_config_t config;
ENET_QOS_GetDefaultConfig(&config);
```

Parameters

- config – The ENET mac controller configuration structure pointer.

status_t ENET_QOS_Up(ENET_QOS_Type *base, const *enet_qos_config_t* *config, uint8_t *macAddr, uint8_t macCount, uint32_t refclkSrc_Hz)
Initializes the ENET module.

This function initializes it with the ENET basic configuration.

Parameters

- base – ENET peripheral base address.
- config – ENET mac configuration structure pointer. The “enet_qos_config_t” type mac configuration return from ENET_QOS_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.
- macAddr – Pointer to ENET mac address array of Ethernet device. This MAC address should be provided.
- macCount – Count of macAddr in the ENET mac address array
- refclkSrc_Hz – ENET input reference clock.

status_t ENET_QOS_Init(ENET_QOS_Type *base, const *enet_qos_config_t* *config, uint8_t *macAddr, uint8_t macCount, uint32_t refclkSrc_Hz)

Initializes the ENET module.

This function ungates the module clock and initializes it with the ENET basic configuration.

Parameters

- base – ENET peripheral base address.
- config – ENET mac configuration structure pointer. The "enet_qos_config_t" type mac configuration return from ENET_QOS_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.
- macAddr – Pointer to ENET mac address array of Ethernet device. This MAC address should be provided.
- macCount – Count of macAddr in the ENET mac address array
- refclkSrc_Hz – ENET input reference clock.

void ENET_QOS_Down(ENET_QOS_Type *base)

Stops the ENET module.

This function disables the ENET module.

Parameters

- base – ENET peripheral base address.

void ENET_QOS_Deinit(ENET_QOS_Type *base)

Deinitializes the ENET module.

This function gates the module clock and disables the ENET module.

Parameters

- base – ENET peripheral base address.

uint32_t ENET_QOS_GetInstance(ENET_QOS_Type *base)

Get the ENET instance from peripheral base address.

Parameters

- base – ENET peripheral base address.

Returns

ENET instance.

status_t ENET_QOS_DescriptorInit(ENET_QOS_Type *base, *enet_qos_config_t* *config, *enet_qos_buffer_config_t* *bufferConfig)

Initialize for all ENET descriptors.

Note: This function is do all tx/rx descriptors initialization. Because this API read all interrupt registers first and then set the interrupt flag for all descriptors, if the interrupt register is set. so the descriptor initialization should be called after ENET_QOS_Init(), ENET_QOS_EnableInterrupts() and ENET_QOS_CreateHandle()(if transactional APIs are used).

Parameters

- base – ENET peripheral base address.
- config – The configuration for ENET.
- bufferConfig – All buffers configuration.

status_t ENET_QOS_RxBufferAllocAll(ENET_QOS_Type *base, *enet_qos_handle_t* *handle)

Allocates Rx buffers for all BDs. It's used for zero copy Rx. In zero copy Rx case, Rx buffers are dynamic. This function will populate initial buffers in all BDs for receiving. Then ENET_QOS_GetRxFrame() used to get Rx frame with zero copy, it will allocate new buffer to replace the buffer in BD taken by application application should free those buffers after they're used.

Note: This function should be called after ENET_QOS_CreateHandler() and buffer allocating callback function should be ready.

Parameters

- base – ENET_QOS peripheral base address.
- handle – The ENET_QOS handler structure. This is the same handler pointer used in the ENET_QOS_Init.

void ENET_QOS_RxBufferFreeAll(ENET_QOS_Type *base, *enet_qos_handle_t* *handle)

Frees Rx buffers in all BDs. It's used for zero copy Rx. In zero copy Rx case, Rx buffers are dynamic. This function will free left buffers in all BDs.

Parameters

- base – ENET_QOS peripheral base address.
- handle – The ENET_QOS handler structure. This is the same handler pointer used in the ENET_QOS_Init.

void ENET_QOS_StartRxTx(ENET_QOS_Type *base, uint8_t txRingNum, uint8_t rxRingNum)

Starts the ENET rx/tx. This function enable the tx/rx and starts the rx/tx DMA. This shall be set after ENET initialization and before starting to receive the data.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- base – ENET peripheral base address.
- rxRingNum – The number of the used rx rings. It shall not be larger than the ENET_QOS_RING_NUM_MAX(2). If the ringNum is set with 1, the ring 0 will be used.
- txRingNum – The number of the used tx rings. It shall not be larger than the ENET_QOS_RING_NUM_MAX(2). If the ringNum is set with 1, the ring 0 will be used.

status_t ENET_QOS_SetMII(ENET_QOS_Type *base, *enet_qos_mii_speed_t* speed, *enet_qos_mii_duplex_t* duplex)

Sets the ENET MII speed and duplex.

This API is provided to dynamically change the speed and duplex for MAC.

Parameters

- base – ENET peripheral base address.
- speed – The speed of the RMII mode.
- duplex – The duplex of the RMII mode.

Returns

kStatus_Success The ENET MII speed and duplex has been set successfully.

Returns
kStatus_InvalidArgument Could not set the desired ENET MII speed and duplex combination.

void ENET_QOS_SetSMI(ENET_QOS_Type *base, uint32_t csrClock_Hz)

Sets the ENET SMI(serial management interface)- MII management interface.

Parameters

- base – ENET peripheral base address.
- csrClock_Hz – CSR clock frequency in HZ

static inline bool ENET_QOS_IsSMIBusy(ENET_QOS_Type *base)

Checks if the SMI is busy.

Parameters

- base – ENET peripheral base address.

Returns
The status of MII Busy status.

static inline uint16_t ENET_QOS_ReadSMIData(ENET_QOS_Type *base)

Reads data from the PHY register through SMI interface.

Parameters

- base – ENET peripheral base address.

Returns
The data read from PHY

void ENET_QOS_StartSMIWrite(ENET_QOS_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

Sends the MDIO IEEE802.3 Clause 22 format write command. After send command, user needs to check whether the transmission is over with ENET_QOS_IsSMIBusy().

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register address.
- data – The data written to PHY.

void ENET_QOS_StartSMIRead(ENET_QOS_Type *base, uint8_t phyAddr, uint8_t regAddr)

Sends the MDIO IEEE802.3 Clause 22 format read command. After send command, user needs to check whether the transmission is over with ENET_QOS_IsSMIBusy().

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register address.

void ENET_QOS_StartExtC45SMIWrite(ENET_QOS_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t data)

Sends the MDIO IEEE802.3 Clause 45 format write command. After send command, user needs to check whether the transmission is over with ENET_QOS_IsSMIBusy().

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).

- devAddr – The device address.
- regAddr – The PHY register address.
- data – The data written to PHY.

void ENET_QOS_StartExtC45SMIRead(ENET_QOS_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr)

Sends the MDIO IEEE802.3 Clause 45 format read command. After send command, user needs to check whether the transmission is over with ENET_QOS_IsSMIBusy().

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.

status_t ENET_QOS_MDIOWrite(ENET_QOS_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

MDIO write with IEEE802.3 MDIO Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register.
- data – The data written to PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

status_t ENET_QOS_MDIORead(ENET_QOS_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t *pData)

MDIO read with IEEE802.3 MDIO Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register.
- pData – The data read from PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

status_t ENET_QOS_MDIOC45Write(ENET_QOS_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t data)

MDIO write with IEEE802.3 Clause 45 format.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).

- devAddr – The device address.
- regAddr – The PHY register address.
- data – The data written to PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

status_t ENET_QOS_MDIOC45Read(ENET_QOS_Type *base, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t *pData)

MDIO read with IEEE802.3 Clause 45 format.

Parameters

- base – ENET peripheral base address.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.
- pData – The data read from PHY.

Returns
kStatus_Success MDIO access succeeds.

Returns
kStatus_Timeout MDIO access timeout.

static inline void ENET_QOS_SetMacAddr(ENET_QOS_Type *base, uint8_t *macAddr, uint8_t index)

Sets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.
- index – Configure macAddr to MAC_ADDRESS[index] register.

void ENET_QOS_GetMacAddr(ENET_QOS_Type *base, uint8_t *macAddr, uint8_t index)

Gets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.
- index – Get macAddr from MAC_ADDRESS[index] register.

void ENET_QOS_AddMulticastGroup(ENET_QOS_Type *base, uint8_t *address)

Adds the ENET_QOS device to a multicast group.

Parameters

- base – ENET_QOS peripheral base address.
- address – The six-byte multicast group address which is provided by application.

void ENET_QOS_LeaveMulticastGroup(ENET_QOS_Type *base, uint8_t *address)

Moves the ENET_QOS device from a multicast group.

Parameters

- base – ENET_QOS peripheral base address.
- address – The six-byte multicast group address which is provided by application.

static inline void ENET_QOS_AcceptAllMulticast(ENET_QOS_Type *base)

Enable ENET device to accept all multicast frames.

Parameters

- base – ENET peripheral base address.

static inline void ENET_QOS_RejectAllMulticast(ENET_QOS_Type *base)

ENET device reject to accept all multicast frames.

Parameters

- base – ENET peripheral base address.

void ENET_QOS_EnterPowerDown(ENET_QOS_Type *base, uint32_t *wakeFilter)

Set the MAC to enter into power down mode. the remote power wake up frame and magic frame can wake up the ENET from the power down mode.

Parameters

- base – ENET peripheral base address.
- wakeFilter – The wakeFilter provided to configure the wake up frame filter. Set the wakeFilter to NULL is not required. But if you have the filter requirement, please make sure the wakeFilter pointer shall be eight continuous 32-bits configuration.

static inline void ENET_QOS_ExitPowerDown(ENET_QOS_Type *base)

Set the MAC to exit power down mode. Exit from the power down mode and recover to normal work mode.

Parameters

- base – ENET peripheral base address.

status_t ENET_QOS_EnableRxParser(ENET_QOS_Type *base, bool enable)

Enable/Disable Rx parser,please notice that for enable/disable Rx Parser, should better disable Receive first.

Parameters

- base – ENET_QOS peripheral base address.
- enable – Enable/Disable Rx parser function

Return values

- kStatus_Success – Configure rx parser success.
- kStatus_ENET_QOS_Timeout – Poll status flag timeout.

void ENET_QOS_EnableInterrupts(ENET_QOS_Type *base, uint32_t mask)

Enables the ENET DMA and MAC interrupts.

This function enables the ENET interrupt according to the provided mask. The mask is a logical OR of enet_qos_dma_interrupt_enable_t and enet_qos_mac_interrupt_enable_t. For example, to enable the dma and mac interrupt, do the following.

```
ENET_QOS_EnableInterrupts(ENET, kENET_QOS_DmaRx | kENET_QOS_DmaTx | kENET_
↪QOS_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to enable. This is a logical OR of both enumeration :: enet_qos_dma_interrupt_enable_t and enet_qos_mac_interrupt_enable_t.

void ENET_QOS_DisableInterrupts(ENET_QOS_Type *base, uint32_t mask)

Disables the ENET DMA and MAC interrupts.

This function disables the ENET interrupt according to the provided mask. The mask is a logical OR of enet_qos_dma_interrupt_enable_t and enet_qos_mac_interrupt_enable_t. For example, to disable the dma and mac interrupt, do the following.

```
ENET_QOS_DisableInterrupts(ENET, kENET_QOS_DmaRx | kENET_QOS_DmaTx | kENET_
↪QOS_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to disables. This is a logical OR of both enumeration :: enet_qos_dma_interrupt_enable_t and enet_qos_mac_interrupt_enable_t.

static inline uint32_t ENET_QOS_GetDmaInterruptStatus(ENET_QOS_Type *base, uint8_t channel)

Gets the ENET DMA interrupt status flag.

Parameters

- base – ENET peripheral base address.
- channel – The DMA Channel. Shall not be larger than ENET_QOS_RING_NUM_MAX.

Returns

The event status of the interrupt source. This is the logical OR of members of the enumeration :: enet_qos_dma_interrupt_enable_t.

static inline void ENET_QOS_ClearDmaInterruptStatus(ENET_QOS_Type *base, uint8_t channel, uint32_t mask)

Clear the ENET DMA interrupt status flag.

Parameters

- base – ENET peripheral base address.
- channel – The DMA Channel. Shall not be larger than ENET_QOS_RING_NUM_MAX.
- mask – The interrupt status to be cleared. This is the logical OR of members of the enumeration :: enet_qos_dma_interrupt_enable_t.

static inline uint32_t ENET_QOS_GetMacInterruptStatus(ENET_QOS_Type *base)

Gets the ENET MAC interrupt status flag.

Parameters

- base – ENET peripheral base address.

Returns

The event status of the interrupt source. Use the enum in enet_qos_mac_interrupt_enable_t and right shift ENET_QOS_MACINT_ENUM_OFFSET to mask the returned value to get the exact interrupt status.

void ENET_QOS_ClearMacInterruptStatus(ENET_QOS_Type *base, uint32_t mask)

Clears the ENET mac interrupt events status flag.

This function clears enabled ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See the enet_qos_mac_interrupt_enable_t. For example, to clear the TX frame interrupt and RX frame interrupt, do the following.

```
ENET_QOS_ClearMacInterruptStatus(ENET, kENET_QOS_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupt source to be cleared. This is the logical OR of members of the enumeration :: enet_qos_mac_interrupt_enable_t.

static inline bool ENET_QOS_IsTxDescriptorDmaOwn(*enet_qos_tx_bd_struct_t* *txDesc)

Get the tx descriptor DMA Own flag.

Parameters

- txDesc – The given tx descriptor.

Return values

True – the dma own tx descriptor, false application own tx descriptor.

void ENET_QOS_SetupTxDescriptor(*enet_qos_tx_bd_struct_t* *txDesc, void *buffer1, uint32_t bytes1, void *buffer2, uint32_t bytes2, uint32_t framelen, bool intEnable, bool tsEnable, *enet_qos_desc_flag* flag, uint8_t slotNum)

Setup a given tx descriptor. This function is a low level functional API to setup or prepare a given tx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required. Transmit buffers are 'zero-copy' buffers, so the buffer must remain in memory until the packet has been fully transmitted. The buffers should be free or requeued in the transmit interrupt irq handler.

Parameters

- txDesc – The given tx descriptor.
- buffer1 – The first buffer address in the descriptor.
- bytes1 – The bytes in the fist buffer.
- buffer2 – The second buffer address in the descriptor.
- bytes2 – The bytes in the second buffer.
- framelen – The length of the frame to be transmitted.
- intEnable – Interrupt enable flag.
- tsEnable – The timestamp enable.
- flag – The flag of this tx descriptor, enet_qos_desc_flag .
- slotNum – The slot num used for AV only.

static inline void ENET_QOS_UpdateTxDescriptorTail(ENET_QOS_Type *base, uint8_t channel, uint32_t txDescTailAddrAlign)

Update the tx descriptor tail pointer. This function is a low level functional API to update the the tx descriptor tail. This is called after you setup a new tx descriptor to update the tail pointer to make the new descriptor accessible by DMA.

Parameters

- base – ENET peripheral base address.
- channel – The tx DMA channel.
- txDescTailAddrAlign – The new tx tail pointer address.

static inline void ENET_QOS_UpdateRxDescriptorTail(ENET_QOS_Type *base, uint8_t channel, uint32_t rxDescTailAddrAlign)

Update the rx descriptor tail pointer. This function is a low level functional API to update the the rx descriptor tail. This is called after you setup a new rx descriptor to update the tail pointer to make the new descriptor accessible by DMA and to anouse the rx poll command for DMA.

Parameters

- base – ENET peripheral base address.
- channel – The rx DMA channel.
- rxDescTailAddrAlign – The new rx tail pointer address.

static inline uint32_t ENET_QOS_GetRxDescriptor(*enet_qos_rx_bd_struct_t* *rxDesc)

Gets the context in the ENET rx descriptor. This function is a low level functional API to get the the status flag from a given rx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- rxDesc – The given rx descriptor.

Return values

The – RDES3 regions for write-back format rx buffer descriptor.

void ENET_QOS_UpdateRxDescriptor(*enet_qos_rx_bd_struct_t* *rxDesc, void *buffer1, void *buffer2, bool intEnable, bool doubleBuffEnable)

Updates the buffers and the own status for a given rx descriptor. This function is a low level functional API to Updates the buffers and the own status for a given rx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- rxDesc – The given rx descriptor.
- buffer1 – The first buffer address in the descriptor.
- buffer2 – The second buffer address in the descriptor.
- intEnable – Interrupt enable flag.
- doubleBuffEnable – The double buffer enable flag.

status_t ENET_QOS_ConfigureRxParser(ENET_QOS_Type *base, *enet_qos_rxp_config_t* *rxpConfig, uint16_t entryCount)

Configure flexible rx parser.

This function is used to configure the flexible rx parser table.

Parameters

- base – ENET peripheral base address..
- rxpConfig – The rx parser configuration pointer.
- entryCount – The rx parser entry count.

Return values

- kStatus_Success – Configure rx parser success.
- kStatus_ENET_QOS_Timeout – Poll status flag timeout.

status_t ENET_QOS_ReadRxParser(ENET_QOS_Type *base, *enet_qos_rxp_config_t* *rxpConfig, uint16_t entryIndex)

Read flexible rx parser configuration at specified index.

This function is used to read flexible rx parser configuration at specified index.

Parameters

- base – ENET peripheral base address..
- rxpConfig – The rx parser configuration pointer.
- entryIndex – The rx parser entry index to read, start from 0.

Return values

- kStatus_Success – Configure rx parser success.
- kStatus_ENET_QOS_Timeout – Poll status flag timeout.

status_t ENET_QOS_EstProgramGcl(ENET_QOS_Type *base, *enet_qos_est_gcl_t* *gcl, uint32_t ptpClk_Hz)

Program Gate Control List.

This function is used to program the Enhanced Scheduled Transmisson. (IEEE802.1Qbv)

Parameters

- base – ENET peripheral base address..
- gcl – Pointer to the Gate Control List structure.
- ptpClk_Hz – frequency of the PTP clock.

status_t ENET_QOS_EstReadGcl(ENET_QOS_Type *base, *enet_qos_est_gcl_t* *gcl, uint32_t listLen, bool hwList)

Read Gate Control List.

This function is used to read the Enhanced Scheduled Transmisson list. (IEEE802.1Qbv)

Parameters

- base – ENET peripheral base address..
- gcl – Pointer to the Gate Control List structure.
- listLen – length of the provided opList array in gcl structure.
- hwList – Boolean if True read HW list, false read SW list.

static inline void ENET_QOS_FpeEnable(ENET_QOS_Type *base)

Enable Frame Preemption.

This function is used to enable frame preemption. (IEEE802.1Qbu)

Parameters

- base – ENET peripheral base address..

static inline void ENET_QOS_FpeDisable(ENET_QOS_Type *base)

Disable Frame Preemption.

This function is used to disable frame preemption. (IEEE802.1Qbu)

Parameters

- base – ENET peripheral base address..

static inline void ENET_QOS_FpeConfigPreemptable(ENET_QOS_Type *base, uint8_t queueMask)

Configure preemptable transmit queues.

This function is used to configure the preemptable queues. (IEEE802.1Qbu)

Parameters

- base – ENET peripheral base address..
- queueMask – bitmask representing queues to set in preemptable mode. The N-th bit represents the queue N.

void ENET_QOS_AVBConfigure(ENET_QOS_Type *base, const *enet_qos_cbs_config_t* *config, uint8_t queueIndex)

Sets the ENET AVB feature.

ENET_QOS AVB feature configuration, set transmit bandwidth. This API is called when the AVB feature is required.

Parameters

- base – ENET_QOS peripheral base address.
- config – The ENET_QOS AVB feature configuration structure.
- queueIndex – ENET_QOS queue index.

void ENET_QOS_GetStatistics(ENET_QOS_Type *base, *enet_qos_transfer_stats_t* *statistics)

Gets statistical data in transfer.

Parameters

- base – ENET_QOS peripheral base address.
- statistics – The statistics structure pointer.

void ENET_QOS_CreateHandler(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, *enet_qos_config_t* *config, *enet_qos_buffer_config_t* *bufferConfig, *enet_qos_callback_t* callback, void *userData)

Create ENET Handler.

This is a transactional API and it's provided to store all data which are needed during the whole transactional process. This API should not be used when you use functional APIs to do data tx/rx. This is function will store many data/flag for transactional use, so all configure API such as ENET_QOS_Init(), ENET_QOS_DescriptorInit(), ENET_QOS_EnableInterrupts() etc.

Note: as our transactional transmit API use the zero-copy transmit buffer. so there are two thing we emphasize here:

a. tx buffer free/requeue for application should be done in the tx interrupt handler. Please set callback: kENET_QOS_TxIntEvent with tx buffer free/requeue process APIs.

b. the tx interrupt is forced to open.

Parameters

- base – ENET peripheral base address.
- handle – ENET handler.
- config – ENET configuration.
- bufferConfig – ENET buffer configuration.
- callback – The callback function.
- userData – The application data.

status_t ENET_QOS_GetRxFrameSize(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, uint32_t *length, uint8_t channel)

Gets the size of the read frame. This function gets a received frame size from the ENET buffer descriptors.

Note: The FCS of the frame is automatically removed by MAC and the size is the length without the FCS. After calling ENET_QOS_GetRxFrameSize, ENET_QOS_ReadFrame() should be called to update the receive buffers If the result is not "kStatus_ENET_QOS_RxFrameEmpty".

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler structure. This is the same handler pointer used in the ENET_QOS_Init.
- length – The length of the valid frame received.
- channel – The DMAC channel for the rx.

Return values

- kStatus_ENET_QOS_RxFrameEmpty – No frame received. Should not call ENET_QOS_ReadFrame to read frame.
- kStatus_ENET_QOS_RxFrameError – Data error happens. ENET_QOS_ReadFrame should be called with NULL data and NULL length to update the receive buffers.
- kStatus_Success – Receive a frame Successfully then the ENET_QOS_ReadFrame should be called with the right data buffer and the captured data length input.

status_t ENET_QOS_ReadFrame(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, uint8_t *data, uint32_t length, uint8_t channel, *enet_qos_ptp_time_t* *ts)

Reads a frame from the ENET device. This function reads a frame from the ENET DMA descriptors. The ENET_QOS_GetRxFrameSize should be used to get the size of the prepared data buffer. For example use rx dma channel 0:

```
uint32_t length;
enet_qos_handle_t g_handle;
status = ENET_QOS_GetRxFrameSize(&g_handle, &length, 0);
if (length != 0)
{
    uint8_t *data = memory allocate interface;
    if (!data)
    {
        ENET_QOS_ReadFrame(ENET, &g_handle, NULL, 0, 0);
    }
    else
    {
      status = ENET_QOS_ReadFrame(ENET, &g_handle, data, length, 0);
    }
}
else if (status == kStatus_ENET_QOS_RxFrameError)
{
    ENET_QOS_ReadFrame(ENET, &g_handle, NULL, 0, 0);
}
```

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler structure. This is the same handler pointer used in the ENET_QOS_Init.
- data – The data buffer provided by user to store the frame which memory size should be at least "length".
- length – The size of the data buffer which is still the length of the received frame.
- channel – The rx DMA channel. shall not be larger than 2.
- ts – Pointer to the structure enet_qos_ptp_time_t to save frame timestamp.

Returns

The execute status, successful or failure.

status_t ENET_QOS_SendFrame(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, uint8_t *data, uint32_t length, uint8_t channel, bool isNeedTs, void *context, *enet_qos_tx_offload_t* txOffloadOps)

Transmits an ENET frame.

Note: The CRC is automatically appended to the data. Input the data to send without the CRC.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_QOS_Init.
- data – The data buffer provided by user to be send.
- length – The length of the data to be send.
- channel – Channel to send the frame, same with queue index.
- isNeedTs – True to enable timestamp save for the frame

- context – pointer to user context to be kept in the tx dirty frame information.
- txOffloadOps – The Tx frame checksum offload option.

Return values

- kStatus_Success – Send frame succeed.
- kStatus_ENET_QOS_TxFrameBusy – Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with kStatus_ENET_QOS_TxFrameBusy.

void ENET_QOS_ReclaimTxDescriptor(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, uint8_t channel)

Reclaim tx descriptors. This function is used to update the tx descriptor status and store the tx timestamp when the 1588 feature is enabled. This is called by the transmit interrupt IRQ handler after the complete of a frame transmission.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_QOS_Init.
- channel – The tx DMA channel.

void ENET_QOS_CommonIRQHandler(ENET_QOS_Type *base, *enet_qos_handle_t* *handle)

The ENET IRQ handler.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer.

void ENET_QOS_SetISRHandler(ENET_QOS_Type *base, *enet_qos_isr_t* ISRHandler)

Set the second level IRQ handler, allow user to overwrite the default second level weak IRQ handler.

Parameters

- base – ENET peripheral base address.
- ISRHandler – The handler to install.

status_t ENET_QOS_Ptp1588CorrectTimerInCoarse(ENET_QOS_Type *base, *enet_qos_systime_op* operation, uint32_t second, uint32_t nanosecond)

Correct the ENET PTP 1588 timer in coarse method.

Parameters

- base – ENET peripheral base address.
- operation – The system time operation, refer to “enet_qos_systime_op”
- second – The correction second.
- nanosecond – The correction nanosecond.

status_t ENET_QOS_Ptp1588CorrectTimerInFine(ENET_QOS_Type *base, uint32_t addend)

Correct the ENET PTP 1588 timer in fine method.

Note: Should take refer to the chapter “System time correction” and see the description for the “fine correction method”.

Parameters

- base – ENET peripheral base address.
- addend – The addend value to be set in the fine method

static inline uint32_t ENET_QOS_Ptp1588GetAddend(ENET_QOS_Type *base)

Get the ENET Time stamp current addend value.

Parameters

- base – ENET peripheral base address.

Returns

The addend value.

void ENET_QOS_Ptp1588GetTimerNoIRQDisable(ENET_QOS_Type *base, uint64_t *second, uint32_t *nanosecond)

Gets the current ENET time from the PTP 1588 timer without IRQ disable.

Parameters

- base – ENET peripheral base address.
- second – The PTP 1588 system timer second.
- nanosecond – The PTP 1588 system timer nanosecond. For the unit of the nanosecond is 1ns. so the nanosecond is the real nanosecond.

static inline *status_t* ENET_Ptp1588PpsControl(ENET_QOS_Type *base, *enet_qos_ptp_pps_instance_t* instance, *enet_qos_ptp_pps_trgt_mode_t* trgtMode, *enet_qos_ptp_pps_cmd_t* cmd)

Sets the ENET PTP 1588 PPS control. All channels operate in flexible PPS output mode.

Parameters

- base – ENET peripheral base address.
- instance – The ENET QOS PTP PPS instance.
- trgtMode – The target time register mode.
- cmd – The target flexible PPS output control command.

status_t ENET_QOS_Ptp1588PpsSetTrgtTime(ENET_QOS_Type *base, *enet_qos_ptp_pps_instance_t* instance, uint32_t seconds, uint32_t nanoseconds)

Sets the ENET OQS PTP 1588 PPS target time registers.

Parameters

- base – ENET QOS peripheral base address.
- instance – The ENET QOS PTP PPS instance.
- seconds – The target seconds.
- nanoseconds – The target nanoseconds.

static inline void ENET_QOS_Ptp1588PpsSetWidth(ENET_QOS_Type *base, *enet_qos_ptp_pps_instance_t* instance, uint32_t width)

Sets the ENET OQS PTP 1588 PPS output signal interval.

Parameters

- base – ENET QOS peripheral base address.
- instance – The ENET QOS PTP PPS instance.

- width – Signal Width. It is stored in terms of number of units of sub-second increment value. The width value must be lesser than interval value.

static inline void ENET_QOS_Ptp1588PpsSetInterval(ENET_QOS_Type *base, *enet_qos_ptp_pps_instance_t* instance, uint32_t interval)

Sets the ENET OQS PTP 1588 PPS output signal width.

Parameters

- base – ENET QOS peripheral base address.
- instance – The ENET QOS PTP PPS instance.
- interval – Signal Interval. It is stored in terms of number of units of sub-second increment value.

void ENET_QOS_Ptp1588GetTimer(ENET_QOS_Type *base, uint64_t *second, uint32_t *nanosecond)

Gets the current ENET time from the PTP 1588 timer.

Parameters

- base – ENET peripheral base address.
- second – The PTP 1588 system timer second.
- nanosecond – The PTP 1588 system timer nanosecond. For the unit of the nanosecond is 1ns.so the nanosecond is the real nanosecond.

void ENET_QOS_GetTxFrame(*enet_qos_handle_t* *handle, *enet_qos_frame_info_t* *txFrame, uint8_t channel)

Gets the time stamp of the transmit frame.

This function is used for PTP stack to get the timestamp captured by the ENET driver.

Parameters

- handle – The ENET handler pointer.This is the same state pointer used in ENET_QOS_Init.
- txFrame – Input parameter, pointer to enet_qos_frame_info_t for saving read out frame information.
- channel – Channel for searching the tx frame.

status_t ENET_QOS_GetRxFrame(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, *enet_qos_rx_frame_struct_t* *rxFrame, uint8_t channel)

Receives one frame in specified BD ring with zero copy.

This function will use the user-defined allocate and free callback. Every time application gets one frame through this function, driver will allocate new buffers for the BDs whose buffers have been taken by application.

Note: This function will drop current frame and update related BDs as available for DMA if new buffers allocating fails. Application must provide a memory pool including at least BD number + 1 buffers(+2 if enable double buffer) to make this function work normally. If user calls this function in Rx interrupt handler, be careful that this function makes Rx BD ready with allocating new buffer(normal) or updating current BD(out of memory). If there's always new Rx frame input, Rx interrupt will be triggered forever. Application need to disable Rx interrupt according to specific design in this case.

Parameters

- base – ENET peripheral base address.

- handle – The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
- rxFrame – The received frame information structure provided by user.
- channel – Channel for searching the rx frame.

Return values

- kStatus_Success – Succeed to get one frame and allocate new memory for Rx buffer.
- kStatus_ENET_QOS_RxFrameEmpty – There's no Rx frame in the BD.
- kStatus_ENET_QOS_RxFrameError – There's issue in this receiving.
- kStatus_ENET_QOS_RxFrameDrop – There's no new buffer memory for BD, drop this frame.

FSL_ENET_QOS_DRIVER_VERSION

Defines the driver version.

ENET_QOS_RXDESCRIP_RD_BUFF1VALID_MASK

Defines for read format.

Buffer1 address valid.

ENET_QOS_RXDESCRIP_RD_BUFF2VALID_MASK

Buffer2 address valid.

ENET_QOS_RXDESCRIP_RD_IOC_MASK

Interrupt enable on complete.

ENET_QOS_RXDESCRIP_RD_OWN_MASK

Own bit.

ENET_QOS_RXDESCRIP_WR_ERR_MASK

Defines for write back format.

ENET_QOS_RXDESCRIP_WR_PYLOAD_MASK

ENET_QOS_RXDESCRIP_WR_PTPMSGTYPE_MASK

ENET_QOS_RXDESCRIP_WR_PTPTYPE_MASK

ENET_QOS_RXDESCRIP_WR_PTPVERSION_MASK

ENET_QOS_RXDESCRIP_WR_PTPTSA_MASK

ENET_QOS_RXDESCRIP_WR_PACKETLEN_MASK

ENET_QOS_RXDESCRIP_WR_ERRSUM_MASK

ENET_QOS_RXDESCRIP_WR_TYPE_MASK

ENET_QOS_RXDESCRIP_WR_DE_MASK

ENET_QOS_RXDESCRIP_WR_RE_MASK

ENET_QOS_RXDESCRIP_WR_OE_MASK

ENET_QOS_RXDESCRIP_WR_RWT_MASK

ENET_QOS_RXDESCRIP_WR_GP_MASK

ENET_QOS_RXDESCRIP_WR_CRC_MASK

ENET_QOS_RXDESCRIP_WR_RS0V_MASK

ENET_QOS_RXDESCRIP_WR_RS1V_MASK

ENET_QOS_RXDESCRIP_WR_RS2V_MASK

ENET_QOS_RXDESCRIP_WR_LD_MASK

ENET_QOS_RXDESCRIP_WR_FD_MASK

ENET_QOS_RXDESCRIP_WR_CTXT_MASK

ENET_QOS_RXDESCRIP_WR_OWN_MASK

ENET_QOS_RXDESCRIP_WR_SA_FAILURE_MASK

ENET_QOS_RXDESCRIP_WR_DA_FAILURE_MASK

ENET_QOS_TXDESCRIP_RD_BL1_MASK
Defines for read format.

ENET_QOS_TXDESCRIP_RD_BL2_MASK

ENET_QOS_TXDESCRIP_RD_BL1(n)

ENET_QOS_TXDESCRIP_RD_BL2(n)

ENET_QOS_TXDESCRIP_RD_TTSE_MASK

ENET_QOS_TXDESCRIP_RD_IOC_MASK

ENET_QOS_TXDESCRIP_RD_FL_MASK

ENET_QOS_TXDESCRIP_RD_FL(n)

ENET_QOS_TXDESCRIP_RD_CIC(n)

ENET_QOS_TXDESCRIP_RD_TSE_MASK

ENET_QOS_TXDESCRIP_RD_SLOT(n)

ENET_QOS_TXDESCRIP_RD_SAIC(n)

ENET_QOS_TXDESCRIP_RD_CPC(n)

ENET_QOS_TXDESCRIP_RD_LDFD(n)

ENET_QOS_TXDESCRIP_RD_LD_MASK

ENET_QOS_TXDESCRIP_RD_FD_MASK

ENET_QOS_TXDESCRIP_RD_CTXT_MASK

ENET_QOS_TXDESCRIP_RD_OWN_MASK

ENET_QOS_TXDESCRIP_WB_TTSS_MASK
Defines for write back format.

ENET_QOS_ABNORM_INT_MASK

ENET_QOS_NORM_INT_MASK

ENET_QOS_RING_NUM_MAX
The Maximum number of tx/rx descriptor rings.

ENET_QOS_FRAME_MAX_FRAMELEN
Default maximum Ethernet frame size.

ENET_QOS_FCS_LEN
Ethernet FCS length.

ENET_QOS_ADDR_ALIGNMENT
Recommended Ethernet buffer alignment.

ENET_QOS_BUFF_ALIGNMENT
Receive buffer alignment shall be 4bytes-aligned.

ENET_QOS_MTL_RXFIFOSIZE
The rx fifo size.

ENET_QOS_MTL_TXFIFOSIZE
The tx fifo size.

ENET_QOS_MACINT_ENUM_OFFSET
The offest for mac interrupt in enum type.

ENET_QOS_RXP_ENTRY_COUNT
RXP table entry count, implied by FRPES in MAC_HW_FEATURE3

ENET_QOS_RXP_BUFFER_SIZE
RXP Buffer size, implied by FRPBS in MAC_HW_FEATURE3

ENET_QOS_EST_WID
Width of the time interval in Gate Control List

ENET_QOS_EST_DEP
Maxmimum depth of Gate Control List

Defines the status return codes for transaction.

Values:

enumerator kStatus_ENET_QOS_InitMemoryFail
Init fails since buffer memory is not enough.

enumerator kStatus_ENET_QOS_RxFrameError
A frame received but data error happen.

enumerator kStatus_ENET_QOS_RxFrameFail
Failed to receive a frame.

enumerator kStatus_ENET_QOS_RxFrameEmpty
No frame arrive.

enumerator kStatus_ENET_QOS_RxFrameDrop
Rx frame is dropped since no buffer memory.

enumerator kStatus_ENET_QOS_TxFrameBusy
Transmit descriptors are under process.

enumerator kStatus_ENET_QOS_TxFrameFail
Transmit frame fail.

enumerator kStatus_ENET_QOS_TxFrameOverLen
Transmit oversize.

enumerator kStatus_ENET_QOS_Est_SwListBusy
SW Gcl List not yet processed by HW.

enumerator kStatus_ENET_QOS_Est_SwListWriteAbort
SW Gcl List write aborted .

enumerator kStatus_ENET_QOS_Est_InvalidParameter
Invalid parameter in Gcl List .

enumerator kStatus_ENET_QOS_Est_BtrError
Base Time Error when loading list.

enumerator kStatus_ENET_QOS_TrgtBusy
Target time register busy.

enumerator kStatus_ENET_QOS_Timeout
Target time register busy.

enumerator kStatus_ENET_QOS_PpsBusy
Pps command busy.

enum _enet_qos_mii_mode
Defines the MII/RGMII mode for data interface between the MAC and the PHY.

Values:

enumerator kENET_QOS_MiiMode
MII mode for data interface.

enumerator kENET_QOS_RgmiiMode
RGMII mode for data interface.

enumerator kENET_QOS_RmiiMode
RMII mode for data interface.

enum _enet_qos_mii_speed
Defines the 10/100/1000 Mbps speed for the MII data interface.

Values:

enumerator kENET_QOS_MiiSpeed10M
Speed 10 Mbps.

enumerator kENET_QOS_MiiSpeed100M
Speed 100 Mbps.

enumerator kENET_QOS_MiiSpeed1000M
Speed 1000 Mbps.

enumerator kENET_QOS_MiiSpeed2500M
Speed 2500 Mbps.

enum _enet_qos_mii_duplex
Defines the half or full duplex for the MII data interface.

Values:

enumerator kENET_QOS_MiiHalfDuplex
Half duplex mode.

enumerator kENET_QOS_MiiFullDuplex
Full duplex mode.

enum _enet_qos_mii_normal_opcode

Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

Values:

enumerator kENET_QOS_MiiWriteFrame

Write frame operation for a valid MII management frame.

enumerator kENET_QOS_MiiReadFrame

Read frame operation for a valid MII management frame.

enum _enet_qos_dma_burstlen

Define the DMA maximum transmit burst length.

Values:

enumerator kENET_QOS_BurstLen1

DMA burst length 1.

enumerator kENET_QOS_BurstLen2

DMA burst length 2.

enumerator kENET_QOS_BurstLen4

DMA burst length 4.

enumerator kENET_QOS_BurstLen8

DMA burst length 8.

enumerator kENET_QOS_BurstLen16

DMA burst length 16.

enumerator kENET_QOS_BurstLen32

DMA burst length 32.

enumerator kENET_QOS_BurstLen64

DMA burst length 64. eight times enabled.

enumerator kENET_QOS_BurstLen128

DMA burst length 128. eight times enabled.

enumerator kENET_QOS_BurstLen256

DMA burst length 256. eight times enabled.

enum _enet_qos_desc_flag

Define the flag for the descriptor.

Values:

enumerator kENET_QOS_MiddleFlag

It's a middle descriptor of the frame.

enumerator kENET_QOS_LastFlagOnly

It's the last descriptor of the frame.

enumerator kENET_QOS_FirstFlagOnly

It's the first descriptor of the frame.

enumerator kENET_QOS_FirstLastFlag

It's the first and last descriptor of the frame.

enum _enet_qos_systime_op

Define the system time adjust operation control.

Values:

enumerator kENET_QOS_SystimeAdd
System time add to.

enumerator kENET_QOS_SystimeSubtract
System time subtract.

enum _enet_qos_ts_rollover_type
Define the system time rollover control.

Values:

enumerator kENET_QOS_BinaryRollover
System time binary rollover.

enumerator kENET_QOS_DigitalRollover
System time digital rollover.

enum _enet_qos_special_config
Defines some special configuration for ENET.

These control flags are provided for special user requirements. Normally, these is no need to set this control flags for ENET initialization. But if you have some special requirements, set the flags to specialControl in the enet_qos_config_t.

Note: "kENET_QOS_StoreAndForward" is recommended to be set.

Values:

enumerator kENET_QOS_DescDoubleBuffer
The double buffer is used in the tx/rx descriptor.

enumerator kENET_QOS_StoreAndForward
The rx/tx store and forward enable.

enumerator kENET_QOS_PromiscuousEnable
The promiscuous enabled.

enumerator kENET_QOS_FlowControlEnable
The flow control enabled.

enumerator kENET_QOS_BroadCastRxDisable
The broadcast disabled.

enumerator kENET_QOS_MulticastAllEnable
All multicast are passed.

enumerator kENET_QOS_8023AS2KPacket
8023as support for 2K packets.

enumerator kENET_QOS_HashMulticastEnable
The multicast packets are filtered through hash table.

enumerator kENET_QOS_RxChecksumOffloadEnable
The Rx checksum offload enabled.

enum _enet_qos_dma_interrupt_enable
List of DMA interrupts supported by the ENET interrupt. This enumeration uses one-bot encoding to allow a logical OR of multiple members.

Values:

enumerator kENET_QOS_DmaTx
Tx interrupt.

enumerator kENET_QOS_DmaTxStop
Tx stop interrupt.

enumerator kENET_QOS_DmaTxBuffUnavail
Tx buffer unavailable.

enumerator kENET_QOS_DmaRx
Rx interrupt.

enumerator kENET_QOS_DmaRxBuffUnavail
Rx buffer unavailable.

enumerator kENET_QOS_DmaRxStop
Rx stop.

enumerator kENET_QOS_DmaRxWatchdogTimeout
Rx watchdog timeout.

enumerator kENET_QOS_DmaEarlyTx
Early transmit.

enumerator kENET_QOS_DmaEarlyRx
Early receive.

enumerator kENET_QOS_DmaBusErr
Fatal bus error.

enum _enet_qos_mac_interrupt_enable
List of mac interrupts supported by the ENET interrupt. This enumeration uses one-bot encoding to allow a logical OR of multiple members.

Values:

enumerator kENET_QOS_MacPmt

enumerator kENET_QOS_MacTimestamp

enum _enet_qos_event
Defines the common interrupt event for callback use.

Values:

enumerator kENET_QOS_RxIntEvent
Receive interrupt event.

enumerator kENET_QOS_TxIntEvent
Transmit interrupt event.

enumerator kENET_QOS_WakeUpIntEvent
Wake up interrupt event.

enumerator kENET_QOS_TimeStampIntEvent
Time stamp interrupt event.

enum _enet_qos_queue_mode
Define the MTL mode for multiple queues/rings.

Values:

enumerator kENET_QOS_AVB_Mode
Enable queue in AVB mode.

enumerator kENET_QOS_DCB_Mode
Enable queue in DCB mode.

enum _enet_qos_mtl_multiqueue_txsche
Define the MTL tx scheduling algorithm for multiple queues/rings.

Values:

enumerator kENET_QOS_txWeightRR
Tx weight round-robin.

enumerator kENET_QOS_txWeightFQ
Tx weight fair queuing.

enumerator kENET_QOS_txDefictWeightRR
Tx deficit weighted round-robin.

enumerator kENET_QOS_txStrPrio
Tx strict priority.

enum _enet_qos_mtl_multiqueue_rxsche
Define the MTL rx scheduling algorithm for multiple queues/rings.

Values:

enumerator kENET_QOS_rxStrPrio
Rx strict priority, Queue 0 has the lowest priority.

enumerator kENET_QOS_rxWeightStrPrio
Weighted Strict Priority.

enum _enet_qos_mtl_rxqueuemap
Define the MTL rx queue and DMA channel mapping.

Values:

enumerator kENET_QOS_StaticDirctMap
The received fame in rx Qn(n = 0,1) directly map to dma channel n.

enumerator kENET_QOS_DynamicMap
The received frame in rx Qn(n = 0,1) map to the dma channel m(m = 0,1) related with the same Mac.

enum _enet_qos_rx_queue_route
Defines the package type for receive queue routing.

Values:

enumerator kENET_QOS_PacketNoQ

enumerator kENET_QOS_PacketAVCPQ

enumerator kENET_QOS_PacketPTPQ

enumerator kENET_QOS_PacketDCBCPQ

enumerator kENET_QOS_PacketUPQ

enumerator kENET_QOS_PacketMCBCQ

enum _enet_qos_ptp_event_type
Defines the ENET PTP message related constant.

Values:

enumerator kENET_QOS_PtpEventMsgType
PTP event message type.

enumerator kENET_QOS_PtpSrcPortIdLen
PTP message sequence id length.

enumerator kENET_QOS_PtpEventPort
PTP event port number.

enumerator kENET_QOS_PtpGnrlPort
PTP general port number.

enum _enet_qos_ptp_pps_instance
Defines the PPS instance numbers.

Values:

enumerator kENET_QOS_PtpPpsIstance0
PPS instance 0.

enumerator kENET_QOS_PtpPpsIstance1
PPS instance 1.

enumerator kENET_QOS_PtpPpsIstance2
PPS instance 2.

enumerator kENET_QOS_PtpPpsIstance3
PPS instance 3.

enum _enet_qos_ptp_pps_trgt_mode
Defines the Target Time register mode.

Values:

enumerator kENET_QOS_PtpPpsTrgtModeOnlyInt
Only interrupts.

enumerator kENET_QOS_PtpPpsTrgtModeIntSt
Both interrupt and output signal.

enumerator kENET_QOS_PtpPpsTrgtModeOnlySt
Only output signal.

enum _enet_qos_ptp_pps_cmd
Defines commands for ppscmd register.

Values:

enumerator kENET_QOS_PtpPpsCmdNC
No Command.

enumerator kENET_QOS_PtpPpsCmdSSP
Start Single Pulse.

enumerator kENET_QOS_PtpPpsCmdSPT
Start Pulse Train.

enumerator kENET_QOS_PtpPpsCmdCS
Cancel Start.

enumerator kENET_QOS_PtpPpsCmdSPTAT
Stop Pulse Train At Time.

enumerator kENET_QOS_PtpPpsCmdSPTI
Stop Pulse Train Immediately.

enumerator kENET_QOS_PtpPpsCmdCSPT
Cancel Stop Pulse Train.

enum _enet_qos_ets_list_length
Defines the enmueration of ETS list length.

Values:

enumerator kENET_QOS_Ets_List_64
List length of 64

enumerator kENET_QOS_Ets_List_128
List length of 128

enumerator kENET_QOS_Ets_List_256
List length of 256

enumerator kENET_QOS_Ets_List_512
List length of 512

enumerator kENET_QOS_Ets_List_1024
List length of 1024

enum _enet_qos_ets_gccr_addr
Defines the enmueration of ETS gate control address.

Values:

enumerator kENET_QOS_Ets_btr_low
BTR Low

enumerator kENET_QOS_Ets_btr_high
BTR High

enumerator kENET_QOS_Ets_ctr_low
CTR Low

enumerator kENET_QOS_Ets_ctr_high
CTR High

enumerator kENET_QOS_Ets_ter
TER

enumerator kENET_QOS_Ets_llr
LLR

enum _enet_qos_rxp_dma_chn
Defines the enmueration of DMA channel used for rx parser entry.

Values:

enumerator kENET_QOS_Rxp_DMAChn0
DMA Channel 0 used for RXP entry match

enumerator kENET_QOS_Rxp_DMAChn1
DMA Channel 1 used for RXP entry match

enumerator kENET_QOS_Rxp_DMAChn2
DMA Channel 2 used for RXP entry match

enumerator kENET_QOS_Rxp_DMAChn3
DMA Channel 3 used for RXP entry match

enumerator kENET_QOS_Rxp_DMAChn4
DMA Channel 4 used for RXP entry match

enum _enet_qos_tx_offload
Define the Tx checksum offload options.

Values:

enumerator kENET_QOS_TxOffloadDisable
Disable Tx checksum offload.

enumerator kENET_QOS_TxOffloadIPHeader
Enable IP header checksum calculation and insertion.

enumerator kENET_QOS_TxOffloadIPHeaderPlusPayload
Enable IP header and payload checksum calculation and insertion.

enumerator kENET_QOS_TxOffloadAll
Enable IP header, payload and pseudo header checksum calculation and insertion.

typedef enum *_enet_qos_mii_mode* enet_qos_mii_mode_t
Defines the MII/RGMII mode for data interface between the MAC and the PHY.

typedef enum *_enet_qos_mii_speed* enet_qos_mii_speed_t
Defines the 10/100/1000 Mbps speed for the MII data interface.

typedef enum *_enet_qos_mii_duplex* enet_qos_mii_duplex_t
Defines the half or full duplex for the MII data interface.

typedef enum *_enet_qos_mii_normal_opcode* enet_qos_mii_normal_opcode
Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

typedef enum *_enet_qos_dma_burstlen* enet_qos_dma_burstlen
Define the DMA maximum transmit burst length.

typedef enum *_enet_qos_desc_flag* enet_qos_desc_flag
Define the flag for the descriptor.

typedef enum *_enet_qos_systime_op* enet_qos_systime_op
Define the system time adjust operation control.

typedef enum *_enet_qos_ts_rollover_type* enet_qos_ts_rollover_type
Define the system time rollover control.

typedef enum *_enet_qos_special_config* enet_qos_special_config_t
Defines some special configuration for ENET.

These control flags are provided for special user requirements. Normally, these is no need to set this control flags for ENET initialization. But if you have some special requirements, set the flags to specialControl in the enet_qos_config_t.

Note: "kENET_QOS_StoreAndForward" is recommended to be set.

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typedef enum *_enet_qos_dma_interrupt_enable* enet_qos_dma_interrupt_enable_t
List of DMA interrupts supported by the ENET interrupt. This enumeration uses one-bot encoding to allow a logical OR of multiple members.

typedef enum *_enet_qos_mac_interrupt_enable* enet_qos_mac_interrupt_enable_t

List of mac interrupts supported by the ENET interrupt. This enumeration uses one-bot encoding to allow a logical OR of multiple members.

typedef enum *_enet_qos_event* enet_qos_event_t

Defines the common interrupt event for callback use.

typedef enum *_enet_qos_queue_mode* enet_qos_queue_mode_t

Define the MTL mode for multiple queues/rings.

typedef enum *_enet_qos_mtl_multiqueue_txsche* enet_qos_mtl_multiqueue_txsche

Define the MTL tx scheduling algorithm for multiple queues/rings.

typedef enum *_enet_qos_mtl_multiqueue_rxsche* enet_qos_mtl_multiqueue_rxsche

Define the MTL rx scheduling algorithm for multiple queues/rings.

typedef enum *_enet_qos_mtl_rxqueuemap* enet_qos_mtl_rxqueuemap_t

Define the MTL rx queue and DMA channel mapping.

typedef enum *_enet_qos_rx_queue_route* enet_qos_rx_queue_route_t

Defines the package type for receive queue routing.

typedef enum *_enet_qos_ptp_event_type* enet_qos_ptp_event_type_t

Defines the ENET PTP message related constant.

typedef enum *_enet_qos_ptp_pps_instance* enet_qos_ptp_pps_instance_t

Defines the PPS instance numbers.

typedef enum *_enet_qos_ptp_pps_trgt_mode* enet_qos_ptp_pps_trgt_mode_t

Defines the Target Time register mode.

typedef enum *_enet_qos_ptp_pps_cmd* enet_qos_ptp_pps_cmd_t

Defines commands for ppscmd register.

typedef enum *_enet_qos_ets_list_length* enet_qos_ets_list_length_t

Defines the enmueration of ETS list length.

typedef enum *_enet_qos_ets_gccr_addr* enet_qos_ets_gccr_addr_t

Defines the enmueration of ETS gate control address.

typedef enum *_enet_qos_rxp_dma_chn* enet_qos_rxp_dma_chn_t

Defines the enmueration of DMA channel used for rx parser entry.

typedef enum *_enet_qos_tx_offload* enet_qos_tx_offload_t

Define the Tx checksum offload options.

typedef struct *_enet_qos_rx_bd_struct* enet_qos_rx_bd_struct_t

Defines the receive descriptor structure has the read-format and write-back format structure. They both has the same size with different region definition. so we define the read-format region as the receive descriptor structure Use the read-format region mask bits in the descriptor initialization Use the write-back format region mask bits in the receive data process.

typedef struct *_enet_qos_tx_bd_struct* enet_qos_tx_bd_struct_t

Defines the transmit descriptor structure has the read-format and write-back format structure. They both has the same size with different region definition. so we define the read-format region as the transmit descriptor structure Use the read-format region mask bits in the descriptor initialization Use the write-back format region mask bits in the transmit data process.

typedef struct *_enet_qos_tx_bd_config_struct* enet_qos_tx_bd_config_struct_t

Defines the Tx BD configuration structure.

typedef struct *_enet_qos_ptp_time* enet_qos_ptp_time_t

Defines the ENET PTP time stamp structure.

typedef struct *enet_qos_frame_info* enet_qos_frame_info_t

Defines the frame info structure.

typedef struct *_enet_qos_tx_dirty_ring* enet_qos_tx_dirty_ring_t

Defines the ENET transmit dirty addresses ring/queue structure.

typedef struct *_enet_qos_ptp_config* enet_qos_ptp_config_t

Defines the ENET PTP configuration structure.

typedef struct *_enet_qos_est_gate_op* enet_qos_est_gate_op_t

Defines the EST gate operation structure.

typedef struct *_enet_qos_est_gcl* enet_qos_est_gcl_t

Defines the EST gate control list structure.

typedef struct *_enet_qos_rxp_config* enet_qos_rxp_config_t

Defines the ENET_QOS Rx parser configuration structure.

typedef struct *_enet_qos_buffer_config* enet_qos_buffer_config_t

Defines the buffer descriptor configure structure.

Note:

a. The receive and transmit descriptor start address pointer and tail pointer must be word-aligned.

b. The recommended minimum tx/rx ring length is 4.

c. The tx/rx descriptor tail address shall be the address pointer to the address just after the end of the last last descriptor. because only the descriptors between the start address and the tail address will be used by DMA.

d. The descriptor address is the start address of all used contiguous memory. for example, the rxDescStartAddrAlign is the start address of rxRingLen contiguous descriptor memories for rx descriptor ring 0.

e. The "*rxBufferstartAddr" is the first element of rxRingLen (2*rxRingLen for double buffers) rx buffers. It means the *rxBufferStartAddr is the rx buffer for the first descriptor the *rxBufferStartAddr + 1 is the rx buffer for the second descriptor or the rx buffer for the second buffer in the first descriptor. so please make sure the rxBufferStartAddr is the address of a rxRingLen or 2*rxRingLen array.

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typedef struct *_enet_qos_cbs_config* enet_qos_cbs_config_t

Defines the CBS configuration for queue.

typedef struct *enet_qos_tx_queue_config* enet_qos_queue_tx_config_t

Defines the queue configuration structure.

typedef struct *enet_qos_rx_queue_config* enet_qos_queue_rx_config_t

Defines the queue configuration structure.

typedef struct *enet_qos_multiqueue_config* enet_qos_multiqueue_config_t

Defines the configuration when multi-queue is used.

typedef void *(*enet_qos_rx_alloc_callback_t)(ENET_QOS_Type *base, void *userData, uint8_t channel)

Defines the Rx memory buffer alloc function pointer.

typedef void (*enet_qos_rx_free_callback_t)(ENET_QOS_Type *base, void *buffer, void *userData, uint8_t channel)

Defines the Rx memory buffer free function pointer.

typedef struct *_enet_qos_config* enet_qos_config_t

Defines the basic configuration structure for the ENET device.

Note: Default the signal queue is used so the "*multiqueueCfg" is set default with NULL. Set the pointer with a valid configuration pointer if the multiple queues are required. If multiple queue is enabled, please make sure the buffer configuration for all are prepared also.

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typedef struct *_enet_qos_handle* enet_qos_handle_t

typedef void (*enet_qos_callback_t)(ENET_QOS_Type *base, *enet_qos_handle_t* *handle, *enet_qos_event_t* event, uint8_t channel, void *userData)

ENET callback function.

typedef struct *_enet_qos_tx_bd_ring* enet_qos_tx_bd_ring_t

Defines the ENET transmit buffer descriptor ring/queue structure.

typedef struct *_enet_qos_rx_bd_ring* enet_qos_rx_bd_ring_t

Defines the ENET receive buffer descriptor ring/queue structure.

typedef struct *_enet_qos_state* enet_qos_state_t

Defines the ENET state structure.

Note: The structure contains saved state for the instance. It could be stored in enet_qos_handle_t, but that's used only with the transactional API.

---

typedef struct *_enet_qos_buffer_struct* enet_qos_buffer_struct_t

Defines the frame buffer structure.

typedef struct *_enet_qos_rx_frame_error* enet_qos_rx_frame_error_t

Defines the Rx frame error structure.

typedef struct *_enet_qos_rx_frame_attribute_struct* enet_qos_rx_frame_attribute_t

typedef struct *_enet_qos_rx_frame_struct* enet_qos_rx_frame_struct_t

Defines the Rx frame data structure.

typedef struct *_enet_qos_transfer_stats* enet_qos_transfer_stats_t

Defines the ENET QOS transfer statistics structure.

typedef void (*enet_qos_isr_t)(ENET_QOS_Type *base, *enet_qos_handle_t* *handle)

const *clock_ip_name_t* s_enetqosClock[]

Pointers to enet clocks for each instance.

void ENET_QOS_SetSYSControl(*enet_qos_mii_mode_t* miiMode)

Set ENET system configuration.

Note: User needs to provide the implementation because the implementation is SoC specific. This function set the phy selection and enable clock. It should be called before any other ethernet operation.

Parameters

- miiMode – The MII/RGMII/RMII mode for interface between the phy and Ethernet.

void ENET_QOS_EnableClock(bool enable)

Enable/Disable ENET qos clock.

Note: User needs to provide the implementation because the implementation is SoC specific. This function should be called before config RMII mode.

struct _enet_qos_rx_bd_struct

#include <fsl_enet_qos.h> Defines the receive descriptor structure has the read-format and write-back format structure. They both has the same size with different region definition. so we define the read-format region as the receive descriptor structure Use the read-format region mask bits in the descriptor initialization Use the write-back format region mask bits in the receive data process.

Public Members

___IO uint32_t buff1Addr

Buffer 1 address

___IO uint32_t reserved

Reserved

___IO uint32_t buff2Addr

Buffer 2 or next descriptor address

___IO uint32_t control

Buffer 1/2 byte counts and control

struct _enet_qos_tx_bd_struct

#include <fsl_enet_qos.h> Defines the transmit descriptor structure has the read-format and write-back format structure. They both has the same size with different region definition. so we define the read-format region as the transmit descriptor structure Use the read-format region mask bits in the descriptor initialization Use the write-back format region mask bits in the transmit data process.

Public Members

___IO uint32_t buff1Addr

Buffer 1 address

___IO uint32_t buff2Addr

Buffer 2 address

___IO uint32_t buffLen

Buffer 1/2 byte counts

___IO uint32_t controlStat

TDES control and status word

struct _enet_qos_tx_bd_config_struct

#include <fsl_enet_qos.h> Defines the Tx BD configuration structure.

Public Members

void *buffer1
: The first buffer address in the descriptor.

uint32_t bytes1
: The bytes in the fist buffer.

void *buffer2
: The second buffer address in the descriptor.

uint32_t bytes2
: The bytes in the second buffer.

uint32_t framelen
: The length of the frame to be transmitted.

bool intEnable
: Interrupt enable flag.

bool tsEnable
: The timestamp enable.

enet_qos_tx_offload_t txOffloadOps
: The Tx checksum offload option.

enet_qos_desc_flag flag
: The flag of this tx desciriptor, see “enet_qos_desc_flag”.

struct __enet_qos_ptp_time
: *#include <fsl_enet_qos.h>* Defines the ENET PTP time stamp structure.

Public Members

uint64_t second
: Second.

uint32_t nanosecond
: Nanosecond.

struct enet_qos_frame_info
: *#include <fsl_enet_qos.h>* Defines the frame info structure.

Public Members

void *context
: User specified data, could be buffer address for free

bool isTsAvail
: Flag indicates timestamp available status

enet_qos_ptp_time_t timeStamp
: Timestamp of frame

struct __enet_qos_tx_dirty_ring
: *#include <fsl_enet_qos.h>* Defines the ENET transmit dirty addresses ring/queue structure.

Public Members

enet_qos_frame_info_t *txDirtyBase
Dirty buffer descriptor base address pointer.

uint16_t txGenIdx
tx generate index.

uint16_t txConsumIdx
tx consume index.

uint16_t txRingLen
tx ring length.

bool isFull
tx ring is full flag, add this parameter to avoid waste one element.

struct _enet_qos_ptp_config
#include <fsl_enet_qos.h> Defines the ENET PTP configuration structure.

Public Members

bool fineUpdateEnable
Use the fine update.

uint32_t defaultAddend
Default addend value when fine update is enable, could be 2^32 / (refClk_Hz / ENET_QOS_MICRSECS_ONESECOND / ENET_QOS_SYSTIME_REQUIRED_CLK_MHZ).

bool ptp1588V2Enable
The desired system time frequency. Must be lower than reference clock. (Only used with fine correction method). ptp 1588 version 2 is used.

enet_qos_ts_rollover_type tsRollover
1588 time nanosecond rollover.

struct _enet_qos_est_gate_op
#include <fsl_enet_qos.h> Defines the EST gate operation structure.

struct _enet_qos_est_gcl
#include <fsl_enet_qos.h> Defines the EST gate control list structure.

Public Members

bool enable
Enable or disable EST

uint64_t cycleTime
Base Time 32 bits seconds 32 bits nanoseconds

uint32_t extTime
Cycle Time 32 bits seconds 32 bits nanoseconds

uint32_t numEntries
Time Extension 32 bits seconds 32 bits nanoseconds

enet_qos_est_gate_op_t *opList
Number of entries

struct _enet_qos_rxp_config
#include <fsl_enet_qos.h> Defines the ENET_QOS Rx parser configuration structure.

Public Members

uint32_t matchEnable
: 4-byte match data used for comparing with incoming packet

uint8_t acceptFrame
: When matchEnable is set to 1, the matchData is used for comparing

uint8_t rejectFrame
: When acceptFrame = 1 and data is matched, the frame will be sent to DMA channel

uint8_t inverseMatch
: When rejectFrame = 1 and data is matched, the frame will be dropped

uint8_t nextControl
: Inverse match

uint8_t reserved
: Next instruction indexing control

uint8_t frameOffset
: Reserved control fields

uint8_t okIndex
: Frame offset in the packet data to be compared for match, in terms of 4 bytes.

uint8_t dmaChannel
: Memory Index to be used next.

uint32_t reserved2
: The DMA channel enet_qos_rxp_dma_chn_t used for receiving the frame when frame match and acceptFrame = 1

struct _enet_qos_buffer_config
: *#include <fsl_enet_qos.h>* Defines the buffer descriptor configure structure.

Note:

a. The receive and transmit descriptor start address pointer and tail pointer must be word-aligned.

b. The recommended minimum tx/rx ring length is 4.

c. The tx/rx descriptor tail address shall be the address pointer to the address just after the end of the last last descriptor. because only the descriptors between the start address and the tail address will be used by DMA.

d. The descriptor address is the start address of all used contiguous memory. for example, the rxDescStartAddrAlign is the start address of rxRingLen contiguous descriptor memories for rx descriptor ring 0.

e. The “*rxBufferstartAddr” is the first element of rxRingLen (2*rxRingLen for double buffers) rx buffers. It means the *rxBufferStartAddr is the rx buffer for the first descriptor the *rxBufferStartAddr + 1 is the rx buffer for the second descriptor or the rx buffer for the second buffer in the first descriptor. so please make sure the rxBufferStartAddr is the address of a rxRingLen or 2*rxRingLen array.

Public Members

uint8_t rxRingLen
: The length of receive buffer descriptor ring.

uint8_t txRingLen
The length of transmit buffer descriptor ring.

enet_qos_tx_bd_struct_t *txDescStartAddrAlign
Aligned transmit descriptor start address.

enet_qos_tx_bd_struct_t *txDescTailAddrAlign
Aligned transmit descriptor tail address.

enet_qos_frame_info_t *txDirtyStartAddr
Start address of the dirty tx frame information.

enet_qos_rx_bd_struct_t *rxDescStartAddrAlign
Aligned receive descriptor start address.

enet_qos_rx_bd_struct_t *rxDescTailAddrAlign
Aligned receive descriptor tail address.

uint32_t *rxBufferStartAddr
Start address of the rx buffers.

uint32_t rxBuffSizeAlign
Aligned receive data buffer size.

bool rxBuffNeedMaintain
Whether receive data buffer need cache maintain.

struct __enet_qos_cbs_config
#include <fsl_enet_qos.h> Defines the CBS configuration for queue.

Public Members

uint16_t sendSlope
Send slope configuration.

uint16_t idleSlope
Idle slope configuration.

uint32_t highCredit
High credit.

uint32_t lowCredit
Low credit.

struct enet_qos_tx_queue_config
#include <fsl_enet_qos.h> Defines the queue configuration structure.

Public Members

enet_qos_queue_mode_t mode
tx queue mode configuration.

uint32_t weight
Refer to the MTL TxQ Quantum Weight register.

uint32_t priority
Refer to Transmit Queue Priority Mapping register.

enet_qos_cbs_config_t *cbsConfig
CBS configuration if queue use AVB mode.

struct enet_qos_rx_queue_config

#include <fsl_enet_qos.h> Defines the queue configuration structure.

Public Members

enet_qos_queue_mode_t mode

rx queue mode configuration.

uint8_t mapChannel

tx queue map dma channel.

uint32_t priority

Rx queue priority.

enet_qos_rx_queue_route_t packetRoute

Receive packet routing.

struct enet_qos_multiqueue_config

#include <fsl_enet_qos.h> Defines the configuration when multi-queue is used.

Public Members

enet_qos_dma_burstlen burstLen

Burst len for the multi-queue.

uint8_t txQueueUse

Used Tx queue count.

enet_qos_mtl_multiqueue_txsche mtltxSche

Transmit schedule for multi-queue.

enet_qos_queue_tx_config_t txQueueConfig[(5U)]

Tx Queue configuration.

uint8_t rxQueueUse

Used Rx queue count.

enet_qos_mtl_multiqueue_rxsche mtlrxSche

Receive schedule for multi-queue.

enet_qos_queue_rx_config_t rxQueueConfig[(5U)]

Rx Queue configuration.

struct __enet_qos_config

#include <fsl_enet_qos.h> Defines the basic configuration structure for the ENET device.

Note: Default the signal queue is used so the "*multiqueueCfg" is set default with NULL. Set the pointer with a valid configuration pointer if the multiple queues are required. If multiple queue is enabled, please make sure the buffer configuration for all are prepared also.

Public Members

uint16_t specialControl

The logic or of enet_qos_special_config_t

enet_qos_multiqueue_config_t *multiqueueCfg
Use multi-queue.

enet_qos_mii_mode_t miiMode
MII mode.

enet_qos_mii_speed_t miiSpeed
MII Speed.

enet_qos_mii_duplex_t miiDuplex
MII duplex.

uint16_t pauseDuration
Used in the tx flow control frame, only valid when kENET_QOS_FlowControlEnable is set.

enet_qos_ptp_config_t *ptpConfig
PTP 1588 feature configuration

uint32_t csrClock_Hz
CSR clock frequency in HZ.

enet_qos_rx_alloc_callback_t rxBuffAlloc
Callback to alloc memory, must be provided for zero-copy Rx.

enet_qos_rx_free_callback_t rxBuffFree
Callback to free memory, must be provided for zero-copy Rx.

struct __enet_qos_tx_bd_ring
#include <fsl_enet_qos.h> Defines the ENET transmit buffer descriptor ring/queue structure.

Public Members

enet_qos_tx_bd_struct_t *txBdBase
Buffer descriptor base address pointer.

uint16_t txGenIdx
tx generate index.

uint16_t txConsumIdx
tx consume index.

volatile uint16_t txDescUsed
tx descriptor used number.

uint16_t txRingLen
tx ring length.

struct __enet_qos_rx_bd_ring
#include <fsl_enet_qos.h> Defines the ENET receive buffer descriptor ring/queue structure.

Public Members

enet_qos_rx_bd_struct_t *rxBdBase
Buffer descriptor base address pointer.

uint16_t rxGenIdx
The current available receive buffer descriptor pointer.

uint16_t rxRingLen
: Receive ring length.

uint32_t rxBuffSizeAlign
: Receive buffer size.

struct __enet_qos_handle
: *#include <fsl_enet_qos.h>* Defines the ENET handler structure.

Public Members

uint8_t txQueueUse
: Used tx queue count.

uint8_t rxQueueUse
: Used rx queue count.

bool doubleBuffEnable
: The double buffer is used in the descriptor.

bool rxintEnable
: Rx interrupt enabled.

bool rxMaintainEnable[(5U)]
: Rx buffer cache maintain enabled.

enet_qos_rx_bd_ring_t rxBdRing[(5U)]
: Receive buffer descriptor.

enet_qos_tx_bd_ring_t txBdRing[(5U)]
: Transmit buffer descriptor.

enet_qos_tx_dirty_ring_t txDirtyRing[(5U)]
: Transmit dirty buffers addresses.

uint32_t *rxBufferStartAddr[(5U)]
: Rx buffer start address for reInitialize.

enet_qos_callback_t callback
: Callback function.

void *userData
: Callback function parameter.

uint8_t multicastCount[64]
: Multicast collisions counter

enet_qos_rx_alloc_callback_t rxBuffAlloc
: Callback to alloc memory, must be provided for zero-copy Rx.

enet_qos_rx_free_callback_t rxBuffFree
: Callback to free memory, must be provided for zero-copy Rx.

struct __enet_qos_state
: *#include <fsl_enet_qos.h>* Defines the ENET state structure.

Note: The structure contains saved state for the instance. It could be stored in enet_qos_handle_t, but that's used only with the transactional API.

Public Members

enet_qos_mii_mode_t miiMode
MII mode.

struct _enet_qos_buffer_struct
#include <fsl_enet_qos.h> Defines the frame buffer structure.

Public Members

void *buffer
The buffer store the whole or partial frame.

uint16_t length
The byte length of this buffer.

struct _enet_qos_rx_frame_error
#include <fsl_enet_qos.h> Defines the Rx frame error structure.

Public Members

bool rxDstAddrFilterErr
Destination Address Filter Fail.

bool rxSrcAddrFilterErr
SA Address Filter Fail.

bool rxDribbleErr
Dribble error.

bool rxReceiveErr
Receive error.

bool rxOverFlowErr
Receive over flow.

bool rxWatchDogErr
Watch dog timeout.

bool rxGaintPacketErr
Receive gaint packet.

bool rxCrcErr
Receive CRC error.

struct _enet_qos_rx_frame_attribute_struct
#include <fsl_enet_qos.h>

Public Members

bool isTsAvail
Rx frame timestamp is available or not.

enet_qos_ptp_time_t timestamp
The nanosecond part timestamp of this Rx frame.

struct _enet_qos_rx_frame_struct
#include <fsl_enet_qos.h> Defines the Rx frame data structure.

Public Members

enet_qos_buffer_struct_t *rxBuffArray
Rx frame buffer structure.

uint16_t totLen
Rx frame total length.

enet_qos_rx_frame_attribute_t rxAttribute
Rx frame attribute structure.

enet_qos_rx_frame_error_t rxFrameError
Rx frame error.

struct __enet_qos_transfer_stats
#include <fsl_enet_qos.h> Defines the ENET QOS transfer statistics structure.

Public Members

uint32_t statsRxFrameCount
Rx frame number.

uint32_t statsRxCrcErr
Rx frame number with CRC error.

uint32_t statsRxAlignErr
Rx frame number with alignment error.

uint32_t statsRxLengthErr
Rx frame length field doesn't equal to packet size.

uint32_t statsRxFifoOverflowErr
Rx FIFO overflow count.

uint32_t statsTxFrameCount
Tx frame number.

uint32_t statsTxFifoUnderRunErr
Tx FIFO underrun count.

2.44 EWM: External Watchdog Monitor Driver

void EWM_Init(EWM_Type *base, const *ewm_config_t* *config)
Initializes the EWM peripheral.

This function is used to initialize the EWM. After calling, the EWM runs immediately according to the configuration. Note that, except for the interrupt enable control bit, other control bits and registers are write once after a CPU reset. Modifying them more than once generates a bus transfer error.

This is an example.

```
ewm_config_t config;
EWM_GetDefaultConfig(&config);
config.compareHighValue = 0xAAU;
EWM_Init(ewm_base,&config);
```

Parameters

- base – EWM peripheral base address
- config – The configuration of the EWM

void EWM_Deinit(EWM_Type *base)

Deinitializes the EWM peripheral.

This function is used to shut down the EWM.

Parameters

- base – EWM peripheral base address

void EWM_GetDefaultConfig(*ewm_config_t* *config)

Initializes the EWM configuration structure.

This function initializes the EWM configuration structure to default values. The default values are as follows.

```
ewmConfig->enableEwm = true;
ewmConfig->enableEwmInput = false;
ewmConfig->setInputAssertLogic = false;
ewmConfig->enableInterrupt = false;
ewmConfig->ewm_lpo_clock_source_t = kEWM_LpoClockSource0;
ewmConfig->prescaler = 0;
ewmConfig->compareLowValue = 0;
ewmConfig->compareHighValue = 0xFEU;
```

See also:

ewm_config_t

Parameters

- config – Pointer to the EWM configuration structure.

static inline void EWM_EnableInterrupts(EWM_Type *base, uint32_t mask)

Enables the EWM interrupt.

This function enables the EWM interrupt.

Parameters

- base – EWM peripheral base address
- mask – The interrupts to enable The parameter can be combination of the following source if defined
  - kEWM_InterruptEnable

static inline void EWM_DisableInterrupts(EWM_Type *base, uint32_t mask)

Disables the EWM interrupt.

This function enables the EWM interrupt.

Parameters

- base – EWM peripheral base address
- mask – The interrupts to disable The parameter can be combination of the following source if defined
  - kEWM_InterruptEnable

static inline uint32_t EWM_GetStatusFlags(EWM_Type *base)

Gets all status flags.

This function gets all status flags.

This is an example for getting the running flag.

```
uint32_t status;
status = EWM_GetStatusFlags(ewm_base) & kEWM_RunningFlag;
```

See also:

_ewm_status_flags_t

- True: a related status flag has been set.
- False: a related status flag is not set.

Parameters

- base – EWM peripheral base address

Returns

State of the status flag: asserted (true) or not-asserted (false).

void EWM_Refresh(EWM_Type *base)

Services the EWM.

This function resets the EWM counter to zero.

Parameters

- base – EWM peripheral base address

FSL_EWM_DRIVER_VERSION

EWM driver version 2.0.4.

enum _ewm_lpo_clock_source

Describes EWM clock source.

Values:

enumerator kEWM_LpoClockSource0

EWM clock sourced from lpo_clk[0]

enumerator kEWM_LpoClockSource1

EWM clock sourced from lpo_clk[1]

enumerator kEWM_LpoClockSource2

EWM clock sourced from lpo_clk[2]

enumerator kEWM_LpoClockSource3

EWM clock sourced from lpo_clk[3]

enum _ewm_interrupt_enable_t

EWM interrupt configuration structure with default settings all disabled.

This structure contains the settings for all of EWM interrupt configurations.

Values:

enumerator kEWM_InterruptEnable

Enable the EWM to generate an interrupt

enum _ewm_status_flags_t

EWM status flags.

This structure contains the constants for the EWM status flags for use in the EWM functions.

Values:

enumerator kEWM_RunningFlag

Running flag, set when EWM is enabled

typedef enum *_ewm_lpo_clock_source* ewm_lpo_clock_source_t

Describes EWM clock source.

typedef struct *_ewm_config* ewm_config_t

Data structure for EWM configuration.

This structure is used to configure the EWM.

struct _ewm_config

#include <fsl_ewm.h> Data structure for EWM configuration.

This structure is used to configure the EWM.

Public Members

bool enableEwm

Enable EWM module

bool enableEwmInput

Enable EWM_in input

bool setInputAssertLogic

EWM_in signal assertion state

bool enableInterrupt

Enable EWM interrupt

ewm_lpo_clock_source_t clockSource

Clock source select

uint8_t prescaler

Clock prescaler value

uint8_t compareLowValue

Compare low-register value

uint8_t compareHighValue

Compare high-register value

2.45 FlexCAN: Flex Controller Area Network Driver

2.46 FlexCAN Driver

bool FLEXCAN_IsInstanceHasFDMode(CAN_Type *base)

Determine whether the FlexCAN instance support CAN FD mode at run time.

Note: Use this API only if different soc parts share the SOC part name macro define. Otherwise, a different SOC part name can be used to determine at compile time whether the

FlexCAN instance supports CAN FD mode or not. If need use this API to determine if CAN FD mode is supported, the FLEXCAN_Init function needs to be executed first, and then call this API and use the return to value determines whether to supports CAN FD mode, if return true, continue calling FLEXCAN_FDInit to enable CAN FD mode.

Parameters

- base – FlexCAN peripheral base address.

Returns

return TRUE if instance support CAN FD mode, FALSE if instance only support classic CAN (2.0) mode.

void FLEXCAN_EnterFreezeMode(CAN_Type *base)

Enter FlexCAN Freeze Mode.

This function makes the FlexCAN work under Freeze Mode.

Parameters

- base – FlexCAN peripheral base address.

void FLEXCAN_ExitFreezeMode(CAN_Type *base)

Exit FlexCAN Freeze Mode.

This function makes the FlexCAN leave Freeze Mode.

Parameters

- base – FlexCAN peripheral base address.

uint32_t FLEXCAN_GetInstance(CAN_Type *base)

Get the FlexCAN instance from peripheral base address.

Parameters

- base – FlexCAN peripheral base address.

Returns

FlexCAN instance.

bool FLEXCAN_CalculateImprovedTimingValues(CAN_Type *base, uint32_t bitRate, uint32_t sourceClock_Hz, *flexcan_timing_config_t* *pTimingConfig)

Calculates the improved timing values by specific bit Rates for classical CAN.

This function use to calculates the Classical CAN timing values according to the given bit rate. The Calculated timing values will be set in CTRL1/CBT/ENCBT register. The calculation is based on the recommendation of the CiA 301 v4.2.0 and previous version document.

Parameters

- base – FlexCAN peripheral base address.
- bitRate – The classical CAN speed in bps defined by user, should be less than or equal to 1Mbps.
- sourceClock_Hz – The Source clock frequency in Hz.
- pTimingConfig – Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration.

void FLEXCAN_Init(CAN_Type *base, const *flexcan_config_t* *pConfig, uint32_t sourceClock_Hz)

Initializes a FlexCAN instance.

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the flexcan_config_t parameters and how to call the FLEXCAN_Init function by passing in these parameters.

```
flexcan_config_t flexcanConfig;
flexcanConfig.clkSrc                 = kFLEXCAN_ClkSrc0;
flexcanConfig.bitRate                = 1000000U;
flexcanConfig.maxMbNum               = 16;
flexcanConfig.enableLoopBack         = false;
flexcanConfig.enableSelfWakeup       = false;
flexcanConfig.enableIndividMask      = false;
flexcanConfig.enableDoze             = false;
flexcanConfig.disableSelfReception   = false;
flexcanConfig.enableListenOnlyMode   = false;
flexcanConfig.timingConfig           = timingConfig;
FLEXCAN_Init(CAN0, &flexcanConfig, 40000000UL);
```

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the user-defined configuration structure.
- sourceClock_Hz – FlexCAN Protocol Engine clock source frequency in Hz.

bool FLEXCAN_FDCalculateImprovedTimingValues(CAN_Type *base, uint32_t bitRate, uint32_t bitRateFD, uint32_t sourceClock_Hz, *flexcan_timing_config_t* *pTimingConfig)

Calculates the improved timing values by specific bit rates for CANFD.

This function use to calculates the CANFD timing values according to the given nominal phase bit rate and data phase bit rate. The Calculated timing values will be set in CBT/ENCBT and FDCBT/EDCBT registers. The calculation is based on the recommendation of the CiA 1301 v1.0.0 document.

Parameters

- base – FlexCAN peripheral base address.
- bitRate – The CANFD bus control speed in bps defined by user.
- bitRateFD – The CAN FD data phase speed in bps defined by user. Equal to bitRate means disable bit rate switching.
- sourceClock_Hz – The Source clock frequency in Hz.
- pTimingConfig – Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

void FLEXCAN_FDInit(CAN_Type *base, const *flexcan_config_t* *pConfig, uint32_t sourceClock_Hz, *flexcan_mb_size_t* dataSize, bool brs)

Initializes a FlexCAN instance.

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the flexcan_config_t parameters and how to call the FLEXCAN_FDInit function by passing in these parameters.

```
flexcan_config_t flexcanConfig;
flexcanConfig.clkSrc                 = kFLEXCAN_ClkSrc0;
flexcanConfig.bitRate                = 1000000U;
```

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```
flexcanConfig.bitRateFD          = 2000000U;
flexcanConfig.maxMbNum           = 16;
flexcanConfig.enableLoopBack     = false;
flexcanConfig.enableSelfWakeup   = false;
flexcanConfig.enableIndividMask  = false;
flexcanConfig.disableSelfReception = false;
flexcanConfig.enableListenOnlyMode = false;
flexcanConfig.enableDoze         = false;
flexcanConfig.timingConfig       = timingConfig;
FLEXCAN_FDInit(CAN0, &flexcanConfig, 80000000UL, kFLEXCAN_16BperMB, true);
```

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the user-defined configuration structure.
- sourceClock_Hz – FlexCAN Protocol Engine clock source frequency in Hz.
- dataSize – FlexCAN Message Buffer payload size. The actual transmitted or received CAN FD frame data size needs to be less than or equal to this value.
- brs – True if bit rate switch is enabled in FD mode.

void FLEXCAN_Deinit(CAN_Type *base)

De-initializes a FlexCAN instance.

This function disables the FlexCAN module clock and sets all register values to the reset value.

Parameters

- base – FlexCAN peripheral base address.

void FLEXCAN_GetDefaultConfig(*flexcan_config_t* *pConfig)

Gets the default configuration structure.

This function initializes the FlexCAN configuration structure to default values. The default values are as follows. flexcanConfig->clkSrc = kFLEXCAN_ClkSrc0; flexcanConfig->bitRate = 1000000U; flexcanConfig->bitRateFD = 2000000U; flexcanConfig->maxMbNum = 16; flexcanConfig->enableLoopBack = false; flexcanConfig->enableSelfWakeup = false; flexcanConfig->enableIndividMask = false; flexcanConfig->disableSelfReception = false; flexcanConfig->enableListenOnlyMode = false; flexcanConfig->enableDoze = false; flexcanConfig->enablePretendedeNetworking = false; flexcanConfig->enableMemoryErrorControl = true; flexcanConfig->enableNonCorrectableErrorEnterFreeze = true; flexcanConfig->enableTransceiverDelayMeasure = true; flexcanConfig->enableRemoteRequestFrameStored = true; flexcanConfig->payloadEndianness = kFLEXCAN_bigEndian; flexcanConfig.timingConfig = timingConfig;

Parameters

- pConfig – Pointer to the FlexCAN configuration structure.

void FLEXCAN_SetTimingConfig(CAN_Type *base, const *flexcan_timing_config_t* *pConfig)

Sets the FlexCAN classical CAN protocol timing characteristic.

This function gives user settings to classical CAN or CAN FD nominal phase timing characteristic. The function is for an experienced user. For less experienced users, call the FLEXCAN_SetBitRate() instead.

Note: Calling FLEXCAN_SetTimingConfig() overrides the bit rate set in FLEXCAN_Init() or FLEXCAN_SetBitRate().

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the timing configuration structure.

status_t FLEXCAN_SetBitRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t bitRate_Bps)

Set bit rate of FlexCAN classical CAN frame or CAN FD frame nominal phase.

This function set the bit rate of classical CAN frame or CAN FD frame nominal phase base on FLEXCAN_CalculateImprovedTimingValues() API calculated timing values.

Note: Calling FLEXCAN_SetBitRate() overrides the bit rate set in FLEXCAN_Init().

Parameters

- base – FlexCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- bitRate_Bps – Bit rate in Bps.

Returns

kStatus_Success - Set CAN baud rate (only Nominal phase) successfully.

void FLEXCAN_SetFDTimingConfig(CAN_Type *base, const *flexcan_timing_config_t* *pConfig)

Sets the FlexCAN CANFD data phase timing characteristic.

This function gives user settings to CANFD data phase timing characteristic. The function is for an experienced user. For less experienced users, call the FLEXCAN_SetFDBitRate() to set both Nominal/Data bit Rate instead.

Note: Calling FLEXCAN_SetFDTimingConfig() overrides the data phase bit rate set in FLEXCAN_FDInit()/FLEXCAN_SetFDBitRate().

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the timing configuration structure.

status_t FLEXCAN_SetFDBitRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t bitRateN_Bps, uint32_t bitRateD_Bps)

Set bit rate of FlexCAN FD frame.

This function set the baud rate of FLEXCAN FD base on FLEXCAN_FDCalculateImprovedTimingValues() API calculated timing values.

Parameters

- base – FlexCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- bitRateN_Bps – Nominal bit Rate in Bps.
- bitRateD_Bps – Data bit Rate in Bps.

Returns

kStatus_Success - Set CAN FD bit rate (include Nominal and Data phase) successfully.

void FLEXCAN_SetRxMbGlobalMask(CAN_Type *base, uint32_t mask)

Sets the FlexCAN receive message buffer global mask.

This function sets the global mask for the FlexCAN message buffer in a matching process. The configuration is only effective when the Rx individual mask is disabled in the FLEXCAN_Init().

Parameters

- base – FlexCAN peripheral base address.
- mask – Rx Message Buffer Global Mask value.

void FLEXCAN_SetRxFifoGlobalMask(CAN_Type *base, uint32_t mask)

Sets the FlexCAN receive FIFO global mask.

This function sets the global mask for FlexCAN FIFO in a matching process.

Parameters

- base – FlexCAN peripheral base address.
- mask – Rx Fifo Global Mask value.

void FLEXCAN_SetRxIndividualMask(CAN_Type *base, uint8_t maskIdx, uint32_t mask)

Sets the FlexCAN receive individual mask.

This function sets the individual mask for the FlexCAN matching process. The configuration is only effective when the Rx individual mask is enabled in the FLEXCAN_Init(). If the Rx FIFO is disabled, the individual mask is applied to the corresponding Message Buffer. If the Rx FIFO is enabled, the individual mask for Rx FIFO occupied Message Buffer is applied to the Rx Filter with the same index. Note that only the first 32 individual masks can be used as the Rx FIFO filter mask.

Parameters

- base – FlexCAN peripheral base address.
- maskIdx – The Index of individual Mask.
- mask – Rx Individual Mask value.

void FLEXCAN_SetTxMbConfig(CAN_Type *base, uint8_t mbIdx, bool enable)

Configures a FlexCAN transmit message buffer.

This function aborts the previous transmission, cleans the Message Buffer, and configures it as a Transmit Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- enable – Enable/disable Tx Message Buffer.
  - true: Enable Tx Message Buffer.
  - false: Disable Tx Message Buffer.

void FLEXCAN_SetRxMbConfig(CAN_Type *base, uint8_t mbIdx, const *flexcan_rx_mb_config_t* *pRxMbConfig, bool enable)

Configures a FlexCAN Receive Message Buffer.

This function cleans a FlexCAN build-in Message Buffer and configures it as a Receive Message Buffer. User should invoke this API when CTRL2[RRS]=1. When CTRL2[RRS]=1, frame's

ID is compared to the IDs of the receive mailboxes with the CODE field configured as kFLEXCAN_RxMbEmpty, kFLEXCAN_RxMbFull or kFLEXCAN_RxMbOverrun. Message buffer will store the remote frame in the same fashion of a data frame. No automatic remote response frame will be generated. User need to setup another message buffer to respond remote request.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pRxMbConfig – Pointer to the FlexCAN Message Buffer configuration structure.
- enable – Enable/disable Rx Message Buffer.
  - true: Enable Rx Message Buffer.
  - false: Disable Rx Message Buffer.

void FLEXCAN_SetFDTxMbConfig(CAN_Type *base, uint8_t mbIdx, bool enable)

Configures a FlexCAN transmit message buffer.

This function aborts the previous transmission, cleans the Message Buffer, and configures it as a Transmit Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- enable – Enable/disable Tx Message Buffer.
  - true: Enable Tx Message Buffer.
  - false: Disable Tx Message Buffer.

void FLEXCAN_SetFDRxMbConfig(CAN_Type *base, uint8_t mbIdx, const *flexcan_rx_mb_config_t* *pRxMbConfig, bool enable)

Configures a FlexCAN Receive Message Buffer.

This function cleans a FlexCAN build-in Message Buffer and configures it as a Receive Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pRxMbConfig – Pointer to the FlexCAN Message Buffer configuration structure.
- enable – Enable/disable Rx Message Buffer.
  - true: Enable Rx Message Buffer.
  - false: Disable Rx Message Buffer.

void FLEXCAN_SetRemoteResponseMbConfig(CAN_Type *base, uint8_t mbIdx, const *flexcan_frame_t* *pFrame)

Configures a FlexCAN Remote Response Message Buffer.

User should invoke this API when CTRL2[RRS]=0. When CTRL2[RRS]=0, frame's ID is compared to the IDs of the receive mailboxes with the CODE field configured as kFLEXCAN_RxMbRanswer. If there is a matching ID, then this mailbox content will be transmitted as response. The received remote request frame is not stored in receive buffer. It is only used to trigger a transmission of a frame in response.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pFrame – Pointer to CAN message frame structure for response.

void FLEXCAN_SetRxFifoConfig(CAN_Type *base, const *flexcan_rx_fifo_config_t* *pRxFifoConfig, bool enable)

Configures the FlexCAN Legacy Rx FIFO.

This function configures the FlexCAN Rx FIFO with given configuration.

Note: Legacy Rx FIFO only can receive classic CAN message.

Parameters

- base – FlexCAN peripheral base address.
- pRxFifoConfig – Pointer to the FlexCAN Legacy Rx FIFO configuration structure. Can be NULL when enable parameter is false.
- enable – Enable/disable Legacy Rx FIFO.
  - true: Enable Legacy Rx FIFO.
  - false: Disable Legacy Rx FIFO.

void FLEXCAN_SetPNConfig(CAN_Type *base, const *flexcan_pn_config_t* *pConfig)

Configures the FlexCAN Pretended Networking mode.

This function configures the FlexCAN Pretended Networking mode with given configuration.

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the FlexCAN Rx FIFO configuration structure.

static inline uint64_t FLEXCAN_GetStatusFlags(CAN_Type *base)

Gets the FlexCAN module interrupt flags.

This function gets all FlexCAN status flags. The flags are returned as the logical OR value of the enumerators _flexcan_flags. To check the specific status, compare the return value with enumerators in _flexcan_flags.

Parameters

- base – FlexCAN peripheral base address.

Returns

FlexCAN status flags which are ORed by the enumerators in the _flexcan_flags.

static inline void FLEXCAN_ClearStatusFlags(CAN_Type *base, uint64_t mask)

Clears status flags with the provided mask.

This function clears the FlexCAN status flags with a provided mask. An automatically cleared flag can't be cleared by this function.

Parameters

- base – FlexCAN peripheral base address.
- mask – The status flags to be cleared, it is logical OR value of _flexcan_flags.

static inline void FLEXCAN_GetBusErrCount(CAN_Type *base, uint8_t *txErrBuf, uint8_t *rxErrBuf)

Gets the FlexCAN Bus Error Counter value.

This function gets the FlexCAN Bus Error Counter value for both Tx and Rx direction. These values may be needed in the upper layer error handling.

Parameters

- base – FlexCAN peripheral base address.
- txErrBuf – Buffer to store Tx Error Counter value.
- rxErrBuf – Buffer to store Rx Error Counter value.

static inline uint64_t FLEXCAN_GetMbStatusFlags(CAN_Type *base, uint64_t mask)

Gets the FlexCAN low 64 Message Buffer interrupt flags.

This function gets the interrupt flags of a given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

static inline uint64_t FLEXCAN_GetHigh64MbStatusFlags(CAN_Type *base, uint64_t mask)

Gets the FlexCAN High 64 Message Buffer interrupt flags.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

static inline void FLEXCAN_ClearMbStatusFlags(CAN_Type *base, uint64_t mask)

Clears the FlexCAN low 64 Message Buffer interrupt flags.

This function clears the interrupt flags of a given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

static inline void FLEXCAN_ClearHigh64MbStatusFlags(CAN_Type *base, uint64_t mask)

Clears the FlexCAN High 64 Message Buffer interrupt flags.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

void FLEXCAN_GetMemoryErrorReportStatus(CAN_Type *base, *flexcan_memory_error_report_status_t* *errorStatus)

Gets the FlexCAN Memory Error Report registers status.

This function gets the FlexCAN Memory Error Report registers status.

Parameters

- base – FlexCAN peripheral base address.
- errorStatus – Pointer to FlexCAN Memory Error Report registers status structure.

static inline uint8_t FLEXCAN_GetPNMatchCount(CAN_Type *base)

Gets the FlexCAN Number of Matches when in Pretended Networking.

This function gets the number of times a given message has matched the predefined filtering criteria for ID and/or PL before a wakeup event.

Parameters

- base – FlexCAN peripheral base address.

Returns

The number of received wake up msessages.

static inline void FLEXCAN_EnableInterrupts(CAN_Type *base, uint64_t mask)

Enables FlexCAN interrupts according to the provided mask.

This function enables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see _flexcan_interrupt_enable.

Parameters

- base – FlexCAN peripheral base address.
- mask – The interrupts to enable. Logical OR of _flexcan_interrupt_enable.

static inline void FLEXCAN_DisableInterrupts(CAN_Type *base, uint64_t mask)

Disables FlexCAN interrupts according to the provided mask.

This function disables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see _flexcan_interrupt_enable.

Parameters

- base – FlexCAN peripheral base address.
- mask – The interrupts to disable. Logical OR of _flexcan_interrupt_enable.

static inline void FLEXCAN_EnableMbInterrupts(CAN_Type *base, uint64_t mask)

Enables FlexCAN low 64 Message Buffer interrupts.

This function enables the interrupts of given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

static inline void FLEXCAN_EnableHigh64MbInterrupts(CAN_Type *base, uint64_t mask)

Enables FlexCAN high 64 Message Buffer interrupts.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

static inline void FLEXCAN_DisableMbInterrupts(CAN_Type *base, uint64_t mask)

Disables FlexCAN low 64 Message Buffer interrupts.

This function disables the interrupts of given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

static inline void FLEXCAN_DisableHigh64MbInterrupts(CAN_Type *base, uint64_t mask)

Disables FlexCAN high 64 Message Buffer interrupts.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

void FLEXCAN_EnableRxFifoDMA(CAN_Type *base, bool enable)

Enables or disables the FlexCAN Rx FIFO DMA request.

This function enables or disables the DMA feature of FlexCAN build-in Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.
- enable – true to enable, false to disable.

static inline uintptr_t FLEXCAN_GetRxFifoHeadAddr(CAN_Type *base)

Gets the Rx FIFO Head address.

This function returns the FlexCAN Rx FIFO Head address, which is mainly used for the DMA/eDMA use case.

Parameters

- base – FlexCAN peripheral base address.

Returns

FlexCAN Rx FIFO Head address.

static inline void FLEXCAN_Enable(CAN_Type *base, bool enable)

Enables or disables the FlexCAN module operation.

This function enables or disables the FlexCAN module.

Parameters

- base – FlexCAN base pointer.
- enable – true to enable, false to disable.

status_t FLEXCAN_WriteTxMb(CAN_Type *base, uint8_t mbIdx, const *flexcan_frame_t* *pTxFrame)

Writes a FlexCAN Message to the Transmit Message Buffer.

This function writes a CAN Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN Message transmit. After that the function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN Message Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.

status_t FLEXCAN_ReadRxMb(CAN_Type *base, uint8_t mbIdx, *flexcan_frame_t* *pRxFrame)

Reads a FlexCAN Message from Receive Message Buffer.

This function reads a CAN message from a specified Receive Message Buffer. The function fills a receive CAN message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN Message Buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – - Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow – - Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail – - Rx Message Buffer is empty.

status_t FLEXCAN_WriteFDTxMb(CAN_Type *base, uint8_t mbIdx, const *flexcan_fd_frame_t* *pTxFrame)

Writes a FlexCAN FD Message to the Transmit Message Buffer.

This function writes a CAN FD Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN FD Message transmit. After that the function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN FD Message Buffer index.
- pTxFrame – Pointer to CAN FD message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.

status_t FLEXCAN_ReadFDRxMb(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pRxFrame)

Reads a FlexCAN FD Message from Receive Message Buffer.

This function reads a CAN FD message from a specified Receive Message Buffer. The function fills a receive CAN FD message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN FD Message Buffer index.
- pRxFrame – Pointer to CAN FD message frame structure for reception.

Return values

- kStatus_Success – - Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow – - Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail – - Rx Message Buffer is empty.

status_t FLEXCAN_ReadRxFifo(CAN_Type *base, *flexcan_frame_t* *pRxFrame)

Reads a FlexCAN Message from Legacy Rx FIFO.

This function reads a CAN message from the FlexCAN Legacy Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – - Read Message from Rx FIFO successfully.
- kStatus_Fail – - Rx FIFO is not enabled.

status_t FLEXCAN_ReadPNWakeUpMB(CAN_Type *base, uint8_t mbIdx, *flexcan_frame_t* *pRxFrame)

Reads a FlexCAN Message from Wake Up MB.

This function reads a CAN message from the FlexCAN Wake up Message Buffers. There are four Wake up Message Buffers (WMBs) used to store incoming messages in Pretended Networking mode. The WMB index indicates the arrival order. The last message is stored in WMB3.

Parameters

- base – FlexCAN peripheral base address.
- pRxFrame – Pointer to CAN message frame structure for reception.
- mbIdx – The FlexCAN Wake up Message Buffer index. Range in 0x0 ~ 0x3.

Return values

- kStatus_Success – - Read Message from Wake up Message Buffer successfully.
- kStatus_Fail – - Wake up Message Buffer has no valid content.

status_t FLEXCAN_TransferFDSendBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pTxFrame)

Performs a polling send transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN FD Message Buffer index.
- pTxFrame – Pointer to CAN FD message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.

status_t FLEXCAN_TransferFDReceiveBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pRxFrame)

Performs a polling receive transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN FD Message Buffer index.
- pRxFrame – Pointer to CAN FD message frame structure for reception.

Return values

- kStatus_Success – - Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow – - Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail – - Rx Message Buffer is empty.

status_t FLEXCAN_TransferFDSendNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN FD Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – Start Tx Message Buffer sending process successfully.
- kStatus_Fail – Write Tx Message Buffer failed.
- kStatus_FLEXCAN_TxBusy – Tx Message Buffer is in use.

status_t FLEXCAN_TransferFDReceiveNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Receives a message using IRQ.

This function receives a message using IRQ. This is non-blocking function, which returns right away. When the message has been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN FD Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – - Start Rx Message Buffer receiving process successfully.
- kStatus_FLEXCAN_RxBusy – - Rx Message Buffer is in use.

void FLEXCAN_TransferFDAbortSend(CAN_Type *base, *flexcan_handle_t* *handle, uint8_t mbIdx)

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- base – FlexCAN peripheral base address.

- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN FD Message Buffer index.

void FLEXCAN_TransferFDAbortReceive(CAN_Type *base, *flexcan_handle_t* *handle, uint8_t mbIdx)

Aborts the interrupt driven message receive process.

This function aborts the interrupt driven message receive process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN FD Message Buffer index.

status_t FLEXCAN_TransferSendBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_frame_t* *pTxFrame)

Performs a polling send transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN Message Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.

status_t FLEXCAN_TransferReceiveBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_frame_t* *pRxFrame)

Performs a polling receive transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN Message Buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – - Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow – - Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail – - Rx Message Buffer is empty.

status_t FLEXCAN_TransferReceiveFifoBlocking(CAN_Type *base, *flexcan_frame_t* *pRxFrame)

Performs a polling receive transaction from Legacy Rx FIFO on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – - Read Message from Rx FIFO successfully.
- kStatus_Fail – - Rx FIFO is not enabled.

void FLEXCAN_TransferCreateHandle(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_transfer_callback_t* callback, void *userData)

Initializes the FlexCAN handle.

This function initializes the FlexCAN handle, which can be used for other FlexCAN transactional APIs. Usually, for a specified FlexCAN instance, call this API once to get the initialized handle.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

status_t FLEXCAN_TransferSendNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – Start Tx Message Buffer sending process successfully.
- kStatus_Fail – Write Tx Message Buffer failed.
- kStatus_FLEXCAN_TxBusy – Tx Message Buffer is in use.

status_t FLEXCAN_TransferReceiveNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Receives a message using IRQ.

This function receives a message using IRQ. This is non-blocking function, which returns right away. When the message has been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – - Start Rx Message Buffer receiving process successfully.
- kStatus_FLEXCAN_RxBusy – - Rx Message Buffer is in use.

status_t FLEXCAN_TransferReceiveFifoNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle, *flexcan_fifo_transfer_t* *pFifoXfer)

Receives a message from Rx FIFO using IRQ.

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pFifoXfer – FlexCAN Rx FIFO transfer structure. See the flexcan_fifo_transfer_t.

Return values

- kStatus_Success – - Start Rx FIFO receiving process successfully.
- kStatus_FLEXCAN_RxFifoBusy – - Rx FIFO is currently in use.

status_t FLEXCAN_TransferGetReceiveFifoCount(CAN_Type *base, *flexcan_handle_t* *handle, size_t *count)

Gets the Legacy Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- count – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

uint32_t FLEXCAN_GetTimeStamp(*flexcan_handle_t* *handle, uint8_t mbIdx)

Gets the detail index of Mailbox's Timestamp by handle.

Then function can only be used when calling non-blocking Data transfer (TX/RX) API, After TX/RX data transfer done (User can get the status by handler's callback function), we can get the detail index of Mailbox's timestamp by handle, Detail non-blocking data transfer API (TX/RX) contain. -FLEXCAN_TransferSendNonBlocking -FLEXCAN_TransferFDSendNonBlocking -FLEXCAN_TransferReceiveNonBlocking -FLEXCAN_TransferFDReceiveNonBlocking -FLEXCAN_TransferReceiveFifoNonBlocking

Parameters

- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

Return values

the – index of mailbox 's timestamp stored in the handle.

void FLEXCAN_TransferAbortSend(CAN_Type *base, *flexcan_handle_t* *handle, uint8_t mbIdx)

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

void FLEXCAN_TransferAbortReceive(CAN_Type *base, *flexcan_handle_t* *handle, uint8_t mbIdx)

Aborts the interrupt driven message receive process.

This function aborts the interrupt driven message receive process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

void FLEXCAN_TransferAbortReceiveFifo(CAN_Type *base, *flexcan_handle_t* *handle)

Aborts the interrupt driven message receive from Rx FIFO process.

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_TransferHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)

FlexCAN IRQ handle function.

This function handles the FlexCAN Error, the Message Buffer, and the Rx FIFO IRQ request.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_MbHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle, uint32_t startMbIdx, uint32_t endMbIdx)

FlexCAN Message Buffer IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- startMbIdx – First Message Buffer to handle.
- endMbIdx – Last Message Buffer to handle.

void FLEXCAN_BusoffErrorHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)

FlexCAN Bus Off, Error and Warning IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.

- handle – FlexCAN handle pointer.

void FLEXCAN_PNWakeUpHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)

FlexCAN Pretended Networking Wake-up IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_MemoryErrorHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)

FlexCAN Memory Error IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

FSL_FLEXCAN_DRIVER_VERSION

FlexCAN driver version.

FlexCAN transfer status.

Values:

enumerator kStatus_FLEXCAN_TxBusy

Tx Message Buffer is Busy.

enumerator kStatus_FLEXCAN_TxIdle

Tx Message Buffer is Idle.

enumerator kStatus_FLEXCAN_TxSwitchToRx

Remote Message is send out and Message buffer changed to Receive one.

enumerator kStatus_FLEXCAN_RxBusy

Rx Message Buffer is Busy.

enumerator kStatus_FLEXCAN_RxIdle

Rx Message Buffer is Idle.

enumerator kStatus_FLEXCAN_RxOverflow

Rx Message Buffer is Overflowed.

enumerator kStatus_FLEXCAN_RxFifoBusy

Rx Message FIFO is Busy.

enumerator kStatus_FLEXCAN_RxFifoIdle

Rx Message FIFO is Idle.

enumerator kStatus_FLEXCAN_RxFifoOverflow

Rx Message FIFO is overflowed.

enumerator kStatus_FLEXCAN_RxFifoWarning

Rx Message FIFO is almost overflowed.

enumerator kStatus_FLEXCAN_RxFifoDisabled

Rx Message FIFO is disabled during reading.

enumerator kStatus_FLEXCAN_ErrorStatus

FlexCAN Module Error and Status.

enumerator kStatus_FLEXCAN_WakeUp

FlexCAN is waken up from STOP mode.

enumerator kStatus_FLEXCAN_UnHandled
UnHadled Interrupt asserted.

enumerator kStatus_FLEXCAN_RxRemote
Rx Remote Message Received in Mail box.

enumerator kStatus_FLEXCAN_MemoryError
FlexCAN Memory Error.

enum _flexcan_frame_format
FlexCAN frame format.

Values:

enumerator kFLEXCAN_FrameFormatStandard
Standard frame format attribute.

enumerator kFLEXCAN_FrameFormatExtend
Extend frame format attribute.

enum _flexcan_frame_type
FlexCAN frame type.

Values:

enumerator kFLEXCAN_FrameTypeData
Data frame type attribute.

enumerator kFLEXCAN_FrameTypeRemote
Remote frame type attribute.

enum _flexcan_clock_source
FlexCAN clock source.

Deprecated:
Do not use the kFLEXCAN_ClkSrcOs. It has been superceded kFLEXCAN_ClkSrc0

Do not use the kFLEXCAN_ClkSrcPeri. It has been superceded kFLEXCAN_ClkSrc1

Values:

enumerator kFLEXCAN_ClkSrcOsc
FlexCAN Protocol Engine clock from Oscillator.

enumerator kFLEXCAN_ClkSrcPeri
FlexCAN Protocol Engine clock from Peripheral Clock.

enumerator kFLEXCAN_ClkSrc0
FlexCAN Protocol Engine clock selected by user as SRC == 0.

enumerator kFLEXCAN_ClkSrc1
FlexCAN Protocol Engine clock selected by user as SRC == 1.

enum _flexcan_wake_up_source
FlexCAN wake up source.

Values:

enumerator kFLEXCAN_WakeupSrcUnfiltered
FlexCAN uses unfiltered Rx input to detect edge.

enumerator kFLEXCAN_WakeupSrcFiltered
FlexCAN uses filtered Rx input to detect edge.

enum _flexcan_rx_fifo_filter_type

FlexCAN Rx Fifo Filter type.

Values:

enumerator kFLEXCAN_RxFifoFilterTypeA

One full ID (standard and extended) per ID Filter element.

enumerator kFLEXCAN_RxFifoFilterTypeB

Two full standard IDs or two partial 14-bit ID slices per ID Filter Table element.

enumerator kFLEXCAN_RxFifoFilterTypeC

Four partial 8-bit Standard or extended ID slices per ID Filter Table element.

enumerator kFLEXCAN_RxFifoFilterTypeD

All frames rejected.

enum _flexcan_mb_size

FlexCAN Message Buffer Payload size.

Values:

enumerator kFLEXCAN_8BperMB

Selects 8 bytes per Message Buffer.

enumerator kFLEXCAN_16BperMB

Selects 16 bytes per Message Buffer.

enumerator kFLEXCAN_32BperMB

Selects 32 bytes per Message Buffer.

enumerator kFLEXCAN_64BperMB

Selects 64 bytes per Message Buffer.

enum _flexcan_fd_frame_length

FlexCAN CAN FD frame supporting data length (available DLC values).

For Tx, when the Data size corresponding to DLC value stored in the MB selected for transmission is larger than the MB Payload size, FlexCAN adds the necessary number of bytes with constant 0xCC pattern to complete the expected DLC. For Rx, when the Data size corresponding to DLC value received from the CAN bus is larger than the MB Payload size, the high order bytes that do not fit the Payload size will lose.

Values:

enumerator kFLEXCAN_0BperFrame

Frame contains 0 valid data bytes.

enumerator kFLEXCAN_1BperFrame

Frame contains 1 valid data bytes.

enumerator kFLEXCAN_2BperFrame

Frame contains 2 valid data bytes.

enumerator kFLEXCAN_3BperFrame

Frame contains 3 valid data bytes.

enumerator kFLEXCAN_4BperFrame

Frame contains 4 valid data bytes.

enumerator kFLEXCAN_5BperFrame

Frame contains 5 valid data bytes.

enumerator kFLEXCAN_6BperFrame
Frame contains 6 valid data bytes.

enumerator kFLEXCAN_7BperFrame
Frame contains 7 valid data bytes.

enumerator kFLEXCAN_8BperFrame
Frame contains 8 valid data bytes.

enumerator kFLEXCAN_12BperFrame
Frame contains 12 valid data bytes.

enumerator kFLEXCAN_16BperFrame
Frame contains 16 valid data bytes.

enumerator kFLEXCAN_20BperFrame
Frame contains 20 valid data bytes.

enumerator kFLEXCAN_24BperFrame
Frame contains 24 valid data bytes.

enumerator kFLEXCAN_32BperFrame
Frame contains 32 valid data bytes.

enumerator kFLEXCAN_48BperFrame
Frame contains 48 valid data bytes.

enumerator kFLEXCAN_64BperFrame
Frame contains 64 valid data bytes.

enum _flexcan_rx_fifo_priority
FlexCAN Enhanced/Legacy Rx FIFO priority.

The matching process starts from the Rx MB(or Enhanced/Legacy Rx FIFO) with higher priority. If no MB(or Enhanced/Legacy Rx FIFO filter) is satisfied, the matching process goes on with the Enhanced/Legacy Rx FIFO(or Rx MB) with lower priority.

Values:

enumerator kFLEXCAN_RxFifoPrioLow
Matching process start from Rx Message Buffer first.

enumerator kFLEXCAN_RxFifoPrioHigh
Matching process start from Enhanced/Legacy Rx FIFO first.

enum _flexcan_interrupt_enable
FlexCAN interrupt enable enumerations.

This provides constants for the FlexCAN interrupt enable enumerations for use in the FlexCAN functions.

Note: FlexCAN Message Buffers and Legacy Rx FIFO interrupts not included in.

Values:

enumerator kFLEXCAN_BusOffInterruptEnable
Bus Off interrupt, use bit 15.

enumerator kFLEXCAN_ErrorInterruptEnable
CAN Error interrupt, use bit 14.

enumerator kFLEXCAN_TxWarningInterruptEnable
Tx Warning interrupt, use bit 11.

enumerator kFLEXCAN_RxWarningInterruptEnable
Rx Warning interrupt, use bit 10.

enumerator kFLEXCAN_WakeUpInterruptEnable
Self Wake Up interrupt, use bit 26.

enumerator kFLEXCAN_FDErrorInterruptEnable
CAN FD Error interrupt, use bit 31.

enumerator kFLEXCAN_PNMatchWakeUpInterruptEnable
PN Match Wake Up interrupt, use high word bit 17.

enumerator kFLEXCAN_PNTimeoutWakeUpInterruptEnable
PN Timeout Wake Up interrupt, use high word bit 16.

enumerator kFLEXCAN_HostAccessNCErrorInterruptEnable
Host Access With Non-Correctable Errors interrupt, use high word bit 0.

enumerator kFLEXCAN_FlexCanAccessNCErrorInterruptEnable
FlexCAN Access With Non-Correctable Errors interrupt, use high word bit 2.

enumerator kFLEXCAN_HostOrFlexCanCErrorInterruptEnable
Host or FlexCAN Access With Correctable Errors interrupt, use high word bit 3.

enum _flexcan_flags
FlexCAN status flags.

This provides constants for the FlexCAN status flags for use in the FlexCAN functions.

Note: The CPU read action clears the bits corresponding to the FlEXCAN_ErrorFlag macro, therefore user need to read status flags and distinguish which error is occur using _flexcan_error_flags enumerations.

Values:

enumerator kFLEXCAN_ErrorOverrunFlag
Error Overrun Status.

enumerator kFLEXCAN_FDErrorIntFlag
CAN FD Error Interrupt Flag.

enumerator kFLEXCAN_BusoffDoneIntFlag
Bus Off process completed Interrupt Flag.

enumerator kFLEXCAN_SynchFlag
CAN Synchronization Status.

enumerator kFLEXCAN_TxWarningIntFlag
Tx Warning Interrupt Flag.

enumerator kFLEXCAN_RxWarningIntFlag
Rx Warning Interrupt Flag.

enumerator kFLEXCAN_IdleFlag
FlexCAN In IDLE Status.

enumerator kFLEXCAN_FaultConfinementFlag
FlexCAN Fault Confinement State.

enumerator kFLEXCAN_TransmittingFlag
FlexCAN In Transmission Status.

enumerator kFLEXCAN_ReceivingFlag
FlexCAN In Reception Status.

enumerator kFLEXCAN_BusOffIntFlag
Bus Off Interrupt Flag.

enumerator kFLEXCAN_ErrorIntFlag
CAN Error Interrupt Flag.

enumerator kFLEXCAN_WakeUpIntFlag
Self Wake-Up Interrupt Flag.

enumerator kFLEXCAN_ErrorFlag

enumerator kFLEXCAN_PNMatchIntFlag
PN Matching Event Interrupt Flag.

enumerator kFLEXCAN_PNTimeoutIntFlag
PN Timeout Event Interrupt Flag.

enumerator kFLEXCAN_HostAccessNonCorrectableErrorIntFlag
Host Access With Non-Correctable Error Interrupt Flag.

enumerator kFLEXCAN_FlexCanAccessNonCorrectableErrorIntFlag
FlexCAN Access With Non-Correctable Error Interrupt Flag.

enumerator kFLEXCAN_CorrectableErrorIntFlag
Correctable Error Interrupt Flag.

enumerator kFLEXCAN_HostAccessNonCorrectableErrorOverrunFlag
Host Access With Non-Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_FlexCanAccessNonCorrectableErrorOverrunFlag
FlexCAN Access With Non-Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_CorrectableErrorOverrunFlag
Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_AllMemoryErrorIntFlag
All Memory Error Interrupt Flags.

enumerator kFLEXCAN_AllMemoryErrorFlag
All Memory Error Flags.

enum _flexcan_error_flags
FlexCAN error status flags.

The FlexCAN Error Status enumerations is used to report current error of the FlexCAN bus. This enumerations should be used with KFLEXCAN_ErrorFlag in _flexcan_flags enumerations to ditermine which error is generated.

Values:

enumerator kFLEXCAN_FDStuffingError
Stuffing Error.

enumerator kFLEXCAN_FDFormError
Form Error.

enumerator kFLEXCAN_FDCrcError
Cyclic Redundancy Check Error.

enumerator kFLEXCAN_FDBit0Error
Unable to send dominant bit.

enumerator kFLEXCAN_FDBit1Error
Unable to send recessive bit.

enumerator kFLEXCAN_TxErrorWarningFlag
Tx Error Warning Status.

enumerator kFLEXCAN_RxErrorWarningFlag
Rx Error Warning Status.

enumerator kFLEXCAN_StuffingError
Stuffing Error.

enumerator kFLEXCAN_FormError
Form Error.

enumerator kFLEXCAN_CrcError
Cyclic Redundancy Check Error.

enumerator kFLEXCAN_AckError
Received no ACK on transmission.

enumerator kFLEXCAN_Bit0Error
Unable to send dominant bit.

enumerator kFLEXCAN_Bit1Error
Unable to send recessive bit.

FlexCAN Legacy Rx FIFO status flags.

The FlexCAN Legacy Rx FIFO Status enumerations are used to determine the status of the Rx FIFO. Because Rx FIFO occupy the MB0 ~ MB7 (Rx Fifo filter also occupies more Message Buffer space), Rx FIFO status flags are mapped to the corresponding Message Buffer status flags.

Values:

enumerator kFLEXCAN_RxFifoOverflowFlag
Rx FIFO overflow flag.

enumerator kFLEXCAN_RxFifoWarningFlag
Rx FIFO almost full flag.

enumerator kFLEXCAN_RxFifoFrameAvlFlag
Frames available in Rx FIFO flag.

enum _flexcan_memory_error_type
FlexCAN Memory Error Type.

Values:

enumerator kFLEXCAN_CorrectableError
The memory error is correctable which means on bit error.

enumerator kFLEXCAN_NonCorrectableError
The memory error is non-correctable which means two bit errors.

enum _flexcan_memory_access_type
FlexCAN Memory Access Type.

Values:

enumerator kFLEXCAN_MoveOutFlexCanAccess
The memory error was detected during move-out FlexCAN access.

enumerator kFLEXCAN_MoveInAccess
The memory error was detected during move-in FlexCAN access.

enumerator kFLEXCAN_TxArbitrationAccess
The memory error was detected during Tx Arbitration FlexCAN access.

enumerator kFLEXCAN_RxMatchingAccess
The memory error was detected during Rx Matching FlexCAN access.

enumerator kFLEXCAN_MoveOutHostAccess
The memory error was detected during Rx Matching Host (CPU) access.

enum _flexcan_byte_error_syndrome
FlexCAN Memory Error Byte Syndrome.

Values:

enumerator kFLEXCAN_NoError
No bit error in this byte.

enumerator kFLEXCAN_ParityBits0Error
Parity bit 0 error in this byte.

enumerator kFLEXCAN_ParityBits1Error
Parity bit 1 error in this byte.

enumerator kFLEXCAN_ParityBits2Error
Parity bit 2 error in this byte.

enumerator kFLEXCAN_ParityBits3Error
Parity bit 3 error in this byte.

enumerator kFLEXCAN_ParityBits4Error
Parity bit 4 error in this byte.

enumerator kFLEXCAN_DataBits0Error
Data bit 0 error in this byte.

enumerator kFLEXCAN_DataBits1Error
Data bit 1 error in this byte.

enumerator kFLEXCAN_DataBits2Error
Data bit 2 error in this byte.

enumerator kFLEXCAN_DataBits3Error
Data bit 3 error in this byte.

enumerator kFLEXCAN_DataBits4Error
Data bit 4 error in this byte.

enumerator kFLEXCAN_DataBits5Error
Data bit 5 error in this byte.

enumerator kFLEXCAN_DataBits6Error
Data bit 6 error in this byte.

enumerator kFLEXCAN_DataBits7Error
Data bit 7 error in this byte.

enumerator kFLEXCAN_AllZeroError
All-zeros non-correctable error in this byte.

enumerator kFLEXCAN_AllOneError
All-ones non-correctable error in this byte.

enumerator kFLEXCAN_NonCorrectableErrors
Non-correctable error in this byte.

enum _flexcan_pn_match_source
FlexCAN Pretended Networking match source selection.

Values:

enumerator kFLEXCAN_PNMatSrcID
Message match with ID filtering.

enumerator kFLEXCAN_PNMatSrcIDAndData
Message match with ID filtering and payload filtering.

enum _flexcan_pn_match_mode
FlexCAN Pretended Networking mode match type.

Values:

enumerator kFLEXCAN_PNMatModeEqual
Match upon ID/Payload contents against an exact target value.

enumerator kFLEXCAN_PNMatModeGreater
Match upon an ID/Payload value greater than or equal to a specified target value.

enumerator kFLEXCAN_PNMatModeSmaller
Match upon an ID/Payload value smaller than or equal to a specified target value.

enumerator kFLEXCAN_PNMatModeRange
Match upon an ID/Payload value inside a range, greater than or equal to a specified lower limit, and smaller than or equal to a specified upper limit

typedef enum *_flexcan_frame_format* flexcan_frame_format_t
FlexCAN frame format.

typedef enum *_flexcan_frame_type* flexcan_frame_type_t
FlexCAN frame type.

typedef enum *_flexcan_clock_source* flexcan_clock_source_t
FlexCAN clock source.

Deprecated:
Do not use the kFLEXCAN_ClkSrcOs. It has been superceded kFLEXCAN_ClkSrc0

Do not use the kFLEXCAN_ClkSrcPeri. It has been superceded kFLEXCAN_ClkSrc1

typedef enum *_flexcan_wake_up_source* flexcan_wake_up_source_t
FlexCAN wake up source.

typedef enum *_flexcan_rx_fifo_filter_type* flexcan_rx_fifo_filter_type_t
FlexCAN Rx Fifo Filter type.

typedef enum *_flexcan_mb_size* flexcan_mb_size_t
FlexCAN Message Buffer Payload size.

typedef enum *_flexcan_rx_fifo_priority* flexcan_rx_fifo_priority_t

FlexCAN Enhanced/Legacy Rx FIFO priority.

The matching process starts from the Rx MB(or Enhanced/Legacy Rx FIFO) with higher priority. If no MB(or Enhanced/Legacy Rx FIFO filter) is satisfied, the matching process goes on with the Enhanced/Legacy Rx FIFO(or Rx MB) with lower priority.

typedef enum *_flexcan_memory_error_type* flexcan_memory_error_type_t

FlexCAN Memory Error Type.

typedef enum *_flexcan_memory_access_type* flexcan_memory_access_type_t

FlexCAN Memory Access Type.

typedef enum *_flexcan_byte_error_syndrome* flexcan_byte_error_syndrome_t

FlexCAN Memory Error Byte Syndrome.

typedef struct *_flexcan_memory_error_report_status* flexcan_memory_error_report_status_t

FlexCAN memory error register status structure.

This structure contains the memory access properties that caused a memory error access. It is used as the parameter of FLEXCAN_GetMemoryErrorReportStatus() function. And user can use FLEXCAN_GetMemoryErrorReportStatus to get the status of the last memory error access.

typedef struct *_flexcan_frame* flexcan_frame_t

FlexCAN message frame structure.

typedef struct *_flexcan_fd_frame* flexcan_fd_frame_t

CAN FD message frame structure.

The CAN FD message supporting up to sixty four bytes can be used for a data frame, depending on the length selected for the message buffers. The length should be a enumeration member, see _flexcan_fd_frame_length.

typedef struct *_flexcan_timing_config* flexcan_timing_config_t

FlexCAN protocol timing characteristic configuration structure.

typedef struct *_flexcan_config* flexcan_config_t

FlexCAN module configuration structure.

Deprecated:

Do not use the baudRate. It has been superceded bitRate

Do not use the baudRateFD. It has been superceded bitRateFD

typedef struct *_flexcan_rx_mb_config* flexcan_rx_mb_config_t

FlexCAN Receive Message Buffer configuration structure.

This structure is used as the parameter of FLEXCAN_SetRxMbConfig() function. The FLEXCAN_SetRxMbConfig() function is used to configure FlexCAN Receive Message Buffer. The function abort previous receiving process, clean the Message Buffer and activate the Rx Message Buffer using given Message Buffer setting.

typedef enum *_flexcan_pn_match_source* flexcan_pn_match_source_t

FlexCAN Pretended Networking match source selection.

typedef enum *_flexcan_pn_match_mode* flexcan_pn_match_mode_t

FlexCAN Pretended Networking mode match type.

typedef struct *_flexcan_pn_config* flexcan_pn_config_t

FlexCAN Pretended Networking configuration structure.

This structure is used as the parameter of FLEXCAN_SetPNConfig() function. The FLEXCAN_SetPNConfig() function is used to configure FlexCAN Networking work mode.

typedef struct *_flexcan_rx_fifo_config* flexcan_rx_fifo_config_t

FlexCAN Legacy Rx FIFO configuration structure.

typedef struct *_flexcan_mb_transfer* flexcan_mb_transfer_t

FlexCAN Message Buffer transfer.

typedef struct *_flexcan_fifo_transfer* flexcan_fifo_transfer_t

FlexCAN Rx FIFO transfer.

typedef struct *_flexcan_handle* flexcan_handle_t

FlexCAN handle structure definition.

typedef void (*flexcan_transfer_callback_t)(CAN_Type *base, *flexcan_handle_t* *handle, *status_t* status, uint64_t result, void *userData)

FLEXCAN_WAIT_TIMEOUT

DLC_LENGTH_DECODE(dlc)

FlexCAN frame length helper macro.

FLEXCAN_ID_STD(id)

FlexCAN Frame ID helper macro.

Standard Frame ID helper macro.

FLEXCAN_ID_EXT(id)

Extend Frame ID helper macro.

FLEXCAN_RX_MB_STD_MASK(id, rtr, ide)

FlexCAN Rx Message Buffer Mask helper macro.

Standard Rx Message Buffer Mask helper macro.

FLEXCAN_RX_MB_EXT_MASK(id, rtr, ide)

Extend Rx Message Buffer Mask helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(id, rtr, ide)

FlexCAN Legacy Rx FIFO Mask helper macro.

Standard Rx FIFO Mask helper macro Type A helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH(id, rtr, ide)

Standard Rx FIFO Mask helper macro Type B upper part helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW(id, rtr, ide)

Standard Rx FIFO Mask helper macro Type B lower part helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(id)

Standard Rx FIFO Mask helper macro Type C upper part helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(id)

Standard Rx FIFO Mask helper macro Type C mid-upper part helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(id)

Standard Rx FIFO Mask helper macro Type C mid-lower part helper macro.

FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(id)

Standard Rx FIFO Mask helper macro Type C lower part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)
Extend Rx FIFO Mask helper macro Type A helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(id, rtr, ide)
Extend Rx FIFO Mask helper macro Type B upper part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(id, rtr, ide)
Extend Rx FIFO Mask helper macro Type B lower part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(id)
Extend Rx FIFO Mask helper macro Type C upper part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(id)
Extend Rx FIFO Mask helper macro Type C mid-upper part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(id)
Extend Rx FIFO Mask helper macro Type C mid-lower part helper macro.

FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)
Extend Rx FIFO Mask helper macro Type C lower part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_A(id, rtr, ide)
FlexCAN Rx FIFO Filter helper macro.

Standard Rx FIFO Filter helper macro Type A helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_HIGH(id, rtr, ide)
Standard Rx FIFO Filter helper macro Type B upper part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_LOW(id, rtr, ide)
Standard Rx FIFO Filter helper macro Type B lower part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_HIGH(id)
Standard Rx FIFO Filter helper macro Type C upper part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_HIGH(id)
Standard Rx FIFO Filter helper macro Type C mid-upper part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_LOW(id)
Standard Rx FIFO Filter helper macro Type C mid-lower part helper macro.

FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_LOW(id)
Standard Rx FIFO Filter helper macro Type C lower part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_A(id, rtr, ide)
Extend Rx FIFO Filter helper macro Type A helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_HIGH(id, rtr, ide)
Extend Rx FIFO Filter helper macro Type B upper part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_LOW(id, rtr, ide)
Extend Rx FIFO Filter helper macro Type B lower part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_HIGH(id)
Extend Rx FIFO Filter helper macro Type C upper part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_HIGH(id)
Extend Rx FIFO Filter helper macro Type C mid-upper part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_LOW(id)
Extend Rx FIFO Filter helper macro Type C mid-lower part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_LOW(id)

Extend Rx FIFO Filter helper macro Type C lower part helper macro.

FLEXCAN_PN_STD_MASK(id, rtr)

FlexCAN Pretended Networking ID Mask helper macro.

Standard Rx Message Buffer Mask helper macro.

FLEXCAN_PN_EXT_MASK(id, rtr)

Extend Rx Message Buffer Mask helper macro.

FLEXCAN_PN_INT_MASK(x)

FlexCAN interrupt/status flag helper macro.

FLEXCAN_PN_INT_UNMASK(x)

FLEXCAN_PN_STATUS_MASK(x)

FLEXCAN_PN_STATUS_UNMASK(x)

FLEXCAN_MECR_INT_MASK(x)

FLEXCAN_MECR_INT_UNMASK(x)

FLEXCAN_MECR_STATUS_MASK(x)

FLEXCAN_MECR_STATUS_UNMASK(x)

FLEXCAN_ERROR_AND_STATUS_INT_FLAG

FLEXCAN_PNWAKE_UP_FLAG

FLEXCAN_WAKE_UP_FLAG

FLEXCAN_MEMORY_ERROR_INT_FLAG

FLEXCAN_MEMORY_ENHANCED_RX_FIFO_INT_FLAG

FlexCAN Enhanced Rx FIFO base address helper macro.

FLEXCAN_CALLBACK(x)

FlexCAN transfer callback function.

The FlexCAN transfer callback returns a value from the underlying layer. If the status equals to kStatus_FLEXCAN_ErrorStatus, the result parameter is the Content of FlexCAN status register which can be used to get the working status(or error status) of FlexCAN module. If the status equals to other FlexCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other FlexCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

struct _flexcan_memory_error_report_status

#include <fsl_flexcan.h> FlexCAN memory error register status structure.

This structure contains the memory access properties that caused a memory error access. It is used as the parameter of FLEXCAN_GetMemoryErrorReportStatus() function. And user can use FLEXCAN_GetMemoryErrorReportStatus to get the status of the last memory error access.

Public Members

flexcan_memory_error_type_t errorType

The type of memory error that giving rise to the report.

flexcan_memory_access_type_t accessType
The type of memory access that giving rise to the memory error.

uint16_t accessAddress
The address where memory error detected.

uint32_t errorData
The raw data word read from memory with error.

struct _flexcan_frame
#include <fsl_flexcan.h> FlexCAN message frame structure.

struct _flexcan_fd_frame
#include <fsl_flexcan.h> CAN FD message frame structure.

The CAN FD message supporting up to sixty four bytes can be used for a data frame, depending on the length selected for the message buffers. The length should be a enumeration member, see _flexcan_fd_frame_length.

struct _flexcan_timing_config
#include <fsl_flexcan.h> FlexCAN protocol timing characteristic configuration structure.

Public Members

uint16_t preDivider
Classic CAN or CAN FD nominal phase bit rate prescaler.

uint8_t rJumpwidth
Classic CAN or CAN FD nominal phase Re-sync Jump Width.

uint8_t phaseSeg1
Classic CAN or CAN FD nominal phase Segment 1.

uint8_t phaseSeg2
Classic CAN or CAN FD nominal phase Segment 2.

uint8_t propSeg
Classic CAN or CAN FD nominal phase Propagation Segment.

uint16_t fpreDivider
CAN FD data phase bit rate prescaler.

uint8_t frJumpwidth
CAN FD data phase Re-sync Jump Width.

uint8_t fphaseSeg1
CAN FD data phase Phase Segment 1.

uint8_t fphaseSeg2
CAN FD data phase Phase Segment 2.

uint8_t fpropSeg
CAN FD data phase Propagation Segment.

struct _flexcan_config
#include <fsl_flexcan.h> FlexCAN module configuration structure.

Deprecated:
Do not use the baudRate. It has been superceded bitRate

Do not use the baudRateFD. It has been superceded bitRateFD

Public Members

flexcan_clock_source_t clkSrc

Clock source for FlexCAN Protocol Engine.

flexcan_wake_up_source_t wakeupSrc

Wake up source selection.

uint8_t maxMbNum

The maximum number of Message Buffers used by user.

bool enableLoopBack

Enable or Disable Loop Back Self Test Mode.

bool enableTimerSync

Enable or Disable Timer Synchronization.

bool enableSelfWakeup

Enable or Disable Self Wakeup Mode.

bool enableIndividMask

Enable or Disable Rx Individual Mask and Queue feature.

bool disableSelfReception

Enable or Disable Self Reflection.

bool enableListenOnlyMode

Enable or Disable Listen Only Mode.

bool enableDoze

Enable or Disable Doze Mode.

bool enablePretendedeNetworking

Enable or Disable the Pretended Networking mode.

bool enableMemoryErrorControl

Enable or Disable the memory errors detection and correction mechanism.

bool enableNonCorrectableErrorEnterFreeze

Enable or Disable Non-Correctable Errors In FlexCAN Access Put Device In Freeze Mode.

bool enableTransceiverDelayMeasure

Enable or Disable the transceiver delay measurement, when it is enabled, then the secondary sample point position is determined by the sum of the transceiver delay measurement plus the enhanced TDC offset.

bool enableRemoteRequestFrameStored

true: Store Remote Request Frame in the same fashion of data frame. false: Generate an automatic Remote Response Frame.

struct __flexcan__rx__mb__config

#include <fsl_flexcan.h> FlexCAN Receive Message Buffer configuration structure.

This structure is used as the parameter of FLEXCAN_SetRxMbConfig() function. The FLEXCAN_SetRxMbConfig() function is used to configure FlexCAN Receive Message Buffer. The function abort previous receiving process, clean the Message Buffer and activate the Rx Message Buffer using given Message Buffer setting.

Public Members

uint32_t id

CAN Message Buffer Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD() macro.

flexcan_frame_format_t format

CAN Frame Identifier format(Standard of Extend).

flexcan_frame_type_t type

CAN Frame Type(Data or Remote).

struct __flexcan__pn__config

#include <fsl_flexcan.h> FlexCAN Pretended Networking configuration structure.

This structure is used as the parameter of FLEXCAN_SetPNConfig() function. The FLEXCAN_SetPNConfig() function is used to configure FlexCAN Networking work mode.

Public Members

bool enableTimeout

Enable or Disable timeout event trigger wakeup.

uint16_t timeoutValue

The timeout value that generates a wakeup event, the counter timer is incremented based on 64 times the CAN Bit Time unit.

bool enableMatch

Enable or Disable match event trigger wakeup.

flexcan_pn_match_source_t matchSrc

Selects the match source (ID and/or data match) to trigger wakeup.

uint8_t matchNum

The number of times a given message must match the predefined ID and/or data before generating a wakeup event, range in 0x1 ~ 0xFF.

flexcan_pn_match_mode_t idMatchMode

The ID match type.

flexcan_pn_match_mode_t dataMatchMode

The data match type.

uint32_t idLower

The ID target values 1 which used either for ID match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in ID match “range detection”.

uint32_t idUpper

The ID target values 2 which used only as the upper limit value in ID match “range detection” or used to store the ID mask in “equal to”.

uint8_t lengthLower

The lower limit for length of data bytes which used only in data match “range detection”. Range in 0x0 ~ 0x8.

uint8_t lengthUpper

The upper limit for length of data bytes which used only in data match “range detection”. Range in 0x0 ~ 0x8.

struct _flexcan_rx_fifo_config

#include <fsl_flexcan.h> FlexCAN Legacy Rx FIFO configuration structure.

Public Members

uint32_t *idFilterTable

Pointer to the FlexCAN Legacy Rx FIFO identifier filter table.

uint8_t idFilterNum

The FlexCAN Legacy Rx FIFO Filter elements quantity.

flexcan_rx_fifo_filter_type_t idFilterType

The FlexCAN Legacy Rx FIFO Filter type.

flexcan_rx_fifo_priority_t priority

The FlexCAN Legacy Rx FIFO receive priority.

struct _flexcan_mb_transfer

#include <fsl_flexcan.h> FlexCAN Message Buffer transfer.

Public Members

flexcan_frame_t *frame

The buffer of CAN Message to be transfer.

uint8_t mbIdx

The index of Message buffer used to transfer Message.

struct _flexcan_fifo_transfer

#include <fsl_flexcan.h> FlexCAN Rx FIFO transfer.

Public Members

flexcan_frame_t *frame

The buffer of CAN Message to be received from Legacy Rx FIFO.

size_t frameNum

Number of CAN Message need to be received from Legacy or Ehanced Rx FIFO.

struct _flexcan_handle

#include <fsl_flexcan.h> FlexCAN handle structure.

Public Members

flexcan_transfer_callback_t callback

Callback function.

void *userData

FlexCAN callback function parameter.

flexcan_frame_t *volatile mbFrameBuf[CAN_WORD1_COUNT]

The buffer for received CAN data from Message Buffers.

flexcan_fd_frame_t *volatile mbFDFrameBuf[CAN_WORD1_COUNT]

The buffer for received CAN FD data from Message Buffers.

flexcan_frame_t *volatile rxFifoFrameBuf
The buffer for received CAN data from Legacy Rx FIFO.

size_t rxFifoFrameNum
The number of CAN messages remaining to be received from Legacy or Ehanced Rx FIFO.

size_t rxFifoTransferTotalNum
Total CAN Message number need to be received from Legacy or Ehanced Rx FIFO.

volatile uint8_t mbState[CAN_WORD1_COUNT]
Message Buffer transfer state.

volatile uint8_t rxFifoState
Rx FIFO transfer state.

volatile uint32_t timestamp[CAN_WORD1_COUNT]
Mailbox transfer timestamp.

struct byteStatus

Public Members

bool byteIsRead
The byte n (0~3) was read or not. The type of error and which bit in byte (n) is affected by the error.

struct ___unnamed33___

Public Members

uint32_t timestamp
FlexCAN internal Free-Running Counter Time Stamp.

uint32_t length
CAN frame data length in bytes (Range: 0~8).

uint32_t type
CAN Frame Type(DATA or REMOTE).

uint32_t format
CAN Frame Identifier(STD or EXT format).

uint32_t ___pad0___
Reserved.

uint32_t idhit
CAN Rx FIFO filter hit id(This value is only used in Rx FIFO receive mode).

struct ___unnamed35___

Public Members

uint32_t id
CAN Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD() macro.

uint32_t ___pad0___
Reserved.

union ___unnamed37___

Public Members

struct _flexcan_frame

struct _flexcan_frame

struct ___unnamed39___

Public Members

uint32_t dataWord0
CAN Frame payload word0.

uint32_t dataWord1
CAN Frame payload word1.

struct ___unnamed41___

Public Members

uint8_t dataByte3
CAN Frame payload byte3.

uint8_t dataByte2
CAN Frame payload byte2.

uint8_t dataByte1
CAN Frame payload byte1.

uint8_t dataByte0
CAN Frame payload byte0.

uint8_t dataByte7
CAN Frame payload byte7.

uint8_t dataByte6
CAN Frame payload byte6.

uint8_t dataByte5
CAN Frame payload byte5.

uint8_t dataByte4
CAN Frame payload byte4.

struct ___unnamed43___

Public Members

uint32_t timestamp
FlexCAN internal Free-Running Counter Time Stamp.

uint32_t length
CAN FD frame data length code (DLC), range see _flexcan_fd_frame_length, When the length <= 8, it equal to the data length, otherwise the number of valid frame data is not equal to the length value. user can use DLC_LENGTH_DECODE(length) macro to get the number of valid data bytes.

uint32_t type
CAN Frame Type(DATA or REMOTE).

uint32_t format
: CAN Frame Identifier(STD or EXT format).

uint32_t srr
: Substitute Remote request.

uint32_t esi
: Error State Indicator.

uint32_t brs
: Bit Rate Switch.

uint32_t edl
: Extended Data Length.

struct ___unnamed45___

Public Members

uint32_t id
: CAN Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD() macro.

uint32_t ___pad0___
: Reserved.

union ___unnamed47___

Public Members

struct _flexcan_fd_frame

struct _flexcan_fd_frame

struct ___unnamed49___

Public Members

uint32_t dataWord[16]
: CAN FD Frame payload, 16 double word maximum.

struct ___unnamed51___

Public Members

uint8_t dataByte3
: CAN Frame payload byte3.

uint8_t dataByte2
: CAN Frame payload byte2.

uint8_t dataByte1
: CAN Frame payload byte1.

uint8_t dataByte0
: CAN Frame payload byte0.

uint8_t dataByte7
CAN Frame payload byte7.

uint8_t dataByte6
CAN Frame payload byte6.

uint8_t dataByte5
CAN Frame payload byte5.

uint8_t dataByte4
CAN Frame payload byte4.

union ___unnamed53___

Public Members

struct __flexcan__config

struct __flexcan__config

struct ___unnamed55___

Public Members

uint32_t baudRate
FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.

uint32_t baudRateFD
FlexCAN FD bit rate in bps, for CANFD data phase.

struct ___unnamed57___

Public Members

uint32_t bitRate
FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.

uint32_t bitRateFD
FlexCAN FD bit rate in bps, for CANFD data phase.

union ___unnamed59___

Public Members

struct __flexcan__pn__config

< The data target values 1 which used either for data match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in data match “range

detection”.

struct __flexcan__pn__config

struct ___unnamed63___

< The data target values 1 which used either for data match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in data match “range

detection”.

Public Members

uint32_t lowerWord0
: CAN Frame payload word0.

uint32_t lowerWord1
: CAN Frame payload word1.

struct ___unnamed65___

Public Members

uint8_t lowerByte3
: CAN Frame payload byte3.

uint8_t lowerByte2
: CAN Frame payload byte2.

uint8_t lowerByte1
: CAN Frame payload byte1.

uint8_t lowerByte0
: CAN Frame payload byte0.

uint8_t lowerByte7
: CAN Frame payload byte7.

uint8_t lowerByte6
: CAN Frame payload byte6.

uint8_t lowerByte5
: CAN Frame payload byte5.

uint8_t lowerByte4
: CAN Frame payload byte4.

union ___unnamed61___

Public Members

struct _flexcan_pn_config
: < The data target values 2 which used only as the upper limit value in data match “range

  detection” or used to store the data mask in “equal to”.

struct _flexcan_pn_config

struct ___unnamed67___

< The data target values 2 which used only as the upper limit value in data match “range detection” or used to store the data mask in “equal to”.

Public Members

uint32_t upperWord0
: CAN Frame payload word0.

uint32_t upperWord1
CAN Frame payload word1.

struct ___unnamed69___

Public Members

uint8_t upperByte3
CAN Frame payload byte3.

uint8_t upperByte2
CAN Frame payload byte2.

uint8_t upperByte1
CAN Frame payload byte1.

uint8_t upperByte0
CAN Frame payload byte0.

uint8_t upperByte7
CAN Frame payload byte7.

uint8_t upperByte6
CAN Frame payload byte6.

uint8_t upperByte5
CAN Frame payload byte5.

uint8_t upperByte4
CAN Frame payload byte4.

2.47 FlexCAN eDMA Driver

void FLEXCAN_TransferCreateHandleEDMA(CAN_Type *base, *flexcan_edma_handle_t* *handle, *flexcan_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *rxFifoEdmaHandle)

Initializes the FlexCAN handle, which is used in transactional functions.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- callback – The callback function.
- userData – The parameter of the callback function.
- rxFifoEdmaHandle – User-requested DMA handle for Rx FIFO DMA transfer.

void FLEXCAN_PrepareTransfConfiguration(CAN_Type *base, *flexcan_fifo_transfer_t* *pFifoXfer, *edma_transfer_config_t* *pEdmaConfig)

Prepares the eDMA transfer configuration for FLEXCAN Legacy RX FIFO.

This function prepares the eDMA transfer configuration structure according to FLEXCAN Legacy RX FIFO.

Parameters

- base – FlexCAN peripheral base address.

- pFifoXfer – FlexCAN Rx FIFO EDMA transfer structure, see flexcan_fifo_transfer_t.
- pEdmaConfig – The user configuration structure of type edma_transfer_t.

status_t FLEXCAN_StartTransferDatafromRxFIFO(CAN_Type *base, *flexcan_edma_handle_t* *handle, *edma_transfer_config_t* *pEdmaConfig)

Start Transfer Data from the FLEXCAN Legacy Rx FIFO using eDMA.

This function to Update edma transfer confiugration and Start eDMA transfer

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- pEdmaConfig – The user configuration structure of type edma_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXCAN_RxFifoBusy – Previous transfer ongoing.

status_t FLEXCAN_TransferReceiveFifoEDMA(CAN_Type *base, *flexcan_edma_handle_t* *handle, *flexcan_fifo_transfer_t* *pFifoXfer)

Receives the CAN Message from the Legacy Rx FIFO using eDMA.

This function receives the CAN Message using eDMA. This is a non-blocking function, which returns right away. After the CAN Message is received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- pFifoXfer – FlexCAN Rx FIFO EDMA transfer structure, see flexcan_fifo_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXCAN_RxFifoBusy – Previous transfer ongoing.

status_t FLEXCAN_TransferGetReceiveFifoCountEMDA(CAN_Type *base, *flexcan_edma_handle_t* *handle, size_t *count)

Gets the Legacy Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- count – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXCAN_TransferAbortReceiveFifoEDMA(CAN_Type *base, *flexcan_edma_handle_t* *handle)

Aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

This function aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.

FSL_FLEXCAN_EDMA_DRIVER_VERSION

FlexCAN EDMA driver version.

typedef struct *_flexcan_edma_handle* flexcan_edma_handle_t

typedef void (*flexcan_edma_transfer_callback_t)(CAN_Type *base, *flexcan_edma_handle_t* *handle, *status_t* status, void *userData)

FlexCAN transfer callback function.

struct _flexcan_edma_handle

#include <fsl_flexcan_edma.h> FlexCAN eDMA handle.

Public Members

flexcan_edma_transfer_callback_t callback

Callback function.

void *userData

FlexCAN callback function parameter.

edma_handle_t *rxFifoEdmaHandle

The EDMA handler for Rx FIFO.

volatile uint8_t rxFifoState

Rx FIFO transfer state.

size_t frameNum

The number of messages that need to be received.

2.48 FlexIO: FlexIO Driver

2.49 FlexIO Driver

void FLEXIO_GetDefaultConfig(*flexio_config_t* *userConfig)

Gets the default configuration to configure the FlexIO module. The configuration can used directly to call the FLEXIO_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

Parameters

- userConfig – pointer to flexio_config_t structure

void FLEXIO_Init(FLEXIO_Type *base, const *flexio_config_t* *userConfig)

Configures the FlexIO with a FlexIO configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO_GetDefaultConfig().

Example

```
flexio_config_t config = {
.enableFlexio = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false
};
FLEXIO_Configure(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- userConfig – pointer to flexio_config_t structure

void FLEXIO_Deinit(FLEXIO_Type *base)

Gates the FlexIO clock. Call this API to stop the FlexIO clock.

Note: After calling this API, call the FLEXO_Init to use the FlexIO module.

Parameters

- base – FlexIO peripheral base address

uint32_t FLEXIO_GetInstance(FLEXIO_Type *base)

Get instance number for FLEXIO module.

Parameters

- base – FLEXIO peripheral base address.

void FLEXIO_Reset(FLEXIO_Type *base)

Resets the FlexIO module.

Parameters

- base – FlexIO peripheral base address

static inline void FLEXIO_Enable(FLEXIO_Type *base, bool enable)

Enables the FlexIO module operation.

Parameters

- base – FlexIO peripheral base address
- enable – true to enable, false to disable.

static inline uint32_t FLEXIO_ReadPinInput(FLEXIO_Type *base)

Reads the input data on each of the FlexIO pins.

Parameters

- base – FlexIO peripheral base address

Returns

FlexIO pin input data

static inline uint8_t FLEXIO_GetShifterState(FLEXIO_Type *base)

Gets the current state pointer for state mode use.

Parameters

- base – FlexIO peripheral base address

Returns

current State pointer

void FLEXIO_SetShifterConfig(FLEXIO_Type *base, uint8_t index, const *flexio_shifter_config_t* *shifterConfig)

Configures the shifter with the shifter configuration. The configuration structure covers both the SHIFTCTL and SHIFTCFG registers. To configure the shifter to the proper mode, select which timer controls the shifter to shift, whether to generate start bit/stop bit, and the polarity of start bit and stop bit.

Example

```
flexio_shifter_config_t config = {
.timerSelect = 0,
.timerPolarity = kFLEXIO_ShifterTimerPolarityOnPositive,
.pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
.pinPolarity = kFLEXIO_PinActiveLow,
.shifterMode = kFLEXIO_ShifterModeTransmit,
.inputSource = kFLEXIO_ShifterInputFromPin,
.shifterStop = kFLEXIO_ShifterStopBitHigh,
.shifterStart = kFLEXIO_ShifterStartBitLow
};
FLEXIO_SetShifterConfig(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- index – Shifter index
- shifterConfig – Pointer to flexio_shifter_config_t structure

void FLEXIO_SetTimerConfig(FLEXIO_Type *base, uint8_t index, const *flexio_timer_config_t* *timerConfig)

Configures the timer with the timer configuration. The configuration structure covers both the TIMCTL and TIMCFG registers. To configure the timer to the proper mode, select trigger source for timer and the timer pin output and the timing for timer.

Example

```
flexio_timer_config_t config = {
.triggerSelect = FLEXIO_TIMER_TRIGGER_SEL_SHIFTnSTAT(0),
.triggerPolarity = kFLEXIO_TimerTriggerPolarityActiveLow,
.triggerSource = kFLEXIO_TimerTriggerSourceInternal,
.pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
.pinSelect = 0,
.pinPolarity = kFLEXIO_PinActiveHigh,
.timerMode = kFLEXIO_TimerModeDual8BitBaudBit,
.timerOutput = kFLEXIO_TimerOutputZeroNotAffectedByReset,
.timerDecrement = kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput,
.timerReset = kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput,
.timerDisable = kFLEXIO_TimerDisableOnTimerCompare,
.timerEnable = kFLEXIO_TimerEnableOnTriggerHigh,
.timerStop = kFLEXIO_TimerStopBitEnableOnTimerDisable,
.timerStart = kFLEXIO_TimerStartBitEnabled
};
FLEXIO_SetTimerConfig(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- index – Timer index
- timerConfig – Pointer to the flexio_timer_config_t structure

static inline void FLEXIO_SetClockMode(FLEXIO_Type *base, uint8_t index, *flexio_timer_decrement_source_t* clocksource)

This function set the value of the prescaler on flexio channels.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.
- index – Timer index
- clocksource – Set clock value

static inline void FLEXIO_EnableShifterStatusInterrupts(FLEXIO_Type *base, uint32_t mask)

Enables the shifter status interrupt. The interrupt generates when the corresponding SSF is set.

Note: For multiple shifter status interrupt enable, for example, two shifter status enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)

static inline void FLEXIO_DisableShifterStatusInterrupts(FLEXIO_Type *base, uint32_t mask)

Disables the shifter status interrupt. The interrupt won't generate when the corresponding SSF is set.

Note: For multiple shifter status interrupt enable, for example, two shifter status enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)

static inline void FLEXIO_EnableShifterErrorInterrupts(FLEXIO_Type *base, uint32_t mask)

Enables the shifter error interrupt. The interrupt generates when the corresponding SEF is set.

Note: For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by (1 « shifter index)

static inline void FLEXIO_DisableShifterErrorInterrupts(FLEXIO_Type *base, uint32_t mask)

Disables the shifter error interrupt. The interrupt won't generate when the corresponding SEF is set.

Note: For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by (1 « shifter index)

static inline void FLEXIO_EnableTimerStatusInterrupts(FLEXIO_Type *base, uint32_t mask)

Enables the timer status interrupt. The interrupt generates when the corresponding SSF is set.

Note: For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using ((1 « timer index0) | (1 « timer index1))

Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by (1 « timer index)

static inline void FLEXIO_DisableTimerStatusInterrupts(FLEXIO_Type *base, uint32_t mask)

Disables the timer status interrupt. The interrupt won't generate when the corresponding SSF is set.

Note: For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using ((1 « timer index0) | (1 « timer index1))

Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by (1 « timer index)

static inline uint32_t FLEXIO_GetShifterStatusFlags(FLEXIO_Type *base)

Gets the shifter status flags.

Parameters

- base – FlexIO peripheral base address

Returns

Shifter status flags

static inline void FLEXIO_ClearShifterStatusFlags(FLEXIO_Type *base, uint32_t mask)

Clears the shifter status flags.

Note: For clearing multiple shifter status flags, for example, two shifter status flags, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address

- mask – The shifter status mask which can be calculated by (1 « shifter index)

static inline uint32_t FLEXIO_GetShifterErrorFlags(FLEXIO_Type *base)

Gets the shifter error flags.

Parameters

- base – FlexIO peripheral base address

Returns

Shifter error flags

static inline void FLEXIO_ClearShifterErrorFlags(FLEXIO_Type *base, uint32_t mask)

Clears the shifter error flags.

Note: For clearing multiple shifter error flags, for example, two shifter error flags, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by (1 « shifter index)

static inline uint32_t FLEXIO_GetTimerStatusFlags(FLEXIO_Type *base)

Gets the timer status flags.

Parameters

- base – FlexIO peripheral base address

Returns

Timer status flags

static inline void FLEXIO_ClearTimerStatusFlags(FLEXIO_Type *base, uint32_t mask)

Clears the timer status flags.

Note: For clearing multiple timer status flags, for example, two timer status flags, can calculate the mask by using ((1 « timer index0) | (1 « timer index1))

Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by (1 « timer index)

static inline void FLEXIO_EnableShifterStatusDMA(FLEXIO_Type *base, uint32_t mask, bool enable)

Enables/disables the shifter status DMA. The DMA request generates when the corresponding SSF is set.

Note: For multiple shifter status DMA enables, for example, calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)

- enable – True to enable, false to disable.

uint32_t FLEXIO_GetShifterBufferAddress(FLEXIO_Type *base, *flexio_shifter_buffer_type_t* type, uint8_t index)

Gets the shifter buffer address for the DMA transfer usage.

Parameters

- base – FlexIO peripheral base address
- type – Shifter type of flexio_shifter_buffer_type_t
- index – Shifter index

Returns

Corresponding shifter buffer index

status_t FLEXIO_RegisterHandleIRQ(void *base, void *handle, *flexio_isr_t* isr)

Registers the handle and the interrupt handler for the FlexIO-simulated peripheral.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.
- handle – Pointer to the handler for FlexIO simulated peripheral.
- isr – FlexIO simulated peripheral interrupt handler.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_UnregisterHandleIRQ(void *base)

Unregisters the handle and the interrupt handler for the FlexIO-simulated peripheral.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

static inline void FLEXIO_ClearPortOutput(FLEXIO_Type *base, uint32_t mask)

Sets the output level of the multiple FLEXIO pins to the logic 0.

Parameters

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO_SetPortOutput(FLEXIO_Type *base, uint32_t mask)

Sets the output level of the multiple FLEXIO pins to the logic 1.

Parameters

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO_TogglePortOutput(FLEXIO_Type *base, uint32_t mask)

Reverses the current output logic of the multiple FLEXIO pins.

Parameters

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO_PinWrite(FLEXIO_Type *base, uint32_t pin, uint8_t output)

Sets the output level of the FLEXIO pins to the logic 1 or 0.

Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.
- output – FLEXIO pin output logic level.
  - 0: corresponding pin output low-logic level.
  - 1: corresponding pin output high-logic level.

static inline void FLEXIO_EnablePinOutput(FLEXIO_Type *base, uint32_t pin)

Enables the FLEXIO output pin function.

Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

static inline uint32_t FLEXIO_PinRead(FLEXIO_Type *base, uint32_t pin)

Reads the current input value of the FLEXIO pin.

Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

Return values

FLEXIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

static inline uint32_t FLEXIO_GetPinStatus(FLEXIO_Type *base, uint32_t pin)

Gets the FLEXIO input pin status.

Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

Return values

FLEXIO – port input status

- 0: corresponding pin input capture no status.
- 1: corresponding pin input capture rising or falling edge.

static inline void FLEXIO_SetPinLevel(FLEXIO_Type *base, uint8_t pin, bool level)

Sets the FLEXIO output pin level.

Parameters

- base – FlexIO peripheral base address
- pin – FlexIO pin number.
- level – FlexIO output pin level to set, can be either 0 or 1.

static inline bool FLEXIO_GetPinOverride(const FLEXIO_Type *const base, uint8_t pin)

Gets the enabled status of a FLEXIO output pin.

Parameters

- base – FlexIO peripheral base address

- pin – FlexIO pin number.

Return values

FlexIO – port enabled status

- 0: corresponding output pin is in disabled state.
- 1: corresponding output pin is in enabled state.

static inline void FLEXIO_ConfigPinOverride(FLEXIO_Type *base, uint8_t pin, bool enabled)

Enables or disables a FLEXIO output pin.

Parameters

- base – FlexIO peripheral base address
- pin – Flexio pin number.
- enabled – Enable or disable the FlexIO pin.

static inline void FLEXIO_ClearPortStatus(FLEXIO_Type *base, uint32_t mask)

Clears the multiple FLEXIO input pins status.

Parameters

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

FSL_FLEXIO_DRIVER_VERSION

FlexIO driver version.

enum _flexio_timer_trigger_polarity

Define time of timer trigger polarity.

Values:

enumerator kFLEXIO_TimerTriggerPolarityActiveHigh

Active high.

enumerator kFLEXIO_TimerTriggerPolarityActiveLow

Active low.

enum _flexio_timer_trigger_source

Define type of timer trigger source.

Values:

enumerator kFLEXIO_TimerTriggerSourceExternal

External trigger selected.

enumerator kFLEXIO_TimerTriggerSourceInternal

Internal trigger selected.

enum _flexio_pin_config

Define type of timer/shifter pin configuration.

Values:

enumerator kFLEXIO_PinConfigOutputDisabled

Pin output disabled.

enumerator kFLEXIO_PinConfigOpenDrainOrBidirection

Pin open drain or bidirectional output enable.

enumerator kFLEXIO_PinConfigBidirectionOutputData

Pin bidirectional output data.

enumerator kFLEXIO_PinConfigOutput
Pin output.

enum _flexio_pin_polarity
Definition of pin polarity.

Values:

enumerator kFLEXIO_PinActiveHigh
Active high.

enumerator kFLEXIO_PinActiveLow
Active low.

enum _flexio_timer_mode
Define type of timer work mode.

Values:

enumerator kFLEXIO_TimerModeDisabled
Timer Disabled.

enumerator kFLEXIO_TimerModeDual8BitBaudBit
Dual 8-bit counters baud/bit mode.

enumerator kFLEXIO_TimerModeDual8BitPWM
Dual 8-bit counters PWM mode.

enumerator kFLEXIO_TimerModeSingle16Bit
Single 16-bit counter mode.

enumerator kFLEXIO_TimerModeDual8BitPWMLow
Dual 8-bit counters PWM Low mode.

enum _flexio_timer_output
Define type of timer initial output or timer reset condition.

Values:

enumerator kFLEXIO_TimerOutputOneNotAffectedByReset
Logic one when enabled and is not affected by timer reset.

enumerator kFLEXIO_TimerOutputZeroNotAffectedByReset
Logic zero when enabled and is not affected by timer reset.

enumerator kFLEXIO_TimerOutputOneAffectedByReset
Logic one when enabled and on timer reset.

enumerator kFLEXIO_TimerOutputZeroAffectedByReset
Logic zero when enabled and on timer reset.

enum _flexio_timer_decrement_source
Define type of timer decrement.

Values:

enumerator kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput
Decrement counter on FlexIO clock, Shift clock equals Timer output.

enumerator kFLEXIO_TimerDecSrcOnTriggerInputShiftTimerOutput
Decrement counter on Trigger input (both edges), Shift clock equals Timer output.

enumerator kFLEXIO_TimerDecSrcOnPinInputShiftPinInput
Decrement counter on Pin input (both edges), Shift clock equals Pin input.

enumerator kFLEXIO_TimerDecSrcOnTriggerInputShiftTriggerInput
Decrement counter on Trigger input (both edges), Shift clock equals Trigger input.

enum _flexio_timer_reset_condition
Define type of timer reset condition.

Values:

enumerator kFLEXIO_TimerResetNever
Timer never reset.

enumerator kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput
Timer reset on Timer Pin equal to Timer Output.

enumerator kFLEXIO_TimerResetOnTimerTriggerEqualToTimerOutput
Timer reset on Timer Trigger equal to Timer Output.

enumerator kFLEXIO_TimerResetOnTimerPinRisingEdge
Timer reset on Timer Pin rising edge.

enumerator kFLEXIO_TimerResetOnTimerTriggerRisingEdge
Timer reset on Trigger rising edge.

enumerator kFLEXIO_TimerResetOnTimerTriggerBothEdge
Timer reset on Trigger rising or falling edge.

enum _flexio_timer_disable_condition
Define type of timer disable condition.

Values:

enumerator kFLEXIO_TimerDisableNever
Timer never disabled.

enumerator kFLEXIO_TimerDisableOnPreTimerDisable
Timer disabled on Timer N-1 disable.

enumerator kFLEXIO_TimerDisableOnTimerCompare
Timer disabled on Timer compare.

enumerator kFLEXIO_TimerDisableOnTimerCompareTriggerLow
Timer disabled on Timer compare and Trigger Low.

enumerator kFLEXIO_TimerDisableOnPinBothEdge
Timer disabled on Pin rising or falling edge.

enumerator kFLEXIO_TimerDisableOnPinBothEdgeTriggerHigh
Timer disabled on Pin rising or falling edge provided Trigger is high.

enumerator kFLEXIO_TimerDisableOnTriggerFallingEdge
Timer disabled on Trigger falling edge.

enum _flexio_timer_enable_condition
Define type of timer enable condition.

Values:

enumerator kFLEXIO_TimerEnabledAlways
Timer always enabled.

enumerator kFLEXIO_TimerEnableOnPrevTimerEnable
Timer enabled on Timer N-1 enable.

enumerator kFLEXIO_TimerEnableOnTriggerHigh
Timer enabled on Trigger high.

enumerator kFLEXIO_TimerEnableOnTriggerHighPinHigh
Timer enabled on Trigger high and Pin high.

enumerator kFLEXIO_TimerEnableOnPinRisingEdge
Timer enabled on Pin rising edge.

enumerator kFLEXIO_TimerEnableOnPinRisingEdgeTriggerHigh
Timer enabled on Pin rising edge and Trigger high.

enumerator kFLEXIO_TimerEnableOnTriggerRisingEdge
Timer enabled on Trigger rising edge.

enumerator kFLEXIO_TimerEnableOnTriggerBothEdge
Timer enabled on Trigger rising or falling edge.

enum _flexio_timer_stop_bit_condition
Define type of timer stop bit generate condition.

Values:

enumerator kFLEXIO_TimerStopBitDisabled
Stop bit disabled.

enumerator kFLEXIO_TimerStopBitEnableOnTimerCompare
Stop bit is enabled on timer compare.

enumerator kFLEXIO_TimerStopBitEnableOnTimerDisable
Stop bit is enabled on timer disable.

enumerator kFLEXIO_TimerStopBitEnableOnTimerCompareDisable
Stop bit is enabled on timer compare and timer disable.

enum _flexio_timer_start_bit_condition
Define type of timer start bit generate condition.

Values:

enumerator kFLEXIO_TimerStartBitDisabled
Start bit disabled.

enumerator kFLEXIO_TimerStartBitEnabled
Start bit enabled.

enum _flexio_timer_output_state
FlexIO as PWM channel output state.

Values:

enumerator kFLEXIO_PwmLow
The output state of PWM channel is low

enumerator kFLEXIO_PwmHigh
The output state of PWM channel is high

enum _flexio_shifter_timer_polarity
Define type of timer polarity for shifter control.

Values:

enumerator kFLEXIO_ShifterTimerPolarityOnPositive
Shift on positive edge of shift clock.

enumerator kFLEXIO_ShifterTimerPolarityOnNegitive
Shift on negative edge of shift clock.

enum _flexio_shifter_mode
Define type of shifter working mode.

Values:

enumerator kFLEXIO_ShifterDisabled
Shifter is disabled.

enumerator kFLEXIO_ShifterModeReceive
Receive mode.

enumerator kFLEXIO_ShifterModeTransmit
Transmit mode.

enumerator kFLEXIO_ShifterModeMatchStore
Match store mode.

enumerator kFLEXIO_ShifterModeMatchContinuous
Match continuous mode.

enumerator kFLEXIO_ShifterModeState
SHIFTBUF contents are used for storing programmable state attributes.

enumerator kFLEXIO_ShifterModeLogic
SHIFTBUF contents are used for implementing programmable logic look up table.

enum _flexio_shifter_input_source
Define type of shifter input source.

Values:

enumerator kFLEXIO_ShifterInputFromPin
Shifter input from pin.

enumerator kFLEXIO_ShifterInputFromNextShifterOutput
Shifter input from Shifter N+1.

enum _flexio_shifter_stop_bit
Define of STOP bit configuration.

Values:

enumerator kFLEXIO_ShifterStopBitDisable
Disable shifter stop bit.

enumerator kFLEXIO_ShifterStopBitLow
Set shifter stop bit to logic low level.

enumerator kFLEXIO_ShifterStopBitHigh
Set shifter stop bit to logic high level.

enum _flexio_shifter_start_bit
Define type of START bit configuration.

Values:

enumerator kFLEXIO_ShifterStartBitDisabledLoadDataOnEnable
Disable shifter start bit, transmitter loads data on enable.

enumerator kFLEXIO_ShifterStartBitDisabledLoadDataOnShift
Disable shifter start bit, transmitter loads data on first shift.

enumerator kFLEXIO_ShifterStartBitLow
Set shifter start bit to logic low level.

enumerator kFLEXIO_ShifterStartBitHigh
Set shifter start bit to logic high level.

enum _flexio_shifter_buffer_type
Define FlexIO shifter buffer type.

Values:

enumerator kFLEXIO_ShifterBuffer
Shifter Buffer N Register.

enumerator kFLEXIO_ShifterBufferBitSwapped
Shifter Buffer N Bit Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferByteSwapped
Shifter Buffer N Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferBitByteSwapped
Shifter Buffer N Bit Swapped Register.

enumerator kFLEXIO_ShifterBufferNibbleByteSwapped
Shifter Buffer N Nibble Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferHalfWordSwapped
Shifter Buffer N Half Word Swapped Register.

enumerator kFLEXIO_ShifterBufferNibbleSwapped
Shifter Buffer N Nibble Swapped Register.

enum _flexio_gpio_direction
FLEXIO gpio direction definition.

Values:

enumerator kFLEXIO_DigitalInput
Set current pin as digital input

enumerator kFLEXIO_DigitalOutput
Set current pin as digital output

enum _flexio_pin_input_config
FLEXIO gpio input config.

Values:

enumerator kFLEXIO_InputInterruptDisabled
Interrupt request is disabled.

enumerator kFLEXIO_InputInterruptEnable
Interrupt request is enable.

enumerator kFLEXIO_FlagRisingEdgeEnable
Input pin flag on rising edge.

enumerator kFLEXIO_FlagFallingEdgeEnable
Input pin flag on falling edge.

typedef enum *_flexio_timer_trigger_polarity* flexio_timer_trigger_polarity_t
Define time of timer trigger polarity.

typedef enum *_flexio_timer_trigger_source* flexio_timer_trigger_source_t
Define type of timer trigger source.

typedef enum *_flexio_pin_config* flexio_pin_config_t
Define type of timer/shifter pin configuration.

typedef enum *_flexio_pin_polarity* flexio_pin_polarity_t
Definition of pin polarity.

typedef enum *_flexio_timer_mode* flexio_timer_mode_t
Define type of timer work mode.

typedef enum *_flexio_timer_output* flexio_timer_output_t
Define type of timer initial output or timer reset condition.

typedef enum *_flexio_timer_decrement_source* flexio_timer_decrement_source_t
Define type of timer decrement.

typedef enum *_flexio_timer_reset_condition* flexio_timer_reset_condition_t
Define type of timer reset condition.

typedef enum *_flexio_timer_disable_condition* flexio_timer_disable_condition_t
Define type of timer disable condition.

typedef enum *_flexio_timer_enable_condition* flexio_timer_enable_condition_t
Define type of timer enable condition.

typedef enum *_flexio_timer_stop_bit_condition* flexio_timer_stop_bit_condition_t
Define type of timer stop bit generate condition.

typedef enum *_flexio_timer_start_bit_condition* flexio_timer_start_bit_condition_t
Define type of timer start bit generate condition.

typedef enum *_flexio_timer_output_state* flexio_timer_output_state_t
FlexIO as PWM channel output state.

typedef enum *_flexio_shifter_timer_polarity* flexio_shifter_timer_polarity_t
Define type of timer polarity for shifter control.

typedef enum *_flexio_shifter_mode* flexio_shifter_mode_t
Define type of shifter working mode.

typedef enum *_flexio_shifter_input_source* flexio_shifter_input_source_t
Define type of shifter input source.

typedef enum *_flexio_shifter_stop_bit* flexio_shifter_stop_bit_t
Define of STOP bit configuration.

typedef enum *_flexio_shifter_start_bit* flexio_shifter_start_bit_t
Define type of START bit configuration.

typedef enum *_flexio_shifter_buffer_type* flexio_shifter_buffer_type_t
Define FlexIO shifter buffer type.

typedef struct *_flexio_config_* flexio_config_t
Define FlexIO user configuration structure.

typedef struct *_flexio_timer_config* flexio_timer_config_t
Define FlexIO timer configuration structure.

typedef struct *_flexio_shifter_config* flexio_shifter_config_t
Define FlexIO shifter configuration structure.

typedef enum *_flexio_gpio_direction* flexio_gpio_direction_t

FLEXIO gpio direction definition.

typedef enum *_flexio_pin_input_config* flexio_pin_input_config_t

FLEXIO gpio input config.

typedef struct *_flexio_gpio_config* flexio_gpio_config_t

The FLEXIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, use inputConfig param. If configured as an output pin, use outputLogic.

typedef void (*flexio_isr_t)(void *base, void *handle)

typedef for FlexIO simulated driver interrupt handler.

FLEXIO_Type *const s_flexioBases[]

Pointers to flexio bases for each instance.

const *clock_ip_name_t* s_flexioClocks[]

Pointers to flexio clocks for each instance.

void FLEXIO_SetPinConfig(FLEXIO_Type *base, uint32_t pin, *flexio_gpio_config_t* *config)

Configure a FLEXIO pin used by the board.

To Config the FLEXIO PIN, define a pin configuration, as either input or output, in the user file. Then, call the FLEXIO_SetPinConfig() function.

This is an example to define an input pin or an output pin configuration.

```
Define a digital input pin configuration,
flexio_gpio_config_t config =
{
  kFLEXIO_DigitalInput,
  0U,
  kFLEXIO_FlagRisingEdgeEnable | kFLEXIO_InputInterruptEnable,
}
Define a digital output pin configuration,
flexio_gpio_config_t config =
{
  kFLEXIO_DigitalOutput,
  0U,
  0U
}
```

Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.
- config – FLEXIO pin configuration pointer.

FLEXIO_TIMER_TRIGGER_SEL_PININPUT(x)

Calculate FlexIO timer trigger.

FLEXIO_TIMER_TRIGGER_SEL_SHIFTnSTAT(x)

FLEXIO_TIMER_TRIGGER_SEL_TIMn(x)

struct _flexio_config_

#include <fsl_flexio.h> Define FlexIO user configuration structure.

Public Members

bool enableFlexio
: Enable/disable FlexIO module

bool enableInDoze
: Enable/disable FlexIO operation in doze mode

bool enableInDebug
: Enable/disable FlexIO operation in debug mode

bool enableFastAccess
: Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

struct __flexio__timer__config
: *#include <fsl_flexio.h>* Define FlexIO timer configuration structure.

Public Members

uint32_t triggerSelect
: The internal trigger selection number using MACROs.

flexio_timer_trigger_polarity_t triggerPolarity
: Trigger Polarity.

flexio_timer_trigger_source_t triggerSource
: Trigger Source, internal (see 'trgsel') or external.

flexio_pin_config_t pinConfig
: Timer Pin Configuration.

uint32_t pinSelect
: Timer Pin number Select.

flexio_pin_polarity_t pinPolarity
: Timer Pin Polarity.

flexio_timer_mode_t timerMode
: Timer work Mode.

flexio_timer_output_t timerOutput
: Configures the initial state of the Timer Output and whether it is affected by the Timer reset.

flexio_timer_decrement_source_t timerDecrement
: Configures the source of the Timer decrement and the source of the Shift clock.

flexio_timer_reset_condition_t timerReset
: Configures the condition that causes the timer counter (and optionally the timer output) to be reset.

flexio_timer_disable_condition_t timerDisable
: Configures the condition that causes the Timer to be disabled and stop decrementing.

flexio_timer_enable_condition_t timerEnable
: Configures the condition that causes the Timer to be enabled and start decrementing.

flexio_timer_stop_bit_condition_t timerStop
: Timer STOP Bit generation.

flexio_timer_start_bit_condition_t timerStart
Timer STRAT Bit generation.

uint32_t timerCompare
Value for Timer Compare N Register.

struct __flexio_shifter_config
#include <fsl_flexio.h> Define FlexIO shifter configuration structure.

Public Members

uint32_t timerSelect
Selects which Timer is used for controlling the logic/shift register and generating the Shift clock.

flexio_shifter_timer_polarity_t timerPolarity
Timer Polarity.

flexio_pin_config_t pinConfig
Shifter Pin Configuration.

uint32_t pinSelect
Shifter Pin number Select.

flexio_pin_polarity_t pinPolarity
Shifter Pin Polarity.

flexio_shifter_mode_t shifterMode
Configures the mode of the Shifter.

uint32_t parallelWidth
Configures the parallel width when using parallel mode.

flexio_shifter_input_source_t inputSource
Selects the input source for the shifter.

flexio_shifter_stop_bit_t shifterStop
Shifter STOP bit.

flexio_shifter_start_bit_t shifterStart
Shifter START bit.

struct __flexio_gpio_config
#include <fsl_flexio.h> The FLEXIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, use inputConfig param. If configured as an output pin, use outputLogic.

Public Members

flexio_gpio_direction_t pinDirection
FLEXIO pin direction, input or output

uint8_t outputLogic
Set a default output logic, which has no use in input

uint8_t inputConfig
Set an input config

2.50 FlexIO eDMA I2S Driver

void FLEXIO_I2S_TransferTxCreateHandleEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *flexio_i2s_edma_callback_t* callback, void *userData, *edma_handle_t* *dmaHandle)

Initializes the FlexIO I2S eDMA handle.

This function initializes the FlexIO I2S master DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer.
- callback – FlexIO I2S eDMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

void FLEXIO_I2S_TransferRxCreateHandleEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *flexio_i2s_edma_callback_t* callback, void *userData, *edma_handle_t* *dmaHandle)

Initializes the FlexIO I2S Rx eDMA handle.

This function initializes the FlexIO I2S slave DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer.
- callback – FlexIO I2S eDMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

void FLEXIO_I2S_TransferSetFormatEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S Tx audio format.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred. This function also sets the eDMA parameter according to format.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock_Hz – FlexIO I2S clock source frequency in Hz, it should be 0 while in slave mode.

status_t FLEXIO_I2S_TransferSendEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs a non-blocking FlexIO I2S transfer using DMA.

Note: This interface returned immediately after transfer initiates. Users should call FLEXIO_I2S_GetTransferStatus to poll the transfer status and check whether the FlexIO I2S transfer is finished.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a FlexIO I2S eDMA send successfully.
- kStatus_InvalidArgument – The input arguments is invalid.
- kStatus_TxBusy – FlexIO I2S is busy sending data.

status_t FLEXIO_I2S_TransferReceiveEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs a non-blocking FlexIO I2S receive using eDMA.

Note: This interface returned immediately after transfer initiates. Users should call FLEXIO_I2S_GetReceiveRemainingBytes to poll the transfer status and check whether the FlexIO I2S transfer is finished.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a FlexIO I2S eDMA receive successfully.
- kStatus_InvalidArgument – The input arguments is invalid.
- kStatus_RxBusy – FlexIO I2S is busy receiving data.

void FLEXIO_I2S_TransferAbortSendEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle)

Aborts a FlexIO I2S transfer using eDMA.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.

void FLEXIO_I2S_TransferAbortReceiveEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle)

Aborts a FlexIO I2S receive using eDMA.

Parameters

- base – FlexIO I2S peripheral base address.

- handle – FlexIO I2S DMA handle pointer.

status_t FLEXIO_I2S_TransferGetSendCountEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, size_t *count)

Gets the remaining bytes to be sent.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes sent.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

status_t FLEXIO_I2S_TransferGetReceiveCountEDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, size_t *count)

Get the remaining bytes to be received.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes received.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

FSL_FLEXIO_I2S_EDMA_DRIVER_VERSION

FlexIO I2S EDMA driver version 2.1.9.

typedef struct *_flexio_i2s_edma_handle* flexio_i2s_edma_handle_t

typedef void (*flexio_i2s_edma_callback_t)(*FLEXIO_I2S_Type* *base, *flexio_i2s_edma_handle_t* *handle, *status_t* status, void *userData)

FlexIO I2S eDMA transfer callback function for finish and error.

struct _flexio_i2s_edma_handle

#include <fsl_flexio_i2s_edma.h> FlexIO I2S DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaHandle

DMA handler for FlexIO I2S send

uint8_t bytesPerFrame

Bytes in a frame

uint8_t nbytes

eDMA minor byte transfer count initially configured.

uint32_t state
: Internal state for FlexIO I2S eDMA transfer

flexio_i2s_edma_callback_t callback
: Callback for users while transfer finish or error occurred

void *userData
: User callback parameter

edma_tcd_t tcd[(4U) + 1U]
: TCD pool for eDMA transfer.

flexio_i2s_transfer_t queue[(4U)]
: Transfer queue storing queued transfer.

size_t transferSize[(4U)]
: Data bytes need to transfer

volatile uint8_t queueUser
: Index for user to queue transfer.

volatile uint8_t queueDriver
: Index for driver to get the transfer data and size

2.51 FlexIO eDMA SPI Driver

status_t FLEXIO_SPI_MasterTransferCreateHandleEDMA(*FLEXIO_SPI_Type* *base,
flexio_spi_master_edma_handle_t *handle,
flexio_spi_master_edma_transfer_callback_t callback, void *userData,
edma_handle_t *txHandle,
edma_handle_t *rxHandle)

Initializes the FlexIO SPI master eDMA handle.

This function initializes the FlexIO SPI master eDMA handle which can be used for other FlexIO SPI master transactional APIs. For a specified FlexIO SPI instance, call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
- callback – SPI callback, NULL means no callback.
- userData – callback function parameter.
- txHandle – User requested eDMA handle for FlexIO SPI RX eDMA transfer.
- rxHandle – User requested eDMA handle for FlexIO SPI TX eDMA transfer.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO SPI eDMA type/handle table out of range.

status_t FLEXIO_SPI_MasterTransferEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_edma_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Performs a non-blocking FlexIO SPI transfer using eDMA.

Note: This interface returns immediately after transfer initiates. Call FLEXIO_SPI_MasterGetTransferCountEDMA to poll the transfer status and check whether the FlexIO SPI transfer is finished.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
- xfer – Pointer to FlexIO SPI transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – FlexIO SPI is not idle, is running another transfer.

void FLEXIO_SPI_MasterTransferAbortEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_edma_handle_t* *handle)

Aborts a FlexIO SPI transfer using eDMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI eDMA handle pointer.

status_t FLEXIO_SPI_MasterTransferGetCountEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_edma_handle_t* *handle, size_t *count)

Gets the number of bytes transferred so far using FlexIO SPI master eDMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI eDMA handle pointer.
- count – Number of bytes transferred so far by the non-blocking transaction.

static inline void FLEXIO_SPI_SlaveTransferCreateHandleEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_edma_handle_t* *handle, *flexio_spi_slave_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *txHandle, *edma_handle_t* *rxHandle)

Initializes the FlexIO SPI slave eDMA handle.

This function initializes the FlexIO SPI slave eDMA handle.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.

- handle – Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.
- callback – SPI callback, NULL means no callback.
- userData – callback function parameter.
- txHandle – User requested eDMA handle for FlexIO SPI TX eDMA transfer.
- rxHandle – User requested eDMA handle for FlexIO SPI RX eDMA transfer.

status_t FLEXIO_SPI_SlaveTransferEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_edma_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Performs a non-blocking FlexIO SPI transfer using eDMA.

Note: This interface returns immediately after transfer initiates. Call FLEXIO_SPI_SlaveGetTransferCountEDMA to poll the transfer status and check whether the FlexIO SPI transfer is finished.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.
- xfer – Pointer to FlexIO SPI transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – FlexIO SPI is not idle, is running another transfer.

static inline void FLEXIO_SPI_SlaveTransferAbortEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_edma_handle_t* *handle)

Aborts a FlexIO SPI transfer using eDMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.

static inline *status_t* FLEXIO_SPI_SlaveTransferGetCountEDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_edma_handle_t* *handle, size_t *count)

Gets the number of bytes transferred so far using FlexIO SPI slave eDMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI eDMA handle pointer.
- count – Number of bytes transferred so far by the non-blocking transaction.

FSL_FLEXIO_SPI_EDMA_DRIVER_VERSION

FlexIO SPI EDMA driver version.

typedef struct *_flexio_spi_master_edma_handle* flexio_spi_master_edma_handle_t

typedef for flexio_spi_master_edma_handle_t in advance.

typedef *flexio_spi_master_edma_handle_t* flexio_spi_slave_edma_handle_t

Slave handle is the same with master handle.

typedef void (*flexio_spi_master_edma_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_master_edma_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI master callback for finished transmit.

typedef void (*flexio_spi_slave_edma_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_edma_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI slave callback for finished transmit.

struct _flexio_spi_master_edma_handle

#include <fsl_flexio_spi_edma.h> FlexIO SPI eDMA transfer handle, users should not touch the content of the handle.

Public Members

size_t transferSize

Total bytes to be transferred.

uint8_t nbytes

eDMA minor byte transfer count initially configured.

bool txInProgress

Send transfer in progress

bool rxInProgress

Receive transfer in progress

edma_handle_t *txHandle

DMA handler for SPI send

edma_handle_t *rxHandle

DMA handler for SPI receive

flexio_spi_master_edma_transfer_callback_t callback

Callback for SPI DMA transfer

void *userData

User Data for SPI DMA callback

2.52 FlexIO eDMA UART Driver

status_t FLEXIO_UART_TransferCreateHandleEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, *flexio_uart_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *txEdmaHandle, *edma_handle_t* *rxEdmaHandle)

Initializes the UART handle which is used in transactional functions.

Parameters

- base – Pointer to FLEXIO_UART_Type.
- handle – Pointer to flexio_uart_edma_handle_t structure.

- callback – The callback function.
- userData – The parameter of the callback function.
- rxEdmaHandle – User requested DMA handle for RX DMA transfer.
- txEdmaHandle – User requested DMA handle for TX DMA transfer.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO SPI eDMA type/handle table out of range.

status_t FLEXIO_UART_TransferSendEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Sends data using eDMA.

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent out, the send callback function is called.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – UART handle pointer.
- xfer – UART eDMA transfer structure, see flexio_uart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXIO_UART_TxBusy – Previous transfer on going.

status_t FLEXIO_UART_TransferReceiveEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Receives data using eDMA.

This function receives data using eDMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – Pointer to flexio_uart_edma_handle_t structure
- xfer – UART eDMA transfer structure, see flexio_uart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_UART_RxBusy – Previous transfer on going.

void FLEXIO_UART_TransferAbortSendEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle)

Aborts the sent data which using eDMA.

This function aborts sent data which using eDMA.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – Pointer to flexio_uart_edma_handle_t structure

void FLEXIO_UART_TransferAbortReceiveEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle)

Aborts the receive data which using eDMA.

This function aborts the receive data which using eDMA.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – Pointer to flexio_uart_edma_handle_t structure

status_t FLEXIO_UART_TransferGetSendCountEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, size_t *count)

Gets the number of bytes sent out.

This function gets the number of bytes sent out.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – Pointer to flexio_uart_edma_handle_t structure
- count – Number of bytes sent so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

status_t FLEXIO_UART_TransferGetReceiveCountEDMA(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, size_t *count)

Gets the number of bytes received.

This function gets the number of bytes received.

Parameters

- base – Pointer to FLEXIO_UART_Type
- handle – Pointer to flexio_uart_edma_handle_t structure
- count – Number of bytes received so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

FSL_FLEXIO_UART_EDMA_DRIVER_VERSION

FlexIO UART EDMA driver version.

typedef struct *_flexio_uart_edma_handle* flexio_uart_edma_handle_t

typedef void (*flexio_uart_edma_transfer_callback_t)(*FLEXIO_UART_Type* *base, *flexio_uart_edma_handle_t* *handle, *status_t* status, void *userData)

UART transfer callback function.

struct _flexio_uart_edma_handle

#include <fsl_flexio_uart_edma.h> UART eDMA handle.

Public Members

flexio_uart_edma_transfer_callback_t callback
Callback function.

void *userData
UART callback function parameter.

size_t txDataSizeAll
Total bytes to be sent.

size_t rxDataSizeAll
Total bytes to be received.

edma_handle_t *txEdmaHandle
The eDMA TX channel used.

edma_handle_t *rxEdmaHandle
The eDMA RX channel used.

uint8_t nbytes
eDMA minor byte transfer count initially configured.

volatile uint8_t txState
TX transfer state.

volatile uint8_t rxState
RX transfer state

2.53 FlexIO I2C Master Driver

status_t FLEXIO_I2C_CheckForBusyBus(*FLEXIO_I2C_Type* *base)
Make sure the bus isn't already pulled down.

Check the FLEXIO pin status to see whether either of SDA and SCL pin is pulled down.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure..

Return values

- kStatus_Success –
- kStatus_FLEXIO_I2C_Busy –

status_t FLEXIO_I2C_MasterInit(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_config_t* *masterConfig, uint32_t srcClock_Hz)
Ungates the FlexIO clock, resets the FlexIO module, and configures the FlexIO I2C hardware configuration.

Example

```
FLEXIO_I2C_Type base = {
.flexioBase = FLEXIO,
.SDAPinIndex = 0,
.SCLPinIndex = 1,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_i2c_master_config_t config = {
.enableInDoze = false,
```

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```
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 100000
};
FLEXIO_I2C_MasterInit(base, &config, srcClock_Hz);
```

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- masterConfig – Pointer to flexio_i2c_master_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

Return values

- kStatus_Success – Initialization successful
- kStatus_InvalidArgument – The source clock exceed upper range limitation

void FLEXIO_I2C_MasterDeinit(*FLEXIO_I2C_Type* *base)

De-initializes the FlexIO I2C master peripheral. Calling this API Resets the FlexIO I2C master shifer and timer config, module can't work unless the FLEXIO_I2C_MasterInit is called.

Parameters

- base – pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterGetDefaultConfig(*flexio_i2c_master_config_t* *masterConfig)

Gets the default configuration to configure the FlexIO module. The configuration can be used directly for calling the FLEXIO_I2C_MasterInit().

Example:

```
flexio_i2c_master_config_t config;
FLEXIO_I2C_MasterGetDefaultConfig(&config);
```

Parameters

- masterConfig – Pointer to flexio_i2c_master_config_t structure.

static inline void FLEXIO_I2C_MasterEnable(*FLEXIO_I2C_Type* *base, bool enable)

Enables/disables the FlexIO module operation.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- enable – Pass true to enable module, false does not have any effect.

uint32_t FLEXIO_I2C_MasterGetStatusFlags(*FLEXIO_I2C_Type* *base)

Gets the FlexIO I2C master status flags.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure

Returns

Status flag, use status flag to AND _flexio_i2c_master_status_flags can get the related status.

void FLEXIO_I2C_MasterClearStatusFlags(*FLEXIO_I2C_Type* *base, uint32_t mask)

Clears the FlexIO I2C master status flags.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO_I2C_RxFullFlag
  - kFLEXIO_I2C_ReceiveNakFlag

void FLEXIO_I2C_MasterEnableInterrupts(*FLEXIO_I2C_Type* *base, uint32_t mask)

Enables the FlexIO i2c master interrupt requests.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- mask – Interrupt source. Currently only one interrupt request source:
  - kFLEXIO_I2C_TransferCompleteInterruptEnable

void FLEXIO_I2C_MasterDisableInterrupts(*FLEXIO_I2C_Type* *base, uint32_t mask)

Disables the FlexIO I2C master interrupt requests.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- mask – Interrupt source.

void FLEXIO_I2C_MasterSetBaudRate(*FLEXIO_I2C_Type* *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the FlexIO I2C master transfer baudrate.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- baudRate_Bps – the baud rate value in HZ
- srcClock_Hz – source clock in HZ

void FLEXIO_I2C_MasterStart(*FLEXIO_I2C_Type* *base, uint8_t address, *flexio_i2c_direction_t* direction)

Sends START + 7-bit address to the bus.

Note: This API should be called when the transfer configuration is ready to send a START signal and 7-bit address to the bus. This is a non-blocking API, which returns directly after the address is put into the data register but the address transfer is not finished on the bus. Ensure that the kFLEXIO_I2C_RxFullFlag status is asserted before calling this API.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- address – 7-bit address.
- direction – transfer direction. This parameter is one of the values in flexio_i2c_direction_t:
  - kFLEXIO_I2C_Write: Transmit
  - kFLEXIO_I2C_Read: Receive

void FLEXIO_I2C_MasterStop(*FLEXIO_I2C_Type* *base)

Sends the stop signal on the bus.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterRepeatedStart(*FLEXIO_I2C_Type* *base)

Sends the repeated start signal on the bus.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterAbortStop(*FLEXIO_I2C_Type* *base)

Sends the stop signal when transfer is still on-going.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterEnableAck(*FLEXIO_I2C_Type* *base, bool enable)

Configures the sent ACK/NAK for the following byte.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- enable – True to configure send ACK, false configure to send NAK.

status_t FLEXIO_I2C_MasterSetTransferCount(*FLEXIO_I2C_Type* *base, uint16_t count)

Sets the number of bytes to be transferred from a start signal to a stop signal.

Note: Call this API before a transfer begins because the timer generates a number of clocks according to the number of bytes that need to be transferred.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- count – Number of bytes need to be transferred from a start signal to a re-start/stop signal

Return values

- kStatus_Success – Successfully configured the count.
- kStatus_InvalidArgument – Input argument is invalid.

static inline void FLEXIO_I2C_MasterWriteByte(*FLEXIO_I2C_Type* *base, uint32_t data)

Writes one byte of data to the I2C bus.

Note: This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- data – a byte of data.

static inline uint8_t FLEXIO_I2C_MasterReadByte(*FLEXIO_I2C_Type* *base)

Reads one byte of data from the I2C bus.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the data is ready in the register.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

Returns
data byte read.

status_t FLEXIO_I2C_MasterWriteBlocking(*FLEXIO_I2C_Type* *base, const uint8_t *txBuff, uint8_t txSize)

Sends a buffer of data in bytes.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- txBuff – The data bytes to send.
- txSize – The number of data bytes to send.

Return values

- kStatus_Success – Successfully write data.
- kStatus_FLEXIO_I2C_Nak – Receive NAK during writing data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

status_t FLEXIO_I2C_MasterReadBlocking(*FLEXIO_I2C_Type* *base, uint8_t *rxBuff, uint8_t rxSize)

Receives a buffer of bytes.

Note: This function blocks via polling until all bytes have been received.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- rxBuff – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

Return values

- kStatus_Success – Successfully read data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

status_t FLEXIO_I2C_MasterTransferBlocking(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_transfer_t* *xfer)

Performs a master polling transfer on the I2C bus.

Note: The API does not return until the transfer succeeds or fails due to receiving NAK.

Parameters

- base – pointer to FLEXIO_I2C_Type structure.
- xfer – pointer to flexio_i2c_master_transfer_t structure.

Returns
status of status_t.

status_t FLEXIO_I2C_MasterTransferCreateHandle(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *flexio_i2c_master_transfer_callback_t* callback, void *userData)

Initializes the I2C handle which is used in transactional functions.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- handle – Pointer to flexio_i2c_master_handle_t structure to store the transfer state.
- callback – Pointer to user callback function.
- userData – User param passed to the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/isr table out of range.

status_t FLEXIO_I2C_MasterTransferNonBlocking(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *flexio_i2c_master_transfer_t* *xfer)

Performs a master interrupt non-blocking transfer on the I2C bus.

Note: The API returns immediately after the transfer initiates. Call FLEXIO_I2C_MasterTransferGetCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_FLEXIO_I2C_Busy, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state
- xfer – pointer to flexio_i2c_master_transfer_t structure

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_FLEXIO_I2C_Busy – FlexIO I2C is not idle, is running another transfer.

status_t FLEXIO_I2C_MasterTransferGetCount(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, size_t *count)

Gets the master transfer status during a interrupt non-blocking transfer.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.

- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.
- kStatus_Success – Successfully return the count.

void FLEXIO_I2C_MasterTransferAbort(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle)

Aborts an interrupt non-blocking transfer early.

Note: This API can be called at any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state

void FLEXIO_I2C_MasterTransferHandleIRQ(void *i2cType, void *i2cHandle)

Master interrupt handler.

Parameters

- i2cType – Pointer to FLEXIO_I2C_Type structure
- i2cHandle – Pointer to flexio_i2c_master_transfer_t structure

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FlexIO I2C transfer status.

Values:

enumerator kStatus_FLEXIO_I2C_Busy

I2C is busy doing transfer.

enumerator kStatus_FLEXIO_I2C_Idle

I2C is busy doing transfer.

enumerator kStatus_FLEXIO_I2C_Nak

NAK received during transfer.

enumerator kStatus_FLEXIO_I2C_Timeout

Timeout polling status flags.

enum _flexio_i2c_master_interrupt

Define FlexIO I2C master interrupt mask.

Values:

enumerator kFLEXIO_I2C_TxEmptyInterruptEnable

Tx buffer empty interrupt enable.

enumerator kFLEXIO_I2C_RxFullInterruptEnable

Rx buffer full interrupt enable.

enum _flexio_i2c_master_status_flags

Define FlexIO I2C master status mask.

Values:

enumerator kFLEXIO_I2C_TxEmptyFlag
Tx shifter empty flag.

enumerator kFLEXIO_I2C_RxFullFlag
Rx shifter full/Transfer complete flag.

enumerator kFLEXIO_I2C_ReceiveNakFlag
Receive NAK flag.

enum _flexio_i2c_direction
Direction of master transfer.

Values:

enumerator kFLEXIO_I2C_Write
Master send to slave.

enumerator kFLEXIO_I2C_Read
Master receive from slave.

typedef enum *_flexio_i2c_direction* flexio_i2c_direction_t
Direction of master transfer.

typedef struct *_flexio_i2c_type* FLEXIO_I2C_Type
Define FlexIO I2C master access structure typedef.

typedef struct *_flexio_i2c_master_config* flexio_i2c_master_config_t
Define FlexIO I2C master user configuration structure.

typedef struct *_flexio_i2c_master_transfer* flexio_i2c_master_transfer_t
Define FlexIO I2C master transfer structure.

typedef struct *_flexio_i2c_master_handle* flexio_i2c_master_handle_t
FlexIO I2C master handle typedef.

typedef void (*flexio_i2c_master_transfer_callback_t)(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *status_t* status, void *userData)
FlexIO I2C master transfer callback typedef.

I2C_RETRY_TIMES
Retry times for waiting flag.

struct _flexio_i2c_type
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master access structure typedef.

Public Members

FLEXIO_Type *flexioBase
FlexIO base pointer.

uint8_t SDAPinIndex
Pin select for I2C SDA.

uint8_t SCLPinIndex
Pin select for I2C SCL.

uint8_t shifterIndex[2]
Shifter index used in FlexIO I2C.

uint8_t timerIndex[3]
Timer index used in FlexIO I2C.

uint32_t baudrate
Master transfer baudrate, used to calculate delay time.

struct __flexio_i2c_master_config
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master user configuration structure.

Public Members

bool enableMaster
Enables the FlexIO I2C peripheral at initialization time.

bool enableInDoze
Enable/disable FlexIO operation in doze mode.

bool enableInDebug
Enable/disable FlexIO operation in debug mode.

bool enableFastAccess
Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps
Baud rate in Bps.

struct __flexio_i2c_master_transfer
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master transfer structure.

Public Members

uint32_t flags
Transfer flag which controls the transfer, reserved for FlexIO I2C.

uint8_t slaveAddress
7-bit slave address.

flexio_i2c_direction_t direction
Transfer direction, read or write.

uint32_t subaddress
Sub address. Transferred MSB first.

uint8_t subaddressSize
Size of sub address.

uint8_t volatile *data
Transfer buffer.

volatile size_t dataSize
Transfer size.

struct __flexio_i2c_master_handle
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master handle structure.

Public Members

flexio_i2c_master_transfer_t transfer
FlexIO I2C master transfer copy.

size_t transferSize
Total bytes to be transferred.

uint8_t state
Transfer state maintained during transfer.

flexio_i2c_master_transfer_callback_t completionCallback
Callback function called at transfer event. Callback function called at transfer event.

void *userData
Callback parameter passed to callback function.

bool needRestart
Whether master needs to send re-start signal.

2.54 FlexIO I2S Driver

void FLEXIO_I2S_Init(*FLEXIO_I2S_Type* *base, const *flexio_i2s_config_t* *config)
Initializes the FlexIO I2S.

This API configures FlexIO pins and shifter to I2S and configures the FlexIO I2S with a configuration structure. The configuration structure can be filled by the user, or be set with default values by FLEXIO_I2S_GetDefaultConfig().

Note: This API should be called at the beginning of the application to use the FlexIO I2S driver. Otherwise, any access to the FlexIO I2S module can cause hard fault because the clock is not enabled.

Parameters

- base – FlexIO I2S base pointer
- config – FlexIO I2S configure structure.

void FLEXIO_I2S_GetDefaultConfig(*flexio_i2s_config_t* *config)
Sets the FlexIO I2S configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in FLEXIO_I2S_Init(). Users may use the initialized structure unchanged in FLEXIO_I2S_Init() or modify some fields of the structure before calling FLEXIO_I2S_Init().

Parameters

- config – pointer to master configuration structure

void FLEXIO_I2S_Deinit(*FLEXIO_I2S_Type* *base)
De-initializes the FlexIO I2S.

Calling this API resets the FlexIO I2S shifter and timer config. After calling this API, call the FLEXO_I2S_Init to use the FlexIO I2S module.

Parameters

- base – FlexIO I2S base pointer

static inline void FLEXIO_I2S_Enable(*FLEXIO_I2S_Type* *base, bool enable)
Enables/disables the FlexIO I2S module operation.

Parameters

- base – Pointer to FLEXIO_I2S_Type

- enable – True to enable, false dose not have any effect.

uint32_t FLEXIO_I2S_GetStatusFlags(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S status flags.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns

Status flag, which are ORed by the enumerators in the _flexio_i2s_status_flags.

void FLEXIO_I2S_EnableInterrupts(*FLEXIO_I2S_Type* *base, uint32_t mask)

Enables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- mask – interrupt source

void FLEXIO_I2S_DisableInterrupts(*FLEXIO_I2S_Type* *base, uint32_t mask)

Disables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – pointer to FLEXIO_I2S_Type structure
- mask – interrupt source

static inline void FLEXIO_I2S_TxEnableDMA(*FLEXIO_I2S_Type* *base, bool enable)

Enables/disables the FlexIO I2S Tx DMA requests.

Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline void FLEXIO_I2S_RxEnableDMA(*FLEXIO_I2S_Type* *base, bool enable)

Enables/disables the FlexIO I2S Rx DMA requests.

Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t FLEXIO_I2S_TxGetDataRegisterAddress(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S send data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns

FlexIO i2s send data register address.

static inline uint32_t FLEXIO_I2S_RxGetDataRegisterAddress(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S receive data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns
FlexIO i2s receive data register address.

void FLEXIO_I2S_MasterSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S audio format in master mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock_Hz – I2S master clock source frequency in Hz.

void FLEXIO_I2S_SlaveSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_format_t* *format)

Configures the FlexIO I2S audio format in slave mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- format – Pointer to FlexIO I2S audio data format structure.

status_t FLEXIO_I2S_WriteBlocking(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint8_t *txData, size_t size)

Sends data using a blocking method.

Note: This function blocks via polling until data is ready to be sent.

Parameters

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- txData – Pointer to the data to be written.
- size – Bytes to be written.

Return values

- kStatus_Success – Successfully write data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

static inline void FLEXIO_I2S_WriteData(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint32_t data)

Writes data into a data register.

Parameters

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- data – Data to be written.

status_t FLEXIO_I2S_ReadBlocking(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint8_t *rxData, size_t size)

Receives a piece of data using a blocking method.

Note: This function blocks via polling until data is ready to be sent.

Parameters

- base – FlexIO I2S base pointer
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- rxData – Pointer to the data to be read.
- size – Bytes to be read.

Return values

- kStatus_Success – Successfully read data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

static inline uint32_t FLEXIO_I2S_ReadData(*FLEXIO_I2S_Type* *base)

Reads a data from the data register.

Parameters

- base – FlexIO I2S base pointer

Returns

Data read from data register.

void FLEXIO_I2S_TransferTxCreateHandle(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_callback_t* callback, void *userData)

Initializes the FlexIO I2S handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- handle – Pointer to flexio_i2s_handle_t structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

void FLEXIO_I2S_TransferSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S audio format.

Audio format can be changed at run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – FlexIO I2S handle pointer.
- format – Pointer to audio data format structure.
- srcClock_Hz – FlexIO I2S bit clock source frequency in Hz. This parameter should be 0 while in slave mode.

void FLEXIO_I2S_TransferRxCreateHandle(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_callback_t* callback, void *userData)

Initializes the FlexIO I2S receive handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

status_t FLEXIO_I2S_TransferSendNonBlocking(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs an interrupt non-blocking send transfer on FlexIO I2S.

Note: The API returns immediately after transfer initiates. Call FLEXIO_I2S_GetRemainingBytes to poll the transfer status and check whether the transfer is finished. If the return status is 0, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- xfer – Pointer to flexio_i2s_transfer_t structure

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_FLEXIO_I2S_TxBusy – Previous transmission still not finished, data not all written to TX register yet.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t FLEXIO_I2S_TransferReceiveNonBlocking(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on FlexIO I2S.

Note: The API returns immediately after transfer initiates. Call FLEXIO_I2S_GetRemainingBytes to poll the transfer status to check whether the transfer is finished. If the return status is 0, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- xfer – Pointer to flexio_i2s_transfer_t structure

Return values

- kStatus_Success – Successfully start the data receive.

- kStatus_FLEXIO_I2S_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

void FLEXIO_I2S_TransferAbortSend(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle)

Aborts the current send.

Note: This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state

void FLEXIO_I2S_TransferAbortReceive(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle)

Aborts the current receive.

Note: This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state

status_t FLEXIO_I2S_TransferGetSendCount(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, size_t *count)

Gets the remaining bytes to be sent.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- count – Bytes sent.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

status_t FLEXIO_I2S_TransferGetReceiveCount(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, size_t *count)

Gets the remaining bytes to be received.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- count – Bytes recieved.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

Returns
count Bytes received.

void FLEXIO_I2S_TransferTxHandleIRQ(void *i2sBase, void *i2sHandle)

Tx interrupt handler.

Parameters

- i2sBase – Pointer to FLEXIO_I2S_Type structure.
- i2sHandle – Pointer to flexio_i2s_handle_t structure

void FLEXIO_I2S_TransferRxHandleIRQ(void *i2sBase, void *i2sHandle)

Rx interrupt handler.

Parameters

- i2sBase – Pointer to FLEXIO_I2S_Type structure.
- i2sHandle – Pointer to flexio_i2s_handle_t structure.

FSL_FLEXIO_I2S_DRIVER_VERSION

FlexIO I2S driver version 2.2.2.

FlexIO I2S transfer status.

Values:

enumerator kStatus_FLEXIO_I2S_Idle
FlexIO I2S is in idle state

enumerator kStatus_FLEXIO_I2S_TxBusy
FlexIO I2S Tx is busy

enumerator kStatus_FLEXIO_I2S_RxBusy
FlexIO I2S Tx is busy

enumerator kStatus_FLEXIO_I2S_Error
FlexIO I2S error occurred

enumerator kStatus_FLEXIO_I2S_QueueFull
FlexIO I2S transfer queue is full.

enumerator kStatus_FLEXIO_I2S_Timeout
FlexIO I2S timeout polling status flags.

enum _flexio_i2s_master_slave

Master or slave mode.

Values:

enumerator kFLEXIO_I2S_Master
Master mode

enumerator kFLEXIO_I2S_Slave
Slave mode

_flexio_i2s_interrupt_enable Define FlexIO FlexIO I2S interrupt mask.

Values:

enumerator kFLEXIO_I2S_TxDataRegEmptyInterruptEnable
Transmit buffer empty interrupt enable.

enumerator kFLEXIO_I2S_RxDataRegFullInterruptEnable
Receive buffer full interrupt enable.

_flexio_i2s_status_flags Define FlexIO FlexIO I2S status mask.

Values:

enumerator kFLEXIO_I2S_TxDataRegEmptyFlag
Transmit buffer empty flag.

enumerator kFLEXIO_I2S_RxDataRegFullFlag
Receive buffer full flag.

enum _flexio_i2s_sample_rate
Audio sample rate.

Values:

enumerator kFLEXIO_I2S_SampleRate8KHz
Sample rate 8000Hz

enumerator kFLEXIO_I2S_SampleRate11025Hz
Sample rate 11025Hz

enumerator kFLEXIO_I2S_SampleRate12KHz
Sample rate 12000Hz

enumerator kFLEXIO_I2S_SampleRate16KHz
Sample rate 16000Hz

enumerator kFLEXIO_I2S_SampleRate22050Hz
Sample rate 22050Hz

enumerator kFLEXIO_I2S_SampleRate24KHz
Sample rate 24000Hz

enumerator kFLEXIO_I2S_SampleRate32KHz
Sample rate 32000Hz

enumerator kFLEXIO_I2S_SampleRate44100Hz
Sample rate 44100Hz

enumerator kFLEXIO_I2S_SampleRate48KHz
Sample rate 48000Hz

enumerator kFLEXIO_I2S_SampleRate96KHz
Sample rate 96000Hz

enum _flexio_i2s_word_width
Audio word width.

Values:

enumerator kFLEXIO_I2S_WordWidth8bits
Audio data width 8 bits

enumerator kFLEXIO_I2S_WordWidth16bits
Audio data width 16 bits

enumerator kFLEXIO_I2S_WordWidth24bits
Audio data width 24 bits

enumerator kFLEXIO_I2S_WordWidth32bits
Audio data width 32 bits

typedef struct *_flexio_i2s_type* FLEXIO_I2S_Type
Define FlexIO I2S access structure typedef.

typedef enum *_flexio_i2s_master_slave* flexio_i2s_master_slave_t
Master or slave mode.

typedef struct *_flexio_i2s_config* flexio_i2s_config_t
FlexIO I2S configure structure.

typedef struct *_flexio_i2s_format* flexio_i2s_format_t
FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

typedef enum *_flexio_i2s_sample_rate* flexio_i2s_sample_rate_t
Audio sample rate.

typedef enum *_flexio_i2s_word_width* flexio_i2s_word_width_t
Audio word width.

typedef struct *_flexio_i2s_transfer* flexio_i2s_transfer_t
Define FlexIO I2S transfer structure.

typedef struct *_flexio_i2s_handle* flexio_i2s_handle_t

typedef void (*flexio_i2s_callback_t)(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *status_t* status, void *userData)
FlexIO I2S xfer callback prototype.

I2S_RETRY_TIMES
Retry times for waiting flag.

FLEXIO_I2S_XFER_QUEUE_SIZE
FlexIO I2S transfer queue size, user can refine it according to use case.

struct _flexio_i2s_type
#include <fsl_flexio_i2s.h> Define FlexIO I2S access structure typedef.

Public Members

FLEXIO_Type *flexioBase
FlexIO base pointer

uint8_t txPinIndex
Tx data pin index in FlexIO pins

uint8_t rxPinIndex
Rx data pin index

uint8_t bclkPinIndex
Bit clock pin index

uint8_t fsPinIndex
Frame sync pin index

uint8_t txShifterIndex
Tx data shifter index

uint8_t rxShifterIndex
: Rx data shifter index

uint8_t bclkTimerIndex
: Bit clock timer index

uint8_t fsTimerIndex
: Frame sync timer index

struct __flexio_i2s_config
: *#include <fsl_flexio_i2s.h>* FlexIO I2S configure structure.

Public Members

bool enableI2S
: Enable FlexIO I2S

flexio_i2s_master_slave_t masterSlave
: Master or slave

flexio_pin_polarity_t txPinPolarity
: Tx data pin polarity, active high or low

flexio_pin_polarity_t rxPinPolarity
: Rx data pin polarity

flexio_pin_polarity_t bclkPinPolarity
: Bit clock pin polarity

flexio_pin_polarity_t fsPinPolarity
: Frame sync pin polarity

flexio_shifter_timer_polarity_t txTimerPolarity
: Tx data valid on bclk rising or falling edge

flexio_shifter_timer_polarity_t rxTimerPolarity
: Rx data valid on bclk rising or falling edge

struct __flexio_i2s_format
: *#include <fsl_flexio_i2s.h>* FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

Public Members

uint8_t bitWidth
: Bit width of audio data, always 8/16/24/32 bits

uint32_t sampleRate_Hz
: Sample rate of the audio data

struct __flexio_i2s_transfer
: *#include <fsl_flexio_i2s.h>* Define FlexIO I2S transfer structure.

Public Members

uint8_t *data
: Data buffer start pointer

size_t dataSize
Bytes to be transferred.

struct _flexio_i2s_handle
#include <fsl_flexio_i2s.h> Define FlexIO I2S handle structure.

Public Members

uint32_t state
Internal state

flexio_i2s_callback_t callback
Callback function called at transfer event

void *userData
Callback parameter passed to callback function

uint8_t bitWidth
Bit width for transfer, 8/16/24/32bits

flexio_i2s_transfer_t queue[(4U)]
Transfer queue storing queued transfer

size_t transferSize[(4U)]
Data bytes need to transfer

volatile uint8_t queueUser
Index for user to queue transfer

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

2.55 FlexIO SPI Driver

void FLEXIO_SPI_MasterInit(*FLEXIO_SPI_Type* *base, *flexio_spi_master_config_t* *masterConfig, uint32_t srcClock_Hz)
Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI master hardware, and configures the FlexIO SPI with FlexIO SPI master configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_MasterGetDefaultConfig().

Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_spi_master_config_t config = {
.enableMaster = true,
.enableInDoze = false,
.enableInDebug = true,
```

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```
.enableFastAccess = false,
.baudRate_Bps = 500000,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_MasterInit(&spiDev, &config, srcClock_Hz);
```

Note: 1.FlexIO SPI master only support CPOL = 0, which means clock inactive low. 2.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI master communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by 2*2=4. If FlexIO SPI master communicates with FlexIO SPI slave, the maximum baud rate is FlexIO clock frequency divided by (1.5+2.5)*2=8.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- masterConfig – Pointer to the flexio_spi_master_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

void FLEXIO_SPI_MasterDeinit(*FLEXIO_SPI_Type* *base)

Resets the FlexIO SPI timer and shifter config.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_MasterGetDefaultConfig(*flexio_spi_master_config_t* *masterConfig)

Gets the default configuration to configure the FlexIO SPI master. The configuration can be used directly by calling the FLEXIO_SPI_MasterConfigure(). Example:

```
flexio_spi_master_config_t masterConfig;
FLEXIO_SPI_MasterGetDefaultConfig(&masterConfig);
```

Parameters

- masterConfig – Pointer to the flexio_spi_master_config_t structure.

void FLEXIO_SPI_SlaveInit(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_config_t* *slaveConfig)

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI slave hardware configuration, and configures the FlexIO SPI with FlexIO SPI slave configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_SlaveGetDefaultConfig().

Note: 1.Only one timer is needed in the FlexIO SPI slave. As a result, the second timer index is ignored. 2.FlexIO SPI slave only support CPOL = 0, which means clock inactive low. 3.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI slave communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by 3*2=6. If FlexIO SPI slave communicates with FlexIO SPI master, the maximum baud rate is FlexIO clock frequency divided by (1.5+2.5)*2=8. Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
```

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```
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0}
};
flexio_spi_slave_config_t config = {
.enableSlave = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_SlaveInit(&spiDev, &config);
```

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

void FLEXIO_SPI_SlaveDeinit(*FLEXIO_SPI_Type* *base)

Gates the FlexIO clock.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_SlaveGetDefaultConfig(*flexio_spi_slave_config_t* *slaveConfig)

Gets the default configuration to configure the FlexIO SPI slave. The configuration can be used directly for calling the FLEXIO_SPI_SlaveConfigure(). Example:

```
flexio_spi_slave_config_t slaveConfig;
FLEXIO_SPI_SlaveGetDefaultConfig(&slaveConfig);
```

Parameters

- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

uint32_t FLEXIO_SPI_GetStatusFlags(*FLEXIO_SPI_Type* *base)

Gets FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

Returns

status flag; Use the status flag to AND the following flag mask and get the status.

- kFLEXIO_SPI_TxEmptyFlag
- kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_ClearStatusFlags(*FLEXIO_SPI_Type* *base, uint32_t mask)

Clears FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

- mask – status flag The parameter can be any combination of the following values:
  - kFLEXIO_SPI_TxEmptyFlag
  - kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_EnableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Enables the FlexIO SPI interrupt.

This function enables the FlexIO SPI interrupt.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – interrupt source. The parameter can be any combination of the following values:
  - kFLEXIO_SPI_RxFullInterruptEnable
  - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_DisableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Disables the FlexIO SPI interrupt.

This function disables the FlexIO SPI interrupt.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – interrupt source The parameter can be any combination of the following values:
  - kFLEXIO_SPI_RxFullInterruptEnable
  - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_EnableDMA(*FLEXIO_SPI_Type* *base, uint32_t mask, bool enable)

Enables/disables the FlexIO SPI transmit DMA. This function enables/disables the FlexIO SPI Tx DMA, which means that asserting the kFLEXIO_SPI_TxEmptyFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – SPI DMA source.
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t FLEXIO_SPI_GetTxDataRegisterAddress(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Gets the FlexIO SPI transmit data register address for MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI transmit data register address.

static inline uint32_t FLEXIO_SPI_GetRxDataRegisterAddress(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Gets the FlexIO SPI receive data register address for the MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI receive data register address.

static inline void FLEXIO_SPI_Enable(*FLEXIO_SPI_Type* *base, bool enable)

Enables/disables the FlexIO SPI module operation.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.
- enable – True to enable, false does not have any effect.

void FLEXIO_SPI_MasterSetBaudRate(*FLEXIO_SPI_Type* *base, uint32_t baudRate_Bps, uint32_t srcClockHz)

Sets baud rate for the FlexIO SPI transfer, which is only used for the master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- baudRate_Bps – Baud Rate needed in Hz.
- srcClockHz – SPI source clock frequency in Hz.

static inline void FLEXIO_SPI_WriteData(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, uint32_t data)

Writes one byte of data, which is sent using the MSB method.

Note: This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- data – 8/16/32 bit data.

static inline uint32_t FLEXIO_SPI_ReadData(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Reads 8 bit/16 bit data.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

- direction – Shift direction of MSB first or LSB first.

Returns
8 bit/16 bit data received.

status_t FLEXIO_SPI_WriteBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, const uint8_t *buffer, size_t size)

Sends a buffer of data bytes.

Note: This function blocks using the polling method until all bytes have been sent.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The data bytes to send.
- size – The number of data bytes to send.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_ReadBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, uint8_t *buffer, size_t size)

Receives a buffer of bytes.

Note: This function blocks using the polling method until all bytes have been received.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The buffer to store the received bytes.
- size – The number of data bytes to be received.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_MasterTransferBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_transfer_t* *xfer)

Receives a buffer of bytes.

Note: This function blocks via polling until all bytes have been received.

Parameters

- base – pointer to FLEXIO_SPI_Type structure
- xfer – FlexIO SPI transfer structure, see flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully create the handle.

- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

void FLEXIO_SPI_FlushShifters(*FLEXIO_SPI_Type* *base)

Flush tx/rx shifters.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

status_t FLEXIO_SPI_MasterTransferCreateHandle(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *flexio_spi_master_transfer_callback_t* callback, void *userData)

Initializes the FlexIO SPI Master handle, which is used in transactional functions.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_SPI_MasterTransferNonBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Master transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- xfer – FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – SPI is not idle, is running another transfer.

void FLEXIO_SPI_MasterTransferAbort(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle)

Aborts the master data transfer, which used IRQ.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

status_t FLEXIO_SPI_MasterTransferGetCount(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, size_t *count)

Gets the data transfer status which used IRQ.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXIO_SPI_MasterTransferHandleIRQ(void *spiType, void *spiHandle)

FlexIO SPI master IRQ handler function.

Parameters

- spiType – Pointer to the FLEXIO_SPI_Type structure.
- spiHandle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

status_t FLEXIO_SPI_SlaveTransferCreateHandle(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle, *flexio_spi_slave_transfer_callback_t* callback, void *userData)

Initializes the FlexIO SPI Slave handle, which is used in transactional functions.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_SPI_SlaveTransferNonBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Slave transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- base – Pointer to the FLEXIO_SPI_Type structure.
- xfer – FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – SPI is not idle; it is running another transfer.

static inline void FLEXIO_SPI_SlaveTransferAbort(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle)

Aborts the slave data transfer which used IRQ, share same API with master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

static inline *status_t* FLEXIO_SPI_SlaveTransferGetCount(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle, size_t *count)

Gets the data transfer status which used IRQ, share same API with master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXIO_SPI_SlaveTransferHandleIRQ(void *spiType, void *spiHandle)

FlexIO SPI slave IRQ handler function.

Parameters

- spiType – Pointer to the FLEXIO_SPI_Type structure.
- spiHandle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

FSL_FLEXIO_SPI_DRIVER_VERSION

FlexIO SPI driver version.

Error codes for the FlexIO SPI driver.

Values:

enumerator kStatus_FLEXIO_SPI_Busy

FlexIO SPI is busy.

enumerator kStatus_FLEXIO_SPI_Idle

SPI is idle

enumerator kStatus_FLEXIO_SPI_Error

FlexIO SPI error.

enumerator kStatus_FLEXIO_SPI_Timeout

FlexIO SPI timeout polling status flags.

enum _flexio_spi_clock_phase

FlexIO SPI clock phase configuration.

Values:

enumerator kFLEXIO_SPI_ClockPhaseFirstEdge

First edge on SPSCK occurs at the middle of the first cycle of a data transfer.

enumerator kFLEXIO_SPI_ClockPhaseSecondEdge

First edge on SPSCK occurs at the start of the first cycle of a data transfer.

enum _flexio_spi_shift_direction

FlexIO SPI data shifter direction options.

Values:

enumerator kFLEXIO_SPI_MsbFirst

Data transfers start with most significant bit.

enumerator kFLEXIO_SPI_LsbFirst

Data transfers start with least significant bit.

enum _flexio_spi_data_bitcount_mode

FlexIO SPI data length mode options.

Values:

enumerator kFLEXIO_SPI_8BitMode

8-bit data transmission mode.

enumerator kFLEXIO_SPI_16BitMode

16-bit data transmission mode.

enumerator kFLEXIO_SPI_32BitMode

32-bit data transmission mode.

enum _flexio_spi_interrupt_enable

Define FlexIO SPI interrupt mask.

Values:

enumerator kFLEXIO_SPI_TxEmptyInterruptEnable

Transmit buffer empty interrupt enable.

enumerator kFLEXIO_SPI_RxFullInterruptEnable

Receive buffer full interrupt enable.

enum _flexio_spi_status_flags

Define FlexIO SPI status mask.

Values:

enumerator kFLEXIO_SPI_TxBufferEmptyFlag

Transmit buffer empty flag.

enumerator kFLEXIO_SPI_RxBufferFullFlag

Receive buffer full flag.

enum _flexio_spi_dma_enable

Define FlexIO SPI DMA mask.

Values:

enumerator kFLEXIO_SPI_TxDmaEnable

Tx DMA request source

enumerator kFLEXIO_SPI_RxDmaEnable
Rx DMA request source

enumerator kFLEXIO_SPI_DmaAllEnable
All DMA request source

enum _flexio_spi_transfer_flags
Define FlexIO SPI transfer flags.

Note: Use kFLEXIO_SPI_csContinuous and one of the other flags to OR together to form the transfer flag.

Values:

enumerator kFLEXIO_SPI_8bitMsb
FlexIO SPI 8-bit MSB first

enumerator kFLEXIO_SPI_8bitLsb
FlexIO SPI 8-bit LSB first

enumerator kFLEXIO_SPI_16bitMsb
FlexIO SPI 16-bit MSB first

enumerator kFLEXIO_SPI_16bitLsb
FlexIO SPI 16-bit LSB first

enumerator kFLEXIO_SPI_32bitMsb
FlexIO SPI 32-bit MSB first

enumerator kFLEXIO_SPI_32bitLsb
FlexIO SPI 32-bit LSB first

enumerator kFLEXIO_SPI_csContinuous
Enable the CS signal continuous mode

typedef enum *_flexio_spi_clock_phase* flexio_spi_clock_phase_t
FlexIO SPI clock phase configuration.

typedef enum *_flexio_spi_shift_direction* flexio_spi_shift_direction_t
FlexIO SPI data shifter direction options.

typedef enum *_flexio_spi_data_bitcount_mode* flexio_spi_data_bitcount_mode_t
FlexIO SPI data length mode options.

typedef struct *_flexio_spi_type* FLEXIO_SPI_Type
Define FlexIO SPI access structure typedef.

typedef struct *_flexio_spi_master_config* flexio_spi_master_config_t
Define FlexIO SPI master configuration structure.

typedef struct *_flexio_spi_slave_config* flexio_spi_slave_config_t
Define FlexIO SPI slave configuration structure.

typedef struct *_flexio_spi_transfer* flexio_spi_transfer_t
Define FlexIO SPI transfer structure.

typedef struct *_flexio_spi_master_handle* flexio_spi_master_handle_t
typedef for flexio_spi_master_handle_t in advance.

typedef *flexio_spi_master_handle_t* flexio_spi_slave_handle_t
Slave handle is the same with master handle.

typedef void (*flexio_spi_master_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI master callback for finished transmit.

typedef void (*flexio_spi_slave_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI slave callback for finished transmit.

FLEXIO_SPI_DUMMYDATA

FlexIO SPI dummy transfer data, the data is sent while txData is NULL.

SPI_RETRY_TIMES

Retry times for waiting flag.

FLEXIO_SPI_XFER_DATA_FORMAT(flag)

Get the transfer data format of width and bit order.

struct _flexio_spi_type

#include <fsl_flexio_spi.h> Define FlexIO SPI access structure typedef.

Public Members

FLEXIO_Type *flexioBase

FlexIO base pointer.

uint8_t SDOPinIndex

Pin select for data output. To set SDO pin in Hi-Z state, user needs to mux the pin as GPIO input and disable all pull up/down in application.

uint8_t SDIPinIndex

Pin select for data input.

uint8_t SCKPinIndex

Pin select for clock.

uint8_t CSnPinIndex

Pin select for enable.

uint8_t shifterIndex[2]

Shifter index used in FlexIO SPI.

uint8_t timerIndex[2]

Timer index used in FlexIO SPI.

struct _flexio_spi_master_config

#include <fsl_flexio_spi.h> Define FlexIO SPI master configuration structure.

Public Members

bool enableMaster

Enable/disable FlexIO SPI master after configuration.

bool enableInDoze

Enable/disable FlexIO operation in doze mode.

bool enableInDebug

Enable/disable FlexIO operation in debug mode.

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps

Baud rate in Bps.

flexio_spi_clock_phase_t phase

Clock phase.

flexio_spi_data_bitcount_mode_t dataMode

8bit or 16bit mode.

struct _flexio_spi_slave_config

#include <fsl_flexio_spi.h> Define FlexIO SPI slave configuration structure.

Public Members

bool enableSlave

Enable/disable FlexIO SPI slave after configuration.

bool enableInDoze

Enable/disable FlexIO operation in doze mode.

bool enableInDebug

Enable/disable FlexIO operation in debug mode.

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

flexio_spi_clock_phase_t phase

Clock phase.

flexio_spi_data_bitcount_mode_t dataMode

8bit or 16bit mode.

struct _flexio_spi_transfer

#include <fsl_flexio_spi.h> Define FlexIO SPI transfer structure.

Public Members

const uint8_t *txData

Send buffer.

uint8_t *rxData

Receive buffer.

size_t dataSize

Transfer bytes.

uint8_t flags

FlexIO SPI control flag, MSB first or LSB first.

struct _flexio_spi_master_handle

#include <fsl_flexio_spi.h> Define FlexIO SPI handle structure.

Public Members

const uint8_t *txData
Transfer buffer.

uint8_t *rxData
Receive buffer.

size_t transferSize
Total bytes to be transferred.

volatile size_t txRemainingBytes
Send data remaining in bytes.

volatile size_t rxRemainingBytes
Receive data remaining in bytes.

volatile uint32_t state
FlexIO SPI internal state.

uint8_t bytePerFrame
SPI mode, 2bytes or 1byte in a frame

flexio_spi_shift_direction_t direction
Shift direction.

flexio_spi_master_transfer_callback_t callback
FlexIO SPI callback.

void *userData
Callback parameter.

bool isCsContinuous
Is current transfer using CS continuous mode.

uint32_t timer1Cfg
TIMER1 TIMCFG regiser value backup.

2.56 FlexIO UART Driver

status_t FLEXIO_UART_Init(*FLEXIO_UART_Type* *base, const *flexio_uart_config_t* *userConfig, uint32_t srcClock_Hz)

Ungates the FlexIO clock, resets the FlexIO module, configures FlexIO UART hardware, and configures the FlexIO UART with FlexIO UART configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO_UART_GetDefaultConfig().

Example

```
FLEXIO_UART_Type base = {
.flexioBase = FLEXIO,
.TxPinIndex = 0,
.RxPinIndex = 1,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_uart_config_t config = {
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 115200U,
```

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```
.bitCountPerChar = 8
};
FLEXIO_UART_Init(base, &config, srcClock_Hz);
```

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- userConfig – Pointer to the flexio_uart_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

Return values

- kStatus_Success – Configuration success.
- kStatus_FLEXIO_UART_BaudrateNotSupport – Baudrate is not supported for current clock source frequency.

void FLEXIO_UART_Deinit(*FLEXIO_UART_Type* *base)

Resets the FlexIO UART shifter and timer config.

Note: After calling this API, call the FLEXO_UART_Init to use the FlexIO UART module.

Parameters

- base – Pointer to FLEXIO_UART_Type structure

void FLEXIO_UART_GetDefaultConfig(*flexio_uart_config_t* *userConfig)

Gets the default configuration to configure the FlexIO UART. The configuration can be used directly for calling the FLEXIO_UART_Init(). Example:

```
flexio_uart_config_t config;
FLEXIO_UART_GetDefaultConfig(&userConfig);
```

Parameters

- userConfig – Pointer to the flexio_uart_config_t structure.

uint32_t FLEXIO_UART_GetStatusFlags(*FLEXIO_UART_Type* *base)

Gets the FlexIO UART status flags.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART status flags.

void FLEXIO_UART_ClearStatusFlags(*FLEXIO_UART_Type* *base, uint32_t mask)

Gets the FlexIO UART status flags.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO_UART_TxDataRegEmptyFlag
  - kFLEXIO_UART_RxEmptyFlag

– kFLEXIO_UART_RxOverRunFlag

void FLEXIO_UART_EnableInterrupts(*FLEXIO_UART_Type* *base, uint32_t mask)

Enables the FlexIO UART interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Interrupt source.

void FLEXIO_UART_DisableInterrupts(*FLEXIO_UART_Type* *base, uint32_t mask)

Disables the FlexIO UART interrupt.

This function disables the FlexIO UART interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Interrupt source.

static inline uint32_t FLEXIO_UART_GetTxDataRegisterAddress(*FLEXIO_UART_Type* *base)

Gets the FlexIO UARt transmit data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART transmit data register address.

static inline uint32_t FLEXIO_UART_GetRxDataRegisterAddress(*FLEXIO_UART_Type* *base)

Gets the FlexIO UART receive data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART receive data register address.

static inline void FLEXIO_UART_EnableTxDMA(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART transmit DMA. This function enables/disables the FlexIO UART Tx DMA, which means asserting the kFLEXIO_UART_TxDataRegEmptyFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- enable – True to enable, false to disable.

static inline void FLEXIO_UART_EnableRxDMA(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART receive DMA. This function enables/disables the FlexIO UART Rx DMA, which means asserting kFLEXIO_UART_RxDataRegFullFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- enable – True to enable, false to disable.

static inline void FLEXIO_UART_Enable(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART module operation.

Parameters

- base – Pointer to the FLEXIO_UART_Type.
- enable – True to enable, false does not have any effect.

static inline void FLEXIO_UART_WriteByte(*FLEXIO_UART_Type* *base, const uint8_t *buffer)

Writes one byte of data.

Note: This is a non-blocking API, which returns directly after the data is put into the data register. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- buffer – The data bytes to send.

static inline void FLEXIO_UART_ReadByte(*FLEXIO_UART_Type* *base, uint8_t *buffer)

Reads one byte of data.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- buffer – The buffer to store the received bytes.

status_t FLEXIO_UART_WriteBlocking(*FLEXIO_UART_Type* *base, const uint8_t *txData, size_t txSize)

Sends a buffer of data bytes.

Note: This function blocks using the polling method until all bytes have been sent.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- txData – The data bytes to send.
- txSize – The number of data bytes to send.

Return values

- kStatus_FLEXIO_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t FLEXIO_UART_ReadBlocking(*FLEXIO_UART_Type* *base, uint8_t *rxData, size_t rxSize)

Receives a buffer of bytes.

Note: This function blocks using the polling method until all bytes have been received.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- rxData – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

Return values

- kStatus_FLEXIO_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

status_t FLEXIO_UART_TransferCreateHandle(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_callback_t* callback, void *userData)

Initializes the UART handle.

This function initializes the FlexIO UART handle, which can be used for other FlexIO UART transactional APIs. Call this API once to get the initialized handle.

The UART driver supports the "background" receiving, which means that users can set up a RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn't call the FLEXIO_UART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as ringBuffer.

Parameters

- base – to FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

void FLEXIO_UART_TransferStartRingBuffer(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, uint8_t *ringBuffer, size_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn't call the UART_ReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly.

Note: When using the RX ring buffer, one byte is reserved for internal use. In other words, if ringBufferSize is 32, only 31 bytes are used for saving data.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

- ringBuffer – Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
- ringBufferSize – Size of the ring buffer.

void FLEXIO_UART_TransferStopRingBuffer(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferSendNonBlocking(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Transmits a buffer of data using the interrupt method.

This function sends data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data to be written to the TX register. When all data is written to the TX register in ISR, the FlexIO UART driver calls the callback function and passes the kStatus_FLEXIO_UART_TxIdle as status parameter.

Note: The kStatus_FLEXIO_UART_TxIdle is passed to the upper layer when all data is written to the TX register. However, it does not ensure that all data is sent out.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- xfer – FlexIO UART transfer structure. See flexio_uart_transfer_t.

Return values

- kStatus_Success – Successfully starts the data transmission.
- kStatus_UART_TxBusy – Previous transmission still not finished, data not written to the TX register.

void FLEXIO_UART_TransferAbortSend(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt-driven data sending. Get the remainBytes to find out how many bytes are still not sent out.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferGetSendCount(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, size_t *count)

Gets the number of bytes sent.

This function gets the number of bytes sent driven by interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- count – Number of bytes sent so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

status_t FLEXIO_UART_TransferReceiveNonBlocking(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_t* *xfer, size_t *receivedBytes)

Receives a buffer of data using the interrupt method.

This function receives data using the interrupt method. This is a non-blocking function, which returns without waiting for all data to be received. If the RX ring buffer is used and not empty, the data in ring buffer is copied and the parameter receivedBytes shows how many bytes are copied from the ring buffer. After copying, if the data in ring buffer is not enough to read, the receive request is saved by the UART driver. When new data arrives, the receive request is serviced first. When all data is received, the UART driver notifies the upper layer through a callback function and passes the status parameter kStatus_UART_RxIdle. For example, if the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer, the 5 bytes are copied to xfer->data. This function returns with the parameter receivedBytes set to 5. For the last 5 bytes, newly arrived data is saved from the xfer->data[5]. When 5 bytes are received, the UART driver notifies upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to xfer->data. When all data is received, the upper layer is notified.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- xfer – UART transfer structure. See flexio_uart_transfer_t.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into the transmit queue.
- kStatus_FLEXIO_UART_RxBusy – Previous receive request is not finished.

void FLEXIO_UART_TransferAbortReceive(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the receive data which was using IRQ.

This function aborts the receive data which was using IRQ.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferGetReceiveCount(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, size_t *count)

Gets the number of bytes received.

This function gets the number of bytes received driven by interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- count – Number of bytes received so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

void FLEXIO_UART_TransferHandleIRQ(void *uartType, void *uartHandle)

FlexIO UART IRQ handler function.

This function processes the FlexIO UART transmit and receives the IRQ request.

Parameters

- uartType – Pointer to the FLEXIO_UART_Type structure.
- uartHandle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

void FLEXIO_UART_FlushShifters(*FLEXIO_UART_Type* *base)

Flush tx/rx shifters.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

FSL_FLEXIO_UART_DRIVER_VERSION

FlexIO UART driver version.

Error codes for the UART driver.

Values:

enumerator kStatus_FLEXIO_UART_TxBusy

Transmitter is busy.

enumerator kStatus_FLEXIO_UART_RxBusy

Receiver is busy.

enumerator kStatus_FLEXIO_UART_TxIdle

UART transmitter is idle.

enumerator kStatus_FLEXIO_UART_RxIdle

UART receiver is idle.

enumerator kStatus_FLEXIO_UART_ERROR

ERROR happens on UART.

enumerator kStatus_FLEXIO_UART_RxRingBufferOverrun

UART RX software ring buffer overrun.

enumerator kStatus_FLEXIO_UART_RxHardwareOverrun
UART RX receiver overrun.

enumerator kStatus_FLEXIO_UART_Timeout
UART times out.

enumerator kStatus_FLEXIO_UART_BaudrateNotSupport
Baudrate is not supported in current clock source

enum _flexio_uart_bit_count_per_char
FlexIO UART bit count per char.

Values:

enumerator kFLEXIO_UART_7BitsPerChar
7-bit data characters

enumerator kFLEXIO_UART_8BitsPerChar
8-bit data characters

enumerator kFLEXIO_UART_9BitsPerChar
9-bit data characters

enum _flexio_uart_interrupt_enable
Define FlexIO UART interrupt mask.

Values:

enumerator kFLEXIO_UART_TxDataRegEmptyInterruptEnable
Transmit buffer empty interrupt enable.

enumerator kFLEXIO_UART_RxDataRegFullInterruptEnable
Receive buffer full interrupt enable.

enum _flexio_uart_status_flags
Define FlexIO UART status mask.

Values:

enumerator kFLEXIO_UART_TxDataRegEmptyFlag
Transmit buffer empty flag.

enumerator kFLEXIO_UART_RxDataRegFullFlag
Receive buffer full flag.

enumerator kFLEXIO_UART_RxOverRunFlag
Receive buffer over run flag.

typedef enum *_flexio_uart_bit_count_per_char* flexio_uart_bit_count_per_char_t
FlexIO UART bit count per char.

typedef struct *_flexio_uart_type* FLEXIO_UART_Type
Define FlexIO UART access structure typedef.

typedef struct *_flexio_uart_config* flexio_uart_config_t
Define FlexIO UART user configuration structure.

typedef struct *_flexio_uart_transfer* flexio_uart_transfer_t
Define FlexIO UART transfer structure.

typedef struct *_flexio_uart_handle* flexio_uart_handle_t

typedef void (*flexio_uart_transfer_callback_t)(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *status_t* status, void *userData)

FlexIO UART transfer callback function.

UART_RETRY_TIMES

Retry times for waiting flag.

struct _flexio_uart_type

#include <fsl_flexio_uart.h> Define FlexIO UART access structure typedef.

Public Members

FLEXIO_Type *flexioBase

FlexIO base pointer.

uint8_t TxPinIndex

Pin select for UART_Tx.

uint8_t RxPinIndex

Pin select for UART_Rx.

uint8_t shifterIndex[2]

Shifter index used in FlexIO UART.

uint8_t timerIndex[2]

Timer index used in FlexIO UART.

struct _flexio_uart_config

#include <fsl_flexio_uart.h> Define FlexIO UART user configuration structure.

Public Members

bool enableUart

Enable/disable FlexIO UART TX & RX.

bool enableInDoze

Enable/disable FlexIO operation in doze mode

bool enableInDebug

Enable/disable FlexIO operation in debug mode

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps

Baud rate in Bps.

flexio_uart_bit_count_per_char_t bitCountPerChar

number of bits, 7/8/9 -bit

struct _flexio_uart_transfer

#include <fsl_flexio_uart.h> Define FlexIO UART transfer structure.

Public Members

size_t dataSize

Transfer size

struct __flexio_uart_handle

#include <fsl_flexio_uart.h> Define FLEXIO UART handle structure.

Public Members

const uint8_t *volatile txData
: Address of remaining data to send.

volatile size_t txDataSize
: Size of the remaining data to send.

uint8_t *volatile rxData
: Address of remaining data to receive.

volatile size_t rxDataSize
: Size of the remaining data to receive.

size_t txDataSizeAll
: Total bytes to be sent.

size_t rxDataSizeAll
: Total bytes to be received.

uint8_t *rxRingBuffer
: Start address of the receiver ring buffer.

size_t rxRingBufferSize
: Size of the ring buffer.

volatile uint16_t rxRingBufferHead
: Index for the driver to store received data into ring buffer.

volatile uint16_t rxRingBufferTail
: Index for the user to get data from the ring buffer.

flexio_uart_transfer_callback_t callback
: Callback function.

void *userData
: UART callback function parameter.

volatile uint8_t txState
: TX transfer state.

volatile uint8_t rxState
: RX transfer state

union ___unnamed150___

Public Members

uint8_t *data
: The buffer of data to be transfer.

uint8_t *rxData
: The buffer to receive data.

const uint8_t *txData
: The buffer of data to be sent.

2.57 FLEXRAM: on-chip RAM manager

FLEXRAM bank type.

Values:

enumerator kFLEXRAM_BankNotUsed
bank is not used

enumerator kFLEXRAM_BankOCRAM
bank is OCRAM

enumerator kFLEXRAM_BankDTCM
bank is DTCM

enumerator kFLEXRAM_BankITCM
bank is ITCM

enum _flexram_bank_allocate_src
FLEXRAM bank allocate source.

Values:

enumerator kFLEXRAM_BankAllocateThroughHardwareFuse
allocate ram through hardware fuse value

enumerator kFLEXRAM_BankAllocateThroughBankCfg
allocate ram through FLEXRAM_BANK_CFG

typedef enum *_flexram_bank_allocate_src* flexram_bank_allocate_src_t
FLEXRAM bank allocate source.

typedef struct *_flexram_allocate_ram* flexram_allocate_ram_t
FLEXRAM allocates OCRAM, ITCM, DTCM size.

status_t FLEXRAM_AllocateRam(*flexram_allocate_ram_t* *config)
FLEXRAM allocates an on-chip ram for OCRAM, ITCM and DTCM. This function is independent from FLEXRAM_Init, and can be called directly if ram re-allocate is needed.

Parameters

- config – Allocate configuration.

Return values

- kStatus_InvalidArgument – When the argument is invalid.
- kStatus_Success – Upon allocate success.

static inline void FLEXRAM_SetAllocateRamSrc(*flexram_bank_allocate_src_t* src)
FLEXRAM set allocate on-chip ram source.

Parameters

- src – Bank config source select value.

FSL_SOC_FLEXRAM_ALLOCATE_DRIVER_VERSION
SOC_FLEXRAM_ALLOCATE driver version 2.0.2.

void FLEXRAM_Init(FLEXRAM_Type *base)
FLEXRAM module initialization function.

Parameters

- base – FLEXRAM base address.

void FLEXRAM_Deinit(FLEXRAM_Type *base)
De-initializes the FLEXRAM.

static inline uint32_t FLEXRAM_GetInterruptStatus(FLEXRAM_Type *base)
FLEXRAM module gets interrupt status.

Parameters

- base – FLEXRAM base address.

static inline void FLEXRAM_ClearInterruptStatus(FLEXRAM_Type *base, uint32_t status)
FLEXRAM module clears interrupt status.

Parameters

- base – FLEXRAM base address.
- status – Status to be cleared.

static inline void FLEXRAM_EnableInterruptStatus(FLEXRAM_Type *base, uint32_t status)
FLEXRAM module enables interrupt status.

Parameters

- base – FLEXRAM base address.
- status – Status to be enabled.

static inline void FLEXRAM_DisableInterruptStatus(FLEXRAM_Type *base, uint32_t status)
FLEXRAM module disable interrupt status.

Parameters

- base – FLEXRAM base address.
- status – Status to be disabled.

static inline void FLEXRAM_EnableInterruptSignal(FLEXRAM_Type *base, uint32_t status)
FLEXRAM module enables interrupt.

Parameters

- base – FLEXRAM base address.
- status – Status interrupt to be enabled.

static inline void FLEXRAM_DisableInterruptSignal(FLEXRAM_Type *base, uint32_t status)
FLEXRAM module disables interrupt.

Parameters

- base – FLEXRAM base address.
- status – Status interrupt to be disabled.

FSL_FLEXRAM_DRIVER_VERSION
Driver version.

Flexram write/read selection.

Values:

enumerator kFLEXRAM_Read
read

enumerator kFLEXRAM_Write
write

Interrupt status flag mask.

Values:

enumerator kFLEXRAM_OCRAMAccessError
OCRAM accesses unallocated address

enumerator kFLEXRAM_DTCMAccessError
DTCM accesses unallocated address

enumerator kFLEXRAM_ITCMAccessError
ITCM accesses unallocated address

enumerator kFLEXRAM_OCRAMMagicAddrMatch
OCRAM magic address match

enumerator kFLEXRAM_DTCMMagicAddrMatch
DTCM magic address match

enumerator kFLEXRAM_ITCMMagicAddrMatch
ITCM magic address match

enumerator kFLEXRAM_OCRAMECCMultiError

enumerator kFLEXRAM_OCRAMECCSingleError

enumerator kFLEXRAM_ITCMECCMultiError

enumerator kFLEXRAM_ITCMECCSingleError

enumerator kFLEXRAM_D0TCMECCMultiError

enumerator kFLEXRAM_D0TCMECCSingleError

enumerator kFLEXRAM_D1TCMECCMultiError

enumerator kFLEXRAM_D1TCMECCSingleError

enumerator kFLEXRAM_InterruptStatusAll

enum _flexram_tcm_access_mode
FLEXRAM TCM access mode. Fast access mode expected to be finished in 1-cycle; Wait access mode expected to be finished in 2-cycle. Wait access mode is a feature of the flexram and it should be used when the CPU clock is too fast to finish TCM access in 1-cycle. Normally, fast mode is the default mode, the efficiency of the TCM access will better.

Values:

enumerator kFLEXRAM_TCMAccessFastMode
fast access mode

enumerator kFLEXRAM_TCMAccessWaitMode
wait access mode

FLEXRAM TCM support size.

Values:

enumerator kFLEXRAM_TCMSize32KB
TCM total size be 32KB

enumerator kFLEXRAM_TCMSize64KB
TCM total size be 64KB

enumerator kFLEXRAM_TCMSize128KB
TCM total size be 128KB

enumerator kFLEXRAM_TCMSize256KB
TCM total size be 256KB

enumerator kFLEXRAM_TCMSize512KB
TCM total size be 512KB

enum _flexram_memory_type
FLEXRAM memory type, such as OCRAM/ITCM/D0TCM/D1TCM.

Values:

enumerator kFLEXRAM_OCRAM
Memory type OCRAM

enumerator kFLEXRAM_ITCM
Memory type ITCM

enumerator kFLEXRAM_D0TCM
Memory type D0TCM

enumerator kFLEXRAM_D1TCM
Memory type D1TCM

typedef enum *_flexram_tcm_access_mode* flexram_tcm_access_mode_t
FLEXRAM TCM access mode. Fast access mode expected to be finished in 1-cycle; Wait access mode expected to be finished in 2-cycle. Wait access mode is a feature of the flexram and it should be used when the CPU clock is too fast to finish TCM access in 1-cycle. Normally, fast mode is the default mode, the efficiency of the TCM access will better.

typedef enum *_flexram_memory_type* flexram_memory_type_t
FLEXRAM memory type, such as OCRAM/ITCM/D0TCM/D1TCM.

typedef struct *_flexram_ecc_error_type* flexram_ecc_error_type_t
FLEXRAM error type, such as single bit error position, multi-bit error position.

typedef struct *_flexram_ocram_ecc_single_error_info* flexram_ocram_ecc_single_error_info_t
FLEXRAM ocram ecc single error information, including single error information, error address, error data.

typedef struct *_flexram_ocram_ecc_multi_error_info* flexram_ocram_ecc_multi_error_info_t
FLEXRAM ocram ecc multiple error information, including multiple error information, error address, error data.

typedef struct *_flexram_itcm_ecc_single_error_info* flexram_itcm_ecc_single_error_info_t
FLEXRAM itcm ecc single error information, including single error information, error address, error data.

typedef struct *_flexram_itcm_ecc_multi_error_info* flexram_itcm_ecc_multi_error_info_t
FLEXRAM itcm ecc multiple error information, including multiple error information, error address, error data.

typedef struct *_flexram_dtcm_ecc_single_error_info* flexram_dtcm_ecc_single_error_info_t
FLEXRAM dtcm ecc single error information, including single error information, error address, error data.

typedef struct *_flexram_dtcm_ecc_multi_error_info* flexram_dtcm_ecc_multi_error_info_t
FLEXRAM dtcm ecc multiple error information, including multiple error information, error address, error data.

const uint8_t ocramBankNum

OCRAM banknumber which the SOC support.

const uint8_t dtcmBankNum

DTCM bank number to allocate, the number should be power of 2.

const uint8_t itcmBankNum

ITCM bank number to allocate, the number should be power of 2.

static inline void FLEXRAM_SetTCMReadAccessMode(FLEXRAM_Type *base, *flexram_tcm_access_mode_t* mode)

FLEXRAM module sets TCM read access mode.

Parameters

- base – FLEXRAM base address.
- mode – Access mode.

static inline void FLEXRAM_SetTCMWriteAccessMode(FLEXRAM_Type *base, *flexram_tcm_access_mode_t* mode)

FLEXRAM module set TCM write access mode.

Parameters

- base – FLEXRAM base address.
- mode – Access mode.

static inline void FLEXRAM_EnableForceRamClockOn(FLEXRAM_Type *base, bool enable)

FLEXRAM module force ram clock on.

Parameters

- base – FLEXRAM base address.
- enable – Enable or disable clock force on.

static inline void FLEXRAM_SetOCRAMMagicAddr(FLEXRAM_Type *base, uint16_t magicAddr, uint32_t rwSel)

FLEXRAM OCRAM magic addr configuration. When read/write access hit magic address, it will generate interrupt.

Parameters

- base – FLEXRAM base address.
- magicAddr – Magic address, the actual address bits [18:3] is corresponding to the register field [16:1].
- rwSel – Read/write selection. 0 for read access while 1 for write access.

static inline void FLEXRAM_SetDTCMMagicAddr(FLEXRAM_Type *base, uint16_t magicAddr, uint32_t rwSel)

FLEXRAM DTCM magic addr configuration. When read/write access hits magic address, it will generate interrupt.

Parameters

- base – FLEXRAM base address.
- magicAddr – Magic address, the actual address bits [18:3] is corresponding to the register field [16:1].
- rwSel – Read/write selection. 0 for read access while 1 write access.

static inline void FLEXRAM_SetITCMMagicAddr(FLEXRAM_Type *base, uint16_t magicAddr, uint32_t rwSel)

FLEXRAM ITCM magic addr configuration. When read/write access hits magic address, it will generate interrupt.

Parameters

- base – FLEXRAM base address.
- magicAddr – Magic address, the actual address bits [18:3] is corresponding to the register field [16:1].
- rwSel – Read/write selection. 0 for read access while 1 for write access.

void FLEXRAM_EnableECC(FLEXRAM_Type *base, bool OcramECCEnable, bool TcmECCEnable)

FLEXRAM get ocram ecc single error information.

Parameters

- base – FLEXRAM base address.
- OcramECCEnable – ocram ecc enablement.
- TcmECCEnable – tcm(itcm/d0tcm/d1tcm) ecc enablement.

void FLEXRAM_ErrorInjection(FLEXRAM_Type *base, *flexram_memory_type_t* memory, *flexram_ecc_error_type_t* *error)

FLEXRAM ECC error injection.

Parameters

- base – FLEXRAM base address.
- memory – memory type, such as OCRAM/ITCM/DTCM.
- error – ECC error type.

void FLEXRAM_GetOcramSingleErroInfo(FLEXRAM_Type *base, *flexram_ocram_ecc_single_error_info_t* *info)

FLEXRAM get ocram ecc single error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.

void FLEXRAM_GetOcramMultiErroInfo(FLEXRAM_Type *base, *flexram_ocram_ecc_multi_error_info_t* *info)

FLEXRAM get ocram ecc multiple error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.

void FLEXRAM_GetItcmSingleErroInfo(FLEXRAM_Type *base, *flexram_itcm_ecc_single_error_info_t* *info)

FLEXRAM get itcm ecc single error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.

void FLEXRAM_GetItcmMultiErroInfo(FLEXRAM_Type *base, *flexram_itcm_ecc_multi_error_info_t* *info)

FLEXRAM get itcm ecc multiple error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.

void FLEXRAM_GetDtcmSingleErroInfo(FLEXRAM_Type *base, *flexram_dtcm_ecc_single_error_info_t* *info, uint8_t bank)

FLEXRAM get d0tcm ecc single error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.
- bank – DTCM bank, 0 is D0TCM, 1 is D1TCM.

void FLEXRAM_GetDtcmMultiErroInfo(FLEXRAM_Type *base, *flexram_dtcm_ecc_multi_error_info_t* *info, uint8_t bank)

FLEXRAM get d0tcm ecc multiple error information.

Parameters

- base – FLEXRAM base address.
- info – ecc error information.
- bank – DTCM bank, 0 is D0TCM, 1 is D1TCM.

FLEXRAM_ECC_ERROR_DETAILED_INFO

Get ECC error detailed information.

struct _flexram_allocate_ram

#include <fsl_flexram_allocate.h> FLEXRAM allocates OCRAM, ITCM, DTCM size.

struct _flexram_ecc_error_type

#include <fsl_flexram.h> FLEXRAM error type, such as single bit error position, multi-bit error position.

Public Members

uint8_t SingleBitPos

Bit position of the bit to inject ECC Error.

uint8_t SecondBitPos

Bit position of the second bit to inject multi-bit ECC Error

bool Fource1BitDataInversion

Force One 1-Bit Data Inversion (single-bit ECC error) on memory write access

bool FourceOneNCDataInversion

Force One Non-correctable Data Inversion(multi-bit ECC error) on memory write access

bool FourceConti1BitDataInversion

Force Continuous 1-Bit Data Inversions (single-bit ECC error) on memory write access

bool FourceContiNCDataInversion

Force Continuous Non-correctable Data Inversions (multi-bit ECC error) on memory write access

struct __flexram__ocram__ecc__single__error__info

#include <fsl_flexram.h> FLEXRAM ocram ecc single error information, including single error information, error address, error data.

Public Members

uint32_t OcramSingleErrorInfo

Ocram single error information, user should parse it by themself.

uint32_t OcramSingleErrorAddr

Ocram single error address

uint32_t OcramSingleErrorDataLSB

Ocram single error data LSB

uint32_t OcramSingleErrorDataMSB

Ocram single error data MSB

struct __flexram__ocram__ecc__multi__error__info

#include <fsl_flexram.h> FLEXRAM ocram ecc multiple error information, including multiple error information, error address, error data.

Public Members

uint32_t OcramMultiErrorInfo

Ocram single error information, user should parse it by themself.

uint32_t OcramMultiErrorAddr

Ocram multiple error address

uint32_t OcramMultiErrorDataLSB

Ocram multiple error data LSB

uint32_t OcramMultiErrorDataMSB

Ocram multiple error data MSB

struct __flexram__itcm__ecc__single__error__info

#include <fsl_flexram.h> FLEXRAM itcm ecc single error information, including single error information, error address, error data.

Public Members

uint32_t ItcmSingleErrorInfo

itcm single error information, user should parse it by themself.

uint32_t ItcmSingleErrorAddr

itcm single error address

uint32_t ItcmSingleErrorDataLSB

itcm single error data LSB

uint32_t ItcmSingleErrorDataMSB

itcm single error data MSB

struct __flexram_itcm_ecc_multi_error_info

#include <fsl_flexram.h> FLEXRAM itcm ecc multiple error information, including multiple error information, error address, error data.

Public Members

uint32_t ItcmMultiErrorInfo

itcm multiple error information, user should parse it by themself.

uint32_t ItcmMultiErrorAddr

itcm multiple error address

uint32_t ItcmMultiErrorDataLSB

itcm multiple error data LSB

uint32_t ItcmMultiErrorDataMSB

itcm multiple error data MSB

struct __flexram_dtcm_ecc_single_error_info

#include <fsl_flexram.h> FLEXRAM dtcm ecc single error information, including single error information, error address, error data.

Public Members

uint32_t DtcmSingleErrorInfo

dtcm single error information, user should parse it by themself.

uint32_t DtcmSingleErrorAddr

dtcm single error address

uint32_t DtcmSingleErrorData

dtcm single error data

struct __flexram_dtcm_ecc_multi_error_info

#include <fsl_flexram.h> FLEXRAM dtcm ecc multiple error information, including multiple error information, error address, error data.

Public Members

uint32_t DtcmMultiErrorInfo

dtcm multiple error information, user should parse it by themself.

uint32_t DtcmMultiErrorAddr

dtcm multiple error address

uint32_t DtcmMultiErrorData

dtcm multiple error data

2.58 FLEXSPI: Flexible Serial Peripheral Interface Driver

uint32_t FLEXSPI_GetInstance(FLEXSPI_Type *base)

Get the instance number for FLEXSPI.

Parameters

- base – FLEXSPI base pointer.

status_t FLEXSPI_CheckAndClearError(FLEXSPI_Type *base, uint32_t status)

Check and clear IP command execution errors.

Parameters

- base – FLEXSPI base pointer.
- status – interrupt status.

void FLEXSPI_Init(FLEXSPI_Type *base, const *flexspi_config_t* *config)

Initializes the FLEXSPI module and internal state.

This function enables the clock for FLEXSPI and also configures the FLEXSPI with the input configure parameters. Users should call this function before any FLEXSPI operations.

Parameters

- base – FLEXSPI peripheral base address.
- config – FLEXSPI configure structure.

void FLEXSPI_GetDefaultConfig(*flexspi_config_t* *config)

Gets default settings for FLEXSPI.

Parameters

- config – FLEXSPI configuration structure.

void FLEXSPI_Deinit(FLEXSPI_Type *base)

Deinitializes the FLEXSPI module.

Clears the FLEXSPI state and FLEXSPI module registers.

Parameters

- base – FLEXSPI peripheral base address.

void FLEXSPI_UpdateDllValue(FLEXSPI_Type *base, *flexspi_device_config_t* *config, *flexspi_port_t* port)

Update FLEXSPI DLL value depending on currently flexspi root clock.

Parameters

- base – FLEXSPI peripheral base address.
- config – Flash configuration parameters.
- port – FLEXSPI Operation port.

void FLEXSPI_SetFlashConfig(FLEXSPI_Type *base, *flexspi_device_config_t* *config, *flexspi_port_t* port)

Configures the connected device parameter.

This function configures the connected device relevant parameters, such as the size, command, and so on. The flash configuration value cannot have a default value. The user needs to configure it according to the connected device.

Parameters

- base – FLEXSPI peripheral base address.
- config – Flash configuration parameters.
- port – FLEXSPI Operation port.

void FLEXSPI_SoftwareReset(FLEXSPI_Type *base)

Software reset for the FLEXSPI logic.

This function sets the software reset flags for both AHB and buffer domain and resets both AHB buffer and also IP FIFOs.

Parameters

- base – FLEXSPI peripheral base address.

static inline void FLEXSPI_Enable(FLEXSPI_Type *base, bool enable)

Enables or disables the FLEXSPI module.

Parameters

- base – FLEXSPI peripheral base address.
- enable – True means enable FLEXSPI, false means disable.

static inline void FLEXSPI_EnableInterrupts(FLEXSPI_Type *base, uint32_t mask)

Enables the FLEXSPI interrupts.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

static inline void FLEXSPI_DisableInterrupts(FLEXSPI_Type *base, uint32_t mask)

Disable the FLEXSPI interrupts.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

static inline void FLEXSPI_EnableTxDMA(FLEXSPI_Type *base, bool enable)

Enables or disables FLEXSPI IP Tx FIFO DMA requests.

Parameters

- base – FLEXSPI peripheral base address.
- enable – Enable flag for transmit DMA request. Pass true for enable, false for disable.

static inline void FLEXSPI_EnableRxDMA(FLEXSPI_Type *base, bool enable)

Enables or disables FLEXSPI IP Rx FIFO DMA requests.

Parameters

- base – FLEXSPI peripheral base address.
- enable – Enable flag for receive DMA request. Pass true for enable, false for disable.

static inline uint32_t FLEXSPI_GetTxFifoAddress(FLEXSPI_Type *base)

Gets FLEXSPI IP tx fifo address for DMA transfer.

Parameters

- base – FLEXSPI peripheral base address.

Return values

The – tx fifo address.

static inline uint32_t FLEXSPI_GetRxFifoAddress(FLEXSPI_Type *base)

Gets FLEXSPI IP rx fifo address for DMA transfer.

Parameters

- base – FLEXSPI peripheral base address.

Return values

The – rx fifo address.

static inline void FLEXSPI_ResetFifos(FLEXSPI_Type *base, bool txFifo, bool rxFifo)

Clears the FLEXSPI IP FIFO logic.

Parameters

- base – FLEXSPI peripheral base address.
- txFifo – Pass true to reset TX FIFO.
- rxFifo – Pass true to reset RX FIFO.

static inline void FLEXSPI_GetFifoCounts(FLEXSPI_Type *base, size_t *txCount, size_t *rxCount)

Gets the valid data entries in the FLEXSPI FIFOs.

Parameters

- base – FLEXSPI peripheral base address.
- txCount – **[out]** Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
- rxCount – **[out]** Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

static inline uint32_t FLEXSPI_GetInterruptStatusFlags(FLEXSPI_Type *base)

Get the FLEXSPI interrupt status flags.

Parameters

- base – FLEXSPI peripheral base address.

Return values

interrupt – status flag, use status flag to AND flexspi_flags_t could get the related status.

static inline void FLEXSPI_ClearInterruptStatusFlags(FLEXSPI_Type *base, uint32_t mask)

Get the FLEXSPI interrupt status flags.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

static inline *flexspi_arb_command_source_t* FLEXSPI_GetArbitratorCommandSource(FLEXSPI_Type *base)

Gets the trigger source of current command sequence granted by arbitrator.

Parameters

- base – FLEXSPI peripheral base address.

Return values

trigger – source of current command sequence.

static inline *flexspi_ip_error_code_t* FLEXSPI_GetIPCommandErrorCode(FLEXSPI_Type *base, uint8_t *index)

Gets the error code when IP command error detected.

Parameters

- base – FLEXSPI peripheral base address.
- index – Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error – code when IP command error detected.

static inline *flexspi_ahb_error_code_t* FLEXSPI_GetAHBCommandErrorCode(FLEXSPI_Type *base, uint8_t *index)

Gets the error code when AHB command error detected.

Parameters

- base – FLEXSPI peripheral base address.
- index – Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error – code when AHB command error detected.

static inline bool FLEXSPI_GetBusIdleStatus(FLEXSPI_Type *base)

Returns whether the bus is idle.

Parameters

- base – FLEXSPI peripheral base address.

Return values

- true – Bus is idle.
- false – Bus is busy.

void FLEXSPI_UpdateRxSampleClock(FLEXSPI_Type *base, *flexspi_read_sample_clock_t* clockSource)

Update read sample clock source.

Parameters

- base – FLEXSPI peripheral base address.
- clockSource – clockSource of type flexspi_read_sample_clock_t

void FLEXSPI_UpdateLUT(FLEXSPI_Type *base, uint32_t index, const uint32_t *cmd, uint32_t count)

Updates the LUT table.

Parameters

- base – FLEXSPI peripheral base address.
- index – From which index start to update. It could be any index of the LUT table, which also allows user to update command content inside a command. Each command consists of up to 8 instructions and occupy 4*32-bit memory.
- cmd – Command sequence array.
- count – Number of sequences.

static inline void FLEXSPI_WriteData(FLEXSPI_Type *base, uint32_t data, uint8_t fifoIndex)

Writes data into FIFO.

Parameters

- base – FLEXSPI peripheral base address
- data – The data bytes to send
- fifoIndex – Destination fifo index.

static inline uint32_t FLEXSPI_ReadData(FLEXSPI_Type *base, uint8_t fifoIndex)

Receives data from data FIFO.

Parameters

- base – FLEXSPI peripheral base address
- fifoIndex – Source fifo index.

Returns
The data in the FIFO.

status_t FLEXSPI_WriteBlocking(FLEXSPI_Type *base, uint8_t *buffer, size_t size)

Sends a buffer of data bytes using blocking method.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- base – FLEXSPI peripheral base address
- buffer – The data bytes to send
- size – The number of data bytes to send

Return values

- kStatus_Success – write success without error
- kStatus_FLEXSPI_SequenceExecutionTimeout – sequence execution timeout
- kStatus_FLEXSPI_IpCommandSequenceError – IP command sequence error detected
- kStatus_FLEXSPI_IpCommandGrantTimeout – IP command grant timeout detected

status_t FLEXSPI_ReadBlocking(FLEXSPI_Type *base, uint8_t *buffer, size_t size)

Receives a buffer of data bytes using a blocking method.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- base – FLEXSPI peripheral base address
- buffer – The data bytes to send
- size – The number of data bytes to receive

Return values

- kStatus_Success – read success without error
- kStatus_FLEXSPI_SequenceExecutionTimeout – sequence execution timeout
- kStatus_FLEXSPI_IpCommandSequenceError – IP command sequencen error detected
- kStatus_FLEXSPI_IpCommandGrantTimeout – IP command grant timeout detected

status_t FLEXSPI_TransferBlocking(FLEXSPI_Type *base, *flexspi_transfer_t* *xfer)

Execute command to transfer a buffer data bytes using a blocking method.

Parameters

- base – FLEXSPI peripheral base address

- xfer – pointer to the transfer structure.

Return values

- kStatus_Success – command transfer success without error
- kStatus_FLEXSPI_SequenceExecutionTimeout – sequence execution timeout
- kStatus_FLEXSPI_IpCommandSequenceError – IP command sequence error detected
- kStatus_FLEXSPI_IpCommandGrantTimeout – IP command grant timeout detected

void FLEXSPI_TransferCreateHandle(FLEXSPI_Type *base, *flexspi_handle_t* *handle, *flexspi_transfer_callback_t* callback, void *userData)

Initializes the FLEXSPI handle which is used in transactional functions.

Parameters

- base – FLEXSPI peripheral base address.
- handle – pointer to flexspi_handle_t structure to store the transfer state.
- callback – pointer to user callback function.
- userData – user parameter passed to the callback function.

status_t FLEXSPI_TransferNonBlocking(FLEXSPI_Type *base, *flexspi_handle_t* *handle, *flexspi_transfer_t* *xfer)

Performs a interrupt non-blocking transfer on the FLEXSPI bus.

Note: Calling the API returns immediately after transfer initiates. The user needs to call FLEXSPI_GetTransferCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_FLEXSPI_Busy, the transfer is finished. For FLEXSPI_Read, the dataSize should be multiple of rx watermark level, or FLEXSPI could not read data properly.

Parameters

- base – FLEXSPI peripheral base address.
- handle – pointer to flexspi_handle_t structure which stores the transfer state.
- xfer – pointer to flexspi_transfer_t structure.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_FLEXSPI_Busy – Previous transmission still not finished.

status_t FLEXSPI_TransferGetCount(FLEXSPI_Type *base, *flexspi_handle_t* *handle, size_t *count)

Gets the master transfer status during a interrupt non-blocking transfer.

Parameters

- base – FLEXSPI peripheral base address.
- handle – pointer to flexspi_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXSPI_TransferAbort(FLEXSPI_Type *base, *flexspi_handle_t* *handle)

Aborts an interrupt non-blocking transfer early.

Note: This API can be called at any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – FLEXSPI peripheral base address.
- handle – pointer to flexspi_handle_t structure which stores the transfer state

void FLEXSPI_TransferHandleIRQ(FLEXSPI_Type *base, *flexspi_handle_t* *handle)

Master interrupt handler.

Parameters

- base – FLEXSPI peripheral base address.
- handle – pointer to flexspi_handle_t structure.

FSL_FLEXSPI_DRIVER_VERSION

FLEXSPI driver version.

Status structure of FLEXSPI.

Values:

enumerator kStatus_FLEXSPI_Busy

FLEXSPI is busy

enumerator kStatus_FLEXSPI_SequenceExecutionTimeout

Sequence execution timeout error occurred during FLEXSPI transfer.

enumerator kStatus_FLEXSPI_IpCommandSequenceError

IP command Sequence execution timeout error occurred during FLEXSPI transfer.

enumerator kStatus_FLEXSPI_IpCommandGrantTimeout

IP command grant timeout error occurred during FLEXSPI transfer.

CMD definition of FLEXSPI, use to form LUT instruction, _flexspi_command.

Values:

enumerator kFLEXSPI_Command_STOP

Stop execution, deassert CS.

enumerator kFLEXSPI_Command_SDR

Transmit Command code to Flash, using SDR mode.

enumerator kFLEXSPI_Command_RADDR_SDR

Transmit Row Address to Flash, using SDR mode.

enumerator kFLEXSPI_Command_CADDR_SDR

Transmit Column Address to Flash, using SDR mode.

enumerator kFLEXSPI_Command_MODE1_SDR
Transmit 1-bit Mode bits to Flash, using SDR mode.

enumerator kFLEXSPI_Command_MODE2_SDR
Transmit 2-bit Mode bits to Flash, using SDR mode.

enumerator kFLEXSPI_Command_MODE4_SDR
Transmit 4-bit Mode bits to Flash, using SDR mode.

enumerator kFLEXSPI_Command_MODE8_SDR
Transmit 8-bit Mode bits to Flash, using SDR mode.

enumerator kFLEXSPI_Command_WRITE_SDR
Transmit Programming Data to Flash, using SDR mode.

enumerator kFLEXSPI_Command_READ_SDR
Receive Read Data from Flash, using SDR mode.

enumerator kFLEXSPI_Command_LEARN_SDR
Receive Read Data or Preamble bit from Flash, SDR mode.

enumerator kFLEXSPI_Command_DATSZ_SDR
Transmit Read/Program Data size (byte) to Flash, SDR mode.

enumerator kFLEXSPI_Command_DUMMY_SDR
Leave data lines undriven by FlexSPI controller.

enumerator kFLEXSPI_Command_DUMMY_RWDS_SDR
Leave data lines undriven by FlexSPI controller, dummy cycles decided by RWDS.

enumerator kFLEXSPI_Command_DDR
Transmit Command code to Flash, using DDR mode.

enumerator kFLEXSPI_Command_RADDR_DDR
Transmit Row Address to Flash, using DDR mode.

enumerator kFLEXSPI_Command_CADDR_DDR
Transmit Column Address to Flash, using DDR mode.

enumerator kFLEXSPI_Command_MODE1_DDR
Transmit 1-bit Mode bits to Flash, using DDR mode.

enumerator kFLEXSPI_Command_MODE2_DDR
Transmit 2-bit Mode bits to Flash, using DDR mode.

enumerator kFLEXSPI_Command_MODE4_DDR
Transmit 4-bit Mode bits to Flash, using DDR mode.

enumerator kFLEXSPI_Command_MODE8_DDR
Transmit 8-bit Mode bits to Flash, using DDR mode.

enumerator kFLEXSPI_Command_WRITE_DDR
Transmit Programming Data to Flash, using DDR mode.

enumerator kFLEXSPI_Command_READ_DDR
Receive Read Data from Flash, using DDR mode.

enumerator kFLEXSPI_Command_LEARN_DDR
Receive Read Data or Preamble bit from Flash, DDR mode.

enumerator kFLEXSPI_Command_DATSZ_DDR
Transmit Read/Program Data size (byte) to Flash, DDR mode.

enumerator kFLEXSPI_Command_DUMMY_DDR
Leave data lines undriven by FlexSPI controller.

enumerator kFLEXSPI_Command_DUMMY_RWDS_DDR
Leave data lines undriven by FlexSPI controller, dummy cycles decided by RWDS.

enumerator kFLEXSPI_Command_JUMP_ON_CS
Stop execution, deassert CS and save operand[7:0] as the instruction start pointer for next sequence

enum _flexspi_pad
pad definition of FLEXSPI, use to form LUT instruction.

Values:

enumerator kFLEXSPI_1PAD
Transmit command/address and transmit/receive data only through DATA0/DATA1.

enumerator kFLEXSPI_2PAD
Transmit command/address and transmit/receive data only through DATA[1:0].

enumerator kFLEXSPI_4PAD
Transmit command/address and transmit/receive data only through DATA[3:0].

enumerator kFLEXSPI_8PAD
Transmit command/address and transmit/receive data only through DATA[7:0].

enum _flexspi_flags
FLEXSPI interrupt status flags.

Values:

enumerator kFLEXSPI_SequenceExecutionTimeoutFlag
Sequence execution timeout.

enumerator kFLEXSPI_AhbBusErrorFlag
AHB Bus error flag.

enumerator kFLEXSPI_SckStoppedBecauseTxEmptyFlag
SCK is stopped during command sequence because Async TX FIFO empty.

enumerator kFLEXSPI_SckStoppedBecauseRxFullFlag
SCK is stopped during command sequence because Async RX FIFO full.

enumerator kFLEXSPI_IpTxFifoWatermarkEmptyFlag
IP TX FIFO WaterMark empty.

enumerator kFLEXSPI_IpRxFifoWatermarkAvailableFlag
IP RX FIFO WaterMark available.

enumerator kFLEXSPI_AhbCommandSequenceErrorFlag
AHB triggered Command Sequences Error.

enumerator kFLEXSPI_IpCommandSequenceErrorFlag
IP triggered Command Sequences Error.

enumerator kFLEXSPI_AhbCommandGrantTimeoutFlag
AHB triggered Command Sequences Grant Timeout.

enumerator kFLEXSPI_IpCommandGrantTimeoutFlag
IP triggered Command Sequences Grant Timeout.

enumerator kFLEXSPI_IpCommandExecutionDoneFlag
IP triggered Command Sequences Execution finished.

enumerator kFLEXSPI_AllInterruptFlags
All flags.

enum _flexspi_read_sample_clock
FLEXSPI sample clock source selection for Flash Reading.

Values:

enumerator kFLEXSPI_ReadSampleClkLoopbackInternally
Dummy Read strobe generated by FlexSPI Controller and loopback internally.

enumerator kFLEXSPI_ReadSampleClkLoopbackFromDqsPad
Dummy Read strobe generated by FlexSPI Controller and loopback from DQS pad.

enumerator kFLEXSPI_ReadSampleClkLoopbackFromSckPad
SCK output clock and loopback from SCK pad.

enumerator kFLEXSPI_ReadSampleClkExternalInputFromDqsPad
Flash provided Read strobe and input from DQS pad.

enum _flexspi_cs_interval_cycle_unit
FLEXSPI interval unit for flash device select.

Values:

enumerator kFLEXSPI_CsIntervalUnit1SckCycle
Chip selection interval: CSINTERVAL * 1 serial clock cycle.

enumerator kFLEXSPI_CsIntervalUnit256SckCycle
Chip selection interval: CSINTERVAL * 256 serial clock cycle.

enum _flexspi_ahb_write_wait_unit
FLEXSPI AHB wait interval unit for writing.

Values:

enumerator kFLEXSPI_AhbWriteWaitUnit2AhbCycle
AWRWAIT unit is 2 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit8AhbCycle
AWRWAIT unit is 8 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit32AhbCycle
AWRWAIT unit is 32 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit128AhbCycle
AWRWAIT unit is 128 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit512AhbCycle
AWRWAIT unit is 512 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit2048AhbCycle
AWRWAIT unit is 2048 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit8192AhbCycle
AWRWAIT unit is 8192 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit32768AhbCycle
AWRWAIT unit is 32768 ahb clock cycle.

enum _flexspi_ip_error_code
Error Code when IP command Error detected.

Values:

enumerator kFLEXSPI_IpCmdErrorNoError
No error.

enumerator kFLEXSPI_IpCmdErrorJumpOnCsInIpCmd
IP command with JMP_ON_CS instruction used.

enumerator kFLEXSPI_IpCmdErrorUnknownOpCode
Unknown instruction opcode in the sequence.

enumerator kFLEXSPI_IpCmdErrorSdrDummyInDdrSequence
Instruction DUMMY_SDR/DUMMY_RWDS_SDR used in DDR sequence.

enumerator kFLEXSPI_IpCmdErrorDdrDummyInSdrSequence
Instruction DUMMY_DDR/DUMMY_RWDS_DDR used in SDR sequence.

enumerator kFLEXSPI_IpCmdErrorInvalidAddress
Flash access start address exceed the whole flash address range (A1/A2/B1/B2).

enumerator kFLEXSPI_IpCmdErrorSequenceExecutionTimeout
Sequence execution timeout.

enumerator kFLEXSPI_IpCmdErrorFlashBoundaryAcrosss
Flash boundary crossed.

enum _flexspi_ahb_error_code
Error Code when AHB command Error detected.

Values:

enumerator kFLEXSPI_AhbCmdErrorNoError
No error.

enumerator kFLEXSPI_AhbCmdErrorJumpOnCsInWriteCmd
AHB Write command with JMP_ON_CS instruction used in the sequence.

enumerator kFLEXSPI_AhbCmdErrorUnknownOpCode
Unknown instruction opcode in the sequence.

enumerator kFLEXSPI_AhbCmdErrorSdrDummyInDdrSequence
Instruction DUMMY_SDR/DUMMY_RWDS_SDR used in DDR sequence.

enumerator kFLEXSPI_AhbCmdErrorDdrDummyInSdrSequence
Instruction DUMMY_DDR/DUMMY_RWDS_DDR used in SDR sequence.

enumerator kFLEXSPI_AhbCmdSequenceExecutionTimeout
Sequence execution timeout.

enum _flexspi_port
FLEXSPI operation port select.

Values:

enumerator kFLEXSPI_PortA1
Access flash on A1 port.

enumerator kFLEXSPI_PortA2
Access flash on A2 port.

enumerator kFLEXSPI_PortB1
Access flash on B1 port.

enumerator kFLEXSPI_PortB2
Access flash on B2 port.

enumerator kFLEXSPI_PortCount

enum _flexspi_arb_command_source

Trigger source of current command sequence granted by arbitrator.

Values:

enumerator kFLEXSPI_AhbReadCommand

enumerator kFLEXSPI_AhbWriteCommand

enumerator kFLEXSPI_IpCommand

enumerator kFLEXSPI_SuspendedCommand

enum _flexspi_command_type

Command type.

Values:

enumerator kFLEXSPI_Command

FlexSPI operation: Only command, both TX and Rx buffer are ignored.

enumerator kFLEXSPI_Config

FlexSPI operation: Configure device mode, the TX fifo size is fixed in LUT.

enumerator kFLEXSPI_Read

enumerator kFLEXSPI_Write

typedef enum *_flexspi_pad* flexspi_pad_t

pad definition of FLEXSPI, use to form LUT instruction.

typedef enum *_flexspi_flags* flexspi_flags_t

FLEXSPI interrupt status flags.

typedef enum *_flexspi_read_sample_clock* flexspi_read_sample_clock_t

FLEXSPI sample clock source selection for Flash Reading.

typedef enum *_flexspi_cs_interval_cycle_unit* flexspi_cs_interval_cycle_unit_t

FLEXSPI interval unit for flash device select.

typedef enum *_flexspi_ahb_write_wait_unit* flexspi_ahb_write_wait_unit_t

FLEXSPI AHB wait interval unit for writing.

typedef enum *_flexspi_ip_error_code* flexspi_ip_error_code_t

Error Code when IP command Error detected.

typedef enum *_flexspi_ahb_error_code* flexspi_ahb_error_code_t

Error Code when AHB command Error detected.

typedef enum *_flexspi_port* flexspi_port_t

FLEXSPI operation port select.

typedef enum *_flexspi_arb_command_source* flexspi_arb_command_source_t

Trigger source of current command sequence granted by arbitrator.

typedef enum *_flexspi_command_type* flexspi_command_type_t

Command type.

typedef struct *_flexspi_ahbBuffer_config* flexspi_ahbBuffer_config_t

typedef struct *_flexspi_config* flexspi_config_t

FLEXSPI configuration structure.

typedef struct *_flexspi_device_config* flexspi_device_config_t
External device configuration items.

typedef struct *_flexspi_transfer* flexspi_transfer_t
Transfer structure for FLEXSPI.

typedef struct *_flexspi_handle* flexspi_handle_t

typedef void (*flexspi_transfer_callback_t)(FLEXSPI_Type *base, *flexspi_handle_t* *handle, *status_t* status, void *userData)
FLEXSPI transfer callback function.

typedef struct *_flexspi_addr_map_config* flexspi_addr_map_config_t
Address mapping configuration structure.

FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNT

FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)
Formula to form FLEXSPI instructions in LUT table.

struct _flexspi_ahbBuffer_config
#include <fsl_flexspi.h>

Public Members

uint8_t priority
This priority for AHB Master Read which this AHB RX Buffer is assigned.

uint8_t masterIndex
AHB Master ID the AHB RX Buffer is assigned.

uint16_t bufferSize
AHB buffer size in byte.

bool enablePrefetch
AHB Read Prefetch Enable for current AHB RX Buffer corresponding Master, allows prefetch disable/enable separately for each master.

struct _flexspi_config
#include <fsl_flexspi.h> FLEXSPI configuration structure.

Public Members

flexspi_read_sample_clock_t rxSampleClock
Sample Clock source selection for Flash Reading.

bool enableSckFreeRunning
Enable/disable SCK output free-running.

bool enableCombination
Enable/disable combining PORT A and B Data Pins (SIOA[3:0] and SIOB[3:0]) to support Flash Octal mode.

bool enableDoze
Enable/disable doze mode support.

bool enableHalfSpeedAccess
Enable/disable divide by 2 of the clock for half speed commands.

bool enableSckBDiffOpt

Enable/disable SCKB pad use as SCKA differential clock output, when enable, Port B flash access is not available.

bool enableSameConfigForAll

Enable/disable same configuration for all connected devices when enabled, same configuration in FLASHA1CRx is applied to all.

uint16_t seqTimeoutCycle

Timeout wait cycle for command sequence execution, timeout after ahbGrantTimeoutCyle*1024 serial root clock cycles.

uint8_t ipGrantTimeoutCycle

Timeout wait cycle for IP command grant, timeout after ipGrantTimeoutCycle*1024 AHB clock cycles.

uint8_t txWatermark

FLEXSPI IP transmit watermark value.

uint8_t rxWatermark

FLEXSPI receive watermark value.

struct __flexspi_device_config

#include <fsl_flexspi.h> External device configuration items.

Public Members

uint32_t flexspiRootClk

FLEXSPI serial root clock.

bool isSck2Enabled

FLEXSPI use SCK2.

uint32_t flashSize

Flash size in KByte.

bool addressShift

Address shift.

flexspi_cs_interval_cycle_unit_t CSIntervalUnit

CS interval unit, 1 or 256 cycle.

uint16_t CSInterval

CS line assert interval, multiply CS interval unit to get the CS line assert interval cycles.

uint8_t CSHoldTime

CS line hold time.

uint8_t CSSetupTime

CS line setup time.

uint8_t dataValidTime

Data valid time for external device.

uint8_t columnspace

Column space size.

bool enableWordAddress

If enable word address.

uint8_t AWRSeqIndex
: Sequence ID for AHB write command.

uint8_t AWRSeqNumber
: Sequence number for AHB write command.

uint8_t ARDSeqIndex
: Sequence ID for AHB read command.

uint8_t ARDSeqNumber
: Sequence number for AHB read command.

flexspi_ahb_write_wait_unit_t AHBWriteWaitUnit
: AHB write wait unit.

uint16_t AHBWriteWaitInterval
: AHB write wait interval, multiply AHB write interval unit to get the AHB write wait cycles.

bool enableWriteMask
: Enable/Disable FLEXSPI drive DQS pin as write mask when writing to external device.

struct _flexspi_transfer
: *#include <fsl_flexspi.h>* Transfer structure for FLEXSPI.

Public Members

uint32_t deviceAddress
: Operation device address.

flexspi_port_t port
: Operation port.

flexspi_command_type_t cmdType
: Execution command type.

uint8_t seqIndex
: Sequence ID for command.

uint8_t SeqNumber
: Sequence number for command.

uint32_t *data
: Data buffer.

size_t dataSize
: Data size in bytes.

struct _flexspi_handle
: *#include <fsl_flexspi.h>* Transfer handle structure for FLEXSPI.

Public Members

uint32_t state
: Internal state for FLEXSPI transfer

uint8_t *data
: Data buffer.

size_t dataSize
Remaining Data size in bytes.

size_t transferTotalSize
Total Data size in bytes.

flexspi_transfer_callback_t completionCallback
Callback for users while transfer finish or error occurred

void *userData
FLEXSPI callback function parameter.

struct _flexspi_addr_map_config
#include <fsl_flexspi.h> Address mapping configuration structure.

Public Members

uint32_t addrStart
Remapping start address.

uint32_t addrEnd
Remapping end address.

uint32_t addrOffset
Address offset.

bool remapEnable
Enable address remapping.

struct ahbConfig

Public Members

uint8_t ahbGrantTimeoutCycle
Timeout wait cycle for AHB command grant, timeout after ahbGrantTimeoutCyle*1024 AHB clock cycles.

uint16_t ahbBusTimeoutCycle
Timeout wait cycle for AHB read/write access, timeout after ahbBusTimeoutCycle*1024 AHB clock cycles.

uint8_t resumeWaitCycle
Wait cycle for idle state before suspended command sequence resume, timeout after ahbBusTimeoutCycle AHB clock cycles.

flexspi_ahbBuffer_config_t buffer[FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNTn(0)]
AHB buffer size.

bool enableClearAHBBufferOpt
Enable/disable automatically clean AHB RX Buffer and TX Buffer when FLEXSPI returns STOP mode ACK.

bool enableReadAddressOpt
Enable/disable remove AHB read burst start address alignment limitation. when enable, there is no AHB read burst start address alignment limitation.

bool enableAHBPrefetch
Enable/disable AHB read prefetch feature, when enabled, FLEXSPI will fetch more data than current AHB burst.

bool enableAHBBufferable

Enable/disable AHB bufferable write access support, when enabled, FLEXSPI return before waiting for command execution finished.

bool enableAHBCachable

Enable AHB bus cachable read access support.

2.59 FLEXSPI eDMA Driver

void FLEXSPI_TransferCreateHandleEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_edma_callback_t* callback, void *userData, *edma_handle_t* *txDmaHandle, *edma_handle_t* *rxDmaHandle)

Initializes the FLEXSPI handle for transfer which is used in transactional functions and set the callback.

Parameters

- base – FLEXSPI peripheral base address
- handle – Pointer to flexspi_edma_handle_t structure
- callback – FLEXSPI callback, NULL means no callback.
- userData – User callback function data.
- txDmaHandle – User requested DMA handle for TX DMA transfer.
- rxDmaHandle – User requested DMA handle for RX DMA transfer.

void FLEXSPI_TransferUpdateSizeEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_edma_transfer_nsize_t* nsize)

Update FLEXSPI EDMA transfer source data transfer size(SSIZE) and destination data transfer size(DSIZE).

See also:

flexspi_edma_transfer_nsize_t .

Parameters

- base – FLEXSPI peripheral base address
- handle – Pointer to flexspi_edma_handle_t structure
- nsize – FLEXSPI DMA transfer data transfer size(SSIZE/DSIZE), by default the size is kFLEXPSI_EDMAnSize1Bytes(one byte).

status_t FLEXSPI_TransferEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_transfer_t* *xfer)

Transfers FLEXSPI data using an eDMA non-blocking method.

This function writes/receives data to/from the FLEXSPI transmit/receive FIFO. This function is non-blocking.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to flexspi_edma_handle_t structure
- xfer – FLEXSPI transfer structure.

Return values

- kStatus_FLEXSPI_Busy – FLEXSPI is busy transfer.
- kStatus_InvalidArgument – The watermark configuration is invalid, the watermark should be power of 2 to do successfully EDMA transfer.
- kStatus_Success – FLEXSPI successfully start edma transfer.

void FLEXSPI_TransferAbortEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle)

Aborts the transfer data using eDMA.

This function aborts the transfer data using eDMA.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to flexspi_edma_handle_t structure

status_t FLEXSPI_TransferGetTransferCountEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, size_t *count)

Gets the transferred counts of transfer.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to flexspi_edma_handle_t structure.
- count – Bytes transfer.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

FSL_FLEXSPI_EDMA_DRIVER_VERSION

FLEXSPI EDMA driver version.

enum _flexspi_edma_ntransfer_size

eDMA transfer configuration

Values:

enumerator kFLEXPSI_EDMAnSize1Bytes

Source/Destination data transfer size is 1 byte every time

enumerator kFLEXPSI_EDMAnSize2Bytes

Source/Destination data transfer size is 2 bytes every time

enumerator kFLEXPSI_EDMAnSize4Bytes

Source/Destination data transfer size is 4 bytes every time

enumerator kFLEXPSI_EDMAnSize8Bytes

Source/Destination data transfer size is 8 bytes every time

enumerator kFLEXPSI_EDMAnSize32Bytes

Source/Destination data transfer size is 32 bytes every time

typedef struct *_flexspi_edma_handle* flexspi_edma_handle_t

typedef void (*flexspi_edma_callback_t)(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *status_t* status, void *userData)

FLEXSPI eDMA transfer callback function for finish and error.

typedef enum *_flexspi_edma_ntransfer_size* flexspi_edma_transfer_nsize_t

eDMA transfer configuration

struct _flexspi_edma_handle

#include <fsl_flexspi_edma.h> FLEXSPI DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *txDmaHandle

eDMA handler for FLEXSPI Tx.

edma_handle_t *rxDmaHandle

eDMA handler for FLEXSPI Rx.

size_t transferSize

Bytes need to transfer.

flexspi_edma_transfer_nsize_t nsize

eDMA SSIZE/DSIZE in each transfer.

uint8_t nbytes

eDMA minor byte transfer count initially configured.

uint8_t count

The transfer data count in a DMA request.

uint32_t state

Internal state for FLEXSPI eDMA transfer.

flexspi_edma_callback_t completionCallback

A callback function called after the eDMA transfer is finished.

void *userData

User callback parameter

2.60 Gpc

static inline void GPC_CM_EnableCpuSleepHold(GPC_CPU_MODE_CTRL_Type *base, bool enable)

static inline void GPC_CM_SetNextCpuMode(GPC_CPU_MODE_CTRL_Type *base, *gpc_cpu_mode_t* mode)

Set the CPU mode on the next sleep event.

This function configures the CPU mode that the CPU core will transmit to on next sleep event.

Note: This API must be called each time before entering sleep.

Parameters

- base – GPC CPU module base address.
- mode – The CPU mode that the core will transmit to, refer to “gpc_cpu_mode_t”.

static inline *gpc_cpu_mode_t* GPC_CM_GetCurrentCpuMode(GPC_CPU_MODE_CTRL_Type *base)

Get current CPU mode.

Parameters

- base – GPC CPU module base address.

Returns

The current CPU mode, in type of gpc_cpu_mode_t.

static inline *gpc_cpu_mode_t* GPC_CM_GetPreviousCpuMode(GPC_CPU_MODE_CTRL_Type *base)

Get previous CPU mode.

Parameters

- base – GPC CPU module base address.

Returns

The previous CPU mode, in type of gpc_cpu_mode_t.

void GPC_CM_EnableIrqWakeup(GPC_CPU_MODE_CTRL_Type *base, uint32_t irqId, bool enable)

Enable IRQ wakeup request.

This function enables the IRQ request which can wakeup the CPU platform.

Parameters

- base – GPC CPU module base address.
- irqId – ID of the IRQ, accessible range is 0-255.
- enable – Enable the IRQ request or not.

static inline void GPC_CM_EnableNonIrqWakeup(GPC_CPU_MODE_CTRL_Type *base, uint32_t mask, bool enable)

Enable Non-IRQ wakeup request.

This function enables the non-IRQ request which can wakeup the CPU platform.

Parameters

- base – GPC CPU module base address.
- mask – Non-IRQ type, refer to "_gpc_cm_non_irq_wakeup_request".
- enable – Enable the Non-IRQ request or not.

bool GPC_CM_GetIrqWakeupStatus(GPC_CPU_MODE_CTRL_Type *base, uint32_t irqId)

Get the status of the IRQ wakeup request.

Parameters

- base – GPC CPU module base address.
- irqId – ID of the IRQ, accessible range is 0-255.

Returns

Indicate the IRQ request is asserted or not.

static inline bool GPC_CM_GetNonIrqWakeupStatus(GPC_CPU_MODE_CTRL_Type *base, uint32_t mask)

Get the status of the Non-IRQ wakeup request.

Parameters

- base – GPC CPU module base address.

- mask – Non-IRQ type, refer to "_gpc_cm_non_irq_wakeup_request".

Returns

Indicate the Non-IRQ request is asserted or not.

void GPC_CM_ConfigCpuModeTransitionStep(GPC_CPU_MODE_CTRL_Type *base, *gpc_cm_tran_step_t* step, const *gpc_tran_step_config_t* *config)

Config the cpu mode transition step.

Deprecated:

Please use GPC_CM_EnableCpuModeTransitionStep() and GPC_CM_DisableCpuModeTransitionStep() as instead.

Note: This function can not config the setpoint sleep/wakeup operation for those operation is controlled by setpoint control. This funcion can not config the standby sleep/wakeup too, because those operation is controlled by standby controlled.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to "gpc_cm_tran_step_t".
- config – transition step configuration, refer to "gpc_tran_step_config_t".

void GPC_CM_EnableCpuModeTransitionStep(GPC_CPU_MODE_CTRL_Type *base, *gpc_cm_tran_step_t* step)

Enable the specific cpu mode transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to "gpc_cm_tran_step_t".

void GPC_CM_DisableCpuModeTransitionStep(GPC_CPU_MODE_CTRL_Type *base, *gpc_cm_tran_step_t* step)

Disable the specific cpu mode transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to "gpc_cm_tran_step_t".

void GPC_CM_RequestSleepModeSetPointTransition(GPC_CPU_MODE_CTRL_Type *base, uint8_t setPointSleep, uint8_t setPointWakeup, *gpc_cm_wakeup_sp_sel_t* wakeupSel)

Request a set point transition before the CPU transfers into a sleep mode.

This function triggers the set point transition during a CPU Sleep/wakeup event and selects which one the CMC want to transfer to.

Parameters

- base – GPC CPU module base address.
- setPointSleep – The set point CPU want the system to transit to on next CPU platform sleep sequence.
- setPointWakeup – The set point CPU want the system to transit to on next CPU platform wakeup sequence.

- wakeupSel – Select the set point transition on the next CPU platform wakeup sequence.

void GPC_CM_RequestRunModeSetPointTransition(GPC_CPU_MODE_CTRL_Type *base, uint8_t setPointRun)

Request a set point transition during run mode.

This function triggers the set point transition and selects which one the CMC want to transfer to.

Parameters

- base – GPC CPU module base address.
- setPointRun – The set point CPU want the system to transit in the run mode.

static inline void GPC_CM_SetSetPointMapping(GPC_CPU_MODE_CTRL_Type *base, uint32_t setPoint, uint32_t setpoint_map)

Set the set point mapping value for each set point.

This function configures which set point is allowed after current set point. If there are multiple setpoints, use:

```
setpoint_map = kGPC_SetPoint0 | kGPC_SetPoint1 | ... | kGPC_SetPoint15;
```

Parameters

- base – GPC CPU module base address.
- setPoint – Set point index, available range is 0-15.
- setpoint_map – Map value of the set point. Refer to "_gpc_setpoint_map".

void GPC_CM_SetCpuModeSetPointMapping(GPC_CPU_MODE_CTRL_Type *base, *gpc_cpu_mode_t* mode, uint32_t setpoint_map)

Set the set point mapping value for each cpu mode.

This function configures which set point is allowed when CPU enters RUN/WAIT/STOP/SUSPEND. If there are multiple setpoints, use:

```
setpoint_map = kGPC_SetPoint0 | kGPC_SetPoint1 | ... | kGPC_SetPoint15;
```

Parameters

- base – GPC CPU module base address.
- mode – CPU mode. Refer to "gpc_cpu_mode_t".
- setpoint_map – Map value of the set point. Refer to "_gpc_setpoint_map".

void GPC_CM_RequestStandbyMode(GPC_CPU_MODE_CTRL_Type *base, const *gpc_cpu_mode_t* mode)

Request the chip into standby mode.

Parameters

- base – GPC CPU module base address.
- mode – CPU mode. Refer to "gpc_cpu_mode_t".

void GPC_CM_ClearStandbyModeRequest(GPC_CPU_MODE_CTRL_Type *base, const *gpc_cpu_mode_t* mode)

Clear the standby mode request.

Parameters

- base – GPC CPU module base address.

- mode – CPU mode. Refer to “gpc_cpu_mode_t”.

static inline bool GPC_CM_GetStandbyModeStatus(GPC_CPU_MODE_CTRL_Type *base, uint32_t mask)

Get the status of the CPU standby mode transition.

Parameters

- base – GPC CPU module base address.
- mask – Standby mode transition status mask, refer to “gpc_cm_standby_mode_status_t”.

Returns

Indicate the CPU’s standby transition status.

static inline uint32_t GPC_CM_GetInterruptStatusFlags(GPC_CPU_MODE_CTRL_Type *base)

Get the status flags of the GPC CPU module.

Parameters

- base – GPC CPU module base address.

Returns

The OR’ed value of status flags.

void GPC_CM_ClearInterruptStatusFlags(GPC_CPU_MODE_CTRL_Type *base, uint32_t mask)

Clears CPU module interrut status flags.

Parameters

- base – GPC CPU module base address.
- mask – The interrupt status flags to be cleared. Should be the OR’ed value of _gpc_cm_interrupt_status_flag.

static inline void GPC_SP_SetSetpointPriority(GPC_SET_POINT_CTRL_Type *base, uint32_t setPoint, uint32_t priority)

Set the priority of set point.

This function will configure the priority of the set point. If the result of API GPC_SP_GetAllowedSetPointMap() has more than one valid bit, high priority set point will be taken.

Parameters

- base – GPC Setpoint controller base address.
- setPoint – Set point index, available range is 0-15.
- priority – Priority level, available range is 0-15.

void GPC_SP_ConfigSetPointTransitionStep(GPC_SET_POINT_CTRL_Type *base, *gpc_sp_tran_step_t* step, const *gpc_tran_step_config_t* *config)

Config the set point transition step.

Deprecated:

Please use GPC_SP_EnableSetPointTransitionStep() and GPC_SP_DisableSetPointTransitionStep() as instead.

Parameters

- base – GPC Setpoint controller base address.
- step – step type, refer to “gpc_sp_tran_step_t”.

- config – transition step configuration, refer to “gpc_tran_step_config_t”.

void GPC_SP_EnableSetPointTransitionStep(GPC_SET_POINT_CTRL_Type *base, *gpc_sp_tran_step_t* step)

Enable the specific setpoint transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to “gpc_cm_tran_step_t”.

void GPC_SP_DisableSetPointTransitionStep(GPC_SET_POINT_CTRL_Type *base, *gpc_sp_tran_step_t* step)

Disable the specific setpoint transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to “gpc_cm_tran_step_t”.

static inline uint8_t GPC_SP_GetCurrentSetPoint(GPC_SET_POINT_CTRL_Type *base)

Get system current setpoint, only valid when setpoint trans not busy.

Parameters

- base – GPC Setpoint controller base address.

Returns

The current setpoint number, range from 0 to 15.

static inline uint8_t GPC_SP_GetPreviousSetPoint(GPC_SET_POINT_CTRL_Type *base)

Get system previous setpoint, only valid when setpoint trans not busy.

Parameters

- base – GPC Setpoint controller base address.

Returns

The previous setpoint number, range from 0 to 15.

static inline uint8_t GPC_SP_GetTargetSetPoint(GPC_SET_POINT_CTRL_Type *base)

Get target setpoint.

Parameters

- base – GPC Setpoint controller base address.

Returns

The target setpoint number, range from 0 to 15.

void GPC_STBY_ConfigStandbyTransitionStep(GPC_STBY_CTRL_Type *base, *gpc_stby_tran_step_t* step, const *gpc_tran_step_config_t* *config)

Config the standby transition step.

Deprecated:

Please use GPC_STBY_EnableStandbyTransitionStep() and GPC_STBY_DisableStandbyTransitionStep() as instead.

Parameters

- base – GPC standby controller base address.
- step – step type, refer to “gpc_stby_tran_step_t”.

- config – transition step configuration, refer to “gpc_tran_step_config_t”.

void GPC_STBY_EnableStandbyTransitionStep(GPC_STBY_CTRL_Type *base, *gpc_stby_tran_step_t* step)

Enable the specific standby transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to “gpc_cm_tran_step_t”.

void GPC_STBY_DisableStandbyTransitionStep(GPC_STBY_CTRL_Type *base, *gpc_stby_tran_step_t* step)

Disable the specific standby transition step.

Parameters

- base – GPC CPU module base address.
- step – step type, refer to “gpc_cm_tran_step_t”.

void GPC_STBY_SetPmicOutStepCountMode(GPC_STBY_CTRL_Type *base, *gpc_tran_step_counter_mode_t* cntMode, uint32_t stepCount)

Set count mode for PMIC_OUT Step.

Parameters

- base – GPC CPU module base address.
- cntMode – Step counter working mode.
- stepCount – Step count, which is depended on the value of cntMode

static inline void GPC_STBY_ForceCoreRequestStandbyMode(GPC_STBY_CTRL_Type *base, *gpc_cpu_domain_name_t* cpuName)

Force selected CPU requesting standby mode.

Parameters

- base – GPC standby controller base address.
- cpuName – The CPU name, refer to gpc_cpu_domain_name_t.

FSL_GPC_RIVER_VERSION

GPC driver version 2.5.0.

_gpc_cm_non_irq_wakeup_request GPC Non-IRQ wakeup request.

Values:

enumerator kGPC_CM_EventWakeupRequest

Event wakeup request.

enumerator kGPC_CM_DebugWakeupRequest

Debug wakeup request.

Values:

enumerator kGPC_SetPoint0

GPC set point 0.

enumerator kGPC_SetPoint1
GPC set point 1.

enumerator kGPC_SetPoint2
GPC set point 2.

enumerator kGPC_SetPoint3
GPC set point 3.

enumerator kGPC_SetPoint4
GPC set point 4.

enumerator kGPC_SetPoint5
GPC set point 5.

enumerator kGPC_SetPoint6
GPC set point 6.

enumerator kGPC_SetPoint7
GPC set point 7.

enumerator kGPC_SetPoint8
GPC set point 8.

enumerator kGPC_SetPoint9
GPC set point 9.

enumerator kGPC_SetPoint10
GPC set point 10.

enumerator kGPC_SetPoint11
GPC set point 11.

enumerator kGPC_SetPoint12
GPC set point 12.

enumerator kGPC_SetPoint13
GPC set point 13.

enumerator kGPC_SetPoint14
GPC set point 14.

enumerator kGPC_SetPoint15
GPC set point 15.

_gpc_cm_interrupt_status_flag

Values:

enumerator kGPC_CM_SoftSPNotAllowedStatusFlag

enumerator kGPC_CM_WaitSPNotAllowedStatusFlag

enumerator kGPC_CM_SleepSPNotAllowedStatusFlag

enum _gpc_cm_standby_mode_status
CPU standby mode status.

Values:

enumerator kGPC_CM_SleepBusy
Indicate the CPU is busy entering standby mode.

enumerator kGPC_CM_WakeupBusy
Indicate the CPU is busy exiting standby mode.

enum _gpc_cm_tran_step
CPU mode transition step in sleep/wakeup sequence.

Values:

enumerator kGPC_CM_SleepSsar
SSAR (State Save And Restore) sleep step.

enumerator kGPC_CM_SleepLpcg
LPCG (Low Power Clock Gating) sleep step.

enumerator kGPC_CM_SleepPll
PLL sleep step.

enumerator kGPC_CM_SleepIso
ISO (Isolation) sleep step.

enumerator kGPC_CM_SleepReset
Reset sleep step.

enumerator kGPC_CM_SleepPower
Power sleep step.

enumerator kGPC_CM_SleepSP
Setpoint sleep step. Note that this step is controlled by setpoint controller.

enumerator kGPC_CM_SleepSTBY
Standby sleep step. Note that this step is controlled by standby controller.

enumerator kGPC_CM_WakeupSTBY
Standby wakeup step. Note that this step is controlled by standby controller.

enumerator kGPC_CM_WakeupSP
Setpoint wakeup step. Note that this step is controlled by setpoint countroller.

enumerator kGPC_CM_WakeupPower
Power wakeup step.

enumerator kGPC_CM_WakeupReset
Reset wakeup step.

enumerator kGPC_CM_WakeupIso
ISO wakeup step.

enumerator kGPC_CM_WakeupPll
PLL wakeup step.

enumerator kGPC_CM_WakeupLpcg
LPCG wakeup step.

enumerator kGPC_CM_WakeupSsar
SSAR wakeup step.

enum _gpc_sp_tran_step
GPC set point transition steps.

Values:

enumerator kGPC_SP_SsarSave
SSAR save step.

enumerator kGPC_SP_LpcgOff
LPCG off step.

enumerator kGPC_SP_GroupDown
Group down step.

enumerator kGPC_SP_RootDown
Root down step.

enumerator kGPC_SP_PllOff
PLL off step.

enumerator kGPC_SP_IsoOn
ISO on.

enumerator kGPC_SP_ResetEarly
Reset early step.

enumerator kGPC_SP_PowerOff
Power off step.

enumerator kGPC_SP_BiasOff
Bias off step.

enumerator kGPC_SP_BandgapPllLdoOff
Bandgap and PLL_LDO off step.

enumerator kGPC_SP_LdoPre
LDO (Low-Dropout) pre step.

enumerator kGPC_SP_DcdcDown
DCDC down step.

enumerator kGPC_SP_DcdcUp
DCDC up step.

enumerator kGPC_SP_LdoPost
LDO post step.

enumerator kGPC_SP_BandgapPllLdoOn
Bandgap and PLL_LDO on step.

enumerator kGPC_SP_BiasOn
Bias on step.

enumerator kGPC_SP_PowerOn
Power on step.

enumerator kGPC_SP_ResetLate
Reset late step.

enumerator kGPC_SP_IsoOff
ISO off step.

enumerator kGPC_SP_PllOn
PLL on step

enumerator kGPC_SP_RootUp
Root up step.

enumerator kGPC_SP_GroupUp
Group up step.

enumerator kGPC_SP_LpcgOn
LPCG on step.

enumerator kGPC_SP_SsarRestore
SSAR restore step.

enum _gpc_cpu_mode
CPU mode.

Values:

enumerator kGPC_RunMode
Stay in RUN mode.

enumerator kGPC_WaitMode
Transit to WAIT mode.

enumerator kGPC_StopMode
Transit to STOP mode.

enumerator kGPC_SuspendMode
Transit to SUSPEND mode.

enum _gpc_cm_wakeup_sp_sel
CPU wakeup sequence setpoint options.

Values:

enumerator kGPC_CM_WakeupSetpoint
Request SP transition to CPU_SP_WAKEUP (param "setPointWakeup" in gpc_cm_sleep_sp_tran_config_t).

enumerator kGPC_CM_RequestPreviousSetpoint
Request SP transition to the set point when the sleep event happens.

enum _gpc_stby_tran_step
GPC standby mode transition steps.

Values:

enumerator kGPC_STBY_LpcgIn
LPCG in step.

enumerator kGPC_STBY_PllIn
PLL in step.

enumerator kGPC_STBY_BiasIn
Bias in step.

enumerator kGPC_STBY_PldoIn
PLDO in step.

enumerator kGPC_STBY_BandgapIn
Bandgap in step.

enumerator kGPC_STBY_LdoIn
LDO in step.

enumerator kGPC_STBY_DcdcIn
DCDC in step.

enumerator kGPC_STBY_PmicIn
PMIC in step.

enumerator kGPC_STBY_PmicOut
PMIC out step.

enumerator kGPC_STBY_DcdcOut
DCDC out step.

enumerator kGPC_STBY_LdoOut
LDO out step.

enumerator kGPC_STBY_BandgapOut
Bandgap out step.

enumerator kGPC_STBY_PldoOut
PLDO out step.

enumerator kGPC_STBY_BiasOut
Bias out step.

enumerator kGPC_STBY_PllOut
PLL out step.

enumerator kGPC_STBY_LpcgOut
LPCG out step.

enum _gpc_cpu_domain_name
GPC CPU domain name, used to select the CPU domain.

Values:

enumerator kGPC_CM7Core
CM7 core.

enumerator kGPC_CM4Core
CM4 core.

enum _gpc_tran_step_counter_mode
Step counter work mode.

Values:

enumerator kGPC_StepCounterDisableMode
Counter disable mode: not use step counter, step completes once receiving step_done.

enumerator kGPC_StepCounterDelayMode
Counter delay mode: delay after receiving step_done, delay cycle number is STEP_CNT

enumerator kGPC_StepCounterIgnoreResponseMode
Ignore step_done response, the counter starts to count once step begins, when counter reaches STEP_CNT value, the step completes.

enumerator kGPC_StepCounterTimeOutMode
Time out mode, the counter starts to count once step begins, the step completes when either step_done received or counting to STEP_CNT value.

typedef enum *_gpc_cm_standby_mode_status* gpc_cm_standby_mode_status_t
CPU standby mode status.

typedef enum *_gpc_cm_tran_step* gpc_cm_tran_step_t
CPU mode transition step in sleep/wakeup sequence.

typedef enum *_gpc_sp_tran_step* gpc_sp_tran_step_t
GPC set point transition steps.

typedef enum *_gpc_cpu_mode* gpc_cpu_mode_t
CPU mode.

typedef struct *_gpc_tran_step_config* gpc_tran_step_config_t
Configuration for GPC transition step.

Deprecated:
Related functions are deprecated.

typedef enum *_gpc_cm_wakeup_sp_sel* gpc_cm_wakeup_sp_sel_t
CPU wakeup sequence setpoint options.

typedef enum *_gpc_stby_tran_step* gpc_stby_tran_step_t
GPC standby mode transition steps.

typedef enum *_gpc_cpu_domain_name* gpc_cpu_domain_name_t
GPC CPU domain name, used to select the CPU domain.

typedef enum *_gpc_tran_step_counter_mode* gpc_tran_step_counter_mode_t
Step counter work mode.

GPC_RESERVED_USE_MACRO

GPC_CM_SLEEP_SSAR_CTRL_OFFSET

GPC_CM_SLEEP_LPCG_CTRL_OFFSET

GPC_CM_SLEEP_PLL_CTRL_OFFSET

GPC_CM_SLEEP_ISO_CTRL_OFFSET

GPC_CM_SLEEP_RESET_CTRL_OFFSET

GPC_CM_SLEEP_POWER_CTRL_OFFSET

GPC_CM_WAKEUP_POWER_CTRL_OFFSET

GPC_CM_WAKEUP_RESET_CTRL_OFFSET

GPC_CM_WAKEUP_ISO_CTRL_OFFSET

GPC_CM_WAKEUP_PLL_CTRL_OFFSET

GPC_CM_WAKEUP_LPCG_CTRL_OFFSET

GPC_CM_WAKEUP_SSAR_CTRL_OFFSET

GPC_SP_SSAR_SAVE_CTRL_OFFSET

GPC_SP_LPCG_OFF_CTRL_OFFSET

GPC_SP_GROUP_DOWN_CTRL_OFFSET

GPC_SP_ROOT_DOWN_CTRL_OFFSET

GPC_SP_PLL_OFF_CTRL_OFFSET

GPC_SP_ISO_ON_CTRL_OFFSET

GPC_SP_RESET_EARLY_CTRL_OFFSET

GPC_SP_POWER_OFF_CTRL_OFFSET

GPC_SP_BIAS_OFF_CTRL_OFFSET

GPC_SP_BG_PLDO_OFF_CTRL_OFFSET

GPC_SP_LDO_PRE_CTRL_OFFSET

GPC_SP_DCDC_DOWN_CTRL_OFFSET

GPC_SP_DCDC_UP_CTRL_OFFSET

GPC_SP_LDO_POST_CTRL_OFFSET

GPC_SP_BG_PLDO_ON_CTRL_OFFSET

GPC_SP_BIAS_ON_CTRL_OFFSET

GPC_SP_POWER_ON_CTRL_OFFSET

GPC_SP_RESET_LATE_CTRL_OFFSET

GPC_SP_ISO_OFF_CTRL_OFFSET

GPC_SP_PLL_ON_CTRL_OFFSET

GPC_SP_ROOT_UP_CTRL_OFFSET

GPC_SP_GROUP_UP_CTRL_OFFSET

GPC_SP_LPCG_ON_CTRL_OFFSET

GPC_SP_SSAR_RESTORE_CTRL_OFFSET

GPC_STBY_LPCG_IN_CTRL_OFFSET

GPC_STBY_PLL_IN_CTRL_OFFSET

GPC_STBY_BIAS_IN_CTRL_OFFSET

GPC_STBY_PLDO_IN_CTRL_OFFSET

GPC_STBY_BANDGAP_IN_CTRL_OFFSET

GPC_STBY_LDO_IN_CTRL_OFFSET

GPC_STBY_DCDC_IN_CTRL_OFFSET

GPC_STBY_PMIC_IN_CTRL_OFFSET

GPC_STBY_PMIC_OUT_CTRL_OFFSET

GPC_STBY_DCDC_OUT_CTRL_OFFSET

GPC_STBY_LDO_OUT_CTRL_OFFSET

GPC_STBY_BANDGAP_OUT_CTRL_OFFSET

GPC_STBY_PLDO_OUT_CTRL_OFFSET

GPC_STBY_BIAS_OUT_CTRL_OFFSET

GPC_STBY_PLL_OUT_CTRL_OFFSET

GPC_STBY_LPCG_OUT_CTRL_OFFSET

GPC_CM_STEP_REG_OFFSET

GPC_SP_STEP_REG_OFFSET

GPC_STBY_STEP_REG_OFFSET

GPC_STAT(mask, shift)

GPC_CM_ALL_INTERRUPT_STATUS

struct __gpc_tran_step_config
#include <fsl_gpc.h> Configuration for GPC transition step.

Deprecated:
Related functions are deprecated.

Public Members

bool enableStep
Enable the step.

2.61 GPIO: General-Purpose Input/Output Driver

void GPIO_PinInit(GPIO_Type *base, uint32_t pin, const *gpio_pin_config_t* *Config)
Initializes the GPIO peripheral according to the specified parameters in the initConfig.

Parameters

- base – GPIO base pointer.
- pin – Specifies the pin number
- Config – pointer to a gpio_pin_config_t structure that contains the configuration information.

void GPIO_PinWrite(GPIO_Type *base, uint32_t pin, uint8_t output)
Sets the output level of the individual GPIO pin to logic 1 or 0.

Parameters

- base – GPIO base pointer.
- pin – GPIO port pin number.
- output – GPIOpin output logic level.
  - 0: corresponding pin output low-logic level.
  - 1: corresponding pin output high-logic level.

static inline void GPIO_WritePinOutput(GPIO_Type *base, uint32_t pin, uint8_t output)
Sets the output level of the individual GPIO pin to logic 1 or 0.

Deprecated:
Do not use this function. It has been superceded by GPIO_PinWrite.

static inline void GPIO_PortSet(GPIO_Type *base, uint32_t mask)
Sets the output level of the multiple GPIO pins to the logic 1.

Parameters

- base – GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)

- mask – GPIO pin number macro

static inline void GPIO_SetPinsOutput(GPIO_Type *base, uint32_t mask)

Sets the output level of the multiple GPIO pins to the logic 1.

Deprecated:

Do not use this function. It has been superceded by GPIO_PortSet.

static inline void GPIO_PortClear(GPIO_Type *base, uint32_t mask)

Sets the output level of the multiple GPIO pins to the logic 0.

Parameters

- base – GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_ClearPinsOutput(GPIO_Type *base, uint32_t mask)

Sets the output level of the multiple GPIO pins to the logic 0.

Deprecated:

Do not use this function. It has been superceded by GPIO_PortClear.

static inline void GPIO_PortToggle(GPIO_Type *base, uint32_t mask)

Reverses the current output logic of the multiple GPIO pins.

Parameters

- base – GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
- mask – GPIO pin number macro

static inline uint32_t GPIO_PinRead(GPIO_Type *base, uint32_t pin)

Reads the current input value of the GPIO port.

Parameters

- base – GPIO base pointer.
- pin – GPIO port pin number.

Return values

GPIO – port input value.

static inline uint32_t GPIO_ReadPinInput(GPIO_Type *base, uint32_t pin)

Reads the current input value of the GPIO port.

Deprecated:

Do not use this function. It has been superceded by GPIO_PinRead.

static inline uint8_t GPIO_PinReadPadStatus(GPIO_Type *base, uint32_t pin)

Reads the current GPIO pin pad status.

Parameters

- base – GPIO base pointer.
- pin – GPIO port pin number.

Return values

GPIO – pin pad status value.

static inline uint8_t GPIO_ReadPadStatus(GPIO_Type *base, uint32_t pin)

Reads the current GPIO pin pad status.

Deprecated:

Do not use this function. It has been superceded by GPIO_PinReadPadStatus.

void GPIO_PinSetInterruptConfig(GPIO_Type *base, uint32_t pin, *gpio_interrupt_mode_t* pinInterruptMode)

Sets the current pin interrupt mode.

Parameters

- base – GPIO base pointer.
- pin – GPIO port pin number.
- pinInterruptMode – pointer to a gpio_interrupt_mode_t structure that contains the interrupt mode information.

static inline void GPIO_SetPinInterruptConfig(GPIO_Type *base, uint32_t pin, *gpio_interrupt_mode_t* pinInterruptMode)

Sets the current pin interrupt mode.

Deprecated:

Do not use this function. It has been superceded by GPIO_PinSetInterruptConfig.

static inline void GPIO_PortEnableInterrupts(GPIO_Type *base, uint32_t mask)

Enables the specific pin interrupt.

Parameters

- base – GPIO base pointer.
- mask – GPIO pin number macro.

static inline void GPIO_EnableInterrupts(GPIO_Type *base, uint32_t mask)

Enables the specific pin interrupt.

Parameters

- base – GPIO base pointer.
- mask – GPIO pin number macro.

static inline void GPIO_PortDisableInterrupts(GPIO_Type *base, uint32_t mask)

Disables the specific pin interrupt.

Parameters

- base – GPIO base pointer.
- mask – GPIO pin number macro.

static inline void GPIO_DisableInterrupts(GPIO_Type *base, uint32_t mask)

Disables the specific pin interrupt.

Deprecated:

Do not use this function. It has been superceded by GPIO_PortDisableInterrupts.

static inline uint32_t GPIO_PortGetInterruptFlags(GPIO_Type *base)

Reads individual pin interrupt status.

Parameters

- base – GPIO base pointer.

Return values

current – pin interrupt status flag.

static inline uint32_t GPIO_GetPinsInterruptFlags(GPIO_Type *base)

Reads individual pin interrupt status.

Parameters

- base – GPIO base pointer.

Return values

current – pin interrupt status flag.

static inline void GPIO_PortClearInterruptFlags(GPIO_Type *base, uint32_t mask)

Clears pin interrupt flag. Status flags are cleared by writing a 1 to the corresponding bit position.

Parameters

- base – GPIO base pointer.
- mask – GPIO pin number macro.

static inline void GPIO_ClearPinsInterruptFlags(GPIO_Type *base, uint32_t mask)

Clears pin interrupt flag. Status flags are cleared by writing a 1 to the corresponding bit position.

Parameters

- base – GPIO base pointer.
- mask – GPIO pin number macro.

FSL_GPIO_DRIVER_VERSION

GPIO driver version.

enum _gpio_pin_direction

GPIO direction definition.

Values:

enumerator kGPIO_DigitalInput

Set current pin as digital input.

enumerator kGPIO_DigitalOutput

Set current pin as digital output.

enum _gpio_interrupt_mode

GPIO interrupt mode definition.

Values:

enumerator kGPIO_NoIntmode

Set current pin general IO functionality.

enumerator kGPIO_IntLowLevel

Set current pin interrupt is low-level sensitive.

enumerator kGPIO_IntHighLevel

Set current pin interrupt is high-level sensitive.

enumerator kGPIO_IntRisingEdge
Set current pin interrupt is rising-edge sensitive.

enumerator kGPIO_IntFallingEdge
Set current pin interrupt is falling-edge sensitive.

enumerator kGPIO_IntRisingOrFallingEdge
Enable the edge select bit to override the ICR register's configuration.

typedef enum *_gpio_pin_direction* gpio_pin_direction_t
GPIO direction definition.

typedef enum *_gpio_interrupt_mode* gpio_interrupt_mode_t
GPIO interrupt mode definition.

typedef struct *_gpio_pin_config* gpio_pin_config_t
GPIO Init structure definition.

struct _gpio_pin_config
#include <fsl_gpio.h> GPIO Init structure definition.

Public Members

gpio_pin_direction_t direction
Specifies the pin direction.

uint8_t outputLogic
Set a default output logic, which has no use in input

gpio_interrupt_mode_t interruptMode
Specifies the pin interrupt mode, a value of gpio_interrupt_mode_t.

2.62 GPT: General Purpose Timer

void GPT_Init(GPT_Type *base, const *gpt_config_t* *initConfig)
Initialize GPT to reset state and initialize running mode.

Parameters

- base – GPT peripheral base address.
- initConfig – GPT mode setting configuration.

void GPT_Deinit(GPT_Type *base)
Disables the module and gates the GPT clock.

Parameters

- base – GPT peripheral base address.

void GPT_GetDefaultConfig(*gpt_config_t* *config)
Fills in the GPT configuration structure with default settings.

The default values are:

```
config->clockSource = kGPT_ClockSource_Periph;
config->divider = 1U;
config->enableRunInStop = true;
config->enableRunInWait = true;
config->enableRunInDoze = false;
```

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```
config->enableRunInDbg = false;
config->enableFreeRun = false;
config->enableMode  = true;
```

Parameters

- config – Pointer to the user configuration structure.

static inline void GPT_SoftwareReset(GPT_Type *base)

Software reset of GPT module.

Parameters

- base – GPT peripheral base address.

static inline void GPT_SetClockSource(GPT_Type *base, *gpt_clock_source_t* gptClkSource)

Set clock source of GPT.

Parameters

- base – GPT peripheral base address.
- gptClkSource – Clock source (see gpt_clock_source_t typedef enumeration).

static inline *gpt_clock_source_t* GPT_GetClockSource(GPT_Type *base)

Get clock source of GPT.

Parameters

- base – GPT peripheral base address.

Returns

clock source (see gpt_clock_source_t typedef enumeration).

static inline void GPT_SetClockDivider(GPT_Type *base, uint32_t divider)

Set pre scaler of GPT.

Parameters

- base – GPT peripheral base address.
- divider – Divider of GPT (1-4096).

static inline uint32_t GPT_GetClockDivider(GPT_Type *base)

Get clock divider in GPT module.

Parameters

- base – GPT peripheral base address.

Returns

clock divider in GPT module (1-4096).

static inline void GPT_SetOscClockDivider(GPT_Type *base, uint32_t divider)

OSC 24M pre-scaler before selected by clock source.

Parameters

- base – GPT peripheral base address.
- divider – OSC Divider(1-16).

static inline uint32_t GPT_GetOscClockDivider(GPT_Type *base)

Get OSC 24M clock divider in GPT module.

Parameters

- base – GPT peripheral base address.

Returns
OSC clock divider in GPT module (1-16).

static inline void GPT_StartTimer(GPT_Type *base)

Start GPT timer.

Parameters

- base – GPT peripheral base address.

static inline void GPT_StopTimer(GPT_Type *base)

Stop GPT timer.

Parameters

- base – GPT peripheral base address.

static inline uint32_t GPT_GetCurrentTimerCount(GPT_Type *base)

Reads the current GPT counting value.

Parameters

- base – GPT peripheral base address.

Returns
Current GPT counter value.

static inline void GPT_SetInputOperationMode(GPT_Type *base, *gpt_input_capture_channel_t* channel, *gpt_input_operation_mode_t* mode)

Set GPT operation mode of input capture channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).
- mode – GPT input capture operation mode (see gpt_input_operation_mode_t typedef enumeration).

static inline *gpt_input_operation_mode_t* GPT_GetInputOperationMode(GPT_Type *base, *gpt_input_capture_channel_t* channel)

Get GPT operation mode of input capture channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns
GPT input capture operation mode (see gpt_input_operation_mode_t typedef enumeration).

static inline uint32_t GPT_GetInputCaptureValue(GPT_Type *base, *gpt_input_capture_channel_t* channel)

Get GPT input capture value of certain channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns
GPT input capture value.

static inline void GPT_SetOutputOperationMode(GPT_Type *base, *gpt_output_compare_channel_t* channel, *gpt_output_operation_mode_t* mode)

Set GPT operation mode of output compare channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
- mode – GPT output operation mode (see gpt_output_operation_mode_t typedef enumeration).

static inline *gpt_output_operation_mode_t* GPT_GetOutputOperationMode(GPT_Type *base, *gpt_output_compare_channel_t* channel)

Get GPT operation mode of output compare channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns
GPT output operation mode (see gpt_output_operation_mode_t typedef enumeration).

static inline void GPT_SetOutputCompareValue(GPT_Type *base, *gpt_output_compare_channel_t* channel, uint32_t value)

Set GPT output compare value of output compare channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
- value – GPT output compare value.

static inline uint32_t GPT_GetOutputCompareValue(GPT_Type *base, *gpt_output_compare_channel_t* channel)

Get GPT output compare value of output compare channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns
GPT output compare value.

static inline void GPT_ForceOutput(GPT_Type *base, *gpt_output_compare_channel_t* channel)

Force GPT output action on output compare channel, ignoring comparator.

Parameters

- base – GPT peripheral base address.

- channel – GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

static inline void GPT_EnableInterrupts(GPT_Type *base, uint32_t mask)

Enables the selected GPT interrupts.

Parameters

- base – GPT peripheral base address.
- mask – The interrupts to enable. This is a logical OR of members of the enumeration gpt_interrupt_enable_t

static inline void GPT_DisableInterrupts(GPT_Type *base, uint32_t mask)

Disables the selected GPT interrupts.

Parameters

- base – GPT peripheral base address
- mask – The interrupts to disable. This is a logical OR of members of the enumeration gpt_interrupt_enable_t

static inline uint32_t GPT_GetEnabledInterrupts(GPT_Type *base)

Gets the enabled GPT interrupts.

Parameters

- base – GPT peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration gpt_interrupt_enable_t

static inline uint32_t GPT_GetStatusFlags(GPT_Type *base, *gpt_status_flag_t* flags)

Get GPT status flags.

Parameters

- base – GPT peripheral base address.
- flags – GPT status flag mask (see gpt_status_flag_t for bit definition).

Returns

GPT status, each bit represents one status flag.

static inline void GPT_ClearStatusFlags(GPT_Type *base, *gpt_status_flag_t* flags)

Clears the GPT status flags.

Parameters

- base – GPT peripheral base address.
- flags – GPT status flag mask (see gpt_status_flag_t for bit definition).

FSL_GPT_DRIVER_VERSION

enum _gpt_clock_source

List of clock sources.

Note: Actual number of clock sources is SoC dependent

Values:

enumerator kGPT_ClockSource_Off

GPT Clock Source Off.

enumerator kGPT_ClockSource_Periph
GPT Clock Source from Peripheral Clock.

enumerator kGPT_ClockSource_HighFreq
GPT Clock Source from High Frequency Reference Clock.

enumerator kGPT_ClockSource_Ext
GPT Clock Source from external pin.

enumerator kGPT_ClockSource_LowFreq
GPT Clock Source from Low Frequency Reference Clock.

enumerator kGPT_ClockSource_Osc
GPT Clock Source from Crystal oscillator.

enum _gpt_input_capture_channel
List of input capture channel number.

Values:

enumerator kGPT_InputCapture_Channel1
GPT Input Capture Channel1.

enumerator kGPT_InputCapture_Channel2
GPT Input Capture Channel2.

enum _gpt_input_operation_mode
List of input capture operation mode.

Values:

enumerator kGPT_InputOperation_Disabled
Don't capture.

enumerator kGPT_InputOperation_RiseEdge
Capture on rising edge of input pin.

enumerator kGPT_InputOperation_FallEdge
Capture on falling edge of input pin.

enumerator kGPT_InputOperation_BothEdge
Capture on both edges of input pin.

enum _gpt_output_compare_channel
List of output compare channel number.

Values:

enumerator kGPT_OutputCompare_Channel1
Output Compare Channel1.

enumerator kGPT_OutputCompare_Channel2
Output Compare Channel2.

enumerator kGPT_OutputCompare_Channel3
Output Compare Channel3.

enum _gpt_output_operation_mode
List of output compare operation mode.

Values:

enumerator kGPT_OutputOperation_Disconnected
Don't change output pin.

enumerator kGPT_OutputOperation_Toggle
Toggle output pin.

enumerator kGPT_OutputOperation_Clear
Set output pin low.

enumerator kGPT_OutputOperation_Set
Set output pin high.

enumerator kGPT_OutputOperation_Activelow
Generate a active low pulse on output pin.

enum _gpt_interrupt_enable
List of GPT interrupts.

Values:

enumerator kGPT_OutputCompare1InterruptEnable
Output Compare Channel1 interrupt enable

enumerator kGPT_OutputCompare2InterruptEnable
Output Compare Channel2 interrupt enable

enumerator kGPT_OutputCompare3InterruptEnable
Output Compare Channel3 interrupt enable

enumerator kGPT_InputCapture1InterruptEnable
Input Capture Channel1 interrupt enable

enumerator kGPT_InputCapture2InterruptEnable
Input Capture Channel1 interrupt enable

enumerator kGPT_RollOverFlagInterruptEnable
Counter rolled over interrupt enable

enum _gpt_status_flag
Status flag.

Values:

enumerator kGPT_OutputCompare1Flag
Output compare channel 1 event.

enumerator kGPT_OutputCompare2Flag
Output compare channel 2 event.

enumerator kGPT_OutputCompare3Flag
Output compare channel 3 event.

enumerator kGPT_InputCapture1Flag
Input Capture channel 1 event.

enumerator kGPT_InputCapture2Flag
Input Capture channel 2 event.

enumerator kGPT_RollOverFlag
Counter reaches maximum value and rolled over to 0 event.

typedef enum *_gpt_clock_source* gpt_clock_source_t
List of clock sources.

Note: Actual number of clock sources is SoC dependent

typedef enum *_gpt_input_capture_channel* gpt_input_capture_channel_t
List of input capture channel number.

typedef enum *_gpt_input_operation_mode* gpt_input_operation_mode_t
List of input capture operation mode.

typedef enum *_gpt_output_compare_channel* gpt_output_compare_channel_t
List of output compare channel number.

typedef enum *_gpt_output_operation_mode* gpt_output_operation_mode_t
List of output compare operation mode.

typedef enum *_gpt_interrupt_enable* gpt_interrupt_enable_t
List of GPT interrupts.

typedef enum *_gpt_status_flag* gpt_status_flag_t
Status flag.

typedef struct *_gpt_init_config* gpt_config_t
Structure to configure the running mode.

struct _gpt_init_config
#include <fsl_gpt.h> Structure to configure the running mode.

Public Members

gpt_clock_source_t clockSource
clock source for GPT module.

uint32_t divider
clock divider (prescaler+1) from clock source to counter.

bool enableFreeRun
true: FreeRun mode, false: Restart mode.

bool enableRunInWait
GPT enabled in wait mode.

bool enableRunInStop
GPT enabled in stop mode.

bool enableRunInDoze
GPT enabled in doze mode.

bool enableRunInDbg
GPT enabled in debug mode.

bool enableMode
true: counter reset to 0 when enabled; false: counter retain its value when enabled.

2.63 IEE: Inline Encryption Engine

FSL_IEE_DRIVER_VERSION
IEE driver version. Version 2.1.1.

Current version: 2.1.1

Change log:

- Version 2.0.0

- Initial version

- Version 2.1.0
  - Add region lock function IEE_LockRegionConfig() and driver clock control
- Version 2.1.1
  - Fixed MISRA issues.
- Version 2.2.0
  - Add ELE (EdgeLock Enclave) key provisioning feature.

enum _iee_region

IEE region.

Values:

enumerator kIEE_Region0

IEE region 0

enumerator kIEE_Region1

IEE region 1

enumerator kIEE_Region2

IEE region 2

enumerator kIEE_Region3

IEE region 3

enumerator kIEE_Region4

IEE region 4

enumerator kIEE_Region5

IEE region 5

enumerator kIEE_Region6

IEE region 6

enumerator kIEE_Region7

IEE region 7

enum _iee_aes_bypass

IEE AES enablement/bypass.

Values:

enumerator kIEE_AesUseMdField

AES encryption/decryption enabled

enumerator kIEE_AesBypass

AES encryption/decryption bypass

enum _iee_aes_mode

IEE AES mode.

Values:

enumerator kIEE_ModeNone

AES NONE mode

enumerator kIEE_ModeAesXTS

AES XTS mode

enumerator kIEE_ModeAesCTRWAddress
AES CTR w address binding mode

enumerator kIEE_ModeAesCTRWOAddress
AES CTR w/o address binding mode

enumerator kIEE_ModeAesCTRkeystream
AES CTR keystream only

enum _iee_aes_key_size
IEE AES key size.

Values:

enumerator kIEE_AesCTR128XTS256
AES 128 bits (CTR), 256 bits (XTS)

enumerator kIEE_AesCTR256XTS512
AES 256 bits (CTR), 512 bits (XTS)

enum _iee_aes_key_num
IEE AES key number.

Values:

enumerator kIEE_AesKey1
AES Key 1

enumerator kIEE_AesKey2
AES Key 2

typedef enum *_iee_region* iee_region_t
IEE region.

typedef enum *_iee_aes_bypass* iee_aes_bypass_t
IEE AES enablement/bypass.

typedef enum *_iee_aes_mode* iee_aes_mode_t
IEE AES mode.

typedef enum *_iee_aes_key_size* iee_aes_key_size_t
IEE AES key size.

typedef enum *_iee_aes_key_num* iee_aes_key_num_t
IEE AES key number.

typedef struct *_iee_config* iee_config_t
IEE configuration structure.

void IEE_Init(IEE_Type *base)
Resets IEE module to factory default values.

This function performs hardware reset of IEE module. Attributes and keys of all regions are cleared.

Parameters

- base – IEER peripheral address.

void IEE_GetDefaultConfig(*iee_config_t* *config)
Loads default values to the IEE configuration structure.

Loads default values to the IEE region configuration structure. The default values are as follows.

```
config->bypass = kIEE_AesUseMdField;
config->mode = kIEE_ModeNone;
config->keySize = kIEE_AesCTR128XTS256;
config->pageOffset = 0U;
```

Parameters

- config – Configuration for the selected IEE region.

void IEE_SetRegionConfig(IEE_Type *base, *iee_region_t* region, *iee_config_t* *config)

Sets the IEE module according to the configuration structure.

This function configures IEE region according to configuration structure.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be configured.
- config – Configuration for the selected IEE region.

status_t IEE_SetRegionKey(IEE_Type *base, *iee_region_t* region, *iee_aes_key_num_t* keyNum, const uint8_t *key, size_t keySize)

Sets the IEE module key.

This function sets specified AES key for the given region.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be configured.
- keyNum – Selection of AES KEY1 or KEY2.
- key – AES key.
- keySize – Size of AES key.

static inline uint32_t IEE_GetOffset(uint32_t addressIee, uint32_t addressMemory)

Computes IEE offset to be set for specifed memory location.

This function calculates offset that must be set for IEE region to access physical memory location.

Parameters

- addressIee – Address of IEE peripheral.
- addressMemory – Address of physical memory location.

void IEE_LockRegionConfig(IEE_Type *base, *iee_region_t* region)

Lock the IEE region configuration.

This function locks IEE region registers for Key, Offset and Attribute. Only system reset can clear the Lock bit.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be locked.

struct _iee_config

#include <fsl_iee.h> IEE configuration structure.

Public Members

iee_aes_bypass_t bypass
AES encryption/decryption bypass

iee_aes_mode_t mode
AES mode

iee_aes_key_size_t keySize
size of AES key

uint32_t pageOffset
Offset to physical memory location from IEE start address

2.64 Ieer

FSL_IEE_APC_DRIVER_VERSION
IEE_APC driver version. Version 2.0.2.

Current version: 2.0.2

Change log:

- Version 2.0.0
  - Initial version
- Version 2.0.1
  - Fixed MISRA issues.
- Version 2.0.2
  - Update to newer version of implementation in HW.

enum _iee_apc_region
APC IEE regions.

Values:

enumerator kIEE_APC_Region0
APC IEE region 0

enumerator kIEE_APC_Region1
APC IEE region 1

enumerator kIEE_APC_Region2
APC IEE region 2

enumerator kIEE_APC_Region3
APC IEE region 3

enumerator kIEE_APC_Region4
APC IEE region 4

enumerator kIEE_APC_Region5
APC IEE region 5

enumerator kIEE_APC_Region6
APC IEE region 6

enumerator kIEE_APC_Region7
APC IEE region 7

enum _apc_iee_domain

APC IEE domains.

Values:

enumerator kIEE_APC_Domain0

APC IEE region 0

enumerator kIEE_APC_Domain1

APC IEE region 1

typedef enum *_iee_apc_region* iee_apc_region_t

APC IEE regions.

typedef enum *_apc_iee_domain* iee_apc_domain_t

APC IEE domains.

void IEE_APC_GlobalEnable(IEE_APC_Type *base)

Enable the APC IEE Region setting.

This function enables IOMUXC LPSR GPR and APC IEE for setting the region.

Parameters

- base – APC IEE peripheral address.

void IEE_APC_GlobalDisable(IEE_APC_Type *base)

Disables the APC IEE Region setting.

This function disables IOMUXC LPSR GPR and APC IEE for setting the region.

Parameters

- base – APC IEE peripheral address.

status_t IEE_APC_SetRegionConfig(IEE_APC_Type *base, *iee_apc_region_t* region, uint32_t startAddr, uint32_t endAddr)

Sets the APC IEE Memory Region Descriptors.

This function configures APC IEE Memory Region Descriptor according to region configuration structure.

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be configured.
- startAddr – Start encryption adress for the selected APC IEE region.
- endAddr – End encryption adress for the selected APC IEE region.

status_t IEE_APC_LockRegionConfig(IEE_APC_Type *base, *iee_apc_region_t* region, *iee_apc_domain_t* domain)

Lock the LPSR GPR and APC IEE configuration.

This function locks writting to IOMUXC LPSR GPR and APC IEE encryption region setting registers. Only system reset can clear the LPSR GPR and APC IEE-RDC_D0/1 Lock bit

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be locked.
- domain – Core domain ID

void IEE_APC_RegionEnable(IEE_APC_Type *base, *iee_apc_region_t* region)

Enable the IEE encryption/decryption and can lock this setting.

This function enables encryption/decryption by writting to IOMUXC LPSR GPR.

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be enabled.

2.65 IOMUXC: IOMUX Controller

enum _iomuxc_gpr_saimclk

Values:

enumerator kIOMUXC_GPR_SAI1MClk1Sel

enumerator kIOMUXC_GPR_SAI1MClk2Sel

enumerator kIOMUXC_GPR_SAI1MClk3Sel

enumerator kIOMUXC_GPR_SAI2MClk3Sel

enumerator kIOMUXC_GPR_SAI3MClk3Sel

enum _iomuxc_mqs_pwm_oversample_rate

Values:

enumerator kIOMUXC_MqsPwmOverSampleRate32

enumerator kIOMUXC_MqsPwmOverSampleRate64

typedef enum *_iomuxc_gpr_saimclk* iomuxc_gpr_saimclk_t

typedef enum *_iomuxc_mqs_pwm_oversample_rate* iomuxc_mqs_pwm_oversample_rate_t

IOMUXC_GPIO_LPSR_00_FLEXCAN3_TX

IOMUXC_GPIO_LPSR_00_MIC_CLK

IOMUXC_GPIO_LPSR_00_MQS_RIGHT

IOMUXC_GPIO_LPSR_00_ARM_CM4_EVENTO

IOMUXC_GPIO_LPSR_00_GPIO_MUX6_IO00

IOMUXC_GPIO_LPSR_00_LPUART12_TXD

IOMUXC_GPIO_LPSR_00_SAI4_MCLK

IOMUXC_GPIO_LPSR_00_GPIO12_IO00

IOMUXC_GPIO_LPSR_01_FLEXCAN3_RX

IOMUXC_GPIO_LPSR_01_MIC_BITSTREAM0

IOMUXC_GPIO_LPSR_01_MQS_LEFT

IOMUXC_GPIO_LPSR_01_ARM_CM4_EVENTI

IOMUXC_GPIO_LPSR_01_GPIO_MUX6_IO01

IOMUXC_GPIO_LPSR_01_LPUART12_RXD

IOMUXC_GPIO_LPSR_01_GPIO12_IO01

IOMUXC_GPIO_LPSR_02_GPIO12_IO02

IOMUXC_GPIO_LPSR_02_SRC_BOOT_MODE00

IOMUXC_GPIO_LPSR_02_LPSPI5_SCK

IOMUXC_GPIO_LPSR_02_SAI4_TX_DATA

IOMUXC_GPIO_LPSR_02_MQS_RIGHT

IOMUXC_GPIO_LPSR_02_GPIO_MUX6_IO02

IOMUXC_GPIO_LPSR_03_SRC_BOOT_MODE01

IOMUXC_GPIO_LPSR_03_LPSPI5_PCS0

IOMUXC_GPIO_LPSR_03_SAI4_TX_SYNC

IOMUXC_GPIO_LPSR_03_MQS_LEFT

IOMUXC_GPIO_LPSR_03_GPIO_MUX6_IO03

IOMUXC_GPIO_LPSR_03_GPIO12_IO03

IOMUXC_GPIO_LPSR_04_LPI2C5_SDA

IOMUXC_GPIO_LPSR_04_LPSPI5_SOUT

IOMUXC_GPIO_LPSR_04_SAI4_TX_BCLK

IOMUXC_GPIO_LPSR_04_LPUART12_RTS_B

IOMUXC_GPIO_LPSR_04_GPIO_MUX6_IO04

IOMUXC_GPIO_LPSR_04_LPUART11_TXD

IOMUXC_GPIO_LPSR_04_GPIO12_IO04

IOMUXC_GPIO_LPSR_05_GPIO12_IO05

IOMUXC_GPIO_LPSR_05_LPI2C5_SCL

IOMUXC_GPIO_LPSR_05_LPSPI5_SIN

IOMUXC_GPIO_LPSR_05_SAI4_MCLK

IOMUXC_GPIO_LPSR_05_LPUART12_CTS_B

IOMUXC_GPIO_LPSR_05_GPIO_MUX6_IO05

IOMUXC_GPIO_LPSR_05_LPUART11_RXD

IOMUXC_GPIO_LPSR_05_NMI_GLUE_NMI

IOMUXC_GPIO_LPSR_06_LPI2C6_SDA

IOMUXC_GPIO_LPSR_06_SAI4_RX_DATA

IOMUXC_GPIO_LPSR_06_LPUART12_TXD

IOMUXC_GPIO_LPSR_06_LPSPI6_PCS3

IOMUXC_GPIO_LPSR_06_GPIO_MUX6_IO06

IOMUXC_GPIO_LPSR_06_FLEXCAN3_TX

IOMUXC_GPIO_LPSR_06_PIT2_TRIGGER3

IOMUXC_GPIO_LPSR_06_LPSPI5_PCS1

IOMUXC_GPIO_LPSR_06_GPIO12_IO06

IOMUXC_GPIO_LPSR_07_LPI2C6_SCL

IOMUXC_GPIO_LPSR_07_SAI4_RX_BCLK

IOMUXC_GPIO_LPSR_07_LPUART12_RXD

IOMUXC_GPIO_LPSR_07_LPSPI6_PCS2

IOMUXC_GPIO_LPSR_07_GPIO_MUX6_IO07

IOMUXC_GPIO_LPSR_07_FLEXCAN3_RX

IOMUXC_GPIO_LPSR_07_PIT2_TRIGGER2

IOMUXC_GPIO_LPSR_07_LPSPI5_PCS2

IOMUXC_GPIO_LPSR_07_GPIO12_IO07

IOMUXC_GPIO_LPSR_08_GPIO12_IO08

IOMUXC_GPIO_LPSR_08_LPUART11_TXD

IOMUXC_GPIO_LPSR_08_FLEXCAN3_TX

IOMUXC_GPIO_LPSR_08_SAI4_RX_SYNC

IOMUXC_GPIO_LPSR_08_MIC_CLK

IOMUXC_GPIO_LPSR_08_LPSPI6_PCS1

IOMUXC_GPIO_LPSR_08_GPIO_MUX6_IO08

IOMUXC_GPIO_LPSR_08_LPI2C5_SDA

IOMUXC_GPIO_LPSR_08_PIT2_TRIGGER1

IOMUXC_GPIO_LPSR_08_LPSPI5_PCS3

IOMUXC_GPIO_LPSR_09_GPIO12_IO09

IOMUXC_GPIO_LPSR_09_LPUART11_RXD

IOMUXC_GPIO_LPSR_09_FLEXCAN3_RX

IOMUXC_GPIO_LPSR_09_PIT2_TRIGGER0

IOMUXC_GPIO_LPSR_09_MIC_BITSTREAM0

IOMUXC_GPIO_LPSR_09_LPSPI6_PCS0

IOMUXC_GPIO_LPSR_09_GPIO_MUX6_IO09

IOMUXC_GPIO_LPSR_09_LPI2C5_SCL

IOMUXC_GPIO_LPSR_09_SAI4_TX_DATA

IOMUXC_GPIO_LPSR_10_GPIO12_IO10

IOMUXC_GPIO_LPSR_10_JTAG_MUX_TRSTB

IOMUXC_GPIO_LPSR_10_LPUART11_CTS_B

IOMUXC_GPIO_LPSR_10_LPI2C6_SDA

IOMUXC_GPIO_LPSR_10_MIC_BITSTREAM1

IOMUXC_GPIO_LPSR_10_LPSPI6_SCK

IOMUXC_GPIO_LPSR_10_GPIO_MUX6_IO10

IOMUXC_GPIO_LPSR_10_LPI2C5_SCLS

IOMUXC_GPIO_LPSR_10_SAI4_TX_SYNC

IOMUXC_GPIO_LPSR_10_LPUART12_TXD

IOMUXC_GPIO_LPSR_11_JTAG_MUX_TDO

IOMUXC_GPIO_LPSR_11_LPUART11_RTS_B

IOMUXC_GPIO_LPSR_11_LPI2C6_SCL

IOMUXC_GPIO_LPSR_11_MIC_BITSTREAM2

IOMUXC_GPIO_LPSR_11_LPSPI6_SOUT

IOMUXC_GPIO_LPSR_11_GPIO_MUX6_IO11

IOMUXC_GPIO_LPSR_11_LPI2C5_SDAS

IOMUXC_GPIO_LPSR_11_ARM_TRACE_SWO

IOMUXC_GPIO_LPSR_11_LPUART12_RXD

IOMUXC_GPIO_LPSR_11_GPIO12_IO11

IOMUXC_GPIO_LPSR_12_GPIO12_IO12

IOMUXC_GPIO_LPSR_12_JTAG_MUX_TDI

IOMUXC_GPIO_LPSR_12_PIT2_TRIGGER0

IOMUXC_GPIO_LPSR_12_MIC_BITSTREAM3

IOMUXC_GPIO_LPSR_12_LPSPI6_SIN

IOMUXC_GPIO_LPSR_12_GPIO_MUX6_IO12

IOMUXC_GPIO_LPSR_12_LPI2C5_HREQ

IOMUXC_GPIO_LPSR_12_SAI4_TX_BCLK

IOMUXC_GPIO_LPSR_12_LPSPI5_SCK

IOMUXC_GPIO_LPSR_13_GPIO12_IO13

IOMUXC_GPIO_LPSR_13_JTAG_MUX_MOD

IOMUXC_GPIO_LPSR_13_MIC_BITSTREAM1

IOMUXC_GPIO_LPSR_13_PIT2_TRIGGER1

IOMUXC_GPIO_LPSR_13_GPIO_MUX6_IO13

IOMUXC_GPIO_LPSR_13_SAI4_RX_DATA

IOMUXC_GPIO_LPSR_13_LPSPI5_PCS0

IOMUXC_GPIO_LPSR_14_JTAG_MUX_TCK

IOMUXC_GPIO_LPSR_14_MIC_BITSTREAM2

IOMUXC_GPIO_LPSR_14_PIT2_TRIGGER2

IOMUXC_GPIO_LPSR_14_GPIO_MUX6_IO14

IOMUXC_GPIO_LPSR_14_SAI4_RX_BCLK

IOMUXC_GPIO_LPSR_14_LPSPI5_SOUT

IOMUXC_GPIO_LPSR_14_GPIO12_IO14

IOMUXC_GPIO_LPSR_15_GPIO12_IO15

IOMUXC_GPIO_LPSR_15_JTAG_MUX_TMS

IOMUXC_GPIO_LPSR_15_MIC_BITSTREAM3

IOMUXC_GPIO_LPSR_15_PIT2_TRIGGER3

IOMUXC_GPIO_LPSR_15_GPIO_MUX6_IO15

IOMUXC_GPIO_LPSR_15_SAI4_RX_SYNC

IOMUXC_GPIO_LPSR_15_LPSPI5_SIN

IOMUXC_WAKEUP_DIG_GPIO13_IO00

IOMUXC_WAKEUP_DIG_NMI_GLUE_NMI

IOMUXC_PMIC_ON_REQ_DIG_SNVS_LP_PMIC_ON_REQ

IOMUXC_PMIC_ON_REQ_DIG_GPIO13_IO01

IOMUXC_PMIC_STBY_REQ_DIG_CCM_PMIC_VSTBY_REQ

IOMUXC_PMIC_STBY_REQ_DIG_GPIO13_IO02

IOMUXC_GPIO_SNVS_00_DIG_SNVS_TAMPER0

IOMUXC_GPIO_SNVS_00_DIG_GPIO13_IO03

IOMUXC_GPIO_SNVS_01_DIG_SNVS_TAMPER1

IOMUXC_GPIO_SNVS_01_DIG_GPIO13_IO04

IOMUXC_GPIO_SNVS_02_DIG_SNVS_TAMPER2

IOMUXC_GPIO_SNVS_02_DIG_GPIO13_IO05

IOMUXC_GPIO_SNVS_03_DIG_SNVS_TAMPER3

IOMUXC_GPIO_SNVS_03_DIG_GPIO13_IO06

IOMUXC_GPIO_SNVS_04_DIG_SNVS_TAMPER4

IOMUXC_GPIO_SNVS_04_DIG_GPIO13_IO07

IOMUXC_GPIO_SNVS_05_DIG_SNVS_TAMPER5

IOMUXC_GPIO_SNVS_05_DIG_GPIO13_IO08

IOMUXC_GPIO_SNVS_06_DIG_SNVS_TAMPER6

IOMUXC_GPIO_SNVS_06_DIG_GPIO13_IO09

IOMUXC_GPIO_SNVS_07_DIG_SNVS_TAMPER7

IOMUXC_GPIO_SNVS_07_DIG_GPIO13_IO10

IOMUXC_GPIO_SNVS_08_DIG_SNVS_TAMPER8

IOMUXC_GPIO_SNVS_08_DIG_GPIO13_IO11

IOMUXC_GPIO_SNVS_09_DIG_SNVS_TAMPER9

IOMUXC_GPIO_SNVS_09_DIG_GPIO13_IO12

IOMUXC_TEST_MODE_DIG

IOMUXC_POR_B_DIG

IOMUXC_ONOFF_DIG

IOMUXC_GPIO_EMC_B1_00_SEMC_DATA00

IOMUXC_GPIO_EMC_B1_00_FLEXPWM4_PWM0_A

IOMUXC_GPIO_EMC_B1_00_GPIO_MUX1_IO00

IOMUXC_GPIO_EMC_B1_00_FLEXIO1_D00

IOMUXC_GPIO_EMC_B1_00_GPIO7_IO00

IOMUXC_GPIO_EMC_B1_01_GPIO7_IO01

IOMUXC_GPIO_EMC_B1_01_SEMC_DATA01

IOMUXC_GPIO_EMC_B1_01_FLEXPWM4_PWM0_B

IOMUXC_GPIO_EMC_B1_01_GPIO_MUX1_IO01

IOMUXC_GPIO_EMC_B1_01_FLEXIO1_D01

IOMUXC_GPIO_EMC_B1_02_SEMC_DATA02

IOMUXC_GPIO_EMC_B1_02_FLEXPWM4_PWM1_A

IOMUXC_GPIO_EMC_B1_02_GPIO_MUX1_IO02

IOMUXC_GPIO_EMC_B1_02_FLEXIO1_D02

IOMUXC_GPIO_EMC_B1_02_GPIO7_IO02

IOMUXC_GPIO_EMC_B1_03_SEMC_DATA03

IOMUXC_GPIO_EMC_B1_03_FLEXPWM4_PWM1_B

IOMUXC_GPIO_EMC_B1_03_GPIO_MUX1_IO03

IOMUXC_GPIO_EMC_B1_03_FLEXIO1_D03

IOMUXC_GPIO_EMC_B1_03_GPIO7_IO03

IOMUXC_GPIO_EMC_B1_04_GPIO7_IO04

IOMUXC_GPIO_EMC_B1_04_SEMC_DATA04

IOMUXC_GPIO_EMC_B1_04_FLEXPWM4_PWM2_A

IOMUXC_GPIO_EMC_B1_04_GPIO_MUX1_IO04

IOMUXC_GPIO_EMC_B1_04_FLEXIO1_D04

IOMUXC_GPIO_EMC_B1_05_SEMC_DATA05

IOMUXC_GPIO_EMC_B1_05_FLEXPWM4_PWM2_B

IOMUXC_GPIO_EMC_B1_05_GPIO_MUX1_IO05

IOMUXC_GPIO_EMC_B1_05_FLEXIO1_D05

IOMUXC_GPIO_EMC_B1_05_GPIO7_IO05

IOMUXC_GPIO_EMC_B1_06_SEMC_DATA06

IOMUXC_GPIO_EMC_B1_06_FLEXPWM2_PWM0_A

IOMUXC_GPIO_EMC_B1_06_GPIO_MUX1_IO06

IOMUXC_GPIO_EMC_B1_06_FLEXIO1_D06

IOMUXC_GPIO_EMC_B1_06_GPIO7_IO06

IOMUXC_GPIO_EMC_B1_07_GPIO7_IO07

IOMUXC_GPIO_EMC_B1_07_SEMC_DATA07

IOMUXC_GPIO_EMC_B1_07_FLEXPWM2_PWM0_B

IOMUXC_GPIO_EMC_B1_07_GPIO_MUX1_IO07

IOMUXC_GPIO_EMC_B1_07_FLEXIO1_D07

IOMUXC_GPIO_EMC_B1_08_SEMC_DM00

IOMUXC_GPIO_EMC_B1_08_FLEXPWM2_PWM1_A

IOMUXC_GPIO_EMC_B1_08_GPIO_MUX1_IO08

IOMUXC_GPIO_EMC_B1_08_FLEXIO1_D08

IOMUXC_GPIO_EMC_B1_08_GPIO7_IO08

IOMUXC_GPIO_EMC_B1_09_SEMC_ADDR00

IOMUXC_GPIO_EMC_B1_09_FLEXPWM2_PWM1_B

IOMUXC_GPIO_EMC_B1_09_GPT5_CAPTURE1

IOMUXC_GPIO_EMC_B1_09_GPIO_MUX1_IO09

IOMUXC_GPIO_EMC_B1_09_FLEXIO1_D09

IOMUXC_GPIO_EMC_B1_09_GPIO7_IO09

IOMUXC_GPIO_EMC_B1_10_SEMC_ADDR01

IOMUXC_GPIO_EMC_B1_10_FLEXPWM2_PWM2_A

IOMUXC_GPIO_EMC_B1_10_GPT5_CAPTURE2

IOMUXC_GPIO_EMC_B1_10_GPIO_MUX1_IO10

IOMUXC_GPIO_EMC_B1_10_FLEXIO1_D10

IOMUXC_GPIO_EMC_B1_10_GPIO7_IO10

IOMUXC_GPIO_EMC_B1_11_GPIO7_IO11

IOMUXC_GPIO_EMC_B1_11_SEMC_ADDR02

IOMUXC_GPIO_EMC_B1_11_FLEXPWM2_PWM2_B

IOMUXC_GPIO_EMC_B1_11_GPT5_COMPARE1

IOMUXC_GPIO_EMC_B1_11_GPIO_MUX1_IO11

IOMUXC_GPIO_EMC_B1_11_FLEXIO1_D11

IOMUXC_GPIO_EMC_B1_12_SEMC_ADDR03

IOMUXC_GPIO_EMC_B1_12_XBAR1_INOUT04

IOMUXC_GPIO_EMC_B1_12_GPT5_COMPARE2

IOMUXC_GPIO_EMC_B1_12_GPIO_MUX1_IO12

IOMUXC_GPIO_EMC_B1_12_FLEXIO1_D12

IOMUXC_GPIO_EMC_B1_12_GPIO7_IO12

IOMUXC_GPIO_EMC_B1_13_SEMC_ADDR04

IOMUXC_GPIO_EMC_B1_13_XBAR1_INOUT05

IOMUXC_GPIO_EMC_B1_13_GPT5_COMPARE3

IOMUXC_GPIO_EMC_B1_13_GPIO_MUX1_IO13

IOMUXC_GPIO_EMC_B1_13_FLEXIO1_D13

IOMUXC_GPIO_EMC_B1_13_GPIO7_IO13

IOMUXC_GPIO_EMC_B1_14_GPIO7_IO14

IOMUXC_GPIO_EMC_B1_14_SEMC_ADDR05

IOMUXC_GPIO_EMC_B1_14_XBAR1_INOUT06

IOMUXC_GPIO_EMC_B1_14_GPT5_CLK

IOMUXC_GPIO_EMC_B1_14_GPIO_MUX1_IO14

IOMUXC_GPIO_EMC_B1_14_FLEXIO1_D14

IOMUXC_GPIO_EMC_B1_15_SEMC_ADDR06

IOMUXC_GPIO_EMC_B1_15_XBAR1_INOUT07

IOMUXC_GPIO_EMC_B1_15_GPIO_MUX1_IO15

IOMUXC_GPIO_EMC_B1_15_FLEXIO1_D15

IOMUXC_GPIO_EMC_B1_15_GPIO7_IO15

IOMUXC_GPIO_EMC_B1_16_SEMC_ADDR07

IOMUXC_GPIO_EMC_B1_16_XBAR1_INOUT08

IOMUXC_GPIO_EMC_B1_16_GPIO_MUX1_IO16

IOMUXC_GPIO_EMC_B1_16_FLEXIO1_D16

IOMUXC_GPIO_EMC_B1_16_GPIO7_IO16

IOMUXC_GPIO_EMC_B1_17_GPIO7_IO17

IOMUXC_GPIO_EMC_B1_17_SEMC_ADDR08

IOMUXC_GPIO_EMC_B1_17_FLEXPWM4_PWM3_A

IOMUXC_GPIO_EMC_B1_17_TMR1_TIMER0

IOMUXC_GPIO_EMC_B1_17_GPIO_MUX1_IO17

IOMUXC_GPIO_EMC_B1_17_FLEXIO1_D17

IOMUXC_GPIO_EMC_B1_18_SEMC_ADDR09

IOMUXC_GPIO_EMC_B1_18_FLEXPWM4_PWM3_B

IOMUXC_GPIO_EMC_B1_18_TMR2_TIMER0

IOMUXC_GPIO_EMC_B1_18_GPIO_MUX1_IO18

IOMUXC_GPIO_EMC_B1_18_FLEXIO1_D18

IOMUXC_GPIO_EMC_B1_18_GPIO7_IO18

IOMUXC_GPIO_EMC_B1_19_SEMC_ADDR11

IOMUXC_GPIO_EMC_B1_19_FLEXPWM2_PWM3_A

IOMUXC_GPIO_EMC_B1_19_TMR3_TIMER0

IOMUXC_GPIO_EMC_B1_19_GPIO_MUX1_IO19

IOMUXC_GPIO_EMC_B1_19_FLEXIO1_D19

IOMUXC_GPIO_EMC_B1_19_GPIO7_IO19

IOMUXC_GPIO_EMC_B1_20_SEMC_ADDR12

IOMUXC_GPIO_EMC_B1_20_FLEXPWM2_PWM3_B

IOMUXC_GPIO_EMC_B1_20_TMR4_TIMER0

IOMUXC_GPIO_EMC_B1_20_GPIO_MUX1_IO20

IOMUXC_GPIO_EMC_B1_20_FLEXIO1_D20

IOMUXC_GPIO_EMC_B1_20_GPIO7_IO20

IOMUXC_GPIO_EMC_B1_21_GPIO7_IO21

IOMUXC_GPIO_EMC_B1_21_SEMC_BA0

IOMUXC_GPIO_EMC_B1_21_FLEXPWM3_PWM3_A

IOMUXC_GPIO_EMC_B1_21_GPIO_MUX1_IO21

IOMUXC_GPIO_EMC_B1_21_FLEXIO1_D21

IOMUXC_GPIO_EMC_B1_22_GPIO7_IO22

IOMUXC_GPIO_EMC_B1_22_SEMC_BA1

IOMUXC_GPIO_EMC_B1_22_FLEXPWM3_PWM3_B

IOMUXC_GPIO_EMC_B1_22_GPIO_MUX1_IO22

IOMUXC_GPIO_EMC_B1_22_FLEXIO1_D22

IOMUXC_GPIO_EMC_B1_23_SEMC_ADDR10

IOMUXC_GPIO_EMC_B1_23_FLEXPWM1_PWM0_A

IOMUXC_GPIO_EMC_B1_23_GPIO_MUX1_IO23

IOMUXC_GPIO_EMC_B1_23_FLEXIO1_D23

IOMUXC_GPIO_EMC_B1_23_GPIO7_IO23

IOMUXC_GPIO_EMC_B1_24_GPIO7_IO24

IOMUXC_GPIO_EMC_B1_24_SEMC_CAS

IOMUXC_GPIO_EMC_B1_24_FLEXPWM1_PWM0_B

IOMUXC_GPIO_EMC_B1_24_GPIO_MUX1_IO24

IOMUXC_GPIO_EMC_B1_24_FLEXIO1_D24

IOMUXC_GPIO_EMC_B1_25_GPIO7_IO25

IOMUXC_GPIO_EMC_B1_25_SEMC_RAS

IOMUXC_GPIO_EMC_B1_25_FLEXPWM1_PWM1_A

IOMUXC_GPIO_EMC_B1_25_GPIO_MUX1_IO25

IOMUXC_GPIO_EMC_B1_25_FLEXIO1_D25

IOMUXC_GPIO_EMC_B1_26_SEMC_CLK

IOMUXC_GPIO_EMC_B1_26_FLEXPWM1_PWM1_B

IOMUXC_GPIO_EMC_B1_26_GPIO_MUX1_IO26

IOMUXC_GPIO_EMC_B1_26_FLEXIO1_D26

IOMUXC_GPIO_EMC_B1_26_GPIO7_IO26

IOMUXC_GPIO_EMC_B1_27_GPIO7_IO27

IOMUXC_GPIO_EMC_B1_27_SEMC_CKE

IOMUXC_GPIO_EMC_B1_27_FLEXPWM1_PWM2_A

IOMUXC_GPIO_EMC_B1_27_GPIO_MUX1_IO27

IOMUXC_GPIO_EMC_B1_27_FLEXIO1_D27

IOMUXC_GPIO_EMC_B1_28_GPIO7_IO28

IOMUXC_GPIO_EMC_B1_28_SEMC_WE

IOMUXC_GPIO_EMC_B1_28_FLEXPWM1_PWM2_B

IOMUXC_GPIO_EMC_B1_28_GPIO_MUX1_IO28

IOMUXC_GPIO_EMC_B1_28_FLEXIO1_D28

IOMUXC_GPIO_EMC_B1_29_SEMC_CS0

IOMUXC_GPIO_EMC_B1_29_FLEXPWM3_PWM0_A

IOMUXC_GPIO_EMC_B1_29_GPIO_MUX1_IO29

IOMUXC_GPIO_EMC_B1_29_FLEXIO1_D29

IOMUXC_GPIO_EMC_B1_29_GPIO7_IO29

IOMUXC_GPIO_EMC_B1_30_SEMC_DATA08

IOMUXC_GPIO_EMC_B1_30_FLEXPWM3_PWM0_B

IOMUXC_GPIO_EMC_B1_30_GPIO_MUX1_IO30

IOMUXC_GPIO_EMC_B1_30_FLEXIO1_D30

IOMUXC_GPIO_EMC_B1_30_GPIO7_IO30

IOMUXC_GPIO_EMC_B1_31_GPIO7_IO31

IOMUXC_GPIO_EMC_B1_31_SEMC_DATA09

IOMUXC_GPIO_EMC_B1_31_FLEXPWM3_PWM1_A

IOMUXC_GPIO_EMC_B1_31_GPIO_MUX1_IO31

IOMUXC_GPIO_EMC_B1_31_FLEXIO1_D31

IOMUXC_GPIO_EMC_B1_32_GPIO8_IO00

IOMUXC_GPIO_EMC_B1_32_SEMC_DATA10

IOMUXC_GPIO_EMC_B1_32_FLEXPWM3_PWM1_B

IOMUXC_GPIO_EMC_B1_32_GPIO_MUX2_IO00

IOMUXC_GPIO_EMC_B1_33_SEMC_DATA11

IOMUXC_GPIO_EMC_B1_33_FLEXPWM3_PWM2_A

IOMUXC_GPIO_EMC_B1_33_GPIO_MUX2_IO01

IOMUXC_GPIO_EMC_B1_33_GPIO8_IO01

IOMUXC_GPIO_EMC_B1_34_GPIO8_IO02

IOMUXC_GPIO_EMC_B1_34_SEMC_DATA12

IOMUXC_GPIO_EMC_B1_34_FLEXPWM3_PWM2_B

IOMUXC_GPIO_EMC_B1_34_GPIO_MUX2_IO02

IOMUXC_GPIO_EMC_B1_35_GPIO8_IO03

IOMUXC_GPIO_EMC_B1_35_SEMC_DATA13

IOMUXC_GPIO_EMC_B1_35_XBAR1_INOUT09

IOMUXC_GPIO_EMC_B1_35_GPIO_MUX2_IO03

IOMUXC_GPIO_EMC_B1_36_SEMC_DATA14

IOMUXC_GPIO_EMC_B1_36_XBAR1_INOUT10

IOMUXC_GPIO_EMC_B1_36_GPIO_MUX2_IO04

IOMUXC_GPIO_EMC_B1_36_GPIO8_IO04

IOMUXC_GPIO_EMC_B1_37_GPIO8_IO05

IOMUXC_GPIO_EMC_B1_37_SEMC_DATA15

IOMUXC_GPIO_EMC_B1_37_XBAR1_INOUT11

IOMUXC_GPIO_EMC_B1_37_GPIO_MUX2_IO05

IOMUXC_GPIO_EMC_B1_38_GPIO8_IO06

IOMUXC_GPIO_EMC_B1_38_SEMC_DM01

IOMUXC_GPIO_EMC_B1_38_FLEXPWM1_PWM3_A

IOMUXC_GPIO_EMC_B1_38_TMR1_TIMER1

IOMUXC_GPIO_EMC_B1_38_GPIO_MUX2_IO06

IOMUXC_GPIO_EMC_B1_39_SEMC_DQS

IOMUXC_GPIO_EMC_B1_39_FLEXPWM1_PWM3_B

IOMUXC_GPIO_EMC_B1_39_TMR2_TIMER1

IOMUXC_GPIO_EMC_B1_39_GPIO_MUX2_IO07

IOMUXC_GPIO_EMC_B1_39_GPIO8_IO07

IOMUXC_GPIO_EMC_B1_40_SEMC_RDY

IOMUXC_GPIO_EMC_B1_40_XBAR1_INOUT12

IOMUXC_GPIO_EMC_B1_40_MQS_RIGHT

IOMUXC_GPIO_EMC_B1_40_LPUART6_TXD

IOMUXC_GPIO_EMC_B1_40_GPIO_MUX2_IO08

IOMUXC_GPIO_EMC_B1_40_ENET_1G_MDC

IOMUXC_GPIO_EMC_B1_40_CCM_CLKO1

IOMUXC_GPIO_EMC_B1_40_GPIO8_IO08

IOMUXC_GPIO_EMC_B1_41_GPIO8_IO09

IOMUXC_GPIO_EMC_B1_41_SEMC_CSX00

IOMUXC_GPIO_EMC_B1_41_XBAR1_INOUT13

IOMUXC_GPIO_EMC_B1_41_MQS_LEFT

IOMUXC_GPIO_EMC_B1_41_LPUART6_RXD

IOMUXC_GPIO_EMC_B1_41_FLEXSPI2_B_DATA07

IOMUXC_GPIO_EMC_B1_41_GPIO_MUX2_IO09

IOMUXC_GPIO_EMC_B1_41_ENET_1G_MDIO

IOMUXC_GPIO_EMC_B1_41_CCM_CLKO2

IOMUXC_GPIO_EMC_B2_00_SEMC_DATA16

IOMUXC_GPIO_EMC_B2_00_CCM_ENET_REF_CLK_25M

IOMUXC_GPIO_EMC_B2_00_TMR3_TIMER1

IOMUXC_GPIO_EMC_B2_00_LPUART6_CTS_B

IOMUXC_GPIO_EMC_B2_00_FLEXSPI2_B_DATA06

IOMUXC_GPIO_EMC_B2_00_GPIO_MUX2_IO10

IOMUXC_GPIO_EMC_B2_00_XBAR1_INOUT20

IOMUXC_GPIO_EMC_B2_00_ENET_QOS_1588_EVENT1_OUT

IOMUXC_GPIO_EMC_B2_00_LPSPI1_SCK

IOMUXC_GPIO_EMC_B2_00_LPI2C2_SCL

IOMUXC_GPIO_EMC_B2_00_GPIO8_IO10

IOMUXC_GPIO_EMC_B2_00_FLEXPWM3_PWM0_A

IOMUXC_GPIO_EMC_B2_01_SEMC_DATA17

IOMUXC_GPIO_EMC_B2_01_USDHC2_CD_B

IOMUXC_GPIO_EMC_B2_01_TMR4_TIMER1

IOMUXC_GPIO_EMC_B2_01_LPUART6_RTS_B

IOMUXC_GPIO_EMC_B2_01_FLEXSPI2_B_DATA05

IOMUXC_GPIO_EMC_B2_01_GPIO_MUX2_IO11

IOMUXC_GPIO_EMC_B2_01_XBAR1_INOUT21

IOMUXC_GPIO_EMC_B2_01_ENET_QOS_1588_EVENT1_IN

IOMUXC_GPIO_EMC_B2_01_LPSPI1_PCS0

IOMUXC_GPIO_EMC_B2_01_LPI2C2_SDA

IOMUXC_GPIO_EMC_B2_01_GPIO8_IO11

IOMUXC_GPIO_EMC_B2_01_FLEXPWM3_PWM0_B

IOMUXC_GPIO_EMC_B2_02_SEMC_DATA18

IOMUXC_GPIO_EMC_B2_02_USDHC2_WP

IOMUXC_GPIO_EMC_B2_02_VIDEO_MUX_CSI_DATA23

IOMUXC_GPIO_EMC_B2_02_FLEXSPI2_B_DATA04

IOMUXC_GPIO_EMC_B2_02_GPIO_MUX2_IO12

IOMUXC_GPIO_EMC_B2_02_XBAR1_INOUT22

IOMUXC_GPIO_EMC_B2_02_ENET_QOS_1588_EVENT1_AUX_IN

IOMUXC_GPIO_EMC_B2_02_LPSPI1_SOUT

IOMUXC_GPIO_EMC_B2_02_GPIO8_IO12

IOMUXC_GPIO_EMC_B2_02_FLEXPWM3_PWM1_A

IOMUXC_GPIO_EMC_B2_03_SEMC_DATA19

IOMUXC_GPIO_EMC_B2_03_USDHC2_VSELECT

IOMUXC_GPIO_EMC_B2_03_VIDEO_MUX_CSI_DATA22

IOMUXC_GPIO_EMC_B2_03_FLEXSPI2_B_DATA03

IOMUXC_GPIO_EMC_B2_03_GPIO_MUX2_IO13

IOMUXC_GPIO_EMC_B2_03_XBAR1_INOUT23

IOMUXC_GPIO_EMC_B2_03_ENET_1G_TX_DATA03

IOMUXC_GPIO_EMC_B2_03_LPSPI1_SIN

IOMUXC_GPIO_EMC_B2_03_GPIO8_IO13

IOMUXC_GPIO_EMC_B2_03_FLEXPWM3_PWM1_B

IOMUXC_GPIO_EMC_B2_04_SEMC_DATA20

IOMUXC_GPIO_EMC_B2_04_USDHC2_RESET_B

IOMUXC_GPIO_EMC_B2_04_SAI2_MCLK

IOMUXC_GPIO_EMC_B2_04_VIDEO_MUX_CSI_DATA21

IOMUXC_GPIO_EMC_B2_04_FLEXSPI2_B_DATA02

IOMUXC_GPIO_EMC_B2_04_GPIO_MUX2_IO14

IOMUXC_GPIO_EMC_B2_04_XBAR1_INOUT24

IOMUXC_GPIO_EMC_B2_04_ENET_1G_TX_DATA02

IOMUXC_GPIO_EMC_B2_04_LPSPI3_SCK

IOMUXC_GPIO_EMC_B2_04_GPIO8_IO14

IOMUXC_GPIO_EMC_B2_04_FLEXPWM3_PWM2_A

IOMUXC_GPIO_EMC_B2_05_SEMC_DATA21

IOMUXC_GPIO_EMC_B2_05_GPT3_CLK

IOMUXC_GPIO_EMC_B2_05_SAI2_RX_SYNC

IOMUXC_GPIO_EMC_B2_05_VIDEO_MUX_CSI_DATA20

IOMUXC_GPIO_EMC_B2_05_FLEXSPI2_B_DATA01

IOMUXC_GPIO_EMC_B2_05_GPIO_MUX2_IO15

IOMUXC_GPIO_EMC_B2_05_XBAR1_INOUT25

IOMUXC_GPIO_EMC_B2_05_ENET_1G_RX_CLK

IOMUXC_GPIO_EMC_B2_05_LPSPI3_PCS0

IOMUXC_GPIO_EMC_B2_05_PIT1_TRIGGER0

IOMUXC_GPIO_EMC_B2_05_GPIO8_IO15

IOMUXC_GPIO_EMC_B2_05_FLEXPWM3_PWM2_B

IOMUXC_GPIO_EMC_B2_06_SEMC_DATA22

IOMUXC_GPIO_EMC_B2_06_GPT3_CAPTURE1

IOMUXC_GPIO_EMC_B2_06_GPIO8_IO16

IOMUXC_GPIO_EMC_B2_06_SAI2_RX_BCLK

IOMUXC_GPIO_EMC_B2_06_FLEXPWM3_PWM3_A

IOMUXC_GPIO_EMC_B2_06_VIDEO_MUX_CSI_DATA19

IOMUXC_GPIO_EMC_B2_06_FLEXSPI2_B_DATA00

IOMUXC_GPIO_EMC_B2_06_GPIO_MUX2_IO16

IOMUXC_GPIO_EMC_B2_06_XBAR1_INOUT26

IOMUXC_GPIO_EMC_B2_06_ENET_1G_TX_ER

IOMUXC_GPIO_EMC_B2_06_LPSPI3_SOUT

IOMUXC_GPIO_EMC_B2_06_PIT1_TRIGGER1

IOMUXC_GPIO_EMC_B2_07_SEMC_DATA23

IOMUXC_GPIO_EMC_B2_07_GPT3_CAPTURE2

IOMUXC_GPIO_EMC_B2_07_SAI2_RX_DATA

IOMUXC_GPIO_EMC_B2_07_VIDEO_MUX_CSI_DATA18

IOMUXC_GPIO_EMC_B2_07_FLEXSPI2_B_DQS

IOMUXC_GPIO_EMC_B2_07_GPIO_MUX2_IO17

IOMUXC_GPIO_EMC_B2_07_XBAR1_INOUT27

IOMUXC_GPIO_EMC_B2_07_ENET_1G_RX_DATA03

IOMUXC_GPIO_EMC_B2_07_LPSPI3_SIN

IOMUXC_GPIO_EMC_B2_07_PIT1_TRIGGER2

IOMUXC_GPIO_EMC_B2_07_GPIO8_IO17

IOMUXC_GPIO_EMC_B2_07_FLEXPWM3_PWM3_B

IOMUXC_GPIO_EMC_B2_08_SEMC_DM02

IOMUXC_GPIO_EMC_B2_08_GPT3_COMPARE1

IOMUXC_GPIO_EMC_B2_08_SAI2_TX_DATA

IOMUXC_GPIO_EMC_B2_08_VIDEO_MUX_CSI_DATA17

IOMUXC_GPIO_EMC_B2_08_FLEXSPI2_B_SS0_B

IOMUXC_GPIO_EMC_B2_08_GPIO_MUX2_IO18

IOMUXC_GPIO_EMC_B2_08_XBAR1_INOUT28

IOMUXC_GPIO_EMC_B2_08_ENET_1G_RX_DATA02

IOMUXC_GPIO_EMC_B2_08_LPSPI3_PCS1

IOMUXC_GPIO_EMC_B2_08_PIT1_TRIGGER3

IOMUXC_GPIO_EMC_B2_08_GPIO8_IO18

IOMUXC_GPIO_EMC_B2_09_GPIO8_IO19

IOMUXC_GPIO_EMC_B2_09_SEMC_DATA24

IOMUXC_GPIO_EMC_B2_09_GPT3_COMPARE2

IOMUXC_GPIO_EMC_B2_09_SAI2_TX_BCLK

IOMUXC_GPIO_EMC_B2_09_VIDEO_MUX_CSI_DATA16

IOMUXC_GPIO_EMC_B2_09_FLEXSPI2_B_SCLK

IOMUXC_GPIO_EMC_B2_09_GPIO_MUX2_IO19

IOMUXC_GPIO_EMC_B2_09_XBAR1_INOUT29

IOMUXC_GPIO_EMC_B2_09_ENET_1G_CRS

IOMUXC_GPIO_EMC_B2_09_LPSPI3_PCS2

IOMUXC_GPIO_EMC_B2_09_TMR1_TIMER0

IOMUXC_GPIO_EMC_B2_10_GPIO8_IO20

IOMUXC_GPIO_EMC_B2_10_SEMC_DATA25

IOMUXC_GPIO_EMC_B2_10_GPT3_COMPARE3

IOMUXC_GPIO_EMC_B2_10_SAI2_TX_SYNC

IOMUXC_GPIO_EMC_B2_10_VIDEO_MUX_CSI_FIELD

IOMUXC_GPIO_EMC_B2_10_FLEXSPI2_A_SCLK

IOMUXC_GPIO_EMC_B2_10_GPIO_MUX2_IO20

IOMUXC_GPIO_EMC_B2_10_XBAR1_INOUT30

IOMUXC_GPIO_EMC_B2_10_ENET_1G_COL

IOMUXC_GPIO_EMC_B2_10_LPSPI3_PCS3

IOMUXC_GPIO_EMC_B2_10_TMR1_TIMER1

IOMUXC_GPIO_EMC_B2_11_SEMC_DATA26

IOMUXC_GPIO_EMC_B2_11_SPDIF_IN

IOMUXC_GPIO_EMC_B2_11_ENET_1G_TX_DATA00

IOMUXC_GPIO_EMC_B2_11_SAI3_RX_SYNC

IOMUXC_GPIO_EMC_B2_11_FLEXSPI2_A_SS0_B

IOMUXC_GPIO_EMC_B2_11_GPIO_MUX2_IO21

IOMUXC_GPIO_EMC_B2_11_XBAR1_INOUT31

IOMUXC_GPIO_EMC_B2_11_EMVSIM1_IO

IOMUXC_GPIO_EMC_B2_11_TMR1_TIMER2

IOMUXC_GPIO_EMC_B2_11_GPIO8_IO21

IOMUXC_GPIO_EMC_B2_12_SEMC_DATA27

IOMUXC_GPIO_EMC_B2_12_SPDIF_OUT

IOMUXC_GPIO_EMC_B2_12_ENET_1G_TX_DATA01

IOMUXC_GPIO_EMC_B2_12_SAI3_RX_BCLK

IOMUXC_GPIO_EMC_B2_12_FLEXSPI2_A_DQS

IOMUXC_GPIO_EMC_B2_12_GPIO_MUX2_IO22

IOMUXC_GPIO_EMC_B2_12_XBAR1_INOUT32

IOMUXC_GPIO_EMC_B2_12_EMVSIM1_CLK

IOMUXC_GPIO_EMC_B2_12_TMR1_TIMER3

IOMUXC_GPIO_EMC_B2_12_GPIO8_IO22

IOMUXC_GPIO_EMC_B2_13_GPIO8_IO23

IOMUXC_GPIO_EMC_B2_13_SEMC_DATA28

IOMUXC_GPIO_EMC_B2_13_ENET_1G_TX_EN

IOMUXC_GPIO_EMC_B2_13_SAI3_RX_DATA

IOMUXC_GPIO_EMC_B2_13_FLEXSPI2_A_DATA00

IOMUXC_GPIO_EMC_B2_13_GPIO_MUX2_IO23

IOMUXC_GPIO_EMC_B2_13_XBAR1_INOUT33

IOMUXC_GPIO_EMC_B2_13_EMVSIM1_RST

IOMUXC_GPIO_EMC_B2_13_TMR2_TIMER0

IOMUXC_GPIO_EMC_B2_14_SEMC_DATA29

IOMUXC_GPIO_EMC_B2_14_ENET_1G_TX_CLK_IO

IOMUXC_GPIO_EMC_B2_14_SAI3_TX_DATA

IOMUXC_GPIO_EMC_B2_14_FLEXSPI2_A_DATA01

IOMUXC_GPIO_EMC_B2_14_GPIO_MUX2_IO24

IOMUXC_GPIO_EMC_B2_14_XBAR1_INOUT34

IOMUXC_GPIO_EMC_B2_14_SFA_ipp_do_atx_clk_under_test

IOMUXC_GPIO_EMC_B2_14_EMVSIM1_SVEN

IOMUXC_GPIO_EMC_B2_14_TMR2_TIMER1

IOMUXC_GPIO_EMC_B2_14_GPIO8_IO24

IOMUXC_GPIO_EMC_B2_15_SEMC_DATA30

IOMUXC_GPIO_EMC_B2_15_ENET_1G_RX_DATA00

IOMUXC_GPIO_EMC_B2_15_SAI3_TX_BCLK

IOMUXC_GPIO_EMC_B2_15_FLEXSPI2_A_DATA02

IOMUXC_GPIO_EMC_B2_15_GPIO_MUX2_IO25

IOMUXC_GPIO_EMC_B2_15_XBAR1_INOUT35

IOMUXC_GPIO_EMC_B2_15_EMVSIM1_PD

IOMUXC_GPIO_EMC_B2_15_TMR2_TIMER2

IOMUXC_GPIO_EMC_B2_15_GPIO8_IO25

IOMUXC_GPIO_EMC_B2_16_GPIO8_IO26

IOMUXC_GPIO_EMC_B2_16_SEMC_DATA31

IOMUXC_GPIO_EMC_B2_16_XBAR1_INOUT14

IOMUXC_GPIO_EMC_B2_16_ENET_1G_RX_DATA01

IOMUXC_GPIO_EMC_B2_16_SAI3_TX_SYNC

IOMUXC_GPIO_EMC_B2_16_FLEXSPI2_A_DATA03

IOMUXC_GPIO_EMC_B2_16_GPIO_MUX2_IO26

IOMUXC_GPIO_EMC_B2_16_EMVSIM1_POWER_FAIL

IOMUXC_GPIO_EMC_B2_16_TMR2_TIMER3

IOMUXC_GPIO_EMC_B2_17_SEMC_DM03

IOMUXC_GPIO_EMC_B2_17_XBAR1_INOUT15

IOMUXC_GPIO_EMC_B2_17_ENET_1G_RX_EN

IOMUXC_GPIO_EMC_B2_17_SAI3_MCLK

IOMUXC_GPIO_EMC_B2_17_FLEXSPI2_A_DATA04

IOMUXC_GPIO_EMC_B2_17_GPIO_MUX2_IO27

IOMUXC_GPIO_EMC_B2_17_WDOG1_ANY

IOMUXC_GPIO_EMC_B2_17_TMR3_TIMER0

IOMUXC_GPIO_EMC_B2_17_GPIO8_IO27

IOMUXC_GPIO_EMC_B2_18_SEMC_DQS4

IOMUXC_GPIO_EMC_B2_18_XBAR1_INOUT16

IOMUXC_GPIO_EMC_B2_18_ENET_1G_RX_ER

IOMUXC_GPIO_EMC_B2_18_EWM_OUT_B

IOMUXC_GPIO_EMC_B2_18_FLEXSPI2_A_DATA05

IOMUXC_GPIO_EMC_B2_18_GPIO_MUX2_IO28

IOMUXC_GPIO_EMC_B2_18_FLEXSPI1_A_DQS

IOMUXC_GPIO_EMC_B2_18_WDOG1_B

IOMUXC_GPIO_EMC_B2_18_TMR3_TIMER1

IOMUXC_GPIO_EMC_B2_18_GPIO8_IO28

IOMUXC_GPIO_EMC_B2_19_GPIO8_IO29

IOMUXC_GPIO_EMC_B2_19_SEMC_CLKX00

IOMUXC_GPIO_EMC_B2_19_ENET_MDC

IOMUXC_GPIO_EMC_B2_19_ENET_1G_MDC

IOMUXC_GPIO_EMC_B2_19_ENET_1G_REF_CLK

IOMUXC_GPIO_EMC_B2_19_FLEXSPI2_A_DATA06

IOMUXC_GPIO_EMC_B2_19_GPIO_MUX2_IO29

IOMUXC_GPIO_EMC_B2_19_ENET_QOS_MDC

IOMUXC_GPIO_EMC_B2_19_TMR3_TIMER2

IOMUXC_GPIO_EMC_B2_20_GPIO8_IO30

IOMUXC_GPIO_EMC_B2_20_SEMC_CLKX01

IOMUXC_GPIO_EMC_B2_20_ENET_MDIO

IOMUXC_GPIO_EMC_B2_20_ENET_1G_MDIO

IOMUXC_GPIO_EMC_B2_20_ENET_QOS_REF_CLK

IOMUXC_GPIO_EMC_B2_20_FLEXSPI2_A_DATA07

IOMUXC_GPIO_EMC_B2_20_GPIO_MUX2_IO30

IOMUXC_GPIO_EMC_B2_20_ENET_QOS_MDIO

IOMUXC_GPIO_EMC_B2_20_TMR3_TIMER3

IOMUXC_GPIO_AD_00_GPIO8_IO31

IOMUXC_GPIO_AD_00_EMVSIM1_IO

IOMUXC_GPIO_AD_00_FLEXCAN2_TX

IOMUXC_GPIO_AD_00_ENET_1G_1588_EVENT1_IN

IOMUXC_GPIO_AD_00_GPT2_CAPTURE1

IOMUXC_GPIO_AD_00_FLEXPWM1_PWM0_A

IOMUXC_GPIO_AD_00_GPIO_MUX2_IO31

IOMUXC_GPIO_AD_00_LPUART7_TXD

IOMUXC_GPIO_AD_00_FLEXIO2_D00

IOMUXC_GPIO_AD_00_FLEXSPI2_B_SS1_B

IOMUXC_GPIO_AD_01_GPIO9_IO00

IOMUXC_GPIO_AD_01_EMVSIM1_CLK

IOMUXC_GPIO_AD_01_FLEXCAN2_RX

IOMUXC_GPIO_AD_01_ENET_1G_1588_EVENT1_OUT

IOMUXC_GPIO_AD_01_GPT2_CAPTURE2

IOMUXC_GPIO_AD_01_FLEXPWM1_PWM0_B

IOMUXC_GPIO_AD_01_GPIO_MUX3_IO00

IOMUXC_GPIO_AD_01_LPUART7_RXD

IOMUXC_GPIO_AD_01_FLEXIO2_D01

IOMUXC_GPIO_AD_01_FLEXSPI2_A_SS1_B

IOMUXC_GPIO_AD_02_GPIO9_IO01

IOMUXC_GPIO_AD_02_EMVSIM1_RST

IOMUXC_GPIO_AD_02_LPUART7_CTS_B

IOMUXC_GPIO_AD_02_ENET_1G_1588_EVENT2_IN

IOMUXC_GPIO_AD_02_GPT2_COMPARE1

IOMUXC_GPIO_AD_02_FLEXPWM1_PWM1_A

IOMUXC_GPIO_AD_02_GPIO_MUX3_IO01

IOMUXC_GPIO_AD_02_LPUART8_TXD

IOMUXC_GPIO_AD_02_FLEXIO2_D02

IOMUXC_GPIO_AD_02_VIDEO_MUX_EXT_DCIC1

IOMUXC_GPIO_AD_03_GPIO9_IO02

IOMUXC_GPIO_AD_03_EMVSIM1_SVEN

IOMUXC_GPIO_AD_03_LPUART7_RTS_B

IOMUXC_GPIO_AD_03_ENET_1G_1588_EVENT2_OUT

IOMUXC_GPIO_AD_03_GPT2_COMPARE2

IOMUXC_GPIO_AD_03_FLEXPWM1_PWM1_B

IOMUXC_GPIO_AD_03_GPIO_MUX3_IO02

IOMUXC_GPIO_AD_03_LPUART8_RXD

IOMUXC_GPIO_AD_03_FLEXIO2_D03

IOMUXC_GPIO_AD_03_VIDEO_MUX_EXT_DCIC2

IOMUXC_GPIO_AD_04_EMVSIM1_PD

IOMUXC_GPIO_AD_04_LPUART8_CTS_B

IOMUXC_GPIO_AD_04_ENET_1G_1588_EVENT3_IN

IOMUXC_GPIO_AD_04_GPT2_COMPARE3

IOMUXC_GPIO_AD_04_FLEXPWM1_PWM2_A

IOMUXC_GPIO_AD_04_GPIO_MUX3_IO03

IOMUXC_GPIO_AD_04_WDOG1_B

IOMUXC_GPIO_AD_04_FLEXIO2_D04

IOMUXC_GPIO_AD_04_TMR4_TIMER0

IOMUXC_GPIO_AD_04_GPIO9_IO03

IOMUXC_GPIO_AD_05_EMVSIM1_POWER_FAIL

IOMUXC_GPIO_AD_05_LPUART8_RTS_B

IOMUXC_GPIO_AD_05_ENET_1G_1588_EVENT3_OUT

IOMUXC_GPIO_AD_05_GPT2_CLK

IOMUXC_GPIO_AD_05_FLEXPWM1_PWM2_B

IOMUXC_GPIO_AD_05_GPIO_MUX3_IO04

IOMUXC_GPIO_AD_05_WDOG2_B

IOMUXC_GPIO_AD_05_FLEXIO2_D05

IOMUXC_GPIO_AD_05_TMR4_TIMER1

IOMUXC_GPIO_AD_05_GPIO9_IO04

IOMUXC_GPIO_AD_06_USB_OTG2_OC

IOMUXC_GPIO_AD_06_FLEXCAN1_TX

IOMUXC_GPIO_AD_06_EMVSIM2_IO

IOMUXC_GPIO_AD_06_GPT3_CAPTURE1

IOMUXC_GPIO_AD_06_VIDEO_MUX_CSI_DATA15

IOMUXC_GPIO_AD_06_GPIO_MUX3_IO05

IOMUXC_GPIO_AD_06_ENET_1588_EVENT1_IN

IOMUXC_GPIO_AD_06_FLEXIO2_D06

IOMUXC_GPIO_AD_06_TMR4_TIMER2

IOMUXC_GPIO_AD_06_GPIO9_IO05

IOMUXC_GPIO_AD_06_FLEXPWM1_PWM0_X

IOMUXC_GPIO_AD_07_USB_OTG2_PWR

IOMUXC_GPIO_AD_07_FLEXCAN1_RX

IOMUXC_GPIO_AD_07_EMVSIM2_CLK

IOMUXC_GPIO_AD_07_GPT3_CAPTURE2

IOMUXC_GPIO_AD_07_VIDEO_MUX_CSI_DATA14

IOMUXC_GPIO_AD_07_GPIO_MUX3_IO06

IOMUXC_GPIO_AD_07_ENET_1588_EVENT1_OUT

IOMUXC_GPIO_AD_07_FLEXIO2_D07

IOMUXC_GPIO_AD_07_TMR4_TIMER3

IOMUXC_GPIO_AD_07_GPIO9_IO06

IOMUXC_GPIO_AD_07_FLEXPWM1_PWM1_X

IOMUXC_GPIO_AD_08_USBPHY2_OTG_ID

IOMUXC_GPIO_AD_08_LPI2C1_SCL

IOMUXC_GPIO_AD_08_EMVSIM2_RST

IOMUXC_GPIO_AD_08_GPT3_COMPARE1

IOMUXC_GPIO_AD_08_VIDEO_MUX_CSI_DATA13

IOMUXC_GPIO_AD_08_GPIO_MUX3_IO07

IOMUXC_GPIO_AD_08_ENET_1588_EVENT2_IN

IOMUXC_GPIO_AD_08_FLEXIO2_D08

IOMUXC_GPIO_AD_08_GPIO9_IO07

IOMUXC_GPIO_AD_08_FLEXPWM1_PWM2_X

IOMUXC_GPIO_AD_09_USBPHY1_OTG_ID

IOMUXC_GPIO_AD_09_LPI2C1_SDA

IOMUXC_GPIO_AD_09_EMVSIM2_SVEN

IOMUXC_GPIO_AD_09_GPT3_COMPARE2

IOMUXC_GPIO_AD_09_VIDEO_MUX_CSI_DATA12

IOMUXC_GPIO_AD_09_GPIO_MUX3_IO08

IOMUXC_GPIO_AD_09_ENET_1588_EVENT2_OUT

IOMUXC_GPIO_AD_09_FLEXIO2_D09

IOMUXC_GPIO_AD_09_GPIO9_IO08

IOMUXC_GPIO_AD_09_FLEXPWM1_PWM3_X

IOMUXC_GPIO_AD_10_USB_OTG1_PWR

IOMUXC_GPIO_AD_10_LPI2C1_SCLS

IOMUXC_GPIO_AD_10_EMVSIM2_PD

IOMUXC_GPIO_AD_10_GPT3_COMPARE3

IOMUXC_GPIO_AD_10_VIDEO_MUX_CSI_DATA11

IOMUXC_GPIO_AD_10_GPIO_MUX3_IO09

IOMUXC_GPIO_AD_10_ENET_1588_EVENT3_IN

IOMUXC_GPIO_AD_10_FLEXIO2_D10

IOMUXC_GPIO_AD_10_GPIO9_IO09

IOMUXC_GPIO_AD_10_FLEXPWM2_PWM0_X

IOMUXC_GPIO_AD_11_USB_OTG1_OC

IOMUXC_GPIO_AD_11_LPI2C1_SDAS

IOMUXC_GPIO_AD_11_EMVSIM2_POWER_FAIL

IOMUXC_GPIO_AD_11_GPT3_CLK

IOMUXC_GPIO_AD_11_VIDEO_MUX_CSI_DATA10

IOMUXC_GPIO_AD_11_GPIO_MUX3_IO10

IOMUXC_GPIO_AD_11_ENET_1588_EVENT3_OUT

IOMUXC_GPIO_AD_11_FLEXIO2_D11

IOMUXC_GPIO_AD_11_GPIO9_IO10

IOMUXC_GPIO_AD_11_FLEXPWM2_PWM1_X

IOMUXC_GPIO_AD_12_SPDIF_LOCK

IOMUXC_GPIO_AD_12_LPI2C1_HREQ

IOMUXC_GPIO_AD_12_GPT1_CAPTURE1

IOMUXC_GPIO_AD_12_FLEXSPI1_B_DATA03

IOMUXC_GPIO_AD_12_VIDEO_MUX_CSI_PIXCLK

IOMUXC_GPIO_AD_12_GPIO_MUX3_IO11

IOMUXC_GPIO_AD_12_ENET_TX_DATA03

IOMUXC_GPIO_AD_12_FLEXIO2_D12

IOMUXC_GPIO_AD_12_EWM_OUT_B

IOMUXC_GPIO_AD_12_GPIO9_IO11

IOMUXC_GPIO_AD_12_FLEXPWM2_PWM2_X

IOMUXC_GPIO_AD_13_SPDIF_SR_CLK

IOMUXC_GPIO_AD_13_PIT1_TRIGGER0

IOMUXC_GPIO_AD_13_GPT1_CAPTURE2

IOMUXC_GPIO_AD_13_FLEXSPI1_B_DATA02

IOMUXC_GPIO_AD_13_VIDEO_MUX_CSI_MCLK

IOMUXC_GPIO_AD_13_GPIO_MUX3_IO12

IOMUXC_GPIO_AD_13_ENET_TX_DATA02

IOMUXC_GPIO_AD_13_FLEXIO2_D13

IOMUXC_GPIO_AD_13_REF_CLK_32K

IOMUXC_GPIO_AD_13_GPIO9_IO12

IOMUXC_GPIO_AD_13_FLEXPWM2_PWM3_X

IOMUXC_GPIO_AD_14_SPDIF_EXT_CLK

IOMUXC_GPIO_AD_14_REF_CLK_24M

IOMUXC_GPIO_AD_14_GPT1_COMPARE1

IOMUXC_GPIO_AD_14_FLEXSPI1_B_DATA01

IOMUXC_GPIO_AD_14_VIDEO_MUX_CSI_VSYNC

IOMUXC_GPIO_AD_14_GPIO_MUX3_IO13

IOMUXC_GPIO_AD_14_ENET_RX_CLK

IOMUXC_GPIO_AD_14_FLEXIO2_D14

IOMUXC_GPIO_AD_14_CCM_ENET_REF_CLK_25M

IOMUXC_GPIO_AD_14_GPIO9_IO13

IOMUXC_GPIO_AD_14_FLEXPWM3_PWM0_X

IOMUXC_GPIO_AD_15_GPIO9_IO14

IOMUXC_GPIO_AD_15_FLEXPWM3_PWM1_X

IOMUXC_GPIO_AD_15_SPDIF_IN

IOMUXC_GPIO_AD_15_LPUART10_TXD

IOMUXC_GPIO_AD_15_GPT1_COMPARE2

IOMUXC_GPIO_AD_15_FLEXSPI1_B_DATA00

IOMUXC_GPIO_AD_15_VIDEO_MUX_CSI_HSYNC

IOMUXC_GPIO_AD_15_GPIO_MUX3_IO14

IOMUXC_GPIO_AD_15_ENET_TX_ER

IOMUXC_GPIO_AD_15_FLEXIO2_D15

IOMUXC_GPIO_AD_16_SPDIF_OUT

IOMUXC_GPIO_AD_16_LPUART10_RXD

IOMUXC_GPIO_AD_16_GPT1_COMPARE3

IOMUXC_GPIO_AD_16_FLEXSPI1_B_SCLK

IOMUXC_GPIO_AD_16_VIDEO_MUX_CSI_DATA09

IOMUXC_GPIO_AD_16_GPIO_MUX3_IO15

IOMUXC_GPIO_AD_16_ENET_RX_DATA03

IOMUXC_GPIO_AD_16_FLEXIO2_D16

IOMUXC_GPIO_AD_16_ENET_1G_MDC

IOMUXC_GPIO_AD_16_GPIO9_IO15

IOMUXC_GPIO_AD_16_FLEXPWM3_PWM2_X

IOMUXC_GPIO_AD_17_SAI1_MCLK

IOMUXC_GPIO_AD_17_ACMP1_OUT

IOMUXC_GPIO_AD_17_GPT1_CLK

IOMUXC_GPIO_AD_17_FLEXSPI1_A_DQS

IOMUXC_GPIO_AD_17_VIDEO_MUX_CSI_DATA08

IOMUXC_GPIO_AD_17_GPIO_MUX3_IO16

IOMUXC_GPIO_AD_17_ENET_RX_DATA02

IOMUXC_GPIO_AD_17_FLEXIO2_D17

IOMUXC_GPIO_AD_17_ENET_1G_MDIO

IOMUXC_GPIO_AD_17_GPIO9_IO16

IOMUXC_GPIO_AD_17_FLEXPWM3_PWM3_X

IOMUXC_GPIO_AD_18_GPIO9_IO17

IOMUXC_GPIO_AD_18_FLEXPWM4_PWM0_X

IOMUXC_GPIO_AD_18_SAI1_RX_SYNC

IOMUXC_GPIO_AD_18_ACMP2_OUT

IOMUXC_GPIO_AD_18_LPSPI1_PCS1

IOMUXC_GPIO_AD_18_FLEXSPI1_A_SS0_B

IOMUXC_GPIO_AD_18_VIDEO_MUX_CSI_DATA07

IOMUXC_GPIO_AD_18_GPIO_MUX3_IO17

IOMUXC_GPIO_AD_18_ENET_CRS

IOMUXC_GPIO_AD_18_FLEXIO2_D18

IOMUXC_GPIO_AD_18_LPI2C2_SCL

IOMUXC_GPIO_AD_19_SAI1_RX_BCLK

IOMUXC_GPIO_AD_19_ACMP3_OUT

IOMUXC_GPIO_AD_19_LPSPI1_PCS2

IOMUXC_GPIO_AD_19_FLEXSPI1_A_SCLK

IOMUXC_GPIO_AD_19_VIDEO_MUX_CSI_DATA06

IOMUXC_GPIO_AD_19_GPIO_MUX3_IO18

IOMUXC_GPIO_AD_19_ENET_COL

IOMUXC_GPIO_AD_19_FLEXIO2_D19

IOMUXC_GPIO_AD_19_LPI2C2_SDA

IOMUXC_GPIO_AD_19_GPIO9_IO18

IOMUXC_GPIO_AD_19_FLEXPWM4_PWM1_X

IOMUXC_GPIO_AD_20_SAI1_RX_DATA00

IOMUXC_GPIO_AD_20_ACMP4_OUT

IOMUXC_GPIO_AD_20_LPSPI1_PCS3

IOMUXC_GPIO_AD_20_FLEXSPI1_A_DATA00

IOMUXC_GPIO_AD_20_VIDEO_MUX_CSI_DATA05

IOMUXC_GPIO_AD_20_GPIO_MUX3_IO19

IOMUXC_GPIO_AD_20_KPP_ROW07

IOMUXC_GPIO_AD_20_FLEXIO2_D20

IOMUXC_GPIO_AD_20_ENET_QOS_1588_EVENT2_OUT

IOMUXC_GPIO_AD_20_GPIO9_IO19

IOMUXC_GPIO_AD_20_FLEXPWM4_PWM2_X

IOMUXC_GPIO_AD_21_SAI1_TX_DATA00

IOMUXC_GPIO_AD_21_LPSPI2_PCS1

IOMUXC_GPIO_AD_21_FLEXSPI1_A_DATA01

IOMUXC_GPIO_AD_21_VIDEO_MUX_CSI_DATA04

IOMUXC_GPIO_AD_21_GPIO_MUX3_IO20

IOMUXC_GPIO_AD_21_KPP_COL07

IOMUXC_GPIO_AD_21_FLEXIO2_D21

IOMUXC_GPIO_AD_21_ENET_QOS_1588_EVENT2_IN

IOMUXC_GPIO_AD_21_GPIO9_IO20

IOMUXC_GPIO_AD_21_FLEXPWM4_PWM3_X

IOMUXC_GPIO_AD_22_GPIO9_IO21

IOMUXC_GPIO_AD_22_SAI1_TX_BCLK

IOMUXC_GPIO_AD_22_LPSPI2_PCS2

IOMUXC_GPIO_AD_22_FLEXSPI1_A_DATA02

IOMUXC_GPIO_AD_22_VIDEO_MUX_CSI_DATA03

IOMUXC_GPIO_AD_22_GPIO_MUX3_IO21

IOMUXC_GPIO_AD_22_KPP_ROW06

IOMUXC_GPIO_AD_22_FLEXIO2_D22

IOMUXC_GPIO_AD_22_ENET_QOS_1588_EVENT3_OUT

IOMUXC_GPIO_AD_23_SAI1_TX_SYNC

IOMUXC_GPIO_AD_23_LPSPI2_PCS3

IOMUXC_GPIO_AD_23_FLEXSPI1_A_DATA03

IOMUXC_GPIO_AD_23_VIDEO_MUX_CSI_DATA02

IOMUXC_GPIO_AD_23_GPIO_MUX3_IO22

IOMUXC_GPIO_AD_23_KPP_COL06

IOMUXC_GPIO_AD_23_FLEXIO2_D23

IOMUXC_GPIO_AD_23_ENET_QOS_1588_EVENT3_IN

IOMUXC_GPIO_AD_23_GPIO9_IO22

IOMUXC_GPIO_AD_24_LPUART1_TXD

IOMUXC_GPIO_AD_24_LPSPI2_SCK

IOMUXC_GPIO_AD_24_VIDEO_MUX_CSI_DATA00

IOMUXC_GPIO_AD_24_ENET_RX_EN

IOMUXC_GPIO_AD_24_FLEXPWM2_PWM0_A

IOMUXC_GPIO_AD_24_GPIO_MUX3_IO23

IOMUXC_GPIO_AD_24_KPP_ROW05

IOMUXC_GPIO_AD_24_FLEXIO2_D24

IOMUXC_GPIO_AD_24_LPI2C4_SCL

IOMUXC_GPIO_AD_24_GPIO9_IO23

IOMUXC_GPIO_AD_25_GPIO9_IO24

IOMUXC_GPIO_AD_25_LPUART1_RXD

IOMUXC_GPIO_AD_25_LPSPI2_PCS0

IOMUXC_GPIO_AD_25_VIDEO_MUX_CSI_DATA01

IOMUXC_GPIO_AD_25_ENET_RX_ER

IOMUXC_GPIO_AD_25_FLEXPWM2_PWM0_B

IOMUXC_GPIO_AD_25_GPIO_MUX3_IO24

IOMUXC_GPIO_AD_25_KPP_COL05

IOMUXC_GPIO_AD_25_FLEXIO2_D25

IOMUXC_GPIO_AD_25_LPI2C4_SDA

IOMUXC_GPIO_AD_26_LPUART1_CTS_B

IOMUXC_GPIO_AD_26_LPSPI2_SOUT

IOMUXC_GPIO_AD_26_SEMC_CSX01

IOMUXC_GPIO_AD_26_ENET_RX_DATA00

IOMUXC_GPIO_AD_26_FLEXPWM2_PWM1_A

IOMUXC_GPIO_AD_26_GPIO_MUX3_IO25

IOMUXC_GPIO_AD_26_KPP_ROW04

IOMUXC_GPIO_AD_26_FLEXIO2_D26

IOMUXC_GPIO_AD_26_ENET_QOS_MDC

IOMUXC_GPIO_AD_26_GPIO9_IO25

IOMUXC_GPIO_AD_26_USDHC2_CD_B

IOMUXC_GPIO_AD_27_LPUART1_RTS_B

IOMUXC_GPIO_AD_27_LPSPI2_SIN

IOMUXC_GPIO_AD_27_SEMC_CSX02

IOMUXC_GPIO_AD_27_ENET_RX_DATA01

IOMUXC_GPIO_AD_27_FLEXPWM2_PWM1_B

IOMUXC_GPIO_AD_27_GPIO_MUX3_IO26

IOMUXC_GPIO_AD_27_KPP_COL04

IOMUXC_GPIO_AD_27_FLEXIO2_D27

IOMUXC_GPIO_AD_27_ENET_QOS_MDIO

IOMUXC_GPIO_AD_27_GPIO9_IO26

IOMUXC_GPIO_AD_27_USDHC2_WP

IOMUXC_GPIO_AD_28_GPIO9_IO27

IOMUXC_GPIO_AD_28_USDHC2_VSELECT

IOMUXC_GPIO_AD_28_LPSPI1_SCK

IOMUXC_GPIO_AD_28_LPUART5_TXD

IOMUXC_GPIO_AD_28_SEMC_CSX03

IOMUXC_GPIO_AD_28_ENET_TX_EN

IOMUXC_GPIO_AD_28_FLEXPWM2_PWM2_A

IOMUXC_GPIO_AD_28_GPIO_MUX3_IO27

IOMUXC_GPIO_AD_28_KPP_ROW03

IOMUXC_GPIO_AD_28_FLEXIO2_D28

IOMUXC_GPIO_AD_28_VIDEO_MUX_EXT_DCIC1

IOMUXC_GPIO_AD_29_LPSPI1_PCS0

IOMUXC_GPIO_AD_29_LPUART5_RXD

IOMUXC_GPIO_AD_29_ENET_REF_CLK

IOMUXC_GPIO_AD_29_ENET_TX_CLK

IOMUXC_GPIO_AD_29_FLEXPWM2_PWM2_B

IOMUXC_GPIO_AD_29_GPIO_MUX3_IO28

IOMUXC_GPIO_AD_29_KPP_COL03

IOMUXC_GPIO_AD_29_FLEXIO2_D29

IOMUXC_GPIO_AD_29_VIDEO_MUX_EXT_DCIC2

IOMUXC_GPIO_AD_29_GPIO9_IO28

IOMUXC_GPIO_AD_29_USDHC2_RESET_B

IOMUXC_GPIO_AD_30_LPSPI1_SOUT

IOMUXC_GPIO_AD_30_USB_OTG2_OC

IOMUXC_GPIO_AD_30_FLEXCAN2_TX

IOMUXC_GPIO_AD_30_ENET_TX_DATA00

IOMUXC_GPIO_AD_30_LPUART3_TXD

IOMUXC_GPIO_AD_30_GPIO_MUX3_IO29

IOMUXC_GPIO_AD_30_KPP_ROW02

IOMUXC_GPIO_AD_30_FLEXIO2_D30

IOMUXC_GPIO_AD_30_WDOG2_RESET_B_DEB

IOMUXC_GPIO_AD_30_GPIO9_IO29

IOMUXC_GPIO_AD_31_LPSPI1_SIN

IOMUXC_GPIO_AD_31_USB_OTG2_PWR

IOMUXC_GPIO_AD_31_FLEXCAN2_RX

IOMUXC_GPIO_AD_31_ENET_TX_DATA01

IOMUXC_GPIO_AD_31_LPUART3_RXD

IOMUXC_GPIO_AD_31_GPIO_MUX3_IO30

IOMUXC_GPIO_AD_31_KPP_COL02

IOMUXC_GPIO_AD_31_FLEXIO2_D31

IOMUXC_GPIO_AD_31_WDOG1_RESET_B_DEB

IOMUXC_GPIO_AD_31_GPIO9_IO30

IOMUXC_GPIO_AD_32_GPIO9_IO31

IOMUXC_GPIO_AD_32_LPI2C1_SCL

IOMUXC_GPIO_AD_32_USBPHY2_OTG_ID

IOMUXC_GPIO_AD_32_PGMC_PMIC_RDY

IOMUXC_GPIO_AD_32_ENET_MDC

IOMUXC_GPIO_AD_32_USDHC1_CD_B

IOMUXC_GPIO_AD_32_GPIO_MUX3_IO31

IOMUXC_GPIO_AD_32_KPP_ROW01

IOMUXC_GPIO_AD_32_LPUART10_TXD

IOMUXC_GPIO_AD_32_ENET_1G_MDC

IOMUXC_GPIO_AD_33_LPI2C1_SDA

IOMUXC_GPIO_AD_33_USBPHY1_OTG_ID

IOMUXC_GPIO_AD_33_XBAR1_INOUT17

IOMUXC_GPIO_AD_33_ENET_MDIO

IOMUXC_GPIO_AD_33_USDHC1_WP

IOMUXC_GPIO_AD_33_GPIO_MUX4_IO00

IOMUXC_GPIO_AD_33_KPP_COL01

IOMUXC_GPIO_AD_33_LPUART10_RXD

IOMUXC_GPIO_AD_33_ENET_1G_MDIO

IOMUXC_GPIO_AD_33_GPIO10_IO00

IOMUXC_GPIO_AD_34_ENET_1G_1588_EVENT0_IN

IOMUXC_GPIO_AD_34_USB_OTG1_PWR

IOMUXC_GPIO_AD_34_XBAR1_INOUT18

IOMUXC_GPIO_AD_34_ENET_1588_EVENT0_IN

IOMUXC_GPIO_AD_34_USDHC1_VSELECT

IOMUXC_GPIO_AD_34_GPIO_MUX4_IO01

IOMUXC_GPIO_AD_34_KPP_ROW00

IOMUXC_GPIO_AD_34_LPUART10_CTS_B

IOMUXC_GPIO_AD_34_WDOG1_ANY

IOMUXC_GPIO_AD_34_GPIO10_IO01

IOMUXC_GPIO_AD_35_GPIO10_IO02

IOMUXC_GPIO_AD_35_ENET_1G_1588_EVENT0_OUT

IOMUXC_GPIO_AD_35_USB_OTG1_OC

IOMUXC_GPIO_AD_35_XBAR1_INOUT19

IOMUXC_GPIO_AD_35_ENET_1588_EVENT0_OUT

IOMUXC_GPIO_AD_35_USDHC1_RESET_B

IOMUXC_GPIO_AD_35_GPIO_MUX4_IO02

IOMUXC_GPIO_AD_35_KPP_COL00

IOMUXC_GPIO_AD_35_LPUART10_RTS_B

IOMUXC_GPIO_AD_35_FLEXSPI1_B_SS1_B

IOMUXC_GPIO_SD_B1_00_USDHC1_CMD

IOMUXC_GPIO_SD_B1_00_XBAR1_INOUT20

IOMUXC_GPIO_SD_B1_00_GPT4_CAPTURE1

IOMUXC_GPIO_SD_B1_00_GPIO_MUX4_IO03

IOMUXC_GPIO_SD_B1_00_FLEXSPI2_A_SS0_B

IOMUXC_GPIO_SD_B1_00_KPP_ROW07

IOMUXC_GPIO_SD_B1_00_GPIO10_IO03

IOMUXC_GPIO_SD_B1_01_USDHC1_CLK

IOMUXC_GPIO_SD_B1_01_XBAR1_INOUT21

IOMUXC_GPIO_SD_B1_01_GPT4_CAPTURE2

IOMUXC_GPIO_SD_B1_01_GPIO_MUX4_IO04

IOMUXC_GPIO_SD_B1_01_FLEXSPI2_A_SCLK

IOMUXC_GPIO_SD_B1_01_KPP_COL07

IOMUXC_GPIO_SD_B1_01_GPIO10_IO04

IOMUXC_GPIO_SD_B1_02_GPIO10_IO05

IOMUXC_GPIO_SD_B1_02_USDHC1_DATA0

IOMUXC_GPIO_SD_B1_02_XBAR1_INOUT22

IOMUXC_GPIO_SD_B1_02_GPT4_COMPARE1

IOMUXC_GPIO_SD_B1_02_GPIO_MUX4_IO05

IOMUXC_GPIO_SD_B1_02_FLEXSPI2_A_DATA00

IOMUXC_GPIO_SD_B1_02_KPP_ROW06

IOMUXC_GPIO_SD_B1_02_FLEXSPI1_A_SS1_B

IOMUXC_GPIO_SD_B1_03_USDHC1_DATA1

IOMUXC_GPIO_SD_B1_03_XBAR1_INOUT23

IOMUXC_GPIO_SD_B1_03_GPT4_COMPARE2

IOMUXC_GPIO_SD_B1_03_GPIO_MUX4_IO06

IOMUXC_GPIO_SD_B1_03_FLEXSPI2_A_DATA01

IOMUXC_GPIO_SD_B1_03_KPP_COL06

IOMUXC_GPIO_SD_B1_03_FLEXSPI1_B_SS1_B

IOMUXC_GPIO_SD_B1_03_GPIO10_IO06

IOMUXC_GPIO_SD_B1_04_USDHC1_DATA2

IOMUXC_GPIO_SD_B1_04_XBAR1_INOUT24

IOMUXC_GPIO_SD_B1_04_GPT4_COMPARE3

IOMUXC_GPIO_SD_B1_04_GPIO_MUX4_IO07

IOMUXC_GPIO_SD_B1_04_FLEXSPI2_A_DATA02

IOMUXC_GPIO_SD_B1_04_FLEXSPI1_B_SS0_B

IOMUXC_GPIO_SD_B1_04_ENET_QOS_1588_EVENT2_AUX_IN

IOMUXC_GPIO_SD_B1_04_GPIO10_IO07

IOMUXC_GPIO_SD_B1_05_GPIO10_IO08

IOMUXC_GPIO_SD_B1_05_USDHC1_DATA3

IOMUXC_GPIO_SD_B1_05_XBAR1_INOUT25

IOMUXC_GPIO_SD_B1_05_GPT4_CLK

IOMUXC_GPIO_SD_B1_05_GPIO_MUX4_IO08

IOMUXC_GPIO_SD_B1_05_FLEXSPI2_A_DATA03

IOMUXC_GPIO_SD_B1_05_FLEXSPI1_B_DQS

IOMUXC_GPIO_SD_B1_05_ENET_QOS_1588_EVENT3_AUX_IN

IOMUXC_GPIO_SD_B2_00_GPIO10_IO09

IOMUXC_GPIO_SD_B2_00_USDHC2_DATA3

IOMUXC_GPIO_SD_B2_00_FLEXSPI1_B_DATA03

IOMUXC_GPIO_SD_B2_00_ENET_1G_RX_EN

IOMUXC_GPIO_SD_B2_00_LPUART9_TXD

IOMUXC_GPIO_SD_B2_00_LPSPI4_SCK

IOMUXC_GPIO_SD_B2_00_GPIO_MUX4_IO09

IOMUXC_GPIO_SD_B2_01_USDHC2_DATA2

IOMUXC_GPIO_SD_B2_01_FLEXSPI1_B_DATA02

IOMUXC_GPIO_SD_B2_01_ENET_1G_RX_CLK

IOMUXC_GPIO_SD_B2_01_LPUART9_RXD

IOMUXC_GPIO_SD_B2_01_LPSPI4_PCS0

IOMUXC_GPIO_SD_B2_01_GPIO_MUX4_IO10

IOMUXC_GPIO_SD_B2_01_GPIO10_IO10

IOMUXC_GPIO_SD_B2_02_GPIO10_IO11

IOMUXC_GPIO_SD_B2_02_USDHC2_DATA1

IOMUXC_GPIO_SD_B2_02_FLEXSPI1_B_DATA01

IOMUXC_GPIO_SD_B2_02_ENET_1G_RX_DATA00

IOMUXC_GPIO_SD_B2_02_LPUART9_CTS_B

IOMUXC_GPIO_SD_B2_02_LPSPI4_SOUT

IOMUXC_GPIO_SD_B2_02_GPIO_MUX4_IO11

IOMUXC_GPIO_SD_B2_03_GPIO10_IO12

IOMUXC_GPIO_SD_B2_03_USDHC2_DATA0

IOMUXC_GPIO_SD_B2_03_FLEXSPI1_B_DATA00

IOMUXC_GPIO_SD_B2_03_ENET_1G_RX_DATA01

IOMUXC_GPIO_SD_B2_03_LPUART9_RTS_B

IOMUXC_GPIO_SD_B2_03_LPSPI4_SIN

IOMUXC_GPIO_SD_B2_03_GPIO_MUX4_IO12

IOMUXC_GPIO_SD_B2_04_USDHC2_CLK

IOMUXC_GPIO_SD_B2_04_FLEXSPI1_B_SCLK

IOMUXC_GPIO_SD_B2_04_ENET_1G_RX_DATA02

IOMUXC_GPIO_SD_B2_04_FLEXSPI1_A_SS1_B

IOMUXC_GPIO_SD_B2_04_LPSPI4_PCS1

IOMUXC_GPIO_SD_B2_04_GPIO_MUX4_IO13

IOMUXC_GPIO_SD_B2_04_GPIO10_IO13

IOMUXC_GPIO_SD_B2_05_GPIO10_IO14

IOMUXC_GPIO_SD_B2_05_USDHC2_CMD

IOMUXC_GPIO_SD_B2_05_FLEXSPI1_A_DQS

IOMUXC_GPIO_SD_B2_05_ENET_1G_RX_DATA03

IOMUXC_GPIO_SD_B2_05_FLEXSPI1_B_SS0_B

IOMUXC_GPIO_SD_B2_05_LPSPI4_PCS2

IOMUXC_GPIO_SD_B2_05_GPIO_MUX4_IO14

IOMUXC_GPIO_SD_B2_06_GPIO10_IO15

IOMUXC_GPIO_SD_B2_06_USDHC2_RESET_B

IOMUXC_GPIO_SD_B2_06_FLEXSPI1_A_SS0_B

IOMUXC_GPIO_SD_B2_06_ENET_1G_TX_DATA03

IOMUXC_GPIO_SD_B2_06_LPSPI4_PCS3

IOMUXC_GPIO_SD_B2_06_GPT6_CAPTURE1

IOMUXC_GPIO_SD_B2_06_GPIO_MUX4_IO15

IOMUXC_GPIO_SD_B2_07_USDHC2_STROBE

IOMUXC_GPIO_SD_B2_07_FLEXSPI1_A_SCLK

IOMUXC_GPIO_SD_B2_07_ENET_1G_TX_DATA02

IOMUXC_GPIO_SD_B2_07_LPUART3_CTS_B

IOMUXC_GPIO_SD_B2_07_GPT6_CAPTURE2

IOMUXC_GPIO_SD_B2_07_GPIO_MUX4_IO16

IOMUXC_GPIO_SD_B2_07_LPSPI2_SCK

IOMUXC_GPIO_SD_B2_07_ENET_TX_ER

IOMUXC_GPIO_SD_B2_07_ENET_QOS_REF_CLK

IOMUXC_GPIO_SD_B2_07_GPIO10_IO16

IOMUXC_GPIO_SD_B2_08_GPIO10_IO17

IOMUXC_GPIO_SD_B2_08_USDHC2_DATA4

IOMUXC_GPIO_SD_B2_08_FLEXSPI1_A_DATA00

IOMUXC_GPIO_SD_B2_08_ENET_1G_TX_DATA01

IOMUXC_GPIO_SD_B2_08_LPUART3_RTS_B

IOMUXC_GPIO_SD_B2_08_GPT6_COMPARE1

IOMUXC_GPIO_SD_B2_08_GPIO_MUX4_IO17

IOMUXC_GPIO_SD_B2_08_LPSPI2_PCS0

IOMUXC_GPIO_SD_B2_09_GPIO10_IO18

IOMUXC_GPIO_SD_B2_09_USDHC2_DATA5

IOMUXC_GPIO_SD_B2_09_FLEXSPI1_A_DATA01

IOMUXC_GPIO_SD_B2_09_ENET_1G_TX_DATA00

IOMUXC_GPIO_SD_B2_09_LPUART5_CTS_B

IOMUXC_GPIO_SD_B2_09_GPT6_COMPARE2

IOMUXC_GPIO_SD_B2_09_GPIO_MUX4_IO18

IOMUXC_GPIO_SD_B2_09_LPSPI2_SOUT

IOMUXC_GPIO_SD_B2_10_GPIO10_IO19

IOMUXC_GPIO_SD_B2_10_USDHC2_DATA6

IOMUXC_GPIO_SD_B2_10_FLEXSPI1_A_DATA02

IOMUXC_GPIO_SD_B2_10_ENET_1G_TX_EN

IOMUXC_GPIO_SD_B2_10_LPUART5_RTS_B

IOMUXC_GPIO_SD_B2_10_GPT6_COMPARE3

IOMUXC_GPIO_SD_B2_10_GPIO_MUX4_IO19

IOMUXC_GPIO_SD_B2_10_LPSPI2_SIN

IOMUXC_GPIO_SD_B2_11_USDHC2_DATA7

IOMUXC_GPIO_SD_B2_11_FLEXSPI1_A_DATA03

IOMUXC_GPIO_SD_B2_11_ENET_1G_TX_CLK_IO

IOMUXC_GPIO_SD_B2_11_ENET_1G_REF_CLK

IOMUXC_GPIO_SD_B2_11_GPT6_CLK

IOMUXC_GPIO_SD_B2_11_GPIO_MUX4_IO20

IOMUXC_GPIO_SD_B2_11_LPSPI2_PCS1

IOMUXC_GPIO_SD_B2_11_GPIO10_IO20

IOMUXC_GPIO_DISP_B1_00_VIDEO_MUX_LCDIF_CLK

IOMUXC_GPIO_DISP_B1_00_ENET_1G_RX_EN

IOMUXC_GPIO_DISP_B1_00_TMR1_TIMER0

IOMUXC_GPIO_DISP_B1_00_XBAR1_INOUT26

IOMUXC_GPIO_DISP_B1_00_GPIO_MUX4_IO21

IOMUXC_GPIO_DISP_B1_00_ENET_QOS_RX_EN

IOMUXC_GPIO_DISP_B1_00_GPIO10_IO21

IOMUXC_GPIO_DISP_B1_01_VIDEO_MUX_LCDIF_ENABLE

IOMUXC_GPIO_DISP_B1_01_ENET_1G_RX_CLK

IOMUXC_GPIO_DISP_B1_01_ENET_1G_RX_ER

IOMUXC_GPIO_DISP_B1_01_TMR1_TIMER1

IOMUXC_GPIO_DISP_B1_01_XBAR1_INOUT27

IOMUXC_GPIO_DISP_B1_01_GPIO_MUX4_IO22

IOMUXC_GPIO_DISP_B1_01_ENET_QOS_RX_CLK

IOMUXC_GPIO_DISP_B1_01_ENET_QOS_RX_ER

IOMUXC_GPIO_DISP_B1_01_GPIO10_IO22

IOMUXC_GPIO_DISP_B1_02_GPIO10_IO23

IOMUXC_GPIO_DISP_B1_02_VIDEO_MUX_LCDIF_HSYNC

IOMUXC_GPIO_DISP_B1_02_ENET_1G_RX_DATA00

IOMUXC_GPIO_DISP_B1_02_LPI2C3_SCL

IOMUXC_GPIO_DISP_B1_02_TMR1_TIMER2

IOMUXC_GPIO_DISP_B1_02_XBAR1_INOUT28

IOMUXC_GPIO_DISP_B1_02_GPIO_MUX4_IO23

IOMUXC_GPIO_DISP_B1_02_ENET_QOS_RX_DATA00

IOMUXC_GPIO_DISP_B1_02_LPUART1_TXD

IOMUXC_GPIO_DISP_B1_03_VIDEO_MUX_LCDIF_VSYNC

IOMUXC_GPIO_DISP_B1_03_ENET_1G_RX_DATA01

IOMUXC_GPIO_DISP_B1_03_LPI2C3_SDA

IOMUXC_GPIO_DISP_B1_03_TMR2_TIMER0

IOMUXC_GPIO_DISP_B1_03_XBAR1_INOUT29

IOMUXC_GPIO_DISP_B1_03_GPIO_MUX4_IO24

IOMUXC_GPIO_DISP_B1_03_ENET_QOS_RX_DATA01

IOMUXC_GPIO_DISP_B1_03_LPUART1_RXD

IOMUXC_GPIO_DISP_B1_03_GPIO10_IO24

IOMUXC_GPIO_DISP_B1_04_VIDEO_MUX_LCDIF_DATA00

IOMUXC_GPIO_DISP_B1_04_ENET_1G_RX_DATA02

IOMUXC_GPIO_DISP_B1_04_LPUART4_RXD

IOMUXC_GPIO_DISP_B1_04_TMR2_TIMER1

IOMUXC_GPIO_DISP_B1_04_XBAR1_INOUT30

IOMUXC_GPIO_DISP_B1_04_GPIO_MUX4_IO25

IOMUXC_GPIO_DISP_B1_04_ENET_QOS_RX_DATA02

IOMUXC_GPIO_DISP_B1_04_LPSPI3_SCK

IOMUXC_GPIO_DISP_B1_04_GPIO10_IO25

IOMUXC_GPIO_DISP_B1_05_GPIO10_IO26

IOMUXC_GPIO_DISP_B1_05_VIDEO_MUX_LCDIF_DATA01

IOMUXC_GPIO_DISP_B1_05_ENET_1G_RX_DATA03

IOMUXC_GPIO_DISP_B1_05_LPUART4_CTS_B

IOMUXC_GPIO_DISP_B1_05_TMR2_TIMER2

IOMUXC_GPIO_DISP_B1_05_XBAR1_INOUT31

IOMUXC_GPIO_DISP_B1_05_GPIO_MUX4_IO26

IOMUXC_GPIO_DISP_B1_05_ENET_QOS_RX_DATA03

IOMUXC_GPIO_DISP_B1_05_LPSPI3_SIN

IOMUXC_GPIO_DISP_B1_06_VIDEO_MUX_LCDIF_DATA02

IOMUXC_GPIO_DISP_B1_06_ENET_1G_TX_DATA03

IOMUXC_GPIO_DISP_B1_06_LPUART4_TXD

IOMUXC_GPIO_DISP_B1_06_TMR3_TIMER0

IOMUXC_GPIO_DISP_B1_06_XBAR1_INOUT32

IOMUXC_GPIO_DISP_B1_06_GPIO_MUX4_IO27

IOMUXC_GPIO_DISP_B1_06_SRC_BT_CFG00

IOMUXC_GPIO_DISP_B1_06_ENET_QOS_TX_DATA03

IOMUXC_GPIO_DISP_B1_06_LPSPI3_SOUT

IOMUXC_GPIO_DISP_B1_06_GPIO10_IO27

IOMUXC_GPIO_DISP_B1_07_VIDEO_MUX_LCDIF_DATA03

IOMUXC_GPIO_DISP_B1_07_ENET_1G_TX_DATA02

IOMUXC_GPIO_DISP_B1_07_LPUART4_RTS_B

IOMUXC_GPIO_DISP_B1_07_TMR3_TIMER1

IOMUXC_GPIO_DISP_B1_07_XBAR1_INOUT33

IOMUXC_GPIO_DISP_B1_07_GPIO_MUX4_IO28

IOMUXC_GPIO_DISP_B1_07_SRC_BT_CFG01

IOMUXC_GPIO_DISP_B1_07_ENET_QOS_TX_DATA02

IOMUXC_GPIO_DISP_B1_07_LPSPI3_PCS0

IOMUXC_GPIO_DISP_B1_07_GPIO10_IO28

IOMUXC_GPIO_DISP_B1_08_GPIO10_IO29

IOMUXC_GPIO_DISP_B1_08_VIDEO_MUX_LCDIF_DATA04

IOMUXC_GPIO_DISP_B1_08_ENET_1G_TX_DATA01

IOMUXC_GPIO_DISP_B1_08_USDHC1_CD_B

IOMUXC_GPIO_DISP_B1_08_TMR3_TIMER2

IOMUXC_GPIO_DISP_B1_08_XBAR1_INOUT34

IOMUXC_GPIO_DISP_B1_08_GPIO_MUX4_IO29

IOMUXC_GPIO_DISP_B1_08_SRC_BT_CFG02

IOMUXC_GPIO_DISP_B1_08_ENET_QOS_TX_DATA01

IOMUXC_GPIO_DISP_B1_08_LPSPI3_PCS1

IOMUXC_GPIO_DISP_B1_09_VIDEO_MUX_LCDIF_DATA05

IOMUXC_GPIO_DISP_B1_09_ENET_1G_TX_DATA00

IOMUXC_GPIO_DISP_B1_09_USDHC1_WP

IOMUXC_GPIO_DISP_B1_09_TMR4_TIMER0

IOMUXC_GPIO_DISP_B1_09_XBAR1_INOUT35

IOMUXC_GPIO_DISP_B1_09_GPIO_MUX4_IO30

IOMUXC_GPIO_DISP_B1_09_SRC_BT_CFG03

IOMUXC_GPIO_DISP_B1_09_ENET_QOS_TX_DATA00

IOMUXC_GPIO_DISP_B1_09_LPSPI3_PCS2

IOMUXC_GPIO_DISP_B1_09_GPIO10_IO30

IOMUXC_GPIO_DISP_B1_10_VIDEO_MUX_LCDIF_DATA06

IOMUXC_GPIO_DISP_B1_10_ENET_1G_TX_EN

IOMUXC_GPIO_DISP_B1_10_USDHC1_RESET_B

IOMUXC_GPIO_DISP_B1_10_TMR4_TIMER1

IOMUXC_GPIO_DISP_B1_10_XBAR1_INOUT36

IOMUXC_GPIO_DISP_B1_10_GPIO_MUX4_IO31

IOMUXC_GPIO_DISP_B1_10_SRC_BT_CFG04

IOMUXC_GPIO_DISP_B1_10_ENET_QOS_TX_EN

IOMUXC_GPIO_DISP_B1_10_LPSPI3_PCS3

IOMUXC_GPIO_DISP_B1_10_GPIO10_IO31

IOMUXC_GPIO_DISP_B1_11_VIDEO_MUX_LCDIF_DATA07

IOMUXC_GPIO_DISP_B1_11_ENET_1G_TX_CLK_IO

IOMUXC_GPIO_DISP_B1_11_ENET_1G_REF_CLK

IOMUXC_GPIO_DISP_B1_11_TMR4_TIMER2

IOMUXC_GPIO_DISP_B1_11_XBAR1_INOUT37

IOMUXC_GPIO_DISP_B1_11_GPIO_MUX5_IO00

IOMUXC_GPIO_DISP_B1_11_SRC_BT_CFG05

IOMUXC_GPIO_DISP_B1_11_ENET_QOS_TX_CLK

IOMUXC_GPIO_DISP_B1_11_ENET_QOS_REF_CLK

IOMUXC_GPIO_DISP_B1_11_GPIO11_IO00

IOMUXC_GPIO_DISP_B2_00_GPIO11_IO01

IOMUXC_GPIO_DISP_B2_00_VIDEO_MUX_LCDIF_DATA08

IOMUXC_GPIO_DISP_B2_00_WDOG1_B

IOMUXC_GPIO_DISP_B2_00_MQS_RIGHT

IOMUXC_GPIO_DISP_B2_00_ENET_1G_TX_ER

IOMUXC_GPIO_DISP_B2_00_SAI1_TX_DATA03

IOMUXC_GPIO_DISP_B2_00_GPIO_MUX5_IO01

IOMUXC_GPIO_DISP_B2_00_SRC_BT_CFG06

IOMUXC_GPIO_DISP_B2_00_ENET_QOS_TX_ER

IOMUXC_GPIO_DISP_B2_01_VIDEO_MUX_LCDIF_DATA09

IOMUXC_GPIO_DISP_B2_01_USDHC1_VSELECT

IOMUXC_GPIO_DISP_B2_01_MQS_LEFT

IOMUXC_GPIO_DISP_B2_01_WDOG2_B

IOMUXC_GPIO_DISP_B2_01_SAI1_TX_DATA02

IOMUXC_GPIO_DISP_B2_01_GPIO_MUX5_IO02

IOMUXC_GPIO_DISP_B2_01_SRC_BT_CFG07

IOMUXC_GPIO_DISP_B2_01_EWM_OUT_B

IOMUXC_GPIO_DISP_B2_01_CCM_ENET_REF_CLK_25M

IOMUXC_GPIO_DISP_B2_01_GPIO11_IO02

IOMUXC_GPIO_DISP_B2_02_GPIO11_IO03

IOMUXC_GPIO_DISP_B2_02_VIDEO_MUX_LCDIF_DATA10

IOMUXC_GPIO_DISP_B2_02_ENET_TX_DATA00

IOMUXC_GPIO_DISP_B2_02_PIT1_TRIGGER3

IOMUXC_GPIO_DISP_B2_02_ARM_TRACE00

IOMUXC_GPIO_DISP_B2_02_SAI1_TX_DATA01

IOMUXC_GPIO_DISP_B2_02_GPIO_MUX5_IO03

IOMUXC_GPIO_DISP_B2_02_SRC_BT_CFG08

IOMUXC_GPIO_DISP_B2_02_ENET_QOS_TX_DATA00

IOMUXC_GPIO_DISP_B2_03_GPIO11_IO04

IOMUXC_GPIO_DISP_B2_03_VIDEO_MUX_LCDIF_DATA11

IOMUXC_GPIO_DISP_B2_03_ENET_TX_DATA01

IOMUXC_GPIO_DISP_B2_03_PIT1_TRIGGER2

IOMUXC_GPIO_DISP_B2_03_ARM_TRACE01

IOMUXC_GPIO_DISP_B2_03_SAI1_MCLK

IOMUXC_GPIO_DISP_B2_03_GPIO_MUX5_IO04

IOMUXC_GPIO_DISP_B2_03_SRC_BT_CFG09

IOMUXC_GPIO_DISP_B2_03_ENET_QOS_TX_DATA01

IOMUXC_GPIO_DISP_B2_04_VIDEO_MUX_LCDIF_DATA12

IOMUXC_GPIO_DISP_B2_04_ENET_TX_EN

IOMUXC_GPIO_DISP_B2_04_PIT1_TRIGGER1

IOMUXC_GPIO_DISP_B2_04_ARM_TRACE02

IOMUXC_GPIO_DISP_B2_04_SAI1_RX_SYNC

IOMUXC_GPIO_DISP_B2_04_GPIO_MUX5_IO05

IOMUXC_GPIO_DISP_B2_04_SRC_BT_CFG10

IOMUXC_GPIO_DISP_B2_04_ENET_QOS_TX_EN

IOMUXC_GPIO_DISP_B2_04_GPIO11_IO05

IOMUXC_GPIO_DISP_B2_05_GPIO11_IO06

IOMUXC_GPIO_DISP_B2_05_VIDEO_MUX_LCDIF_DATA13

IOMUXC_GPIO_DISP_B2_05_ENET_TX_CLK

IOMUXC_GPIO_DISP_B2_05_ENET_REF_CLK

IOMUXC_GPIO_DISP_B2_05_ARM_TRACE03

IOMUXC_GPIO_DISP_B2_05_SAI1_RX_BCLK

IOMUXC_GPIO_DISP_B2_05_GPIO_MUX5_IO06

IOMUXC_GPIO_DISP_B2_05_SRC_BT_CFG11

IOMUXC_GPIO_DISP_B2_05_ENET_QOS_TX_CLK

IOMUXC_GPIO_DISP_B2_06_GPIO11_IO07

IOMUXC_GPIO_DISP_B2_06_VIDEO_MUX_LCDIF_DATA14

IOMUXC_GPIO_DISP_B2_06_ENET_RX_DATA00

IOMUXC_GPIO_DISP_B2_06_LPUART7_TXD

IOMUXC_GPIO_DISP_B2_06_ARM_TRACE_CLK

IOMUXC_GPIO_DISP_B2_06_SAI1_RX_DATA00

IOMUXC_GPIO_DISP_B2_06_GPIO_MUX5_IO07

IOMUXC_GPIO_DISP_B2_06_ENET_QOS_RX_DATA00

IOMUXC_GPIO_DISP_B2_07_VIDEO_MUX_LCDIF_DATA15

IOMUXC_GPIO_DISP_B2_07_ENET_RX_DATA01

IOMUXC_GPIO_DISP_B2_07_LPUART7_RXD

IOMUXC_GPIO_DISP_B2_07_ARM_TRACE_SWO

IOMUXC_GPIO_DISP_B2_07_SAI1_TX_DATA00

IOMUXC_GPIO_DISP_B2_07_GPIO_MUX5_IO08

IOMUXC_GPIO_DISP_B2_07_ENET_QOS_RX_DATA01

IOMUXC_GPIO_DISP_B2_07_GPIO11_IO08

IOMUXC_GPIO_DISP_B2_08_GPIO11_IO09

IOMUXC_GPIO_DISP_B2_08_VIDEO_MUX_LCDIF_DATA16

IOMUXC_GPIO_DISP_B2_08_ENET_RX_EN

IOMUXC_GPIO_DISP_B2_08_LPUART8_TXD

IOMUXC_GPIO_DISP_B2_08_ARM_CM7_EVENTO

IOMUXC_GPIO_DISP_B2_08_SAI1_TX_BCLK

IOMUXC_GPIO_DISP_B2_08_GPIO_MUX5_IO09

IOMUXC_GPIO_DISP_B2_08_ENET_QOS_RX_EN

IOMUXC_GPIO_DISP_B2_08_LPUART1_TXD

IOMUXC_GPIO_DISP_B2_09_GPIO11_IO10

IOMUXC_GPIO_DISP_B2_09_VIDEO_MUX_LCDIF_DATA17

IOMUXC_GPIO_DISP_B2_09_ENET_RX_ER

IOMUXC_GPIO_DISP_B2_09_LPUART8_RXD

IOMUXC_GPIO_DISP_B2_09_ARM_CM7_EVENTI

IOMUXC_GPIO_DISP_B2_09_SAI1_TX_SYNC

IOMUXC_GPIO_DISP_B2_09_GPIO_MUX5_IO10

IOMUXC_GPIO_DISP_B2_09_ENET_QOS_RX_ER

IOMUXC_GPIO_DISP_B2_09_LPUART1_RXD

IOMUXC_GPIO_DISP_B2_10_GPIO11_IO11

IOMUXC_GPIO_DISP_B2_10_VIDEO_MUX_LCDIF_DATA18

IOMUXC_GPIO_DISP_B2_10_EMVSIM2_IO

IOMUXC_GPIO_DISP_B2_10_LPUART2_TXD

IOMUXC_GPIO_DISP_B2_10_WDOG2_RESET_B_DEB

IOMUXC_GPIO_DISP_B2_10_XBAR1_INOUT38

IOMUXC_GPIO_DISP_B2_10_GPIO_MUX5_IO11

IOMUXC_GPIO_DISP_B2_10_LPI2C3_SCL

IOMUXC_GPIO_DISP_B2_10_ENET_QOS_RX_ER

IOMUXC_GPIO_DISP_B2_10_SPDIF_IN

IOMUXC_GPIO_DISP_B2_11_VIDEO_MUX_LCDIF_DATA19

IOMUXC_GPIO_DISP_B2_11_EMVSIM2_CLK

IOMUXC_GPIO_DISP_B2_11_LPUART2_RXD

IOMUXC_GPIO_DISP_B2_11_WDOG1_RESET_B_DEB

IOMUXC_GPIO_DISP_B2_11_XBAR1_INOUT39

IOMUXC_GPIO_DISP_B2_11_GPIO_MUX5_IO12

IOMUXC_GPIO_DISP_B2_11_LPI2C3_SDA

IOMUXC_GPIO_DISP_B2_11_ENET_QOS_CRS

IOMUXC_GPIO_DISP_B2_11_SPDIF_OUT

IOMUXC_GPIO_DISP_B2_11_GPIO11_IO12

IOMUXC_GPIO_DISP_B2_12_GPIO11_IO13

IOMUXC_GPIO_DISP_B2_12_VIDEO_MUX_LCDIF_DATA20

IOMUXC_GPIO_DISP_B2_12_EMVSIM2_RST

IOMUXC_GPIO_DISP_B2_12_FLEXCAN1_TX

IOMUXC_GPIO_DISP_B2_12_LPUART2_CTS_B

IOMUXC_GPIO_DISP_B2_12_XBAR1_INOUT40

IOMUXC_GPIO_DISP_B2_12_GPIO_MUX5_IO13

IOMUXC_GPIO_DISP_B2_12_LPI2C4_SCL

IOMUXC_GPIO_DISP_B2_12_ENET_QOS_COL

IOMUXC_GPIO_DISP_B2_12_LPSPI4_SCK

IOMUXC_GPIO_DISP_B2_13_GPIO11_IO14

IOMUXC_GPIO_DISP_B2_13_VIDEO_MUX_LCDIF_DATA21

IOMUXC_GPIO_DISP_B2_13_EMVSIM2_SVEN

IOMUXC_GPIO_DISP_B2_13_FLEXCAN1_RX

IOMUXC_GPIO_DISP_B2_13_LPUART2_RTS_B

IOMUXC_GPIO_DISP_B2_13_ENET_REF_CLK

IOMUXC_GPIO_DISP_B2_13_GPIO_MUX5_IO14

IOMUXC_GPIO_DISP_B2_13_LPI2C4_SDA

IOMUXC_GPIO_DISP_B2_13_ENET_QOS_1588_EVENT0_OUT

IOMUXC_GPIO_DISP_B2_13_LPSPI4_SIN

IOMUXC_GPIO_DISP_B2_14_GPIO_MUX5_IO15

IOMUXC_GPIO_DISP_B2_14_FLEXCAN1_TX

IOMUXC_GPIO_DISP_B2_14_ENET_QOS_1588_EVENT0_IN

IOMUXC_GPIO_DISP_B2_14_LPSPI4_SOUT

IOMUXC_GPIO_DISP_B2_14_GPIO11_IO15

IOMUXC_GPIO_DISP_B2_14_VIDEO_MUX_LCDIF_DATA22

IOMUXC_GPIO_DISP_B2_14_EMVSIM2_PD

IOMUXC_GPIO_DISP_B2_14_WDOG2_B

IOMUXC_GPIO_DISP_B2_14_VIDEO_MUX_EXT_DCIC1

IOMUXC_GPIO_DISP_B2_14_ENET_1G_REF_CLK

IOMUXC_GPIO_DISP_B2_15_VIDEO_MUX_LCDIF_DATA23

IOMUXC_GPIO_DISP_B2_15_EMVSIM2_POWER_FAIL

IOMUXC_GPIO_DISP_B2_15_WDOG1_B

IOMUXC_GPIO_DISP_B2_15_VIDEO_MUX_EXT_DCIC2

IOMUXC_GPIO_DISP_B2_15_PIT1_TRIGGER0

IOMUXC_GPIO_DISP_B2_15_GPIO_MUX5_IO16

IOMUXC_GPIO_DISP_B2_15_FLEXCAN1_RX

IOMUXC_GPIO_DISP_B2_15_ENET_QOS_1588_EVENT0_AUX_IN

IOMUXC_GPIO_DISP_B2_15_LPSPI4_PCS0

IOMUXC_GPIO_DISP_B2_15_GPIO11_IO16

IOMUXC_GPR_SAIMCLK_LOWBITMASK

IOMUXC_GPR_SAIMCLK_HIGHBITMASK

static inline void IOMUXC_SetPinMux(uint32_t muxRegister, uint32_t muxMode, uint32_t inputRegister, uint32_t inputDaisy, uint32_t configRegister, uint32_t inputOnfield)

Sets the IOMUXC pin mux mode.

This is an example to set the PTA6 as the lpuart0_tx:

```
IOMUXC_SetPinMux(IOMUXC_PTA6_LPUART0_TX, 0);
```

This is an example to set the PTA0 as GPIOA0:

```
IOMUXC_SetPinMux(IOMUXC_PTA0_GPIOA0, 0);
```

Note: The first five parameters can be filled with the pin function ID macros.

Parameters

- muxRegister – The pin mux register.
- muxMode – The pin mux mode.
- inputRegister – The select input register.
- inputDaisy – The input daisy.
- configRegister – The config register.
- inputOnfield – Software input on field.

static inline void IOMUXC_SetPinConfig(uint32_t muxRegister, uint32_t muxMode, uint32_t inputRegister, uint32_t inputDaisy, uint32_t configRegister, uint32_t configValue)

Sets the IOMUXC pin configuration.

This is an example to set pin configuration for IOMUXC_PTA3_LPI2C0_SCLS:

```
IOMUXC_SetPinConfig(IOMUXC_PTA3_LPI2C0_SCLS,IOMUXC_SW_PAD_CTL_PAD_PUS_
↪MASK|IOMUXC_SW_PAD_CTL_PAD_PUS(2U))
```

Note: The previous five parameters can be filled with the pin function ID macros.

Parameters

- muxRegister – The pin mux register.
- muxMode – The pin mux mode.
- inputRegister – The select input register.
- inputDaisy – The input daisy.
- configRegister – The config register.
- configValue – The pin config value.

static inline void IOMUXC_SetSaiMClkClockSource(IOMUXC_GPR_Type *base, *iomuxc_gpr_saimclk_t* mclk, uint8_t clkSrc)

Sets IOMUXC general configuration for SAI MCLK selection.

Parameters

- base – The IOMUXC GPR base address.
- mclk – The SAI MCLK.
- clkSrc – The clock source. Take refer to register setting details for the clock source in RM.

static inline void IOMUXC_MQSEnterSoftwareReset(IOMUXC_GPR_Type *base, bool enable)

Enters or exit MQS software reset.

Parameters

- base – The IOMUXC GPR base address.
- enable – Enter or exit MQS software reset.

static inline void IOMUXC_MQSEnable(IOMUXC_GPR_Type *base, bool enable)

Enables or disables MQS.

Parameters

- base – The IOMUXC GPR base address.
- enable – Enable or disable the MQS.

static inline void IOMUXC_MQSConfig(IOMUXC_GPR_Type *base, *iomuxc_mqs_pwm_oversample_rate_t* rate, uint8_t divider)

Configure MQS PWM oversampling rate compared with mclk and divider ratio control for mclk from hmclk.

Parameters

- base – The IOMUXC GPR base address.
- rate – The MQS PWM oversampling rate, refer to "iomuxc_mqs_pwm_oversample_rate_t".
- divider – The divider ratio control for mclk from hmclk. mclk freq = 1 /(divider + 1) * hmclk freq.

FSL_IOMUXC_DRIVER_VERSION

IOMUXC driver version 2.0.2.

FSL_COMPONENT_ID

2.66 Key_manager

FSL_KEYMGR_DRIVER_VERSION

Key Manager driver version. Version 2.0.2.

Current version: 2.0.2

Change log:

- Version 2.0.2
  - Fix MISRA-2012 issues

- Version 2.0.1
  - Fix MISRA-2012 issues
- Version 2.0.0
  - Initial version

enum _keymgr_lock

Values:

enumerator kKEYMGR_Unlock

enumerator kKEYMGR_Lock

enum _keymgr_allow

Values:

enumerator kKEYMGR_Disallow

enumerator kKEYMGR_Allow

enum _keymgr_slot

Values:

enumerator kKEYMGR_Slot0

enumerator kKEYMGR_Slot1

enumerator kKEYMGR_Slot2

enumerator kKEYMGR_Slot3

enumerator kKEYMGR_Slot4

typedef enum *_keymgr_lock* keymgr_lock_t

typedef enum *_keymgr_allow* keymgr_allow_t

typedef enum *_keymgr_slot* keymgr_slot_t

typedef struct *_domain_slot_config* domain_slot_config_t

Key Manager slot configuration structure.

status_t KEYMGR_MasterKeyControll(KEY_MANAGER_Type *base, uint8_t select, *keymgr_lock_t* lock)

Configures Master key settings.

This function configures Key Manager's setting for Master key.

Parameters

- base – Key Manager peripheral address.
- select – select source for Master key.
- lock – setting for lock Master key.

Returns

status of Master key control operation

status_t KEYMGR_OTFAD1KeyControll(KEY_MANAGER_Type *base, uint8_t select, *keymgr_lock_t* lock)

Configures OTFAD1 key settings.

This function configures Key Manager's setting for OTFAD1 key.

Parameters

- base – Key Manager peripheral address.
- select – select source for OTFAD1 key.
- lock – setting for lock OTFAD1 key.

Returns
status of OTFAD1 key control operation

status_t KEYMGR_OTFAD2KeyControll(KEY_MANAGER_Type *base, uint8_t select, *keymgr_lock_t* lock)

Configures OTFAD2 key settings.

This function configures Key Manager's setting for OTFAD2 key.

Parameters

- base – Key Manager peripheral address.
- select – select source for OTFAD2 key.
- lock – setting for lock OTFAD2 key.

Returns
status of OTFAD2 key control operation

void KEYMGR_IEEKeyReload(KEY_MANAGER_Type *base)

Restart load key signal for IEE.

This function genrates Key Manager's restart signal for IEE key.

Parameters

- base – Key Manager peripheral address.

void KEYMGR_PUFKeyLock(KEY_MANAGER_Type *base, *keymgr_lock_t* lock)

Lock the key select from PUF.

This function locks selection of key for PUF.

Parameters

- base – Key Manager peripheral address.
- lock – Setting for selection of key for PUF.

status_t KEYMGR_SlotControl(KEY_MANAGER_Type *base, *domain_slot_config_t* *config, *keymgr_slot_t* slot)

Configures Slot Domain control.

This function configures domain slot control which locks and allows writes.

Parameters

- base – Key Manager peripheral address.
- config – Pointer to slot configuration structure.
- slot – Select slot to be configured.

Returns
status of slot control operation

void KEYMGR_Init(KEY_MANAGER_Type *base)

Resets Key Manager module to factory default values.

This function performs hardware reset of Key Manager module.

Parameters

- base – Key Manager peripheral address.

status_t KEYMGR_GetDefaultConfig(*domain_slot_config_t* *config)

Sets the default configuration of Key manager slot.

This function initialize Key Manager slot config structure to default values.

Parameters

- config – Pointer to slot configuration structure.

KEYMGR_IEE_RELOAD

KEYMGR_SEL_OCOTP

KEYMGR_SEL_UDF

KEYMGR_SEL_PUF

keymgr_select_t

struct _domain_slot_config

#include <fsl_key_manager.h> Key Manager slot configuration structure.

Public Members

keymgr_lock_t lockControl

Lock control register of slot.

keymgr_allow_t allowUser

Allow user write access to domain control register or domain register.

keymgr_allow_t allowNonSecure

Allow non-secure write access to domain control register or domain register.

keymgr_lock_t lockList

Lock whitelist. SLOTx_CTRL[WHITE_LIST] cannot be changed.

uint8_t whiteList

Domains that on the Whitelist can change given slot. Each field represents one domain. Bit0~Bit3 represent DOMAIN0~DOMAIN3 respectively.

2.67 KPP: KeyPad Port Driver

void KPP_Init(KPP_Type *base, *kpp_config_t* *configure)

KPP initialize. This function ungates the KPP clock and initializes KPP. This function must be called before calling any other KPP driver functions.

Parameters

- base – KPP peripheral base address.
- configure – The KPP configuration structure pointer.

void KPP_Deinit(KPP_Type *base)

Deinitializes the KPP module and gates the clock. This function gates the KPP clock. As a result, the KPP module doesn't work after calling this function.

Parameters

- base – KPP peripheral base address.

static inline void KPP_EnableInterrupts(KPP_Type *base, uint16_t mask)

Enable the interrupt.

Parameters

- base – KPP peripheral base address.
- mask – KPP interrupts to enable. This is a logical OR of the enumeration :: kpp_interrupt_enable_t.

static inline void KPP_DisableInterrupts(KPP_Type *base, uint16_t mask)

Disable the interrupt.

Parameters

- base – KPP peripheral base address.
- mask – KPP interrupts to disable. This is a logical OR of the enumeration :: kpp_interrupt_enable_t.

static inline uint16_t KPP_GetStatusFlag(KPP_Type *base)

Gets the KPP interrupt event status.

Parameters

- base – KPP peripheral base address.

Returns

The status of the KPP. Application can use the enum type in the "kpp_interrupt_enable_t" to get the right status of the related event.

static inline void KPP_ClearStatusFlag(KPP_Type *base, uint16_t mask)

Clears KPP status flag.

Parameters

- base – KPP peripheral base address.
- mask – KPP mask to be cleared. This is a logical OR of the enumeration :: kpp_interrupt_enable_t.

static inline void KPP_SetSynchronizeChain(KPP_Type *base, uint16_t mask)

Set KPP synchronization chain.

Parameters

- base – KPP peripheral base address.
- mask – KPP mask to be cleared. This is a logical OR of the enumeration :: kpp_sync_operation_t.

void KPP_keyPressScanning(KPP_Type *base, uint8_t *data, uint32_t clockSrc_Hz)

Keypad press scanning.

This function will scanning all columns and rows. so all scanning data will be stored in the data pointer.

Parameters

- base – KPP peripheral base address.
- data – KPP key press scanning data. The data buffer should be prepared with length at least equal to KPP_KEYPAD_COLUMNNUM_MAX * KPP_KEYPAD_ROWNUM_MAX. the data pointer is recommended to be a array like uint8_t data[KPP_KEYPAD_COLUMNNUM_MAX]. for example the data[2] = 4, that means in column 1 row 2 has a key press event.
- clockSrc_Hz – Source clock.

FSL_KPP_DRIVER_VERSION

KPP driver version.

enum _kpp_interrupt_enable

List of interrupts supported by the peripheral. This enumeration uses one-bot encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

Values:

enumerator kKPP_keyDepressInterrupt

Keypad depress interrupt source

enumerator kKPP_keyReleaseInterrupt

Keypad release interrupt source

enum _kpp_sync_operation

Lists of KPP synchronize chain operation.

Values:

enumerator kKPP_ClearKeyDepressSyncChain

Keypad depress interrupt status.

enumerator kKPP_SetKeyReleasesSyncChain

Keypad release interrupt status.

typedef enum *_kpp_interrupt_enable* kpp_interrupt_enable_t

List of interrupts supported by the peripheral. This enumeration uses one-bot encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

typedef enum *_kpp_sync_operation* kpp_sync_operation_t

Lists of KPP synchronize chain operation.

typedef struct *_kpp_config* kpp_config_t

Lists of KPP status.

KPP_KEYPAD_COLUMNNUM_MAX

KPP_KEYPAD_ROWNUM_MAX

struct _kpp_config

#include <fsl_kpp.h> Lists of KPP status.

Public Members

uint8_t activeRow

The row number: bit 7 ~ 0 represents the row 7 ~ 0.

uint8_t activeColumn

The column number: bit 7 ~ 0 represents the column 7 ~ 0.

uint16_t interrupt

KPP interrupt source. A logical OR of “kpp_interrupt_enable_t”.

2.68 Common Driver

FSL_COMMON_DRIVER_VERSION
common driver version.

DEBUG_CONSOLE_DEVICE_TYPE_NONE
No debug console.

DEBUG_CONSOLE_DEVICE_TYPE_UART
Debug console based on UART.

DEBUG_CONSOLE_DEVICE_TYPE_LPUART
Debug console based on LPUART.

DEBUG_CONSOLE_DEVICE_TYPE_LPSCI
Debug console based on LPSCI.

DEBUG_CONSOLE_DEVICE_TYPE_USBCDC
Debug console based on USBCDC.

DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM
Debug console based on FLEXCOMM.

DEBUG_CONSOLE_DEVICE_TYPE_IUART
Debug console based on i.MX UART.

DEBUG_CONSOLE_DEVICE_TYPE_VUSART
Debug console based on LPC_VUSART.

DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART
Debug console based on LPC_USART.

DEBUG_CONSOLE_DEVICE_TYPE_SWO
Debug console based on SWO.

DEBUG_CONSOLE_DEVICE_TYPE_QSCI
Debug console based on QSCI.

MIN(a, b)
Computes the minimum of *a* and *b*.

MAX(a, b)
Computes the maximum of *a* and *b*.

UINT16_MAX
Max value of uint16_t type.

UINT32_MAX
Max value of uint32_t type.

SDK_ATOMIC_LOCAL_ADD(addr, val)
Add value *val* from the variable at address *address*.

SDK_ATOMIC_LOCAL_SUB(addr, val)
Subtract value *val* to the variable at address *address*.

SDK_ATOMIC_LOCAL_SET(addr, bits)
Set the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR(addr, bits)
Clear the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_TOGGLE(addr, bits)
Toggle the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR_AND_SET(addr, clearBits, setBits)

For the variable at address *address*, clear the bits specifiled by *clearBits* and set the bits specifiled by *setBits*.

SDK_ATOMIC_LOCAL_COMPARE_AND_SET(addr, expected, newValue)

For the variable at address *address*, check whether the value equal to *expected*. If value same as *expected* then update *newValue* to address and return **true** , else return **false** .

SDK_ATOMIC_LOCAL_TEST_AND_SET(addr, newValue)

For the variable at address *address*, set as *newValue* value and return old value.

USEC_TO_COUNT(us, clockFreqInHz)

Macro to convert a microsecond period to raw count value

COUNT_TO_USEC(count, clockFreqInHz)

Macro to convert a raw count value to microsecond

MSEC_TO_COUNT(ms, clockFreqInHz)

Macro to convert a millisecond period to raw count value

COUNT_TO_MSEC(count, clockFreqInHz)

Macro to convert a raw count value to millisecond

SDK_ISR_EXIT_BARRIER

SDK_L1DCACHE_ALIGN(var)

Macro to define a variable with L1 d-cache line size alignment

SDK_SIZEALIGN(var, alignbytes)

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value

CACHE_LINE_DATA

enum _status_groups

Status group numbers.

Values:

enumerator kStatusGroup_Generic

Group number for generic status codes.

enumerator kStatusGroup_FLASH

Group number for FLASH status codes.

enumerator kStatusGroup_LPSPI

Group number for LPSPI status codes.

enumerator kStatusGroup_FLEXIO_SPI

Group number for FLEXIO SPI status codes.

enumerator kStatusGroup_DSPI

Group number for DSPI status codes.

enumerator kStatusGroup_FLEXIO_UART

Group number for FLEXIO UART status codes.

enumerator kStatusGroup_FLEXIO_I2C

Group number for FLEXIO I2C status codes.

enumerator kStatusGroup_LPI2C

Group number for LPI2C status codes.

enumerator kStatusGroup_UART
Group number for UART status codes.

enumerator kStatusGroup_I2C
Group number for UART status codes.

enumerator kStatusGroup_LPSCI
Group number for LPSCI status codes.

enumerator kStatusGroup_LPUART
Group number for LPUART status codes.

enumerator kStatusGroup_SPI
Group number for SPI status code.

enumerator kStatusGroup_XRDC
Group number for XRDC status code.

enumerator kStatusGroup_SEMA42
Group number for SEMA42 status code.

enumerator kStatusGroup_SDHC
Group number for SDHC status code

enumerator kStatusGroup_SDMMC
Group number for SDMMC status code

enumerator kStatusGroup_SAI
Group number for SAI status code

enumerator kStatusGroup_MCG
Group number for MCG status codes.

enumerator kStatusGroup_SCG
Group number for SCG status codes.

enumerator kStatusGroup_SDSPI
Group number for SDSPI status codes.

enumerator kStatusGroup_FLEXIO_I2S
Group number for FLEXIO I2S status codes

enumerator kStatusGroup_FLEXIO_MCULCD
Group number for FLEXIO LCD status codes

enumerator kStatusGroup_FLASHIAP
Group number for FLASHIAP status codes

enumerator kStatusGroup_FLEXCOMM_I2C
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup_I2S
Group number for I2S status codes

enumerator kStatusGroup_IUART
Group number for IUART status codes

enumerator kStatusGroup_CSI
Group number for CSI status codes

enumerator kStatusGroup_MIPI_DSI
Group number for MIPI DSI status codes

enumerator kStatusGroup_SDRAMC
Group number for SDRAMC status codes.

enumerator kStatusGroup_POWER
Group number for POWER status codes.

enumerator kStatusGroup_ENET
Group number for ENET status codes.

enumerator kStatusGroup_PHY
Group number for PHY status codes.

enumerator kStatusGroup_TRGMUX
Group number for TRGMUX status codes.

enumerator kStatusGroup_SMARTCARD
Group number for SMARTCARD status codes.

enumerator kStatusGroup_LMEM
Group number for LMEM status codes.

enumerator kStatusGroup_QSPI
Group number for QSPI status codes.

enumerator kStatusGroup_DMA
Group number for DMA status codes.

enumerator kStatusGroup_EDMA
Group number for EDMA status codes.

enumerator kStatusGroup_DMAMGR
Group number for DMAMGR status codes.

enumerator kStatusGroup_FLEXCAN
Group number for FlexCAN status codes.

enumerator kStatusGroup_LTC
Group number for LTC status codes.

enumerator kStatusGroup_FLEXIO_CAMERA
Group number for FLEXIO CAMERA status codes.

enumerator kStatusGroup_LPC_SPI
Group number for LPC_SPI status codes.

enumerator kStatusGroup_LPC_USART
Group number for LPC_USART status codes.

enumerator kStatusGroup_DMIC
Group number for DMIC status codes.

enumerator kStatusGroup_SDIF
Group number for SDIF status codes.

enumerator kStatusGroup_SPIFI
Group number for SPIFI status codes.

enumerator kStatusGroup_OTP
Group number for OTP status codes.

enumerator kStatusGroup_MCAN
Group number for MCAN status codes.

enumerator kStatusGroup_CAAM
Group number for CAAM status codes.

enumerator kStatusGroup_ECSPI
Group number for ECSPI status codes.

enumerator kStatusGroup_USDHC
Group number for USDHC status codes.

enumerator kStatusGroup_LPC_I2C
Group number for LPC_I2C status codes.

enumerator kStatusGroup_DCP
Group number for DCP status codes.

enumerator kStatusGroup_MSCAN
Group number for MSCAN status codes.

enumerator kStatusGroup_ESAI
Group number for ESAI status codes.

enumerator kStatusGroup_FLEXSPI
Group number for FLEXSPI status codes.

enumerator kStatusGroup_MMDC
Group number for MMDC status codes.

enumerator kStatusGroup_PDM
Group number for MIC status codes.

enumerator kStatusGroup_SDMA
Group number for SDMA status codes.

enumerator kStatusGroup_ICS
Group number for ICS status codes.

enumerator kStatusGroup_SPDIF
Group number for SPDIF status codes.

enumerator kStatusGroup_LPC_MINISPI
Group number for LPC_MINISPI status codes.

enumerator kStatusGroup_HASHCRYPT
Group number for Hashcrypt status codes

enumerator kStatusGroup_LPC_SPI_SSP
Group number for LPC_SPI_SSP status codes.

enumerator kStatusGroup_I3C
Group number for I3C status codes

enumerator kStatusGroup_LPC_I2C_1
Group number for LPC_I2C_1 status codes.

enumerator kStatusGroup_NOTIFIER
Group number for NOTIFIER status codes.

enumerator kStatusGroup_DebugConsole
Group number for debug console status codes.

enumerator kStatusGroup_SEMC
Group number for SEMC status codes.

enumerator kStatusGroup_ApplicationRangeStart
Starting number for application groups.

enumerator kStatusGroup_IAP
Group number for IAP status codes

enumerator kStatusGroup_SFA
Group number for SFA status codes

enumerator kStatusGroup_SPC
Group number for SPC status codes.

enumerator kStatusGroup_PUF
Group number for PUF status codes.

enumerator kStatusGroup_TOUCH_PANEL
Group number for touch panel status codes

enumerator kStatusGroup_VBAT
Group number for VBAT status codes

enumerator kStatusGroup_XSPI
Group number for XSPI status codes

enumerator kStatusGroup_PNGDEC
Group number for PNGDEC status codes

enumerator kStatusGroup_JPEGDEC
Group number for JPEGDEC status codes

enumerator kStatusGroup_HAL_GPIO
Group number for HAL GPIO status codes.

enumerator kStatusGroup_HAL_UART
Group number for HAL UART status codes.

enumerator kStatusGroup_HAL_TIMER
Group number for HAL TIMER status codes.

enumerator kStatusGroup_HAL_SPI
Group number for HAL SPI status codes.

enumerator kStatusGroup_HAL_I2C
Group number for HAL I2C status codes.

enumerator kStatusGroup_HAL_FLASH
Group number for HAL FLASH status codes.

enumerator kStatusGroup_HAL_PWM
Group number for HAL PWM status codes.

enumerator kStatusGroup_HAL_RNG
Group number for HAL RNG status codes.

enumerator kStatusGroup_HAL_I2S
Group number for HAL I2S status codes.

enumerator kStatusGroup_HAL_ADC_SENSOR
Group number for HAL ADC SENSOR status codes.

enumerator kStatusGroup_TIMERMANAGER
Group number for TiMER MANAGER status codes.

enumerator kStatusGroup_SERIALMANAGER
Group number for SERIAL MANAGER status codes.

enumerator kStatusGroup_LED
Group number for LED status codes.

enumerator kStatusGroup_BUTTON
Group number for BUTTON status codes.

enumerator kStatusGroup_EXTERN_EEPROM
Group number for EXTERN EEPROM status codes.

enumerator kStatusGroup_SHELL
Group number for SHELL status codes.

enumerator kStatusGroup_MEM_MANAGER
Group number for MEM MANAGER status codes.

enumerator kStatusGroup_LIST
Group number for List status codes.

enumerator kStatusGroup_OSA
Group number for OSA status codes.

enumerator kStatusGroup_COMMON_TASK
Group number for Common task status codes.

enumerator kStatusGroup_MSG
Group number for messaging status codes.

enumerator kStatusGroup_SDK_OCOTP
Group number for OCOTP status codes.

enumerator kStatusGroup_SDK_FLEXSPINOR
Group number for FLEXSPINOR status codes.

enumerator kStatusGroup_CODEC
Group number for codec status codes.

enumerator kStatusGroup_ASRC
Group number for codec status ASRC.

enumerator kStatusGroup_OTFAD
Group number for codec status codes.

enumerator kStatusGroup_SDIOSLV
Group number for SDIOSLV status codes.

enumerator kStatusGroup_MECC
Group number for MECC status codes.

enumerator kStatusGroup_ENET_QOS
Group number for ENET_QOS status codes.

enumerator kStatusGroup_LOG
Group number for LOG status codes.

enumerator kStatusGroup_I3CBUS
Group number for I3CBUS status codes.

enumerator kStatusGroup_QSCI
Group number for QSCI status codes.

enumerator kStatusGroup_ELEMU
Group number for ELEMU status codes.

enumerator kStatusGroup_QUEUEDSPI
Group number for QSPI status codes.

enumerator kStatusGroup_POWER_MANAGER
Group number for POWER_MANAGER status codes.

enumerator kStatusGroup_IPED
Group number for IPED status codes.

enumerator kStatusGroup_ELS_PKC
Group number for ELS PKC status codes.

enumerator kStatusGroup_CSS_PKC
Group number for CSS PKC status codes.

enumerator kStatusGroup_HOSTIF
Group number for HOSTIF status codes.

enumerator kStatusGroup_CLIF
Group number for CLIF status codes.

enumerator kStatusGroup_BMA
Group number for BMA status codes.

enumerator kStatusGroup_NETC
Group number for NETC status codes.

enumerator kStatusGroup_ELE
Group number for ELE status codes.

enumerator kStatusGroup_GLIKEY
Group number for GLIKEY status codes.

enumerator kStatusGroup_AON_POWER
Group number for AON_POWER status codes.

enumerator kStatusGroup_AON_COMMON
Group number for AON_COMMON status codes.

enumerator kStatusGroup_ENDAT3
Group number for ENDAT3 status codes.

enumerator kStatusGroup_HIPERFACE
Group number for HIPERFACE status codes.

enumerator kStatusGroup_NPX
Group number for NPX status codes.

enumerator kStatusGroup_ELA_CSEC
Group number for ELA_CSEC status codes.

enumerator kStatusGroup_FLEXIO_T_FORMAT
Group number for T-format status codes.

enumerator kStatusGroup_FLEXIO_A_FORMAT
Group number for A-format status codes.

Generic status return codes.

Values:

enumerator kStatus_Success
Generic status for Success.

enumerator kStatus_Fail
Generic status for Fail.

enumerator kStatus_ReadOnly
Generic status for read only failure.

enumerator kStatus_OutOfRange
Generic status for out of range access.

enumerator kStatus_InvalidArgument
Generic status for invalid argument check.

enumerator kStatus_Timeout
Generic status for timeout.

enumerator kStatus_NoTransferInProgress
Generic status for no transfer in progress.

enumerator kStatus_Busy
Generic status for module is busy.

enumerator kStatus_NoData
Generic status for no data is found for the operation.

typedef int32_t status_t
Type used for all status and error return values.

void *SDK_Malloc(size_t size, size_t alignbytes)
Allocate memory with given alignment and aligned size.

This is provided to support the dynamically allocated memory used in cache-able region.

Parameters

- size – The length required to malloc.
- alignbytes – The alignment size.

Return values
The – allocated memory.

void SDK_Free(void *ptr)
Free memory.

Parameters

- ptr – The memory to be release.

void SDK_DelayAtLeastUs(uint32_t delayTime_us, uint32_t coreClock_Hz)
Delay at least for some time. Please note that, this API uses while loop for delay, different run-time environments make the time not precise, if precise delay count was needed, please implement a new delay function with hardware timer.

Parameters

- delayTime_us – Delay time in unit of microsecond.
- coreClock_Hz – Core clock frequency with Hz.

static inline *status_t* EnableIRQ(IRQn_Type interrupt)

Enable specific interrupt.

Enable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only enables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt enabled successfully
- kStatus_Fail – Failed to enable the interrupt

static inline *status_t* DisableIRQ(IRQn_Type interrupt)

Disable specific interrupt.

Disable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only disables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt disabled successfully
- kStatus_Fail – Failed to disable the interrupt

static inline *status_t* EnableIRQWithPriority(IRQn_Type interrupt, uint8_t priNum)

Enable the IRQ, and also set the interrupt priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to Enable.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_SetPriority(IRQn_Type interrupt, uint8_t priNum)

Set the IRQ priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the

LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to set.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_ClearPendingIRQ(IRQn_Type interrupt)

Clear the pending IRQ flag.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The flag which IRQ to clear.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline uint32_t DisableGlobalIRQ(void)

Disable the global IRQ.

Disable the global interrupt and return the current primask register. User is required to provided the primask register for the EnableGlobalIRQ().

Returns
Current primask value.

static inline void EnableGlobalIRQ(uint32_t primask)

Enable the global IRQ.

Set the primask register with the provided primask value but not just enable the primask. The idea is for the convenience of integration of RTOS. some RTOS get its own management mechanism of primask. User is required to use the EnableGlobalIRQ() and DisableGlobalIRQ() in pair.

Parameters

- primask – value of primask register to be restored. The primask value is supposed to be provided by the DisableGlobalIRQ().

static inline bool _SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t newValue)

static inline uint32_t _SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)

FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ

Macro to use the default weak IRQ handler in drivers.

MAKE_STATUS(group, code)

Construct a status code value from a group and code number.

MAKE_VERSION(major, minor, bugfix)

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms(such as Cortex M) and 16-bit platforms(such as DSC).

```
| Unused    || Major Version || Minor Version ||  Bug Fix    |
31       25  24          17  16          9  8           0
```

ARRAY_SIZE(x)

Computes the number of elements in an array.

UINT64_H(X)

Macro to get upper 32 bits of a 64-bit value

UINT64_L(X)

Macro to get lower 32 bits of a 64-bit value

SUPPRESS_FALL_THROUGH_WARNING()

For switch case code block, if case section ends without "break;" statement, there wil be fallthrough warning with compiler flag -Wextra or -Wimplicit-fallthrough=n when using armgcc. To suppress this warning, "SUPPRESS_FALL_THROUGH_WARNING();" need to be added at the end of each case section which misses "break;"statement.

MSDK_REG_SECURE_ADDR(x)

Convert the register address to the one used in secure mode.

MSDK_REG_NONSECURE_ADDR(x)

Convert the register address to the one used in non-secure mode.

MSDK_INVALID_IRQ_HANDLER

Invalid IRQ handler address.

2.69 LCDIFv2: LCD Interface v2

void LCDIFV2_Init(LCDIFV2_Type *base)

Initializes the LCDIF v2.

This function ungates the LCDIF v2 clock and release the peripheral reset.

Parameters

- base – LCDIF v2 peripheral base address.

void LCDIFV2_Deinit(LCDIFV2_Type *base)

Deinitializes the LCDIF peripheral.

Parameters

- base – LCDIF peripheral base address.

void LCDIFV2_Reset(LCDIFV2_Type *base)

Reset the LCDIF v2.

Parameters

- base – LCDIF peripheral base address.

void LCDIFV2_DisplayGetDefaultConfig(*lcdifv2_display_config_t* *config)

Gets the LCDIF display default configuration structure.

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
config->panelWidth    = 0U;
config->panelHeight   = 0U;
config->hsw           = 3U;
config->hfp           = 3U;
config->hbp           = 3U;
config->vsw           = 3U;
config->vfp           = 3U;
config->vbp           = 3U;
config->polarityFlags = kLCDIFV2_VsyncActiveHigh | kLCDIFV2_HsyncActiveHigh | kLCDIFV2_
↪DataEnableActiveHigh |
                        kLCDIFV2_DriveDataOnRisingClkEdge | kLCDIFV2_DataActiveHigh;
config->lineOrder     = kLCDIFV2_LineOrderRGB;
```

Parameters

- config – Pointer to the LCDIF configuration structure.

void LCDIFV2_SetDisplayConfig(LCDIFV2_Type *base, const *lcdifv2_display_config_t* *config)

Set the LCDIF v2 display configurations.

Parameters

- base – LCDIF peripheral base address.
- config – Pointer to the LCDIF configuration structure.

static inline void LCDIFV2_EnableDisplay(LCDIFV2_Type *base, bool enable)

Enable or disable the display.

Parameters

- base – LCDIF peripheral base address.
- enable – Enable or disable.

static inline void LCDIFV2_EnableInterrupts(LCDIFV2_Type *base, uint8_t domain, uint32_t mask)

Enables LCDIF interrupt requests.

Parameters

- base – LCDIF peripheral base address.
- domain – CPU domain the interrupt signal routed to.
- mask – interrupt source, OR'ed value of _lcdifv2_interrupt.

static inline void LCDIFV2_DisableInterrupts(LCDIFV2_Type *base, uint8_t domain, uint32_t mask)

Disables LCDIF interrupt requests.

Parameters

- base – LCDIF peripheral base address.
- domain – CPU domain the interrupt signal routed to.
- mask – interrupt source, OR'ed value of _lcdifv2_interrupt.

static inline uint32_t LCDIFV2_GetInterruptStatus(LCDIFV2_Type *base, uint8_t domain)

Get LCDIF interrupt peding status.

Parameters

- base – LCDIF peripheral base address.
- domain – CPU domain the interrupt signal routed to.

Returns

Interrupt pending status, OR'ed value of _lcdifv2_interrupt.

static inline void LCDIFV2_ClearInterruptStatus(LCDIFV2_Type *base, uint8_t domain, uint32_t mask)

Clear LCDIF interrupt peding status.

Parameters

- base – LCDIF peripheral base address.
- domain – CPU domain the interrupt signal routed to.
- mask – of the flags to clear, OR'ed value of _lcdifv2_interrupt.

status_t LCDIFV2_SetLut(LCDIFV2_Type *base, uint8_t layerIndex, const uint32_t *lutData, uint16_t count, bool useShadowLoad)

Set the LUT data.

This function sets the specific layer LUT data, if useShadowLoad is true, call LCDIFV2_TriggerLayerShadowLoad after this function, the LUT will be loaded to the hardware during next vertical blanking period. If useShadowLoad is false, the LUT data is loaded to hardware directly.

Parameters

- base – LCDIF v2 peripheral base address.
- layerIndex – Which layer to set.
- lutData – The LUT data to load.
- count – Count of lutData.
- useShadowLoad – Use shadow load.

Return values

- kStatus_Success – Set success.
- kStatus_Fail – Previous LUT data is not loaded to hardware yet.

static inline void LCDIFV2_SetLayerSize(LCDIFV2_Type *base, uint8_t layerIndex, uint16_t width, uint16_t height)

Set the layer dimension.

Note: The layer width must be in multiples of the number of pixels that can be stored in 32 bits

---

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.
- width – Layer width in pixel.
- height – Layer height.

static inline void LCDIFV2_SetLayerOffset(LCDIFV2_Type *base, uint8_t layerIndex, uint16_t offsetX, uint16_t offsetY)

Set the layer position in output frame.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.
- offsetX – Horizontal offset, start from 0.
- offsetY – Vertical offset, start from 0.

void LCDIFV2_SetLayerBufferConfig(LCDIFV2_Type *base, uint8_t layerIndex, const *lcdifv2_buffer_config_t* *config)

Set the layer source buffer configuration.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.
- config – Pointer to the configuration.

static inline void LCDIFV2_SetLayerBufferAddr(LCDIFV2_Type *base, uint8_t layerIndex, uint32_t addr)

Set the layer source buffer address.

This function is used for fast runtime source buffer change.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.
- addr – The new source buffer address passed to the layer, should be 64-bit aligned.

static inline void LCDIFV2_EnableLayer(LCDIFV2_Type *base, uint8_t layerIndex, bool enable)

Enable or disable the layer.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.
- enable – Pass in true to enable, false to disable.

static inline void LCDIFV2_TriggerLayerShadowLoad(LCDIFV2_Type *base, uint8_t layerIndex)

Trigger the layer configuration shadow load.

The new layer configurations are written to the shadow registers first, When all configurations written finished, call this function, then shadowed control registers are updated to the active control registers on VSYNC of next frame.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Layer layerIndex.

static inline void LCDIFV2_SetLayerBackGroundColor(LCDIFV2_Type *base, uint8_t layerIndex, uint32_t backGroundColor)

Set the layer back ground color.

The back ground color is used when layer not actived.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Index of the layer.
- backGroundColor – Background color to use when this layer is not active.

void LCDIFV2_SetLayerBlendConfig(LCDIFV2_Type *base, uint8_t layerIndex, const *lcdifv2_blend_config_t* *config)

Set the layer alpha blend mode.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Index of the CSC unit.
- config – Pointer to the blend configuration.

void LCDIFV2_SetCscMode(LCDIFV2_Type *base, uint8_t layerIndex, *lcdifv2_csc_mode_t* mode)

Set the color space conversion mode.

Supports YUV2RGB and YCbCr2RGB.

Parameters

- base – LCDIFv2 peripheral base address.
- layerIndex – Index of the layer.
- mode – The conversion mode.

status_t LCDIFV2_GetPorterDuffConfig(*lcdifv2_pd_blend_mode_t* mode, *lcdifv2_pd_layer_t* layer, *lcdifv2_blend_config_t* *config)

Get the blend configuration for Porter Duff blend.

This function gets the blend configuration for Porter Duff blend, config->pdFactorMode is set according to layer and mode, other blend configurations are set to:

```
config->pdAlphaMode = kLCDIFV2_PD_AlphaStraight;
config->pdColorMode = kLCDIFV2_PD_ColorStraight;
config->pdGlobalAlphaMode = kLCDIFV2_PD_LocalAlpha;
config->alphaMode = kLCDIFV2_AlphaPoterDuff;
```

This is the basic Porter Duff blend configuration, user still could modify the configurations after this function.

Parameters

- mode – Porter Duff blend mode.
- layer – The configuration for source layer or destination layer.
- config – Pointer to the configuration.

Return values

- kStatus_Success – Get the configuration successfully.
- kStatus_InvalidArgument – The argument is invalid.

status_t LCDIFV2_GetMultiLayerGlobalAlpha(const uint8_t blendedAlpha[], uint8_t globalAlpha[], uint8_t layerCount)

Get the global alpha values for multiple layer blend.

This function calculates the global alpha value for each layer based on the desired blended alpha.

When all layers use the global alpha, the relationship of blended alpha and global alpha of each layer is:

Layer 7: ba7 = ga7 Layer 6: ba6 = ga6 * (1-ga7) Layer 5: ba5 = ga5 * (1-ga6) * (1-ga7) Layer 4: ba4 = ga4 * (1-ga5) * (1-ga6) * (1-ga7) Layer 3: ba3 = ga3 * (1-ga4) * (1-ga5) * (1-ga6) * (1-ga7) Layer 2: ba2 = ga2 * (1-ga3) * (1-ga4) * (1-ga5) * (1-ga6) * (1-ga7) Layer 1: ba1 = ga1 * (1-ga2) * (1-ga3) * (1-ga4) * (1-ga5) * (1-ga6) * (1-ga7) Layer 0: ba0 = 1 * (1-ga1) * (1-ga2) * (1-ga3) * (1-ga4) * (1-ga5) * (1-ga6) * (1-ga7)

Here baN is the blended alpha of layer N, gaN is the global alpha configured to layer N.

This function calculates the global alpha based on the blended alpha. The blendedAlpha and globalAlpha are all arrays of size layerCount. The first layer is a background layer, so blendedAlpha[0] is useless, globalAlpha[0] is always 255.

Parameters

- blendedAlpha – **[in]** The desired blended alpha value, alpha range 0~255.
- globalAlpha – **[out]** Calculated global alpha set to each layer register.
- layerCount – **[in]** Total layer count.

Return values

- kStatus_Success – Get successfully.
- kStatus_InvalidArgument – The argument is invalid.

FSL_LCDIFV2_DRIVER_VERSION

LCDIF v2 driver version.

enum _lcdifv2_polarity_flags

LCDIF v2 signal polarity flags.

Values:

enumerator kLCDIFV2_VsyncActiveHigh

VSYNC active high.

enumerator kLCDIFV2_HsyncActiveHigh

HSYNC active high.

enumerator kLCDIFV2_DataEnableActiveHigh

Data enable line active high.

enumerator kLCDIFV2_DriveDataOnRisingClkEdge

Output data on rising clock edge, capture data on falling clock edge.

enumerator kLCDIFV2_DataActiveHigh

Data active high.

enumerator kLCDIFV2_VsyncActiveLow

VSYNC active low.

enumerator kLCDIFV2_HsyncActiveLow

HSYNC active low.

enumerator kLCDIFV2_DataEnableActiveLow

Data enable line active low.

enumerator kLCDIFV2_DriveDataOnFallingClkEdge

Output data on falling clock edge, capture data on rising clock edge.

enumerator kLCDIFV2_DataActiveLow

Data active high.

enum _lcdifv2_interrupt

The LCDIF v2 interrupts.

Values:

enumerator kLCDIFV2_Layer0FifoEmptyInterrupt
Layer 0 FIFO empty.

enumerator kLCDIFV2_Layer1FifoEmptyInterrupt
Layer 1 FIFO empty.

enumerator kLCDIFV2_Layer2FifoEmptyInterrupt
Layer 2 FIFO empty.

enumerator kLCDIFV2_Layer3FifoEmptyInterrupt
Layer 3 FIFO empty.

enumerator kLCDIFV2_Layer4FifoEmptyInterrupt
Layer 4 FIFO empty.

enumerator kLCDIFV2_Layer5FifoEmptyInterrupt
Layer 5 FIFO empty.

enumerator kLCDIFV2_Layer6FifoEmptyInterrupt
Layer 6 FIFO empty.

enumerator kLCDIFV2_Layer7FifoEmptyInterrupt
Layer 7 FIFO empty.

enumerator kLCDIFV2_Layer0DmaDoneInterrupt
Layer 0 DMA done.

enumerator kLCDIFV2_Layer1DmaDoneInterrupt
Layer 1 DMA done.

enumerator kLCDIFV2_Layer2DmaDoneInterrupt
Layer 2 DMA done.

enumerator kLCDIFV2_Layer3DmaDoneInterrupt
Layer 3 DMA done.

enumerator kLCDIFV2_Layer4DmaDoneInterrupt
Layer 4 DMA done.

enumerator kLCDIFV2_Layer5DmaDoneInterrupt
Layer 5 DMA done.

enumerator kLCDIFV2_Layer6DmaDoneInterrupt
Layer 6 DMA done.

enumerator kLCDIFV2_Layer7DmaDoneInterrupt
Layer 7 DMA done.

enumerator kLCDIFV2_Layer0DmaErrorInterrupt
Layer 0 DMA error.

enumerator kLCDIFV2_Layer1DmaErrorInterrupt
Layer 1 DMA error.

enumerator kLCDIFV2_Layer2DmaErrorInterrupt
Layer 2 DMA error.

enumerator kLCDIFV2_Layer3DmaErrorInterrupt
Layer 3 DMA error.

enumerator kLCDIFV2_Layer4DmaErrorInterrupt
Layer 4 DMA error.

enumerator kLCDIFV2_Layer5DmaErrorInterrupt
Layer 5 DMA error.

enumerator kLCDIFV2_Layer6DmaErrorInterrupt
Layer 6 DMA error.

enumerator kLCDIFV2_Layer7DmaErrorInterrupt
Layer 7 DMA error.

enumerator kLCDIFV2_VerticalBlankingInterrupt
Start of vertical blanking period.

enumerator kLCDIFV2_OutputUnderrunInterrupt
Output buffer underrun.

enumerator kLCDIFV2_VsyncEdgeInterrupt
Interrupt at VSYNC edge.

enum _lcdifv2_line_order
The LCDIF v2 output line order.

Values:

enumerator kLCDIFV2_LineOrderRGB
RGB

enumerator kLCDIFV2_LineOrderRBG
RBG

enumerator kLCDIFV2_LineOrderGBR
GBR

enumerator kLCDIFV2_LineOrderGRB
GRB

enumerator kLCDIFV2_LineOrderBRG
BRG

enumerator kLCDIFV2_LineOrderBGR
BGR

enum _lcdifv2_csc_mode
LCDIF v2 color space conversion mode.

Values:

enumerator kLCDIFV2_CscDisable
Disable the CSC.

enumerator kLCDIFV2_CscYUV2RGB
YUV to RGB.

enumerator kLCDIFV2_CscYCbCr2RGB
YCbCr to RGB.

enum _lcdifv2_pixel_format
LCDIF v2 pixel format.

Values:

enumerator kLCDIFV2_PixelFormatIndex1BPP
LUT index 1 bit.

enumerator kLCDIFV2_PixelFormatIndex2BPP
LUT index 2 bit.

enumerator kLCDIFV2_PixelFormatIndex4BPP
LUT index 4 bit.

enumerator kLCDIFV2_PixelFormatIndex8BPP
LUT index 8 bit.

enumerator kLCDIFV2_PixelFormatRGB565
RGB565, two pixels use 32 bits.

enumerator kLCDIFV2_PixelFormatARGB1555
ARGB1555, two pixels use 32 bits.

enumerator kLCDIFV2_PixelFormatARGB4444
ARGB4444, two pixels use 32 bits.

enumerator kLCDIFV2_PixelFormatUYVY
UYVY, only layer 0 and layer 1 support this.

enumerator kLCDIFV2_PixelFormatVYUY
VYUY, only layer 0 and layer 1 support this.

enumerator kLCDIFV2_PixelFormatYUYV
YUYV, only layer 0 and layer 1 support this.

enumerator kLCDIFV2_PixelFormatYVYU
YVYU, only layer 0 and layer 1 support this.

enumerator kLCDIFV2_PixelFormatRGB888
RGB888 packed, one pixel uses 24 bits.

enumerator kLCDIFV2_PixelFormatARGB8888
ARGB8888 unpacked, one pixel uses 32 bits.

enumerator kLCDIFV2_PixelFormatABGR8888
ABGR8888 unpacked, one pixel uses 32 bits.

enum _lcdifv2_alpha_mode
LCDIF v2 layer alpha blending mode.

Values:

enumerator kLCDIFV2_AlphaDisable
Disable alpha blend.

enumerator kLCDIFV2_AlphaOverride
Use the gobal alpha value, pixel defined alpha value is overridden.

enumerator kLCDIFV2_AlphaEmbedded
Use the pixel defined alpha value.

enumerator kLCDIFV2_AlphaPoterDuff
Use the PoterDuff alpha blending.

enum _lcdifv2_pd_alpha_mode
LCDIF v2 PoterDuff alpha mode.

Values:

enumerator kLCDIFV2_PD_AlphaStraight
Straight mode.

enumerator kLCDIFV2_PD_AlphaInversed
Inversed mode.

enum _lcdifv2_pd_color_mode
LCDIF v2 PoterDuff color mode.

Values:

enumerator kLCDIFV2_PD_ColorNoAlpha
Output color directly.

enumerator kLCDIFV2_PD_ColorWithAlpha
Output color multiples alpha.

enum _lcdifv2_pd_global_alpha_mode
LCDIF v2 PoterDuff global alpha mode.

Values:

enumerator kLCDIFV2_PD_GlobalAlpha
Use global alpha.

enumerator kLCDIFV2_PD_LocalAlpha
Use local alpha.

enumerator kLCDIFV2_PD_ScaledAlpha
Use scaled alpha.

enum _lcdifv2_pd_factor_mode
LCDIF v2 PoterDuff factor mode.

Values:

enumerator kLCDIFV2_PD_FactorOne
Use 1.

enumerator kLCDIFV2_PD_FactorZero
Use 0.

enumerator kLCDIFV2_PD_FactorStraightAlpha
Use straight alpha.

enumerator kLCDIFV2_PD_FactorInversedAlpha
Use inversed alpha.

enum _lcdifv2_pd_blend_mode
LCDIFv2 Porter Duff blend mode. Note: Don't change the enum item value.

Values:

enumerator kLCDIFV2_PD_Src
Source Only

enumerator kLCDIFV2_PD_Atop
Source Atop

enumerator kLCDIFV2_PD_Over
Source Over

enumerator kLCDIFV2_PD_In
Source In.

enumerator kLCDIFV2_PD_Out
Source Out.

enumerator kLCDIFV2_PD_Dst
Destination Only.

enumerator kLCDIFV2_PD_DstAtop
Destination Atop.

enumerator kLCDIFV2_PD_DstOver
Destination Over.

enumerator kLCDIFV2_PD_DstIn
Destination In.

enumerator kLCDIFV2_PD_DstOut
Destination Out.

enumerator kLCDIFV2_PD_Xor
XOR.

enumerator kLCDIFV2_PD_Clear
Clear.

enumerator kLCDIFV2_PD_Max
Used for boarder detection.

enum __lcdifv2_pd_layer
LCDIFv2 Porter Duff layer. Note: Don't change the enum item value.

Values:

enumerator kLCDIFV2_PD_SrcLayer
Source layer.

enumerator kLCDIFV2_PD_DestLayer
Destination layer.

enumerator kLCDIFV2_PD_LayerMax
Used for boarder detection.

typedef enum *_lcdifv2_line_order* lcdifv2_line_order_t
The LCDIF v2 output line order.

typedef struct *_lcdifv2_display_config* lcdifv2_display_config_t
LCDIF v2 display configure structure.

typedef enum *_lcdifv2_csc_mode* lcdifv2_csc_mode_t
LCDIF v2 color space conversion mode.

typedef enum *_lcdifv2_pixel_format* lcdifv2_pixel_format_t
LCDIF v2 pixel format.

typedef struct *_lcdifv2_buffer_config* lcdifv2_buffer_config_t
LCDIF v2 source buffer configuration.

typedef enum *_lcdifv2_alpha_mode* lcdifv2_alpha_mode_t
LCDIF v2 layer alpha blending mode.

typedef enum *_lcdifv2_pd_alpha_mode* lcdifv2_pd_alpha_mode_t
LCDIF v2 PoterDuff alpha mode.

typedef enum *_lcdifv2_pd_color_mode* lcdifv2_pd_color_mode_t
LCDIF v2 PoterDuff color mode.

typedef enum *_lcdifv2_pd_global_alpha_mode* lcdifv2_pd_global_alpha_mode_t
LCDIF v2 PoterDuff global alpha mode.

typedef enum *_lcdifv2_pd_factor_mode* lcdifv2_pd_factor_mode_t
LCDIF v2 PoterDuff factor mode.

typedef struct *_lcdifv2_blend_config* lcdifv2_blend_config_t
LCDIF v2 layer alpha blending configuration.

typedef enum *_lcdifv2_pd_blend_mode* lcdifv2_pd_blend_mode_t
LCDIFv2 Porter Duff blend mode. Note: Don't change the enum item value.

typedef enum *_lcdifv2_pd_layer* lcdifv2_pd_layer_t
LCDIFv2 Porter Duff layer. Note: Don't change the enum item value.

LCDIFV2_LAYER_COUNT

LCDIFV2_LAYER_CSC_COUNT

LCDIFV2_ADDR_CPU_2_IP(addr)

LCDIFV2_MAKE_FIFO_EMPTY_INTERRUPT(layer)
LCDIF v2 FIFO empty interrupt.

LCDIFV2_MAKE_DMA_DONE_INTERRUPT(layer)
LCDIF v2 DMA done interrupt.

LCDIFV2_MAKE_DMA_ERROR_INTERRUPT(layer)
LCDIF v2 DMA error interrupt.

LCDIFV2_LUT_ENTRY_NUM

struct __lcdifv2_display_config
#include <fsl_lcdifv2.h> LCDIF v2 display configure structure.

Public Members

uint16_t panelWidth
Display panel width, pixels per line.

uint16_t panelHeight
Display panel height, how many lines per panel.

uint8_t hsw
HSYNC pulse width.

uint8_t hfp
Horizontal front porch.

uint8_t hbp
Horizontal back porch.

uint8_t vsw
VSYNC pulse width.

uint8_t vfp
Vrtical front porch.

uint8_t vbp
Vertical back porch.

uint32_t polarityFlags
OR'ed value of _lcdifv2_polarity_flags, used to contol the signal polarity.

lcdifv2_line_order_t lineOrder
Line order.

struct __lcdifv2__buffer__config
#include <fsl_lcdifv2.h> LCDIF v2 source buffer configuration.

Public Members

uint16_t strideBytes
Number of bytes between two vertically adjacent pixels, suggest 64-bit aligned.

lcdifv2_pixel_format_t pixelFormat
Source buffer pixel format.

struct __lcdifv2__blend__config
#include <fsl_lcdifv2.h> LCDIF v2 layer alpha blending configuration.

Public Members

uint8_t globalAlpha
Global alpha value, only used when alphaMode is kLCDIFV2_AlphaOverride or kLCDIFV2_AlphaPoterDuff

lcdifv2_alpha_mode_t alphaMode
Alpha mode.

lcdifv2_pd_alpha_mode_t pdAlphaMode
PoterDuff alpha mode, only used when alphaMode is kLCDIFV2_AlphaPoterDuff

lcdifv2_pd_color_mode_t pdColorMode
PoterDuff color mode, only used when alphaMode is kLCDIFV2_AlphaPoterDuff

lcdifv2_pd_global_alpha_mode_t pdGlobalAlphaMode
PoterDuff global alpha mode, only used when alphaMode is kLCDIFV2_AlphaPoterDuff

lcdifv2_pd_factor_mode_t pdFactorMode
PoterDuff factor mode, only used when alphaMode is kLCDIFV2_AlphaPoterDuff

2.70 LPADC: 12-bit SAR Analog-to-Digital Converter Driver

enum __lpadc__status__flags
Define hardware flags of the module.

Values:

enumerator kLPADC__ResultFIFO0OverflowFlag
Indicates that more data has been written to the Result FIFO 0 than it can hold.

enumerator kLPADC__ResultFIFO0ReadyFlag
Indicates when the number of valid datawords in the result FIFO 0 is greater than the setting watermark level.

enumerator kLPADC_TriggerExceptionFlag

Indicates that a trigger exception event has occurred.

enumerator kLPADC_TriggerCompletionFlag

Indicates that a trigger completion event has occurred.

enumerator kLPADC_CalibrationReadyFlag

Indicates that the calibration process is done.

enumerator kLPADC_ActiveFlag

Indicates that the ADC is in active state.

enumerator kLPADC_ResultFIFOOverflowFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowFlag as instead.

enumerator kLPADC_ResultFIFOReadyFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0ReadyFlag as instead.

enum _lpadc_interrupt_enable

Define interrupt switchers of the module.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_ResultFIFO0OverflowInterruptEnable

Configures ADC to generate overflow interrupt requests when FOF0 flag is asserted.

enumerator kLPADC_FIFO0WatermarkInterruptEnable

Configures ADC to generate watermark interrupt requests when RDY0 flag is asserted.

enumerator kLPADC_ResultFIFOOverflowInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowInterruptEnable as instead.

enumerator kLPADC_FIFOWatermarkInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_FIFO0WatermarkInterruptEnable as instead.

enumerator kLPADC_TriggerExceptionInterruptEnable

Configures ADC to generate trigger exception interrupt.

enumerator kLPADC_Trigger0CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 0 completion.

enumerator kLPADC_Trigger1CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 1 completion.

enumerator kLPADC_Trigger2CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 2 completion.

enumerator kLPADC_Trigger3CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 3 completion.

enumerator kLPADC_Trigger4CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 4 completion.

enumerator kLPADC_Trigger5CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 5 completion.

enumerator kLPADC_Trigger6CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 6 completion.

enumerator kLPADC_Trigger7CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 7 completion.

enumerator kLPADC_Trigger8CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 8 completion.

enumerator kLPADC_Trigger9CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 9 completion.

enumerator kLPADC_Trigger10CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 10 completion.

enumerator kLPADC_Trigger11CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 11 completion.

enumerator kLPADC_Trigger12CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 12 completion.

enumerator kLPADC_Trigger13CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 13 completion.

enumerator kLPADC_Trigger14CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 14 completion.

enumerator kLPADC_Trigger15CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 15 completion.

enum _lpadc_trigger_status_flags
The enumerator of lpadc trigger status flags, including interrupted flags and completed flags.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_Trigger0InterruptedFlag
Trigger 0 is interrupted by a high priority exception.

enumerator kLPADC_Trigger1InterruptedFlag
Trigger 1 is interrupted by a high priority exception.

enumerator kLPADC_Trigger2InterruptedFlag
Trigger 2 is interrupted by a high priority exception.

enumerator kLPADC_Trigger3InterruptedFlag
Trigger 3 is interrupted by a high priority exception.

enumerator kLPADC_Trigger4InterruptedFlag
Trigger 4 is interrupted by a high priority exception.

enumerator kLPADC_Trigger5InterruptedFlag
Trigger 5 is interrupted by a high priority exception.

enumerator kLPADC_Trigger6InterruptedFlag
Trigger 6 is interrupted by a high priority exception.

enumerator kLPADC_Trigger7InterruptedFlag
Trigger 7 is interrupted by a high priority exception.

enumerator kLPADC_Trigger8InterruptedFlag
Trigger 8 is interrupted by a high priority exception.

enumerator kLPADC_Trigger9InterruptedFlag
Trigger 9 is interrupted by a high priority exception.

enumerator kLPADC_Trigger10InterruptedFlag
Trigger 10 is interrupted by a high priority exception.

enumerator kLPADC_Trigger11InterruptedFlag
Trigger 11 is interrupted by a high priority exception.

enumerator kLPADC_Trigger12InterruptedFlag
Trigger 12 is interrupted by a high priority exception.

enumerator kLPADC_Trigger13InterruptedFlag
Trigger 13 is interrupted by a high priority exception.

enumerator kLPADC_Trigger14InterruptedFlag
Trigger 14 is interrupted by a high priority exception.

enumerator kLPADC_Trigger15InterruptedFlag
Trigger 15 is interrupted by a high priority exception.

enumerator kLPADC_Trigger0CompletedFlag
Trigger 0 is completed and trigger 0 has enabled completion interrupts.

enumerator kLPADC_Trigger1CompletedFlag
Trigger 1 is completed and trigger 1 has enabled completion interrupts.

enumerator kLPADC_Trigger2CompletedFlag
Trigger 2 is completed and trigger 2 has enabled completion interrupts.

enumerator kLPADC_Trigger3CompletedFlag
Trigger 3 is completed and trigger 3 has enabled completion interrupts.

enumerator kLPADC_Trigger4CompletedFlag
Trigger 4 is completed and trigger 4 has enabled completion interrupts.

enumerator kLPADC_Trigger5CompletedFlag
Trigger 5 is completed and trigger 5 has enabled completion interrupts.

enumerator kLPADC_Trigger6CompletedFlag
Trigger 6 is completed and trigger 6 has enabled completion interrupts.

enumerator kLPADC_Trigger7CompletedFlag
Trigger 7 is completed and trigger 7 has enabled completion interrupts.

enumerator kLPADC_Trigger8CompletedFlag
Trigger 8 is completed and trigger 8 has enabled completion interrupts.

enumerator kLPADC_Trigger9CompletedFlag
Trigger 9 is completed and trigger 9 has enabled completion interrupts.

enumerator kLPADC_Trigger10CompletedFlag
Trigger 10 is completed and trigger 10 has enabled completion interrupts.

enumerator kLPADC_Trigger11CompletedFlag
Trigger 11 is completed and trigger 11 has enabled completion interrupts.

enumerator kLPADC_Trigger12CompletedFlag
Trigger 12 is completed and trigger 12 has enabled completion interrupts.

enumerator kLPADC_Trigger13CompletedFlag
Trigger 13 is completed and trigger 13 has enabled completion interrupts.

enumerator kLPADC_Trigger14CompletedFlag
Trigger 14 is completed and trigger 14 has enabled completion interrupts.

enumerator kLPADC_Trigger15CompletedFlag
Trigger 15 is completed and trigger 15 has enabled completion interrupts.

enum _lpadc_sample_scale_mode
Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

Values:

enumerator kLPADC_SamplePartScale
Use divided input voltage signal. (For scale select,please refer to the reference manual).

enumerator kLPADC_SampleFullScale
Full scale (Factor of 1).

enum _lpadc_sample_channel_mode
Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

Values:

enumerator kLPADC_SampleChannelSingleEndSideA
Single-end mode, only A-side channel is converted.

enumerator kLPADC_SampleChannelSingleEndSideB
Single-end mode, only B-side channel is converted.

enumerator kLPADC_SampleChannelDiffBothSideAB
Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDiffBothSideBA
Differential mode, the ADC result is (CHnB-CHnA).

enumerator kLPADC_SampleChannelDiffBothSide
Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDualSingleEndBothSide
Dual-Single-Ended Mode. Both A side and B side channels are converted independently.

enum _lpadc_hardware_average_mode
Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

Values:

enumerator kLPADC_HardwareAverageCount1
Single conversion.

enumerator kLPADC_HardwareAverageCount2
2 conversions averaged.

enumerator kLPADC_HardwareAverageCount4
4 conversions averaged.

enumerator kLPADC_HardwareAverageCount8
8 conversions averaged.

enumerator kLPADC_HardwareAverageCount16
16 conversions averaged.

enumerator kLPADC_HardwareAverageCount32
32 conversions averaged.

enumerator kLPADC_HardwareAverageCount64
64 conversions averaged.

enumerator kLPADC_HardwareAverageCount128
128 conversions averaged.

enum _lpadc_sample_time_mode
Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

Values:

enumerator kLPADC_SampleTimeADCK3
3 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK5
5 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK7
7 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK11
11 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK19
19 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK35
35 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK67
69 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK131
131 ADCK cycles total sample time.

enum _lpadc_hardware_compare_mode

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

Values:

enumerator kLPADC_HardwareCompareDisabled

Compare disabled.

enumerator kLPADC_HardwareCompareStoreOnTrue

Compare enabled. Store on true.

enumerator kLPADC_HardwareCompareRepeatUntilTrue

Compare enabled. Repeat channel acquisition until true.

enum _lpadc_conversion_resolution_mode

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to lpadc_sample_channel_mode_t

Values:

enumerator kLPADC_ConversionResolutionStandard

Standard resolution. Single-ended 12-bit conversion, Differential 13-bit conversion with 2's complement output.

enumerator kLPADC_ConversionResolutionHigh

High resolution. Single-ended 16-bit conversion; Differential 16-bit conversion with 2's complement output.

enum _lpadc_conversion_average_mode

Define enumeration of conversion averages mode.

Configure the converion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

Values:

enumerator kLPADC_ConversionAverage1

Single conversion.

enumerator kLPADC_ConversionAverage2

2 conversions averaged.

enumerator kLPADC_ConversionAverage4

4 conversions averaged.

enumerator kLPADC_ConversionAverage8

8 conversions averaged.

enumerator kLPADC_ConversionAverage16

16 conversions averaged.

enumerator kLPADC_ConversionAverage32

32 conversions averaged.

enumerator kLPADC_ConversionAverage64
64 conversions averaged.

enumerator kLPADC_ConversionAverage128
128 conversions averaged.

enum _lpadc_reference_voltage_mode
Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

Values:

enumerator kLPADC_ReferenceVoltageAlt1
Option 1 setting.

enumerator kLPADC_ReferenceVoltageAlt2
Option 2 setting.

enumerator kLPADC_ReferenceVoltageAlt3
Option 3 setting.

enum _lpadc_power_level_mode
Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

Values:

enumerator kLPADC_PowerLevelAlt1
Lowest power setting.

enumerator kLPADC_PowerLevelAlt2
Next lowest power setting.

enumerator kLPADC_PowerLevelAlt3
...

enumerator kLPADC_PowerLevelAlt4
Highest power setting.

enum _lpadc_offset_calibration_mode
Define enumeration of offset calibration mode.

Values:

enumerator kLPADC_OffsetCalibration12bitMode
12 bit offset calibration mode.

enumerator kLPADC_OffsetCalibration16bitMode
16 bit offset calibration mode.

enum _lpadc_trigger_priority_policy
Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

Values:

enumerator kLPADC_ConvPreemptImmediatelyNotAutoResumed

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion is not automatically resumed or restarted.

enumerator kLPADC_ConvPreemptSoftlyNotAutoResumed

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion is not resumed or restarted.

enumerator kLPADC_ConvPreemptImmediatelyAutoRestarted

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator kLPADC_ConvPreemptSoftlyAutoRestarted

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator kLPADC_ConvPreemptImmediatelyAutoResumed

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be resumed.

enumerator kLPADC_ConvPreemptSoftlyAutoResumed

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will be automatically be resumed.

enumerator kLPADC_TriggerPriorityPreemptImmediately

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator kLPADC_TriggerPriorityPreemptSoftly

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator kLPADC_TriggerPriorityExceptionDisabled

High priority trigger exception disabled.

typedef enum *_lpadc_sample_scale_mode* lpadc_sample_scale_mode_t

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

typedef enum *_lpadc_sample_channel_mode* lpadc_sample_channel_mode_t

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

typedef enum *_lpadc_hardware_average_mode* lpadc_hardware_average_mode_t

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

typedef enum *_lpadc_sample_time_mode* lpadc_sample_time_mode_t

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

typedef enum *_lpadc_hardware_compare_mode* lpadc_hardware_compare_mode_t

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

typedef enum *_lpadc_conversion_resolution_mode* lpadc_conversion_resolution_mode_t

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to lpadc_sample_channel_mode_t

typedef enum *_lpadc_conversion_average_mode* lpadc_conversion_average_mode_t

Define enumeration of conversion averages mode.

Configure the converion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

typedef enum *_lpadc_reference_voltage_mode* lpadc_reference_voltage_source_t

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

typedef enum *_lpadc_power_level_mode* lpadc_power_level_mode_t

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

typedef enum *_lpadc_offset_calibration_mode* lpadc_offset_calibration_mode_t

Define enumeration of offset calibration mode.

typedef enum *_lpadc_trigger_priority_policy* lpadc_trigger_priority_policy_t

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

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typedef struct *_lpadc_calibration_value* lpadc_calibration_value_t

A structure of calibration value.

LPADC_CONVERSION_COMPLETE_TIMEOUT

Max loops to wait for LPADC conversion complete.

When doing calibration, driver will wait for the completion of conversion. This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

LPADC_CALIBRATION_READY_TIMEOUT

Max loops to wait for LPADC calibration ready.

Before doing calibration, driver will wait for the calibration ready. This parameter defines how many loops to check the calibration ready. If defined as 0, driver will wait forever until ready.

LPADC_GAIN_CAL_READY_TIMEOUT

Max loops to wait for LPADC gain calibration GAIN_CAL ready.

Before doing calibration, driver will wait for the gain calibration GAIN_CAL ready. This parameter defines how many loops to check the gain calibration GAIN_CAL ready. If defined as 0, driver will wait forever until ready.

LPADC_GET_ACTIVE_COMMAND_STATUS(statusVal)

Define the MACRO function to get command status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

LPADC_GET_ACTIVE_TRIGGER_STATUE(statusVal)

Define the MACRO function to get trigger status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

void LPADC_Init(ADC_Type *base, const *lpadc_config_t* *config)

Initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.
- config – Pointer to configuration structure. See “lpadc_config_t”.

void LPADC_GetDefaultConfig(*lpadc_config_t* *config)

Gets an available pre-defined settings for initial configuration.

This function initializes the converter configuration structure with an available settings. The default values are:

```
config->enableInDozeMode        = true;
config->enableAnalogPreliminary = false;
config->powerUpDelay            = 0x80;
config->referenceVoltageSource  = kLPADC_ReferenceVoltageAlt1;
config->powerLevelMode          = kLPADC_PowerLevelAlt1;
config->triggerPriorityPolicy   = kLPADC_TriggerPriorityPreemptImmediately;
```

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```
config->enableConvPause      = false;
config->convPauseDelay       = 0U;
config->FIFOWatermark        = 0U;
```

Parameters

- config – Pointer to configuration structure.

void LPADC_Deinit(ADC_Type *base)

De-initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_Enable(ADC_Type *base, bool enable)

Switch on/off the LPADC module.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the module.

static inline void LPADC_DoResetFIFO(ADC_Type *base)

Do reset the conversion FIFO.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_DoResetConfig(ADC_Type *base)

Do reset the module's configuration.

Reset all ADC internal logic and registers, except the Control Register (ADCx_CTRL).

Parameters

- base – LPADC peripheral base address.

static inline uint32_t LPADC_GetStatusFlags(ADC_Type *base)

Get status flags.

Parameters

- base – LPADC peripheral base address.

Returns

status flags' mask. See to _lpadc_status_flags.

static inline void LPADC_ClearStatusFlags(ADC_Type *base, uint32_t mask)

Clear status flags.

Only the flags can be cleared by writing ADCx_STATUS register would be cleared by this API.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for flags to be cleared. See to _lpadc_status_flags.

static inline uint32_t LPADC_GetTriggerStatusFlags(ADC_Type *base)

Get trigger status flags to indicate which trigger sequences have been completed or interrupted by a high priority trigger exception.

Parameters

- base – LPADC peripheral base address.

Returns
The OR'ed value of _lpadc_trigger_status_flags.

static inline void LPADC_ClearTriggerStatusFlags(ADC_Type *base, uint32_t mask)

Clear trigger status flags.

Parameters

- base – LPADC peripheral base address.
- mask – The mask of trigger status flags to be cleared, should be the OR'ed value of _lpadc_trigger_status_flags.

static inline void LPADC_EnableInterrupts(ADC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to _lpadc_interrupt_enable.

static inline void LPADC_DisableInterrupts(ADC_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to _lpadc_interrupt_enable.

static inline void LPADC_EnableFIFOWatermarkDMA(ADC_Type *base, bool enable)

Switch on/off the DMA trigger for FIFO watermark event.

Parameters

- base – LPADC peripheral base address.
- enable – Switcher to the event.

static inline uint32_t LPADC_GetConvResultCount(ADC_Type *base)

Get the count of result kept in conversion FIFO.

Parameters

- base – LPADC peripheral base address.

Returns
The count of result kept in conversion FIFO.

bool LPADC_GetConvResult(ADC_Type *base, *lpadc_conv_result_t* *result)

Get the result in conversion FIFO.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

Returns
Status whether FIFO entry is valid.

void LPADC_GetConvResultBlocking(ADC_Type *base, *lpadc_conv_result_t* *result)

Get the result in conversion FIFO using blocking method.

Parameters

- base – LPADC peripheral base address.

- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

void LPADC_SetConvTriggerConfig(ADC_Type *base, uint32_t triggerId, const *lpadc_conv_trigger_config_t* *config)

Configure the conversion trigger source.

Each programmable trigger can launch the conversion command in command buffer.

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- config – Pointer to configuration structure. See to lpadc_conv_trigger_config_t.

void LPADC_GetDefaultConvTriggerConfig(*lpadc_conv_trigger_config_t* *config)

Gets an available pre-defined settings for trigger's configuration.

This function initializes the trigger's configuration structure with an available settings. The default values are:

```
config->targetCommandId       = 0U;
config->delayPower            = 0U;
config->priority              = 0U;
config->channelAFIFOSelect    = 0U;
config->channelBFIFOSelect    = 0U;
config->enableHardwareTrigger = false;
```

Parameters

- config – Pointer to configuration structure.

static inline void LPADC_DoSoftwareTrigger(ADC_Type *base, uint32_t triggerIdMask)

Do software trigger to conversion command.

Parameters

- base – LPADC peripheral base address.
- triggerIdMask – Mask value for software trigger indexes, which count from zero.

static inline void LPADC_EnableHardwareTriggerCommandSelection(ADC_Type *base, uint32_t triggerId, bool enable)

Enable hardware trigger command selection.

This function will use the hardware trigger command from ADC_ETC.The trigger command is then defined by ADC hardware trigger command selection field in ADC_ETC->TRIGx_CHAINy_z_n[CSEL].

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- enable – True to enable or flase to disable.

void LPADC_SetConvCommandConfig(ADC_Type *base, uint32_t commandId, const *lpadc_conv_command_config_t* *config)

Configure conversion command.

Note: The number of compare value register on different chips is different, that is mean in some chips, some command buffers do not have the compare functionality.

Parameters

- base – LPADC peripheral base address.
- commandId – ID for command in command buffer. Typically, the available value range is 1 - 15.
- config – Pointer to configuration structure. See to lpadc_conv_command_config_t.

void LPADC_GetDefaultConvCommandConfig(*lpadc_conv_command_config_t* *config)

Gets an available pre-defined settings for conversion command's configuration.

This function initializes the conversion command's configuration structure with an available settings. The default values are:

```
config->sampleScaleMode           = kLPADC_SampleFullScale;
config->channelBScaleMode         = kLPADC_SampleFullScale;
config->sampleChannelMode         = kLPADC_SampleChannelSingleEndSideA;
config->channelNumber             = 0U;
config->channelBNumber            = 0U;
config->chainedNextCommandNumber  = 0U;
config->enableAutoChannelIncrement = false;
config->loopCount                 = 0U;
config->hardwareAverageMode       = kLPADC_HardwareAverageCount1;
config->sampleTimeMode            = kLPADC_SampleTimeADCK3;
config->hardwareCompareMode       = kLPADC_HardwareCompareDisabled;
config->hardwareCompareValueHigh  = 0U;
config->hardwareCompareValueLow   = 0U;
config->conversionResolutionMode  = kLPADC_ConversionResolutionStandard;
config->enableWaitTrigger         = false;
config->enableChannelB            = false;
```

Parameters

- config – Pointer to configuration structure.

void LPADC_EnableCalibration(ADC_Type *base, bool enable)

Enable the calibration function.

When CALOFS is set, the ADC is configured to perform a calibration function anytime the ADC executes a conversion. Any channel selected is ignored and the value returned in the RESFIFO is a signed value between -31 and 31. -32 is not a valid and is never a returned value. Software should copy the lower 6- bits of the conversion result stored in the RESFIFO after a completed calibration conversion to the OFSTRIM field. The OFSTRIM field is used in normal operation for offset correction.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the calibration function.

static inline void LPADC_SetOffsetValue(ADC_Type *base, uint32_t value)

Set proper offset value to trim ADC.

To minimize the offset during normal operation, software should read the conversion result from the RESFIFO calibration operation and write the lower 6 bits to the OFSTRIM register.

Parameters

- base – LPADC peripheral base address.
- value – Setting offset value.

status_t LPADC_DoAutoCalibration(ADC_Type *base)

Do auto calibration.

Calibration function should be executed before using converter in application. It used the software trigger and a dummy conversion, get the offset and write them into the OFSTRIM register. It called some of functional API including: -LPADC_EnableCalibration(...) -LPADC_LPADC_SetOffsetValue(...) -LPADC_SetConvCommandConfig(...) -LPADC_SetConvTriggerConfig(...)

Parameters

- base – LPADC peripheral base address.
- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

static inline void LPADC_EnableOffsetCalibration(ADC_Type *base, bool enable)

Enable the offset calibration function.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the calibration function.

static inline void LPADC_SetOffsetCalibrationMode(ADC_Type *base, *lpadc_offset_calibration_mode_t* mode)

Set offset calibration mode.

Parameters

- base – LPADC peripheral base address.
- mode – set offset calibration mode.see to lpadc_offset_calibration_mode_t .

status_t LPADC_DoOffsetCalibration(ADC_Type *base)

Do offset calibration.

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_PrepareAutoCalibration(ADC_Type *base)

Prepare auto calibration, LPADC_FinishAutoCalibration has to be called before using the LPADC. LPADC_DoAutoCalibration has been split in two API to avoid to be stuck too long in the function.

Parameters

- base – LPADC peripheral base address.

status_t LPADC_FinishAutoCalibration(ADC_Type *base)

Finish auto calibration start with LPADC_PrepareAutoCalibration.

Note: This feature is used for LPADC with CTRL[CALOFSMODE].

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_GetCalibrationValue(ADC_Type *base, *lpadc_calibration_value_t* *ptrCalibrationValue)

Get calibration value into the memory which is defined by invoker.

Note: Please note the ADC will be disabled temporary.

Note: This function should be used after finish calibration.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to lpadc_calibration_value_t structure, this memory block should be always powered on even in low power modes.

status_t LPADC_SetCalibrationValue(ADC_Type *base, const *lpadc_calibration_value_t* *ptrCalibrationValue)

Set calibration value into ADC calibration registers.

Note: Please note the ADC will be disabled temporary.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to lpadc_calibration_value_t structure which contains ADC's calibration value.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

FSL_LPADC_DRIVER_VERSION

LPADC driver version 2.9.3.

struct lpadc_config_t

#include <fsl_lpadc.h> LPADC global configuration.

This structure would used to keep the settings for initialization.

Public Members

bool enableInternalClock

Enables the internally generated clock source. The clock source is used in clock selection logic at the chip level and is optionally used for the ADC clock source.

bool enableVref1LowVoltage

If voltage reference option1 input is below 1.8V, it should be “true”. If voltage reference option1 input is above 1.8V, it should be “false”.

bool enableInDozeMode

Control system transition to Stop and Wait power modes while ADC is converting. When enabled in Doze mode, immediate entries to Wait or Stop are allowed. When disabled, the ADC will wait for the current averaging iteration/FIFO storage to complete before acknowledging stop or wait mode entry.

lpadc_conversion_average_mode_t conversionAverageMode

Auto-Calibration Averages.

bool enableAnalogPreliminary

ADC analog circuits are pre-enabled and ready to execute conversions without startup delays(at the cost of higher DC current consumption).

uint32_t powerUpDelay

When the analog circuits are not pre-enabled, the ADC analog circuits are only powered while the ADC is active and there is a counted delay defined by this field after an initial trigger transitions the ADC from its Idle state to allow time for the analog circuits to stabilize. The startup delay count of (powerUpDelay * 4) ADCK cycles must result in a longer delay than the analog startup time.

lpadc_reference_voltage_source_t referenceVoltageSource

Selects the voltage reference high used for conversions.

lpadc_power_level_mode_t powerLevelMode

Power Configuration Selection.

lpadc_trigger_priority_policy_t triggerPriorityPolicy

Control how higher priority triggers are handled, see to lpadc_trigger_priority_policy_t.

bool enableConvPause

Enables the ADC pausing function. When enabled, a programmable delay is inserted during command execution sequencing between LOOP iterations, between commands in a sequence, and between conversions when command is executing in “Compare Until True” configuration.

uint32_t convPauseDelay

Controls the duration of pausing during command execution sequencing. The pause delay is a count of (convPauseDelay*4) ADCK cycles. Only available when ADC pausing function is enabled. The available value range is in 9-bit.

uint32_t FIFOWatermark

FIFOWatermark is a programmable threshold setting. When the number of datawords stored in the ADC Result FIFO is greater than the value in this field, the ready flag would be asserted to indicate stored data has reached the programmable threshold.

struct lpadc_conv_command_config_t

#include <fsl_lpadc.h> Define structure to keep the configuration for conversion command.

Public Members

lpadc_sample_scale_mode_t sampleScaleMode

Sample scale mode.

lpadc_sample_scale_mode_t channelBScaleMode

Alternate channe B Scale mode.

lpadc_sample_channel_mode_t sampleChannelMode

Channel sample mode.

uint32_t channelNumber

Channel number, select the channel or channel pair.

uint32_t channelBNumber

Alternate Channel B number, select the channel.

uint32_t chainedNextCommandNumber

Selects the next command to be executed after this command completes. 1-15 is available, 0 is to terminate the chain after this command.

bool enableAutoChannelIncrement

Loop with increment: when disabled, the "loopCount" field selects the number of times the selected channel is converted consecutively; when enabled, the "loopCount" field defines how many consecutive channels are converted as part of the command execution.

uint32_t loopCount

Selects how many times this command executes before finish and transition to the next command or Idle state. Command executes LOOP+1 times. 0-15 is available.

lpadc_hardware_average_mode_t hardwareAverageMode

Hardware average selection.

lpadc_sample_time_mode_t sampleTimeMode

Sample time selection.

lpadc_hardware_compare_mode_t hardwareCompareMode

Hardware compare selection.

uint32_t hardwareCompareValueHigh

Compare Value High. The available value range is in 16-bit.

uint32_t hardwareCompareValueLow

Compare Value Low. The available value range is in 16-bit.

lpadc_conversion_resolution_mode_t conversionResolutionMode

Conversion resolution mode.

bool enableWaitTrigger

Wait for trigger assertion before execution: when disabled, this command will be automatically executed; when enabled, the active trigger must be asserted again before executing this command.

struct lpadc_conv_trigger_config_t

#include <fsl_lpadc.h> Define structure to keep the configuration for conversion trigger.

Public Members

uint32_t targetCommandId

Select the command from command buffer to execute upon detect of the associated trigger event.

uint32_t delayPower

Select the trigger delay duration to wait at the start of servicing a trigger event. When this field is clear, then no delay is incurred. When this field is set to a non-zero value, the duration for the delay is 2^delayPower ADCK cycles. The available value range is 4-bit.

uint32_t priority

Sets the priority of the associated trigger source. If two or more triggers have the same priority level setting, the lower order trigger event has the higher priority. The lower value for this field is for the higher priority, the available value range is 1-bit.

bool enableHardwareTrigger

Enable hardware trigger source to initiate conversion on the rising edge of the input trigger source or not. THe software trigger is always available.

struct lpadc_conv_result_t

#include <fsl_lpadc.h> Define the structure to keep the conversion result.

Public Members

uint32_t commandIdSource

Indicate the command buffer being executed that generated this result.

uint32_t loopCountIndex

Indicate the loop count value during command execution that generated this result.

uint32_t triggerIdSource

Indicate the trigger source that initiated a conversion and generated this result.

uint16_t convValue

Data result.

struct __lpadc_calibration_value

#include <fsl_lpadc.h> A structure of calibration value.

2.71 LPI2C: Low Power Inter-Integrated Circuit Driver

void LPI2C_DriverIRQHandler(uint32_t instance)

LPI2C driver IRQ handler common entry.

This function provides the common IRQ request entry for LPI2C.

Parameters

- instance – LPI2C instance.

FSL_LPI2C_DRIVER_VERSION

LPI2C driver version.

LPI2C status return codes.

Values:

enumerator kStatus_LPI2C_Busy
The master is already performing a transfer.

enumerator kStatus_LPI2C_Idle
The slave driver is idle.

enumerator kStatus_LPI2C_Nak
The slave device sent a NAK in response to a byte.

enumerator kStatus_LPI2C_FifoError
FIFO under run or overrun.

enumerator kStatus_LPI2C_BitError
Transferred bit was not seen on the bus.

enumerator kStatus_LPI2C_ArbitrationLost
Arbitration lost error.

enumerator kStatus_LPI2C_PinLowTimeout
SCL or SDA were held low longer than the timeout.

enumerator kStatus_LPI2C_NoTransferInProgress
Attempt to abort a transfer when one is not in progress.

enumerator kStatus_LPI2C_DmaRequestFail
DMA request failed.

enumerator kStatus_LPI2C_Timeout
Timeout polling status flags.

IRQn_Type const kLpi2cIrqs[]
Array to map LPI2C instance number to IRQ number, used internally for LPI2C master interrupt and EDMA transactional APIs.

lpi2c_master_isr_t s_lpi2cMasterIsr
Pointer to master IRQ handler for each instance, used internally for LPI2C master interrupt and EDMA transactional APIs.

void *s_lpi2cMasterHandle[]
Pointers to master handles for each instance, used internally for LPI2C master interrupt and EDMA transactional APIs.

uint32_t LPI2C_GetInstance(LPI2C_Type *base)
Returns an instance number given a base address.

If an invalid base address is passed, debug builds will assert. Release builds will just return instance number 0.

Parameters

- base – The LPI2C peripheral base address.

Returns
LPI2C instance number starting from 0.

I2C_RETRY_TIMES
Retry times for waiting flag.

2.72 LPI2C Master Driver

void LPI2C_MasterGetDefaultConfig(*lpi2c_master_config_t* *masterConfig)

Provides a default configuration for the LPI2C master peripheral.

This function provides the following default configuration for the LPI2C master peripheral:

```
masterConfig->enableMaster            = true;
masterConfig->debugEnable             = false;
masterConfig->ignoreAck               = false;
masterConfig->pinConfig               = kLPI2C_2PinOpenDrain;
masterConfig->baudRate_Hz             = 100000U;
masterConfig->busIdleTimeout_ns       = 0;
masterConfig->pinLowTimeout_ns        = 0;
masterConfig->sdaGlitchFilterWidth_ns = 0;
masterConfig->sclGlitchFilterWidth_ns = 0;
masterConfig->hostRequest.enable      = false;
masterConfig->hostRequest.source      = kLPI2C_HostRequestExternalPin;
masterConfig->hostRequest.polarity    = kLPI2C_HostRequestPinActiveHigh;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with LPI2C_MasterInit().

Parameters

- masterConfig – **[out]** User provided configuration structure for default values. Refer to lpi2c_master_config_t.

void LPI2C_MasterInit(LPI2C_Type *base, const *lpi2c_master_config_t* *masterConfig, uint32_t sourceClock_Hz)

Initializes the LPI2C master peripheral.

This function enables the peripheral clock and initializes the LPI2C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

Parameters

- base – The LPI2C peripheral base address.
- masterConfig – User provided peripheral configuration. Use LPI2C_MasterGetDefaultConfig() to get a set of defaults that you can override.
- sourceClock_Hz – Frequency in Hertz of the LPI2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

void LPI2C_MasterDeinit(LPI2C_Type *base)

Deinitializes the LPI2C master peripheral.

This function disables the LPI2C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- base – The LPI2C peripheral base address.

void LPI2C_MasterConfigureDataMatch(LPI2C_Type *base, const *lpi2c_data_match_config_t* *matchConfig)

Configures LPI2C master data match feature.

Parameters

- base – The LPI2C peripheral base address.
- matchConfig – Settings for the data match feature.

status_t LPI2C_MasterCheckAndClearError(LPI2C_Type *base, uint32_t status)

Convert provided flags to status code, and clear any errors if present.

Parameters

- base – The LPI2C peripheral base address.
- status – Current status flags value that will be checked.

Return values

- kStatus_Success –
- kStatus_LPI2C_PinLowTimeout –
- kStatus_LPI2C_ArbitrationLost –
- kStatus_LPI2C_Nak –
- kStatus_LPI2C_FifoError –

status_t LPI2C_CheckForBusyBus(LPI2C_Type *base)

Make sure the bus isn't already busy.

A busy bus is allowed if we are the one driving it.

Parameters

- base – The LPI2C peripheral base address.

Return values

- kStatus_Success –
- kStatus_LPI2C_Busy –

static inline void LPI2C_MasterReset(LPI2C_Type *base)

Performs a software reset.

Restores the LPI2C master peripheral to reset conditions.

Parameters

- base – The LPI2C peripheral base address.

static inline void LPI2C_MasterEnable(LPI2C_Type *base, bool enable)

Enables or disables the LPI2C module as master.

Parameters

- base – The LPI2C peripheral base address.
- enable – Pass true to enable or false to disable the specified LPI2C as master.

static inline uint32_t LPI2C_MasterGetStatusFlags(LPI2C_Type *base)

Gets the LPI2C master status flags.

A bit mask with the state of all LPI2C master status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

_lpi2c_master_flags

Parameters

- base – The LPI2C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

static inline void LPI2C_MasterClearStatusFlags(LPI2C_Type *base, uint32_t statusMask)

Clears the LPI2C master status flag state.

The following status register flags can be cleared:

- kLPI2C_MasterEndOfPacketFlag
- kLPI2C_MasterStopDetectFlag
- kLPI2C_MasterNackDetectFlag
- kLPI2C_MasterArbitrationLostFlag
- kLPI2C_MasterFifoErrFlag
- kLPI2C_MasterPinLowTimeoutFlag
- kLPI2C_MasterDataMatchFlag

Attempts to clear other flags has no effect.

See also:

_lpi2c_master_flags.

Parameters

- base – The LPI2C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of _lpi2c_master_flags enumerators OR'd together. You may pass the result of a previous call to LPI2C_MasterGetStatusFlags().

static inline void LPI2C_MasterEnableInterrupts(LPI2C_Type *base, uint32_t interruptMask)

Enables the LPI2C master interrupt requests.

All flags except kLPI2C_MasterBusyFlag and kLPI2C_MasterBusBusyFlag can be enabled as interrupts.

Parameters

- base – The LPI2C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

static inline void LPI2C_MasterDisableInterrupts(LPI2C_Type *base, uint32_t interruptMask)

Disables the LPI2C master interrupt requests.

All flags except kLPI2C_MasterBusyFlag and kLPI2C_MasterBusBusyFlag can be enabled as interrupts.

Parameters

- base – The LPI2C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t LPI2C_MasterGetEnabledInterrupts(LPI2C_Type *base)

Returns the set of currently enabled LPI2C master interrupt requests.

Parameters

- base – The LPI2C peripheral base address.

Returns
A bitmask composed of _lpi2c_master_flags enumerators OR'd together to indicate the set of enabled interrupts.

static inline void LPI2C_MasterEnableDMA(LPI2C_Type *base, bool enableTx, bool enableRx)

Enables or disables LPI2C master DMA requests.

Parameters

- base – The LPI2C peripheral base address.
- enableTx – Enable flag for transmit DMA request. Pass true for enable, false for disable.
- enableRx – Enable flag for receive DMA request. Pass true for enable, false for disable.

static inline uint32_t LPI2C_MasterGetTxFifoAddress(LPI2C_Type *base)

Gets LPI2C master transmit data register address for DMA transfer.

Parameters

- base – The LPI2C peripheral base address.

Returns
The LPI2C Master Transmit Data Register address.

static inline uint32_t LPI2C_MasterGetRxFifoAddress(LPI2C_Type *base)

Gets LPI2C master receive data register address for DMA transfer.

Parameters

- base – The LPI2C peripheral base address.

Returns
The LPI2C Master Receive Data Register address.

static inline void LPI2C_MasterSetWatermarks(LPI2C_Type *base, size_t txWords, size_t rxWords)

Sets the watermarks for LPI2C master FIFOs.

Parameters

- base – The LPI2C peripheral base address.
- txWords – Transmit FIFO watermark value in words. The kLPI2C_MasterTxReadyFlag flag is set whenever the number of words in the transmit FIFO is equal or less than *txWords*. Writing a value equal or greater than the FIFO size is truncated.
- rxWords – Receive FIFO watermark value in words. The kLPI2C_MasterRxReadyFlag flag is set whenever the number of words in the receive FIFO is greater than *rxWords*. Writing a value equal or greater than the FIFO size is truncated.

static inline void LPI2C_MasterGetFifoCounts(LPI2C_Type *base, size_t *rxCount, size_t *txCount)

Gets the current number of words in the LPI2C master FIFOs.

Parameters

- base – The LPI2C peripheral base address.
- txCount – **[out]** Pointer through which the current number of words in the transmit FIFO is returned. Pass NULL if this value is not required.
- rxCount – **[out]** Pointer through which the current number of words in the receive FIFO is returned. Pass NULL if this value is not required.

void LPI2C_MasterSetBaudRate(LPI2C_Type *base, uint32_t sourceClock_Hz, uint32_t baudRate_Hz)

Sets the I2C bus frequency for master transactions.

The LPI2C master is automatically disabled and re-enabled as necessary to configure the baud rate. Do not call this function during a transfer, or the transfer is aborted.

Note: Please note that the second parameter is the clock frequency of LPI2C module, the third parameter means user configured bus baudrate, this implementation is different from other I2C drivers which use baudrate configuration as second parameter and source clock frequency as third parameter.

Parameters

- base – The LPI2C peripheral base address.
- sourceClock_Hz – LPI2C functional clock frequency in Hertz.
- baudRate_Hz – Requested bus frequency in Hertz.

static inline bool LPI2C_MasterGetBusIdleState(LPI2C_Type *base)

Returns whether the bus is idle.

Requires the master mode to be enabled.

Parameters

- base – The LPI2C peripheral base address.

Return values

- true – Bus is busy.
- false – Bus is idle.

status_t LPI2C_MasterStart(LPI2C_Type *base, uint8_t address, *lpi2c_direction_t* dir)

Sends a START signal and slave address on the I2C bus.

This function is used to initiate a new master mode transfer. First, the bus state is checked to ensure that another master is not occupying the bus. Then a START signal is transmitted, followed by the 7-bit address specified in the *address* parameter. Note that this function does not actually wait until the START and address are successfully sent on the bus before returning.

Parameters

- base – The LPI2C peripheral base address.
- address – 7-bit slave device address, in bits [6:0].
- dir – Master transfer direction, either kLPI2C_Read or kLPI2C_Write. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

- kStatus_Success – START signal and address were successfully enqueued in the transmit FIFO.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.

static inline *status_t* LPI2C_MasterRepeatedStart(LPI2C_Type *base, uint8_t address, *lpi2c_direction_t* dir)

Sends a repeated START signal and slave address on the I2C bus.

This function is used to send a Repeated START signal when a transfer is already in progress. Like LPI2C_MasterStart(), it also sends the specified 7-bit address.

Note: This function exists primarily to maintain compatible APIs between LPI2C and I2C drivers, as well as to better document the intent of code that uses these APIs.

Parameters

- base – The LPI2C peripheral base address.
- address – 7-bit slave device address, in bits [6:0].
- dir – Master transfer direction, either kLPI2C_Read or kLPI2C_Write. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

- kStatus_Success – Repeated START signal and address were successfully enqueued in the transmit FIFO.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.

status_t LPI2C_MasterSend(LPI2C_Type *base, void *txBuff, size_t txSize)

Performs a polling send transfer on the I2C bus.

Sends up to *txSize* number of bytes to the previously addressed slave device. The slave may reply with a NAK to any byte in order to terminate the transfer early. If this happens, this function returns kStatus_LPI2C_Nak.

Parameters

- base – The LPI2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.

Return values

- kStatus_Success – Data was sent successfully.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.
- kStatus_LPI2C_Nak – The slave device sent a NAK in response to a byte.
- kStatus_LPI2C_FifoError – FIFO under run or over run.
- kStatus_LPI2C_ArbitrationLost – Arbitration lost error.
- kStatus_LPI2C_PinLowTimeout – SCL or SDA were held low longer than the timeout.

status_t LPI2C_MasterReceive(LPI2C_Type *base, void *rxBuff, size_t rxSize)

Performs a polling receive transfer on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.

Return values

- kStatus_Success – Data was received successfully.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.
- kStatus_LPI2C_Nak – The slave device sent a NAK in response to a byte.
- kStatus_LPI2C_FifoError – FIFO under run or overrun.
- kStatus_LPI2C_ArbitrationLost – Arbitration lost error.

- kStatus_LPI2C_PinLowTimeout – SCL or SDA were held low longer than the timeout.

status_t LPI2C_MasterStop(LPI2C_Type *base)

Sends a STOP signal on the I2C bus.

This function does not return until the STOP signal is seen on the bus, or an error occurs.

Parameters

- base – The LPI2C peripheral base address.

Return values

- kStatus_Success – The STOP signal was successfully sent on the bus and the transaction terminated.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.
- kStatus_LPI2C_Nak – The slave device sent a NAK in response to a byte.
- kStatus_LPI2C_FifoError – FIFO under run or overrun.
- kStatus_LPI2C_ArbitrationLost – Arbitration lost error.
- kStatus_LPI2C_PinLowTimeout – SCL or SDA were held low longer than the timeout.

status_t LPI2C_MasterTransferBlocking(LPI2C_Type *base, *lpi2c_master_transfer_t* *transfer)

Performs a master polling transfer on the I2C bus.

Note: The API does not return until the transfer succeeds or fails due to error happens during transfer.

Parameters

- base – The LPI2C peripheral base address.
- transfer – Pointer to the transfer structure.

Return values

- kStatus_Success – Data was received successfully.
- kStatus_LPI2C_Busy – Another master is currently utilizing the bus.
- kStatus_LPI2C_Nak – The slave device sent a NAK in response to a byte.
- kStatus_LPI2C_FifoError – FIFO under run or overrun.
- kStatus_LPI2C_ArbitrationLost – Arbitration lost error.
- kStatus_LPI2C_PinLowTimeout – SCL or SDA were held low longer than the timeout.

void LPI2C_MasterTransferCreateHandle(LPI2C_Type *base, *lpi2c_master_handle_t* *handle, *lpi2c_master_transfer_callback_t* callback, void *userData)

Creates a new handle for the LPI2C master non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C_MasterTransferAbort() API shall be called.

Note: The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C master driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

status_t LPI2C_MasterTransferNonBlocking(LPI2C_Type *base, *lpi2c_master_handle_t* *handle, *lpi2c_master_transfer_t* *transfer)

Performs a non-blocking transaction on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- transfer – The pointer to the transfer descriptor.

Return values

- kStatus_Success – The transaction was started successfully.
- kStatus_LPI2C_Busy – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

status_t LPI2C_MasterTransferGetCount(LPI2C_Type *base, *lpi2c_master_handle_t* *handle, size_t *count)

Returns number of bytes transferred so far.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- count – **[out]** Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_Success –
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void LPI2C_MasterTransferAbort(LPI2C_Type *base, *lpi2c_master_handle_t* *handle)

Terminates a non-blocking LPI2C master transmission early.

Note: It is not safe to call this function from an IRQ handler that has a higher priority than the LPI2C peripheral's IRQ priority.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.

void LPI2C_MasterTransferHandleIRQ(LPI2C_Type *base, void *lpi2cMasterHandle)

Reusable routine to handle master interrupts.

Note: This function does not need to be called unless you are reimplementing the non-blocking API's interrupt handler routines to add special functionality.

Parameters

- base – The LPI2C peripheral base address.
- lpi2cMasterHandle – Pointer to the LPI2C master driver handle.

enum _lpi2c_master_flags

LPI2C master peripheral flags.

The following status register flags can be cleared:

- kLPI2C_MasterEndOfPacketFlag
- kLPI2C_MasterStopDetectFlag
- kLPI2C_MasterNackDetectFlag
- kLPI2C_MasterArbitrationLostFlag
- kLPI2C_MasterFifoErrFlag
- kLPI2C_MasterPinLowTimeoutFlag
- kLPI2C_MasterDataMatchFlag

All flags except kLPI2C_MasterBusyFlag and kLPI2C_MasterBusBusyFlag can be enabled as interrupts.

Note: These enums are meant to be OR'd together to form a bit mask.

Values:

enumerator kLPI2C_MasterTxReadyFlag

Transmit data flag

enumerator kLPI2C_MasterRxReadyFlag

Receive data flag

enumerator kLPI2C_MasterEndOfPacketFlag

End Packet flag

enumerator kLPI2C_MasterStopDetectFlag

Stop detect flag

enumerator kLPI2C_MasterNackDetectFlag

NACK detect flag

enumerator kLPI2C_MasterArbitrationLostFlag

Arbitration lost flag

enumerator kLPI2C_MasterFifoErrFlag

FIFO error flag

enumerator kLPI2C_MasterPinLowTimeoutFlag

Pin low timeout flag

enumerator kLPI2C_MasterDataMatchFlag
Data match flag

enumerator kLPI2C_MasterBusyFlag
Master busy flag

enumerator kLPI2C_MasterBusBusyFlag
Bus busy flag

enumerator kLPI2C_MasterClearFlags
All flags which are cleared by the driver upon starting a transfer.

enumerator kLPI2C_MasterIrqFlags
IRQ sources enabled by the non-blocking transactional API.

enumerator kLPI2C_MasterErrorFlags
Errors to check for.

enum _lpi2c_direction
Direction of master and slave transfers.

Values:

enumerator kLPI2C_Write
Master transmit.

enumerator kLPI2C_Read
Master receive.

enum _lpi2c_master_pin_config
LPI2C pin configuration.

Values:

enumerator kLPI2C_2PinOpenDrain
LPI2C Configured for 2-pin open drain mode

enumerator kLPI2C_2PinOutputOnly
LPI2C Configured for 2-pin output only mode (ultra-fast mode)

enumerator kLPI2C_2PinPushPull
LPI2C Configured for 2-pin push-pull mode

enumerator kLPI2C_4PinPushPull
LPI2C Configured for 4-pin push-pull mode

enumerator kLPI2C_2PinOpenDrainWithSeparateSlave
LPI2C Configured for 2-pin open drain mode with separate LPI2C slave

enumerator kLPI2C_2PinOutputOnlyWithSeparateSlave
LPI2C Configured for 2-pin output only mode(ultra-fast mode) with separate LPI2C slave

enumerator kLPI2C_2PinPushPullWithSeparateSlave
LPI2C Configured for 2-pin push-pull mode with separate LPI2C slave

enumerator kLPI2C_4PinPushPullWithInvertedOutput
LPI2C Configured for 4-pin push-pull mode(inverted outputs)

enum _lpi2c_host_request_source
LPI2C master host request selection.

Values:

enumerator kLPI2C_HostRequestExternalPin
Select the LPI2C_HREQ pin as the host request input

enumerator kLPI2C_HostRequestInputTrigger
Select the input trigger as the host request input

enum _lpi2c_host_request_polarity
LPI2C master host request pin polarity configuration.

Values:

enumerator kLPI2C_HostRequestPinActiveLow
Configure the LPI2C_HREQ pin active low

enumerator kLPI2C_HostRequestPinActiveHigh
Configure the LPI2C_HREQ pin active high

enum _lpi2c_data_match_config_mode
LPI2C master data match configuration modes.

Values:

enumerator kLPI2C_MatchDisabled
LPI2C Match Disabled

enumerator kLPI2C_1stWordEqualsM0OrM1
LPI2C Match Enabled and 1st data word equals MATCH0 OR MATCH1

enumerator kLPI2C_AnyWordEqualsM0OrM1
LPI2C Match Enabled and any data word equals MATCH0 OR MATCH1

enumerator kLPI2C_1stWordEqualsM0And2ndWordEqualsM1
LPI2C Match Enabled and 1st data word equals MATCH0, 2nd data equals MATCH1

enumerator kLPI2C_AnyWordEqualsM0AndNextWordEqualsM1
LPI2C Match Enabled and any data word equals MATCH0, next data equals MATCH1

enumerator kLPI2C_1stWordAndM1EqualsM0AndM1
LPI2C Match Enabled and 1st data word and MATCH0 equals MATCH0 and MATCH1

enumerator kLPI2C_AnyWordAndM1EqualsM0AndM1
LPI2C Match Enabled and any data word and MATCH0 equals MATCH0 and MATCH1

enum _lpi2c_master_transfer_flags
Transfer option flags.

Note: These enumerations are intended to be OR'd together to form a bit mask of options for the _lpi2c_master_transfer::flags field.

Values:

enumerator kLPI2C_TransferDefaultFlag
Transfer starts with a start signal, stops with a stop signal.

enumerator kLPI2C_TransferNoStartFlag
Don't send a start condition, address, and sub address

enumerator kLPI2C_TransferRepeatedStartFlag
Send a repeated start condition

enumerator kLPI2C_TransferNoStopFlag
Don't send a stop condition.

typedef enum *_lpi2c_direction* lpi2c_direction_t

Direction of master and slave transfers.

typedef enum *_lpi2c_master_pin_config* lpi2c_master_pin_config_t

LPI2C pin configuration.

typedef enum *_lpi2c_host_request_source* lpi2c_host_request_source_t

LPI2C master host request selection.

typedef enum *_lpi2c_host_request_polarity* lpi2c_host_request_polarity_t

LPI2C master host request pin polarity configuration.

typedef struct *_lpi2c_master_config* lpi2c_master_config_t

Structure with settings to initialize the LPI2C master module.

This structure holds configuration settings for the LPI2C peripheral. To initialize this structure to reasonable defaults, call the LPI2C_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum *_lpi2c_data_match_config_mode* lpi2c_data_match_config_mode_t

LPI2C master data match configuration modes.

typedef struct *_lpi2c_match_config* lpi2c_data_match_config_t

LPI2C master data match configuration structure.

typedef struct *_lpi2c_master_transfer* lpi2c_master_transfer_t

LPI2C master descriptor of the transfer.

typedef struct *_lpi2c_master_handle* lpi2c_master_handle_t

LPI2C master handle of the transfer.

typedef void (*lpi2c_master_transfer_callback_t)(LPI2C_Type *base, *lpi2c_master_handle_t* *handle, *status_t* completionStatus, void *userData)

Master completion callback function pointer type.

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to LPI2C_MasterTransferCreateHandle().

Param base
The LPI2C peripheral base address.

Param handle
Pointer to the LPI2C master driver handle.

Param completionStatus
Either kStatus_Success or an error code describing how the transfer completed.

Param userData
Arbitrary pointer-sized value passed from the application.

typedef void (*lpi2c_master_isr_t)(LPI2C_Type *base, void *handle)

Typedef for master interrupt handler, used internally for LPI2C master interrupt and EDMA transactional APIs.

struct _lpi2c_master_config

#include <fsl_lpi2c.h> Structure with settings to initialize the LPI2C master module.

This structure holds configuration settings for the LPI2C peripheral. To initialize this structure to reasonable defaults, call the LPI2C_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

bool enableMaster
: Whether to enable master mode.

bool enableDoze
: Whether master is enabled in doze mode.

bool debugEnable
: Enable transfers to continue when halted in debug mode.

bool ignoreAck
: Whether to ignore ACK/NACK.

lpi2c_master_pin_config_t pinConfig
: The pin configuration option.

uint32_t baudRate_Hz
: Desired baud rate in Hertz.

uint32_t busIdleTimeout_ns
: Bus idle timeout in nanoseconds. Set to 0 to disable.

uint32_t pinLowTimeout_ns
: Pin low timeout in nanoseconds. Set to 0 to disable.

uint8_t sdaGlitchFilterWidth_ns
: Width in nanoseconds of glitch filter on SDA pin. Set to 0 to disable.

uint8_t sclGlitchFilterWidth_ns
: Width in nanoseconds of glitch filter on SCL pin. Set to 0 to disable.

struct *_lpi2c_master_config* hostRequest
: Host request options.

struct __lpi2c_match_config
: *#include <fsl_lpi2c.h>* LPI2C master data match configuration structure.

Public Members

lpi2c_data_match_config_mode_t matchMode
: Data match configuration setting.

bool rxDataMatchOnly
: When set to true, received data is ignored until a successful match.

uint32_t match0
: Match value 0.

uint32_t match1
: Match value 1.

struct __lpi2c_master_transfer
: *#include <fsl_lpi2c.h>* Non-blocking transfer descriptor structure.

  This structure is used to pass transaction parameters to the LPI2C_MasterTransferNonBlocking() API.

Public Members

uint32_t flags

Bit mask of options for the transfer. See enumeration _lpi2c_master_transfer_flags for available options. Set to 0 or kLPI2C_TransferDefaultFlag for normal transfers.

uint16_t slaveAddress

The 7-bit slave address.

lpi2c_direction_t direction

Either kLPI2C_Read or kLPI2C_Write.

uint32_t subaddress

Sub address. Transferred MSB first.

size_t subaddressSize

Length of sub address to send in bytes. Maximum size is 4 bytes.

void *data

Pointer to data to transfer.

size_t dataSize

Number of bytes to transfer.

struct __lpi2c_master_handle

#include <fsl_lpi2c.h> Driver handle for master non-blocking APIs.

Note: The contents of this structure are private and subject to change.

Public Members

uint8_t state

Transfer state machine current state.

uint16_t remainingBytes

Remaining byte count in current state.

uint8_t *buf

Buffer pointer for current state.

uint16_t commandBuffer[6]

LPI2C command sequence. When all 6 command words are used: Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word]

lpi2c_master_transfer_t transfer

Copy of the current transfer info.

lpi2c_master_transfer_callback_t completionCallback

Callback function pointer.

void *userData

Application data passed to callback.

struct hostRequest

Public Members

bool enable

Enable host request.

lpi2c_host_request_source_t source

Host request source.

lpi2c_host_request_polarity_t polarity

Host request pin polarity.

2.73 LPI2C Master DMA Driver

void LPI2C_MasterCreateEDMAHandle(LPI2C_Type *base, *lpi2c_master_edma_handle_t* *handle, *edma_handle_t* *rxDmaHandle, *edma_handle_t* *txDmaHandle, *lpi2c_master_edma_transfer_callback_t* callback, void *userData)

Create a new handle for the LPI2C master DMA APIs.

The creation of a handle is for use with the DMA APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C_MasterTransferAbortEDMA() API shall be called.

For devices where the LPI2C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C master driver handle.
- rxDmaHandle – Handle for the eDMA receive channel. Created by the user prior to calling this function.
- txDmaHandle – Handle for the eDMA transmit channel. Created by the user prior to calling this function.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

status_t LPI2C_MasterTransferEDMA(LPI2C_Type *base, *lpi2c_master_edma_handle_t* *handle, *lpi2c_master_transfer_t* *transfer)

Performs a non-blocking DMA-based transaction on the I2C bus.

The callback specified when the *handle* was created is invoked when the transaction has completed.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- transfer – The pointer to the transfer descriptor.

Return values

- kStatus_Success – The transaction was started successfully.
- kStatus_LPI2C_Busy – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

status_t LPI2C_MasterTransferGetCountEDMA(LPI2C_Type *base, *lpi2c_master_edma_handle_t* *handle, size_t *count)

Returns number of bytes transferred so far.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- count – **[out]** Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_Success –
- kStatus_NoTransferInProgress – There is not a DMA transaction currently in progress.

status_t LPI2C_MasterTransferAbortEDMA(LPI2C_Type *base, *lpi2c_master_edma_handle_t* *handle)

Terminates a non-blocking LPI2C master transmission early.

Note: It is not safe to call this function from an IRQ handler that has a higher priority than the eDMA peripheral's IRQ priority.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.

Return values

- kStatus_Success – A transaction was successfully aborted.
- kStatus_LPI2C_Idle – There is not a DMA transaction currently in progress.

typedef struct *_lpi2c_master_edma_handle* lpi2c_master_edma_handle_t

LPI2C master EDMA handle of the transfer.

typedef void (*lpi2c_master_edma_transfer_callback_t)(LPI2C_Type *base, *lpi2c_master_edma_handle_t* *handle, *status_t* completionStatus, void *userData)

Master DMA completion callback function pointer type.

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to LPI2C_MasterCreateEDMAHandle().

Param base
The LPI2C peripheral base address.

Param handle
Handle associated with the completed transfer.

Param completionStatus
Either kStatus_Success or an error code describing how the transfer completed.

Param userData
Arbitrary pointer-sized value passed from the application.

struct __lpi2c_master_edma_handle

#include <fsl_lpi2c_edma.h> Driver handle for master DMA APIs.

Note: The contents of this structure are private and subject to change.

Public Members

LPI2C_Type *base

LPI2C base pointer.

bool isBusy

Transfer state machine current state.

uint8_t nbytes

eDMA minor byte transfer count initially configured.

uint16_t commandBuffer[20]

LPI2C command sequence. When all 10 command words are used: Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word] + receive&Size[4 words]

lpi2c_master_transfer_t transfer

Copy of the current transfer info.

lpi2c_master_edma_transfer_callback_t completionCallback

Callback function pointer.

void *userData

Application data passed to callback.

edma_handle_t *rx

Handle for receive DMA channel.

edma_handle_t *tx

Handle for transmit DMA channel.

edma_tcd_t tcds[3]

Software TCD. Three are allocated to provide enough room to align to 32-bytes.

2.74 LPI2C Slave Driver

void LPI2C_SlaveGetDefaultConfig(*lpi2c_slave_config_t* *slaveConfig)

Provides a default configuration for the LPI2C slave peripheral.

This function provides the following default configuration for the LPI2C slave peripheral:

```
slaveConfig->enableSlave              = true;
slaveConfig->address0                 = 0U;
slaveConfig->address1                 = 0U;
slaveConfig->addressMatchMode         = kLPI2C_MatchAddress0;
slaveConfig->filterDozeEnable         = true;
slaveConfig->filterEnable             = true;
slaveConfig->enableGeneralCall        = false;
slaveConfig->sclStall.enableAck       = false;
slaveConfig->sclStall.enableTx        = true;
slaveConfig->sclStall.enableRx        = true;
```

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```
slaveConfig->sclStall.enableAddress    = true;
slaveConfig->ignoreAck                 = false;
slaveConfig->enableReceivedAddressRead = false;
slaveConfig->sdaGlitchFilterWidth_ns   = 0;
slaveConfig->sclGlitchFilterWidth_ns   = 0;
slaveConfig->dataValidDelay_ns         = 0;
slaveConfig->clockHoldTime_ns          = 0;
```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with LPI2C_SlaveInit(). Be sure to override at least the *address0* member of the configuration structure with the desired slave address.

Parameters

- slaveConfig – **[out]** User provided configuration structure that is set to default values. Refer to lpi2c_slave_config_t.

void LPI2C_SlaveInit(LPI2C_Type *base, const *lpi2c_slave_config_t* *slaveConfig, uint32_t sourceClock_Hz)

Initializes the LPI2C slave peripheral.

This function enables the peripheral clock and initializes the LPI2C slave peripheral as described by the user provided configuration.

Parameters

- base – The LPI2C peripheral base address.
- slaveConfig – User provided peripheral configuration. Use LPI2C_SlaveGetDefaultConfig() to get a set of defaults that you can override.
- sourceClock_Hz – Frequency in Hertz of the LPI2C functional clock. Used to calculate the filter widths, data valid delay, and clock hold time.

void LPI2C_SlaveDeinit(LPI2C_Type *base)

Deinitializes the LPI2C slave peripheral.

This function disables the LPI2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- base – The LPI2C peripheral base address.

static inline void LPI2C_SlaveReset(LPI2C_Type *base)

Performs a software reset of the LPI2C slave peripheral.

Parameters

- base – The LPI2C peripheral base address.

static inline void LPI2C_SlaveEnable(LPI2C_Type *base, bool enable)

Enables or disables the LPI2C module as slave.

Parameters

- base – The LPI2C peripheral base address.
- enable – Pass true to enable or false to disable the specified LPI2C as slave.

static inline uint32_t LPI2C_SlaveGetStatusFlags(LPI2C_Type *base)

Gets the LPI2C slave status flags.

A bit mask with the state of all LPI2C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

_lpi2c_slave_flags

Parameters

- base – The LPI2C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

static inline void LPI2C_SlaveClearStatusFlags(LPI2C_Type *base, uint32_t statusMask)

Clears the LPI2C status flag state.

The following status register flags can be cleared:

- kLPI2C_SlaveRepeatedStartDetectFlag
- kLPI2C_SlaveStopDetectFlag
- kLPI2C_SlaveBitErrFlag
- kLPI2C_SlaveFifoErrFlag

Attempts to clear other flags has no effect.

See also:

_lpi2c_slave_flags.

Parameters

- base – The LPI2C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of _lpi2c_slave_flags enumerators OR'd together. You may pass the result of a previous call to LPI2C_SlaveGetStatusFlags().

static inline void LPI2C_SlaveEnableInterrupts(LPI2C_Type *base, uint32_t interruptMask)

Enables the LPI2C slave interrupt requests.

All flags except kLPI2C_SlaveBusyFlag and kLPI2C_SlaveBusBusyFlag can be enabled as interrupts.

Parameters

- base – The LPI2C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

static inline void LPI2C_SlaveDisableInterrupts(LPI2C_Type *base, uint32_t interruptMask)

Disables the LPI2C slave interrupt requests.

All flags except kLPI2C_SlaveBusyFlag and kLPI2C_SlaveBusBusyFlag can be enabled as interrupts.

Parameters

- base – The LPI2C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t LPI2C_SlaveGetEnabledInterrupts(LPI2C_Type *base)

Returns the set of currently enabled LPI2C slave interrupt requests.

Parameters

- base – The LPI2C peripheral base address.

Returns

A bitmask composed of _lpi2c_slave_flags enumerators OR'd together to indicate the set of enabled interrupts.

static inline void LPI2C_SlaveEnableDMA(LPI2C_Type *base, bool enableAddressValid, bool enableRx, bool enableTx)

Enables or disables the LPI2C slave peripheral DMA requests.

Parameters

- base – The LPI2C peripheral base address.
- enableAddressValid – Enable flag for the address valid DMA request. Pass true for enable, false for disable. The address valid DMA request is shared with the receive data DMA request.
- enableRx – Enable flag for the receive data DMA request. Pass true for enable, false for disable.
- enableTx – Enable flag for the transmit data DMA request. Pass true for enable, false for disable.

static inline bool LPI2C_SlaveGetBusIdleState(LPI2C_Type *base)

Returns whether the bus is idle.

Requires the slave mode to be enabled.

Parameters

- base – The LPI2C peripheral base address.

Return values

- true – Bus is busy.
- false – Bus is idle.

static inline void LPI2C_SlaveTransmitAck(LPI2C_Type *base, bool ackOrNack)

Transmits either an ACK or NAK on the I2C bus in response to a byte from the master.

Use this function to send an ACK or NAK when the kLPI2C_SlaveTransmitAckFlag is asserted. This only happens if you enable the sclStall.enableAck field of the lpi2c_slave_config_t configuration structure used to initialize the slave peripheral.

Parameters

- base – The LPI2C peripheral base address.
- ackOrNack – Pass true for an ACK or false for a NAK.

static inline void LPI2C_SlaveEnableAckStall(LPI2C_Type *base, bool enable)

Enables or disables ACKSTALL.

When enables ACKSTALL, software can transmit either an ACK or NAK on the I2C bus in response to a byte from the master.

Parameters

- base – The LPI2C peripheral base address.
- enable – True will enable ACKSTALL,false will disable ACKSTALL.

static inline uint32_t LPI2C_SlaveGetReceivedAddress(LPI2C_Type *base)

Returns the slave address sent by the I2C master.

This function should only be called if the kLPI2C_SlaveAddressValidFlag is asserted.

Parameters

- base – The LPI2C peripheral base address.

Returns

The 8-bit address matched by the LPI2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

status_t LPI2C_SlaveSend(LPI2C_Type *base, void *txBuff, size_t txSize, size_t *actualTxSize)

Performs a polling send transfer on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- actualTxSize – **[out]**

Returns

Error or success status returned by API.

status_t LPI2C_SlaveReceive(LPI2C_Type *base, void *rxBuff, size_t rxSize, size_t *actualRxSize)

Performs a polling receive transfer on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.
- actualRxSize – **[out]**

Returns

Error or success status returned by API.

void LPI2C_SlaveTransferCreateHandle(LPI2C_Type *base, *lpi2c_slave_handle_t* *handle, *lpi2c_slave_transfer_callback_t* callback, void *userData)

Creates a new handle for the LPI2C slave non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C_SlaveTransferAbort() API shall be called.

Note: The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C slave driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

status_t LPI2C_SlaveTransferNonBlocking(LPI2C_Type *base, *lpi2c_slave_handle_t* *handle, uint32_t eventMask)

Starts accepting slave transfers.

Call this API after calling I2C_SlaveInit() and LPI2C_SlaveTransferCreateHandle() to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to LPI2C_SlaveTransferCreateHandle(). The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of lpi2c_slave_transfer_event_t enumerators for the events you wish to receive. The kLPI2C_SlaveTransmitEvent and kLPI2C_SlaveReceiveEvent events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the kLPI2C_SlaveAllEvents constant is provided as a convenient way to enable all events.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to lpi2c_slave_handle_t structure which stores the transfer state.
- eventMask – Bit mask formed by OR'ing together lpi2c_slave_transfer_event_t enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and kLPI2C_SlaveAllEvents to enable all events.

Return values

- kStatus_Success – Slave transfers were successfully started.
- kStatus_LPI2C_Busy – Slave transfers have already been started on this handle.

status_t LPI2C_SlaveTransferGetCount(LPI2C_Type *base, *lpi2c_slave_handle_t* *handle, size_t *count)

Gets the slave transfer status during a non-blocking transfer.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to i2c_slave_handle_t structure.
- count – **[out]** Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

Return values

- kStatus_Success –
- kStatus_NoTransferInProgress –

void LPI2C_SlaveTransferAbort(LPI2C_Type *base, *lpi2c_slave_handle_t* *handle)

Aborts the slave non-blocking transfers.

Note: This API could be called at any time to stop slave for handling the bus events.

Parameters

- base – The LPI2C peripheral base address.

- handle – Pointer to lpi2c_slave_handle_t structure which stores the transfer state.

void LPI2C_SlaveTransferHandleIRQ(LPI2C_Type *base, *lpi2c_slave_handle_t* *handle)

Reusable routine to handle slave interrupts.

Note: This function does not need to be called unless you are reimplementing the non blocking API's interrupt handler routines to add special functionality.

Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to lpi2c_slave_handle_t structure which stores the transfer state.

enum _lpi2c_slave_flags

LPI2C slave peripheral flags.

The following status register flags can be cleared:

- kLPI2C_SlaveRepeatedStartDetectFlag
- kLPI2C_SlaveStopDetectFlag
- kLPI2C_SlaveBitErrFlag
- kLPI2C_SlaveFifoErrFlag

All flags except kLPI2C_SlaveBusyFlag and kLPI2C_SlaveBusBusyFlag can be enabled as interrupts.

Note: These enumerations are meant to be OR'd together to form a bit mask.

Values:

enumerator kLPI2C_SlaveTxReadyFlag

Transmit data flag

enumerator kLPI2C_SlaveRxReadyFlag

Receive data flag

enumerator kLPI2C_SlaveAddressValidFlag

Address valid flag

enumerator kLPI2C_SlaveTransmitAckFlag

Transmit ACK flag

enumerator kLPI2C_SlaveRepeatedStartDetectFlag

Repeated start detect flag

enumerator kLPI2C_SlaveStopDetectFlag

Stop detect flag

enumerator kLPI2C_SlaveBitErrFlag

Bit error flag

enumerator kLPI2C_SlaveFifoErrFlag

FIFO error flag

enumerator kLPI2C_SlaveAddressMatch0Flag

Address match 0 flag

enumerator kLPI2C_SlaveAddressMatch1Flag
Address match 1 flag

enumerator kLPI2C_SlaveGeneralCallFlag
General call flag

enumerator kLPI2C_SlaveBusyFlag
Master busy flag

enumerator kLPI2C_SlaveBusBusyFlag
Bus busy flag

enumerator kLPI2C_SlaveClearFlags
All flags which are cleared by the driver upon starting a transfer.

enumerator kLPI2C_SlaveIrqFlags
IRQ sources enabled by the non-blocking transactional API.

enumerator kLPI2C_SlaveErrorFlags
Errors to check for.

enum _lpi2c_slave_address_match
LPI2C slave address match options.

Values:

enumerator kLPI2C_MatchAddress0
Match only address 0.

enumerator kLPI2C_MatchAddress0OrAddress1
Match either address 0 or address 1.

enumerator kLPI2C_MatchAddress0ThroughAddress1
Match a range of slave addresses from address 0 through address 1.

enum _lpi2c_slave_transfer_event
Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

Note: These enumerations are meant to be OR'd together to form a bit mask of events.

Values:

enumerator kLPI2C_SlaveAddressMatchEvent
Received the slave address after a start or repeated start.

enumerator kLPI2C_SlaveTransmitEvent
Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kLPI2C_SlaveReceiveEvent
Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kLPI2C_SlaveTransmitAckEvent
Callback needs to either transmit an ACK or NACK.

enumerator kLPI2C_SlaveRepeatedStartEvent
A repeated start was detected.

enumerator kLPI2C_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator kLPI2C_SlaveAllEvents

Bit mask of all available events.

typedef enum *_lpi2c_slave_address_match* lpi2c_slave_address_match_t

LPI2C slave address match options.

typedef struct *_lpi2c_slave_config* lpi2c_slave_config_t

Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum *_lpi2c_slave_transfer_event* lpi2c_slave_transfer_event_t

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

Note: These enumerations are meant to be OR'd together to form a bit mask of events.

typedef struct *_lpi2c_slave_transfer* lpi2c_slave_transfer_t

LPI2C slave transfer structure.

typedef struct *_lpi2c_slave_handle* lpi2c_slave_handle_t

LPI2C slave handle structure.

typedef void (*lpi2c_slave_transfer_callback_t)(LPI2C_Type *base, *lpi2c_slave_transfer_t* *transfer, void *userData)

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the LPI2C_SlaveSetCallback() function after you have created a handle.

Param base
Base address for the LPI2C instance on which the event occurred.

Param transfer
Pointer to transfer descriptor containing values passed to and/or from the callback.

Param userData
Arbitrary pointer-sized value passed from the application.

struct _lpi2c_slave_config

#include <fsl_lpi2c.h> Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

bool enableSlave
: Enable slave mode.

uint8_t address0
: Slave's 7-bit address.

uint8_t address1
: Alternate slave 7-bit address.

lpi2c_slave_address_match_t addressMatchMode
: Address matching options.

bool filterDozeEnable
: Enable digital glitch filter in doze mode.

bool filterEnable
: Enable digital glitch filter.

bool enableGeneralCall
: Enable general call address matching.

struct *_lpi2c_slave_config* sclStall
: SCL stall enable options.

bool ignoreAck
: Continue transfers after a NACK is detected.

bool enableReceivedAddressRead
: Enable reading the address received address as the first byte of data.

uint32_t sdaGlitchFilterWidth_ns
: Width in nanoseconds of the digital filter on the SDA signal. Set to 0 to disable.

uint32_t sclGlitchFilterWidth_ns
: Width in nanoseconds of the digital filter on the SCL signal. Set to 0 to disable.

uint32_t dataValidDelay_ns
: Width in nanoseconds of the data valid delay.

uint32_t clockHoldTime_ns
: Width in nanoseconds of the clock hold time.

struct _lpi2c_slave_transfer
: *#include <fsl_lpi2c.h>* LPI2C slave transfer structure.

Public Members

lpi2c_slave_transfer_event_t event
: Reason the callback is being invoked.

uint8_t receivedAddress
: Matching address send by master.

uint8_t *data
: Transfer buffer

size_t dataSize
: Transfer size

status_t completionStatus

Success or error code describing how the transfer completed. Only applies for kLPI2C_SlaveCompletionEvent.

size_t transferredCount

Number of bytes actually transferred since start or last repeated start.

struct __lpi2c_slave_handle

#include <fsl_lpi2c.h> LPI2C slave handle structure.

Note: The contents of this structure are private and subject to change.

Public Members

lpi2c_slave_transfer_t transfer

LPI2C slave transfer copy.

bool isBusy

Whether transfer is busy.

bool wasTransmit

Whether the last transfer was a transmit.

uint32_t eventMask

Mask of enabled events.

uint32_t transferredCount

Count of bytes transferred.

lpi2c_slave_transfer_callback_t callback

Callback function called at transfer event.

void *userData

Callback parameter passed to callback.

struct sclStall

Public Members

bool enableAck

Enables SCL clock stretching during slave-transmit address byte(s) and slave-receiver address and data byte(s) to allow software to write the Transmit ACK Register before the ACK or NACK is transmitted. Clock stretching occurs when transmitting the 9th bit. When enableAckSCLStall is enabled, there is no need to set either enableRxDataSCLStall or enableAddressSCLStall.

bool enableTx

Enables SCL clock stretching when the transmit data flag is set during a slave-transmit transfer.

bool enableRx

Enables SCL clock stretching when receive data flag is set during a slave-receive transfer.

bool enableAddress

Enables SCL clock stretching when the address valid flag is asserted.

2.75 LPSPI: Low Power Serial Peripheral Interface

2.76 LPSPI Peripheral driver

void LPSPI_MasterInit(LPSPI_Type *base, const *lpspi_master_config_t* *masterConfig, uint32_t srcClock_Hz)

Initializes the LPSPI master.

Parameters

- base – LPSPI peripheral address.
- masterConfig – Pointer to structure lpspi_master_config_t.
- srcClock_Hz – Module source input clock in Hertz

void LPSPI_MasterGetDefaultConfig(*lpspi_master_config_t* *masterConfig)

Sets the lpspi_master_config_t structure to default values.

This API initializes the configuration structure for LPSPI_MasterInit(). The initialized structure can remain unchanged in LPSPI_MasterInit(), or can be modified before calling the LPSPI_MasterInit(). Example:

```
lpspi_master_config_t masterConfig;
LPSPI_MasterGetDefaultConfig(&masterConfig);
```

Parameters

- masterConfig – pointer to lpspi_master_config_t structure

void LPSPI_SlaveInit(LPSPI_Type *base, const *lpspi_slave_config_t* *slaveConfig)

LPSPI slave configuration.

Parameters

- base – LPSPI peripheral address.
- slaveConfig – Pointer to a structure lpspi_slave_config_t.

void LPSPI_SlaveGetDefaultConfig(*lpspi_slave_config_t* *slaveConfig)

Sets the lpspi_slave_config_t structure to default values.

This API initializes the configuration structure for LPSPI_SlaveInit(). The initialized structure can remain unchanged in LPSPI_SlaveInit() or can be modified before calling the LPSPI_SlaveInit(). Example:

```
lpspi_slave_config_t slaveConfig;
LPSPI_SlaveGetDefaultConfig(&slaveConfig);
```

Parameters

- slaveConfig – pointer to lpspi_slave_config_t structure.

void LPSPI_Deinit(LPSPI_Type *base)

De-initializes the LPSPI peripheral. Call this API to disable the LPSPI clock.

Parameters

- base – LPSPI peripheral address.

void LPSPI_Reset(LPSPI_Type *base)

Restores the LPSPI peripheral to reset state. Note that this function sets all registers to reset state. As a result, the LPSPI module can't work after calling this API.

Parameters

- base – LPSPI peripheral address.

uint32_t LPSPI_GetInstance(LPSPI_Type *base)

Get the LPSPI instance from peripheral base address.

Parameters

- base – LPSPI peripheral base address.

Returns

LPSPI instance.

static inline void LPSPI_Enable(LPSPI_Type *base, bool enable)

Enables the LPSPI peripheral and sets the MCR MDIS to 0.

Parameters

- base – LPSPI peripheral address.
- enable – Pass true to enable module, false to disable module.

static inline uint32_t LPSPI_GetStatusFlags(LPSPI_Type *base)

Gets the LPSPI status flag state.

Parameters

- base – LPSPI peripheral address.

Returns

The LPSPI status(in SR register).

static inline uint8_t LPSPI_GetTxFifoSize(LPSPI_Type *base)

Gets the LPSPI Tx FIFO size.

Parameters

- base – LPSPI peripheral address.

Returns

The LPSPI Tx FIFO size.

static inline uint8_t LPSPI_GetRxFifoSize(LPSPI_Type *base)

Gets the LPSPI Rx FIFO size.

Parameters

- base – LPSPI peripheral address.

Returns

The LPSPI Rx FIFO size.

static inline uint32_t LPSPI_GetTxFifoCount(LPSPI_Type *base)

Gets the LPSPI Tx FIFO count.

Parameters

- base – LPSPI peripheral address.

Returns

The number of words in the transmit FIFO.

static inline uint32_t LPSPI_GetRxFifoCount(LPSPI_Type *base)

Gets the LPSPI Rx FIFO count.

Parameters

- base – LPSPI peripheral address.

Returns
The number of words in the receive FIFO.

static inline void LPSPI_ClearStatusFlags(LPSPI_Type *base, uint32_t statusFlags)

Clears the LPSPI status flag.

This function clears the desired status bit by using a write-1-to-clear. The user passes in the base and the desired status flag bit to clear. The list of status flags is defined in the _lpspi_flags. Example usage:

```
LPSPI_ClearStatusFlags(base, kLPSPI_TxDataRequestFlag|kLPSPI_RxDataReadyFlag);
```

Parameters
- base – LPSPI peripheral address.
- statusFlags – The status flag used from type _lpspi_flags.

static inline uint32_t LPSPI_GetTcr(LPSPI_Type *base)

static inline void LPSPI_EnableInterrupts(LPSPI_Type *base, uint32_t mask)

Enables the LPSPI interrupts.

This function configures the various interrupt masks of the LPSPI. The parameters are base and an interrupt mask. Note that, for Tx fill and Rx FIFO drain requests, enabling the interrupt request disables the DMA request.

```
LPSPI_EnableInterrupts(base, kLPSPI_TxInterruptEnable | kLPSPI_RxInterruptEnable );
```

Parameters
- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum _lpspi_interrupt_enable.

static inline void LPSPI_DisableInterrupts(LPSPI_Type *base, uint32_t mask)

Disables the LPSPI interrupts.

```
LPSPI_DisableInterrupts(base, kLPSPI_TxInterruptEnable | kLPSPI_RxInterruptEnable );
```

Parameters
- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum _lpspi_interrupt_enable.

static inline void LPSPI_EnableDMA(LPSPI_Type *base, uint32_t mask)

Enables the LPSPI DMA request.

This function configures the Rx and Tx DMA mask of the LPSPI. The parameters are base and a DMA mask.

```
LPSPI_EnableDMA(base, kLPSPI_TxDmaEnable | kLPSPI_RxDmaEnable);
```

Parameters
- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum _lpspi_dma_enable.

static inline void LPSPI_DisableDMA(LPSPI_Type *base, uint32_t mask)

Disables the LPSPI DMA request.

This function configures the Rx and Tx DMA mask of the LPSPI. The parameters are base and a DMA mask.

```
SPI_DisableDMA(base, kLPSPI_TxDmaEnable | kLPSPI_RxDmaEnable);
```

Parameters

- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum _lpspi_dma_enable.

static inline uint32_t LPSPI_GetTxRegisterAddress(LPSPI_Type *base)

Gets the LPSPI Transmit Data Register address for a DMA operation.

This function gets the LPSPI Transmit Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

Parameters

- base – LPSPI peripheral address.

Returns

The LPSPI Transmit Data Register address.

static inline uint32_t LPSPI_GetRxRegisterAddress(LPSPI_Type *base)

Gets the LPSPI Receive Data Register address for a DMA operation.

This function gets the LPSPI Receive Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

Parameters

- base – LPSPI peripheral address.

Returns

The LPSPI Receive Data Register address.

bool LPSPI_CheckTransferArgument(LPSPI_Type *base, *lpspi_transfer_t* *transfer, bool isEdma)

Check the argument for transfer .

Parameters

- base – LPSPI peripheral address.
- transfer – the transfer struct to be used.
- isEdma – True to check for EDMA transfer, false to check interrupt non-blocking transfer

Returns

Return true for right and false for wrong.

static inline void LPSPI_SetMasterSlaveMode(LPSPI_Type *base, *lpspi_master_slave_mode_t* mode)

Configures the LPSPI for either master or slave.

Note that the CFGR1 should only be written when the LPSPI is disabled (LPSPIx_CR_MEN = 0).

Parameters

- base – LPSPI peripheral address.
- mode – Mode setting (master or slave) of type lpspi_master_slave_mode_t.

static inline void LPSPI_SelectTransferPCS(LPSPI_Type *base, *lpspi_which_pcs_t* select)

Configures the peripheral chip select used for the transfer.

Parameters

- base – LPSPI peripheral address.

- select – LPSPI Peripheral Chip Select (PCS) configuration.

static inline void LPSPI_SetPCSContinous(LPSPI_Type *base, bool IsContinous)

Set the PCS signal to continuous or uncontinuous mode.

Note: In master mode, continuous transfer will keep the PCS asserted at the end of the frame size, until a command word is received that starts a new frame. So PCS must be set back to uncontinuous when transfer finishes. In slave mode, when continuous transfer is enabled, the LPSPI will only transmit the first frame size bits, after that the LPSPI will transmit received data back (assuming a 32-bit shift register).

Parameters

- base – LPSPI peripheral address.
- IsContinous – True to set the transfer PCS to continuous mode, false to set to uncontinuous mode.

static inline bool LPSPI_IsMaster(LPSPI_Type *base)

Returns whether the LPSPI module is in master mode.

Parameters

- base – LPSPI peripheral address.

Returns

Returns true if the module is in master mode or false if the module is in slave mode.

static inline void LPSPI_FlushFifo(LPSPI_Type *base, bool flushTxFifo, bool flushRxFifo)

Flushes the LPSPI FIFOs.

Parameters

- base – LPSPI peripheral address.
- flushTxFifo – Flushes (true) the Tx FIFO, else do not flush (false) the Tx FIFO.
- flushRxFifo – Flushes (true) the Rx FIFO, else do not flush (false) the Rx FIFO.

static inline void LPSPI_SetFifoWatermarks(LPSPI_Type *base, uint32_t txWater, uint32_t rxWater)

Sets the transmit and receive FIFO watermark values.

This function allows the user to set the receive and transmit FIFO watermarks. The function does not compare the watermark settings to the FIFO size. The FIFO watermark should not be equal to or greater than the FIFO size. It is up to the higher level driver to make this check.

Parameters

- base – LPSPI peripheral address.
- txWater – The TX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.
- rxWater – The RX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.

static inline void LPSPI_SetAllPcsPolarity(LPSPI_Type *base, uint32_t mask)

Configures all LPSPI peripheral chip select polarities simultaneously.

Note that the CFGR1 should only be written when the LPSPI is disabled (LPSPIx_CR_MEN = 0).

This is an example: PCS0 and PCS1 set to active low and other PCSs set to active high. Note that the number of PCS is device-specific.

```
LPSPI_SetAllPcsPolarity(base, kLPSPI_Pcs0ActiveLow | kLPSPI_Pcs1ActiveLow);
```

Parameters

- base – LPSPI peripheral address.
- mask – The PCS polarity mask; Use the enum _lpspi_pcs_polarity.

static inline void LPSPI_SetFrameSize(LPSPI_Type *base, uint32_t frameSize)

Configures the frame size.

The minimum frame size is 8-bits and the maximum frame size is 4096-bits. If the frame size is less than or equal to 32-bits, the word size and frame size are identical. If the frame size is greater than 32-bits, the word size is 32-bits for each word except the last (the last word contains the remainder bits if the frame size is not divisible by 32). The minimum word size is 2-bits. A frame size of 33-bits (or similar) is not supported.

Note 1: The transmit command register should be initialized before enabling the LPSPI in slave mode, although the command register does not update until after the LPSPI is enabled. After it is enabled, the transmit command register should only be changed if the LPSPI is idle.

Note 2: The transmit and command FIFO is a combined FIFO that includes both transmit data and command words. That means the TCR register should be written to when the Tx FIFO is not full.

Parameters

- base – LPSPI peripheral address.
- frameSize – The frame size in number of bits.

uint32_t LPSPI_MasterSetBaudRate(LPSPI_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz, uint32_t *tcrPrescaleValue)

Sets the LPSPI baud rate in bits per second.

This function takes in the desired bitsPerSec (baud rate) and calculates the nearest possible baud rate without exceeding the desired baud rate and returns the calculated baud rate in bits-per-second. It requires the caller to provide the frequency of the module source clock (in Hertz). Note that the baud rate does not go into effect until the Transmit Control Register (TCR) is programmed with the prescale value. Hence, this function returns the prescale tcrPrescaleValue parameter for later programming in the TCR. The higher level peripheral driver should alert the user of an out of range baud rate input.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

Parameters

- base – LPSPI peripheral address.
- baudRate_Bps – The desired baud rate in bits per second.
- srcClock_Hz – Module source input clock in Hertz.
- tcrPrescaleValue – The TCR prescale value needed to program the TCR.

Returns

The actual calculated baud rate. This function may also return a “0” if the LPSPI is not configured for master mode or if the LPSPI module is not disabled.

void LPSPI_MasterSetDelayScaler(LPSPI_Type *base, uint32_t scaler, *lpspi_delay_type_t* whichDelay)

Manually configures a specific LPSPI delay parameter (module must be disabled to change the delay values).

This function configures the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type lpspi_delay_type_t.

The user passes the desired delay along with the delay value. This allows the user to directly set the delay values if they have pre-calculated them or if they simply wish to manually increment the value.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

Parameters

- base – LPSPI peripheral address.
- scaler – The 8-bit delay value 0x00 to 0xFF (255).
- whichDelay – The desired delay to configure, must be of type lpspi_delay_type_t.

uint32_t LPSPI_MasterSetDelayTimes(LPSPI_Type *base, uint32_t delayTimeInNanoSec, *lpspi_delay_type_t* whichDelay, uint32_t srcClock_Hz)

Calculates the delay based on the desired delay input in nanoseconds (module must be disabled to change the delay values).

This function calculates the values for the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type lpspi_delay_type_t.

The user passes the desired delay and the desired delay value in nano-seconds. The function calculates the value needed for the desired delay parameter and returns the actual calculated delay because an exact delay match may not be possible. In this case, the closest match is calculated without going below the desired delay value input. It is possible to input a very large delay value that exceeds the capability of the part, in which case the maximum supported delay is returned. It is up to the higher level peripheral driver to alert the user of an out of range delay input.

Note that the LPSPI module must be configured for master mode before configuring this. And note that the delayTime = LPSPI_clockSource / (PRESCALE * Delay_scaler).

Parameters

- base – LPSPI peripheral address.
- delayTimeInNanoSec – The desired delay value in nano-seconds.
- whichDelay – The desired delay to configuration, which must be of type lpspi_delay_type_t.
- srcClock_Hz – Module source input clock in Hertz.

Returns

actual Calculated delay value in nano-seconds.

static inline void LPSPI_WriteData(LPSPI_Type *base, uint32_t data)

Writes data into the transmit data buffer.

This function writes data passed in by the user to the Transmit Data Register (TDR). The user can pass up to 32-bits of data to load into the TDR. If the frame size exceeds 32-bits, the user has to manage sending the data one 32-bit word at a time. Any writes to the TDR result

in an immediate push to the transmit FIFO. This function can be used for either master or slave modes.

Parameters

- base – LPSPI peripheral address.
- data – The data word to be sent.

static inline uint32_t LPSPI_ReadData(LPSPI_Type *base)

Reads data from the data buffer.

This function reads the data from the Receive Data Register (RDR). This function can be used for either master or slave mode.

Parameters

- base – LPSPI peripheral address.

Returns

The data read from the data buffer.

void LPSPI_SetDummyData(LPSPI_Type *base, uint8_t dummyData)

Set up the dummy data.

Parameters

- base – LPSPI peripheral address.
- dummyData – Data to be transferred when tx buffer is NULL. Note: This API has no effect when LPSPI in slave interrupt mode, because driver will set the TXMSK bit to 1 if txData is NULL, no data is loaded from transmit FIFO and output pin is tristated.

void LPSPI_MasterTransferCreateHandle(LPSPI_Type *base, *lpspi_master_handle_t* *handle, *lpspi_master_transfer_callback_t* callback, void *userData)

Initializes the LPSPI master handle.

This function initializes the LPSPI handle, which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Parameters

- base – LPSPI peripheral address.
- handle – LPSPI handle pointer to lpspi_master_handle_t.
- callback – DSPI callback.
- userData – callback function parameter.

status_t LPSPI_MasterTransferBlocking(LPSPI_Type *base, *lpspi_transfer_t* *transfer)

LPSPI master transfer data using a polling method.

This function transfers data using a polling method. This is a blocking function, which does not return until all transfers have been completed.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral address.
- transfer – pointer to lpspi_transfer_t structure.

Returns
status of status_t.

status_t LPSPI_MasterTransferNonBlocking(LPSPI_Type *base, *lpspi_master_handle_t* *handle, *lpspi_transfer_t* *transfer)

LPSPI master transfer data using an interrupt method.

This function transfers data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_master_handle_t structure which stores the transfer state.
- transfer – pointer to lpspi_transfer_t structure.

Returns
status of status_t.

status_t LPSPI_MasterTransferGetCount(LPSPI_Type *base, *lpspi_master_handle_t* *handle, size_t *count)

Gets the master transfer remaining bytes.

This function gets the master transfer remaining bytes.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_master_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Returns
status of status_t.

void LPSPI_MasterTransferAbort(LPSPI_Type *base, *lpspi_master_handle_t* *handle)

LPSPI master abort transfer which uses an interrupt method.

This function aborts a transfer which uses an interrupt method.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_master_handle_t structure which stores the transfer state.

void LPSPI_MasterTransferHandleIRQ(LPSPI_Type *base, *lpspi_master_handle_t* *handle)

LPSPI Master IRQ handler function.

This function processes the LPSPI transmit and receive IRQ.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_master_handle_t structure which stores the transfer state.

void LPSPI_SlaveTransferCreateHandle(LPSPI_Type *base, *lpspi_slave_handle_t* *handle, *lpspi_slave_transfer_callback_t* callback, void *userData)

Initializes the LPSPI slave handle.

This function initializes the LPSPI handle, which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Parameters

- base – LPSPI peripheral address.
- handle – LPSPI handle pointer to lpspi_slave_handle_t.
- callback – DSPI callback.
- userData – callback function parameter.

status_t LPSPI_SlaveTransferNonBlocking(LPSPI_Type *base, *lpspi_slave_handle_t* *handle, *lpspi_transfer_t* *transfer)

LPSPI slave transfer data using an interrupt method.

This function transfer data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_slave_handle_t structure which stores the transfer state.
- transfer – pointer to lpspi_transfer_t structure.

Returns
status of status_t.

status_t LPSPI_SlaveTransferGetCount(LPSPI_Type *base, *lpspi_slave_handle_t* *handle, size_t *count)

Gets the slave transfer remaining bytes.

This function gets the slave transfer remaining bytes.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_slave_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Returns
status of status_t.

void LPSPI_SlaveTransferAbort(LPSPI_Type *base, *lpspi_slave_handle_t* *handle)

LPSPI slave aborts a transfer which uses an interrupt method.

This function aborts a transfer which uses an interrupt method.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_slave_handle_t structure which stores the transfer state.

void LPSPI_SlaveTransferHandleIRQ(LPSPI_Type *base, *lpspi_slave_handle_t* *handle)

LPSPI Slave IRQ handler function.

This function processes the LPSPI transmit and receives an IRQ.

Parameters

- base – LPSPI peripheral address.
- handle – pointer to lpspi_slave_handle_t structure which stores the transfer state.

bool LPSPI_WaitTxFifoEmpty(LPSPI_Type *base)

Wait for tx FIFO to be empty.

This function wait the tx fifo empty

Parameters

- base – LPSPI peripheral address.

Returns

true for the tx FIFO is ready, false is not.

void LPSPI_DriverIRQHandler(uint32_t instance)

LPSPI driver IRQ handler common entry.

This function provides the common IRQ request entry for LPSPI.

Parameters

- instance – LPSPI instance.

FSL_LPSPI_DRIVER_VERSION

LPSPI driver version.

Status for the LPSPI driver.

Values:

enumerator kStatus_LPSPI_Busy

LPSPI transfer is busy.

enumerator kStatus_LPSPI_Error

LPSPI driver error.

enumerator kStatus_LPSPI_Idle

LPSPI is idle.

enumerator kStatus_LPSPI_OutOfRange

LPSPI transfer out Of range.

enumerator kStatus_LPSPI_Timeout

LPSPI timeout polling status flags.

enum _lpspi_flags

LPSPI status flags in SPIx_SR register.

Values:

enumerator kLPSPI_TxDataRequestFlag

Transmit data flag

enumerator kLPSPI_RxDataReadyFlag

Receive data flag

enumerator kLPSPI_WordCompleteFlag
Word Complete flag

enumerator kLPSPI_FrameCompleteFlag
Frame Complete flag

enumerator kLPSPI_TransferCompleteFlag
Transfer Complete flag

enumerator kLPSPI_TransmitErrorFlag
Transmit Error flag (FIFO underrun)

enumerator kLPSPI_ReceiveErrorFlag
Receive Error flag (FIFO overrun)

enumerator kLPSPI_DataMatchFlag
Data Match flag

enumerator kLPSPI_ModuleBusyFlag
Module Busy flag

enumerator kLPSPI_AllStatusFlag
Used for clearing all w1c status flags

enum _lpspi_interrupt_enable
LPSPI interrupt source.

Values:

enumerator kLPSPI_TxInterruptEnable
Transmit data interrupt enable

enumerator kLPSPI_RxInterruptEnable
Receive data interrupt enable

enumerator kLPSPI_WordCompleteInterruptEnable
Word complete interrupt enable

enumerator kLPSPI_FrameCompleteInterruptEnable
Frame complete interrupt enable

enumerator kLPSPI_TransferCompleteInterruptEnable
Transfer complete interrupt enable

enumerator kLPSPI_TransmitErrorInterruptEnable
Transmit error interrupt enable(FIFO underrun)

enumerator kLPSPI_ReceiveErrorInterruptEnable
Receive Error interrupt enable (FIFO overrun)

enumerator kLPSPI_DataMatchInterruptEnable
Data Match interrupt enable

enumerator kLPSPI_AllInterruptEnable
All above interrupts enable.

enum _lpspi_dma_enable
LPSPI DMA source.

Values:

enumerator kLPSPI_TxDmaEnable
Transmit data DMA enable

enumerator kLPSPI_RxDmaEnable
Receive data DMA enable

enum _lpspi_master_slave_mode
LPSPI master or slave mode configuration.

Values:

enumerator kLPSPI_Master
LPSPI peripheral operates in master mode.

enumerator kLPSPI_Slave
LPSPI peripheral operates in slave mode.

enum _lpspi_which_pcs_config
LPSPI Peripheral Chip Select (PCS) configuration (which PCS to configure).

Values:

enumerator kLPSPI_Pcs0
PCS[0]

enumerator kLPSPI_Pcs1
PCS[1]

enumerator kLPSPI_Pcs2
PCS[2]

enumerator kLPSPI_Pcs3
PCS[3]

enum _lpspi_pcs_polarity_config
LPSPI Peripheral Chip Select (PCS) Polarity configuration.

Values:

enumerator kLPSPI_PcsActiveHigh
PCS Active High (idles low)

enumerator kLPSPI_PcsActiveLow
PCS Active Low (idles high)

enum _lpspi_pcs_polarity
LPSPI Peripheral Chip Select (PCS) Polarity.

Values:

enumerator kLPSPI_Pcs0ActiveLow
Pcs0 Active Low (idles high).

enumerator kLPSPI_Pcs1ActiveLow
Pcs1 Active Low (idles high).

enumerator kLPSPI_Pcs2ActiveLow
Pcs2 Active Low (idles high).

enumerator kLPSPI_Pcs3ActiveLow
Pcs3 Active Low (idles high).

enumerator kLPSPI_PcsAllActiveLow
Pcs0 to Pcs5 Active Low (idles high).

enum _lpspi_clock_polarity

LPSPI clock polarity configuration.

Values:

enumerator kLPSPI_ClockPolarityActiveHigh

CPOL=0. Active-high LPSPI clock (idles low)

enumerator kLPSPI_ClockPolarityActiveLow

CPOL=1. Active-low LPSPI clock (idles high)

enum _lpspi_clock_phase

LPSPI clock phase configuration.

Values:

enumerator kLPSPI_ClockPhaseFirstEdge

CPHA=0. Data is captured on the leading edge of the SCK and changed on the following edge.

enumerator kLPSPI_ClockPhaseSecondEdge

CPHA=1. Data is changed on the leading edge of the SCK and captured on the following edge.

enum _lpspi_shift_direction

LPSPI data shifter direction options.

Values:

enumerator kLPSPI_MsbFirst

Data transfers start with most significant bit.

enumerator kLPSPI_LsbFirst

Data transfers start with least significant bit.

enum _lpspi_host_request_select

LPSPI Host Request select configuration.

Values:

enumerator kLPSPI_HostReqExtPin

Host Request is an ext pin.

enumerator kLPSPI_HostReqInternalTrigger

Host Request is an internal trigger.

enum _lpspi_match_config

LPSPI Match configuration options.

Values:

enumerator kLPSI_MatchDisabled

LPSPI Match Disabled.

enumerator kLPSI_1stWordEqualsM0orM1

LPSPI Match Enabled.

enumerator kLPSI_AnyWordEqualsM0orM1

LPSPI Match Enabled.

enumerator kLPSI_1stWordEqualsM0and2ndWordEqualsM1

LPSPI Match Enabled.

enumerator kLPSI_AnyWordEqualsM0andNxtWordEqualsM1

LPSPI Match Enabled.

enumerator kLPSI_1stWordAndM1EqualsM0andM1
LPSPI Match Enabled.

enumerator kLPSI_AnyWordAndM1EqualsM0andM1
LPSPI Match Enabled.

enum _lpspi_pin_config
LPSPI pin (SDO and SDI) configuration.

Values:

enumerator kLPSPI_SdiInSdoOut
LPSPI SDI input, SDO output.

enumerator kLPSPI_SdiInSdiOut
LPSPI SDI input, SDI output.

enumerator kLPSPI_SdoInSdoOut
LPSPI SDO input, SDO output.

enumerator kLPSPI_SdoInSdiOut
LPSPI SDO input, SDI output.

enum _lpspi_data_out_config
LPSPI data output configuration.

Values:

enumerator kLpspiDataOutRetained
Data out retains last value when chip select is de-asserted

enumerator kLpspiDataOutTristate
Data out is tristated when chip select is de-asserted

enum _lpspi_transfer_width
LPSPI transfer width configuration.

Values:

enumerator kLPSPI_SingleBitXfer
1-bit shift at a time, data out on SDO, in on SDI (normal mode)

enumerator kLPSPI_TwoBitXfer
2-bits shift out on SDO/SDI and in on SDO/SDI

enumerator kLPSPI_FourBitXfer
4-bits shift out on SDO/SDI/PCS[3:2] and in on SDO/SDI/PCS[3:2]

enum _lpspi_delay_type
LPSPI delay type selection.

Values:

enumerator kLPSPI_PcsToSck
PCS-to-SCK delay.

enumerator kLPSPI_LastSckToPcs
Last SCK edge to PCS delay.

enumerator kLPSPI_BetweenTransfer
Delay between transfers.

enum _lpspi_transfer_config_flag_for_master

Use this enumeration for LPSPI master transfer configFlags.

Values:

enumerator kLPSPI_MasterPcs0

LPSPI master PCS shift macro , internal used. LPSPI master transfer use PCS0 signal

enumerator kLPSPI_MasterPcs1

LPSPI master PCS shift macro , internal used. LPSPI master transfer use PCS1 signal

enumerator kLPSPI_MasterPcs2

LPSPI master PCS shift macro , internal used. LPSPI master transfer use PCS2 signal

enumerator kLPSPI_MasterPcs3

LPSPI master PCS shift macro , internal used. LPSPI master transfer use PCS3 signal

enumerator kLPSPI_MasterPcsContinuous

Is PCS signal continuous

enumerator kLPSPI_MasterByteSwap

Is master swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set lpspi_shift_direction_t to MSB).

i. If you set bitPerFrame = 8 , no matter the kLPSPI_MasterByteSwapyou flag is used or not, the waveform is 1 2 3 4 5 6 7 8.

ii. If you set bitPerFrame = 16 : (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the kLPSPI_MasterByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPI_MasterByteSwap flag.

iii. If you set bitPerFrame = 32 : (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the kLPSPI_MasterByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPI_MasterByteSwap flag.

enum _lpspi_transfer_config_flag_for_slave

Use this enumeration for LPSPI slave transfer configFlags.

Values:

enumerator kLPSPI_SlavePcs0

LPSPI slave PCS shift macro , internal used. LPSPI slave transfer use PCS0 signal

enumerator kLPSPI_SlavePcs1

LPSPI slave PCS shift macro , internal used. LPSPI slave transfer use PCS1 signal

enumerator kLPSPI_SlavePcs2

LPSPI slave PCS shift macro , internal used. LPSPI slave transfer use PCS2 signal

enumerator kLPSPI_SlavePcs3

LPSPI slave PCS shift macro , internal used. LPSPI slave transfer use PCS3 signal

enumerator kLPSPI_SlaveByteSwap

Is slave swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set lpspi_shift_direction_t to MSB).

i. If you set bitPerFrame = 8 , no matter the kLPSPI_SlaveByteSwap flag is used or not, the waveform is 1 2 3 4 5 6 7 8.

ii. If you set bitPerFrame = 16 : (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the kLPSPI_SlaveByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPI_SlaveByteSwap flag.

iii. If you set bitPerFrame = 32 : (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the kLPSPI_SlaveByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPI_SlaveByteSwap flag.

enum _lpspi_transfer_state

LPSPI transfer state, which is used for LPSPI transactional API state machine.

Values:

enumerator kLPSPI_Idle

Nothing in the transmitter/receiver.

enumerator kLPSPI_Busy

Transfer queue is not finished.

enumerator kLPSPI_Error

Transfer error.

typedef enum *_lpspi_master_slave_mode* lpspi_master_slave_mode_t

LPSPI master or slave mode configuration.

typedef enum *_lpspi_which_pcs_config* lpspi_which_pcs_t

LPSPI Peripheral Chip Select (PCS) configuration (which PCS to configure).

typedef enum *_lpspi_pcs_polarity_config* lpspi_pcs_polarity_config_t

LPSPI Peripheral Chip Select (PCS) Polarity configuration.

typedef enum *_lpspi_clock_polarity* lpspi_clock_polarity_t

LPSPI clock polarity configuration.

typedef enum *_lpspi_clock_phase* lpspi_clock_phase_t

LPSPI clock phase configuration.

typedef enum *_lpspi_shift_direction* lpspi_shift_direction_t

LPSPI data shifter direction options.

typedef enum *_lpspi_host_request_select* lpspi_host_request_select_t

LPSPI Host Request select configuration.

typedef enum *_lpspi_match_config* lpspi_match_config_t

LPSPI Match configuration options.

typedef enum *_lpspi_pin_config* lpspi_pin_config_t

LPSPI pin (SDO and SDI) configuration.

typedef enum *_lpspi_data_out_config* lpspi_data_out_config_t

LPSPI data output configuration.

typedef enum *_lpspi_transfer_width* lpspi_transfer_width_t

LPSPI transfer width configuration.

typedef enum *_lpspi_delay_type* lpspi_delay_type_t

LPSPI delay type selection.

typedef struct *_lpspi_master_config* lpspi_master_config_t

LPSPI master configuration structure.

typedef struct *_lpspi_slave_config* lpspi_slave_config_t

LPSPI slave configuration structure.

typedef struct *_lpspi_master_handle* lpspi_master_handle_t

Forward declaration of the _lpspi_master_handle typedefs.

typedef struct *_lpspi_slave_handle* lpspi_slave_handle_t

Forward declaration of the _lpspi_slave_handle typedefs.

typedef void (*lpspi_master_transfer_callback_t)(LPSPI_Type *base, *lpspi_master_handle_t* *handle, *status_t* status, void *userData)

Master completion callback function pointer type.

Param base
LPSPI peripheral address.

Param handle
Pointer to the handle for the LPSPI master.

Param status
Success or error code describing whether the transfer is completed.

Param userData
Arbitrary pointer-dataSized value passed from the application.

typedef void (*lpspi_slave_transfer_callback_t)(LPSPI_Type *base, *lpspi_slave_handle_t* *handle, *status_t* status, void *userData)

Slave completion callback function pointer type.

Param base
LPSPI peripheral address.

Param handle
Pointer to the handle for the LPSPI slave.

Param status
Success or error code describing whether the transfer is completed.

Param userData
Arbitrary pointer-dataSized value passed from the application.

typedef struct *_lpspi_transfer* lpspi_transfer_t

LPSPI master/slave transfer structure.

volatile uint8_t g_lpspiDummyData[]

Global variable for dummy data value setting.

LPSPI_DUMMY_DATA

LPSPI dummy data if no Tx data.

Dummy data used for tx if there is not txData.

SPI_RETRY_TIMES

Retry times for waiting flag.

LPSPI_MASTER_PCS_SHIFT

LPSPI master PCS shift macro , internal used.

LPSPI_MASTER_PCS_MASK

LPSPI master PCS shift macro , internal used.

LPSPI_SLAVE_PCS_SHIFT

LPSPI slave PCS shift macro , internal used.

LPSPI_SLAVE_PCS_MASK

LPSPI slave PCS shift macro , internal used.

struct lpspi_master_config

#include <fsl_lpspi.h> LPSPI master configuration structure.

Public Members

uint32_t baudRate

Baud Rate for LPSPI.

uint32_t bitsPerFrame

Bits per frame, minimum 8, maximum 4096.

lpspi_clock_polarity_t cpol

Clock polarity.

lpspi_clock_phase_t cpha

Clock phase.

lpspi_shift_direction_t direction

MSB or LSB data shift direction.

uint32_t pcsToSckDelayInNanoSec

PCS to SCK delay time in nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

uint32_t lastSckToPcsDelayInNanoSec

Last SCK to PCS delay time in nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

uint32_t betweenTransferDelayInNanoSec

After the SCK delay time with nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

lpspi_which_pcs_t whichPcs

Desired Peripheral Chip Select (PCS).

lpspi_pcs_polarity_config_t pcsActiveHighOrLow

Desired PCS active high or low

lpspi_pin_config_t pinCfg

Configures which pins are used for input and output data during single bit transfers.

lpspi_data_out_config_t dataOutConfig

Configures if the output data is tristated between accesses (LPSPI_PCS is negated).

bool enableInputDelay

Enable master to sample the input data on a delayed SCK. This can help improve slave setup time. Refer to device data sheet for specific time length.

struct __lpspi__slave__config

#include <fsl_lpspi.h> LPSPI slave configuration structure.

Public Members

uint32_t bitsPerFrame

Bits per frame, minimum 8, maximum 4096.

lpspi_clock_polarity_t cpol

Clock polarity.

lpspi_clock_phase_t cpha

Clock phase.

lpspi_shift_direction_t direction

MSB or LSB data shift direction.

lpspi_which_pcs_t whichPcs
Desired Peripheral Chip Select (pcs)

lpspi_pcs_polarity_config_t pcsActiveHighOrLow
Desired PCS active high or low

lpspi_pin_config_t pinCfg
Configures which pins are used for input and output data during single bit transfers.

lpspi_data_out_config_t dataOutConfig
Configures if the output data is tristated between accesses (LPSPI_PCS is negated).

struct __lpspi__transfer
#include <fsl_lpspi.h> LPSPI master/slave transfer structure.

Public Members

const uint8_t *txData
Send buffer.

uint8_t *rxData
Receive buffer.

volatile size_t dataSize
Transfer bytes.

uint32_t configFlags
Transfer transfer configuration flags. Set from _lpspi_transfer_config_flag_for_master if the transfer is used for master or _lpspi_transfer_config_flag_for_slave enumeration if the transfer is used for slave.

struct __lpspi__master__handle
#include <fsl_lpspi.h> LPSPI master transfer handle structure used for transactional API.

Public Members

volatile bool isPcsContinuous
Is PCS continuous in transfer.

volatile bool writeTcrInIsr
A flag that whether should write TCR in ISR.

volatile bool isByteSwap
A flag that whether should byte swap.

volatile bool isTxMask
A flag that whether TCR[TXMSK] is set.

volatile uint16_t bytesPerFrame
Number of bytes in each frame

volatile uint16_t frameSize
Backup of TCR[FRAMESZ]

volatile uint8_t fifoSize
FIFO dataSize.

volatile uint8_t rxWatermark
Rx watermark.

volatile uint8_t bytesEachWrite
: Bytes for each write TDR.

volatile uint8_t bytesEachRead
: Bytes for each read RDR.

const uint8_t *volatile txData
: Send buffer.

uint8_t *volatile rxData
: Receive buffer.

volatile size_t txRemainingByteCount
: Number of bytes remaining to send.

volatile size_t rxRemainingByteCount
: Number of bytes remaining to receive.

volatile uint32_t writeRegRemainingTimes
: Write TDR register remaining times.

volatile uint32_t readRegRemainingTimes
: Read RDR register remaining times.

uint32_t totalByteCount
: Number of transfer bytes

uint32_t txBuffIfNull
: Used if the txData is NULL.

volatile uint8_t state
: LPSPI transfer state , _lpspi_transfer_state.

lpspi_master_transfer_callback_t callback
: Completion callback.

void *userData
: Callback user data.

struct __lpspi_slave_handle
: *#include <fsl_lpspi.h>* LPSPI slave transfer handle structure used for transactional API.

Public Members

volatile bool isByteSwap
: A flag that whether should byte swap.

volatile uint8_t fifoSize
: FIFO dataSize.

volatile uint8_t rxWatermark
: Rx watermark.

volatile uint8_t bytesEachWrite
: Bytes for each write TDR.

volatile uint8_t bytesEachRead
: Bytes for each read RDR.

const uint8_t *volatile txData
: Send buffer.

uint8_t *volatile rxData
: Receive buffer.

volatile size_t txRemainingByteCount
: Number of bytes remaining to send.

volatile size_t rxRemainingByteCount
: Number of bytes remaining to receive.

volatile uint32_t writeRegRemainingTimes
: Write TDR register remaining times.

volatile uint32_t readRegRemainingTimes
: Read RDR register remaining times.

uint32_t totalByteCount
: Number of transfer bytes

volatile uint8_t state
: LPSPI transfer state , _lpspi_transfer_state.

volatile uint32_t errorCount
: Error count for slave transfer.

lpspi_slave_transfer_callback_t callback
: Completion callback.

void *userData
: Callback user data.

2.77 LPSPI eDMA Driver

FSL_LPSPI_EDMA_DRIVER_VERSION
: LPSPI EDMA driver version.

DMA_MAX_TRANSFER_COUNT
: DMA max transfer size.

typedef struct *_lpspi_master_edma_handle* lpspi_master_edma_handle_t
: Forward declaration of the _lpspi_master_edma_handle typedefs.

typedef struct *_lpspi_slave_edma_handle* lpspi_slave_edma_handle_t
: Forward declaration of the _lpspi_slave_edma_handle typedefs.

typedef void (*lpspi_master_edma_transfer_callback_t)(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, *status_t* status, void *userData)
: Completion callback function pointer type.

  Param base
  : LPSPI peripheral base address.

  Param handle
  : Pointer to the handle for the LPSPI master.

  Param status
  : Success or error code describing whether the transfer completed.

  Param userData
  : Arbitrary pointer-dataSized value passed from the application.

typedef void (*lpspi_slave_edma_transfer_callback_t)(LPSPI_Type *base, *lpspi_slave_edma_handle_t* *handle, *status_t* status, void *userData)

Completion callback function pointer type.

Param base
LPSPI peripheral base address.

Param handle
Pointer to the handle for the LPSPI slave.

Param status
Success or error code describing whether the transfer completed.

Param userData
Arbitrary pointer-dataSized value passed from the application.

void LPSPI_MasterTransferCreateHandleEDMA(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, *lpspi_master_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *edmaRxRegToRxDataHandle, *edma_handle_t* *edmaTxDataToTxRegHandle)

Initializes the LPSPI master eDMA handle.

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that the LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx are the same source) DMA request source. (1) For a separated DMA request source, enable and set the Rx DMAMUX source for edmaRxRegToRxDataHandle and Tx DMAMUX source for edmaTxDataToTxRegHandle. (2) For a shared DMA request source, enable and set the Rx/Tx DMAMUX source for edmaRxRegToRxDataHandle.

Parameters

- base – LPSPI peripheral base address.
- handle – LPSPI handle pointer to lpspi_master_edma_handle_t.
- callback – LPSPI callback.
- userData – callback function parameter.
- edmaRxRegToRxDataHandle – edmaRxRegToRxDataHandle pointer to edma_handle_t.
- edmaTxDataToTxRegHandle – edmaTxDataToTxRegHandle pointer to edma_handle_t.

status_t LPSPI_MasterTransferEDMA(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, *lpspi_transfer_t* *transfer)

LPSPI master transfer data using eDMA.

This function transfers data using eDMA. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_master_edma_handle_t structure which stores the transfer state.

- transfer – pointer to lpspi_transfer_t structure.

Returns
status of status_t.

status_t LPSPI_MasterTransferPrepareEDMALite(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, uint32_t configFlags)

LPSPI master config transfer parameter while using eDMA.

This function is preparing to transfer data using eDMA, work with LPSPI_MasterTransferEDMALite.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_master_edma_handle_t structure which stores the transfer state.
- configFlags – transfer configuration flags. _lpspi_transfer_config_flag_for_master.

Return values

- kStatus_Success – Execution successfully.
- kStatus_LPSPI_Busy – The LPSPI device is busy.

Returns
Indicates whether LPSPI master transfer was successful or not.

status_t LPSPI_MasterTransferEDMALite(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, *lpspi_transfer_t* *transfer)

LPSPI master transfer data using eDMA without configs.

This function transfers data using eDMA. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: This API is only for transfer through DMA without configuration. Before calling this API, you must call LPSPI_MasterTransferPrepareEDMALite to configure it once. The transfer data size should be an integer multiple of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_master_edma_handle_t structure which stores the transfer state.
- transfer – pointer to lpspi_transfer_t structure, config field is not uesed.

Return values

- kStatus_Success – Execution successfully.
- kStatus_LPSPI_Busy – The LPSPI device is busy.
- kStatus_InvalidArgument – The transfer structure is invalid.

Returns
Indicates whether LPSPI master transfer was successful or not.

void LPSPI_MasterTransferAbortEDMA(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle)

LPSPI master aborts a transfer which is using eDMA.

This function aborts a transfer which is using eDMA.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_master_edma_handle_t structure which stores the transfer state.

status_t LPSPI_MasterTransferGetCountEDMA(LPSPI_Type *base, *lpspi_master_edma_handle_t* *handle, size_t *count)

Gets the master eDMA transfer remaining bytes.

This function gets the master eDMA transfer remaining bytes.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_master_edma_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the EDMA transaction.

Returns

status of status_t.

void LPSPI_SlaveTransferCreateHandleEDMA(LPSPI_Type *base, *lpspi_slave_edma_handle_t* *handle, *lpspi_slave_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *edmaRxRegToRxDataHandle, *edma_handle_t* *edmaTxDataToTxRegHandle)

Initializes the LPSPI slave eDMA handle.

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx as the same source) DMA request source.

(1) For a separated DMA request source, enable and set the Rx DMAMUX source for edmaRxRegToRxDataHandle and Tx DMAMUX source for edmaTxDataToTxRegHandle. (2) For a shared DMA request source, enable and set the Rx/Rx DMAMUX source for edmaRxRegToRxDataHandle .

Parameters

- base – LPSPI peripheral base address.
- handle – LPSPI handle pointer to lpspi_slave_edma_handle_t.
- callback – LPSPI callback.
- userData – callback function parameter.
- edmaRxRegToRxDataHandle – edmaRxRegToRxDataHandle pointer to edma_handle_t.
- edmaTxDataToTxRegHandle – edmaTxDataToTxRegHandle pointer to edma_handle_t.

status_t LPSPI_SlaveTransferEDMA(LPSPI_Type *base, *lpspi_slave_edma_handle_t* *handle, *lpspi_transfer_t* *transfer)

LPSPI slave transfers data using eDMA.

This function transfers data using eDMA. This is a non-blocking function, which return right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size

should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.
- transfer – pointer to lpspi_transfer_t structure.

Returns
status of status_t.

void LPSPI_SlaveTransferAbortEDMA(LPSPI_Type *base, *lpspi_slave_edma_handle_t* *handle)

LPSPI slave aborts a transfer which is using eDMA.

This function aborts a transfer which is using eDMA.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.

status_t LPSPI_SlaveTransferGetCountEDMA(LPSPI_Type *base, *lpspi_slave_edma_handle_t* *handle, size_t *count)

Gets the slave eDMA transfer remaining bytes.

This function gets the slave eDMA transfer remaining bytes.

Parameters

- base – LPSPI peripheral base address.
- handle – pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the eDMA transaction.

Returns
status of status_t.

struct __lpspi_master_edma_handle

#include <fsl_lpspi_edma.h> LPSPI master eDMA transfer handle structure used for transactional API.

Public Members

volatile bool isPcsContinuous

Is PCS continuous in transfer.

volatile bool isByteSwap

A flag that whether should byte swap.

volatile uint8_t fifoSize

FIFO dataSize.

volatile uint8_t rxWatermark

Rx watermark.

volatile uint8_t bytesEachWrite

Bytes for each write TDR.

volatile uint8_t bytesEachRead
: Bytes for each read RDR.

volatile uint8_t bytesLastRead
: Bytes for last read RDR.

volatile bool isThereExtraRxBytes
: Is there extra RX byte.

const uint8_t *volatile txData
: Send buffer.

uint8_t *volatile rxData
: Receive buffer.

volatile size_t txRemainingByteCount
: Number of bytes remaining to send.

volatile size_t rxRemainingByteCount
: Number of bytes remaining to receive.

volatile uint32_t writeRegRemainingTimes
: Write TDR register remaining times.

volatile uint32_t readRegRemainingTimes
: Read RDR register remaining times.

uint32_t totalByteCount
: Number of transfer bytes

edma_tcd_t *lastTimeTCD
: Pointer to the lastTime TCD

bool isMultiDMATransmit
: Is there multi DMA transmit

volatile uint8_t dmaTransmitTime
: DMA Transfer times.

uint32_t lastTimeDataBytes
: DMA transmit last Time data Bytes

uint32_t dataBytesEveryTime
: Bytes in a time for DMA transfer, default is DMA_MAX_TRANSFER_COUNT

edma_transfer_config_t transferConfigRx
: Config of DMA rx channel.

edma_transfer_config_t transferConfigTx
: Config of DMA tx channel.

uint32_t txBuffIfNull
: Used if there is not txData for DMA purpose.

uint32_t rxBuffIfNull
: Used if there is not rxData for DMA purpose.

uint32_t transmitCommand
: Used to write TCR for DMA purpose.

volatile uint8_t state
: LPSPI transfer state , _lpspi_transfer_state.

uint8_t nbytes
: eDMA minor byte transfer count initially configured.

lpspi_master_edma_transfer_callback_t callback
: Completion callback.

void *userData
: Callback user data.

edma_handle_t *edmaRxRegToRxDataHandle
: edma_handle_t handle point used for RxReg to RxData buff

edma_handle_t *edmaTxDataToTxRegHandle
: edma_handle_t handle point used for TxData to TxReg buff

edma_tcd_t lpspiSoftwareTCD[3]
: SoftwareTCD, internal used

struct __lpspi_slave_edma_handle
: *#include <fsl_lpspi_edma.h>* LPSPI slave eDMA transfer handle structure used for transactional API.

Public Members

volatile bool isByteSwap
: A flag that whether should byte swap.

volatile uint8_t fifoSize
: FIFO dataSize.

volatile uint8_t rxWatermark
: Rx watermark.

volatile uint8_t bytesEachWrite
: Bytes for each write TDR.

volatile uint8_t bytesEachRead
: Bytes for each read RDR.

volatile uint8_t bytesLastRead
: Bytes for last read RDR.

volatile bool isThereExtraRxBytes
: Is there extra RX byte.

uint8_t nbytes
: eDMA minor byte transfer count initially configured.

const uint8_t *volatile txData
: Send buffer.

uint8_t *volatile rxData
: Receive buffer.

volatile size_t txRemainingByteCount
: Number of bytes remaining to send.

volatile size_t rxRemainingByteCount
: Number of bytes remaining to receive.

volatile uint32_t writeRegRemainingTimes
: Write TDR register remaining times.

volatile uint32_t readRegRemainingTimes
: Read RDR register remaining times.

uint32_t totalByteCount
: Number of transfer bytes

uint32_t txBuffIfNull
: Used if there is not txData for DMA purpose.

uint32_t rxBuffIfNull
: Used if there is not rxData for DMA purpose.

volatile uint8_t state
: LPSPI transfer state.

uint32_t errorCount
: Error count for slave transfer.

lpspi_slave_edma_transfer_callback_t callback
: Completion callback.

void *userData
: Callback user data.

edma_handle_t *edmaRxRegToRxDataHandle
: edma_handle_t handle point used for RxReg to RxData buff

edma_handle_t *edmaTxDataToTxRegHandle
: edma_handle_t handle point used for TxData to TxReg

edma_tcd_t lpspiSoftwareTCD[2]
: SoftwareTCD, internal used

2.78 LPUART: Low Power Universal Asynchronous Receiver/Transmitter Driver

2.79 LPUART Driver

static inline void LPUART_SoftwareReset(LPUART_Type *base)
: Resets the LPUART using software.

  This function resets all internal logic and registers except the Global Register. Remains set until cleared by software.

  Parameters

  - base – LPUART peripheral base address.

status_t LPUART_Init(LPUART_Type *base, const *lpuart_config_t* *config, uint32_t srcClock_Hz)
: Initializes an LPUART instance with the user configuration structure and the peripheral clock.

  This function configures the LPUART module with user-defined settings. Call the LPUART_GetDefaultConfig() function to configure the configuration structure and get the default configuration. The example below shows how to use this API to configure the LPUART.

```
lpuart_config_t lpuartConfig;
lpuartConfig.baudRate_Bps = 115200U;
lpuartConfig.parityMode = kLPUART_ParityDisabled;
lpuartConfig.dataBitsCount = kLPUART_EightDataBits;
lpuartConfig.isMsb = false;
lpuartConfig.stopBitCount = kLPUART_OneStopBit;
lpuartConfig.txFifoWatermark = 0;
lpuartConfig.rxFifoWatermark = 1;
LPUART_Init(LPUART1, &lpuartConfig, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- config – Pointer to a user-defined configuration structure.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – LPUART initialize succeed

void LPUART_Deinit(LPUART_Type *base)

Deinitializes a LPUART instance.

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

- base – LPUART peripheral base address.

void LPUART_GetDefaultConfig(*lpuart_config_t* *config)

Gets the default configuration structure.

This function initializes the LPUART configuration structure to a default value. The default values are: lpuartConfig->baudRate_Bps = 115200U; lpuartConfig->parityMode = kLPUART_ParityDisabled; lpuartConfig->dataBitsCount = kLPUART_EightDataBits; lpuartConfig->isMsb = false; lpuartConfig->stopBitCount = kLPUART_OneStopBit; lpuartConfig->txFifoWatermark = 0; lpuartConfig->rxFifoWatermark = 1; lpuartConfig->rxIdleType = kLPUART_IdleTypeStartBit; lpuartConfig->rxIdleConfig = kLPUART_IdleCharacter1; lpuartConfig->enableTx = false; lpuartConfig->enableRx = false;

Parameters

- config – Pointer to a configuration structure.

status_t LPUART_SetBaudRate(LPUART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the LPUART instance baudrate.

This function configures the LPUART module baudrate. This function is used to update the LPUART module baudrate after the LPUART module is initialized by the LPUART_Init.

```
LPUART_SetBaudRate(LPUART1, 115200U, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- baudRate_Bps – LPUART baudrate to be set.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not supported in the current clock source.
- kStatus_Success – Set baudrate succeeded.

void LPUART_Enable9bitMode(LPUART_Type *base, bool enable)

Enable 9-bit data mode for LPUART.

This function set the 9-bit mode for LPUART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – LPUART peripheral base address.
- enable – true to enable, flase to disable.

static inline void LPUART_SetMatchAddress(LPUART_Type *base, uint16_t address1, uint16_t address2)

Set the LPUART address.

This function configures the address for LPUART module that works as slave in 9-bit data mode. One or two address fields can be configured. When the address field's match enable bit is set, the frame it receices with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note: Any LPUART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

- base – LPUART peripheral base address.
- address1 – LPUART slave address1.
- address2 – LPUART slave address2.

static inline void LPUART_EnableMatchAddress(LPUART_Type *base, bool match1, bool match2)

Enable the LPUART match address feature.

Parameters

- base – LPUART peripheral base address.
- match1 – true to enable match address1, false to disable.
- match2 – true to enable match address2, false to disable.

static inline void LPUART_SetRxFifoWatermark(LPUART_Type *base, uint8_t water)

Sets the rx FIFO watermark.

Parameters

- base – LPUART peripheral base address.
- water – Rx FIFO watermark.

static inline void LPUART_SetTxFifoWatermark(LPUART_Type *base, uint8_t water)

Sets the tx FIFO watermark.

Parameters

- base – LPUART peripheral base address.
- water – Tx FIFO watermark.

static inline void LPUART_TransferEnable16Bit(*lpuart_handle_t* *handle, bool enable)

Sets the LPUART using 16bit transmit, only for 9bit or 10bit mode.

This function Enable 16bit Data transmit in lpuart_handle_t.

Parameters

- handle – LPUART handle pointer.
- enable – true to enable, false to disable.

uint32_t LPUART_GetStatusFlags(LPUART_Type *base)

Gets LPUART status flags.

This function gets all LPUART status flags. The flags are returned as the logical OR value of the enumerators _lpuart_flags. To check for a specific status, compare the return value with enumerators in the _lpuart_flags. For example, to check whether the TX is empty:

```
if (kLPUART_TxDataRegEmptyFlag & LPUART_GetStatusFlags(LPUART1))
{
    ...
}
```

Parameters

- base – LPUART peripheral base address.

Returns

LPUART status flags which are ORed by the enumerators in the _lpuart_flags.

status_t LPUART_ClearStatusFlags(LPUART_Type *base, uint32_t mask)

Clears status flags with a provided mask.

This function clears LPUART status flags with a provided mask. Automatically cleared flags can't be cleared by this function. Flags that can only cleared or set by hardware are: kLPUART_TxDataRegEmptyFlag, kLPUART_TransmissionCompleteFlag, kLPUART_RxDataRegFullFlag, kLPUART_RxActiveFlag, kLPUART_NoiseErrorFlag, kLPUART_ParityErrorFlag, kLPUART_TxFifoEmptyFlag,kLPUART_RxFifoEmptyFlag Note: This API should be called when the Tx/Rx is idle, otherwise it takes no effects.

Parameters

- base – LPUART peripheral base address.
- mask – the status flags to be cleared. The user can use the enumerators in the _lpuart_status_flag_t to do the OR operation and get the mask.

Return values

- kStatus_LPUART_FlagCannotClearManually – The flag can't be cleared by this function but it is cleared automatically by hardware.
- kStatus_Success – Status in the mask are cleared.

Returns

0 succeed, others failed.

void LPUART_EnableInterrupts(LPUART_Type *base, uint32_t mask)

Enables LPUART interrupts according to a provided mask.

This function enables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See the _lpuart_interrupt_enable. This examples shows how to enable TX empty interrupt and RX full interrupt:

```
LPUART_EnableInterrupts(LPUART1,kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to enable. Logical OR of _lpuart_interrupt_enable.

void LPUART_DisableInterrupts(LPUART_Type *base, uint32_t mask)

Disables LPUART interrupts according to a provided mask.

This function disables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See _lpuart_interrupt_enable. This example shows how to disable the TX empty interrupt and RX full interrupt:

```
LPUART_DisableInterrupts(LPUART1,kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to disable. Logical OR of _lpuart_interrupt_enable.

uint32_t LPUART_GetEnabledInterrupts(LPUART_Type *base)

Gets enabled LPUART interrupts.

This function gets the enabled LPUART interrupts. The enabled interrupts are returned as the logical OR value of the enumerators _lpuart_interrupt_enable. To check a specific interrupt enable status, compare the return value with enumerators in _lpuart_interrupt_enable. For example, to check whether the TX empty interrupt is enabled:

```
uint32_t enabledInterrupts = LPUART_GetEnabledInterrupts(LPUART1);

if (kLPUART_TxDataRegEmptyInterruptEnable & enabledInterrupts)
{
    ...
}
```

Parameters

- base – LPUART peripheral base address.

Returns

LPUART interrupt flags which are logical OR of the enumerators in _lpuart_interrupt_enable.

static inline uintptr_t LPUART_GetDataRegisterAddress(LPUART_Type *base)

Gets the LPUART data register address.

This function returns the LPUART data register address, which is mainly used by the DMA/eDMA.

Parameters

- base – LPUART peripheral base address.

Returns
LPUART data register addresses which are used both by the transmitter and receiver.

static inline void LPUART_EnableTxDMA(LPUART_Type *base, bool enable)

Enables or disables the LPUART transmitter DMA request.

This function enables or disables the transmit data register empty flag, STAT[TDRE], to generate DMA requests.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_EnableRxDMA(LPUART_Type *base, bool enable)

Enables or disables the LPUART receiver DMA.

This function enables or disables the receiver data register full flag, STAT[RDRF], to generate DMA requests.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

uint32_t LPUART_GetInstance(LPUART_Type *base)

Get the LPUART instance from peripheral base address.

Parameters

- base – LPUART peripheral base address.

Returns
LPUART instance.

static inline void LPUART_EnableTx(LPUART_Type *base, bool enable)

Enables or disables the LPUART transmitter.

This function enables or disables the LPUART transmitter.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_EnableRx(LPUART_Type *base, bool enable)

Enables or disables the LPUART receiver.

This function enables or disables the LPUART receiver.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_WriteByte(LPUART_Type *base, uint8_t data)

Writes to the transmitter register.

This function writes data to the transmitter register directly. The upper layer must ensure that the TX register is empty or that the TX FIFO has room before calling this function.

Parameters

- base – LPUART peripheral base address.
- data – Data write to the TX register.

static inline uint8_t LPUART_ReadByte(LPUART_Type *base)

Reads the receiver register.

This function reads data from the receiver register directly. The upper layer must ensure that the receiver register is full or that the RX FIFO has data before calling this function.

Parameters

- base – LPUART peripheral base address.

Returns

Data read from data register.

static inline uint8_t LPUART_GetRxFifoCount(LPUART_Type *base)

Gets the rx FIFO data count.

Parameters

- base – LPUART peripheral base address.

Returns

rx FIFO data count.

static inline uint8_t LPUART_GetTxFifoCount(LPUART_Type *base)

Gets the tx FIFO data count.

Parameters

- base – LPUART peripheral base address.

Returns

tx FIFO data count.

void LPUART_SendAddress(LPUART_Type *base, uint8_t address)

Transmit an address frame in 9-bit data mode.

Parameters

- base – LPUART peripheral base address.
- address – LPUART slave address.

status_t LPUART_WriteBlocking(LPUART_Type *base, const uint8_t *data, size_t length)

Writes to the transmitter register using a blocking method.

This function polls the transmitter register, first waits for the register to be empty or TX FIFO to have room, and writes data to the transmitter buffer, then waits for the dat to be sent out to the bus.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t LPUART_WriteBlocking16bit(LPUART_Type *base, const uint16_t *data, size_t length)

Writes to the transmitter register using a blocking method in 9bit or 10bit mode.

Note: This function only support 9bit or 10bit transfer. Please make sure only 10bit of data is valid and other bits are 0.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t LPUART_ReadBlocking(LPUART_Type *base, uint8_t *data, size_t length)

Reads the receiver data register using a blocking method.

This function polls the receiver register, waits for the receiver register full or receiver FIFO has data, and reads data from the TX register.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

Return values

- kStatus_LPUART_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus_LPUART_NoiseError – Noise error happened while receiving data.
- kStatus_LPUART_FramingError – Framing error happened while receiving data.
- kStatus_LPUART_ParityError – Parity error happened while receiving data.
- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

status_t LPUART_ReadBlocking16bit(LPUART_Type *base, uint16_t *data, size_t length)

Reads the receiver data register in 9bit or 10bit mode.

Note: This function only support 9bit or 10bit transfer.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data by 16bit, only 10bit is valid.
- length – Size of the buffer.

Return values

- kStatus_LPUART_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus_LPUART_NoiseError – Noise error happened while receiving data.
- kStatus_LPUART_FramingError – Framing error happened while receiving data.

- kStatus_LPUART_ParityError – Parity error happened while receiving data.
- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

void LPUART_TransferCreateHandle(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_callback_t* callback, void *userData)

Initializes the LPUART handle.

This function initializes the LPUART handle, which can be used for other LPUART transactional APIs. Usually, for a specified LPUART instance, call this API once to get the initialized handle.

The LPUART driver supports the "background" receiving, which means that user can set up an RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn't call the LPUART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as ringBuffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- callback – Callback function.
- userData – User data.

status_t LPUART_TransferSendNonBlocking(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_t* *xfer)

Transmits a buffer of data using the interrupt method.

This function send data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data written to the transmitter register. When all data is written to the TX register in the ISR, the LPUART driver calls the callback function and passes the kStatus_LPUART_TxIdle as status parameter.

Note: The kStatus_LPUART_TxIdle is passed to the upper layer when all data are written to the TX register. However, there is no check to ensure that all the data sent out. Before disabling the TX, check the kLPUART_TransmissionCompleteFlag to ensure that the transmit is finished.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART transfer structure, see lpuart_transfer_t.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_LPUART_TxBusy – Previous transmission still not finished, data not all written to the TX register.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferStartRingBuffer(LPUART_Type *base, *lpuart_handle_t* *handle, uint8_t *ringBuffer, size_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn't call the UART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly.

Note: When using RX ring buffer, one byte is reserved for internal use. In other words, if ringBufferSize is 32, then only 31 bytes are used for saving data.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- ringBuffer – Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
- ringBufferSize – size of the ring buffer.

void LPUART_TransferStopRingBuffer(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

size_t LPUART_TransferGetRxRingBufferLength(LPUART_Type *base, *lpuart_handle_t* *handle)

Get the length of received data in RX ring buffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

Returns

Length of received data in RX ring buffer.

void LPUART_TransferAbortSend(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt driven data sending. The user can get the remainBtyes to find out how many bytes are not sent out.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

status_t LPUART_TransferGetSendCount(LPUART_Type *base, *lpuart_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been sent out to bus.

This function gets the number of bytes that have been sent out to bus by an interrupt method.

Parameters

- base – LPUART peripheral base address.

- handle – LPUART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t LPUART_TransferReceiveNonBlocking(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_t* *xfer, size_t *receivedBytes)

Receives a buffer of data using the interrupt method.

This function receives data using an interrupt method. This is a non-blocking function which returns without waiting to ensure that all data are received. If the RX ring buffer is used and not empty, the data in the ring buffer is copied and the parameter receivedBytes shows how many bytes are copied from the ring buffer. After copying, if the data in the ring buffer is not enough for read, the receive request is saved by the LPUART driver. When the new data arrives, the receive request is serviced first. When all data is received, the LPUART driver notifies the upper layer through a callback function and passes a status parameter kStatus_UART_RxIdle. For example, the upper layer needs 10 bytes but there are only 5 bytes in ring buffer. The 5 bytes are copied to xfer->data, which returns with the parameter receivedBytes set to 5. For the remaining 5 bytes, the newly arrived data is saved from xfer->data[5]. When 5 bytes are received, the LPUART driver notifies the upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to xfer->data. When all data is received, the upper layer is notified.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART transfer structure, see uart_transfer_t.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into the transmit queue.
- kStatus_LPUART_RxBusy – Previous receive request is not finished.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferAbortReceive(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the interrupt-driven data receiving.

This function aborts the interrupt-driven data receiving. The user can get the remainBytes to find out how many bytes not received yet.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

status_t LPUART_TransferGetReceiveCount(LPUART_Type *base, *lpuart_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- base – LPUART peripheral base address.

- handle – LPUART handle pointer.
- count – Receive bytes count.

Return values

- kStatus_NoTransferInProgress – No receive in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

void LPUART_TransferHandleIRQ(LPUART_Type *base, void *irqHandle)

LPUART IRQ handle function.

This function handles the LPUART transmit and receive IRQ request.

Parameters

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART_TransferHandleErrorIRQ(LPUART_Type *base, void *irqHandle)

LPUART Error IRQ handle function.

This function handles the LPUART error IRQ request.

Parameters

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART_DriverIRQHandler(uint32_t instance)

LPUART driver IRQ handler common entry.

This function provides the common IRQ request entry for LPUART.

Parameters

- instance – LPUART instance.

FSL_LPUART_DRIVER_VERSION

LPUART driver version.

Error codes for the LPUART driver.

Values:

enumerator kStatus_LPUART_TxBusy

TX busy

enumerator kStatus_LPUART_RxBusy

RX busy

enumerator kStatus_LPUART_TxIdle

LPUART transmitter is idle.

enumerator kStatus_LPUART_RxIdle

LPUART receiver is idle.

enumerator kStatus_LPUART_TxWatermarkTooLarge

TX FIFO watermark too large

enumerator kStatus_LPUART_RxWatermarkTooLarge

RX FIFO watermark too large

enumerator kStatus_LPUART_FlagCannotClearManually
Some flag can't manually clear

enumerator kStatus_LPUART_Error
Error happens on LPUART.

enumerator kStatus_LPUART_RxRingBufferOverrun
LPUART RX software ring buffer overrun.

enumerator kStatus_LPUART_RxHardwareOverrun
LPUART RX receiver overrun.

enumerator kStatus_LPUART_NoiseError
LPUART noise error.

enumerator kStatus_LPUART_FramingError
LPUART framing error.

enumerator kStatus_LPUART_ParityError
LPUART parity error.

enumerator kStatus_LPUART_BaudrateNotSupport
Baudrate is not support in current clock source

enumerator kStatus_LPUART_IdleLineDetected
IDLE flag.

enumerator kStatus_LPUART_Timeout
LPUART times out.

enum _lpuart_parity_mode
LPUART parity mode.

Values:

enumerator kLPUART_ParityDisabled
Parity disabled

enumerator kLPUART_ParityEven
Parity enabled, type even, bit setting: PE|PT = 10

enumerator kLPUART_ParityOdd
Parity enabled, type odd, bit setting: PE|PT = 11

enum _lpuart_data_bits
LPUART data bits count.

Values:

enumerator kLPUART_EightDataBits
Eight data bit

enumerator kLPUART_SevenDataBits
Seven data bit

enum _lpuart_stop_bit_count
LPUART stop bit count.

Values:

enumerator kLPUART_OneStopBit
One stop bit

enumerator kLPUART_TwoStopBit
Two stop bits

enum _lpuart_transmit_cts_source
LPUART transmit CTS source.

Values:

enumerator kLPUART_CtsSourcePin
CTS resource is the LPUART_CTS pin.

enumerator kLPUART_CtsSourceMatchResult
CTS resource is the match result.

enum _lpuart_transmit_cts_config
LPUART transmit CTS configure.

Values:

enumerator kLPUART_CtsSampleAtStart
CTS input is sampled at the start of each character.

enumerator kLPUART_CtsSampleAtIdle
CTS input is sampled when the transmitter is idle

enum _lpuart_idle_type_select
LPUART idle flag type defines when the receiver starts counting.

Values:

enumerator kLPUART_IdleTypeStartBit
Start counting after a valid start bit.

enumerator kLPUART_IdleTypeStopBit
Start counting after a stop bit.

enum _lpuart_idle_config
LPUART idle detected configuration. This structure defines the number of idle characters that must be received before the IDLE flag is set.

Values:

enumerator kLPUART_IdleCharacter1
the number of idle characters.

enumerator kLPUART_IdleCharacter2
the number of idle characters.

enumerator kLPUART_IdleCharacter4
the number of idle characters.

enumerator kLPUART_IdleCharacter8
the number of idle characters.

enumerator kLPUART_IdleCharacter16
the number of idle characters.

enumerator kLPUART_IdleCharacter32
the number of idle characters.

enumerator kLPUART_IdleCharacter64
the number of idle characters.

enumerator kLPUART_IdleCharacter128
the number of idle characters.

enum _lpuart_interrupt_enable
LPUART interrupt configuration structure, default settings all disabled.

This structure contains the settings for all LPUART interrupt configurations.

Values:

enumerator kLPUART_LinBreakInterruptEnable
LIN break detect. bit 7

enumerator kLPUART_RxActiveEdgeInterruptEnable
Receive Active Edge. bit 6

enumerator kLPUART_TxDataRegEmptyInterruptEnable
Transmit data register empty. bit 23

enumerator kLPUART_TransmissionCompleteInterruptEnable
Transmission complete. bit 22

enumerator kLPUART_RxDataRegFullInterruptEnable
Receiver data register full. bit 21

enumerator kLPUART_IdleLineInterruptEnable
Idle line. bit 20

enumerator kLPUART_RxOverrunInterruptEnable
Receiver Overrun. bit 27

enumerator kLPUART_NoiseErrorInterruptEnable
Noise error flag. bit 26

enumerator kLPUART_FramingErrorInterruptEnable
Framing error flag. bit 25

enumerator kLPUART_ParityErrorInterruptEnable
Parity error flag. bit 24

enumerator kLPUART_Match1InterruptEnable
Parity error flag. bit 15

enumerator kLPUART_Match2InterruptEnable
Parity error flag. bit 14

enumerator kLPUART_TxFifoOverflowInterruptEnable
Transmit FIFO Overflow. bit 9

enumerator kLPUART_RxFifoUnderflowInterruptEnable
Receive FIFO Underflow. bit 8

enumerator kLPUART_AllInterruptEnable

enum _lpuart_flags
LPUART status flags.

This provides constants for the LPUART status flags for use in the LPUART functions.

Values:

enumerator kLPUART_TxDataRegEmptyFlag
Transmit data register empty flag, sets when transmit buffer is empty. bit 23

enumerator kLPUART_TransmissionCompleteFlag
Transmission complete flag, sets when transmission activity complete. bit 22

enumerator kLPUART_RxDataRegFullFlag
Receive data register full flag, sets when the receive data buffer is full. bit 21

enumerator kLPUART_IdleLineFlag
Idle line detect flag, sets when idle line detected. bit 20

enumerator kLPUART_RxOverrunFlag
Receive Overrun, sets when new data is received before data is read from receive register. bit 19

enumerator kLPUART_NoiseErrorFlag
Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets. bit 18

enumerator kLPUART_FramingErrorFlag
Frame error flag, sets if logic 0 was detected where stop bit expected. bit 17

enumerator kLPUART_ParityErrorFlag
If parity enabled, sets upon parity error detection. bit 16

enumerator kLPUART_LinBreakFlag
LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled. bit 31

enumerator kLPUART_RxActiveEdgeFlag
Receive pin active edge interrupt flag, sets when active edge detected. bit 30

enumerator kLPUART_RxActiveFlag
Receiver Active Flag (RAF), sets at beginning of valid start. bit 24

enumerator kLPUART_DataMatch1Flag
The next character to be read from LPUART_DATA matches MA1. bit 15

enumerator kLPUART_DataMatch2Flag
The next character to be read from LPUART_DATA matches MA2. bit 14

enumerator kLPUART_TxFifoEmptyFlag
TXEMPT bit, sets if transmit buffer is empty. bit 7

enumerator kLPUART_RxFifoEmptyFlag
RXEMPT bit, sets if receive buffer is empty. bit 6

enumerator kLPUART_TxFifoOverflowFlag
TXOF bit, sets if transmit buffer overflow occurred. bit 1

enumerator kLPUART_RxFifoUnderflowFlag
RXUF bit, sets if receive buffer underflow occurred. bit 0

enumerator kLPUART_AllClearFlags

enumerator kLPUART_AllFlags

typedef enum *_lpuart_parity_mode* lpuart_parity_mode_t
LPUART parity mode.

typedef enum *_lpuart_data_bits* lpuart_data_bits_t
LPUART data bits count.

typedef enum *_lpuart_stop_bit_count* lpuart_stop_bit_count_t
LPUART stop bit count.

typedef enum *_lpuart_transmit_cts_source* lpuart_transmit_cts_source_t
LPUART transmit CTS source.

typedef enum *_lpuart_transmit_cts_config* lpuart_transmit_cts_config_t
LPUART transmit CTS configure.

typedef enum *_lpuart_idle_type_select* lpuart_idle_type_select_t
LPUART idle flag type defines when the receiver starts counting.

typedef enum *_lpuart_idle_config* lpuart_idle_config_t
LPUART idle detected configuration. This structure defines the number of idle characters that must be received before the IDLE flag is set.

typedef struct *_lpuart_config* lpuart_config_t
LPUART configuration structure.

typedef struct *_lpuart_transfer* lpuart_transfer_t
LPUART transfer structure.

typedef struct *_lpuart_handle* lpuart_handle_t

typedef void (*lpuart_transfer_callback_t)(LPUART_Type *base, *lpuart_handle_t* *handle, *status_t* status, void *userData)
LPUART transfer callback function.

typedef void (*lpuart_isr_t)(LPUART_Type *base, void *handle)

void *s_lpuartHandle[]

const IRQn_Type s_lpuartTxIRQ[]

lpuart_isr_t s_lpuartIsr[]

UART_RETRY_TIMES
Retry times for waiting flag.

struct __lpuart_config
#include <fsl_lpuart.h> LPUART configuration structure.

Public Members

uint32_t baudRate_Bps
LPUART baud rate

lpuart_parity_mode_t parityMode
Parity mode, disabled (default), even, odd

lpuart_data_bits_t dataBitsCount
Data bits count, eight (default), seven

bool isMsb
Data bits order, LSB (default), MSB

lpuart_stop_bit_count_t stopBitCount
Number of stop bits, 1 stop bit (default) or 2 stop bits

uint8_t txFifoWatermark
TX FIFO watermark

uint8_t rxFifoWatermark
RX FIFO watermark

bool enableRxRTS
RX RTS enable

bool enableTxCTS
TX CTS enable

lpuart_transmit_cts_source_t txCtsSource
TX CTS source

lpuart_transmit_cts_config_t txCtsConfig
TX CTS configure

lpuart_idle_type_select_t rxIdleType
RX IDLE type.

lpuart_idle_config_t rxIdleConfig
RX IDLE configuration.

bool enableTx
Enable TX

bool enableRx
Enable RX

struct __lpuart_transfer
#include <fsl_lpuart.h> LPUART transfer structure.

Public Members

size_t dataSize
The byte count to be transfer.

struct __lpuart_handle
#include <fsl_lpuart.h> LPUART handle structure.

Public Members

volatile size_t txDataSize
Size of the remaining data to send.

size_t txDataSizeAll
Size of the data to send out.

volatile size_t rxDataSize
Size of the remaining data to receive.

size_t rxDataSizeAll
Size of the data to receive.

size_t rxRingBufferSize
Size of the ring buffer.

volatile uint16_t rxRingBufferHead
Index for the driver to store received data into ring buffer.

volatile uint16_t rxRingBufferTail
Index for the user to get data from the ring buffer.

lpuart_transfer_callback_t callback
Callback function.

void *userData
LPUART callback function parameter.

volatile uint8_t txState
TX transfer state.

volatile uint8_t rxState
RX transfer state.

bool isSevenDataBits
Seven data bits flag.

bool is16bitData
16bit data bits flag, only used for 9bit or 10bit data

union ___unnamed82___

Public Members

uint8_t *data
The buffer of data to be transfer.

uint8_t *rxData
The buffer to receive data.

uint16_t *rxData16
The buffer to receive data.

const uint8_t *txData
The buffer of data to be sent.

const uint16_t *txData16
The buffer of data to be sent.

union ___unnamed84___

Public Members

const uint8_t *volatile txData
Address of remaining data to send.

const uint16_t *volatile txData16
Address of remaining data to send.

union ___unnamed86___

Public Members

uint8_t *volatile rxData
Address of remaining data to receive.

uint16_t *volatile rxData16
Address of remaining data to receive.

union ___unnamed88___

Public Members

uint8_t *rxRingBuffer

Start address of the receiver ring buffer.

uint16_t *rxRingBuffer16

Start address of the receiver ring buffer.

2.80 LPUART eDMA Driver

void LPUART_TransferCreateHandleEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle, *lpuart_edma_transfer_callback_t* callback, void *userData, *edma_handle_t* *txEdmaHandle, *edma_handle_t* *rxEdmaHandle)

Initializes the LPUART handle which is used in transactional functions.

Note: This function disables all LPUART interrupts.

Parameters

- base – LPUART peripheral base address.
- handle – Pointer to lpuart_edma_handle_t structure.
- callback – Callback function.
- userData – User data.
- txEdmaHandle – User requested DMA handle for TX DMA transfer.
- rxEdmaHandle – User requested DMA handle for RX DMA transfer.

status_t LPUART_SendEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle, *lpuart_transfer_t* *xfer)

Sends data using eDMA.

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent, the send callback function is called.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART eDMA transfer structure. See lpuart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_LPUART_TxBusy – Previous transfer on going.
- kStatus_InvalidArgument – Invalid argument.

status_t LPUART_ReceiveEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle, *lpuart_transfer_t* *xfer)

Receives data using eDMA.

This function receives data using eDMA. This is non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

- base – LPUART peripheral base address.
- handle – Pointer to lpuart_edma_handle_t structure.
- xfer – LPUART eDMA transfer structure, see lpuart_transfer_t.

Return values

- kStatus_Success – if succeed, others fail.
- kStatus_LPUART_RxBusy – Previous transfer ongoing.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferAbortSendEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle)

Aborts the sent data using eDMA.

This function aborts the sent data using eDMA.

Parameters

- base – LPUART peripheral base address.
- handle – Pointer to lpuart_edma_handle_t structure.

void LPUART_TransferAbortReceiveEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle)

Aborts the received data using eDMA.

This function aborts the received data using eDMA.

Parameters

- base – LPUART peripheral base address.
- handle – Pointer to lpuart_edma_handle_t structure.

status_t LPUART_TransferGetSendCountEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle, uint32_t *count)

Gets the number of bytes written to the LPUART TX register.

This function gets the number of bytes written to the LPUART TX register by DMA.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t LPUART_TransferGetReceiveCountEDMA(LPUART_Type *base, *lpuart_edma_handle_t* *handle, uint32_t *count)

Gets the number of received bytes.

This function gets the number of received bytes.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Receive bytes count.

Return values

- kStatus_NoTransferInProgress – No receive in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

void LPUART_TransferEdmaHandleIRQ(LPUART_Type *base, void *lpuartEdmaHandle)

LPUART eDMA IRQ handle function.

This function handles the LPUART tx complete IRQ request and invoke user callback. It is not set to static so that it can be used in user application.

Note: This function is used as default IRQ handler by double weak mechanism. If user's specific IRQ handler is implemented, make sure this function is invoked in the handler.

Parameters

- base – LPUART peripheral base address.
- lpuartEdmaHandle – LPUART handle pointer.

FSL_LPUART_EDMA_DRIVER_VERSION

LPUART EDMA driver version.

typedef struct *_lpuart_edma_handle* lpuart_edma_handle_t

typedef void (*lpuart_edma_transfer_callback_t)(LPUART_Type *base, *lpuart_edma_handle_t* *handle, *status_t* status, void *userData)

LPUART transfer callback function.

struct __lpuart_edma_handle

#include <fsl_lpuart_edma.h> LPUART eDMA handle.

Public Members

lpuart_edma_transfer_callback_t callback

Callback function.

void *userData

LPUART callback function parameter.

size_t rxDataSizeAll

Size of the data to receive.

size_t txDataSizeAll

Size of the data to send out.

edma_handle_t *txEdmaHandle

The eDMA TX channel used.

edma_handle_t *rxEdmaHandle

The eDMA RX channel used.

uint8_t nbytes

eDMA minor byte transfer count initially configured.

volatile uint8_t txState

TX transfer state.

volatile uint8_t rxState

RX transfer state

2.81 MCM: Miscellaneous Control Module

FSL_MCM_DRIVER_VERSION
MCM driver version.

Enum _mcm_interrupt_flag. Interrupt status flag mask. .

Values:

enumerator kMCM_CacheWriteBuffer
Cache Write Buffer Error Enable.

enumerator kMCM_ParityError
Cache Parity Error Enable.

enumerator kMCM_FPUInvalidOperation
FPU Invalid Operation Interrupt Enable.

enumerator kMCM_FPUDivideByZero
FPU Divide-by-zero Interrupt Enable.

enumerator kMCM_FPUOverflow
FPU Overflow Interrupt Enable.

enumerator kMCM_FPUUnderflow
FPU Underflow Interrupt Enable.

enumerator kMCM_FPUInexact
FPU Inexact Interrupt Enable.

enumerator kMCM_FPUInputDenormalInterrupt
FPU Input Denormal Interrupt Enable.

typedef union *_mcm_buffer_fault_attribute* mcm_buffer_fault_attribute_t
The union of buffer fault attribute.

typedef union *_mcm_lmem_fault_attribute* mcm_lmem_fault_attribute_t
The union of LMEM fault attribute.

static inline void MCM_EnableCrossbarRoundRobin(MCM_Type *base, bool enable)
Enables/Disables crossbar round robin.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable crossbar round robin.
  - **true** Enable crossbar round robin.
  - **false** disable crossbar round robin.

static inline void MCM_EnableInterruptStatus(MCM_Type *base, uint32_t mask)
Enables the interrupt.

Parameters

- base – MCM peripheral base address.
- mask – Interrupt status flags mask(_mcm_interrupt_flag).

static inline void MCM_DisableInterruptStatus(MCM_Type *base, uint32_t mask)

Disables the interrupt.

Parameters

- base – MCM peripheral base address.
- mask – Interrupt status flags mask(_mcm_interrupt_flag).

static inline uint16_t MCM_GetInterruptStatus(MCM_Type *base)

Gets the Interrupt status .

Parameters

- base – MCM peripheral base address.

static inline void MCM_ClearCacheWriteBufferErroStatus(MCM_Type *base)

Clears the Interrupt status .

Parameters

- base – MCM peripheral base address.

static inline uint32_t MCM_GetBufferFaultAddress(MCM_Type *base)

Gets buffer fault address.

Parameters

- base – MCM peripheral base address.

static inline void MCM_GetBufferFaultAttribute(MCM_Type *base, *mcm_buffer_fault_attribute_t* *bufferfault)

Gets buffer fault attributes.

Parameters

- base – MCM peripheral base address.

static inline uint32_t MCM_GetBufferFaultData(MCM_Type *base)

Gets buffer fault data.

Parameters

- base – MCM peripheral base address.

static inline void MCM_LimitCodeCachePeripheralWriteBuffering(MCM_Type *base, bool enable)

Limit code cache peripheral write buffering.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable limit code cache peripheral write buffering.
  - **true** Enable limit code cache peripheral write buffering.
  - **false** disable limit code cache peripheral write buffering.

static inline void MCM_BypassFixedCodeCacheMap(MCM_Type *base, bool enable)

Bypass fixed code cache map.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable bypass fixed code cache map.
  - **true** Enable bypass fixed code cache map.
  - **false** disable bypass fixed code cache map.

static inline void MCM_EnableCodeBusCache(MCM_Type *base, bool enable)

Enables/Disables code bus cache.

Parameters

- base – MCM peripheral base address.
- enable – Used to disable/enable code bus cache.
  - **true** Enable code bus cache.
  - **false** disable code bus cache.

static inline void MCM_ForceCodeCacheToNoAllocation(MCM_Type *base, bool enable)

Force code cache to no allocation.

Parameters

- base – MCM peripheral base address.
- enable – Used to force code cache to allocation or no allocation.
  - **true** Force code cache to no allocation.
  - **false** Force code cache to allocation.

static inline void MCM_EnableCodeCacheWriteBuffer(MCM_Type *base, bool enable)

Enables/Disables code cache write buffer.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable code cache write buffer.
  - **true** Enable code cache write buffer.
  - **false** Disable code cache write buffer.

static inline void MCM_ClearCodeBusCache(MCM_Type *base)

Clear code bus cache.

Parameters

- base – MCM peripheral base address.

static inline void MCM_EnablePcParityFaultReport(MCM_Type *base, bool enable)

Enables/Disables PC Parity Fault Report.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable PC Parity Fault Report.
  - **true** Enable PC Parity Fault Report.
  - **false** disable PC Parity Fault Report.

static inline void MCM_EnablePcParity(MCM_Type *base, bool enable)

Enables/Disables PC Parity.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable PC Parity.
  - **true** Enable PC Parity.
  - **false** disable PC Parity.

static inline void MCM_LockConfigState(MCM_Type *base)

Lock the configuration state.

Parameters

- base – MCM peripheral base address.

static inline void MCM_EnableCacheParityReporting(MCM_Type *base, bool enable)

Enables/Disables cache parity reporting.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable cache parity reporting.
  - **true** Enable cache parity reporting.
  - **false** disable cache parity reporting.

static inline uint32_t MCM_GetLmemFaultAddress(MCM_Type *base)

Gets LMEM fault address.

Parameters

- base – MCM peripheral base address.

static inline void MCM_GetLmemFaultAttribute(MCM_Type *base, *mcm_lmem_fault_attribute_t* *lmemFault)

Get LMEM fault attributes.

Parameters

- base – MCM peripheral base address.

static inline uint64_t MCM_GetLmemFaultData(MCM_Type *base)

Gets LMEM fault data.

Parameters

- base – MCM peripheral base address.

MCM_LMFATR_TYPE_MASK

MCM_LMFATR_MODE_MASK

MCM_LMFATR_BUFF_MASK

MCM_LMFATR_CACH_MASK

MCM_ISCR_STAT_MASK

FSL_COMPONENT_ID

union __mcm_buffer_fault_attribute

#include <fsl_mcm.h> The union of buffer fault attribute.

Public Members

uint32_t attribute

Indicates the faulting attributes, when a properly-enabled cache write buffer error interrupt event is detected.

struct *_mcm_buffer_fault_attribute._mcm_buffer_fault_attribut* attribute_memory

struct __mcm_buffer_fault_attribut

#include <fsl_mcm.h>

Public Members

uint32_t busErrorDataAccessType
: Indicates the type of cache write buffer access.

uint32_t busErrorPrivilegeLevel
: Indicates the privilege level of the cache write buffer access.

uint32_t busErrorSize
: Indicates the size of the cache write buffer access.

uint32_t busErrorAccess
: Indicates the type of system bus access.

uint32_t busErrorMasterID
: Indicates the crossbar switch bus master number of the captured cache write buffer bus error.

uint32_t busErrorOverrun
: Indicates if another cache write buffer bus error is detected.

union __mcm_lmem_fault_attribute
: *#include <fsl_mcm.h>* The union of LMEM fault attribute.

Public Members

uint32_t attribute
: Indicates the attributes of the LMEM fault detected.

struct *_mcm_lmem_fault_attribute._mcm_lmem_fault_attribut* attribute_memory

struct __mcm_lmem_fault_attribut
: *#include <fsl_mcm.h>*

Public Members

uint32_t parityFaultProtectionSignal
: Indicates the features of parity fault protection signal.

uint32_t parityFaultMasterSize
: Indicates the parity fault master size.

uint32_t parityFaultWrite
: Indicates the parity fault is caused by read or write.

uint32_t backdoorAccess
: Indicates the LMEM access fault is initiated by core access or backdoor access.

uint32_t parityFaultSyndrome
: Indicates the parity fault syndrome.

uint32_t overrun
: Indicates the number of faultss.

2.82 MECC: internal error correction code

void MECC_Init(MECC_Type *base, *mecc_config_t* *config)

MECC module initialization function.

Parameters

- base – MECC base address.
- config – pointer to the MECC configuration structure.

void MECC_Deinit(MECC_Type *base)

Deinitializes the MECC.

Parameters

- base – MECC base address.

void MECC_GetDefaultConfig(*mecc_config_t* *config)

Sets the MECC configuration structure to default values.

Parameters

- config – pointer to the MECC configuration structure.

static inline uint32_t MECC_GetStatusFlags(MECC_Type *base)

Gets MECC status flags.

Parameters

- base – MECC peripheral base address.

Returns

MECC status flags.

static inline void MECC_ClearStatusFlags(MECC_Type *base, uint32_t mask)

MECC module clear interrupt status.

Parameters

- base – MECC base address.
- mask – status to clear.

static inline void MECC_EnableInterruptStatus(MECC_Type *base, uint32_t mask)

MECC module enable interrupt status.

Parameters

- base – MECC base address.
- mask – status to enable.

static inline void MECC_DisableInterruptStatus(MECC_Type *base, uint32_t mask)

MECC module disable interrupt status.

Parameters

- base – MECC base address.
- mask – status to disable.

static inline void MECC_EnableInterrupts(MECC_Type *base, uint32_t mask)

MECC module enable interrupt.

Parameters

- base – MECC base address.
- mask – The interrupts to enable.

static inline void MECC_DisableInterrupts(MECC_Type *base, uint32_t mask)

MECC module disable interrupt.

Parameters

- base – MECC base address.
- mask – The interrupts to disable.

status_t MECC_ErrorInjection(MECC_Type *base, uint32_t lowerrordata, uint32_t higherrordata, uint8_t eccdata, uint8_t banknumber)

MECC module error injection.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2: ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i = 0,1,2,3,4.....

Parameters

- base – MECC base address.
- lowerrordata – low 32 bits data.
- higherrordata – high 32 bits data.
- eccdata – ecc code.
- banknumber – ocram bank number.

Return values

kStatus_Success. –

status_t MECC_GetSingleErrorInfo(MECC_Type *base, *mecc_single_error_info_t* *info, uint8_t banknumber)

MECC module get single error information.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2: ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i = 0,1,2,3,4.....

Parameters

- base – MECC base address.
- info – single error information.
- banknumber – ocram bank number.

Return values

- kStatus_Success. –
- kStatus_MECC_BankMiss. –

status_t MECC_GetMultiErrorInfo(MECC_Type *base, *mecc_multi_error_info_t* *info, uint8_t banknumber)

MECC module get multiple error information.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2: ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i = 0,1,2,3,4.....

Parameters

- base – MECC base address.

- info – multiple error information.
- banknumber – ocram bank number.

Return values

- kStatus_Success. –
- kStatus_MECC_BankMiss. –

static inline uint32_t MECC_GetPendingFlags(MECC_Type *base)

Get pending flags for OCRAM wait and pipeline enable.

Parameters

- base – MECC base address.

Returns

Pending flags, should be the OR'ed value of mecc_pending_flag_t.

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Error codes for the MECC driver.

Values:

enumerator kStatus_MECC_BankMiss

Ocram bank miss

MECC interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the MECC interrupt configurations.

Values:

enumerator kMECC_SingleError0InterruptEnable

Single Bit Error On Ocram Bank0 interrupt enable.

enumerator kMECC_SingleError1InterruptEnable

Single Bit Error On Ocram Bank1 interrupt enable

enumerator kMECC_SingleError2InterruptEnable

Single Bit Error On Ocram Bank2 interrupt enable

enumerator kMECC_SingleError3InterruptEnable

Single Bit Error On Ocram Bank3 interrupt enable

enumerator kMECC_MultiError0InterruptEnable

Multiple Bits Error On Ocram Bank0 interrupt enable

enumerator kMECC_MultiError1InterruptEnable

Multiple Bits Error On Ocram Bank1 interrupt enable

enumerator kMECC_MultiError2InterruptEnable

Multiple Bits Error On Ocram Bank2 interrupt enable

enumerator kMECC_MultiError3InterruptEnable

Multiple Bits Error On Ocram Bank3 interrupt enable

enumerator kMECC_StrobeError0InterruptEnable

AXI Strobe Error On Ocram Bank0 interrupt enable

enumerator kMECC_StrobeError1InterruptEnable

AXI Strobe Error On Ocram Bank1 interrupt enable

enumerator kMECC_StrobeError2InterruptEnable
AXI Strobe Error On Ocram Bank2 interrupt enable

enumerator kMECC_StrobeError3InterruptEnable
AXI Strobe Error On Ocram Bank3 interrupt enable

enumerator kMECC_AccessError0InterruptEnable
Ocram Access Error On Bank0 interrupt enable

enumerator kMECC_AccessError1InterruptEnable
Ocram Access Error On Bank1 interrupt enable

enumerator kMECC_AccessError2InterruptEnable
Ocram Access Error On Bank2 interrupt enable

enumerator kMECC_AccessError3InterruptEnable
Ocram Access Error On Bank3 interrupt enable

enumerator kMECC_AllInterruptsEnable
all interrupts enable

MECC interrupt status configuration structure, default settings all disabled.

This structure contains the settings for all of the MECC interrupt status configurations.

Values:

enumerator kMECC_SingleError0InterruptStatusEnable
Single Bit Error On Ocram Bank0 interrupt status enable.

enumerator kMECC_SingleError1InterruptStatusEnable
Single Bit Error On Ocram Bank1 interrupt status enable

enumerator kMECC_SingleError2InterruptStatusEnable
Single Bit Error On Ocram Bank2 interrupt status enable

enumerator kMECC_SingleError3InterruptStatusEnable
Single Bit Error On Ocram Bank3 interrupt status enable

enumerator kMECC_MultiError0InterruptStatusEnable
Multiple Bits Error On Ocram Bank0 interrupt status enable

enumerator kMECC_MultiError1InterruptStatusEnable
Multiple Bits Error On Ocram Bank1 interrupt status enable

enumerator kMECC_MultiError2InterruptStatusEnable
Multiple Bits Error On Ocram Bank2 interrupt status enable

enumerator kMECC_MultiError3InterruptStatusEnable
Multiple Bits Error On Ocram Bank3 interrupt status enable

enumerator kMECC_StrobeError0InterruptStatusEnable
AXI Strobe Error On Ocram Bank0 interrupt status enable

enumerator kMECC_StrobeError1InterruptStatusEnable
AXI Strobe Error On Ocram Bank1 interrupt status enable

enumerator kMECC_StrobeError2InterruptStatusEnable
AXI Strobe Error On Ocram Bank2 interrupt status enable

enumerator kMECC_StrobeError3InterruptStatusEnable
AXI Strobe Error On Ocram Bank3 interrupt status enable

enumerator kMECC_AccessError0InterruptStatusEnable
Ocram Access Error On Bank0 interrupt status enable

enumerator kMECC_AccessError1InterruptStatusEnable
Ocram Access Error On Bank1 interrupt status enable

enumerator kMECC_AccessError2InterruptStatusEnable
Ocram Access Error On Bank2 interrupt status enable

enumerator kMECC_AccessError3InterruptStatusEnable
Ocram Access Error On Bank3 interrupt status enable

enumerator kMECC_AllInterruptsStatusEnable
all interrupts enable

MECC status flags.

This provides constants for the MECC status flags for use in the MECC functions.

Values:

enumerator kMECC_SingleError0InterruptFlag
Single Bit Error On Ocram Bank0 interrupt flag

enumerator kMECC_SingleError1InterruptFlag
Single Bit Error On Ocram Bank1 interrupt flag

enumerator kMECC_SingleError2InterruptFlag
Single Bit Error On Ocram Bank2 interrupt flag

enumerator kMECC_SingleError3InterruptFlag
Single Bit Error On Ocram Bank3 interrupt flag

enumerator kMECC_MultiError0InterruptFlag
Multiple Bits Error On Ocram Bank0 interrupt flag

enumerator kMECC_MultiError1InterruptFlag
Multiple Bits Error On Ocram Bank1 interrupt flag

enumerator kMECC_MultiError2InterruptFlag
Multiple Bits Error On Ocram Bank2 interrupt flag

enumerator kMECC_MultiError3InterruptFlag
Multiple Bits Error On Ocram Bank3 interrupt flag

enumerator kMECC_StrobeError0InterruptFlag
AXI Strobe Error On Ocram Bank0 interrupt flag

enumerator kMECC_StrobeError1InterruptFlag
AXI Strobe Error On Ocram Bank1 interrupt flag

enumerator kMECC_StrobeError2InterruptFlag
AXI Strobe Error On Ocram Bank2 interrupt flag

enumerator kMECC_StrobeError3InterruptFlag
AXI Strobe Error On Ocram Bank3 interrupt flag

enumerator kMECC_AccessError0InterruptFlag
Ocram Access Error On Bank0 interrupt flag

enumerator kMECC_AccessError1InterruptFlag
Ocram Access Error On Bank1 interrupt flag

enumerator kMECC_AccessError2InterruptFlag
Ocram Access Error On Bank2 interrupt flag

enumerator kMECC_AccessError3InterruptFlag
Ocram Access Error On Bank3 interrupt flag

enumerator kMECC_AllInterruptsFlag
all interrupts interrupt flag

MECC ocram bank number.

Values:

enumerator kMECC_OcramBank0
ocram bank number 0: ocram_base_address+0x20*i

enumerator kMECC_OcramBank1
ocram bank number 1: ocram_base_address+0x20*i+0x8

enumerator kMECC_OcramBank2
ocram bank number 2: ocram_base_address+0x20*i+0x10

enumerator kMECC_OcramBank3
ocram bank number 3: ocram_base_address+0x20*i+0x18

enum _mecc_pending_flag
Pending flags for OCRAM wait and pipeline enable. .

Values:

enumerator kMECC_ReadDataWaitPendingFlag
Indicate an update pending status for read data wait.

enumerator kMECC_ReadAddrPipelinePendingFlag
Indicate an update pending status for read address pipeline.

enumerator kMECC_WriteDataPipelinePendingFlag
Indicate an update pending status for write data pipeline.

enumerator kMECC_WriteAddrPipelinePendingFlag
Indicate an update pending status for write address pipeline.

enumerator kMECC_AllPendingFlags
Indicate all pending status flags.

typedef struct *_mecc_config* mecc_config_t
MECC user configuration.

Note: Ocram1StartAddress, Ocram1EndAddress, Ocram2StartAddress, Ocram2EndAddress are removed since 2.1.0 version; This changes will cause compile error for applications which use MECC driver before 2.1.0 version; To resolve compile error please use *startAddress* and *endAddress* as instead.

---

typedef struct *_mecc_single_error_info* mecc_single_error_info_t
MECC ocram single error information, including single error address, ECC code, error data and error bit position.

typedef struct *_mecc_multi_error_info* mecc_multi_error_info_t
MECC ocram multiple error information, including multiple error address, ECC code, error data.

struct __mecc__config

#include <fsl_mecc.h> MECC user configuration.

Note: Ocram1StartAddress, Ocram1EndAddress, Ocram2StartAddress, Ocram2EndAddress are removed since 2.1.0 version; This changes will cause compile error for applications which use MECC driver before 2.1.0 version; To resolve compile error please use *startAddress* and *endAddress* as instead.

Public Members

bool enableMecc

Enable the MECC function.

uint32_t startAddress

Start address of corresponding OCRAM memory region to enable ECC.

uint32_t endAddress

end address of corresponding OCRAM memory region to enable ECC.

bool enableReadDataWait

uint32_t Ocram1StartAddress; Ocram 1 start address, deprecated since 2.1.0

uint32_t Ocram1EndAddress; Ocram 1 end address, deprecated since 2.1.0

uint32_t Ocram2StartAddress; Ocram 2 start address, deprecated since 2.1.0.

uint32_t Ocram2EndAddress; Ocram 2 end address, deprecated since 2.1.0 If enabled, 1-cycle wait state will be inserted into each read access:

- **true** Enable read data wait;
- **false** Disable read data wait.

bool enableReadAddrPipeline

If enabled, the read address will be registered before can be applied to memory cell:

- **true** Enable Read address pipeline;
- **false** Disable Read address pipeline.

bool enableWriteDataPipeline

If enabled, the write data will be registered before can be applied to memory cell:

- **true** Enable write data pipeline;
- **false** Disable write data pipeline.

bool enableWriteAddrPipeline

If enabled, write address will be registered before can be applied to memory cell:

- **true** Enable write address pipeline;
- **false** Disable write address pipeline.

struct __mecc__single__error__info

#include <fsl_mecc.h> MECC ocram single error information, including single error address, ECC code, error data and error bit position.

Public Members

uint32_t singleErrorAddress

Single error address on Ocram bank n

uint32_t singleErrorDataLow
: Single error low 32 bits uncorrected read data on Ocram bank n

uint32_t singleErrorDataHigh
: Single error high 32 bits uncorrected read data on Ocram bank n

uint32_t singleErrorPosLow
: Single error bit postion of low 32 bits read data on Ocram bank n

uint32_t singleErrorPosHigh
: Single error bit postion of high 32 bits read data on Ocram bank n

uint8_t singleErrorEccCode
: Single error ECC code on Ocram bank n

struct __mecc_multi_error_info
: *#include <fsl_mecc.h>* MECC ocram multiple error information, including multiple error address, ECC code, error data.

Public Members

uint32_t multiErrorAddress
: Multiple error address on Ocram bank n

uint32_t multiErrorDataLow
: Multiple error low 32 bits read data on Ocram bank n

uint32_t multiErrorDataHigh
: Multiple error high 32 bits read data on Ocram bank n

uint8_t multiErrorEccCode
: Multiple error ECC code on Ocram bank n

2.83 MIPI DSI Driver

void DSI_Init(const *MIPI_DSI_Type* *base, const *dsi_config_t* *config)
: Initializes an MIPI DSI host with the user configuration.

  This function initializes the MIPI DSI host with the configuration, it should be called first before other MIPI DSI driver functions.

  Parameters

  - base – MIPI DSI host peripheral base address.
  - config – Pointer to a user-defined configuration structure.

void DSI_Deinit(const *MIPI_DSI_Type* *base)
: Deinitializes an MIPI DSI host.

  This function should be called after all bother MIPI DSI driver functions.

  Parameters

  - base – MIPI DSI host peripheral base address.

void DSI_GetDefaultConfig(*dsi_config_t* *config)
: Get the default configuration to initialize the MIPI DSI host.

  The default value is:

```
config->numLanes = 4;
config->enableNonContinuousHsClk = false;
config->enableTxUlps = false;
config->autoInsertEoTp = true;
config->numExtraEoTp = 0;
config->htxTo_ByteClk = 0;
config->lrxHostTo_ByteClk = 0;
config->btaTo_ByteClk = 0;
```

Parameters

- config – Pointer to a user-defined configuration structure.

void DSI_SetDpiConfig(const *MIPI_DSI_Type* *base, const *dsi_dpi_config_t* *config, uint8_t numLanes, uint32_t dpiPixelClkFreq_Hz, uint32_t dsiHsBitClkFreq_Hz)

Configure the DPI interface core.

This function sets the DPI interface configuration, it should be used in video mode.

Parameters

- base – MIPI DSI host peripheral base address.
- config – Pointer to the DPI interface configuration.
- numLanes – Lane number, should be same with the setting in dsi_dpi_config_t.
- dpiPixelClkFreq_Hz – The DPI pixel clock frequency in Hz.
- dsiHsBitClkFreq_Hz – The DSI high speed bit clock frequency in Hz. It is the same with DPHY PLL output.

uint32_t DSI_InitDphy(const *MIPI_DSI_Type* *base, const *dsi_dphy_config_t* *config, uint32_t refClkFreq_Hz)

Initializes the D-PHY.

This function configures the D-PHY timing and setups the D-PHY PLL based on user configuration. The configuration structure could be got by the function DSI_GetDphyDefaultConfig.

For some platforms there is not dedicated D-PHY PLL, indicated by the macro FSL_FEATURE_MIPI_DSI_NO_DPHY_PLL. For these platforms, the refClkFreq_Hz is useless.

Parameters

- base – MIPI DSI host peripheral base address.
- config – Pointer to the D-PHY configuration.
- refClkFreq_Hz – The REFCLK frequency in Hz.

Returns

The actual D-PHY PLL output frequency. If could not configure the PLL to the target frequency, the return value is 0.

void DSI_DeinitDphy(const *MIPI_DSI_Type* *base)

Deinitializes the D-PHY.

Power down the D-PHY PLL and shut down D-PHY.

Parameters

- base – MIPI DSI host peripheral base address.

void DSI_GetDphyDefaultConfig(*dsi_dphy_config_t* *config, uint32_t txHsBitClk_Hz, uint32_t txEscClk_Hz)

Get the default D-PHY configuration.

Gets the default D-PHY configuration, the timing parameters are set according to D-PHY specification. User could use the configuration directly, or change some parameters according to the special device.

Parameters

- config – Pointer to the D-PHY configuration.
- txHsBitClk_Hz – High speed bit clock in Hz.
- txEscClk_Hz – Esc clock in Hz.

static inline void DSI_EnableInterrupts(const *MIPI_DSI_Type* *base, uint32_t intGroup1, uint32_t intGroup2)

Enable the interrupts.

The interrupts to enable are passed in as OR'ed mask value of _dsi_interrupt.

Parameters

- base – MIPI DSI host peripheral base address.
- intGroup1 – Interrupts to enable in group 1.
- intGroup2 – Interrupts to enable in group 2.

static inline void DSI_DisableInterrupts(const *MIPI_DSI_Type* *base, uint32_t intGroup1, uint32_t intGroup2)

Disable the interrupts.

The interrupts to disable are passed in as OR'ed mask value of _dsi_interrupt.

Parameters

- base – MIPI DSI host peripheral base address.
- intGroup1 – Interrupts to disable in group 1.
- intGroup2 – Interrupts to disable in group 2.

static inline void DSI_GetAndClearInterruptStatus(const *MIPI_DSI_Type* *base, uint32_t *intGroup1, uint32_t *intGroup2)

Get and clear the interrupt status.

Parameters

- base – MIPI DSI host peripheral base address.
- intGroup1 – Group 1 interrupt status.
- intGroup2 – Group 2 interrupt status.

void DSI_SetApbPacketControl(const *MIPI_DSI_Type* *base, uint16_t wordCount, uint8_t virtualChannel, *dsi_tx_data_type_t* dataType, uint8_t flags)

Configure the APB packet to send.

This function configures the next APB packet transfer. After configuration, the packet transfer could be started with function DSI_SendApbPacket. If the packet is long packet, Use DSI_WriteApbTxPayload to fill the payload before start transfer.

Parameters

- base – MIPI DSI host peripheral base address.
- wordCount – For long packet, this is the byte count of the payload. For short packet, this is (data1 « 8) | data0.
- virtualChannel – Virtual channel.

- dataType – The packet data type, (DI).
- flags – The transfer control flags, see _dsi_transfer_flags.

void DSI_WriteApbTxPayload(const *MIPI_DSI_Type* *base, const uint8_t *payload, uint16_t payloadSize)

Fill the long APB packet payload.

Write the long packet payload to TX FIFO.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.

void DSI_WriteApbTxPayloadExt(const *MIPI_DSI_Type* *base, const uint8_t *payload, uint16_t payloadSize, bool sendDscCmd, uint8_t dscCmd)

Extended function to fill the payload to TX FIFO.

Write the long packet payload to TX FIFO. This function could be used in two ways

a. Include the DSC command in parameter payload. In this case, the DSC command is the first byte of payload. The parameter sendDscCmd is set to false, the dscCmd is not used. This function is the same as DSI_WriteApbTxPayload when used in this way.
b. The DSC command in not in parameter payload, but specified by parameter dscCmd. In this case, the parameter sendDscCmd is set to true, the dscCmd is the DSC command to send. The payload is sent after dscCmd.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.
- sendDscCmd – If set to true, the DSC command is specified by dscCmd, otherwise the DSC command is included in the payload.
- dscCmd – The DSC command to send, only used when sendDscCmd is true.

void DSI_ReadApbRxPayload(const *MIPI_DSI_Type* *base, uint8_t *payload, uint16_t payloadSize)

Read the long APB packet payload.

Read the long packet payload from RX FIFO. This function reads directly but does not check the RX FIFO status. Upper layer should make sure there are available data.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.

static inline void DSI_SendApbPacket(const *MIPI_DSI_Type* *base)

Trigger the controller to send out APB packet.

Send the packet set by DSI_SetApbPacketControl.

Parameters

- base – MIPI DSI host peripheral base address.

static inline uint32_t DSI_GetApbStatus(const *MIPI_DSI_Type* *base)

Get the APB status.

The return value is OR'ed value of _dsi_apb_status.

Parameters

- base – MIPI DSI host peripheral base address.

Returns

The APB status.

static inline uint32_t DSI_GetRxErrorStatus(const *MIPI_DSI_Type* *base)

Get the error status during data transfer.

The return value is OR'ed value of _dsi_rx_error_status.

Parameters

- base – MIPI DSI host peripheral base address.

Returns

The error status.

static inline uint8_t DSI_GetEccRxErrorPosition(uint32_t rxErrorStatus)

Get the one-bit RX ECC error position.

When one-bit ECC RX error detected using DSI_GetRxErrorStatus, this function could be used to get the error bit position.

```
uint8_t eccErrorPos;
uint32_t rxErrorStatus = DSI_GetRxErrorStatus(MIPI_DSI);
if (kDSI_RxErrorEccOneBit & rxErrorStatus)
{
    eccErrorPos = DSI_GetEccRxErrorPosition(rxErrorStatus);
}
```

Parameters

- rxErrorStatus – The error status returned by DSI_GetRxErrorStatus.

Returns

The 1-bit ECC error position.

static inline uint32_t DSI_GetAndClearHostStatus(const *MIPI_DSI_Type* *base)

Get and clear the DSI host status.

The host status are returned as mask value of _dsi_host_status.

Parameters

- base – MIPI DSI host peripheral base address.

Returns

The DSI host status.

static inline uint32_t DSI_GetRxPacketHeader(const *MIPI_DSI_Type* *base)

Get the RX packet header.

Parameters

- base – MIPI DSI host peripheral base address.

Returns

The RX packet header.

static inline *dsi_rx_data_type_t* DSI_GetRxPacketType(uint32_t rxPktHeader)

Extract the RX packet type from the packet header.

Extract the RX packet type from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

The RX packet type.

static inline uint16_t DSI_GetRxPacketWordCount(uint32_t rxPktHeader)

Extract the RX packet word count from the packet header.

Extract the RX packet word count from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

For long packet, return the payload word count (byte). For short packet, return the (data0 « 8) | data1.

static inline uint8_t DSI_GetRxPacketVirtualChannel(uint32_t rxPktHeader)

Extract the RX packet virtual channel from the packet header.

Extract the RX packet virtual channel from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

The virtual channel.

status_t DSI_TransferBlocking(const *MIPI_DSI_Type* *base, *dsi_transfer_t* *xfer)

APB data transfer using blocking method.

Perform APB data transfer using blocking method. This function waits until all data send or received, or timeout happens.

When using this API to read data, the actually read data count could be got from xfer->rxDataSize.

Parameters

- base – MIPI DSI host peripheral base address.
- xfer – Pointer to the transfer structure.

Return values

- kStatus_Success – Data transfer finished with no error.
- kStatus_Timeout – Transfer failed because of timeout.
- kStatus_DSI_RxDataError – RX data error, user could use DSI_GetRxErrorStatus to check the error details.
- kStatus_DSI_ErrorReportReceived – Error Report packet received, user could use DSI_GetAndClearHostStatus to check the error report status.
- kStatus_DSI_NotSupported – Transfer format not supported.
- kStatus_DSI_Fail – Transfer failed for other reasons.

status_t DSI_TransferCreateHandle(const *MIPI_DSI_Type* *base, *dsi_handle_t* *handle, *dsi_callback_t* callback, void *userData)

Create the MIPI DSI handle.

This function initializes the MIPI DSI handle which can be used for other transactional APIs.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – Handle pointer.
- callback – Callback function.
- userData – User data.

status_t DSI_TransferNonBlocking(const *MIPI_DSI_Type* *base, *dsi_handle_t* *handle, *dsi_transfer_t* *xfer)

APB data transfer using interrupt method.

Perform APB data transfer using interrupt method, when transfer finished, upper layer could be informed through callback function.

When using this API to read data, the actually read data count could be got from handle->xfer->rxDataSize after read finished.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.
- xfer – Pointer to the transfer structure.

Return values

- kStatus_Success – Data transfer started successfully.
- kStatus_DSI_Busy – Failed to start transfer because DSI is busy with pervious transfer.
- kStatus_DSI_NotSupported – Transfer format not supported.

void DSI_TransferAbort(const *MIPI_DSI_Type* *base, *dsi_handle_t* *handle)

Abort current APB data transfer.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.

void DSI_TransferHandleIRQ(const *MIPI_DSI_Type* *base, *dsi_handle_t* *handle)

Interrupt handler for the DSI.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.

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Error codes for the MIPI DSI driver.

Values:

enumerator kStatus_DSI_Busy

DSI is busy.

enumerator kStatus_DSI_RxDataError
Read data error.

enumerator kStatus_DSI_ErrorReportReceived
Error report package received.

enumerator kStatus_DSI_NotSupported
The transfer type not supported.

enum _dsi_dpi_color_coding
MIPI DPI interface color coding.

Values:

enumerator kDSI_Dpi16BitConfig1
16-bit configuration 1. RGB565: XXXXXXXX_RRRRRGGG_GGGBBBBB.

enumerator kDSI_Dpi16BitConfig2
16-bit configuration 2. RGB565: XXXRRRRR_XXGGGGGG_XXXBBBBB.

enumerator kDSI_Dpi16BitConfig3
16-bit configuration 3. RGB565: XXRRRRRX_XXGGGGGG_XXBBBBBX.

enumerator kDSI_Dpi18BitConfig1
18-bit configuration 1. RGB666: XXXXXXRR_RRRRGGGG_GGBBBBBB.

enumerator kDSI_Dpi18BitConfig2
18-bit configuration 2. RGB666: XXRRRRRR_XXGGGGGG_XXBBBBBB.

enumerator kDSI_Dpi24Bit
24-bit.

enum _dsi_dpi_pixel_packet
MIPI DSI pixel packet type send through DPI interface.

Values:

enumerator kDSI_PixelPacket16Bit
16 bit RGB565.

enumerator kDSI_PixelPacket18Bit
18 bit RGB666 packed.

enumerator kDSI_PixelPacket18BitLoosely
18 bit RGB666 loosely packed into three bytes.

enumerator kDSI_PixelPacket24Bit
24 bit RGB888, each pixel uses three bytes.

_dsi_dpi_polarity_flag DPI signal polarity.

Values:

enumerator kDSI_DpiVsyncActiveLow
VSYNC active low.

enumerator kDSI_DpiHsyncActiveLow
HSYNC active low.

enumerator kDSI_DpiVsyncActiveHigh
VSYNC active high.

enumerator kDSI_DpiHsyncActiveHigh
HSYNC active high.

enum _dsi_dpi_video_mode
DPI video mode.

Values:

enumerator kDSI_DpiNonBurstWithSyncPulse
Non-Burst mode with Sync Pulses.

enumerator kDSI_DpiNonBurstWithSyncEvent
Non-Burst mode with Sync Events.

enumerator kDSI_DpiBurst
Burst mode.

enum _dsi_dpi_bllp_mode
Behavior in BLLP (Blanking or Low-Power Interval).

Values:

enumerator kDSI_DpiBllpLowPower
LP mode used in BLLP periods.

enumerator kDSI_DpiBllpBlanking
Blanking packets used in BLLP periods.

enumerator kDSI_DpiBllpNull
Null packets used in BLLP periods.

_dsi_apb_status Status of APB to packet interface.

Values:

enumerator kDSI_ApbNotIdle
State machine not idle

enumerator kDSI_ApbTxDone
Tx packet done

enumerator kDSI_ApbRxControl
DPHY direction 0 - tx had control, 1 - rx has control

enumerator kDSI_ApbTxOverflow
TX fifo overflow

enumerator kDSI_ApbTxUnderflow
TX fifo underflow

enumerator kDSI_ApbRxOverflow
RX fifo overflow

enumerator kDSI_ApbRxUnderflow
RX fifo underflow

enumerator kDSI_ApbRxHeaderReceived
RX packet header has been received

enumerator kDSI_ApbRxPacketReceived
All RX packet payload data has been received

_dsi_rx_error_status Host receive error status.

Values:

enumerator kDSI_RxErrorEccOneBit
ECC single bit error detected.

enumerator kDSI_RxErrorEccMultiBit
ECC multi bit error detected.

enumerator kDSI_RxErrorCrc
CRC error detected.

enumerator kDSI_RxErrorHtxTo
High Speed forward TX timeout detected.

enumerator kDSI_RxErrorLrxTo
Reverse Low power data receive timeout detected.

enumerator kDSI_RxErrorBtaTo
BTA timeout detected.

enum _dsi_host_status
DSI host controller status (status_out)

Values:

enumerator kDSI_HostSoTError
SoT error from peripheral error report.

enumerator kDSI_HostSoTSyncError
SoT Sync error from peripheral error report.

enumerator kDSI_HostEoTSyncError
EoT Sync error from peripheral error report.

enumerator kDSI_HostEscEntryCmdError
Escape Mode Entry Command Error from peripheral error report.

enumerator kDSI_HostLpTxSyncError
Low-power transmit Sync Error from peripheral error report.

enumerator kDSI_HostPeriphToError
Peripheral timeout error from peripheral error report.

enumerator kDSI_HostFalseControlError
False control error from peripheral error report.

enumerator kDSI_HostContentionDetected
Contention detected from peripheral error report.

enumerator kDSI_HostEccErrorOneBit
Single bit ECC error (corrected) from peripheral error report.

enumerator kDSI_HostEccErrorMultiBit
Multi bit ECC error (not corrected) from peripheral error report.

enumerator kDSI_HostChecksumError
Checksum error from peripheral error report.

enumerator kDSI_HostInvalidDataType
DSI data type not recognized.

enumerator kDSI_HostInvalidVcId
DSI VC ID invalid.

enumerator kDSI_HostInvalidTxLength
Invalid transmission length.

enumerator kDSI_HostProtocalViolation
DSI protocal violation.

enumerator kDSI_HostResetTriggerReceived
Reset trigger received.

enumerator kDSI_HostTearTriggerReceived
Tear effect trigger receive.

enumerator kDSI_HostAckTriggerReceived
Acknowledge trigger message received.

_dsi_interrupt DSI interrupt.

Values:

enumerator kDSI_InterruptGroup1ApbNotIdle
State machine not idle

enumerator kDSI_InterruptGroup1ApbTxDone
Tx packet done

enumerator kDSI_InterruptGroup1ApbRxControl
DPHY direction 0 - tx control, 1 - rx control

enumerator kDSI_InterruptGroup1ApbTxOverflow
TX fifo overflow

enumerator kDSI_InterruptGroup1ApbTxUnderflow
TX fifo underflow

enumerator kDSI_InterruptGroup1ApbRxOverflow
RX fifo overflow

enumerator kDSI_InterruptGroup1ApbRxUnderflow
RX fifo underflow

enumerator kDSI_InterruptGroup1ApbRxHeaderReceived
RX packet header has been received

enumerator kDSI_InterruptGroup1ApbRxPacketReceived
All RX packet payload data has been received

enumerator kDSI_InterruptGroup1SoTError
SoT error from peripheral error report.

enumerator kDSI_InterruptGroup1SoTSyncError
SoT Sync error from peripheral error report.

enumerator kDSI_InterruptGroup1EoTSyncError
EoT Sync error from peripheral error report.

enumerator kDSI_InterruptGroup1EscEntryCmdError
Escape Mode Entry Command Error from peripheral error report.

enumerator kDSI_InterruptGroup1LpTxSyncError
Low-power transmit Sync Error from peripheral error report.

enumerator kDSI_InterruptGroup1PeriphToError
Peripheral timeout error from peripheral error report.

enumerator kDSI_InterruptGroup1FalseControlError
False control error from peripheral error report.

enumerator kDSI_InterruptGroup1ContentionDetected
Contention detected from peripheral error report.

enumerator kDSI_InterruptGroup1EccErrorOneBit
Single bit ECC error (corrected) from peripheral error report.

enumerator kDSI_InterruptGroup1EccErrorMultiBit
Multi bit ECC error (not corrected) from peripheral error report.

enumerator kDSI_InterruptGroup1ChecksumError
Checksum error from peripheral error report.

enumerator kDSI_InterruptGroup1InvalidDataType
DSI data type not recognized.

enumerator kDSI_InterruptGroup1InvalidVcId
DSI VC ID invalid.

enumerator kDSI_InterruptGroup1InvalidTxLength
Invalid transmission length.

enumerator kDSI_InterruptGroup1ProtocalViolation
DSI protocal violation.

enumerator kDSI_InterruptGroup1ResetTriggerReceived
Reset trigger received.

enumerator kDSI_InterruptGroup1TearTriggerReceived
Tear effect trigger receive.

enumerator kDSI_InterruptGroup1AckTriggerReceived
Acknowledge trigger message received.

enumerator kDSI_InterruptGroup1HtxTo
High speed TX timeout.

enumerator kDSI_InterruptGroup1LrxTo
Low power RX timeout.

enumerator kDSI_InterruptGroup1BtaTo
Host BTA timeout.

enumerator kDSI_InterruptGroup2EccOneBit
Sinle bit ECC error.

enumerator kDSI_InterruptGroup2EccMultiBit
Multi bit ECC error.

enumerator kDSI_InterruptGroup2CrcError
CRC error.

enum __dsi_tx_data_type
DSI TX data type.

Values:

enumerator kDSI_TxDataVsyncStart
V Sync start.

enumerator kDSI_TxDataVsyncEnd
V Sync end.

enumerator kDSI_TxDataHsyncStart
H Sync start.

enumerator kDSI_TxDataHsyncEnd
H Sync end.

enumerator kDSI_TxDataEoTp
End of transmission packet.

enumerator kDSI_TxDataCmOff
Color mode off.

enumerator kDSI_TxDataCmOn
Color mode on.

enumerator kDSI_TxDataShutDownPeriph
Shut down peripheral.

enumerator kDSI_TxDataTurnOnPeriph
Turn on peripheral.

enumerator kDSI_TxDataGenShortWrNoParam
Generic Short WRITE, no parameters.

enumerator kDSI_TxDataGenShortWrOneParam
Generic Short WRITE, one parameter.

enumerator kDSI_TxDataGenShortWrTwoParam
Generic Short WRITE, two parameter.

enumerator kDSI_TxDataGenShortRdNoParam
Generic Short READ, no parameters.

enumerator kDSI_TxDataGenShortRdOneParam
Generic Short READ, one parameter.

enumerator kDSI_TxDataGenShortRdTwoParam
Generic Short READ, two parameter.

enumerator kDSI_TxDataDcsShortWrNoParam
DCS Short WRITE, no parameters.

enumerator kDSI_TxDataDcsShortWrOneParam
DCS Short WRITE, one parameter.

enumerator kDSI_TxDataDcsShortRdNoParam
DCS Short READ, no parameters.

enumerator kDSI_TxDataSetMaxReturnPktSize
Set the Maximum Return Packet Size.

enumerator kDSI_TxDataNull
Null Packet, no data.

enumerator kDSI_TxDataBlanking
Blanking Packet, no data.

enumerator kDSI_TxDataGenLongWr
Generic long write.

enumerator kDSI_TxDataDcsLongWr
DCS Long Write/write_LUT Command Packet.

enumerator kDSI_TxDataLooselyPackedPixel20BitYCbCr
Loosely Packed Pixel Stream, 20-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel24BitYCbCr
Packed Pixel Stream, 24-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel16BitYCbCr
Packed Pixel Stream, 16-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel30BitRGB
Packed Pixel Stream, 30-bit RGB, 10-10-10 Format.

enumerator kDSI_TxDataPackedPixel36BitRGB
Packed Pixel Stream, 36-bit RGB, 12-12-12 Format.

enumerator kDSI_TxDataPackedPixel12BitYCrCb
Packed Pixel Stream, 12-bit YCbCr, 4:2:0 Format.

enumerator kDSI_TxDataPackedPixel16BitRGB
Packed Pixel Stream, 16-bit RGB, 5-6-5 Format.

enumerator kDSI_TxDataPackedPixel18BitRGB
Packed Pixel Stream, 18-bit RGB, 6-6-6 Format.

enumerator kDSI_TxDataLooselyPackedPixel18BitRGB
Loosely Packed Pixel Stream, 18-bit RGB, 6-6-6 Format.

enumerator kDSI_TxDataPackedPixel24BitRGB
Packed Pixel Stream, 24-bit RGB, 8-8-8 Format.

enum _dsi_rx_data_type
DSI RX data type.

Values:

enumerator kDSI_RxDataAckAndErrorReport
Acknowledge and Error Report

enumerator kDSI_RxDataEoTp
End of Transmission packet.

enumerator kDSI_RxDataGenShortRdResponseOneByte
Generic Short READ Response, 1 byte returned.

enumerator kDSI_RxDataGenShortRdResponseTwoByte
Generic Short READ Response, 2 byte returned.

enumerator kDSI_RxDataGenLongRdResponse
Generic Long READ Response.

enumerator kDSI_RxDataDcsLongRdResponse
DCS Long READ Response.

enumerator kDSI_RxDataDcsShortRdResponseOneByte
DCS Short READ Response, 1 byte returned.

enumerator kDSI_RxDataDcsShortRdResponseTwoByte
DCS Short READ Response, 2 byte returned.

_dsi_transfer_flags DSI transfer control flags.

Values:

enumerator kDSI_TransferUseHighSpeed
Use high speed mode or not.

enumerator kDSI_TransferPerformBTA
Perform BTA or not.

typedef struct *_dsi_config* dsi_config_t
MIPI DSI controller configuration.

typedef enum *_dsi_dpi_color_coding* dsi_dpi_color_coding_t
MIPI DPI interface color coding.

typedef enum *_dsi_dpi_pixel_packet* dsi_dpi_pixel_packet_t
MIPI DSI pixel packet type send through DPI interface.

typedef enum *_dsi_dpi_video_mode* dsi_dpi_video_mode_t
DPI video mode.

typedef enum *_dsi_dpi_bllp_mode* dsi_dpi_bllp_mode_t
Behavior in BLLP (Blanking or Low-Power Interval).

typedef struct *_dsi_dpi_config* dsi_dpi_config_t
MIPI DSI controller DPI interface configuration.

typedef struct *_dsi_dphy_config* dsi_dphy_config_t
MIPI DSI D-PHY configuration.

typedef enum *_dsi_tx_data_type* dsi_tx_data_type_t
DSI TX data type.

typedef enum *_dsi_rx_data_type* dsi_rx_data_type_t
DSI RX data type.

typedef struct *_dsi_transfer* dsi_transfer_t
Structure for the data transfer.

typedef struct *_dsi_handle* dsi_handle_t
MIPI DSI transfer handle.

typedef void (*dsi_callback_t)(const *MIPI_DSI_Type* *base, *dsi_handle_t* *handle, *status_t* status, void *userData)
MIPI DSI callback for finished transfer.

When transfer finished, one of these status values will be passed to the user:

- kStatus_Success Data transfer finished with no error.
- kStatus_Timeout Transfer failed because of timeout.
- kStatus_DSI_RxDataError RX data error, user could use DSI_GetRxErrorStatus to check the error details.
- kStatus_DSI_ErrorReportReceived Error Report packet received, user could use DSI_GetAndClearHostStatus to check the error report status.
- kStatus_Fail Transfer failed for other reasons.

FSL_DSI_TX_MAX_PAYLOAD_BYTE

FSL_DSI_RX_MAX_PAYLOAD_BYTE

struct MIPI_DSI_Type

#include <fsl_mipi_dsi.h> MIPI DSI structure definition.

Public Members

DSI_HOST_Type *host

Pointer to HOST registers.

DSI_HOST_APB_PKT_IF_Type *apb

Pointer to APB registers.

DSI_HOST_DPI_INTFC_Type *dpi

Pointer to DPI registers.

DSI_HOST_NXP_FDSOI28_DPHY_INTFC_Type *dphy

Pointer to DPHY registers.

struct _dsi_config

#include <fsl_mipi_dsi.h> MIPI DSI controller configuration.

Public Members

uint8_t numLanes

Number of lanes.

bool enableNonContinuousHsClk

In enabled, the high speed clock will enter low power mode between transmissions.

bool enableTxUlps

Enable the TX ULPS.

bool autoInsertEoTp

Insert an EoTp short package when switching from HS to LP.

uint8_t numExtraEoTp

How many extra EoTp to send after the end of a packet.

uint32_t htxTo_ByteClk

HS TX timeout count (HTX_TO) in byte clock.

uint32_t lrxHostTo_ByteClk

LP RX host timeout count (LRX-H_TO) in byte clock.

uint32_t btaTo_ByteClk

Bus turn around timeout count (TA_TO) in byte clock.

struct _dsi_dpi_config

#include <fsl_mipi_dsi.h> MIPI DSI controller DPI interface configuration.

Public Members

uint16_t pixelPayloadSize

Maximum number of pixels that should be sent as one DSI packet. Recommended that the line size (in pixels) is evenly divisible by this parameter.

dsi_dpi_color_coding_t dpiColorCoding
DPI color coding.

dsi_dpi_pixel_packet_t pixelPacket
Pixel packet format.

dsi_dpi_video_mode_t videoMode
Video mode.

dsi_dpi_bllp_mode_t bllpMode
Behavior in BLLP.

uint8_t polarityFlags
OR'ed value of _dsi_dpi_polarity_flag controls signal polarity.

uint16_t hfp
Horizontal front porch, in dpi pixel clock.

uint16_t hbp
Horizontal back porch, in dpi pixel clock.

uint16_t hsw
Horizontal sync width, in dpi pixel clock.

uint8_t vfp
Number of lines in vertical front porch.

uint8_t vbp
Number of lines in vertical back porch.

uint16_t panelHeight
Line number in vertical active area.

uint8_t virtualChannel
Virtual channel.

struct __dsi__dphy__config
#include <fsl_mipi_dsi.h> MIPI DSI D-PHY configuration.

Public Members

uint32_t txHsBitClk_Hz
The generated HS TX bit clock in Hz.

uint8_t tClkPre_ByteClk
TLPX + TCLK-PREPARE + TCLK-ZERO + TCLK-PRE in byte clock. Set how long the controller will wait after enabling clock lane for HS before enabling data lanes for HS.

uint8_t tClkPost_ByteClk
TCLK-POST + T_CLK-TRAIL in byte clock. Set how long the controller will wait before putting clock lane into LP mode after data lanes detected in stop state.

uint8_t tHsExit_ByteClk
THS-EXIT in byte clock. Set how long the controller will wait after the clock lane has been put into LP mode before enabling clock lane for HS again.

uint32_t tWakeup_EscClk
Number of clk_esc clock periods to keep a clock or data lane in Mark-1 state after exiting ULPS.

uint8_t tHsPrepare_HalfEscClk

THS-PREPARE in clk_esc/2. Set how long to drive the LP-00 state before HS transmissions, available values are 2, 3, 4, 5.

uint8_t tClkPrepare_HalfEscClk

TCLK-PREPARE in clk_esc/2. Set how long to drive the LP-00 state before HS transmissions, available values are 2, 3.

uint8_t tHsZero_ByteClk

THS-ZERO in clk_byte. Set how long that controller drives data lane HS-0 state before transmit the Sync sequence. Available values are 6, 7, ..., 37.

uint8_t tClkZero_ByteClk

TCLK-ZERO in clk_byte. Set how long that controller drives clock lane HS-0 state before transmit the Sync sequence. Available values are 3, 4, ..., 66.

uint8_t tHsTrail_ByteClk

THS-TRAIL + 4*UI in clk_byte. Set the time of the flipped differential state after last payload data bit of HS transmission burst. Available values are 0, 1, ..., 15.

uint8_t tClkTrail_ByteClk

TCLK-TRAIL + 4*UI in clk_byte. Set the time of the flipped differential state after last payload data bit of HS transmission burst. Available values are 0, 1, ..., 15.

struct _dsi_transfer

#include <fsl_mipi_dsi.h> Structure for the data transfer.

Public Members

uint8_t virtualChannel

Virtual channel.

dsi_tx_data_type_t txDataType

TX data type.

uint8_t flags

Flags to control the transfer, see _dsi_transfer_flags.

const uint8_t *txData

The TX data buffer.

uint8_t *rxData

The TX data buffer.

uint16_t txDataSize

Size of the TX data.

uint16_t rxDataSize

Size of the RX data.

bool sendDscCmd

If set to true, the DSC command is specified by dscCmd, otherwise the DSC command is included in the txData.

uint8_t dscCmd

The DSC command to send, only valid when sendDscCmd is true.

struct _dsi_handle

#include <fsl_mipi_dsi.h> MIPI DSI transfer handle structure.

Public Members

volatile bool isBusy
MIPI DSI is busy with APB data transfer.

dsi_transfer_t xfer
Transfer information.

dsi_callback_t callback
DSI callback

void *userData
Callback parameter

const *MIPI_DSI_Type* *dsi
Pointer to MIPI DSI peripheral.

2.84 MIPI_DSI: MIPI DSI Host Controller

2.85 MU: Messaging Unit

void MU_Init(MU_Type *base)
Initializes the MU module.

This function enables the MU clock only.

Parameters

- base – MU peripheral base address.

void MU_Deinit(MU_Type *base)
De-initializes the MU module.

This function disables the MU clock only.

Parameters

- base – MU peripheral base address.

static inline void MU_SendMsgNonBlocking(MU_Type *base, uint32_t regIndex, uint32_t msg)
Writes a message to the TX register.

This function writes a message to the specific TX register. It does not check whether the TX register is empty or not. The upper layer should make sure the TX register is empty before calling this function. This function can be used in ISR for better performance.

```
while (!(kMU_Tx0EmptyFlag & MU_GetStatusFlags(base))) { }  Wait for TX0 register empty.
MU_SendMsgNonBlocking(base, kMU_MsgReg0, MSG_VAL);  Write message to the TX0 register.
```

Parameters

- base – MU peripheral base address.
- regIndex – TX register index, see mu_msg_reg_index_t.
- msg – Message to send.

void MU_SendMsg(MU_Type *base, uint32_t regIndex, uint32_t msg)
Blocks to send a message.

This function waits until the TX register is empty and sends the message.

Parameters

- base – MU peripheral base address.
- regIndex – MU message register, see mu_msg_reg_index_t.
- msg – Message to send.

static inline uint32_t MU_ReceiveMsgNonBlocking(MU_Type *base, uint32_t regIndex)

Reads a message from the RX register.

This function reads a message from the specific RX register. It does not check whether the RX register is full or not. The upper layer should make sure the RX register is full before calling this function. This function can be used in ISR for better performance.

```
uint32_t msg;
while (!(kMU_Rx0FullFlag & MU_GetStatusFlags(base)))
{
}  Wait for the RX0 register full.

msg = MU_ReceiveMsgNonBlocking(base, kMU_MsgReg0);  Read message from RX0 register.
```

Parameters

- base – MU peripheral base address.
- regIndex – RX register index, see mu_msg_reg_index_t.

Returns

The received message.

uint32_t MU_ReceiveMsg(MU_Type *base, uint32_t regIndex)

Blocks to receive a message.

This function waits until the RX register is full and receives the message.

Parameters

- base – MU peripheral base address.
- regIndex – MU message register, see mu_msg_reg_index_t

Returns

The received message.

static inline void MU_SetFlagsNonBlocking(MU_Type *base, uint32_t flags)

Sets the 3-bit MU flags reflect on the other MU side.

This function sets the 3-bit MU flags directly. Every time the 3-bit MU flags are changed, the status flag kMU_FlagsUpdatingFlag asserts indicating the 3-bit MU flags are updating to the other side. After the 3-bit MU flags are updated, the status flag kMU_FlagsUpdatingFlag is cleared by hardware. During the flags updating period, the flags cannot be changed. The upper layer should make sure the status flag kMU_FlagsUpdatingFlag is cleared before calling this function.

```
while (kMU_FlagsUpdatingFlag & MU_GetStatusFlags(base))
{
}  Wait for previous MU flags updating.

MU_SetFlagsNonBlocking(base, 0U);  Set the mU flags.
```

Parameters

- base – MU peripheral base address.
- flags – The 3-bit MU flags to set.

void MU_SetFlags(MU_Type *base, uint32_t flags)

Blocks setting the 3-bit MU flags reflect on the other MU side.

This function blocks setting the 3-bit MU flags. Every time the 3-bit MU flags are changed, the status flag kMU_FlagsUpdatingFlag asserts indicating the 3-bit MU flags are updating to the other side. After the 3-bit MU flags are updated, the status flag kMU_FlagsUpdatingFlag is cleared by hardware. During the flags updating period, the flags cannot be changed. This function waits for the MU status flag kMU_FlagsUpdatingFlag cleared and sets the 3-bit MU flags.

Parameters

- base – MU peripheral base address.
- flags – The 3-bit MU flags to set.

static inline uint32_t MU_GetFlags(MU_Type *base)

Gets the current value of the 3-bit MU flags set by the other side.

This function gets the current 3-bit MU flags on the current side.

Parameters

- base – MU peripheral base address.

Returns

flags Current value of the 3-bit flags.

static inline uint32_t MU_GetStatusFlags(MU_Type *base)

Gets the MU status flags.

This function returns the bit mask of the MU status flags. See _mu_status_flags.

```
uint32_t flags;
flags = MU_GetStatusFlags(base);  Get all status flags.
if (kMU_Tx0EmptyFlag & flags)
{
    The TX0 register is empty. Message can be sent.
    MU_SendMsgNonBlocking(base, kMU_MsgReg0, MSG0_VAL);
}
if (kMU_Tx1EmptyFlag & flags)
{
    The TX1 register is empty. Message can be sent.
    MU_SendMsgNonBlocking(base, kMU_MsgReg1, MSG1_VAL);
}
```

Parameters

- base – MU peripheral base address.

Returns

Bit mask of the MU status flags, see _mu_status_flags.

static inline uint32_t MU_GetRxStatusFlags(MU_Type *base)

Return the RX status flags.

This function return the RX status flags. Note: RFn bits of SR[27-24](mu status register) are mapped in reverse numerical order: RF0 -> SR[27] RF1 -> SR[26] RF2 -> SR[25] RF3 -> SR[24]

```
status_reg = MU_GetRxStatusFlags(base);
```

Parameters

- base – MU peripheral base address.

Returns
MU RX status

static inline uint32_t MU_GetInterruptsPending(MU_Type *base)

Gets the MU IRQ pending status of enabled interrupts.

This function returns the bit mask of the pending MU IRQs of enabled interrupts. Only these flags are checked. kMU_Tx0EmptyFlag kMU_Tx1EmptyFlag kMU_Tx2EmptyFlag kMU_Tx3EmptyFlag kMU_Rx0FullFlag kMU_Rx1FullFlag kMU_Rx2FullFlag kMU_Rx3FullFlag kMU_GenInt0Flag kMU_GenInt1Flag kMU_GenInt2Flag kMU_GenInt3Flag

Parameters

- base – MU peripheral base address.

Returns
Bit mask of the MU IRQs pending.

static inline void MU_ClearStatusFlags(MU_Type *base, uint32_t mask)

Clears the specific MU status flags.

This function clears the specific MU status flags. The flags to clear should be passed in as bit mask. See _mu_status_flags.

```
Clear general interrupt 0 and general interrupt 1 pending flags.
MU_ClearStatusFlags(base, kMU_GenInt0Flag | kMU_GenInt1Flag);
```

Parameters

- base – MU peripheral base address.
- mask – Bit mask of the MU status flags. See _mu_status_flags. The following flags are cleared by hardware, this function could not clear them.
  - kMU_Tx0EmptyFlag
  - kMU_Tx1EmptyFlag
  - kMU_Tx2EmptyFlag
  - kMU_Tx3EmptyFlag
  - kMU_Rx0FullFlag
  - kMU_Rx1FullFlag
  - kMU_Rx2FullFlag
  - kMU_Rx3FullFlag
  - kMU_EventPendingFlag
  - kMU_FlagsUpdatingFlag
  - kMU_OtherSideInResetFlag

static inline void MU_EnableInterrupts(MU_Type *base, uint32_t mask)

Enables the specific MU interrupts.

This function enables the specific MU interrupts. The interrupts to enable should be passed in as bit mask. See _mu_interrupt_enable.

```
  Enable general interrupt 0 and TX0 empty interrupt.
MU_EnableInterrupts(base, kMU_GenInt0InterruptEnable | kMU_Tx0EmptyInterruptEnable);
```

Parameters

- base – MU peripheral base address.

- mask – Bit mask of the MU interrupts. See _mu_interrupt_enable.

static inline void MU_DisableInterrupts(MU_Type *base, uint32_t mask)

Disables the specific MU interrupts.

This function disables the specific MU interrupts. The interrupts to disable should be passed in as bit mask. See _mu_interrupt_enable.

```
  Disable general interrupt 0 and TX0 empty interrupt.
MU_DisableInterrupts(base, kMU_GenInt0InterruptEnable | kMU_Tx0EmptyInterruptEnable);
```

Parameters

- base – MU peripheral base address.
- mask – Bit mask of the MU interrupts. See _mu_interrupt_enable.

status_t MU_TriggerInterrupts(MU_Type *base, uint32_t mask)

Triggers interrupts to the other core.

This function triggers the specific interrupts to the other core. The interrupts to trigger are passed in as bit mask. See _mu_interrupt_trigger. The MU should not trigger an interrupt to the other core when the previous interrupt has not been processed by the other core. This function checks whether the previous interrupts have been processed. If not, it returns an error.

```
if (kStatus_Success != MU_TriggerInterrupts(base, kMU_GenInt0InterruptTrigger | kMU_
↪GenInt2InterruptTrigger))
{
    Previous general purpose interrupt 0 or general purpose interrupt 2
    has not been processed by the other core.
}
```

Parameters

- base – MU peripheral base address.
- mask – Bit mask of the interrupts to trigger. See _mu_interrupt_trigger.

Return values

- kStatus_Success – Interrupts have been triggered successfully.
- kStatus_Fail – Previous interrupts have not been accepted.

static inline void MU_MaskHardwareReset(MU_Type *base, bool mask)

Mask hardware reset by the other core.

The other core could call MU_HardwareResetOtherCore() to reset current core. To mask the reset, call this function and pass in true.

Parameters

- base – MU peripheral base address.
- mask – Pass true to mask the hardware reset, pass false to unmask it.

FSL_MU_DRIVER_VERSION

MU driver version.

enum _mu_status_flags

MU status flags.

Values:

enumerator kMU_Tx0EmptyFlag
TX0 empty.

enumerator kMU_Tx1EmptyFlag
TX1 empty.

enumerator kMU_Tx2EmptyFlag
TX2 empty.

enumerator kMU_Tx3EmptyFlag
TX3 empty.

enumerator kMU_Rx0FullFlag
RX0 full.

enumerator kMU_Rx1FullFlag
RX1 full.

enumerator kMU_Rx2FullFlag
RX2 full.

enumerator kMU_Rx3FullFlag
RX3 full.

enumerator kMU_GenInt0Flag
General purpose interrupt 0 pending.

enumerator kMU_GenInt1Flag
General purpose interrupt 1 pending.

enumerator kMU_GenInt2Flag
General purpose interrupt 2 pending.

enumerator kMU_GenInt3Flag
General purpose interrupt 3 pending.

enumerator kMU_EventPendingFlag
MU event pending.

enumerator kMU_FlagsUpdatingFlag
MU flags update is on-going.

enumerator kMU_ResetAssertInterruptFlag
The other core reset assert interrupt pending.

enumerator kMU_ResetDeassertInterruptFlag
The other core reset de-assert interrupt pending.

enumerator kMU_OtherSideInResetFlag
The other side is in reset.

enumerator kMU_MuResetInterruptFlag
The other side initializes MU reset.

enumerator kMU_HardwareResetInterruptFlag
Current side has been hardware reset by the other side.

enum _mu_interrupt_enable
MU interrupt source to enable.

Values:

enumerator kMU_Tx0EmptyInterruptEnable
TX0 empty.

enumerator kMU_Tx1EmptyInterruptEnable
TX1 empty.

enumerator kMU_Tx2EmptyInterruptEnable
TX2 empty.

enumerator kMU_Tx3EmptyInterruptEnable
TX3 empty.

enumerator kMU_Rx0FullInterruptEnable
RX0 full.

enumerator kMU_Rx1FullInterruptEnable
RX1 full.

enumerator kMU_Rx2FullInterruptEnable
RX2 full.

enumerator kMU_Rx3FullInterruptEnable
RX3 full.

enumerator kMU_GenInt0InterruptEnable
General purpose interrupt 0.

enumerator kMU_GenInt1InterruptEnable
General purpose interrupt 1.

enumerator kMU_GenInt2InterruptEnable
General purpose interrupt 2.

enumerator kMU_GenInt3InterruptEnable
General purpose interrupt 3.

enumerator kMU_ResetAssertInterruptEnable
The other core reset assert interrupt.

enumerator kMU_ResetDeassertInterruptEnable
The other core reset de-assert interrupt.

enumerator kMU_MuResetInterruptEnable
The other side initializes MU reset. The interrupt is ORed with the general purpose interrupt 3. The general purpose interrupt 3 is issued when the other side set the MU reset and this interrupt is enabled.

enumerator kMU_HardwareResetInterruptEnable
Current side has been hardware reset by the other side.

enum __mu_interrupt_trigger
MU interrupt that could be triggered to the other core.

Values:

enumerator kMU_GenInt0InterruptTrigger
General purpose interrupt 0.

enumerator kMU_GenInt1InterruptTrigger
General purpose interrupt 1.

enumerator kMU_GenInt2InterruptTrigger
General purpose interrupt 2.

enumerator kMU_GenInt3InterruptTrigger
General purpose interrupt 3.

enum __mu_msg_reg_index
MU message register.

Values:

enumerator kMU_MsgReg0

enumerator kMU_MsgReg1

enumerator kMU_MsgReg2

enumerator kMU_MsgReg3

typedef enum *_mu_msg_reg_index* mu_msg_reg_index_t
MU message register.

MU_CR_NMI_MASK

MU_GET_CORE_FLAG(flags)

MU_GET_STAT_FLAG(flags)

MU_GET_TX_FLAG(flags)

MU_GET_RX_FLAG(flags)

MU_GET_GI_FLAG(flags)

2.86 Nic301

enum __nic_reg

Values:

enumerator kNIC_REG_READ_QOS_GC355

enumerator kNIC_REG_READ_QOS_PXP

enumerator kNIC_REG_READ_QOS_LCDIF

enumerator kNIC_REG_READ_QOS_LCDIFV2

enumerator kNIC_REG_READ_QOS_CSI

enumerator kNIC_REG_READ_QOS_CAAM

enumerator kNIC_REG_READ_QOS_ENET1G_RX

enumerator kNIC_REG_READ_QOS_ENET1G_TX

enumerator kNIC_REG_READ_QOS_ENET

enumerator kNIC_REG_READ_QOS_USBO2

enumerator kNIC_REG_READ_QOS_USDHC1

enumerator kNIC_REG_READ_QOS_USDHC2

enumerator kNIC_REG_READ_QOS_ENET_QOS

enumerator kNIC_REG_READ_QOS_CM7

enumerator kNIC_REG_READ_QOS_DMA

enumerator kNIC_REG_READ_QOS_IEE

enumerator kNIC_REG_WRITE_QOS_GC355

enumerator kNIC_REG_WRITE_QOS_PXP

enumerator kNIC_REG_WRITE_QOS_LCDIF

enumerator kNIC_REG_WRITE_QOS_LCDIFV2

enumerator kNIC_REG_WRITE_QOS_CSI

enumerator kNIC_REG_WRITE_QOS_CAAM

enumerator kNIC_REG_WRITE_QOS_ENET1G_RX

enumerator kNIC_REG_WRITE_QOS_ENET1G_TX

enumerator kNIC_REG_WRITE_QOS_ENET

enumerator kNIC_REG_WRITE_QOS_USBO2

enumerator kNIC_REG_WRITE_QOS_USDHC1

enumerator kNIC_REG_WRITE_QOS_USDHC2

enumerator kNIC_REG_WRITE_QOS_ENET_QOS

enumerator kNIC_REG_WRITE_QOS_CM7

enumerator kNIC_REG_WRITE_QOS_DMA

enumerator kNIC_REG_WRITE_QOS_IEE

enumerator kNIC_REG_FN_MOD_GC355

enumerator kNIC_REG_FN_MOD_PXP

enumerator kNIC_REG_FN_MOD_LCDIF

enumerator kNIC_REG_FN_MOD_LCDIFV2

enumerator kNIC_REG_FN_MOD_CSI

enumerator kNIC_REG_FN_MOD_CAAM

enumerator kNIC_REG_FN_MOD_ENET1G_RX

enumerator kNIC_REG_FN_MOD_ENET1G_TX

enumerator kNIC_REG_FN_MOD_ENET

enumerator kNIC_REG_FN_MOD_USBO2

enumerator kNIC_REG_FN_MOD_USDHC1

enumerator kNIC_REG_FN_MOD_USDHC2

enumerator kNIC_REG_FN_MOD_ENET_QOS

enumerator kNIC_REG_FN_MOD_CM7

enumerator kNIC_REG_FN_MOD_DMA

enumerator kNIC_REG_FN_MOD_IEE

enumerator kNIC_REG_FN_MOD_AHB_ENET

enumerator kNIC_REG_FN_MOD_AHB_DMA

enumerator kNIC_REG_WR_TIDEMARK_LPSRMIX_M

enum _nic_fn_mod_ahb

Values:

enumerator kNIC_FN_MOD_AHB_RD_INCR_OVERRIDE

enumerator kNIC_FN_MOD_AHB_WR_INCR_OVERRIDE

enumerator kNIC_FN_MOD_AHB_LOCK_OVERRIDE

enum _nic_fn_mod

Values:

enumerator kNIC_FN_MOD_ReadIssue

enumerator kNIC_FN_MOD_WriteIssue

enum _nic_qos

Values:

enumerator kNIC_QOS_0

enumerator kNIC_QOS_1

enumerator kNIC_QOS_2

enumerator kNIC_QOS_3

enumerator kNIC_QOS_4

enumerator kNIC_QOS_5

enumerator kNIC_QOS_6

enumerator kNIC_QOS_7

enumerator kNIC_QOS_8

enumerator kNIC_QOS_9

enumerator kNIC_QOS_10

enumerator kNIC_QOS_11

enumerator kNIC_QOS_12

enumerator kNIC_QOS_13

enumerator kNIC_QOS_14

enumerator kNIC_QOS_15

typedef enum *_nic_reg* nic_reg_t

typedef enum *_nic_fn_mod_ahb* nic_fn_mod_ahb_t

typedef enum *_nic_fn_mod* nic_fn_mod_t

typedef enum *_nic_qos* nic_qos_t

static inline void NIC_SetReadQos(*nic_reg_t* base, *nic_qos_t* value)

Set read_qos Value.

Parameters

- base – Base address of GPV address
- value – Target value (0 - 15)

static inline *nic_qos_t* NIC_GetReadQos(*nic_reg_t* base)

Get read_qos Value.

Parameters

- base – Base address of GPV address

Returns

Current value configured

static inline void NIC_SetWriteQos(*nic_reg_t* base, *nic_qos_t* value)

Set write_qos Value.

Parameters

- base – Base address of GPV address
- value – Target value (0 - 15)

static inline *nic_qos_t* NIC_GetWriteQos(*nic_reg_t* base)

Get write_qos Value.

Parameters

- base – Base address of GPV address

Returns

Current value configured

static inline void NIC_SetFnModAhb(*nic_reg_t* base, *nic_fn_mod_ahb_t* value)

Set fn_mod_ahb Value.

Parameters

- base – Base address of GPV address
- value – Target value

static inline *nic_fn_mod_ahb_t* NIC_GetFnModAhb(*nic_reg_t* base)

Get fn_mod_ahb Value.

Parameters

- base – Base address of GPV address

Returns

Current value configured

static inline void NIC_SetWrTideMark(*nic_reg_t* base, uint8_t value)

Set wr_tidemark Value.

Parameters

- base – Base address of GPV address
- value – Target value (0 - 15)

static inline uint8_t NIC_GetWrTideMark(*nic_reg_t* base)

Get wr_tidemark Value.

Parameters

- base – Base address of GPV address

Returns

Current value configured

static inline void NIC_SetFnMod(*nic_reg_t* base, *nic_fn_mod_t* value)

Set fn_mod Value.

Parameters

- base – Base address of GPV address
- value – Target value

static inline *nic_fn_mod_t* NIC_GetFnMod(*nic_reg_t* base)

Get fn_mod Value.

Parameters

- base – Base address of GPV address

Returns

Current value configured

FSL_NIC301_DRIVER_VERSION

NIC301 driver version 2.0.1.

GPV0_BASE

GPV1_BASE

GPV4_BASE

NIC_FN_MOD_AHB_OFFSET

NIC_WR_TIDEMARK_OFFSET

NIC_READ_QOS_OFFSET

NIC_WRITE_QOS_OFFSET

NIC_FN_MOD_OFFSET

NIC_GC355_BASE

NIC_PXP_BASE

NIC_LCDIF_BASE

NIC_LCDIFV2_BASE

NIC_CSI_BASE

NIC_CAAM_BASE

NIC_ENET1G_RX_BASE

NIC_ENET1G_TX_BASE

NIC_ENET_BASE

NIC_USBO2_BASE

NIC_USDHC1_BASE

NIC_USDHC2_BASE

NIC_ENET_QOS_BASE

NIC_CM7_BASE

NIC_LPSRMIX_M_BASE

NIC_DMA_BASE

NIC_IEE_BASE

NIC_QOS_MASK

NIC_WR_TIDEMARK_MASK

NIC_FN_MOD_AHB_MASK

NIC_FN_MOD_MASK

FSL_COMPONENT_ID

2.87 OCOTP: On Chip One-Time Programmable controller.

FSL_OCOTP_DRIVER_VERSION
OCOTP driver version.

_ocotp_status Error codes for the OCOTP driver.

Values:

enumerator kStatus_OCOTP_AccessError
eFuse and shadow register access error.

enumerator kStatus_OCOTP_CrcFail
CRC check failed.

enumerator kStatus_OCOTP_ReloadError
Error happens during reload shadow register.

enumerator kStatus_OCOTP_ProgramFail
Fuse programming failed.

enumerator kStatus_OCOTP_Locked
Fuse is locked and cannot be programmed.

typedef struct *_ocotp_timing* ocotp_timing_t
OCOTP timing structure. Note that, these value are used for calcalating the read/write timings. And the values should statisfy below rules:

Tsp_rd=(WAIT+1)/ipg_clk_freq should be >= 150ns; Tsp_pgm=(RELAX+1)/ipg_clk_freq should be >= 100ns; Trd = ((STROBE_READ+1)- 2*(RELAX_READ+1)) /ipg_clk_freq, The Trd is required to be larger than 40 ns. Tpgm = ((STROBE_PROG+1)- 2*(RELAX_PROG+1)) /ipg_clk_freq; The Tpgm should be configured within the range of 9000 ns < Tpgm < 11000 ns;

void OCOTP_Init(OCOTP_Type *base, uint32_t srcClock_Hz)

Initializes OCOTP controller.

Parameters

- base – OCOTP peripheral base address.
- srcClock_Hz – source clock frequency in unit of Hz. When the macro FSL_FEATURE_OCOTP_HAS_TIMING_CTRL is defined as 0, this parameter is not used, application could pass in 0 in this case.

void OCOTP_Deinit(OCOTP_Type *base)

De-initializes OCOTP controller.

Return values

kStatus_Success – upon successful execution, error status otherwise.

static inline bool OCOTP_CheckBusyStatus(OCOTP_Type *base)

Checking the BUSY bit in CTRL register. Checking this BUSY bit will help confirm if the OCOTP controller is ready for access.

Parameters

- base – OCOTP peripheral base address.

Return values

true – for bit set and false for cleared.

static inline bool OCOTP_CheckErrorStatus(OCOTP_Type *base)

Checking the ERROR bit in CTRL register.

Parameters

- base – OCOTP peripheral base address.

Return values

true – for bit set and false for cleared.

static inline void OCOTP_ClearErrorStatus(OCOTP_Type *base)

Clear the error bit if this bit is set.

Parameters

- base – OCOTP peripheral base address.

status_t OCOTP_ReloadShadowRegister(OCOTP_Type *base)

Reload the shadow register. This function will help reload the shadow register without reseting the OCOTP module. Please make sure the OCOTP has been initialized before calling this API.

Parameters

- base – OCOTP peripheral base addess.

Return values

- kStatus_Success – Reload success.
- kStatus_OCOTP_ReloadError – Reload failed.

uint32_t OCOTP_ReadFuseShadowRegister(OCOTP_Type *base, uint32_t address)

Read the fuse shadow register with the fuse addess.

Deprecated:

Use OCOTP_ReadFuseShadowRegisterExt instead of this function.

Parameters

- base – OCOTP peripheral base address.
- address – the fuse address to be read from.

Returns
The read out data.

status_t OCOTP_ReadFuseShadowRegisterExt(OCOTP_Type *base, uint32_t address, uint32_t *data, uint8_t fuseWords)

Read the fuse shadow register from the fuse addess.

This function reads fuse from address, how many words to read is specified by the parameter fuseWords. This function could read at most OCOTP_READ_FUSE_DATA_COUNT fuse word one time.

Parameters

- base – OCOTP peripheral base address.
- address – the fuse address to be read from.
- data – Data array to save the readout fuse value.
- fuseWords – How many words to read.

Return values

- kStatus_Success – Read success.
- kStatus_Fail – Error occurs during read.

status_t OCOTP_WriteFuseShadowRegister(OCOTP_Type *base, uint32_t address, uint32_t data)

Write the fuse shadow register with the fuse addess and data. Please make sure the wrtie address is not locked while calling this API.

Parameters

- base – OCOTP peripheral base address.
- address – the fuse address to be written.
- data – the value will be writen to fuse address.

Return values
write – status, kStatus_Success for success and kStatus_Fail for failed.

status_t OCOTP_WriteFuseShadowRegisterWithLock(OCOTP_Type *base, uint32_t address, uint32_t data, bool lock)

Write the fuse shadow register and lock it.

Please make sure the wrtie address is not locked while calling this API.

Some OCOTP controller supports ECC mode and redundancy mode (see reference mananual for more details). OCOTP controller will auto select ECC or redundancy mode to program the fuse word according to fuse map definition. In ECC mode, the 32 fuse bits in one word can only be written once. In redundancy mode, the word can be written more than once as long as they are different fuse bits. Set parameter lock as true to force use ECC mode.

Parameters

- base – OCOTP peripheral base address.
- address – The fuse address to be written.
- data – The value will be writen to fuse address.
- lock – Lock or unlock write fuse shadow register operation.

Return values

- kStatus_Success – Program and reload success.

- kStatus_OCOTP_Locked – The eFuse word is locked and cannot be programmed.
- kStatus_OCOTP_ProgramFail – eFuse word programming failed.
- kStatus_OCOTP_ReloadError – eFuse word programming success, but error happens during reload the values.
- kStatus_OCOTP_AccessError – Cannot access eFuse word.

static inline uint32_t OCOTP_GetVersion(OCOTP_Type *base)

Get the OCOTP controller version from the register.

Parameters

- base – OCOTP peripheral base address.

Return values

return – the version value.

OCOTP_READ_FUSE_DATA_COUNT

struct _ocotp_timing

#include <fsl_ocotp.h> OCOTP timing structure. Note that, these value are used for calcalating the read/write timings. And the values should statisfy below rules:

Tsp_rd=(WAIT+1)/ipg_clk_freq should be >= 150ns; Tsp_pgm=(RELAX+1)/ipg_clk_freq should be >= 100ns; Trd = ((STROBE_READ+1)- 2*(RELAX_READ+1)) /ipg_clk_freq, The Trd is required to be larger than 40 ns. Tpgm = ((STROBE_PROG+1)- 2*(RELAX_PROG+1)) /ipg_clk_freq; The Tpgm should be configured within the range of 9000 ns < Tpgm < 11000 ns;

Public Members

uint32_t wait

Wait time value to fill in the TIMING register.

uint32_t relax

Relax time value to fill in the TIMING register.

uint32_t strobe_prog

Storbe program time value to fill in the TIMING register.

uint32_t strobe_read

Storbe read time value to fill in the TIMING register.

2.88 OTFAD: On The Fly AES-128 Decryption Driver

void OTFAD_GetDefaultConfig(*otfad_config_t* *config)

OTFAD module initialization function.

Parameters

- config – OTFAD configuration.

AT_QUICKACCESS_SECTION_CODE (void OTFAD_Init(OTFAD_Type *base, const otfad_config_t *config))

OTFAD module initialization function.

Parameters

- base – OTFAD base address.

- config – OTFAD configuration.

AT_QUICKACCESS_SECTION_CODE (void OTFAD_Deinit(OTFAD_Type *base))

Deinitializes the OTFAD.

static inline uint32_t OTFAD_GetOperateMode(OTFAD_Type *base)

OTFAD module get operate mode.

Parameters

- base – OTFAD base address.

static inline uint32_t OTFAD_GetStatus(OTFAD_Type *base)

OTFAD module get status.

Parameters

- base – OTFAD base address.

status_t OTFAD_SetEncryptionConfig(OTFAD_Type *base, const *otfad_encryption_config_t* *config)

OTFAD module set encryption configuration.

Note: if enable keyblob process, the first 256 bytes external memory is use for keyblob data, so this region shouldn't be in OTFAD region.

Parameters

- base – OTFAD base address.
- config – encryption configuration.

status_t OTFAD_GetEncryptionConfig(OTFAD_Type *base, *otfad_encryption_config_t* *config)

OTFAD module get encryption configuration.

Note: if enable keyblob process, the first 256 bytes external memory is use for keyblob data, so this region shouldn't be in OTFAD region.

Parameters

- base – OTFAD base address.
- config – encryption configuration.

status_t OTFAD_HitDetermination(OTFAD_Type *base, uint32_t address, uint8_t *contextIndex)

OTFAD module do hit determination.

Parameters

- base – OTFAD base address.
- address – the physical address space assigned to the QuadSPI(FlexSPI) module.
- contextIndex – hitted context region index.

Returns

status, such as kStatus_Success or kStatus_OTFAD_ResRegAccessMode.

FSL_OTFAD_DRIVER_VERSION

Driver version.

Status codes for the OTFAD driver.

Values:

enumerator kStatus_OTFAD_ResRegAccessMode
Restricted register mode

enumerator kStatus_OTFAD_AddressError
End address less than start address

enumerator kStatus_OTFAD_RegionOverlap
the OTFAD does not support any form of memory region overlap, for system accesses that hit in multiple contexts or no contexts, the fetched data is simply bypassed

enumerator kStatus_OTFAD_RegionMiss
For accesses that hit in a single context, but not the selected one

OTFAD context type.

Values:

enumerator kOTFAD_Context_0
context 0

enumerator kOTFAD_Context_1
context 1

enumerator kOTFAD_Context_2
context 2

enumerator kOTFAD_Context_3
context 3

OTFAD operate mode.

Values:

enumerator kOTFAD_NRM
Normal Mode

enumerator kOTFAD_SVM
Security Violation Mode

enumerator kOTFAD_LDM
Logically Disabled Mode

typedef struct *_otfad_encryption_config* otfad_encryption_config_t
OTFAD encryption configuration structure.

typedef struct *_otfad_config* otfad_config_t
OTFAD configuration structure.

struct _otfad_encryption_config
#include <fsl_otfad.h> OTFAD encryption configuration structure.

Public Members

bool valid
The context is valid or not

bool AESdecryption
AES decryption enable

uint8_t readOnly
: read write attribute for the entire set of context registers

uint8_t contextIndex
: OTFAD context index

uint32_t startAddr
: Start address

uint32_t endAddr
: End address

uint32_t key[4]
: Encryption key

uint32_t counter[2]
: Encryption counter

struct _otfad_config
: *#include <fsl_otfad.h>* OTFAD configuration structure.

Public Members

bool forceSVM
: Force entry into SVM after a write

bool forceLDM
: Force entry into LDM after a write

bool restrictedRegAccess
: Restricted register access enable

bool enableOTFAD
: OTFAD has decryption enabled

2.89 PDM: Microphone Interface

2.90 PDM Driver

void PDM_Init(PDM_Type *base, const *pdm_config_t* *config)
: Initializes the PDM peripheral.

  Ungates the PDM clock, resets the module, and configures PDM with a configuration structure. The configuration structure can be custom filled or set with default values by PDM_GetDefaultConfig().

  Note: This API should be called at the beginning of the application to use the PDM driver. Otherwise, accessing the PDM module can cause a hard fault because the clock is not enabled.

  Parameters

  - base – PDM base pointer
  - config – PDM configuration structure.

void PDM_Deinit(PDM_Type *base)

De-initializes the PDM peripheral.

This API gates the PDM clock. The PDM module can't operate unless PDM_Init is called to enable the clock.

Parameters

- base – PDM base pointer

static inline void PDM_Reset(PDM_Type *base)

Resets the PDM module.

Parameters

- base – PDM base pointer

static inline void PDM_Enable(PDM_Type *base, bool enable)

Enables/disables PDM interface.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is enabled, false means PDM interface is disabled.

static inline void PDM_EnableDebugMode(PDM_Type *base, bool enable)

Enables/disables debug mode for PDM. The PDM interface cannot enter debug mode once in Disable/Low Leakage or Low Power mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface enter debug mode, false means PDM interface in normal mode.

static inline void PDM_EnableInDebugMode(PDM_Type *base, bool enable)

Enables/disables PDM interface in debug mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is enabled debug mode, false means PDM interface is disabled after after completing the current frame in debug mode.

static inline void PDM_EnterLowLeakageMode(PDM_Type *base, bool enable)

Enables/disables PDM interface disable/Low Leakage mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is in disable/low leakage mode, False means PDM interface is in normal mode.

static inline void PDM_EnableChannel(PDM_Type *base, uint8_t channel, bool enable)

Enables/disables the PDM channel.

Parameters

- base – PDM base pointer
- channel – PDM channel number need to enable or disable.
- enable – True means enable PDM channel, false means disable.

void PDM_SetChannelConfig(PDM_Type *base, uint32_t channel, const *pdm_channel_config_t* *config)

PDM one channel configurations.

Parameters

- base – PDM base pointer
- config – PDM channel configurations.
- channel – channel number. after completing the current frame in debug mode.

status_t PDM_SetSampleRateConfig(PDM_Type *base, uint32_t sourceClock_HZ, uint32_t sampleRate_HZ)

PDM set sample rate.

Note: This function is depend on the configuration of the PDM and PDM channel, so the correct call sequence is

```
PDM_Init(base, pdmConfig)
PDM_SetChannelConfig(base, channel, &channelConfig)
PDM_SetSampleRateConfig(base, source, sampleRate)
```

Parameters

- base – PDM base pointer
- sourceClock_HZ – PDM source clock frequency.
- sampleRate_HZ – PDM sample rate.

status_t PDM_SetSampleRate(PDM_Type *base, uint32_t enableChannelMask, *pdm_df_quality_mode_t* qualityMode, uint8_t osr, uint32_t clkDiv)

PDM set sample rate.

Deprecated:

Do not use this function. It has been superceded by PDM_SetSampleRateConfig

Parameters

- base – PDM base pointer
- enableChannelMask – PDM channel enable mask.
- qualityMode – quality mode.
- osr – cic oversample rate
- clkDiv – clock divider

uint32_t PDM_GetInstance(PDM_Type *base)

Get the instance number for PDM.

Parameters

- base – PDM base pointer.

static inline uint32_t PDM_GetStatus(PDM_Type *base)

Gets the PDM internal status flag. Use the Status Mask in _pdm_internal_status to get the status value needed.

Parameters

- base – PDM base pointer

Returns
PDM status flag value.

static inline uint32_t PDM_GetFifoStatus(PDM_Type *base)

Gets the PDM FIFO status flag. Use the Status Mask in _pdm_fifo_status to get the status value needed.

Parameters

- base – PDM base pointer

Returns
FIFO status.

static inline uint32_t PDM_GetRangeStatus(PDM_Type *base)

Gets the PDM Range status flag. Use the Status Mask in _pdm_range_status to get the status value needed.

Parameters

- base – PDM base pointer

Returns
output status.

static inline void PDM_ClearStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status between kPDM_StatusFrequencyLow and kPDM_StatusCh7FifoDataAvaliable.

static inline void PDM_ClearFIFOStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer
- mask – State mask.It can be a combination of the status in _pdm_fifo_status.

static inline void PDM_ClearRangeStatus(PDM_Type *base, uint32_t mask)

Clears the PDM range status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status in _pdm_range_status.

void PDM_EnableInterrupts(PDM_Type *base, uint32_t mask)

Enables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kPDM_ErrorInterruptEnable
  - kPDM_FIFOInterruptEnable

static inline void PDM_DisableInterrupts(PDM_Type *base, uint32_t mask)

Disables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kPDM_ErrorInterruptEnable
  - kPDM_FIFOInterruptEnable

static inline void PDM_EnableDMA(PDM_Type *base, bool enable)

Enables/disables the PDM DMA requests.

Parameters

- base – PDM base pointer
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t PDM_GetDataRegisterAddress(PDM_Type *base, uint32_t channel)

Gets the PDM data register address.

This API is used to provide a transfer address for the PDM DMA transfer configuration.

Parameters

- base – PDM base pointer.
- channel – Which data channel used.

Returns

data register address.

void PDM_ReadFifo(PDM_Type *base, uint32_t startChannel, uint32_t channelNums, void *buffer, size_t size, uint32_t dataWidth)

PDM read fifo.

Note: : This function support 16 bit only for IP version that only supports 16bit.

Parameters

- base – PDM base pointer.
- startChannel – start channel number.
- channelNums – total enabled channelnums.
- buffer – received buffer address.
- size – number of samples to read.
- dataWidth – sample width.

void PDM_SetChannelGain(PDM_Type *base, uint32_t channel, *pdm_df_output_gain_t* gain)

Set the PDM channel gain.

Please note for different quality mode, the valid gain value is different, reference RM for detail.

Parameters

- base – PDM base pointer.
- channel – PDM channel index.

- gain – channel gain, the register gain value range is 0 - 15.

void PDM_SetHwvadConfig(PDM_Type *base, const *pdm_hwvad_config_t* *config)

Configure voice activity detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector configure structure pointer .

static inline void PDM_ForceHwvadOutputDisable(PDM_Type *base, bool enable)

PDM hwvad force output disable.

Parameters

- base – PDM base pointer
- enable – true is output force disable, false is output not force.

static inline void PDM_ResetHwvad(PDM_Type *base)

PDM hwvad reset. It will reset VADNDATA register and will clean all internal buffers, should be called when the PDM isn't running.

Parameters

- base – PDM base pointer

static inline void PDM_EnableHwvad(PDM_Type *base, bool enable)

Enable/Disable Voice activity detector. Should be called when the PDM isn't running.

Parameters

- base – PDM base pointer.
- enable – True means enable voice activity detector, false means disable.

static inline void PDM_EnableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Enables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kPDM_HWVADErrorInterruptEnable
  - kPDM_HWVADInterruptEnable

static inline void PDM_DisableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Disables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kPDM_HWVADErrorInterruptEnable
  - kPDM_HWVADInterruptEnable

static inline void PDM_ClearHwvadInterruptStatusFlags(PDM_Type *base, uint32_t mask)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer

- mask – State mask,reference _pdm_hwvad_int_status.

static inline uint32_t PDM_GetHwvadInterruptStatusFlags(PDM_Type *base)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer

Returns

status, reference _pdm_hwvad_int_status

static inline uint32_t PDM_GetHwvadInitialFlag(PDM_Type *base)

Get the PDM voice activity detector initial flags.

Parameters

- base – PDM base pointer

Returns

initial flag.

static inline void PDM_EnableHwvadSignalFilter(PDM_Type *base, bool enable)

Enables/disables voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enable – True means enable signal filter, false means disable.

void PDM_SetHwvadSignalFilterConfig(PDM_Type *base, bool enableMaxBlock, uint32_t signalGain)

Configure voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enableMaxBlock – If signal maximum block enabled.
- signalGain – Gain value for the signal energy.

void PDM_SetHwvadNoiseFilterConfig(PDM_Type *base, const *pdm_hwvad_noise_filter_t* *config)

Configure voice activity detector noise filter.

Parameters

- base – PDM base pointer
- config – Voice activity detector noise filter configure structure pointer .

static inline void PDM_EnableHwvadZeroCrossDetector(PDM_Type *base, bool enable)

Enables/disables voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- enable – True means enable zero cross detector, false means disable.

void PDM_SetHwvadZeroCrossDetectorConfig(PDM_Type *base, const *pdm_hwvad_zero_cross_detector_t* *config)

Configure voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector zero cross detector configure structure pointer .

static inline uint16_t PDM_GetNoiseData(PDM_Type *base)

Reads noise data.

Parameters

- base – PDM base pointer.

Returns

Data in PDM noise data register.

static inline void PDM_SetHwvadInternalFilterStatus(PDM_Type *base, *pdm_hwvad_filter_status_t* status)

set hwvad internal filter status . Note: filter initial status should be asserted for two more cycles, then set it to normal operation.

Parameters

- base – PDM base pointer.
- status – internal filter status.

void PDM_SetHwvadInEnvelopeBasedMode(PDM_Type *base, const *pdm_hwvad_config_t* *hwvadConfig, const *pdm_hwvad_noise_filter_t* *noiseConfig, const *pdm_hwvad_zero_cross_detector_t* *zcdConfig, uint32_t signalGain)

set HWVAD in envelope based mode . Recommand configurations,

```
  static const pdm_hwvad_config_t hwvadConfig = {
    .channel          = 0,
    .initializeTime   = 10U,
    .cicOverSampleRate = 0U,
    .inputGain        = 0U,
    .frameTime        = 10U,
    .cutOffFreq       = kPDM_HwvadHpfBypassed,
    .enableFrameEnergy = false,
    .enablePreFilter  = true,
};

  static const pdm_hwvad_noise_filter_t noiseFilterConfig = {
    .enableAutoNoiseFilter = false,
    .enableNoiseMin        = true,
    .enableNoiseDecimation = true,
    .noiseFilterAdjustment = 0U,
    .noiseGain             = 7U,
    .enableNoiseDetectOR   = true,
  };
```

Parameters

- base – PDM base pointer.
- hwvadConfig – internal filter status.
- noiseConfig – Voice activity detector noise filter configure structure pointer.
- zcdConfig – Voice activity detector zero cross detector configure structure pointer .
- signalGain – signal gain value.

void PDM_SetHwvadInEnergyBasedMode(PDM_Type *base, const *pdm_hwvad_config_t* *hwvadConfig, const *pdm_hwvad_noise_filter_t* *noiseConfig, const *pdm_hwvad_zero_cross_detector_t* *zcdConfig, uint32_t signalGain)

brief set HWVAD in energy based mode . Recommand configurations, code static const pdm_hwvad_config_t hwvadConfig = { .channel = 0, .initializeTime = 10U, .cicOverSampleRate = 0U, .inputGain = 0U, .frameTime = 10U, .cutOffFreq = kPDM_HwvadHpfBypassed, .enableFrameEnergy = true, .enablePreFilter = true, };

static const pdm_hwvad_noise_filter_t noiseFilterConfig = { .enableAutoNoiseFilter = true, .enableNoiseMin = false, .enableNoiseDecimation = false, .noiseFilterAdjustment = 0U, .noiseGain = 7U, .enableNoiseDetectOR = false, }; code param base PDM base pointer. param hwvadConfig internal filter status. param noiseConfig Voice activity detector noise filter configure structure pointer. param zcdConfig Voice activity detector zero cross detector configure structure pointer . param signalGain signal gain value, signal gain value should be properly according to application.

void PDM_EnableHwvadInterruptCallback(PDM_Type *base, *pdm_hwvad_callback_t* vadCallback, void *userData, bool enable)

Enable/Disable hwvad callback.

This function enable/disable the hwvad interrupt for the selected PDM peripheral.

Parameters

- base – Base address of the PDM peripheral.
- vadCallback – callback Pointer to store callback function, should be NULL when disable.
- userData – user data.
- enable – true is enable, false is disable.

Return values

None. –

void PDM_TransferCreateHandle(PDM_Type *base, *pdm_handle_t* *handle, *pdm_transfer_callback_t* callback, void *userData)

Initializes the PDM handle.

This function initializes the handle for the PDM transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

status_t PDM_TransferSetChannelConfig(PDM_Type *base, *pdm_handle_t* *handle, uint32_t channel, const *pdm_channel_config_t* *config, uint32_t format)

PDM set channel transfer config.

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- channel – PDM channel.
- config – channel config.
- format – data format, support data width configurations,_pdm_data_width.

Return values

kStatus_PDM_ChannelConfig_Failed – or kStatus_Success.

status_t PDM_TransferReceiveNonBlocking(PDM_Type *base, *pdm_handle_t* *handle, *pdm_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on PDM.

Note: This API returns immediately after the transfer initiates. Call the PDM_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_PDM_Busy, the transfer is finished.

Parameters

- base – PDM base pointer
- handle – Pointer to the pdm_handle_t structure which stores the transfer state.
- xfer – Pointer to the pdm_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_PDM_Busy – Previous receive still not finished.

void PDM_TransferAbortReceive(PDM_Type *base, *pdm_handle_t* *handle)

Aborts the current IRQ receive.

Note: This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – PDM base pointer
- handle – Pointer to the pdm_handle_t structure which stores the transfer state.

void PDM_TransferHandleIRQ(PDM_Type *base, *pdm_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – PDM base pointer.
- handle – Pointer to the pdm_handle_t structure.

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PDM return status.

Values:

enumerator kStatus_PDM_Busy

PDM is busy.

enumerator kStatus_PDM_CLK_LOW

PDM clock frequency low

enumerator kStatus_PDM_FIFO_ERROR
PDM FIFO underrun or overflow

enumerator kStatus_PDM_QueueFull
PDM FIFO underrun or overflow

enumerator kStatus_PDM_Idle
PDM is idle

enumerator kStatus_PDM_Output_ERROR
PDM is output error

enumerator kStatus_PDM_ChannelConfig_Failed
PDM channel config failed

enumerator kStatus_PDM_HWVAD_VoiceDetected
PDM hwvad voice detected

enumerator kStatus_PDM_HWVAD_Error
PDM hwvad error

enum _pdm_interrupt_enable
The PDM interrupt enable flag.

Values:

enumerator kPDM_ErrorInterruptEnable
PDM channel error interrupt enable.

enumerator kPDM_FIFOInterruptEnable
PDM channel FIFO interrupt

enum _pdm_internal_status
The PDM status.

Values:

enumerator kPDM_StatusDfBusyFlag
Decimation filter is busy processing data

enumerator kPDM_StatusFrequencyLow
Mic app clock frequency not high enough

enumerator kPDM_StatusCh0FifoDataAvaliable
channel 0 fifo data reached watermark level

enumerator kPDM_StatusCh1FifoDataAvaliable
channel 1 fifo data reached watermark level

enumerator kPDM_StatusCh2FifoDataAvaliable
channel 2 fifo data reached watermark level

enumerator kPDM_StatusCh3FifoDataAvaliable
channel 3 fifo data reached watermark level

enum _pdm_channel_enable_mask
PDM channel enable mask.

Values:

enumerator kPDM_EnableChannel0
channgel 0 enable mask

enumerator kPDM_EnableChannel1
channgel 1 enable mask

enumerator kPDM_EnableChannel2
channgel 2 enable mask

enumerator kPDM_EnableChannel3
channgel 3 enable mask

enumerator kPDM_EnableChannelAll

enum _pdm_fifo_status
The PDM fifo status.

Values:

enumerator kPDM_FifoStatusUnderflowCh0
channel0 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh1
channel1 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh2
channel2 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh3
channel3 fifo status underflow

enumerator kPDM_FifoStatusOverflowCh0
channel0 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh1
channel1 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh2
channel2 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh3
channel3 fifo status overflow

enum _pdm_range_status
The PDM output status.

Values:

enumerator kPDM_RangeStatusUnderFlowCh0
channel0 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh1
channel1 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh2
channel2 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh3
channel3 range status underflow

enumerator kPDM_RangeStatusOverFlowCh0
channel0 range status overflow

enumerator kPDM_RangeStatusOverFlowCh1
channel1 range status overflow

enumerator kPDM_RangeStatusOverFlowCh2
channel2 range status overflow

enumerator kPDM_RangeStatusOverFlowCh3
channel3 range status overflow

enum _pdm_dc_remover
PDM DC remover configurations.

Values:

enumerator kPDM_DcRemoverCutOff21Hz
DC remover cut off 21HZ

enumerator kPDM_DcRemoverCutOff83Hz
DC remover cut off 83HZ

enumerator kPDM_DcRemoverCutOff152Hz
DC remover cut off 152HZ

enumerator kPDM_DcRemoverBypass
DC remover bypass

enum _pdm_df_quality_mode
PDM decimation filter quality mode.

Values:

enumerator kPDM_QualityModeMedium
quality mode memdium

enumerator kPDM_QualityModeHigh
quality mode high

enumerator kPDM_QualityModeLow
quality mode low

enumerator kPDM_QualityModeVeryLow0
quality mode very low0

enumerator kPDM_QualityModeVeryLow1
quality mode very low1

enumerator kPDM_QualityModeVeryLow2
quality mode very low2

enum _pdm_qulaity_mode_k_factor
PDM quality mode K factor.

Values:

enumerator kPDM_QualityModeHighKFactor
high quality mode K factor = 1 / 2

enumerator kPDM_QualityModeMediumKFactor
medium/very low0 quality mode K factor = 2 / 2

enumerator kPDM_QualityModeLowKFactor
low/very low1 quality mode K factor = 4 / 2

enumerator kPDM_QualityModeVeryLow2KFactor
very low2 quality mode K factor = 8 / 2

enum _pdm_df_output_gain

PDM decimation filter output gain.

Values:

enumerator kPDM_DfOutputGain0
Decimation filter output gain 0

enumerator kPDM_DfOutputGain1
Decimation filter output gain 1

enumerator kPDM_DfOutputGain2
Decimation filter output gain 2

enumerator kPDM_DfOutputGain3
Decimation filter output gain 3

enumerator kPDM_DfOutputGain4
Decimation filter output gain 4

enumerator kPDM_DfOutputGain5
Decimation filter output gain 5

enumerator kPDM_DfOutputGain6
Decimation filter output gain 6

enumerator kPDM_DfOutputGain7
Decimation filter output gain 7

enumerator kPDM_DfOutputGain8
Decimation filter output gain 8

enumerator kPDM_DfOutputGain9
Decimation filter output gain 9

enumerator kPDM_DfOutputGain10
Decimation filter output gain 10

enumerator kPDM_DfOutputGain11
Decimation filter output gain 11

enumerator kPDM_DfOutputGain12
Decimation filter output gain 12

enumerator kPDM_DfOutputGain13
Decimation filter output gain 13

enumerator kPDM_DfOutputGain14
Decimation filter output gain 14

enumerator kPDM_DfOutputGain15
Decimation filter output gain 15

enum _pdm_data_width

PDM data width.

Values:

enumerator kPDM_DataWwidth24
PDM data width 24bit

enumerator kPDM_DataWwidth32
PDM data width 32bit

enum _pdm_hwvad_interrupt_enable
PDM voice activity detector interrupt type.
Values:
enumerator kPDM_HwvadErrorInterruptEnable
PDM channel HWVAD error interrupt enable.
enumerator kPDM_HwvadInterruptEnable
PDM channel HWVAD interrupt

enum _pdm_hwvad_int_status
The PDM hwvad interrupt status flag.
Values:
enumerator kPDM_HwvadStatusInputSaturation
HWVAD saturation condition
enumerator kPDM_HwvadStatusVoiceDetectFlag
HWVAD voice detect interrupt triggered

enum _pdm_hwvad_hpf_config
High pass filter configure cut-off frequency.
Values:
enumerator kPDM_HwvadHpfBypassed
High-pass filter bypass
enumerator kPDM_HwvadHpfCutOffFreq1750Hz
High-pass filter cut off frequency 1750HZ
enumerator kPDM_HwvadHpfCutOffFreq215Hz
High-pass filter cut off frequency 215HZ
enumerator kPDM_HwvadHpfCutOffFreq102Hz
High-pass filter cut off frequency 102HZ

enum _pdm_hwvad_filter_status
HWVAD internal filter status.
Values:
enumerator kPDM_HwvadInternalFilterNormalOperation
internal filter ready for normal operation
enumerator kPDM_HwvadInternalFilterInitial
interla filter are initial

enum _pdm_hwvad_zcd_result
PDM voice activity detector zero cross detector result.
Values:
enumerator kPDM_HwvadResultOREnergyBasedDetection
zero cross detector result will be OR with energy based detection
enumerator kPDM_HwvadResultANDEnergyBasedDetection
zero cross detector result will be AND with energy based detection

typedef enum *_pdm_dc_remover* pdm_dc_remover_t
PDM DC remover configurations.

typedef enum *_pdm_df_quality_mode* pdm_df_quality_mode_t
PDM decimation filter quality mode.

typedef enum *_pdm_df_output_gain* pdm_df_output_gain_t
PDM decimation filter output gain.

typedef struct *_pdm_channel_config* pdm_channel_config_t
PDM channel configurations.

typedef struct *_pdm_config* pdm_config_t
PDM user configuration structure.

typedef enum *_pdm_hwvad_hpf_config* pdm_hwvad_hpf_config_t
High pass filter configure cut-off frequency.

typedef enum *_pdm_hwvad_filter_status* pdm_hwvad_filter_status_t
HWVAD internal filter status.

typedef struct *_pdm_hwvad_config* pdm_hwvad_config_t
PDM voice activity detector user configuration structure.

typedef struct *_pdm_hwvad_noise_filter* pdm_hwvad_noise_filter_t
PDM voice activity detector noise filter user configuration structure.

typedef enum *_pdm_hwvad_zcd_result* pdm_hwvad_zcd_result_t
PDM voice activity detector zero cross detector result.

typedef struct *_pdm_hwvad_zero_cross_detector* pdm_hwvad_zero_cross_detector_t
PDM voice activity detector zero cross detector configuration structure.

typedef struct *_pdm_transfer* pdm_transfer_t
PDM SDMA transfer structure.

typedef struct *_pdm_handle* pdm_handle_t
PDM handle.

typedef void (*pdm_transfer_callback_t)(PDM_Type *base, *pdm_handle_t* *handle, *status_t* status, void *userData)
PDM transfer callback prototype.

typedef void (*pdm_hwvad_callback_t)(*status_t* status, void *userData)
PDM HWVAD callback prototype.

typedef struct *_pdm_hwvad_notification* pdm_hwvad_notification_t
PDM HWVAD notification structure.

PDM_XFER_QUEUE_SIZE
PDM XFER QUEUE SIZE.

struct __pdm_channel_config
#include <fsl_pdm.h> PDM channel configurations.

Public Members

pdm_dc_remover_t cutOffFreq
DC remover cut off frequency

pdm_df_output_gain_t gain
Decimation Filter Output Gain

struct __pdm_config
#include <fsl_pdm.h> PDM user configuration structure.

Public Members

bool enableDoze
: This module will enter disable/low leakage mode if DOZEN is active with ipg_doze is asserted

bool enableFilterBypass
: Switchable bypass path for the decimation filter

uint8_t fifoWatermark
: Watermark value for FIFO

pdm_df_quality_mode_t qualityMode
: Quality mode

uint8_t cicOverSampleRate
: CIC filter over sampling rate

struct __pdm_hwvad_config
: *#include <fsl_pdm.h>* PDM voice activity detector user configuration structure.

Public Members

uint8_t channel
: Which channel uses voice activity detector

uint8_t initializeTime
: Number of frames or samples to initialize voice activity detector.

uint8_t cicOverSampleRate
: CIC filter over sampling rate

uint8_t inputGain
: Voice activity detector input gain

uint32_t frameTime
: Voice activity frame time

pdm_hwvad_hpf_config_t cutOffFreq
: High pass filter cut off frequency

bool enableFrameEnergy
: If frame energy enabled, true means enable

bool enablePreFilter
: If pre-filter enabled

struct __pdm_hwvad_noise_filter
: *#include <fsl_pdm.h>* PDM voice activity detector noise filter user configuration structure.

Public Members

bool enableAutoNoiseFilter
: If noise fileter automatically activated, true means enable

bool enableNoiseMin
: If Noise minimum block enabled, true means enabled

bool enableNoiseDecimation
: If enable noise input decimation

bool enableNoiseDetectOR
: Enables a OR logic in the output of minimum noise estimator block

uint32_t noiseFilterAdjustment
: The adjustment value of the noise filter

uint32_t noiseGain
: Gain value for the noise energy or envelope estimated

struct __pdm_hwvad_zero_cross_detector
: *#include <fsl_pdm.h>* PDM voice activity detector zero cross detector configuration structure.

Public Members

bool enableAutoThreshold
: If ZCD auto-threshold enabled, true means enabled.

pdm_hwvad_zcd_result_t zcdAnd
: Is ZCD result is AND'ed with energy-based detection, false means OR'ed

uint32_t threshold
: The adjustment value of the noise filter

uint32_t adjustmentThreshold
: Gain value for the noise energy or envelope estimated

struct __pdm_transfer
: *#include <fsl_pdm.h>* PDM SDMA transfer structure.

Public Members

volatile uint8_t *data
: Data start address to transfer.

volatile size_t dataSize
: Total Transfer bytes size.

struct __pdm_hwvad_notification
: *#include <fsl_pdm.h>* PDM HWVAD notification structure.

struct __pdm_handle
: *#include <fsl_pdm.h>* PDM handle structure.

Public Members

uint32_t state
: Transfer status

pdm_transfer_callback_t callback
: Callback function called at transfer event

void *userData
: Callback parameter passed to callback function

pdm_transfer_t pdmQueue[(4U)]
: Transfer queue storing queued transfer

size_t transferSize[(4U)]
: Data bytes need to transfer

volatile uint8_t queueUser
: Index for user to queue transfer

volatile uint8_t queueDriver
: Index for driver to get the transfer data and size

uint32_t format
: data format

uint8_t watermark
: Watermark value

uint8_t startChannel
: end channel

uint8_t channelNums
: Enabled channel number

2.91 PDM EDMA Driver

void PDM_TransferInstallEDMATCDMemory(*pdm_edma_handle_t* *handle, void *tcdAddr, size_t tcdNum)

Install EDMA descriptor memory.

Parameters

- handle – Pointer to EDMA channel transfer handle.
- tcdAddr – EDMA head descriptor address.
- tcdNum – EDMA link descriptor address.

void PDM_TransferCreateHandleEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, *pdm_edma_callback_t* callback, void *userData, *edma_handle_t* *dmaHandle)

Initializes the PDM Rx eDMA handle.

This function initializes the PDM slave DMA handle, which can be used for other PDM master transactional APIs. Usually, for a specified PDM instance, call this API once to get the initialized handle.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

void PDM_TransferSetMultiChannelInterleaveType(*pdm_edma_handle_t* *handle, *pdm_edma_multi_channel_interleave_t* multiChannelInterleaveType)

Initializes the multi PDM channel interleave type.

This function initializes the PDM DMA handle member interleaveType, it shall be called only when application would like to use type

kPDM_EDMAMultiChannelInterleavePerChannelBlock, since the default interleaveType is kPDM_EDMAMultiChannelInterleavePerChannelSample always

Parameters

- handle – PDM eDMA handle pointer.
- multiChannelInterleaveType – Multi channel interleave type.

void PDM_TransferSetChannelConfigEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, uint32_t channel, const *pdm_channel_config_t* *config)

Configures the PDM channel.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.
- channel – channel index.
- config – pdm channel configurations.

status_t PDM_TransferReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, *pdm_edma_transfer_t* *xfer)

Performs a non-blocking PDM receive using eDMA.

Mcaro MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL can control whether PDM is enabled internally or externally.

a. Scatter gather case: This functio support dynamic scatter gather and staic scatter gather, a. for the dynamic scatter gather case: Application should call PDM_TransferReceiveEDMA function continuously to make sure new receive request is submit before the previous one finish. b. for the static scatter gather case: Application should use the link transfer feature and make sure a loop link transfer is provided, such as:

```
pdm_edma_transfer_t pdmXfer[2] =
{
    {
    .data  = s_buffer,
    .dataSize = BUFFER_SIZE,
    .linkTransfer = &pdmXfer[1],
    },

    {
    .data  = &s_buffer[BUFFER_SIZE],
    .dataSize = BUFFER_SIZE,
    .linkTransfer = &pdmXfer[0]
    },
};
```

b. Multi channel case: This function support receive multi pdm channel data, for example, if two channel is requested,

```
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↪ENABLE_CHANNEL_0, &channelConfig);
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↪ENABLE_CHANNEL_1, &channelConfig);
PDM_TransferReceiveEDMA(DEMO_PDM, &s_pdmRxHandle_0, pdmXfer);
```

The output data will be formatted as below if handle->interleaveType =

Note: This interface returns immediately after the transfer initiates. Call the PDM_GetReceiveRemainingBytes to poll the transfer status and check whether the PDM transfer is finished.

void PDM_TransferTerminateReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Terminate all PDM receive.

This function will clear all transfer slots buffered in the pdm queue. If users only want to abort the current transfer slot, please call PDM_TransferAbortReceiveEDMA.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.

void PDM_TransferAbortReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Aborts a PDM receive using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call PDM_TransferTerminateReceiveEDMA.

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.

status_t PDM_TransferGetReceiveCountEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, size_t *count)

Gets byte count received by PDM.

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.
- count – Bytes count received by PDM.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

FSL_PDM_EDMA_DRIVER_VERSION

Version 2.6.5

enum _pdm_edma_multi_channel_interleave

pdm multi channel interleave type

Values:

enumerator kPDM_EDMAMultiChannelInterleavePerChannelSample

enumerator kPDM_EDMAMultiChannelInterleavePerChannelBlock

typedef struct *_pdm_edma_handle* pdm_edma_handle_t

PDM edma handler.

typedef enum *_pdm_edma_multi_channel_interleave* pdm_edma_multi_channel_interleave_t

pdm multi channel interleave type

typedef struct *_pdm_edma_transfer* pdm_edma_transfer_t

PDM edma transfer.

typedef void (*pdm_edma_callback_t)(PDM_Type *base, *pdm_edma_handle_t* *handle, *status_t* status, void *userData)

PDM eDMA transfer callback function for finish and error.

MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL

the PDM enable position When calling PDM_TransferReceiveEDMA

struct _pdm_edma_transfer

#include <fsl_pdm_edma.h> PDM edma transfer.

Public Members

volatile uint8_t *data

Data start address to transfer.

volatile size_t dataSize

Total Transfer bytes size.

struct *_pdm_edma_transfer* *linkTransfer

linked transfer configurations

struct _pdm_edma_handle

#include <fsl_pdm_edma.h> PDM DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaHandle

DMA handler for PDM send

uint8_t count

The transfer data count in a DMA request

uint32_t receivedBytes

total transfer count

uint32_t state

Internal state for PDM eDMA transfer

pdm_edma_callback_t callback

Callback for users while transfer finish or error occurs

bool isLoopTransfer

loop transfer

void *userData

User callback parameter

edma_tcd_t *tcd

TCD pool for eDMA transfer.

uint32_t tcdNum

TCD number

uint32_t tcdUser

Index for user to queue transfer.

uint32_t tcdDriver
Index for driver to get the transfer data and size

volatile uint32_t tcdUsedNum
Index for user to queue transfer.

pdm_edma_multi_channel_interleave_t interleaveType
multi channel transfer interleave type

uint8_t endChannel
The last enabled channel

uint8_t channelNums
total channel numbers

2.92 PGMC

The enumeration of setpoint. .

Values:

enumerator kPGMC_SetPoint0
The mask of set point0.

enumerator kPGMC_SetPoint1
The mask of set point1.

enumerator kPGMC_SetPoint2
The mask of set point2.

enumerator kPGMC_SetPoint3
The mask of set point3.

enumerator kPGMC_SetPoint4
The mask of set point4.

enumerator kPGMC_SetPoint5
The mask of set point5.

enumerator kPGMC_SetPoint6
The mask of set point6.

enumerator kPGMC_SetPoint7
The mask of set point7.

enumerator kPGMC_SetPoint8
The mask of set point8.

enumerator kPGMC_SetPoint9
The mask of set point9.

enumerator kPGMC_SetPoint10
The mask of set point10.

enumerator kPGMC_SetPoint11
The mask of set point11.

enumerator kPGMC_SetPoint12
The mask of set point12.

enumerator kPGMC_SetPoint13
The mask of set point13.

enumerator kPGMC_SetPoint14
The mask of set point14.

enumerator kPGMC_SetPoint15
The mask of set point15.

enum _pgmc_mif_signal_behaviour
The enumeration of MIF signal behaviour(Such as Sleep Signal, Standby Signal, and so on).

Values:

enumerator kPGMC_AssertSleepSignal
Assert Sleep signal.

enumerator kPGMC_AssertInputGateSignal
Assert InputGate signal.

enumerator kPGMC_AssetLowSpeedSignal
Assert LowSpeed signal.

enumerator kPGMC_AssertHighSpeedSignal
Assert HighSpeed signal.

enumerator kPGMC_AssertStandbySignal
Assert Standby signal.

enumerator kPGMC_AssertArrayPowerDownSignal
Assert ArrayPowerDown signal.

enumerator kPGMC_AssertPeripheralPowerDownSignal
Assert PeripheralPowerDown signal.

enumerator kPGMC_AssertInitnSignal
Assert Initn signal.

enumerator kPGMC_AssertSwitch1OffSignal
Assert Switch1Off signal.

enumerator kPGMC_AssertSwitch2OffSignal
Assert Switch2Off signal.

enumerator kPGMC_AssertIsoSignal
Assert Iso_en signal.

enum _pgmc_bpc_assign_domain
PGMC BPC assign domain enumeration.

Values:

enumerator kPGMC_CM7Core
CM7 Core domain.

enumerator kPGMC_CM4Core
CM4 Core domain.

enum _pgmc_cpu_mode
CPU mode.

Values:

enumerator kPGMC_RunMode
RUN mode.

enumerator kPGMC_WaitMode
WAIT mode.

enumerator kPGMC_StopMode
STOP mode.

enumerator kPGMC_SuspendMode
SUSPEND mode.

enum _pgmc_control_mode
PGMC control modes.

Values:

enumerator kPGMC_DisableLowPowerControl

enumerator kPGMC_ControlledByCpuPowerMode

enumerator kPGMC_ControlledBySetPoint

enum _pgmc_memory_low_power_level
The enumeration of memory low power level.

Values:

enumerator kPGMC_MLPLHighSpeed
Memory low power level: High speed.

enumerator kPGMC_MLPLNormal
Memory low power level: Normal.

enumerator kPGMC_MLPLLowSpeed
Memory low power level: Low Speed.

enumerator kPGMC_MLPLInputGating
Memory low power level: Input Gating.

enumerator kPGMC_MLPLStandby
Memory low power level: Standby.

enumerator kPGMC_MLPLSleep
Memory low power level: Sleep.

enumerator kPGMC_MLPLArrOnPerOff
Memory low power level: Arr on per off.

enumerator kPGMC_MLPLArrOffPerOn
Memory low power level: Arr off per on.

enumerator kPGMC_MLPLArrOffPerOff
Memory low power level: Arr off per off.

enumerator kPGMC_MLPLSw2
Memory low power level: SW2.

enumerator kPGMC_MLPLSw2PerOff
Memory low power level: SW2 Per off.

enumerator kPGMC_MLPLSw1PerOff
Memory low power level: SW1 Per off.

enum _pgmc_mif_signal

The enumeration of MIF signal.

Values:

enumerator kPGMC_SleepSignal

MIF Sleep signal.

enumerator kPGMC_InputGateSignal

MIF InputGate signal.

enumerator kPGMC_LowSpeedSignal

MIF LowSpeed signal.

enumerator kPGMC_HighSpeedSignal

MIF HighSpeed signal.

enumerator kPGMC_StandbySignal

MIF Standby signal.

enumerator kPGMC_ArrayPowerDownSignal

MIF ArrayPowerDown signal.

enumerator kPGMC_PeripheralPowerDownSignal

MIF PeripheralPowerDown signal.

enumerator kPGMC_InitnSignal

MIF Initn signal.

enumerator kPGMC_Switch1OffSignal

MIF Switch1Off signal.

enumerator kPGMC_Switch2OffSignal

MIF Switch2Off signal.

enumerator kPGMC_IsoSignal

MIF Iso_en signal.

typedef enum *_pgmc_bpc_assign_domain* pgmc_bpc_assign_domain_t

PGMC BPC assign domain enumeration.

typedef enum *_pgmc_cpu_mode* pgmc_cpu_mode_t

CPU mode.

typedef enum *_pgmc_control_mode* pgmc_control_mode_t

PGMC control modes.

typedef enum *_pgmc_memory_low_power_level* pgmc_memory_low_power_level_t

The enumeration of memory low power level.

typedef enum *_pgmc_mif_signal* pgmc_mif_signal_t

The enumeration of MIF signal.

typedef struct *_pgmc_bpc_cpu_power_mode_option* pgmc_bpc_cpu_power_mode_option_t

The control option of the power domain controlled by CPU power mode.

typedef struct *_pgmc_bpc_setpoint_mode_option* pgmc_bpc_setpoint_mode_option_t

The control option of the power domain controlled by setpoint mode.

FSL_PGMC_RIVER_VERSION

PGMC driver version 2.1.2.

void PGMC_BPC_ControlPowerDomainByCpuPowerMode(PGMC_BPC_Type *base, *pgmc_cpu_mode_t* mode, const *pgmc_bpc_cpu_power_mode_option_t* *option)

Makes the BPC module controlled by the target CPU power mode, such as Wait mode.

This function makes the module controlled by four typical CPU power modes, It also configs the resource domain and set memory low power level.

Parameters

- base – PGMC basic power controller base address.
- mode – Target CPU power mode.
- option – The pointer of pgmc_bpc_cpu_power_mode_option_t structure.

void PGMC_BPC_ControlPowerDomainBySetPointMode(PGMC_BPC_Type *base, uint32_t setPointMap, const *pgmc_bpc_setpoint_mode_option_t* *option)

Makes the BPC module controlled by the target set points.

This function makes the module controlled by specific set point, It also supports set memory lowe power level.

Note: When setting more than one set point, use "|" between the map values in _pgmc_setpoint_map.

Parameters

- base – PGMC basic power controller base address.
- setPointMap – Should be the OR'ed value of _pgmc_setpoint_map.
- option – The pointer of pgmc_bpc_setpoint_mode_option_t structure.

void PGMC_BPC_ControlPowerDomainBySoftwareMode(PGMC_BPC_Type *base, bool powerOff)

Controls the selected power domain by software mode.

Note: The function is used to control power domain when the CPU is in RUN mode.

Parameters

- base – PGMC basic power controller base address.
- powerOff – Power On/Off power domain in software mode.
  - **true** Power off the power domain in software mode.
  - **false** Power on the power domain in software mode.

static inline void PGMC_BPC_DisableLowPower(PGMC_BPC_Type *base)

Disables low power mode control.

Parameters

- base – PGMC basic power controller base address.

static inline void PGMC_BPC_RequestStateRestoreAtRunMode(PGMC_BPC_Type *base)

Requests power domain state restore at run mode.

Parameters

- base – PGMC basic power controller base address.

static inline void PGMC_BPC_RequestStateRestoreAtSetPoint(PGMC_BPC_Type *base, uint32_t setPointMap)

Requests power domain state restore when enters the selected set points.

Note: When setting more than one set point, use "|" between the map values in _pgmc_setpoint_map.

Parameters

- base – PGMC basic power controller base address.
- setPointMap – Should be the OR'ed value of _pgmc_setpoint_map.

static inline void PGMC_BPC_AllowUserModeAccess(PGMC_BPC_Type *base, bool enable)

Allows user mode access or not for the BPC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – PGMC basic power controller base address.
- enable – Used to control whether allow user mode access.
  - **true** Allow both privilege and user mode to access CPU mode control registers.
  - **false** Allow only privilege mode to access CPU mode control registers.

static inline void PGMC_BPC_AllowNonSecureModeAccess(PGMC_BPC_Type *base, bool enable)

Allows non-secure mode access or not for the BPC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – PGMC basic power controller base address.
- enable – Used to control whether allow non-secure mode to access CPU mode control registers.
  - **true** Allow both secure and non-secure mode to access CPU mode control registers.
  - **false** Allow only secure mode to access CPU mode control registers.

static inline void PGMC_BPC_LockAccessSetting(PGMC_BPC_Type *base)

Locks access related settings for the BPC module, including Secure access setting and user access setting.

Note: This function used to lock access related settings. After locked the related bit field can not be written unless POR.

Parameters

- base – PGMC basic power controller base address.

static inline void PGMC_BPC_SetDomainIdWhiteList(PGMC_BPC_Type *base, uint8_t domainId)

Sets the corrsponding domain ID that can access CPU mode control registers for the BPC module.

Note: If locked the domain ID white list, the setting via this function is useless.

Parameters

- base – PGMC basic power controller base address.
- domainId – Should be the OR'ed value of pgmc_bpc_assign_domain_t.

static inline void PGMC_BPC_LockDomainIDWhiteList(PGMC_BPC_Type *base)

Locks the value of Domain ID white list for the BPC module.

Note: After locked the domain ID white list can not be written again unless POR.

Parameters

- base – PGMC basic power controller base address.

static inline void PGMC_BPC_LockLowPowerConfigurationFields(PGMC_BPC_Type *base)

Locks low power configuration fields for the BPC module.

Note: After locked the low power configurations fields can not be updated unless POR.

Parameters

- base – PGMC basic power controller base address.

void PGMC_CPC_CORE_PowerOffByCpuPowerMode(PGMC_CPC_Type *base, *pgmc_cpu_mode_t* mode)

Powers off the CPC core module by the target CPU power mode, such as Wait mode.

Parameters

- base – CPC CORE module base address.
- mode – Target CPU power mode.

static inline void PGMC_CPC_CORE_PowerOffBySoftwareMode(PGMC_CPC_Type *base, bool powerOff)

Powers off/on the CPC core module by the software.

Parameters

- base – CPC CORE module base address.
- powerOff – Used to power off/on the CPC core module.
  - **true** Power off the CPC core module.
  - **false** Power on the CPC core module.

static inline void PGMC_CPC_CORE_DisableLowPower(PGMC_CPC_Type *base)

Disables low power mode control, the CPU core will not be affected by any low power modes.

Parameters

- base – CPC CORE module base address.

void PGMC_CPC_CACHE_ControlByCpuPowerMode(PGMC_CPC_Type *base, *pgmc_cpu_mode_t* mode, *pgmc_memory_low_power_level_t* memoryLowPowerLevel)

Makes the CPC CACHE module controlled by the target CPU power mode, such as Wait mode.

This function makes the module controlled by four typical CPU power modes, it also can set memory low power level.

Parameters

- base – CPC CACHE module base address.
- mode – Target CPU power mode.
- memoryLowPowerLevel – Memory low power level.

void PGMC_CPC_CACHE_ControlBySetPointMode(PGMC_CPC_Type *base, uint32_t setPointMap, *pgmc_memory_low_power_level_t* memoryLowPowerLevel)

Makes the CPC CACHE module controlled by the target set points.

This function makes the module controlled by specific set point, It also supports set memory lowe power level.

Note: When setting more than one set point, use "|" between the map values in _pgmc_setpoint_map.

Parameters

- base – CPC CACHE module base address.
- setPointMap – Should be the OR'ed value of _pgmc_setpoint_map.
- memoryLowPowerLevel – Memory low power level.

static inline void PGMC_CPC_CACHE_DisableLowPower(PGMC_CPC_Type *base)

Disables low power mode control, so the cache will not be affected by any low power modes.

Parameters

- base – CPC CACHE module base address.

void PGMC_CPC_CACHE_TriggerMLPLSoftwareChange(PGMC_CPC_Type *base)

Requests CPC cache module's memory low power level change by software mode.

Note: If request memory low power level change, must wait the MLPL transition complete.

Parameters

- base – CPC LMEM module base address.

void PGMC_CPC_LMEM_ControlByCpuPowerMode(PGMC_CPC_Type *base, *pgmc_cpu_mode_t* mode, *pgmc_memory_low_power_level_t* memoryLowPowerLevel)

Makes the CPC LMEM module controlled by the target CPU power mode, such as Wait mode.

This function makes the module controlled by four typical CPU power modes, it also can set memory low power level.

Parameters

- base – CPC LMEM module base address.
- mode – Target CPU power mode.
- memoryLowPowerLevel – Memory low power level.

void PGMC_CPC_LMEM_ControlBySetPointMode(PGMC_CPC_Type *base, uint32_t setPointMap, *pgmc_memory_low_power_level_t* memoryLowPowerLevel)

Makes the CPC LMEM module controlled by the target set points.

This function makes the module controlled by specific set point, It also supports set memory lowe power level.

Note: When setting more than one set point, use "|" between the map values in _pgmc_setpoint_map.

Parameters

- base – CPC LMEM module base address.
- setPointMap – Should be the OR'ed value of _pgmc_setpoint_map.
- memoryLowPowerLevel – Memory low power level.

static inline void PGMC_CPC_LMEM_DisableLowPower(PGMC_CPC_Type *base)

Disables low power mode control, so that the CPC LMEM will not be affected by any low power modes.

Parameters

- base – CPC LMEM module base address.

void PGMC_CPC_LMEM_TriggerMLPLSoftwareChange(PGMC_CPC_Type *base)

Requests CPC LMEM module's memory low power level change in software mode.

Note: If request memory low power level change, must wait the MLPL transition complete.

Parameters

- base – CPC LMEM module base address.

static inline void PGMC_CPC_AllowUserModeAccess(PGMC_CPC_Type *base, bool enable)

Allows user mode access or not for the CPC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – CPC LMEM module base address.
- enable – Used to control whether allow user mode access.
  - **true** Allow both privilege and user mode to access CPU mode control registers.
  - **false** Allow only privilege mode to access CPU mode control registers.

static inline void PGMC_CPC_AllowNonSecureModeAccess(PGMC_CPC_Type *base, bool enable)

Allows non-secure mode access or not for the CPC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – CPC LMEM module base address.
- enable – Used to control whether allow non-secure mode to access CPU mode control registers.
  - **true** Allow both secure and non-secure mode to access CPU mode control registers.
  - **false** Allow only secure mode to access CPU mode control registers.

static inline void PGMC_CPC_LockAccessSetting(PGMC_CPC_Type *base)

Locks access related settings, including secure access setting and user access setting, for the CPC module.

Note: This function used to lock access related settings. After locked the related bit field can not be written unless POR.

Parameters

- base – CPC LMEM module base address.

static inline void PGMC_CPC_SetDomainIdWhiteList(PGMC_CPC_Type *base, uint8_t domainId)

Sets the corrsponding domain ID that can access CPU mode control registers for the CPC module.

Note: If the domain ID whitelist is locked, the setting via this function is useless.

Parameters

- base – CPC LMEM module base address.
- domainId – Should be the OR'ed value of pgmc_bpc_assign_domain_t.

static inline void PGMC_CPC_LockDomainIDWhiteList(PGMC_CPC_Type *base)

Locks the value of Domain ID white list for CPC module.

Note: After locked the domain ID white list can not be written again unless POR.

Parameters

- base – CPC LMEM module base address.

static inline void PGMC_CPC_LockLowPowerConfigurationFields(PGMC_CPC_Type *base)

Locks CPC realted low power configuration fields for CPC module.

Note: After locked the low power configurations fields can not be updated unless POR.

Parameters

- base – CPC LMEM module base address.

void PGMC_MIF_SetSignalBehaviour(PGMC_MIF_Type *base, *pgmc_memory_low_power_level_t* memoryLevel, uint32_t mask)

Sets the behaviour of each signal in MIF, such as Sleep signal.

Note: To control the memory low power operation, this function must be invoked after selecting the memory low power level. Use case:

```
PGMC_BPC_ControlPowerDomainByCpuPowerMode(PGMC_BPC0_BASE, kPGMC_WaitMode,␣
↪kPGMC_CM7Core,
    kPGMC_MLPLSleep, false);
PGMC_MIF_SetSignalBehaviour(PGMC_BPC0_MIF_BASE, kPGMC_MLPLSleep, kPGMC_
↪AssertSleepSignal);
```

Parameters

- base – PGMC MIF peripheral base address.
- memoryLevel – The selected memory low power level. For details please refer to pgmc_memory_low_power_level_t.
- mask – The mask of MIF signal behaviour. Should be the OR'ed value of _pgmc_mif_signal_behaviour

static inline void PGMC_MIF_LockLowPowerConfigurationFields(PGMC_MIF_Type *base)

Locks MIF realted low power configuration fields for MIF module.

Note: After locked the low power configurations fields can not be updated unless POR.

Parameters

- base – PGMC MIF peripheral base address.

static inline void PGMC_PPC_TriggerPMICStandbySoftMode(PGMC_PPC_Type *base, bool enable)

Trigger PMIC standby ON/OFF.

Parameters

- base – PMIC module base address.
- enable – Trigger on/off PMIC standby.
  - **true** Trigger PMIC standby ON.
  - **false** Trigger PMIC standby OFF.

void PGMC_PPC_ControlByCpuPowerMode(PGMC_PPC_Type *base, *pgmc_cpu_mode_t* mode)

Makes the PMIC module controlled by the target CPU power mode, such as Wait mode.

Parameters

- base – PMIC module base address.
- mode – Target CPU power mode.

void PGMC_PPC_ControlBySetPointMode(PGMC_PPC_Type *base, uint32_t setPointMap, bool enableStandby)

Makes the PMIC module controlled by the target set points.

This function makes the module controlled by specific set point, It also supports PMIC standby on.

Note: When setting more than one set point, use "|" between the map values in _pgmc_setpoint_map.

Parameters

- base – PMIC module base address.
- setPointMap – Should be the OR'ed value of _pgmc_setpoint_map.
- enableStandby – true: PMIC standby on when system enters set point number and system is in standby mode. false: PMIC standby on when system enters set point number

static inline void PGMC_PPC_DisableLowPower(PGMC_PPC_Type *base)

Disables low power mode control.

Parameters

- base – PMIC module bsase address.

static inline void PGMC_PPC_AllowUserModeAccess(PGMC_PPC_Type *base, bool enable)

Allows user mode access or not for PMIC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – PMIC module base address.
- enable – Used to control whether allow user mode access.
  - **true** Allow both privilege and user mode to access CPU mode control registers.
  - **false** Allow only privilege mode to access CPU mode control registers.

static inline void PGMC_PPC_AllowNonSecureModeAccess(PGMC_PPC_Type *base, bool enable)

Allows non-secure mode access or not for the PMIC module.

Note: If locked access related settings, the setting via this function is useless.

Parameters

- base – PMIC module base address.
- enable – Used to control whether allow non-secure mode to access CPU mode control registers.
  - **true** Allow both secure and non-secure mode to access CPU mode control registers.
  - **false** Allow only secure mode to access CPU mode control registers.

static inline void PGMC_PPC_LockAccessSetting(PGMC_PPC_Type *base)

Locks access related settings, including secure access setting and user access setting, for the PMIC module.

Note: This function used to lock access related settings. After locked the related bit field can not be written unless POR.

Parameters

- base – PMIC module base address.

static inline void PGMC_PPC_SetDomainIdWhiteList(PGMC_PPC_Type *base, uint8_t domainId)

Sets the corrsponding domain ID that can access CPU mode control registers for the PMIC module.

Note: If the domain ID whitelist is locked, the setting via this function is useless.

Parameters

- base – PMIC module base address.
- domainId – Should be the OR'ed value of pgmc_bpc_assign_domain_t.

static inline void PGMC_PPC_LockDomainIDWhiteList(PGMC_PPC_Type *base)

Locks the value of Domain ID white list for the PMIC module.

Note: After locked the domain ID white list can not be written again unless POR.

Parameters

- base – PMIC module base address.

static inline void PGMC_PPC_LockLowPowerConfigurationFields(PGMC_PPC_Type *base)

Locks low power configuration fields for the PMIC module.

Note: After locked the low power configurations fields can not be updated unless POR.

Parameters

- base – PMIC module base address.

struct __pgmc_bpc_cpu_power_mode_option

#include <fsl_pgmc.h> The control option of the power domain controlled by CPU power mode.

Public Members

pgmc_bpc_assign_domain_t assignDomain

Domain assignment of the BPC. The power mode of the selected core domain will control the selected power domain.

bool stateSave

Request save the state of power domain before entering target power mode.

- **true** Save data when domain enter the selected mode.

- **false** Do not save data when domain enter the selected mode.

bool powerOff

Request power off the power domain.

- **true** Power off the power domain when enter the selected mode.
- **false** Do not power off the power domain when enter the selected mode.

struct __pgmc_bpc_setpoint_mode_option

#include <fsl_pgmc.h> The control option of the power domain controlled by setpoint mode.

Public Members

bool stateSave

Request save the state of power domain before entering target setpoint.

- **true** Save data when domain enter the selected setpoint.
- **false** Do not save data when domain enter the selected setpoint.

bool powerOff

Request power off the power domain.

- **true** Power off the power domain when enter the selected setpoint.
- **false** Do not power off the power domain when enter the selected setpoint.

2.93 PIT: Periodic Interrupt Timer

void PIT_Init(PIT_Type *base, const *pit_config_t* *config)

Ungates the PIT clock, enables the PIT module, and configures the peripheral for basic operations.

Note: This API should be called at the beginning of the application using the PIT driver.

Parameters

- base – PIT peripheral base address
- config – Pointer to the user's PIT config structure

void PIT_Deinit(PIT_Type *base)

Gates the PIT clock and disables the PIT module.

Parameters

- base – PIT peripheral base address

static inline void PIT_GetDefaultConfig(*pit_config_t* *config)

Fills in the PIT configuration structure with the default settings.

The default values are as follows.

```
config->enableRunInDebug = false;
```

Parameters

- config – Pointer to the configuration structure.

static inline void PIT_SetTimerChainMode(PIT_Type *base, *pit_chnl_t* channel, bool enable)

Enables or disables chaining a timer with the previous timer.

When a timer has a chain mode enabled, it only counts after the previous timer has expired. If the timer n-1 has counted down to 0, counter n decrements the value by one. Each timer is 32-bits, which allows the developers to chain timers together and form a longer timer (64-bits and larger). The first timer (timer 0) can't be chained to any other timer.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number which is chained with the previous timer
- enable – Enable or disable chain. true: Current timer is chained with the previous timer. false: Timer doesn't chain with other timers.

static inline void PIT_EnableInterrupts(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Enables the selected PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

static inline void PIT_DisableInterrupts(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Disables the selected PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- mask – The interrupts to disable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

static inline uint32_t PIT_GetEnabledInterrupts(PIT_Type *base, *pit_chnl_t* channel)

Gets the enabled PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns

The enabled interrupts. This is the logical OR of members of the enumeration pit_interrupt_enable_t

static inline uint32_t PIT_GetStatusFlags(PIT_Type *base, *pit_chnl_t* channel)

Gets the PIT status flags.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns

The status flags. This is the logical OR of members of the enumeration pit_status_flags_t

static inline void PIT_ClearStatusFlags(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Clears the PIT status flags.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- mask – The status flags to clear. This is a logical OR of members of the enumeration pit_status_flags_t

static inline void PIT_SetTimerPeriod(PIT_Type *base, *pit_chnl_t* channel, uint32_t count)

Sets the timer period in units of count.

Timers begin counting from the value set by this function until it reaches 0, then it generates an interrupt and load this register value again. Writing a new value to this register does not restart the timer. Instead, the value is loaded after the timer expires.

Note: Users can call the utility macros provided in fsl_common.h to convert to ticks.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- count – Timer period in units of ticks

static inline uint32_t PIT_GetCurrentTimerCount(PIT_Type *base, *pit_chnl_t* channel)

Reads the current timer counting value.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: Users can call the utility macros provided in fsl_common.h to convert ticks to usec or msec.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns

Current timer counting value in ticks

static inline void PIT_StartTimer(PIT_Type *base, *pit_chnl_t* channel)

Starts the timer counting.

After calling this function, timers load period value, count down to 0 and then load the respective start value again. Each time a timer reaches 0, it generates a trigger pulse and sets the timeout interrupt flag.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number.

static inline void PIT_StopTimer(PIT_Type *base, *pit_chnl_t* channel)

Stops the timer counting.

This function stops every timer counting. Timers reload their periods respectively after the next time they call the PIT_DRV_StartTimer.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number.

FSL_PIT_DRIVER_VERSION
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enum _pit_chnl
List of PIT channels.

Note: Actual number of available channels is SoC dependent

Values:

enumerator kPIT_Chnl_0
PIT channel number 0

enumerator kPIT_Chnl_1
PIT channel number 1

enumerator kPIT_Chnl_2
PIT channel number 2

enumerator kPIT_Chnl_3
PIT channel number 3

enum _pit_interrupt_enable
List of PIT interrupts.

Values:

enumerator kPIT_TimerInterruptEnable
Timer interrupt enable

enum _pit_status_flags
List of PIT status flags.

Values:

enumerator kPIT_TimerFlag
Timer flag

typedef enum *_pit_chnl* pit_chnl_t
List of PIT channels.

Note: Actual number of available channels is SoC dependent

typedef enum *_pit_interrupt_enable* pit_interrupt_enable_t
List of PIT interrupts.

typedef enum *_pit_status_flags* pit_status_flags_t
List of PIT status flags.

typedef struct *_pit_config* pit_config_t
PIT configuration structure.

This structure holds the configuration settings for the PIT peripheral. To initialize this structure to reasonable defaults, call the PIT_GetDefaultConfig() function and pass a pointer to your config structure instance.

The configuration structure can be made constant so it resides in flash.

uint64_t PIT_GetLifetimeTimerCount(PIT_Type *base)

Reads the current lifetime counter value.

The lifetime timer is a 64-bit timer which chains timer 0 and timer 1 together. Timer 0 and 1 are chained by calling the PIT_SetTimerChainMode before using this timer. The period of lifetime timer is equal to the "period of timer 0 * period of timer 1". For the 64-bit value, the higher 32-bit has the value of timer 1, and the lower 32-bit has the value of timer 0.

Parameters

- base – PIT peripheral base address

Returns

Current lifetime timer value

struct _pit_config

#include <fsl_pit.h> PIT configuration structure.

This structure holds the configuration settings for the PIT peripheral. To initialize this structure to reasonable defaults, call the PIT_GetDefaultConfig() function and pass a pointer to your config structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

bool enableRunInDebug

true: Timers run in debug mode; false: Timers stop in debug mode

2.94 Pmu

void PMU_SetPllLdoControlMode(ANADIG_PMU_Type *base, *pmu_control_mode_t* mode)

Selects the control mode of the PLL LDO.

Parameters

- base – PMU peripheral base address.
- mode – The control mode of the PLL LDO. Please refer to pmu_control_mode_t.

void PMU_SwitchPllLdoToGPCMode(ANADIG_PMU_Type *base)

Switches the PLL LDO from Static/Software Mode to GPC/Hardware Mode.

Parameters

- base – PMU peripheral base address.

void PMU_StaticEnablePllLdo(ANADIG_PMU_Type *base)

Enables PLL LDO via AI interface in Static/Software mode.

Parameters

- base – PMU peripheral base address.

void PMU_StaticDisablePllLdo(void)

Disables PLL LDO via AI interface in Static/Software mode.

void PMU_SetLpsrAnaLdoControlMode(ANADIG_LDO_SNVS_Type *base, *pmu_control_mode_t* mode)

Selects the control mode of the LPSR ANA LDO.

Parameters

- base – PMU peripheral base address.
- mode – The control mode of the LPSR ANA LDO. Please refer to pmu_control_mode_t.

void PMU_StaticEnableLpsrAnaLdoBypassMode(ANADIG_LDO_SNVS_Type *base, bool enable)

Sets the Bypass mode of the LPSR ANA LDO.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.
- enable – Enable/Disable bypass mode.
  - **true** Enable LPSR ANA Bypass mode.
  - **false** Disable LPSR ANA Bypass mode.

static inline bool PMU_StaticCheckLpsrAnaLdoBypassMode(ANADIG_LDO_SNVS_Type *base)

Checks whether the LPSR ANA LDO is in bypass mode.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.

Returns

The result used to indicates whether the LPSR ANA LDO is in bypass mode.

- **true** The LPSR ANA LDO is in bypass mode.
- **false** The LPSR ANA LDO not in bypass mode.

void PMU_StaticGetLpsrAnaLdoDefaultConfig(*pmu_static_lpsr_ana_ldo_config_t* *config)

Fill the LPSR ANA LDO configuration structure with default settings.

The default values are:

```
config->mode                = kPMU_HighPowerMode;
config->enable2mALoad       = true;
config->enable20uALoad      = false;
config->enable4mALoad       = true;
config->enableStandbyMode   = false;
config->driverStrength      = kPMU_LpsrAnaLdoDriverStrength0;
config->brownOutDetectorConfig = kPMU_LpsrAnaLdoBrownOutDetectorDisable;
config->chargePumpCurrent   = kPMU_LpsrAnaChargePump300nA;
config->outputRange         = kPMU_LpsrAnaLdoOutputFrom1P77To1P83;
```

Parameters

- config – Pointer to the structure pmu_static_lpsr_ana_ldo_config_t.

void PMU_StaticLpsrAnaLdoInit(ANADIG_LDO_SNVS_Type *base, const *pmu_static_lpsr_ana_ldo_config_t* *config)

Initialize the LPSR ANA LDO in Static/Sofware Mode.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.
- config – Pointer to the structure pmu_static_lpsr_ana_ldo_config_t.

void PMU_StaticLpsrAnaLdoDeinit(ANADIG_LDO_SNVS_Type *base)

Disable the output of LPSR ANA LDO.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.

void PMU_SetLpsrDigLdoControlMode(ANADIG_LDO_SNVS_Type *base, *pmu_control_mode_t* mode)

Selects the control mode of the LPSR DIG LDO.

Parameters

- base – PMU peripheral base address.
- mode – The control mode of the LPSR DIG LDO. Please refer to pmu_control_mode_t.

void PMU_StaticEnableLpsrDigLdoBypassMode(ANADIG_LDO_SNVS_Type *base, bool enable)

Turn on/off Bypass mode of the LPSR DIG LDO in Static/Software mode.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.
- enable –
  - **true** Turns on Bypass mode of the LPSR DIG LDO.
  - **false** Turns off Bypass mode of the LPSR DIG LDO.

static inline bool PMU_StaticCheckLpsrDigLdoBypassMode(ANADIG_LDO_SNVS_Type *base)

Checks whether the LPSR DIG LDO is in bypass mode.

Parameters

- base – PMU peripheral base address.

Returns

The result used to indicates whether the LPSR DIG LDO is in bypass mode.

- **true** The LPSR DIG LDO is in bypass mode.
- **false** The LPSR DIG LDO not in bypass mode.

void PMU_StaticGetLpsrDigLdoDefaultConfig(*pmu_static_lpsr_dig_config_t* *config)

Gets the default configuration of LPSR DIG LDO.

The default values are:

```
config->enableStableDetect = false;
config->voltageStepTime    = kPMU_LpsrDigVoltageStepInc50us;
config->brownOutConfig     = kPMU_LpsrDigBrownOutDisable;
config->targetVoltage      = kPMU_LpsrDigTargetStableVoltage1P0V;
config->mode               = kPMU_HighPowerMode;
```

Parameters

- config – Pointer to the structure pmu_static_lpsr_dig_config_t.

void PMU_StaticLpsrDigLdoInit(ANADIG_LDO_SNVS_Type *base, const *pmu_static_lpsr_dig_config_t* *config)

Initialize the LPSR DIG LDO in static mode.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.
- config – Pointer to the structure pmu_static_lpsr_dig_config_t.

void PMU_StaticLpsrDigLdoDeinit(ANADIG_LDO_SNVS_Type *base)

Disable the LPSR DIG LDO.

Parameters

- base – ANADIG_LDO_SNVS peripheral base address.

void PMU_GPCSetLpsrDigLdoTargetVoltage(uint32_t setpointMap, *pmu_lpsr_dig_target_output_voltage_t* voltageValue)

Sets the voltage step of LPSR DIG LDO in certain setpoint during GPC mode.

Note: The function provides the feature to set the voltage step to different setpoints.

Parameters

- setpointMap – The map of setpoints should be the OR'ed Value of _pmu_setpoint_map.
- voltageValue – The voltage step to be set. See enumeration pmu_lpsr_dig_target_output_voltage_t.

void PMU_GetSnvsDigLdoDefaultConfig(*pmu_snvs_dig_config_t* *config)

Gets the default config of the SNVS DIG LDO.

The default values are:

```
config->mode                = kPMU_LowPowerMode;
config->chargePumpCurrent   = kPMU_SnvsDigChargePump12P5nA;
config->dischargeResistorValue = kPMU_SnvsDigDischargeResistor15K;
config->trimValue           = 0U;
config->enablePullDown      = true;
config->enableLdoStable     = false;
```

Parameters

- config – Pointer to pmu_snvs_dig_config_t.

void PMU_SnvsDigLdoInit(ANADIG_LDO_SNVS_DIG_Type *base, *pmu_ldo_operate_mode_t* mode)

Initialize the SNVS DIG LDO.

Parameters

- base – LDO SNVS DIG peripheral base address.
- mode – Used to control LDO power mode, please refer to pmu_ldo_operate_mode_t.

static inline void PMU_SnvsDigLdoDeinit(ANADIG_LDO_SNVS_DIG_Type *base)

Disable SNVS DIG LDO.

void PMU_GPCEnableLdo(*pmu_ldo_name_t* name, uint32_t setpointMap)

Controls the ON/OFF of the selected LDO in certain setpoints with GPC mode.

Parameters

- name – The name of the selected ldo. Please see enumeration pmu_ldo_name_t for details.
- setpointMap – The map of setpoints should be the OR'ed Value of _pmu_setpoint_map, 1b'1 means enable specific ldo in that setpoint. For example, the code PMU_GPCEnableLdo(kPMU_PllLdo, 0x1U) means to enable PLL LDO in setpoint 0 and disable PLL LDO in other setpoint.

void PMU_GPCSetLdoOperateMode(*pmu_ldo_name_t* name, uint32_t setpointMap, *pmu_ldo_operate_mode_t* mode)

Sets the operating mode of the selected LDO in certain setpoints with GPC mode.

Parameters

- name – The name of the selected ldo. Please see enumeration pmu_ldo_name_t for details.
- setpointMap – The map of setpoints should be the OR'ed Value of _pmu_setpoint_map.
- mode – The operating mode of the selected ldo. Please refer to enumeration pmu_ldo_operate_mode_t for details.

void PMU_GPCEnableLdoTrackingMode(*pmu_ldo_name_t* name, uint32_t setpointMap)

Controls the ON/OFF of the selected LDOs' Tracking mode in certain setpoints with GPC mode.

Parameters

- name – The name of the selected ldo. Please see enumeration pmu_ldo_name_t for details.
- setpointMap – The map of setpoints that the LDO tracking mode will be enabled in those setpoints, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_GPCEnableLdoBypassMode(*pmu_ldo_name_t* name, uint32_t setpointMap)

Controls the ON/OFF of the selected LDOs' Bypass mode in certain setpoints with GPC mode.

Parameters

- name – The name of the selected ldo. Please see enumeration pmu_ldo_name_t for details.
- setpointMap – The map of setpoints that the LDO bypass mode will be enabled in those setpoints, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_GPCEnableLdoStandbyMode(*pmu_ldo_name_t* name, uint32_t setpointMap)

When STBY assert, enable/disable the selected LDO enter it's Low power mode.

Parameters

- name – The name of the selected ldo. Please see enumeration pmu_ldo_name_t for details.
- setpointMap – The map of setpoints that the LDO low power mode will be enabled in those setpoints if STBY assert, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_SetBandgapControlMode(ANADIG_PMU_Type *base, *pmu_control_mode_t* mode)

Selects the control mode of the Bandgap Reference.

Parameters

- base – PMU peripheral base address.
- mode – The control mode of the Bandgap Reference. Please refer to pmu_control_mode_t.

void PMU_SwitchBandgapToGPCMode(ANADIG_PMU_Type *base)

Switches the Bandgap from Static/Software Mode to GPC/Hardware Mode.

Parameters

- base – PMU peripheral base address.

void PMU_DisableBandgapSelfBiasAfterPowerUp(void)

Disables Bandgap self bias for best noise performance.

This function should be invoked after powering up. This function will wait for the bandgap stable and disable the bandgap self bias. After powering up, it need to wait for the bandgap to get stable and then disable Bandgap Self bias for best noise performance.

void PMU_EnableBandgapSelfBiasBeforePowerDown(void)

Enables Bandgap self bias before power down.

This function will enable Bandgap self bias feature before powering down or there will be risk of Bandgap not starting properly.

void PMU_StaticBandgapInit(const *pmu_static_bandgap_config_t* *config)

Initialize Bandgap.

Parameters

- config – Pointer to the structure pmu_static_bandgap_config_t.

static inline void PMU_GPCEnableBandgap(ANADIG_PMU_Type *base, uint32_t setpointMap)

Controls the ON/OFF of the Bandgap in certain setpoints with GPC mode.

For example, the code PMU_GPCEnableBandgap(PMU, kPMU_SetPoint0 | kPMU_SetPoint1); means enable bandgap in setpoint0 and setpoint1 and disable bandgap in other setpoints.

Parameters

- base – PMU peripheral base address.
- setpointMap – The map of setpoints that the bandgap will be enabled in those setpoints, this parameter should be the OR'ed Value of _pmu_setpoint_map.

static inline void PMU_GPCEnableBandgapStandbyMode(ANADIG_PMU_Type *base, uint32_t setpointMap)

Controls the ON/OFF of the Bandgap's Standby mode in certain setpoints with GPC mode.

Parameters

- base – PMU peripheral base address.
- setpointMap – The map of setpoints that the bandgap standby mode will be enabled in those setpoints, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_WellBiasInit(ANADIG_PMU_Type *base, const *pmu_well_bias_config_t* *config)

Configures Well bias, such as power source, clock source and so on.

Parameters

- base – PMU peripheral base address.
- config – Pointer to the pmu_well_bias_config_t structure.

void PMU_GetWellBiasDefaultConfig(*pmu_well_bias_config_t* *config)

Gets the default configuration of well bias.

Parameters

- config – The pointer to the pmu_well_bias_config_t structure.

void PMU_SetBodyBiasControlMode(ANADIG_PMU_Type *base, *pmu_body_bias_name_t* name, *pmu_control_mode_t* mode)

Selects the control mode of the Body Bias.

Parameters

- base – PMU peripheral base address.
- name – The name of the body bias. Please refer to pmu_body_bias_name_t.
- mode – The control mode of the Body Bias. Please refer to pmu_control_mode_t.

void PMU_EnableBodyBias(ANADIG_PMU_Type *base, *pmu_body_bias_name_t* name, bool enable)

Enables/disables the selected body bias.

Parameters

- base – PMU peripheral base address.
- name – The name of the body bias to be turned on/off, please refer to pmu_body_bias_name_t.
- enable – Used to turn on/off the specific body bias.
  - **true** Enable the selected body bias.
  - **false** Disable the selected body bias.

void PMU_GPCEnableBodyBias(*pmu_body_bias_name_t* name, uint32_t setpointMap)

Controls the ON/OFF of the selected body bias in certain setpoints with GPC mode.

Parameters

- name – The name of the selected body bias. Please see enumeration pmu_body_bias_name_t for details.
- setpointMap – The map of setpoints that the specific body bias will be enabled in those setpoints, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_GPCEnableBodyBiasStandbyMode(*pmu_body_bias_name_t* name, uint32_t setpointMap)

Controls the ON/OFF of the selected Body Bias' Wbias power switch in certain setpoints with GPC mode.

Parameters

- name – The name of the selected body bias. Please see the enumeration pmu_body_bias_name_t for details.
- setpointMap – The map of setpoints that the specific body bias's wbias power switch will be turn on in those setpoints, this value should be the OR'ed Value of _pmu_setpoint_map.

void PMU_GPCGetBodyBiasDefaultConfig(*pmu_gpc_body_bias_config_t* *config)

Gets the default config of body bias in GPC mode.

Parameters

- config – Pointer to structure pmu_gpc_body_bias_config_t.

void PMU_GPCSetBodyBiasConfig(*pmu_body_bias_name_t* name, const *pmu_gpc_body_bias_config_t* *config)

Sets the config of the selected Body Bias in GPC mode.

Parameters

- name – The name of the selected body bias. Please see enumeration pmu_body_bias_name_t for details.
- config – Pointer to structure pmu_gpc_body_bias_config_t.

FSL_PMU_DRIVER_VERSION

PMU driver version.

Version 2.1.2.

enum _pmu_setpoint_map

System setpoints enumeration.

Values:

enumerator kPMU_SetPoint0

Set point 0.

enumerator kPMU_SetPoint1

Set point 1.

enumerator kPMU_SetPoint2

Set point 2.

enumerator kPMU_SetPoint3

Set point 3.

enumerator kPMU_SetPoint4

Set point 4.

enumerator kPMU_SetPoint5

Set point 5.

enumerator kPMU_SetPoint6

Set point 6.

enumerator kPMU_SetPoint7

Set point 7.

enumerator kPMU_SetPoint8

Set point 8.

enumerator kPMU_SetPoint9

Set point 9.

enumerator kPMU_SetPoint10

Set point 10.

enumerator kPMU_SetPoint11

Set point 11.

enumerator kPMU_SetPoint12

Set point 12.

enumerator kPMU_SetPoint13

Set point 13.

enumerator kPMU_SetPoint14

Set point 14.

enumerator kPMU_SetPoint15

Set point 15.

enum _pmu_ldo_name

The name of LDOs.

Values:

enumerator kPMU_PllLdo

The PLL LDO in SOC domain.

enumerator kPMU_LpsrAnaLdo

The LPSR ANA LDO in LPSR domain.

enumerator kPMU_LpsrDigLdo
The LPSR DIG LDO in LPSR domain.

enumerator kPMU_SnvsDigLdo
The SNVS DIG LDO in SNVS domain.

enum _pmu_body_bias_name
The name of body bias.

Values:

enumerator kPMU_RBB_SOC
The RBB implemented in SOC.

enumerator kPMU_RBB_LPSR
The RBB implemented in LPSRMIX.

enum _pmu_control_mode
The control mode of LDOs/Bandgaps/Body Bias.

Values:

enumerator kPMU_StaticMode
Static/Software Control mode.

enumerator kPMU_GPCMode
GPC/Hardware Control mode.

enum _pmu_ldo_operate_mode
The operation mode for the LDOs.

Values:

enumerator kPMU_LowPowerMode
LDOs operate in Low power mode.

enumerator kPMU_HighPowerMode
LDOs operate in High power mode.

enum _pmu_lpsr_ana_ldo_charge_pump_current
The enumeration of LPSR ANA LDO's charge pump current.

Values:

enumerator kPMU_LpsrAnaChargePump300nA
The current of the charge pump is selected as 300nA.

enumerator kPMU_LpsrAnaChargePump400nA
The current of the charge pump is selected as 400nA.

enumerator kPMU_LpsrAnaChargePump500nA
The current of the charge pump is selected as 500nA.

enumerator kPMU_LpsrAnaChargePump600nA
The current of the charge pump is selected as 600nA.

enum _pmu_lpsr_ana_ldo_output_range
The enumeration of LPSR ANA LDO's output range.

Values:

enumerator kPMU_LpsrAnaLdoOutputFrom1P77To1P83
The output voltage varies from 1.77V to 1.83V.

enumerator kPMU_LpsrAnaLdoOutputFrom1P72To1P77
The output voltage varies from 1.72V to 1.77V.

enumerator kPMU_LpsrAnaLdoOutputFrom1P82To1P88
The output voltage varies from 1.82V to 1.88V.

enum _pmu_lpsr_dig_voltage_step_time
The enumeration of voltage step time for LPSR DIG LDO.

Values:

enumerator kPMU_LpsrDigVoltageStepInc15us
LPSR DIG LDO voltage step time selected as 15us.

enumerator kPMU_LpsrDigVoltageStepInc25us
LPSR DIG LDO voltage step time selected as 25us.

enumerator kPMU_LpsrDigVoltageStepInc50us
LPSR DIG LDO voltage step time selected as 50us.

enumerator kPMU_LpsrDigVoltageStepInc100us
LPSR DIG LDO voltage step time selected as 100us.

enum _pmu_lpsr_dig_target_output_voltage
The target output voltage of LPSR DIG LDO.

Values:

enumerator kPMU_LpsrDigTargetStableVoltage0P631V
The target voltage selected as 0.631V

enumerator kPMU_LpsrDigTargetStableVoltage0P65V
The target voltage selected as 0.65V

enumerator kPMU_LpsrDigTargetStableVoltage0P67V
The target voltage selected as 0.67V

enumerator kPMU_LpsrDigTargetStableVoltage0P689V
The target voltage selected as 0.689V

enumerator kPMU_LpsrDigTargetStableVoltage0P709V
The target voltage selected as 0.709V

enumerator kPMU_LpsrDigTargetStableVoltage0P728V
The target voltage selected as 0.728V

enumerator kPMU_LpsrDigTargetStableVoltage0P748V
The target voltage selected as 0.748V

enumerator kPMU_LpsrDigTargetStableVoltage0P767V
The target voltage selected as 0.767V

enumerator kPMU_LpsrDigTargetStableVoltage0P786V
The target voltage selected as 0.786V

enumerator kPMU_LpsrDigTargetStableVoltage0P806V
The target voltage selected as 0.806V

enumerator kPMU_LpsrDigTargetStableVoltage0P825V
The target voltage selected as 0.825V

enumerator kPMU_LpsrDigTargetStableVoltage0P845V
The target voltage selected as 0.845V

enumerator kPMU_LpsrDigTargetStableVoltage0P864V
The target voltage selected as 0.864V

enumerator kPMU_LpsrDigTargetStableVoltage0P883V
The target voltage selected as 0.883V

enumerator kPMU_LpsrDigTargetStableVoltage0P903V
The target voltage selected as 0.903V

enumerator kPMU_LpsrDigTargetStableVoltage0P922V
The target voltage selected as 0.922V

enumerator kPMU_LpsrDigTargetStableVoltage0P942V
The target voltage selected as 0.942V

enumerator kPMU_LpsrDigTargetStableVoltage0P961V
The target voltage selected as 0.961V

enumerator kPMU_LpsrDigTargetStableVoltage0P981V
The target voltage selected as 0.981V

enumerator kPMU_LpsrDigTargetStableVoltage1P0V
The target voltage selected as 1.0V

enumerator kPMU_LpsrDigTargetStableVoltage1P019V
The target voltage selected as 1.019V

enumerator kPMU_LpsrDigTargetStableVoltage1P039V
The target voltage selected as 1.039V

enumerator kPMU_LpsrDigTargetStableVoltage1P058V
The target voltage selected as 1.058V

enumerator kPMU_LpsrDigTargetStableVoltage1P078V
The target voltage selected as 1.078V

enumerator kPMU_LpsrDigTargetStableVoltage1P097V
The target voltage selected as 1.097V

enumerator kPMU_LpsrDigTargetStableVoltage1P117V
The target voltage selected as 1.117V

enumerator kPMU_LpsrDigTargetStableVoltage1P136V
The target voltage selected as 1.136V

enumerator kPMU_LpsrDigTargetStableVoltage1P155V
The target voltage selected as 1.155V

enumerator kPMU_LpsrDigTargetStableVoltage1P175V
The target voltage selected as 1.175V

enumerator kPMU_LpsrDigTargetStableVoltage1P194V
The target voltage selected as 1.194V

enumerator kPMU_LpsrDigTargetStableVoltage1P214V
The target voltage selected as 1.214V

enumerator kPMU_LpsrDigTargetStableVoltage1P233V
The target voltage selected as 1.233V

enum __pmu_snvs_dig_charge_pump_current
The enumeration of the SNVS DIG LDO's charge pump current.

Values:

enumerator kPMU_SnvsDigChargePump12P5nA
The current of SNVS DIG LDO's charge pump is selected as 12.5nA.

enumerator kPMU_SnvsDigChargePump6P25nA
The current of SNVS DIG LDO's charge pump is selected as 6.25nA.

enumerator kPMU_SnvsDigChargePump18P75nA
The current of SNVS DIG LDO's charge pump is selected as 18.75nA.

enum _pmu_snvs_dig_discharge_resistor_value
The enumeration of the SNVS DIG LDO's discharge resistor.

Values:

enumerator kPMU_SnvsDigDischargeResistor15K
The Discharge Resistor is selected as 15K ohm

enumerator kPMU_SnvsDigDischargeResistor30K
The Discharge Resistor is selected as 30K ohm

enumerator kPMU_SnvsDigDischargeResistor9K
The Discharge Resistor is selected as 9K ohm

enum _pmu_static_bandgap_power_down_option
The enumeration of bandgap power down option.

Values:

enumerator kPMU_PowerDownBandgapFully
Fully power down the bandgap module.

enumerator kPMU_PowerDownVoltageReferenceOutputOnly
Power down only the reference output section of the bandgap

enumerator kPMU_PowerDownBandgapVBGUPDetector
Power down the VBGUP detector of the bandgap without affecting any additional functionality.

enum _pmu_bandgap_output_VBG_voltage_value
The enumeration of output VBG voltage.

Values:

enumerator kPMU_BandgapOutputVBGVoltageNominal
Output nominal voltage.

enumerator kPMU_BandgapOutputVBGVoltagePlus10mV
Output VBG voltage Plus 10mV.

enumerator kPMU_BandgapOutputVBGVoltagePlus20mV
Output VBG voltage Plus 20mV.

enumerator kPMU_BandgapOutputVBGVoltagePlus30mV
Output VBG voltage Plus 30mV.

enumerator kPMU_BandgapOutputVBGVoltageMinus10mV
Output VBG voltage Minus 10mV.

enumerator kPMU_BandgapOutputVBGVoltageMinus20mV
Output VBG voltage Minus 20mV.

enumerator kPMU_BandgapOutputVBGVoltageMinus30mV
Output VBG voltage Minus 30mV.

enumerator kPMU_BandgapOutputVBGVoltageMinus40mV
Output VBG voltage Minus 40mV.

enum _pmu_bandgap_output_current_value
The enumeration of output current.

Values:

enumerator kPMU_OutputCurrent11P5uA
Output 11.5uA current from the bandgap.

enumerator kPMU_OutputCurrent11P8uA
Output 11.8uA current from the bandgap.

enumerator kPMU_OutputCurrent12P1uA
Output 12.1uA current from the bandgap.

enumerator kPMU_OutputCurrent12P4uA
Output 12.4uA current from the bandgap.

enumerator kPMU_OutputCurrent12P7uA
Output 12.7uA current from the bandgap.

enumerator kPMU_OutputCurrent13P0uA
Output 13.0uA current from the bandgap.

enumerator kPMU_OutputCurrent13P3uA
Output 13.3uA current from the bandgap.

enum _pmu_well_bias_power_source
The enumerator of well bias power source.

Values:

enumerator kPMU_WellBiasPowerFromLpsrDigLdo
LPSR Dig LDO supplies the power stage and NWELL sampler.

enumerator kPMU_WellBiasPowerFromDCDC
DCDC supplies the power stage and NWELL sampler.

enum _pmu_bias_area_size
The enumerator of bias area size.

Values:

enumerator kPMU_180uA_6mm2At125C
Imax = 180uA; Areamax-RVT = 6.00mm2 at 125C

enumerator kPMU_150uA_5mm2At125C
Imax = 150uA; Areamax-RVT = 5.00mm2 at 125C

enumerator kPMU_120uA_4mm2At125C
Imax = 120uA; Areamax-RVT = 4.00mm2 at 125C

enumerator kPMU_90uA_3mm2At125C
Imax = 90uA; Areamax-RVT = 3.00mm2 at 125C

enumerator kPMU_60uA_2mm2At125C
Imax = 60uA; Areamax-RVT = 2.00mm2 at 125C

enumerator kPMU_45uA_1P5mm2At125C
Imax = 45uA; Areamax-RVT = 1P5mm2 at 125C

enumerator kPMU_30uA_1mm2At125C
Imax = 30uA; Areamax-RVT = 1.00mm2 at 125C

enumerator kPMU_15uA_0P5mm2At125C
Imax = 15uA; Areamax-RVT = 0.50mm2 at 125C

enum _pmu_well_bias_typical_freq
The enumerator of well bias typical frequency.

Values:

enumerator kPMU_OscFreqDiv128
Typical frequency = osc_freq / 128.

enumerator kPMU_OscFreqDiv64
Typical frequency = osc_freq / 64.

enumerator kPMU_OscFreqDiv32
Typical frequency = osc_freq / 32.

enumerator kPMU_OscFreqDiv16
Typical frequency = osc_freq / 16.

enumerator kPMU_OscFreqDiv8
Typical frequency = osc_freq / 8.

enumerator kPMU_OscFreqDiv2
Typical frequency = osc_freq / 2.

enumerator kPMU_OscFreq
Typical frequency = oscillator frequency.

enum _pmu_adaptive_clock_source
The enumerator of well bias adaptive clock source.

Values:

enumerator kPMU_AdaptiveClkSourceOscClk
The adaptive clock source is oscillator clock.

enumerator kPMU_AdaptiveClkSourceChargePumpClk
The adaptive clock source is charge pump clock.

enum _pmu_freq_reduction
The enumerator of frequency reduction due to cap increment.

Values:

enumerator kPMU_FreqReductionNone
No frequency reduction.

enumerator kPMU_FreqReduction30PCT
30% frequency reduction due to cap increment.

enumerator kPMU_FreqReduction40PCT
40% frequency reduction due to cap increment.

enumerator kPMU_FreqReduction50PCT
50% frequency reduction due to cap increment.

enum _pmu_well_bias_1P8_adjustment
The enumerator of well bias 1P8 adjustment.

Values:

enumerator kPMU_Cref0fFCspl0fFDeltaC0fF
Cref = 0fF, Cspl = 0fF, DeltaC = 0fF.

enumerator kPMU_Cref0fFCspl30fFDeltaCN30fF
Cref = 0fF, Cspl = 30fF, DeltaC = -30fF.

enumerator kPMU_Cref0fFCspl43fFDeltaCN43fF
Cref = 0fF, Cspl = 43fF, DeltaC = -43fF.

enumerator kPMU_Cref0fFCspl62fFDeltaCN62fF
Cref = 0fF, Cspl = 62fF, DeltaC = -62fF.

enumerator kPMU_Cref0fFCspl105fFDeltaCN105fF
Cref = 0fF, Cspl = 105fF, DeltaC = -105fF.

enumerator kPMU_Cref30fFCspl0fFDeltaC30fF
Cref = 30fF, Cspl = 0fF, DeltaC = 30fF.

enumerator kPMU_Cref30fFCspl43fFDeltaCN12fF
Cref = 30fF, Cspl = 43fF, DeltaC = -12fF.

enumerator kPMU_Cref30fFCspl105fFDeltaCN75fF
Cref = 30fF, Cspl = 105fF, DeltaC = -75fF.

enumerator kPMU_Cref43fFCspl0fFDeltaC43fF
Cref = 43fF, Cspl = 0fF, DeltaC = 43fF.

enumerator kPMU_Cref43fFCspl30fFDeltaC13fF
Cref = 43fF, Cspl = 30fF, DeltaC = 13fF.

enumerator kPMU_Cref43fFCspl62fFDeltaCN19fF
Cref = 43fF, Cspl = 62fF, DeltaC = -19fF.

enumerator kPMU_Cref62fFCspl0fFDeltaC62fF
Cref = 62fF, Cspl = 0fF, DeltaC = 62fF.

enumerator kPMU_Cref62fFCspl43fFDeltaC19fF
Cref = 62fF, Cspl = 43fF, DeltaC = 19fF.

enumerator kPMU_Cref105fFCspl0fFDeltaC105fF
Cref = 105fF, Cspl = 0fF, DeltaC = 105fF.

enumerator kPMU_Cref105fFCspl30fFDeltaC75fF
Cref = 105fF, Cspl = 30fF, DeltaC = 75fF.

typedef enum *_pmu_ldo_name* pmu_ldo_name_t
The name of LDOs.

typedef enum *_pmu_body_bias_name* pmu_body_bias_name_t
The name of body bias.

typedef enum *_pmu_control_mode* pmu_control_mode_t
The control mode of LDOs/Bandgaps/Body Bias.

typedef enum *_pmu_ldo_operate_mode* pmu_ldo_operate_mode_t
The operation mode for the LDOs.

typedef enum *_pmu_lpsr_ana_ldo_charge_pump_current* pmu_lpsr_ana_ldo_charge_pump_current_t
The enumeration of LPSR ANA LDO's charge pump current.

typedef enum *_pmu_lpsr_ana_ldo_output_range* pmu_lpsr_ana_ldo_output_range_t
The enumeration of LPSR ANA LDO's output range.

typedef enum *_pmu_lpsr_dig_voltage_step_time* pmu_lpsr_dig_voltage_step_time_t
The enumeration of voltage step time for LPSR DIG LDO.

typedef enum *_pmu_lpsr_dig_target_output_voltage* pmu_lpsr_dig_target_output_voltage_t
The target output voltage of LPSR DIG LDO.

typedef enum *_pmu_snvs_dig_charge_pump_current* pmu_snvs_dig_charge_pump_current_t
The enumeration of the SNVS DIG LDO's charge pump current.

typedef enum *_pmu_snvs_dig_discharge_resistor_value*
pmu_snvs_dig_discharge_resistor_value_t
The enumeration of the SNVS DIG LDO's discharge resistor.

typedef enum *_pmu_bandgap_output_VBG_voltage_value*
pmu_bandgap_output_VBG_voltage_value_t
The enumeration of output VBG voltage.

typedef enum *_pmu_bandgap_output_current_value* pmu_bandgap_output_current_value_t
The enumeration of output current.

typedef enum *_pmu_well_bias_power_source* pmu_well_bias_power_source_t
The enumerator of well bias power source.

typedef enum *_pmu_bias_area_size* pmu_bias_area_size_t
The enumerator of bias area size.

typedef enum *_pmu_well_bias_typical_freq* pmu_well_bias_typical_freq_t
The enumerator of well bias typical frequency.

typedef enum *_pmu_adaptive_clock_source* pmu_adaptive_clock_source_t
The enumerator of well bias adaptive clock source.

typedef enum *_pmu_freq_reduction* pmu_freq_reduction_t
The enumerator of frequency reduction due to cap increment.

typedef enum *_pmu_well_bias_1P8_adjustment* pmu_well_bias_1P8_adjustment_t
The enumerator of well bias 1P8 adjustment.

typedef struct *_pmu_static_lpsr_ana_ldo_config* pmu_static_lpsr_ana_ldo_config_t
LPSR ANA LDO config.

typedef struct *_pmu_static_lpsr_dig_config* pmu_static_lpsr_dig_config_t
LPSR DIG LDO Config in Static/Software Mode.

typedef struct *_pmu_snvs_dig_config* pmu_snvs_dig_config_t
SNVS DIG LDO config.

typedef struct *_pmu_static_bandgap_config* pmu_static_bandgap_config_t
Bandgap config in static mode.

typedef union *_pmu_well_bias_option* pmu_well_bias_option_t
The union of well bias basic options, such as clock source, power source and so on.

typedef struct *_pmu_well_bias_config* pmu_well_bias_config_t
The structure of well bias configuration.

typedef struct *_pmu_gpc_body_bias_config* pmu_gpc_body_bias_config_t
The stucture of body bias config in GPC mode.

PMU_HAS_FBB

struct __pmu_static_lpsr_ana_ldo_config
#include <fsl_pmu.h> LPSR ANA LDO config.

Public Members

pmu_ldo_operate_mode_t mode
The operate mode of LPSR ANA LDO.

bool enable2mALoad
Enable/Disable 2mA load.

- **true** Enables 2mA loading to prevent overshoot;
- **false** Disables 2mA loading.

bool enable4mALoad
Enable/Disable 4mA load.

- **true** Enables 4mA loading to prevent dramatic voltage drop;
- **false** Disables 4mA load.

bool enable20uALoad
Enable/Disable 20uA load.

- **true** Enables 20uA loading to prevent overshoot;
- **false** Disables 20uA load.

bool enableStandbyMode
Enable/Disable Standby Mode.

- **true** Enables Standby mode, if the STBY assert, the LPSR ANA LDO enter LP mode
- **false** Disables Standby mode.

struct __pmu_static_lpsr_dig_config
#include <fsl_pmu.h> LPSR DIG LDO Config in Static/Software Mode.

Public Members

bool enableStableDetect
Enable/Disable Stable Detect.

- **true** Enables Stable Detect.
- **false** Disables Stable Detect.

pmu_lpsr_dig_voltage_step_time_t voltageStepTime
Step time.

pmu_lpsr_dig_target_output_voltage_t targetVoltage
The target output voltage.

struct __pmu_snvs_dig_config
#include <fsl_pmu.h> SNVS DIG LDO config.

Public Members

pmu_ldo_operate_mode_t mode
The operate mode the SNVS DIG LDO.

pmu_snvs_dig_charge_pump_current_t chargePumpCurrent
The current of SNVS DIG LDO's charge pump current.

pmu_snvs_dig_discharge_resistor_value_t dischargeResistorValue
The value of SNVS DIG LDO's Discharge Resistor.

uint8_t trimValue

The trim value.

bool enablePullDown

Enable/Disable Pull down.

- **true** Enables the feature of using 1M ohm resistor to discharge the LDO output.
- **false** Disables the feature of using 1M ohm resistor to discharge the LDO output.

bool enableLdoStable

Enable/Disable SNVS DIG LDO Stable.

struct __pmu_static_bandgap_config

#include <fsl_pmu.h> Bandgap config in static mode.

Public Members

uint8_t powerDownOption

The OR'ed value of _pmu_static_bandgap_power_down_option. Please refer to _pmu_static_bandgap_power_down_option.

bool enableLowPowerMode

Turn on/off the Low power mode.

- **true** Turns on the low power operation of the bandgap.
- **false** Turns off the low power operation of the bandgap.

pmu_bandgap_output_VBG_voltage_value_t outputVoltage

The output VBG voltage of Bandgap.

pmu_bandgap_output_current_value_t outputCurrent

The output current from the bandgap to the temperature sensors.

union __pmu_well_bias_option

#include <fsl_pmu.h> The union of well bias basic options, such as clock source, power source and so on.

Public Members

uint16_t wellBiasData

well bias configuration data.

struct *_pmu_well_bias_option* wellBiasStruct

struct __pmu_well_bias_config

#include <fsl_pmu.h> The structure of well bias configuration.

Public Members

pmu_well_bias_option_t wellBiasOption

Well bias basic function, please refer to pmu_well_bias_option_t.

pmu_well_bias_1P8_adjustment_t adjustment

Well bias adjustment 1P8, please refer to pmu_well_bias_1P8_adjustment_t.

struct __pmu_gpc_body_bias_config

#include <fsl_pmu.h> The stucture of body bias config in GPC mode.

Public Members

uint8_t PWELLRegulatorSize
: The size of the PWELL Regulator.

uint8_t NWELLRegulatorSize
: The size of the NWELL Regulator.

uint8_t oscillatorSize
: The size of the oscillator bits.

uint8_t regulatorStrength
: The strength of the selected regulator.

struct wellBiasStruct

Public Members

uint16_t enablePWellOnly
: Turn on both PWELL and NWELL, or only trun on PWELL.
  - **1b0** PWELL and NEWLL are both turned on.
  - **1b1** PWELL is turned on only.

uint16_t reserved1
: Reserved.

uint16_t biasAreaSize
: Select size of bias area, please refer to pmu_bias_area_size_t

uint16_t disableAdaptiveFreq
: Enable/Disable adaptive frequency.
  - **1b0** Frequency change after each half cycle minimum frequency determined by typical frequency.
  - **1b1** Adaptive frequency disabled. Frequency determined by typical frequency.

uint16_t wellBiasFreq
: Set well bias typical frequency, please refer to pmu_well_bias_typical_freq_t.

uint16_t clkSource
: Config the adaptive clock source, please pmu_adaptive_clock_source_t.

uint16_t freqReduction
: Config the percent of frequency reduction due to cap increment, please refer to pmu_freq_reduction_t.

uint16_t enablePowerDownOption
: Enable/Disable pull down option.
  - **false** Pull down option is disabled.
  - **true** Pull down option is enabled.

uint16_t reserved2
: Reserved.

uint16_t powerSource
: Set power source, please refer to pmu_well_bias_power_source_t.

uint16_t reserved3
: Reserved.

2.95 PUF: Physical Unclonable Function

FSL_PUF_DRIVER_VERSION

PUF driver version. Version 2.2.0.

Current version: 2.2.0

Change log:

- 2.0.0
  - Initial version.
- 2.0.1
  - Fixed puf_wait_usec function optimization issue.
- 2.0.2
  - Add PUF configuration structure and support for PUF SRAM controller. Remove magic constants.
- 2.0.3
  - Fix MISRA C-2012 issue.
- 2.1.0
  - Align driver with PUF SRAM controller registers on LPCXpresso55s16.
  - Update initizalition logic .
- 2.1.1
  - Fix ARMGCC build warning .
- 2.1.2
  - Update: Add automatic big to little endian swap for user (pre-shared) keys destinated to secret hardware bus (PUF key index 0).
- 2.1.3
  - Fix MISRA C-2012 issue.
- 2.1.4
  - Replace register uint32_t ticksCount with volatile uint32_t ticksCount in puf_wait_usec() to prevent optimization out delay loop.
- 2.1.5
  - Use common SDK delay in puf_wait_usec()
- 2.1.6
  - Changed wait time in PUF_Init(), when initialization fails it will try PUF_Powercycle() with shorter time. If this shorter time will also fail, initialization will be tried with worst case time as before.
- 2.2.0
- Add support for kPUF_KeySlot4.
- Add new PUF_ClearKey() function, that clears a desired PUF internal HW key register.

enum _puf_key_index_register

Values:

enumerator kPUF_KeyIndex_00

enumerator kPUF_KeyIndex_01

enumerator kPUF_KeyIndex_02

enumerator kPUF_KeyIndex_03

enumerator kPUF_KeyIndex_04

enumerator kPUF_KeyIndex_05

enumerator kPUF_KeyIndex_06

enumerator kPUF_KeyIndex_07

enumerator kPUF_KeyIndex_08

enumerator kPUF_KeyIndex_09

enumerator kPUF_KeyIndex_10

enumerator kPUF_KeyIndex_11

enumerator kPUF_KeyIndex_12

enumerator kPUF_KeyIndex_13

enumerator kPUF_KeyIndex_14

enumerator kPUF_KeyIndex_15

enum _puf_min_max

Values:

enumerator kPUF_KeySizeMin

enumerator kPUF_KeySizeMax

enumerator kPUF_KeyIndexMax

enum _puf_key_slot

PUF key slot.

Values:

enumerator kPUF_KeySlot0

PUF key slot 0

enumerator kPUF_KeySlot1

PUF key slot 1

PUF status return codes.

Values:

enumerator kStatus_EnrollNotAllowed

enumerator kStatus_StartNotAllowed

typedef enum *_puf_key_index_register* puf_key_index_register_t

typedef enum *_puf_min_max* puf_min_max_t

typedef enum *_puf_key_slot* puf_key_slot_t

PUF key slot.

PUF_GET_KEY_CODE_SIZE_FOR_KEY_SIZE(x)

Get Key Code size in bytes from key size in bytes at compile time.

PUF_MIN_KEY_CODE_SIZE

PUF_ACTIVATION_CODE_SIZE

KEYSTORE_PUF_DISCHARGE_TIME_FIRST_TRY_MS

KEYSTORE_PUF_DISCHARGE_TIME_MAX_MS

struct puf_config_t

#include <fsl_puf.h>

2.96 PWM: Pulse Width Modulator

status_t PWM_Init(PWM_Type *base, *pwm_submodule_t* subModule, const *pwm_config_t* *config)

Ungates the PWM submodule clock and configures the peripheral for basic operation.

This API should be called at the beginning of the application using the PWM driver. When user select PWMX, user must choose edge aligned output, becasue there are some limitation on center aligned PWMX output. When output PWMX in center aligned mode, VAL1 register controls both PWM period and PWMX duty cycle, PWMA and PWMB output will be corrupted. But edge aligned PWMX output do not have such limit. In master reload counter initialization mode, PWM period is depended by period of set LDOK in submodule 0 because this operation will reload register. Submodule 0 counter initialization cannot be master sync or master reload.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- config – Pointer to user's PWM config structure.

Returns

kStatus_Success means success; else failed.

void PWM_Deinit(PWM_Type *base, *pwm_submodule_t* subModule)

Gate the PWM submodule clock.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to deinitialize

void PWM_GetDefaultConfig(*pwm_config_t* *config)

Fill in the PWM config struct with the default settings.

The default values are:

```
config->enableDebugMode = false;
config->enableWait = false;
config->reloadSelect = kPWM_LocalReload;
config->clockSource = kPWM_BusClock;
config->prescale = kPWM_Prescale_Divide_1;
config->initializationControl = kPWM_Initialize_LocalSync;
config->forceTrigger = kPWM_Force_Local;
config->reloadFrequency = kPWM_LoadEveryOportunity;
```

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```
config->reloadLogic = kPWM_ReloadImmediate;
config->pairOperation = kPWM_Independent;
```

Parameters

- config – Pointer to user's PWM config structure.

status_t PWM_SetupPwm(PWM_Type *base, *pwm_submodule_t* subModule, const *pwm_signal_param_t* *chnlParams, uint8_t numOfChnls, *pwm_mode_t* mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)

Sets up the PWM signals for a PWM submodule.

The function initializes the submodule according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements. If the dead time insertion logic is enabled, the pulse period is reduced by the dead time period specified by the user. When user select PWMX, user must choose edge aligned output, becasue there are some limitation on center aligned PWMX output. Due to edge aligned PWMX is negative true signal, need to configure PWMX active low true level to get correct duty cycle. The half cycle point will not be exactly in the middle of the PWM cycle when PWMX enabled.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- chnlParams – Array of PWM channel parameters to configure the channel(s).
- numOfChnls – Number of channels to configure, this should be the size of the array passed in. Array size should not be more than 3 as each submodule has 3 pins to output PWM.
- mode – PWM operation mode, options available in enumeration pwm_mode_t
- pwmFreq_Hz – PWM signal frequency in Hz
- srcClock_Hz – PWM source clock of correspond submodule in Hz. If source clock of submodule1,2,3 is from submodule0 AUX_CLK, its source clock is submodule0 source clock divided with submodule0 prescaler value instead of submodule0 source clock.

Returns

Returns kStatus_Fail if there was error setting up the signal; kStatus_Success otherwise

status_t PWM_SetupPwmPhaseShift(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz, uint8_t shiftvalue, bool doSync)

Set PWM phase shift for PWM channel running on channel PWM_A, PWM_B which with 50% duty cycle.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- pwmFreq_Hz – PWM signal frequency in Hz
- srcClock_Hz – PWM main counter clock in Hz.

- shiftvalue – Phase shift value, range in 0 ~ 50
- doSync – true: Set LDOK bit for the submodule list; false: LDOK bit don't set, need to call PWM_SetPwmLdok to sync update.

Returns

Returns kStatus_Fail if there was error setting up the signal; kStatus_Success otherwise

void PWM_UpdatePwmDutycycle(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmSignal, *pwm_mode_t* currPwmMode, uint8_t dutyCyclePercent)

Updates the PWM signal's dutycycle.

The function updates the PWM dutycyle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A, PWM B, PWM X) to update
- currPwmMode – The current PWM mode set during PWM setup
- dutyCyclePercent – New PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

void PWM_UpdatePwmDutycycleHighAccuracy(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmSignal, *pwm_mode_t* currPwmMode, uint16_t dutyCycle)

Updates the PWM signal's dutycycle with 16-bit accuracy.

The function updates the PWM dutycyle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A, PWM B, PWM X) to update
- currPwmMode – The current PWM mode set during PWM setup
- dutyCycle – New PWM pulse width, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle)

void PWM_UpdatePwmPeriodAndDutycycle(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmSignal, *pwm_mode_t* currPwmMode, uint16_t pulseCnt, uint16_t dutyCycle)

Update the PWM signal's period and dutycycle for a PWM submodule.

The function updates PWM signal period generated by a specific submodule according to the parameters passed in by the user. This function can also set dutycycle weather you want to keep original dutycycle or update new dutycycle. Call this function in local sync control mode because PWM period is depended by

INIT and VAL1 register of each submodule. In master sync initialization control mode, call this function to update INIT and VAL1 register of all submodule because PWM period is

depended by INIT and VAL1 register in submodule0. If the dead time insertion logic is enabled, the pulse period is reduced by the dead time period specified by the user. PWM signal will not be generated if its period is less than dead time duration.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A or PWM B) to update
- currPwmMode – The current PWM mode set during PWM setup, options available in enumeration pwm_mode_t
- pulseCnt – New PWM period, value should be between 0 to 65535 0=minimum PWM period... 65535=maximum PWM period
- dutyCycle – New PWM pulse width of channel, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle) You can keep original duty cycle or update new duty cycle

static inline void PWM_EnableInterrupts(PWM_Type *base, *pwm_submodule_t* subModule, uint32_t mask)

Enables the selected PWM interrupts.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- mask – The interrupts to enable. This is a logical OR of members of the enumeration pwm_interrupt_enable_t

static inline void PWM_DisableInterrupts(PWM_Type *base, *pwm_submodule_t* subModule, uint32_t mask)

Disables the selected PWM interrupts.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- mask – The interrupts to enable. This is a logical OR of members of the enumeration pwm_interrupt_enable_t

static inline uint32_t PWM_GetEnabledInterrupts(PWM_Type *base, *pwm_submodule_t* subModule)

Gets the enabled PWM interrupts.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure

Returns

The enabled interrupts. This is the logical OR of members of the enumeration pwm_interrupt_enable_t

static inline void PWM_DMAFIFOWatermarkControl(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_watermark_control_t* pwm_watermark_control)

Capture DMA Enable Source Select.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwm_watermark_control – PWM FIFO watermark and control

static inline void PWM_DMACaptureSourceSelect(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_dma_source_select_t* pwm_dma_source_select)

Capture DMA Enable Source Select.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwm_dma_source_select – PWM capture DMA enable source select

static inline void PWM_EnableDMACapture(PWM_Type *base, *pwm_submodule_t* subModule, uint16_t mask, bool activate)

Enables or disables the selected PWM DMA Capture read request.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- mask – The DMA to enable or disable. This is a logical OR of members of the enumeration pwm_dma_enable_t
- activate – true: Enable DMA read request; false: Disable DMA read request

static inline void PWM_EnableDMAWrite(PWM_Type *base, *pwm_submodule_t* subModule, bool activate)

Enables or disables the PWM DMA write request.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- activate – true: Enable DMA write request; false: Disable DMA write request

static inline uint32_t PWM_GetStatusFlags(PWM_Type *base, *pwm_submodule_t* subModule)

Gets the PWM status flags.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure

Returns

The status flags. This is the logical OR of members of the enumeration pwm_status_flags_t

static inline void PWM_ClearStatusFlags(PWM_Type *base, *pwm_submodule_t* subModule, uint32_t mask)

Clears the PWM status flags.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure

- mask – The status flags to clear. This is a logical OR of members of the enumeration pwm_status_flags_t

static inline void PWM_StartTimer(PWM_Type *base, uint8_t subModulesToStart)

Starts the PWM counter for a single or multiple submodules.

Sets the Run bit which enables the clocks to the PWM submodule. This function can start multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToStart – PWM submodules to start. This is a logical OR of members of the enumeration pwm_module_control_t

static inline void PWM_StopTimer(PWM_Type *base, uint8_t subModulesToStop)

Stops the PWM counter for a single or multiple submodules.

Clears the Run bit which resets the submodule's counter. This function can stop multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToStop – PWM submodules to stop. This is a logical OR of members of the enumeration pwm_module_control_t

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enum _pwm_submodule

List of PWM submodules.

Values:

enumerator kPWM_Module_0

Submodule 0

enumerator kPWM_Module_1

Submodule 1

enumerator kPWM_Module_2

Submodule 2

enum _pwm_channels

List of PWM channels in each module.

Values:

enumerator kPWM_PwmB

enumerator kPWM_PwmA

enumerator kPWM_PwmX

enum _pwm_value_register

List of PWM value registers.

Values:

enumerator kPWM_ValueRegister_0

PWM Value0 register

enumerator kPWM_ValueRegister_1

PWM Value1 register

enumerator kPWM_ValueRegister_2
PWM Value2 register

enumerator kPWM_ValueRegister_3
PWM Value3 register

enumerator kPWM_ValueRegister_4
PWM Value4 register

enumerator kPWM_ValueRegister_5
PWM Value5 register

enum _pwm_value_register_mask
List of PWM value registers mask.

Values:

enumerator kPWM_ValueRegisterMask_0
PWM Value0 register mask

enumerator kPWM_ValueRegisterMask_1
PWM Value1 register mask

enumerator kPWM_ValueRegisterMask_2
PWM Value2 register mask

enumerator kPWM_ValueRegisterMask_3
PWM Value3 register mask

enumerator kPWM_ValueRegisterMask_4
PWM Value4 register mask

enumerator kPWM_ValueRegisterMask_5
PWM Value5 register mask

enum _pwm_clock_source
PWM clock source selection.

Values:

enumerator kPWM_BusClock
The IPBus clock is used as the clock

enumerator kPWM_ExternalClock
EXT_CLK is used as the clock

enumerator kPWM_Submodule0Clock
Clock of the submodule 0 (AUX_CLK) is used as the source clock

enum _pwm_clock_prescale
PWM prescaler factor selection for clock source.

Values:

enumerator kPWM_Prescale_Divide_1
PWM clock frequency = fclk/1

enumerator kPWM_Prescale_Divide_2
PWM clock frequency = fclk/2

enumerator kPWM_Prescale_Divide_4
PWM clock frequency = fclk/4

enumerator kPWM_Prescale_Divide_8
PWM clock frequency = fclk/8

enumerator kPWM_Prescale_Divide_16
PWM clock frequency = fclk/16

enumerator kPWM_Prescale_Divide_32
PWM clock frequency = fclk/32

enumerator kPWM_Prescale_Divide_64
PWM clock frequency = fclk/64

enumerator kPWM_Prescale_Divide_128
PWM clock frequency = fclk/128

enum __pwm_force_output_trigger
Options that can trigger a PWM FORCE_OUT.

Values:

enumerator kPWM_Force_Local
The local force signal, CTRL2[FORCE], from the submodule is used to force updates

enumerator kPWM_Force_Master
The master force signal from submodule 0 is used to force updates

enumerator kPWM_Force_LocalReload
The local reload signal from this submodule is used to force updates without regard to the state of LDOK

enumerator kPWM_Force_MasterReload
The master reload signal from submodule 0 is used to force updates if LDOK is set

enumerator kPWM_Force_LocalSync
The local sync signal from this submodule is used to force updates

enumerator kPWM_Force_MasterSync
The master sync signal from submodule0 is used to force updates

enumerator kPWM_Force_External
The external force signal, EXT_FORCE, from outside the PWM module causes updates

enumerator kPWM_Force_ExternalSync
The external sync signal, EXT_SYNC, from outside the PWM module causes updates

enum __pwm_output_state
PWM channel output status.

Values:

enumerator kPWM_HighState
The output state of PWM channel is high

enumerator kPWM_LowState
The output state of PWM channel is low

enumerator kPWM_NormalState
The output state of PWM channel is normal

enumerator kPWM_InvertState
The output state of PWM channel is invert

enumerator kPWM_MaskState
The output state of PWM channel is mask

enum _pwm_init_source

PWM counter initialization options.

Values:

enumerator kPWM_Initialize_LocalSync

Local sync causes initialization

enumerator kPWM_Initialize_MasterReload

Master reload from submodule 0 causes initialization

enumerator kPWM_Initialize_MasterSync

Master sync from submodule 0 causes initialization

enumerator kPWM_Initialize_ExtSync

EXT_SYNC causes initialization

enum _pwm_load_frequency

PWM load frequency selection.

Values:

enumerator kPWM_LoadEveryOportunity

Every PWM opportunity

enumerator kPWM_LoadEvery2Oportunity

Every 2 PWM opportunities

enumerator kPWM_LoadEvery3Oportunity

Every 3 PWM opportunities

enumerator kPWM_LoadEvery4Oportunity

Every 4 PWM opportunities

enumerator kPWM_LoadEvery5Oportunity

Every 5 PWM opportunities

enumerator kPWM_LoadEvery6Oportunity

Every 6 PWM opportunities

enumerator kPWM_LoadEvery7Oportunity

Every 7 PWM opportunities

enumerator kPWM_LoadEvery8Oportunity

Every 8 PWM opportunities

enumerator kPWM_LoadEvery9Oportunity

Every 9 PWM opportunities

enumerator kPWM_LoadEvery10Oportunity

Every 10 PWM opportunities

enumerator kPWM_LoadEvery11Oportunity

Every 11 PWM opportunities

enumerator kPWM_LoadEvery12Oportunity

Every 12 PWM opportunities

enumerator kPWM_LoadEvery13Oportunity

Every 13 PWM opportunities

enumerator kPWM_LoadEvery14Oportunity

Every 14 PWM opportunities

enumerator kPWM_LoadEvery15Oportunity
Every 15 PWM opportunities

enumerator kPWM_LoadEvery16Oportunity
Every 16 PWM opportunities

enum _pwm_fault_input
List of PWM fault selections.

Values:

enumerator kPWM_Fault_0
Fault 0 input pin

enumerator kPWM_Fault_1
Fault 1 input pin

enumerator kPWM_Fault_2
Fault 2 input pin

enumerator kPWM_Fault_3
Fault 3 input pin

enum _pwm_fault_disable
List of PWM fault disable mapping selections.

Values:

enumerator kPWM_FaultDisable_0
Fault 0 disable mapping

enumerator kPWM_FaultDisable_1
Fault 1 disable mapping

enumerator kPWM_FaultDisable_2
Fault 2 disable mapping

enumerator kPWM_FaultDisable_3
Fault 3 disable mapping

enum _pwm_fault_channels
List of PWM fault channels.

Values:

enumerator kPWM_faultchannel_0

enumerator kPWM_faultchannel_1

enum _pwm_input_capture_edge
PWM capture edge select.

Values:

enumerator kPWM_Disable
Disabled

enumerator kPWM_FallingEdge
Capture on falling edge only

enumerator kPWM_RisingEdge
Capture on rising edge only

enumerator kPWM_RiseAndFallEdge
Capture on rising or falling edge

enum _pwm_force_signal

PWM output options when a FORCE_OUT signal is asserted.

Values:

enumerator kPWM_UsePwm

Generated PWM signal is used by the deadtime logic.

enumerator kPWM_InvertedPwm

Inverted PWM signal is used by the deadtime logic.

enumerator kPWM_SoftwareControl

Software controlled value is used by the deadtime logic.

enumerator kPWM_UseExternal

PWM_EXTA signal is used by the deadtime logic.

enum _pwm_chnl_pair_operation

Options available for the PWM A & B pair operation.

Values:

enumerator kPWM_Independent

PWM A & PWM B operate as 2 independent channels

enumerator kPWM_ComplementaryPwmA

PWM A & PWM B are complementary channels, PWM A generates the signal

enumerator kPWM_ComplementaryPwmB

PWM A & PWM B are complementary channels, PWM B generates the signal

enum _pwm_register_reload

Options available on how to load the buffered-registers with new values.

Values:

enumerator kPWM_ReloadImmediate

Buffered-registers get loaded with new values as soon as LDOK bit is set

enumerator kPWM_ReloadPwmHalfCycle

Registers loaded on a PWM half cycle

enumerator kPWM_ReloadPwmFullCycle

Registers loaded on a PWM full cycle

enumerator kPWM_ReloadPwmHalfAndFullCycle

Registers loaded on a PWM half & full cycle

enum _pwm_fault_recovery_mode

Options available on how to re-enable the PWM output when recovering from a fault.

Values:

enumerator kPWM_NoRecovery

PWM output will stay inactive

enumerator kPWM_RecoverHalfCycle

PWM output re-enabled at the first half cycle

enumerator kPWM_RecoverFullCycle

PWM output re-enabled at the first full cycle

enumerator kPWM_RecoverHalfAndFullCycle

PWM output re-enabled at the first half or full cycle

enum _pwm_interrupt_enable

List of PWM interrupt options.

Values:

enumerator kPWM_CompareVal0InterruptEnable
PWM VAL0 compare interrupt

enumerator kPWM_CompareVal1InterruptEnable
PWM VAL1 compare interrupt

enumerator kPWM_CompareVal2InterruptEnable
PWM VAL2 compare interrupt

enumerator kPWM_CompareVal3InterruptEnable
PWM VAL3 compare interrupt

enumerator kPWM_CompareVal4InterruptEnable
PWM VAL4 compare interrupt

enumerator kPWM_CompareVal5InterruptEnable
PWM VAL5 compare interrupt

enumerator kPWM_CaptureX0InterruptEnable
PWM capture X0 interrupt

enumerator kPWM_CaptureX1InterruptEnable
PWM capture X1 interrupt

enumerator kPWM_CaptureB0InterruptEnable
PWM capture B0 interrupt

enumerator kPWM_CaptureB1InterruptEnable
PWM capture B1 interrupt

enumerator kPWM_CaptureA0InterruptEnable
PWM capture A0 interrupt

enumerator kPWM_CaptureA1InterruptEnable
PWM capture A1 interrupt

enumerator kPWM_ReloadInterruptEnable
PWM reload interrupt

enumerator kPWM_ReloadErrorInterruptEnable
PWM reload error interrupt

enumerator kPWM_Fault0InterruptEnable
PWM fault 0 interrupt

enumerator kPWM_Fault1InterruptEnable
PWM fault 1 interrupt

enumerator kPWM_Fault2InterruptEnable
PWM fault 2 interrupt

enumerator kPWM_Fault3InterruptEnable
PWM fault 3 interrupt

enum _pwm_status_flags

List of PWM status flags.

Values:

enumerator kPWM_CompareVal0Flag
PWM VAL0 compare flag

enumerator kPWM_CompareVal1Flag
PWM VAL1 compare flag

enumerator kPWM_CompareVal2Flag
PWM VAL2 compare flag

enumerator kPWM_CompareVal3Flag
PWM VAL3 compare flag

enumerator kPWM_CompareVal4Flag
PWM VAL4 compare flag

enumerator kPWM_CompareVal5Flag
PWM VAL5 compare flag

enumerator kPWM_CaptureX0Flag
PWM capture X0 flag

enumerator kPWM_CaptureX1Flag
PWM capture X1 flag

enumerator kPWM_CaptureB0Flag
PWM capture B0 flag

enumerator kPWM_CaptureB1Flag
PWM capture B1 flag

enumerator kPWM_CaptureA0Flag
PWM capture A0 flag

enumerator kPWM_CaptureA1Flag
PWM capture A1 flag

enumerator kPWM_ReloadFlag
PWM reload flag

enumerator kPWM_ReloadErrorFlag
PWM reload error flag

enumerator kPWM_RegUpdatedFlag
PWM registers updated flag

enumerator kPWM_Fault0Flag
PWM fault 0 flag

enumerator kPWM_Fault1Flag
PWM fault 1 flag

enumerator kPWM_Fault2Flag
PWM fault 2 flag

enumerator kPWM_Fault3Flag
PWM fault 3 flag

enum _pwm_dma_enable
List of PWM DMA options.

Values:

enumerator kPWM_CaptureX0DMAEnable
PWM capture X0 DMA

enumerator kPWM_CaptureX1DMAEnable
PWM capture X1 DMA

enumerator kPWM_CaptureB0DMAEnable
PWM capture B0 DMA

enumerator kPWM_CaptureB1DMAEnable
PWM capture B1 DMA

enumerator kPWM_CaptureA0DMAEnable
PWM capture A0 DMA

enumerator kPWM_CaptureA1DMAEnable
PWM capture A1 DMA

enum __pwm_dma_source_select
List of PWM capture DMA enable source select.

Values:

enumerator kPWM_DMARequestDisable
Read DMA requests disabled

enumerator kPWM_DMAWatermarksEnable
Exceeding a FIFO watermark sets the DMA read request

enumerator kPWM_DMALocalSync
A local sync (VAL1 matches counter) sets the read DMA request

enumerator kPWM_DMALocalReload
A local reload (STS[RF] being set) sets the read DMA request

enum __pwm_watermark_control
PWM FIFO Watermark AND Control.

Values:

enumerator kPWM_FIFOWatermarksOR
Selected FIFO watermarks are OR'ed together

enumerator kPWM_FIFOWatermarksAND
Selected FIFO watermarks are AND'ed together

enum __pwm_mode
PWM operation mode.

Values:

enumerator kPWM_SignedCenterAligned
Signed center-aligned

enumerator kPWM_CenterAligned
Unsigned cente-aligned

enumerator kPWM_SignedEdgeAligned
Signed edge-aligned

enumerator kPWM_EdgeAligned
Unsigned edge-aligned

enum _pwm_level_select

PWM output pulse mode, high-true or low-true.

Values:

enumerator kPWM_HighTrue

High level represents “on” or “active” state

enumerator kPWM_LowTrue

Low level represents “on” or “active” state

enum _pwm_fault_state

PWM output fault status.

Values:

enumerator kPWM_PwmFaultState0

Output is forced to logic 0 state prior to consideration of output polarity control.

enumerator kPWM_PwmFaultState1

Output is forced to logic 1 state prior to consideration of output polarity control.

enumerator kPWM_PwmFaultState2

Output is tristated.

enumerator kPWM_PwmFaultState3

Output is tristated.

enum _pwm_reload_source_select

PWM reload source select.

Values:

enumerator kPWM_LocalReload

The local reload signal is used to reload registers

enumerator kPWM_MasterReload

The master reload signal (from submodule 0) is used to reload

enum _pwm_fault_clear

PWM fault clearing options.

Values:

enumerator kPWM_Automatic

Automatic fault clearing

enumerator kPWM_ManualNormal

Manual fault clearing with no fault safety mode

enumerator kPWM_ManualSafety

Manual fault clearing with fault safety mode

enum _pwm_module_control

Options for submodule master control operation.

Values:

enumerator kPWM_Control_Module_0

Control submodule 0’s start/stop,buffer reload operation

enumerator kPWM_Control_Module_1

Control submodule 1’s start/stop,buffer reload operation

enumerator kPWM_Control_Module_2
Control submodule 2's start/stop,buffer reload operation

enumerator kPWM_Control_Module_3
Control submodule 3's start/stop,buffer reload operation

typedef enum *_pwm_submodule* pwm_submodule_t
List of PWM submodules.

typedef enum *_pwm_channels* pwm_channels_t
List of PWM channels in each module.

typedef enum *_pwm_value_register* pwm_value_register_t
List of PWM value registers.

typedef enum *_pwm_clock_source* pwm_clock_source_t
PWM clock source selection.

typedef enum *_pwm_clock_prescale* pwm_clock_prescale_t
PWM prescaler factor selection for clock source.

typedef enum *_pwm_force_output_trigger* pwm_force_output_trigger_t
Options that can trigger a PWM FORCE_OUT.

typedef enum *_pwm_output_state* pwm_output_state_t
PWM channel output status.

typedef enum *_pwm_init_source* pwm_init_source_t
PWM counter initialization options.

typedef enum *_pwm_load_frequency* pwm_load_frequency_t
PWM load frequency selection.

typedef enum *_pwm_fault_input* pwm_fault_input_t
List of PWM fault selections.

typedef enum *_pwm_fault_disable* pwm_fault_disable_t
List of PWM fault disable mapping selections.

typedef enum *_pwm_fault_channels* pwm_fault_channels_t
List of PWM fault channels.

typedef enum *_pwm_input_capture_edge* pwm_input_capture_edge_t
PWM capture edge select.

typedef enum *_pwm_force_signal* pwm_force_signal_t
PWM output options when a FORCE_OUT signal is asserted.

typedef enum *_pwm_chnl_pair_operation* pwm_chnl_pair_operation_t
Options available for the PWM A & B pair operation.

typedef enum *_pwm_register_reload* pwm_register_reload_t
Options available on how to load the buffered-registers with new values.

typedef enum *_pwm_fault_recovery_mode* pwm_fault_recovery_mode_t
Options available on how to re-enable the PWM output when recovering from a fault.

typedef enum *_pwm_interrupt_enable* pwm_interrupt_enable_t
List of PWM interrupt options.

typedef enum *_pwm_status_flags* pwm_status_flags_t
List of PWM status flags.

typedef enum *_pwm_dma_enable* pwm_dma_enable_t
List of PWM DMA options.

typedef enum *_pwm_dma_source_select* pwm_dma_source_select_t
List of PWM capture DMA enable source select.

typedef enum *_pwm_watermark_control* pwm_watermark_control_t
PWM FIFO Watermark AND Control.

typedef enum *_pwm_mode* pwm_mode_t
PWM operation mode.

typedef enum *_pwm_level_select* pwm_level_select_t
PWM output pulse mode, high-true or low-true.

typedef enum *_pwm_fault_state* pwm_fault_state_t
PWM output fault status.

typedef enum *_pwm_reload_source_select* pwm_reload_source_select_t
PWM reload source select.

typedef enum *_pwm_fault_clear* pwm_fault_clear_t
PWM fault clearing options.

typedef enum *_pwm_module_control* pwm_module_control_t
Options for submodule master control operation.

typedef struct *_pwm_signal_param* pwm_signal_param_t
Structure for the user to define the PWM signal characteristics.

typedef struct *_pwm_config* pwm_config_t
PWM config structure.

This structure holds the configuration settings for the PWM peripheral. To initialize this structure to reasonable defaults, call the PWM_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

typedef struct *_pwm_fault_input_filter_param* pwm_fault_input_filter_param_t
Structure for the user to configure the fault input filter.

typedef struct *_pwm_fault_param* pwm_fault_param_t
Structure is used to hold the parameters to configure a PWM fault.

typedef struct *_pwm_input_capture_param* pwm_input_capture_param_t
Structure is used to hold parameters to configure the capture capability of a signal pin.

void PWM_SetupInputCapture(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, const *pwm_input_capture_param_t* *inputCaptureParams)
Sets up the PWM input capture.

Each PWM submodule has 3 pins that can be configured for use as input capture pins. This function sets up the capture parameters for each pin and enables the pin for input capture operation.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel in the submodule to setup
- inputCaptureParams – Parameters passed in to set up the input pin

void PWM_SetupFaultInputFilter(PWM_Type *base, const *pwm_fault_input_filter_param_t* *faultInputFilterParams)

Sets up the PWM fault input filter.

Parameters

- base – PWM peripheral base address
- faultInputFilterParams – Parameters passed in to set up the fault input filter.

void PWM_SetupFaults(PWM_Type *base, *pwm_fault_input_t* faultNum, const *pwm_fault_param_t* *faultParams)

Sets up the PWM fault protection.

PWM has 4 fault inputs.

Parameters

- base – PWM peripheral base address
- faultNum – PWM fault to configure.
- faultParams – Pointer to the PWM fault config structure

void PWM_FaultDefaultConfig(*pwm_fault_param_t* *config)

Fill in the PWM fault config struct with the default settings.

The default values are:

```
config->faultClearingMode = kPWM_Automatic;
config->faultLevel = false;
config->enableCombinationalPath = true;
config->recoverMode = kPWM_NoRecovery;
```

Parameters

- config – Pointer to user's PWM fault config structure.

void PWM_SetupForceSignal(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, *pwm_force_signal_t* mode)

Selects the signal to output on a PWM pin when a FORCE_OUT signal is asserted.

The user specifies which channel to configure by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel to configure
- mode – Signal to output when a FORCE_OUT is triggered

static inline void PWM_SetVALxValue(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_value_register_t* valueRegister, uint16_t value)

Set the PWM VALx registers.

This function allows the user to write value into VAL registers directly. And it will destroying the PWM clock period set by the PWM_SetupPwm()/PWM_SetupPwmPhaseShift() functions. Due to VALx registers are bufferd, the new value will not active uless call PWM_SetPwmLdok() and the reload point is reached.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure

- valueRegister – VALx register that will be writen new value
- value – Value that will been write into VALx register

static inline uint16_t PWM_GetVALxValue(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_value_register_t* valueRegister)

Get the PWM VALx registers.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegister – VALx register that will be read value

Returns

The VALx register value

static inline void PWM_OutputTriggerEnable(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_value_register_t* valueRegister, bool activate)

Enables or disables the PWM output trigger.

This function allows the user to enable or disable the PWM trigger. The PWM has 2 triggers. Trigger 0 is activated when the counter matches VAL 0, VAL 2, or VAL 4 register. Trigger 1 is activated when the counter matches VAL 1, VAL 3, or VAL 5 register.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegister – Value register that will activate the trigger
- activate – true: Enable the trigger; false: Disable the trigger

static inline void PWM_ActivateOutputTrigger(PWM_Type *base, *pwm_submodule_t* subModule, uint16_t valueRegisterMask)

Enables the PWM output trigger.

This function allows the user to enable one or more (VAL0-5) PWM trigger.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegisterMask – Value register mask that will activate one or more (VAL0-5) trigger enumeration _pwm_value_register_mask

static inline void PWM_DeactivateOutputTrigger(PWM_Type *base, *pwm_submodule_t* subModule, uint16_t valueRegisterMask)

Disables the PWM output trigger.

This function allows the user to disables one or more (VAL0-5) PWM trigger.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegisterMask – Value register mask that will Deactivate one or more (VAL0-5) trigger enumeration _pwm_value_register_mask

static inline void PWM_SetupSwCtrlOut(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, bool value)

Sets the software control output for a pin to high or low.

The user specifies which channel to modify by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel to configure
- value – true: Supply a logic 1, false: Supply a logic 0.

static inline void PWM_SetPwmLdok(PWM_Type *base, uint8_t subModulesToUpdate, bool value)

Sets or clears the PWM LDOK bit on a single or multiple submodules.

Set LDOK bit to load buffered values into CTRL[PRSC] and the INIT, FRACVAL and VAL registers. The values are loaded immediately if kPWM_ReloadImmediate option was choosen during config. Else the values are loaded at the next PWM reload point. This function can issue the load command to multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToUpdate – PWM submodules to update with buffered values. This is a logical OR of members of the enumeration pwm_module_control_t
- value – true: Set LDOK bit for the submodule list; false: Clear LDOK bit

static inline void PWM_SetPwmFaultState(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, *pwm_fault_state_t* faultState)

Set PWM output fault status.

These bits determine the fault state for the PWM_A output in fault conditions and STOP mode. It may also define the output state in WAIT and DEBUG modes depending on the settings of CTRL2[WAITEN] and CTRL2[DBGEN]. This function can update PWM output fault status.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel to configure
- faultState – PWM output fault status

static inline void PWM_SetupFaultDisableMap(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, *pwm_fault_channels_t* pwm_fault_channels, uint16_t value)

Set PWM fault disable mapping.

Each of the four bits of this read/write field is one-to-one associated with the four FAULTx inputs of fault channel 0/1. The PWM output will be turned off if there is a logic 1 on an FAULTx input and a 1 in the corresponding bit of this field. A reset sets all bits in this field.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- pwm_fault_channels – PWM fault channel to configure
- value – Fault disable mapping mask value enumeration pwm_fault_disable_t

static inline void PWM_OutputEnable(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule)

Set PWM output enable.

This feature allows the user to enable the PWM Output. Recommend to invoke this API after PWM and fault configuration. But invoke this API before configure MCTRL register is okay, such as set LDOK or start timer.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure

static inline void PWM_OutputDisable(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule)

Set PWM output disable.

This feature allows the user to disable the PWM output. Recommend to invoke this API after PWM and fault configuration. But invoke this API before configure MCTRL register is okay, such as set LDOK or start timer.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure

uint8_t PWM_GetPwmChannelState(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel)

Get the dutycycle value.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure

Returns

Current channel dutycycle value.

status_t PWM_SetOutputToIdle(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule, bool idleStatus)

Set PWM output in idle status (high or low).

Note: This API should call after PWM_SetupPwm() APIs, and PWMX submodule is not supported.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure
- idleStatus – True: PWM output is high in idle status; false: PWM output is low in idle status.

Returns

kStatus_Fail if there was error setting up the signal; kStatus_Success if set output idle success

void PWM_SetClockMode(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_clock_prescale_t* prescaler)

Set the pwm submodule prescaler.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- prescaler – Set prescaler value

void PWM_SetPwmForceOutputToZero(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, bool forcetozero)

This function enables-disables the forcing of the output of a given eFlexPwm channel to logic 0.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure
- forcetozero – True: Enable the pwm force output to zero; False: Disable the pwm output resumes normal function.

void PWM_SetChannelOutput(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, *pwm_output_state_t* outputstate)

This function set the output state of the PWM pin as requested for the current cycle.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- outputstate – Set pwm output state, see pwm_output_state_t.

status_t PWM_SetPhaseDelay(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule, uint16_t delayCycles)

This function set the phase delay from the master sync signal of submodule 0.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- delayCycles – Number of cycles delayed from submodule 0.

Returns

kStatus_Fail if the number of delay cycles is set larger than the period defined in submodule 0; kStatus_Success if set phase delay success

static inline void PWM_SetFilterSampleCount(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule, uint8_t filterSampleCount)

This function set the number of consecutive samples that must agree prior to the input filter.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- filterSampleCount – Number of consecutive samples.

static inline void PWM_SetFilterSamplePeriod(PWM_Type *base, *pwm_channels_t* pwmChannel, *pwm_submodule_t* subModule, uint8_t filterSamplePeriod)

This function set the sampling period of the fault pin input filter.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- filterSamplePeriod – Sampling period of input filter.

PWM_SUBMODULE_SWCONTROL_WIDTH

Number of bits per submodule for software output control

PWM_SUBMODULE_CHANNEL

Submodule channels include PWMA, PWMB, PWMX.

struct __pwm_signal_param

#include <fsl_pwm.h> Structure for the user to define the PWM signal characteristics.

Public Members

pwm_channels_t pwmChannel

PWM channel being configured; PWM A or PWM B

uint8_t dutyCyclePercent

PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=always active signal (100% duty cycle)

pwm_level_select_t level

PWM output active level select

uint16_t deadtimeValue

The deadtime value; only used if channel pair is operating in complementary mode

pwm_fault_state_t faultState

PWM output fault status

bool pwmchannelenable

Enable PWM output

struct _pwm_config

#include <fsl_pwm.h> PWM config structure.

This structure holds the configuration settings for the PWM peripheral. To initialize this structure to reasonable defaults, call the PWM_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

Public Members

bool enableDebugMode

true: PWM continues to run in debug mode; false: PWM is paused in debug mode

pwm_init_source_t initializationControl

Option to initialize the counter

pwm_clock_source_t clockSource

Clock source for the counter

pwm_clock_prescale_t prescale

Pre-scaler to divide down the clock

pwm_chnl_pair_operation_t pairOperation

Channel pair in indepedent or complementary mode

pwm_register_reload_t reloadLogic

PWM Reload logic setup

pwm_reload_source_select_t reloadSelect

Reload source select

pwm_load_frequency_t reloadFrequency

Specifies when to reload, used when user's choice is not immediate reload

pwm_force_output_trigger_t forceTrigger

Specify which signal will trigger a FORCE_OUT

struct _pwm_fault_input_filter_param

#include <fsl_pwm.h> Structure for the user to configure the fault input filter.

Public Members

uint8_t faultFilterCount

Fault filter count

uint8_t faultFilterPeriod

Fault filter period;value of 0 will bypass the filter

bool faultGlitchStretch

Fault Glitch Stretch Enable: A logic 1 means that input fault signals will be stretched to at least 2 IPBus clock cycles

struct _pwm_fault_param

#include <fsl_pwm.h> Structure is used to hold the parameters to configure a PWM fault.

Public Members

pwm_fault_clear_t faultClearingMode

Fault clearing mode to use

bool faultLevel

true: Logic 1 indicates fault; false: Logic 0 indicates fault

bool enableCombinationalPath

true: Combinational Path from fault input is enabled; false: No combination path is available

pwm_fault_recovery_mode_t recoverMode

Specify when to re-enable the PWM output

struct __pwm_input_capture_param

#include <fsl_pwm.h> Structure is used to hold parameters to configure the capture capability of a signal pin.

Public Members

bool captureInputSel

true: Use the edge counter signal as source false: Use the raw input signal from the pin as source

uint8_t edgeCompareValue

Compare value, used only if edge counter is used as source

pwm_input_capture_edge_t edge0

Specify which edge causes a capture for input circuitry 0

pwm_input_capture_edge_t edge1

Specify which edge causes a capture for input circuitry 1

bool enableOneShotCapture

true: Use one-shot capture mode; false: Use free-running capture mode

uint8_t fifoWatermark

Watermark level for capture FIFO. The capture flags in the status register will set if the word count in the FIFO is greater than this watermark level

2.97 PXP: Pixel Pipeline

void PXP_Init(PXP_Type *base)

Initialize the PXP.

This function enables the PXP peripheral clock, and resets the PXP registers to default status.

Parameters

- base – PXP peripheral base address.

void PXP_Deinit(PXP_Type *base)

De-initialize the PXP.

This function disables the PXP peripheral clock.

Parameters

- base – PXP peripheral base address.

void PXP_Reset(PXP_Type *base)

Reset the PXP.

This function resets the PXP peripheral registers to default status.

Parameters

- base – PXP peripheral base address.

void PXP_ResetControl(PXP_Type *base)

Reset the PXP and the control register to initialized state.

Parameters

- base – PXP peripheral base address.

static inline void PXP_Start(PXP_Type *base)

Start process.

Start PXP process using current configuration.

Parameters

- base – PXP peripheral base address.

static inline void PXP_EnableLcdHandShake(PXP_Type *base, bool enable)

Enable or disable LCD hand shake.

Parameters

- base – PXP peripheral base address.
- enable – True to enable, false to disable.

static inline void PXP_EnableContinousRun(PXP_Type *base, bool enable)

Enable or disable continous run.

If continous run not enabled, PXP_Start starts the PXP process. When completed, PXP enters idle mode and flag kPXP_CompleteFlag asserts.

If continous run enabled, the PXP will repeat based on the current configuration register settings.

Parameters

- base – PXP peripheral base address.
- enable – True to enable, false to disable.

static inline void PXP_SetProcessBlockSize(PXP_Type *base, *pxp_block_size_t* size)

Set the PXP processing block size.

This function chooses the pixel block size that PXP using during process. Larger block size means better performace, but be careful that when PXP is rotating, the output must be divisible by the block size selected.

Parameters

- base – PXP peripheral base address.
- size – The pixel block size.

static inline void PXP_EnableProcessEngine(PXP_Type *base, uint32_t mask, bool enable)

Enables or disables PXP engines in the process flow.

Parameters

- base – PXP peripheral base address.
- mask – The engines to enable. Logical OR of pxp_process_engine_name_t.

- enable – true to enable, false to disable.

static inline uint32_t PXP_GetStatusFlags(PXP_Type *base)

Gets PXP status flags.

This function gets all PXP status flags. The flags are returned as the logical OR value of the enumerators _pxp_flags. To check a specific status, compare the return value with enumerators in _pxp_flags. For example, to check whether the PXP has completed process, use like this:

```
if (kPXP_CompleteFlag & PXP_GetStatusFlags(PXP))
{
    ...
}
```

Parameters

- base – PXP peripheral base address.

Returns

PXP status flags which are OR'ed by the enumerators in the _pxp_flags.

static inline void PXP_ClearStatusFlags(PXP_Type *base, uint32_t statusMask)

Clears status flags with the provided mask.

This function clears PXP status flags with a provided mask.

Parameters

- base – PXP peripheral base address.
- statusMask – The status flags to be cleared; it is logical OR value of _pxp_flags.

static inline uint8_t PXP_GetAxiErrorId(PXP_Type *base, uint8_t axiIndex)

Gets the AXI ID of the failing bus operation.

Parameters

- base – PXP peripheral base address.
- axiIndex – Whitch AXI to get
  - 0: AXI0
  - 1: AXI1

Returns

The AXI ID of the failing bus operation.

static inline void PXP_EnableInterrupts(PXP_Type *base, uint32_t mask)

Enables PXP interrupts according to the provided mask.

This function enables the PXP interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _pxp_interrupt_enable. For example, to enable PXP process complete interrupt and command loaded interrupt, do the following.

```
PXP_EnableInterrupts(PXP, kPXP_CommandLoadInterruptEnable | kPXP_
↪CompleteInterruptEnable);
```

Parameters

- base – PXP peripheral base address.
- mask – The interrupts to enable. Logical OR of _pxp_interrupt_enable.

static inline void PXP_DisableInterrupts(PXP_Type *base, uint32_t mask)

Disables PXP interrupts according to the provided mask.

This function disables the PXP interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _pxp_interrupt_enable.

Parameters

- base – PXP peripheral base address.
- mask – The interrupts to disable. Logical OR of _pxp_interrupt_enable.

void PXP_SetAlphaSurfaceBufferConfig(PXP_Type *base, const *pxp_as_buffer_config_t* *config)

Set the alpha surface input buffer configuration.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration.

void PXP_SetAlphaSurfaceBlendConfig(PXP_Type *base, const *pxp_as_blend_config_t* *config)

Set the alpha surface blending configuration.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration structure.

void PXP_SetAlphaSurfaceBlendSecondaryConfig(PXP_Type *base, const *pxp_as_blend_secondary_config_t* *config)

Set the alpha surface blending configuration for the secondary engine.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration structure.

void PXP_SetAlphaSurfaceOverlayColorKey(PXP_Type *base, uint8_t num, uint32_t colorKeyLow, uint32_t colorKeyHigh)

Set the alpha surface overlay color key.

If a pixel in the current overlay image with a color that falls in the range from the colorKeyLow to colorKeyHigh range, it will use the process surface pixel value for that location. If no PS image is present or if the PS image also matches its colorkey range, the PS background color is used.

Note: Colorkey operations are higher priority than alpha or ROP operations

Parameters

- base – PXP peripheral base address.
- num – instance number. 0 for alpha engine A, 1 for alpha engine B.
- colorKeyLow – Color key low range.
- colorKeyHigh – Color key high range.

static inline void PXP_EnableAlphaSurfaceOverlayColorKey(PXP_Type *base, uint32_t num, bool enable)

Enable or disable the alpha surface color key.

Parameters

- base – PXP peripheral base address.
- num – instance number. 0 for alpha engine A, 1 for alpha engine B.
- enable – True to enable, false to disable.

void PXP_SetAlphaSurfacePosition(PXP_Type *base, uint16_t upperLeftX, uint16_t upperLeftY, uint16_t lowerRightX, uint16_t lowerRightY)

Set the alpha surface position in output buffer.

Parameters

- base – PXP peripheral base address.
- upperLeftX – X of the upper left corner.
- upperLeftY – Y of the upper left corner.
- lowerRightX – X of the lower right corner.
- lowerRightY – Y of the lower right corner.

static inline void PXP_SetProcessSurfaceBackGroundColor(PXP_Type *base, uint8_t num, uint32_t backGroundColor)

Set the back ground color of PS.

Parameters

- base – PXP peripheral base address.
- num – instance number. 0 for alpha engine A, 1 for alpha engine B.
- backGroundColor – Pixel value of the background color.

void PXP_SetProcessSurfaceBufferConfig(PXP_Type *base, const *pxp_ps_buffer_config_t* *config)

Set the process surface input buffer configuration.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration.

void PXP_SetProcessSurfaceScaler(PXP_Type *base, uint16_t inputWidth, uint16_t inputHeight, uint16_t outputWidth, uint16_t outputHeight)

Set the process surface scaler configuration.

The valid down scale fact is 1/(2^12) ~ 16.

Parameters

- base – PXP peripheral base address.
- inputWidth – Input image width.
- inputHeight – Input image height.
- outputWidth – Output image width.
- outputHeight – Output image height.

void PXP_SetProcessSurfacePosition(PXP_Type *base, uint16_t upperLeftX, uint16_t upperLeftY, uint16_t lowerRightX, uint16_t lowerRightY)

Set the process surface position in output buffer.

Parameters

- base – PXP peripheral base address.
- upperLeftX – X of the upper left corner.
- upperLeftY – Y of the upper left corner.

- lowerRightX – X of the lower right corner.
- lowerRightY – Y of the lower right corner.

void PXP_SetProcessSurfaceColorKey(PXP_Type *base, uint8_t num, uint32_t colorKeyLow, uint32_t colorKeyHigh)

Set the process surface color key.

If the PS image matches colorkey range, the PS background color is output. Set colorKeyLow to 0xFFFFFFFF and p colorKeyHigh to 0 will disable the colorkeying.

Parameters

- base – PXP peripheral base address.
- num – instance number. 0 for alpha engine A, 1 for alpha engine B.
- colorKeyLow – Color key low range.
- colorKeyHigh – Color key high range.

static inline void PXP_SetProcessSurfaceYUVFormat(PXP_Type *base, *pxp_ps_yuv_format_t* format)

Set the process surface input pixel format YUV or YCbCr.

If process surface input pixel format is YUV and CSC1 is not enabled, in other words, the process surface output pixel format is also YUV, then this function should be called to set whether input pixel format is YUV or YCbCr.

Parameters

- base – PXP peripheral base address.
- format – The YUV format.

void PXP_SetOutputBufferConfig(PXP_Type *base, const *pxp_output_buffer_config_t* *config)

Set the PXP outpt buffer configuration.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration.

static inline void PXP_SetOverwrittenAlphaValue(PXP_Type *base, uint8_t alpha)

Set the global overwritten alpha value.

If global overwritten alpha is enabled, the alpha component in output buffer pixels will be overwritten, otherwise the computed alpha value is used.

Parameters

- base – PXP peripheral base address.
- alpha – The alpha value.

static inline void PXP_EnableOverWrittenAlpha(PXP_Type *base, bool enable)

Enable or disable the global overwritten alpha value.

If global overwritten alpha is enabled, the alpha component in output buffer pixels will be overwritten, otherwise the computed alpha value is used.

Parameters

- base – PXP peripheral base address.
- enable – True to enable, false to disable.

static inline void PXP_SetRotateConfig(PXP_Type *base, *pxp_rotate_position_t* position, *pxp_rotate_degree_t* degree, *pxp_flip_mode_t* flipMode)

Set the rotation configuration.

The PXP could rotate the process surface or the output buffer. There are two PXP versions:

- Version 1: Only has one rotate sub module, the output buffer and process surface share the same rotate sub module, which means the process surface and output buffer could not be rotate at the same time. When pass in kPXP_RotateOutputBuffer, the process surface could not use the rotate, Also when pass in kPXP_RotateProcessSurface, output buffer could not use the rotate.
- Version 2: Has two seperate rotate sub modules, the output buffer and process surface could configure the rotation independently.

Upper layer could use the macro PXP_SHARE_ROTATE to check which version is. PXP_SHARE_ROTATE=1 means version 1.

Note: This function is different depends on the macro PXP_SHARE_ROTATE.

Parameters

- base – PXP peripheral base address.
- position – Rotate process surface or output buffer.
- degree – Rotate degree.
- flipMode – Flip mode.

void PXP_BuildRect(PXP_Type *base, *pxp_output_pixel_format_t* outFormat, uint32_t value, uint16_t width, uint16_t height, uint16_t pitch, uint32_t outAddr)

Build a solid rectangle of given pixel value.

Parameters

- base – PXP peripheral base address.
- outFormat – output pixel format.
- value – The value of the pixel to be filled in the rectangle in ARGB8888 format.
- width – width of the rectangle.
- height – height of the rectangle.
- pitch – output pitch in byte.
- outAddr – address of the memory to store the rectangle.

void PXP_SetNextCommand(PXP_Type *base, void *commandAddr)

Set the next command.

The PXP supports a primitive ability to queue up one operation while the current operation is running. Workflow:

a. Prepare the PXP register values except STAT, CSCCOEFn, NEXT in the memory in the order they appear in the register map.

b. Call this function sets the new operation to PXP.

c. There are two methods to check whether the PXP has loaded the new operation. The first method is using PXP_IsNextCommandPending. If there is new operation not loaded by the PXP, this function returns true. The second method is checking the flag

kPXP_CommandLoadFlag, if command loaded, this flag asserts. User could enable interrupt kPXP_CommandLoadInterruptEnable to get the loaded signal in interrupt way.

d. When command loaded by PXP, a new command could be set using this function.

```
uint32_t pxp_command1[48];
uint32_t pxp_command2[48];

pxp_command1[0] = ...;
pxp_command1[1] = ...;
...
pxp_command2[0] = ...;
pxp_command2[1] = ...;
...

while (PXP_IsNextCommandPending(PXP))
{
}

PXP_SetNextCommand(PXP, pxp_command1);

while (PXP_IsNextCommandPending(PXP))
{
}

PXP_SetNextCommand(PXP, pxp_command2);
```

Parameters

- base – PXP peripheral base address.
- commandAddr – Address of the new command.

static inline bool PXP_IsNextCommandPending(PXP_Type *base)

Check whether the next command is pending.

Parameters

- base – UART peripheral base address.

Returns

True is pending, false is not.

static inline void PXP_CancelNextCommand(PXP_Type *base)

Cancel command set by PXP_SetNextCommand.

Parameters

- base – UART peripheral base address.

void PXP_SetCsc1Mode(PXP_Type *base, *pxp_csc1_mode_t* mode)

Set the CSC1 mode.

The CSC1 module receives scaled YUV/YCbCr444 pixels from the scale engine and converts the pixels to the RGB888 color space. It could only be used by process surface.

Parameters

- base – PXP peripheral base address.
- mode – The conversion mode.

static inline void PXP_EnableCsc1(PXP_Type *base, bool enable)

Enable or disable the CSC1.

Parameters

- base – PXP peripheral base address.

- enable – True to enable, false to disable.

void PXP_SetInternalRamData(PXP_Type *base, *pxp_ram_t* ram, uint32_t bytesNum, uint8_t *data, uint16_t memStartAddr)

Write data to the PXP internal memory.

Parameters

- base – PXP peripheral base address.
- ram – Which internal memory to write.
- bytesNum – How many bytes to write.
- data – Pointer to the data to write.
- memStartAddr – The start address in the internal memory to write the data.

void PXP_SetDitherFinalLutData(PXP_Type *base, const *pxp_dither_final_lut_data_t* *data)

Set the dither final LUT data.

The dither final LUT is only applicble to dither engine 0. It takes the bits[7:4] of the output pixel and looks up and 8 bit value from the 16 value LUT to generate the final output pixel to the next process module.

Parameters

- base – PXP peripheral base address.
- data – Pointer to the LUT data to set.

static inline void PXP_SetDitherConfig(PXP_Type *base, const *pxp_dither_config_t* *config)

Set the configuration for the dither block.

If the pre-dither LUT, post-dither LUT or ordered dither is used, please call PXP_SetInternalRamData to set the LUT data to internal memory.

If the final LUT is used, please call PXP_SetDitherFinalLutData to set the LUT data.

Note: When using ordered dithering, please set the PXP process block size same with the ordered dithering matrix size using function PXP_SetProcessBlockSize.

Parameters

- base – PXP peripheral base address.
- config – Pointer to the configuration.

void PXP_EnableDither(PXP_Type *base, bool enable)

Enable or disable dither engine in the PXP process path.

After the initialize function PXP_Init, the dither engine is disabled and not use in the PXP processing path. This function enables the dither engine and routes the dither engine output to the output buffer. When the dither engine is enabled using this function, PXP_SetDitherConfig must be called to configure dither engine correctly, otherwise there is not output to the output buffer.

Parameters

- base – PXP peripheral base address.
- enable – Pass in true to enable, false to disable.

void PXP_SetPorterDuffConfig(PXP_Type *base, uint8_t num, const *pxp_porter_duff_config_t* *config)

Set the Porter Duff configuration for one of the alpha process engine.

Parameters

- base – PXP peripheral base address.
- num – instance number.
- config – Pointer to the configuration.

status_t PXP_GetPorterDuffConfigExt(*pxp_porter_duff_blend_mode_t* mode, *pxp_porter_duff_config_t* *config, uint8_t dstGlobalAlphaMode, uint8_t dstAlphaMode, uint8_t dstColorMode, uint8_t srcGlobalAlphaMode, uint8_t srcAlphaMode, uint8_t srcColorMode, uint8_t dstGlobalAlpha, uint8_t srcGlobalAlpha)

Get the Porter Duff configuration.

The FactorMode are selected based on blend mode, the other values are set based on input parameters. These values could be modified after calling this function. This function is extened PXP_GetPorterDuffConfig.

Parameters

- mode – The blend mode.
- config – Pointer to the configuration.
- dstGlobalAlphaMode – Destination layer (or PS, s0) global alpha mode, see pxp_porter_duff_global_alpha_mode
- dstAlphaMode – Destination layer (or PS, s0) alpha mode, see pxp_porter_duff_alpha_mode.
- dstColorMode – Destination layer (or PS, s0) color mode, see pxp_porter_duff_color_mode.
- srcGlobalAlphaMode – Source layer (or AS, s1) global alpha mode, see pxp_porter_duff_global_alpha_mode
- srcAlphaMode – Source layer (or AS, s1) alpha mode, see pxp_porter_duff_alpha_mode.
- srcColorMode – Source layer (or AS, s1) color mode, see pxp_porter_duff_color_mode.
- dstGlobalAlpha – Destination layer (or PS, s0) global alpha value, 0~255
- srcGlobalAlpha – Source layer (or AS, s1) global alpha value, 0~255

Return values

- kStatus_Success – Successfully get the configuratoin.
- kStatus_InvalidArgument – The blend mode not supported.

static inline *status_t* PXP_GetPorterDuffConfig(*pxp_porter_duff_blend_mode_t* mode, *pxp_porter_duff_config_t* *config)

Get the Porter Duff configuration by blend mode.

The FactorMode are selected based on blend mode, the AlphaMode are set to kPXP_PorterDuffAlphaStraight, the ColorMode are set to kPXP_PorterDuffColorWithAlpha, the GlobalAlphaMode are set to kPXP_PorterDuffLocalAlpha. These values could be modified after calling this function.

Parameters

- mode – The blend mode.
- config – Pointer to the configuration.

Return values

- kStatus_Success – Successfully get the configuratoin.
- kStatus_InvalidArgument – The blend mode not supported.

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enum _pxp_interrupt_enable

PXP interrupts to enable.

Values:

enumerator kPXP_CompleteInterruptEnable

PXP process completed. bit 1

enumerator kPXP_CommandLoadInterruptEnable

Interrupt to show that the command set by PXP_SetNextCommand has been loaded. bit 2

enumerator kPXP_CompressDoneInterruptEnable

Compress done interrupt enable. bit 15

enumerator kPXP_InputFetchCh0InterruptEnable

Input fetch channel 0 completed. bit 16

enumerator kPXP_InputFetchCh1InterruptEnable

Input fetch channel 1 completed. bit 17

enumerator kPXP_InputStoreCh0InterruptEnable

Input store channel 0 completed. bit 18

enumerator kPXP_InputStoreCh1InterruptEnable

Input store channel 1 completed. bit 19

enumerator kPXP_DitherFetchCh0InterruptEnable

Dither fetch channel 0 completed. bit 20

enumerator kPXP_DitherFetchCh1InterruptEnable

Dither fetch channel 1 completed. bit 21

enumerator kPXP_DitherStoreCh0InterruptEnable

Dither store channle 0 completed. bit 22

enumerator kPXP_DitherStoreCh1InterruptEnable

Dither store channle 1 completed. bit 23

enumerator kPXP_WfeaStoreCh0InterruptEnable

WFE-A store channel 0 completed. bit 24

enumerator kPXP_WfeaStoreCh1InterruptEnable

WFE-A store channel 1 completed. bit 25

enumerator kPXP_WfebStoreCh0InterruptEnable

WFE-B store channel 0 completed. bit 26

enumerator kPXP_WfebStoreCh1InterruptEnable

WFE-B store channel 1 completed. bit 27

enumerator kPXP_InputStoreInterruptEnable

Input store completed. bit 28

enumerator kPXP_DitherStoreInterruptEnable

Dither store completed. bit 29

enumerator kPXP_WfeaStoreInterruptEnable
WFE-A store completed. bit 30

enumerator kPXP_WfebStoreInterruptEnable
WFE-B store completed. bit 31

enum _pxp_flags
PXP status flags.

Note: These enumerations are meant to be OR'd together to form a bit mask.

Values:

enumerator kPXP_CompleteFlag
PXP process completed. bit 0

enumerator kPXP_Axi0WriteErrorFlag
PXP encountered an AXI write error and processing has been terminated. bit 1

enumerator kPXP_Axi0ReadErrorFlag
PXP encountered an AXI read error and processing has been terminated. bit 2

enumerator kPXP_CommandLoadFlag
The command set by PXP_SetNextCommand has been loaded, could set new command. bit 3

enumerator kPXP_CompressDoneFlag
Compress done. bit 15

enumerator kPXP_InputFetchCh0CompleteFlag
Input fetch channel 0 completed. bit 16

enumerator kPXP_InputFetchCh1CompleteFlag
Input fetch channel 1 completed. bit 17

enumerator kPXP_InputStoreCh0CompleteFlag
Input store channel 0 completed. bit 18

enumerator kPXP_InputStoreCh1CompleteFlag
Input store channel 1 completed. bit 19

enumerator kPXP_DitherFetchCh0CompleteFlag
Dither fetch channel 0 completed. bit 20

enumerator kPXP_DitherFetchCh1CompleteFlag
Dither fetch channel 1 completed. bit 21

enumerator kPXP_DitherStoreCh0CompleteFlag
Dither store channel 0 completed. bit 22

enumerator kPXP_DitherStoreCh1CompleteFlag
Dither store channel 1 completed. bit 23

enumerator kPXP_WfeaStoreCh0CompleteFlag
WFE-A store channel 0 completed. bit 24

enumerator kPXP_WfeaStoreCh1CompleteFlag
WFE-A store channel 1 completed. bit 25

enumerator kPXP_WfebStoreCh0CompleteFlag
WFE-B store channel 0 completed. bit 26

enumerator kPXP_WfebStoreCh1CompleteFlag
WFE-B store channel 1 completed. bit 27

enumerator kPXP_InputStoreCompleteFlag
Input store completed. bit 28

enumerator kPXP_DitherStoreCompleteFlag
Dither store completed. bit 29

enumerator kPXP_WfeaStoreCompleteFlag
WFE-A store completed. bit 30

enumerator kPXP_WfebStoreCompleteFlag
WFE-B store completed. bit 31

enum _pxp_flip_mode
PXP output flip mode.

Values:

enumerator kPXP_FlipDisable
Flip disable.

enumerator kPXP_FlipHorizontal
Horizontal flip.

enumerator kPXP_FlipVertical
Vertical flip.

enumerator kPXP_FlipBoth
Flip both directions.

enum _pxp_rotate_position
PXP rotate mode.

Values:

enumerator kPXP_RotateOutputBuffer
Rotate the output buffer.

enumerator kPXP_RotateProcessSurface
Rotate the process surface. Cannot be used together with flip, scale, or decimation function.

enum _pxp_rotate_degree
PXP rotate degree.

Values:

enumerator kPXP_Rotate0
Clock wise rotate 0 deg.

enumerator kPXP_Rotate90
Clock wise rotate 90 deg.

enumerator kPXP_Rotate180
Clock wise rotate 180 deg.

enumerator kPXP_Rotate270
Clock wise rotate 270 deg.

enum _pxp_interlaced_output_mode
PXP interlaced output mode.

Values:

enumerator kPXP_OutputProgressive
All data written in progressive format to output buffer 0.

enumerator kPXP_OutputField0
Only write field 0 data to output buffer 0.

enumerator kPXP_OutputField1
Only write field 1 data to output buffer 0.

enumerator kPXP_OutputInterlaced
Field 0 write to buffer 0, field 1 write to buffer 1.

enum _pxp_output_pixel_format
PXP output buffer format.

Values:

enumerator kPXP_OutputPixelFormatARGB8888
32-bit pixels with alpha.

enumerator kPXP_OutputPixelFormatRGB888
32-bit pixels without alpha (unpacked 24-bit format)

enumerator kPXP_OutputPixelFormatRGB888P
24-bit pixels without alpha (packed 24-bit format)

enumerator kPXP_OutputPixelFormatARGB1555
16-bit pixels with alpha.

enumerator kPXP_OutputPixelFormatARGB4444
16-bit pixels with alpha.

enumerator kPXP_OutputPixelFormatRGB555
16-bit pixels without alpha.

enumerator kPXP_OutputPixelFormatRGB444
16-bit pixels without alpha.

enumerator kPXP_OutputPixelFormatRGB565
16-bit pixels without alpha.

enumerator kPXP_OutputPixelFormatYUV1P444
32-bit pixels (1-plane XYUV unpacked).

enumerator kPXP_OutputPixelFormatUYVY1P422
16-bit pixels (1-plane U0,Y0,V0,Y1 interleaved bytes)

enumerator kPXP_OutputPixelFormatVYUY1P422
16-bit pixels (1-plane V0,Y0,U0,Y1 interleaved bytes)

enumerator kPXP_OutputPixelFormatY8
8-bit monochrome pixels (1-plane Y luma output)

enumerator kPXP_OutputPixelFormatY4
4-bit monochrome pixels (1-plane Y luma, 4 bit truncation)

enumerator kPXP_OutputPixelFormatYUV2P422
16-bit pixels (2-plane UV interleaved bytes)

enumerator kPXP_OutputPixelFormatYUV2P420
16-bit pixels (2-plane UV)

enumerator kPXP_OutputPixelFormatYVU2P422
16-bit pixels (2-plane VU interleaved bytes)

enumerator kPXP_OutputPixelFormatYVU2P420
16-bit pixels (2-plane VU)

enum _pxp_ps_pixel_format
PXP process surface buffer pixel format.

Values:

enumerator kPXP_PsPixelFormatRGB888
32-bit pixels without alpha (unpacked 24-bit format)

enumerator kPXP_PsPixelFormatRGB555
16-bit pixels without alpha.

enumerator kPXP_PsPixelFormatRGB444
16-bit pixels without alpha.

enumerator kPXP_PsPixelFormatRGB565
16-bit pixels without alpha.

enumerator kPXP_PsPixelFormatYUV1P444
32-bit pixels (1-plane XYUV unpacked).

enumerator kPXP_PsPixelFormatUYVY1P422
16-bit pixels (1-plane U0,Y0,V0,Y1 interleaved bytes)

enumerator kPXP_PsPixelFormatVYUY1P422
16-bit pixels (1-plane V0,Y0,U0,Y1 interleaved bytes)

enumerator kPXP_PsPixelFormatY8
8-bit monochrome pixels (1-plane Y luma output)

enumerator kPXP_PsPixelFormatY4
4-bit monochrome pixels (1-plane Y luma, 4 bit truncation)

enumerator kPXP_PsPixelFormatYUV2P422
16-bit pixels (2-plane UV interleaved bytes)

enumerator kPXP_PsPixelFormatYUV2P420
16-bit pixels (2-plane UV)

enumerator kPXP_PsPixelFormatYVU2P422
16-bit pixels (2-plane VU interleaved bytes)

enumerator kPXP_PsPixelFormatYVU2P420
16-bit pixels (2-plane VU)

enumerator kPXP_PsPixelFormatYVU422
16-bit pixels (3-plane)

enumerator kPXP_PsPixelFormatYVU420
16-bit pixels (3-plane)

enum _pxp_ps_yuv_format
PXP process surface buffer YUV format.

Values:

enumerator kPXP_PsYUVFormatYUV
YUV format.

enumerator kPXP_PsYUVFormatYCbCr
YCbCr format.

enum _pxp_as_pixel_format
PXP alpha surface buffer pixel format.

Values:

enumerator kPXP_AsPixelFormatARGB8888
32-bit pixels with alpha.

enumerator kPXP_AsPixelFormatRGB888
32-bit pixels without alpha (unpacked 24-bit format)

enumerator kPXP_AsPixelFormatARGB1555
16-bit pixels with alpha.

enumerator kPXP_AsPixelFormatARGB4444
16-bit pixels with alpha.

enumerator kPXP_AsPixelFormatRGB555
16-bit pixels without alpha.

enumerator kPXP_AsPixelFormatRGB444
16-bit pixels without alpha.

enumerator kPXP_AsPixelFormatRGB565
16-bit pixels without alpha.

enum _pxp_alpha_mode
PXP alpha mode during blending.

Values:

enumerator kPXP_AlphaEmbedded
The alpha surface pixel alpha value will be used for blend.

enumerator kPXP_AlphaOverride
The user defined alpha value will be used for blend directly.

enumerator kPXP_AlphaMultiply
The alpha surface pixel alpha value scaled the user defined alpha value will be used for blend, for example, pixel alpha set set to 200, user defined alpha set to 100, then the reault alpha is 200 * 100 / 255.

enumerator kPXP_AlphaRop
Raster operation.

enum _pxp_rop_mode
PXP ROP mode during blending.

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

Values:

enumerator kPXP_RopMaskAs
AS AND PS.

enumerator kPXP_RopMaskNotAs
nAS AND PS.

enumerator kPXP_RopMaskAsNot
AS AND nPS.

enumerator kPXP_RopMergeAs
AS OR PS.

enumerator kPXP_RopMergeNotAs
nAS OR PS.

enumerator kPXP_RopMergeAsNot
AS OR nPS.

enumerator kPXP_RopNotCopyAs
nAS.

enumerator kPXP_RopNot
nPS.

enumerator kPXP_RopNotMaskAs
AS NAND PS.

enumerator kPXP_RopNotMergeAs
AS NOR PS.

enumerator kPXP_RopXorAs
AS XOR PS.

enumerator kPXP_RopNotXorAs
AS XNOR PS.

enum _pxp_block_size
PXP process block size.

Values:

enumerator kPXP_BlockSize8
Process 8x8 pixel blocks.

enumerator kPXP_BlockSize16
Process 16x16 pixel blocks.

enum _pxp_csc1_mode
PXP CSC1 mode.

Values:

enumerator kPXP_Csc1YUV2RGB
YUV to RGB.

enumerator kPXP_Csc1YCbCr2RGB
YCbCr to RGB.

enum _pxp_csc2_mode
PXP CSC2 mode.

Values:

enumerator kPXP_Csc2YUV2RGB
YUV to RGB.

enumerator kPXP_Csc2YCbCr2RGB
YCbCr to RGB.

enumerator kPXP_Csc2RGB2YUV
RGB to YUV.

enumerator kPXP_Csc2RGB2YCbCr
RGB to YCbCr.

enum _pxp_ram
PXP internal memory.

Values:

enumerator kPXP_RamDither0Lut
Dither 0 LUT memory.

enumerator kPXP_RamDither1Lut
Dither 1 LUT memory.

enumerator kPXP_RamDither2Lut
Dither 2 LUT memory.

enumerator kPXP_RamDither0Err0
Dither 0 ERR0 memory.

enumerator kPXP_RamDither0Err1
Dither 0 ERR1 memory.

enumerator kPXP_RamAluA
ALU A instr memory.

enumerator kPXP_RamAluB
ALU B instr memory.

enumerator kPXP_WfeAFetch
WFE-A fetch memory.

enumerator kPXP_WfeBFetch
WFE-B fetch memory.

enum _pxp_dither_mode
PXP dither mode.

Values:

enumerator kPXP_DitherPassThrough
Pass through, no dither.

enumerator kPXP_DitherFloydSteinberg
Floyd-Steinberg. For dither engine 0 only.

enumerator kPXP_DitherAtkinson
Atkinson. For dither engine 0 only.

enumerator kPXP_DitherOrdered
Ordered dither.

enumerator kPXP_DitherQuantOnly
No dithering, only quantization.

enumerator kPXP_DitherSierra
Sierra. For dither engine 0 only.

enum __pxp__dither__lut__mode

PXP dither LUT mode.

Values:

enumerator kPXP__DitherLutOff

The LUT memory is not used for LUT, could be used as ordered dither index matrix.

enumerator kPXP__DitherLutPreDither

Use LUT at the pre-dither stage, The pre-dither LUT could only be used in Floyd mode or Atkinson mode, which are not supported by current PXP module.

enumerator kPXP__DitherLutPostDither

Use LUT at the post-dither stage.

enum __pxp__dither__matrix__size

PXP dither matrix size.

Values:

enumerator kPXP__DitherMatrix4

The dither index matrix is 4x4.

enumerator kPXP__DitherMatrix8

The dither index matrix is 8x8.

enumerator kPXP__DitherMatrix16

The dither index matrix is 16x16.

Porter Duff factor mode. .

Values:

enumerator kPXP__PorterDuffFactorOne

Use 1.

enumerator kPXP__PorterDuffFactorZero

Use 0.

enumerator kPXP__PorterDuffFactorStraight

Use straight alpha.

enumerator kPXP__PorterDuffFactorInversed

Use inversed alpha.

Porter Duff global alpha mode. .

Values:

enumerator kPXP__PorterDuffGlobalAlpha

Use global alpha.

enumerator kPXP__PorterDuffLocalAlpha

Use local alpha in each pixel.

enumerator kPXP__PorterDuffScaledAlpha

Use global alpha * local alpha.

Porter Duff alpha mode. .

Values:

enumerator kPXP_PorterDuffAlphaStraight
Use straight alpha, s0_alpha' = s0_alpha.

enumerator kPXP_PorterDuffAlphaInversed
Use inversed alpha, s0_alpha' = 0xFF - s0_alpha.

Porter Duff color mode. .

Values:

enumerator kPXP_PorterDuffColorStraight

Deprecated:
Use kPXP_PorterDuffColorNoAlpha.

enumerator kPXP_PorterDuffColorInversed

Deprecated:
Use kPXP_PorterDuffColorWithAlpha.

enumerator kPXP_PorterDuffColorNoAlpha
s0_pixel' = s0_pixel.

enumerator kPXP_PorterDuffColorWithAlpha
s0_pixel' = s0_pixel * s0_alpha".

enum _pxp_porter_duff_blend_mode
PXP Porter Duff blend mode. Note: don't change the enum item value.

Values:

enumerator kPXP_PorterDuffSrc
Source Only

enumerator kPXP_PorterDuffAtop
Source Atop

enumerator kPXP_PorterDuffOver
Source Over

enumerator kPXP_PorterDuffIn
Source In.

enumerator kPXP_PorterDuffOut
Source Out.

enumerator kPXP_PorterDuffDst
Destination Only.

enumerator kPXP_PorterDuffDstAtop
Destination Atop.

enumerator kPXP_PorterDuffDstOver
Destination Over.

enumerator kPXP_PorterDuffDstIn
Destination In.

enumerator kPXP_PorterDuffDstOut
Destination Out.

enumerator kPXP_PorterDuffXor
XOR.

enumerator kPXP_PorterDuffClear
Clear.

enumerator kPXP_PorterDuffMax

enum _pxp_process_engine_name
PXP process engine enumeration.

Values:

enumerator kPXP_PsAsOutEngine

enumerator kPXP_DitherEngine

enumerator kPXP_WfeaEngine

enumerator kPXP_WfebEngine

enumerator kPXP_InputFetchStoreEngine

enumerator kPXP_Alpha1Engine

enumerator kPXP_Csc2Engine

enumerator kPXP_LutEngine

enumerator kPXP_Rotate0Engine

enumerator kPXP_Rotate1Engine

enum _pxp_fetch_engine_name
PXP fetch engine enumeration.

There are actually 4 fetch engine implemented, the others are WFE-A fetch engine and WFE-B fetch engine, whose registers are reserved from developer.

Values:

enumerator kPXP_FetchInput

enumerator kPXP_FetchDither

enum _pxp_fetch_interface_mode
PXP fetch engine interface mode with the upstream store engine.

Values:

enumerator kPXP_FetchModeNormal

enumerator kPXP_FetchModeHandshake

enumerator kPXP_FetchModeBypass

enum _pxp_scanline_burst
PXP fetch/store engine burst length for scanline mode.

Values:

enumerator kPXP_Scanline8bytes

enumerator kPXP_Scanline16bytes

enumerator kPXP_Scanline32bytes

enumerator kPXP_Scanline64bytes

enum _pxp_activeBits

PXP fetch/store engine input/output active bits configuration.

Since fetch engine is 64-bit input and 32-bit output per channel, need to configure both channels to use 64-bit input mode. And expand configuration will have no effect.

Values:

enumerator kPXP_Active8Bits

enumerator kPXP_Active16Bits

enumerator kPXP_Active32Bits

enumerator kPXP_Active64Bits

enum _pxp_fetch_output_word_order

PXP fetch engine output word order when using 2 channels for 64-bit mode.

Values:

enumerator kPXP_FetchOutputChannel1channel0

In 64bit mode, channel 1 output high byte.

enumerator kPXP_FetchOutputChannel0channel1

In 64bit mode, channel 0 output high byte.

enum _pxp_fetch_pixel_format

PXP fetch engine input pixel format.

Values:

enumerator kPXP_FetchFormatRGB565

enumerator kPXP_FetchFormatRGB555

enumerator kPXP_FetchFormatARGB1555

enumerator kPXP_FetchFormatRGB444

enumerator kPXP_FetchFormatARGB4444

enumerator kPXP_FetchFormatYUYVorYVYU

enumerator kPXP_FetchFormatUYVYorVYUY

enumerator kPXP_FetchFormatYUV422_2P

enum _pxp_store_engine_name

PXP store engine enumeration.

There are actually 4 store engine implemented, the others are WFE-A store engine and WFE-B store engine, whose registers are reserved from developer.

Values:

enumerator kPXP_StoreInput

enumerator kPXP_StoreDither

enum _pxp_store_interface_mode

PXP store engine interface mode with the downstream fetch engine.

Values:

enumerator kPXP_StoreModeBypass

Store engine output the input data, after the shift function directly to the downstream Fetch Engine.

enumerator kPXP_StoreModeNormal

Store engine stores the input data to memory.

enumerator kPXP_StoreModeHandshake

Downstream fetch engine fetch data per scanline from memory using buffer sharing with store engine.

enumerator kPXP_StoreModeDual

Store engine outputs data directly to downstream fetch engine(Bypass) but also storing it to memory at the same time.

enum _pxp_store_yuv_mode

PXP store engine YUV output mode.

Values:

enumerator kPXP_StoreYUVDisable

Do not output YUV pixel format.

enumerator kPXP_StoreYUVPlane1

Use channel to output YUV422_1p pixel format, need to use shift operation to make sure each pixel component in its proper position: 64-bits of pixel data format and each 32 bits as {Y0, U0, Y1, V0}.

enumerator kPXP_StoreYUVPlane2

Use channel to output YUV422_2p pixel format, need to use shift operation to make sure each pixel component in its proper position: channel 0 {Y0,Y1}, channel 1 {U0,V0}.

enum _pxp_cfa_input_format

PXP pre-dither CFA engine input pixel format.

Values:

enumerator kPXP_CfaRGB888

enumerator kPXP_CfaRGB444

enum _pxp_histogram_mask_condition

PXP histogram mask condition.

Values:

enumerator kPXP_HistogramMaskEqual

Value that equal to value0 will pass the mask operation.

enumerator kPXP_HistogramMaskNotequal

Value that not equal to value0 will pass the mask operation.

enumerator kPXP_HistogramMaskIn

Value that within the range of value0-value1 will pass the mask operation.

enumerator kPXP_HistogramMaskOut

Value that without the range of value0-value1 will pass the mask operation.

enum _pxp_histgram_flags

PXP Histogram operation result flags.

Values:

enumerator kPXP_Histogram2levelMatch

enumerator kPXP_Histogram4levelMatch

enumerator kPXP_Histogram8levelMatch

enumerator kPXP_Histogram16levelMatch

enumerator kPXP_Histogram32levelMatch

typedef enum *_pxp_flip_mode* pxp_flip_mode_t
PXP output flip mode.

typedef enum *_pxp_rotate_position* pxp_rotate_position_t
PXP rotate mode.

typedef enum *_pxp_rotate_degree* pxp_rotate_degree_t
PXP rotate degree.

typedef enum *_pxp_interlaced_output_mode* pxp_interlaced_output_mode_t
PXP interlaced output mode.

typedef enum *_pxp_output_pixel_format* pxp_output_pixel_format_t
PXP output buffer format.

typedef struct *_pxp_output_buffer_config* pxp_output_buffer_config_t
PXP output buffer configuration.

typedef enum *_pxp_ps_pixel_format* pxp_ps_pixel_format_t
PXP process surface buffer pixel format.

typedef enum *_pxp_ps_yuv_format* pxp_ps_yuv_format_t
PXP process surface buffer YUV format.

typedef struct *_pxp_ps_buffer_config* pxp_ps_buffer_config_t
PXP process surface buffer configuration.

typedef enum *_pxp_as_pixel_format* pxp_as_pixel_format_t
PXP alpha surface buffer pixel format.

typedef struct *_pxp_as_buffer_config* pxp_as_buffer_config_t
PXP alphs surface buffer configuration.

typedef enum *_pxp_alpha_mode* pxp_alpha_mode_t
PXP alpha mode during blending.

typedef enum *_pxp_rop_mode* pxp_rop_mode_t
PXP ROP mode during blending.

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

typedef struct *_pxp_as_blend_config* pxp_as_blend_config_t
PXP alpha surface blending configuration.

typedef struct *_pxp_as_blend_secondary_config* pxp_as_blend_secondary_config_t
PXP secondary alpha surface blending engine configuration.

typedef enum *_pxp_block_size* pxp_block_size_t
PXP process block size.

typedef enum *_pxp_csc1_mode* pxp_csc1_mode_t

PXP CSC1 mode.

typedef enum *_pxp_csc2_mode* pxp_csc2_mode_t

PXP CSC2 mode.

typedef struct *_pxp_csc2_config* pxp_csc2_config_t

PXP CSC2 configuration.

Converting from YUV/YCbCr color spaces to the RGB color space uses the following equation structure:

R = A1(Y+D1) + A2(U+D2) + A3(V+D3) G = B1(Y+D1) + B2(U+D2) + B3(V+D3) B = C1(Y+D1) + C2(U+D2) + C3(V+D3)

Converting from the RGB color space to YUV/YCbCr color spaces uses the following equation structure:

Y = A1*R + A2*G + A3*B + D1 U = B1*R + B2*G + B3*B + D2 V = C1*R + C2*G + C3*B + D3

typedef enum *_pxp_ram* pxp_ram_t

PXP internal memory.

typedef struct *_pxp_dither_final_lut_data* pxp_dither_final_lut_data_t

PXP dither final LUT data.

typedef struct *_pxp_dither_config* pxp_dither_config_t

PXP dither configuration.

typedef enum *_pxp_porter_duff_blend_mode* pxp_porter_duff_blend_mode_t

PXP Porter Duff blend mode. Note: don't change the enum item value.

typedef struct *_pxp_pic_copy_config* pxp_pic_copy_config_t

PXP Porter Duff blend mode. Note: don't change the enum item value.

typedef enum *_pxp_process_engine_name* pxp_process_engine_name_t

PXP process engine enumeration.

typedef enum *_pxp_fetch_engine_name* pxp_fetch_engine_name_t

PXP fetch engine enumeration.

There are actually 4 fetch engine implemented, the others are WFE-A fetch engine and WFE-B fetch engine, whose registers are reserved from developer.

typedef enum *_pxp_fetch_interface_mode* pxp_fetch_interface_mode_t

PXP fetch engine interface mode with the upstream store engine.

typedef enum *_pxp_scanline_burst* pxp_scanline_burst_t

PXP fetch/store engine burst length for scanline mode.

typedef struct *_pxp_block_format_config* pxp_block_config_t

PXP fetch engine block configuration.

typedef enum *_pxp_activeBits* pxp_active_bits_t

PXP fetch/store engine input/output active bits configuration.

Since fetch engine is 64-bit input and 32-bit output per channel, need to configure both channels to use 64-bit input mode. And expand configuration will have no effect.

typedef enum *_pxp_fetch_output_word_order* pxp_fetch_output_word_order_t

PXP fetch engine output word order when using 2 channels for 64-bit mode.

typedef struct *_pxp_fetch_shift_component* pxp_fetch_shift_component_t
PXP fetch engine shift component configuration.

Fetch engine can divded each word into 4 components and shift them.

typedef struct *_pxp_fetch_shift_config* pxp_fetch_shift_config_t
PXP fetch engine shift configuration.

Fetch engine can divded each word into 4 components and shift them. For example, to change YUV444 to YVU444, U and V positions need to be shifted: OFFSET0=8, OFFSET1=0, OFFSET2=16, OFFSET3=24, WIDTH0/1/2/3=8

typedef enum *_pxp_fetch_pixel_format* pxp_fetch_pixel_format_t
PXP fetch engine input pixel format.

typedef struct *_pxp_fetch_engine_config* pxp_fetch_engine_config_t
PXP fetch engine configuration for one of the channel.

typedef enum *_pxp_store_engine_name* pxp_store_engine_name_t
PXP store engine enumeration.

There are actually 4 store engine implemented, the others are WFE-A store engine and WFE-B store engine, whose registers are reserved from developer.

typedef enum *_pxp_store_interface_mode* pxp_store_interface_mode_t
PXP store engine interface mode with the downstream fetch engine.

typedef enum *_pxp_store_yuv_mode* pxp_store_yuv_mode_t
PXP store engine YUV output mode.

typedef struct *_pxp_store_shift_config* pxp_store_shift_config_t
Shift configuration for PXP store engine.

typedef struct *_pxp_store_engine_config* pxp_store_engine_config_t
PXP store engine configuration for one of the channel.

typedef enum *_pxp_cfa_input_format* pxp_cfa_input_format_t
PXP pre-dither CFA engine input pixel format.

typedef struct *_pxp_cfa_config* pxp_cfa_config_t
PXP pre-dither CFA engine configuration.

typedef enum *_pxp_histogram_mask_condition* pxp_histogram_mask_condition_t
PXP histogram mask condition.

typedef struct *_pxp_histogram_config* pxp_histogram_config_t
PXP Histogram configuration.

typedef struct *_pxp_histogram_mask_result* pxp_histogram_mask_result_t
PXP Histogram mask result.

typedef struct *_pxp_wfea_engine_config* pxp_wfea_engine_config_t
PXP WFE-A engine configuration.

PXP_LUT_TABLE_BYTE

PXP_INTERNAL_RAM_LUT_BYTE

PXP_SHARE_ROTATE

PXP_USE_PATH

PXP_COMBINE_BYTE_TO_WORD(dataAddr)

struct pxp_output_buffer_config
#include <fsl_pxp.h> PXP output buffer configuration.

Public Members

pxp_output_pixel_format_t pixelFormat
Output buffer pixel format.

pxp_interlaced_output_mode_t interlacedMode
Interlaced output mode.

uint32_t buffer0Addr
Output buffer 0 address.

uint32_t buffer1Addr
Output buffer 1 address, used for UV data in YUV 2-plane mode, or field 1 in output interlaced mode.

uint16_t pitchBytes
Number of bytes between two vertically adjacent pixels.

uint16_t width
Pixels per line.

uint16_t height
How many lines in output buffer.

struct __pxp__ps__buffer__config
#include <fsl_pxp.h> PXP process surface buffer configuration.

Public Members

pxp_ps_pixel_format_t pixelFormat
PS buffer pixel format.

bool swapByte
For each 16 bit word, set true to swap the two bytes.

uint32_t bufferAddr
Input buffer address for the first panel.

uint32_t bufferAddrU
Input buffer address for the second panel.

uint32_t bufferAddrV
Input buffer address for the third panel.

uint16_t pitchBytes
Number of bytes between two vertically adjacent pixels.

struct __pxp__as__buffer__config
#include <fsl_pxp.h> PXP alphs surface buffer configuration.

Public Members

pxp_as_pixel_format_t pixelFormat
AS buffer pixel format.

uint32_t bufferAddr
Input buffer address.

uint16_t pitchBytes
Number of bytes between two vertically adjacent pixels.

struct __pxp_as_blend_config

#include <fsl_pxp.h> PXP alpha surface blending configuration.

Public Members

uint8_t alpha

User defined alpha value, only used when alphaMode is kPXP_AlphaOverride or kPXP_AlphaRop.

bool invertAlpha

Set true to invert the alpha.

pxp_alpha_mode_t alphaMode

Alpha mode.

pxp_rop_mode_t ropMode

ROP mode, only valid when alphaMode is kPXP_AlphaRop.

struct __pxp_as_blend_secondary_config

#include <fsl_pxp.h> PXP secondary alpha surface blending engine configuration.

Public Members

bool invertAlpha

Set true to invert the alpha.

bool ropEnable

Enable rop mode.

pxp_rop_mode_t ropMode

ROP mode, only valid when ropEnable is true.

struct __pxp_csc2_config

#include <fsl_pxp.h> PXP CSC2 configuration.

Converting from YUV/YCbCr color spaces to the RGB color space uses the following equation structure:

R = A1(Y+D1) + A2(U+D2) + A3(V+D3) G = B1(Y+D1) + B2(U+D2) + B3(V+D3) B = C1(Y+D1) + C2(U+D2) + C3(V+D3)

Converting from the RGB color space to YUV/YCbCr color spaces uses the following equation structure:

Y = A1*R + A2*G + A3*B + D1 U = B1*R + B2*G + B3*B + D2 V = C1*R + C2*G + C3*B + D3

Public Members

pxp_csc2_mode_t mode

Convertion mode.

float A1

A1.

float A2

A2.

float A3

A3.

float B1
B1.

float B2
B2.

float B3
B3.

float C1
C1.

float C2
C2.

float C3
C3.

int16_t D1
D1.

int16_t D2
D2.

int16_t D3
D3.

struct __pxp_dither_final_lut_data
#include <fsl_pxp.h> PXP dither final LUT data.

Public Members

uint32_t data_3_0
Data 3 to data 0. Data 0 is the least significant byte.

uint32_t data_7_4
Data 7 to data 4. Data 4 is the least significant byte.

uint32_t data_11_8
Data 11 to data 8. Data 8 is the least significant byte.

uint32_t data_15_12
Data 15 to data 12. Data 12 is the least significant byte.

struct __pxp_dither_config
#include <fsl_pxp.h> PXP dither configuration.

Public Members

uint32_t enableDither0
Enable dither engine 0 or not, set 1 to enable, 0 to disable.

uint32_t enableDither1
Enable dither engine 1 or not, set 1 to enable, 0 to disable.

uint32_t enableDither2
Enable dither engine 2 or not, set 1 to enable, 0 to disable.

uint32_t ditherMode0
Dither mode for dither engine 0. See _pxp_dither_mode.

uint32_t ditherMode1

Dither mode for dither engine 1. See _pxp_dither_mode.

uint32_t ditherMode2

Dither mode for dither engine 2. See _pxp_dither_mode.

uint32_t quantBitNum

Number of bits quantize down to, the valid value is 1~7.

uint32_t lutMode

How to use the memory LUT, see _pxp_dither_lut_mode. This must be set to kPXP_DitherLutOff if any dither engine uses kPXP_DitherOrdered mode.

uint32_t idxMatrixSize0

Size of index matrix used for dither for dither engine 0, see _pxp_dither_matrix_size.

uint32_t idxMatrixSize1

Size of index matrix used for dither for dither engine 1, see _pxp_dither_matrix_size.

uint32_t idxMatrixSize2

Size of index matrix used for dither for dither engine 2, see _pxp_dither_matrix_size.

uint32_t enableFinalLut

Enable the final LUT, set 1 to enable, 0 to disable.

struct pxp_porter_duff_config_t

#include <fsl_pxp.h> PXP Porter Duff configuration.

Public Members

uint32_t enable

Enable or disable Porter Duff.

uint32_t srcFactorMode

Source layer (or AS, s1) factor mode, see pxp_porter_duff_factor_mode.

uint32_t dstGlobalAlphaMode

Destination layer (or PS, s0) global alpha mode, see pxp_porter_duff_global_alpha_mode.

uint32_t dstAlphaMode

Destination layer (or PS, s0) alpha mode, see pxp_porter_duff_alpha_mode.

uint32_t dstColorMode

Destination layer (or PS, s0) color mode, see pxp_porter_duff_color_mode.

uint32_t dstFactorMode

Destination layer (or PS, s0) factor mode, see pxp_porter_duff_factor_mode.

uint32_t srcGlobalAlphaMode

Source layer (or AS, s1) global alpha mode, see pxp_porter_duff_global_alpha_mode.

uint32_t srcAlphaMode

Source layer (or AS, s1) alpha mode, see pxp_porter_duff_alpha_mode.

uint32_t srcColorMode

Source layer (or AS, s1) color mode, see pxp_porter_duff_color_mode.

uint32_t dstGlobalAlpha

Destination layer (or PS, s0) global alpha value, 0~255.

uint32_t srcGlobalAlpha

Source layer (or AS, s1) global alpha value, 0~255.

struct __pxp_pic_copy_config

#include <fsl_pxp.h> PXP Porter Duff blend mode. Note: don't change the enum item value.

Public Members

uint32_t srcPicBaseAddr

Source picture base address.

uint16_t srcPitchBytes

Pitch of the source buffer.

uint16_t srcOffsetX

Copy position in source picture.

uint16_t srcOffsetY

Copy position in source picture.

uint32_t destPicBaseAddr

Destination picture base address.

uint16_t destPitchBytes

Pitch of the destination buffer.

uint16_t destOffsetX

Copy position in destination picture.

uint16_t destOffsetY

Copy position in destination picture.

uint16_t width

Pixel number each line to copy.

uint16_t height

Lines to copy.

pxp_as_pixel_format_t pixelFormat

Buffer pixel format.

struct __pxp_block_format_config

#include <fsl_pxp.h> PXP fetch engine block configuration.

Public Members

bool enableblock

Enable to use block mode instead of scanline mode. Note: 1.Make sure to enable if rotate or flip mode is enabled. 2.Block mode cannot work on 64bpp data stream where activeBits = 64. 3. If LUT processing is in the path between the fetch and store engind, block mode must be enabled.

bool blockSize16

Enable to use 16*16 block, otherwise it will be 8*8 block.

pxp_scanline_burst_t burstLength

When using scanline mode, configure this for burst length.

struct __pxp_fetch_shift_component

#include <fsl_pxp.h> PXP fetch engine shift component configuration.

Fetch engine can divded each word into 4 components and shift them.

struct __pxp_fetch_shift_config

#include <fsl_pxp.h> PXP fetch engine shift configuration.

Fetch engine can divded each word into 4 components and shift them. For example, to change YUV444 to YVU444, U and V positions need to be shifted: OFFSET0=8, OFFSET1=0, OFFSET2=16, OFFSET3=24, WIDTH0/1/2/3=8

struct __pxp_fetch_engine_config

#include <fsl_pxp.h> PXP fetch engine configuration for one of the channel.

Public Members

bool channelEnable

Enable channel.

uint32_t inputBaseAddr0

The input base address. Used for Y plane input when pixel format is YUV422_2p.

uint32_t inputBaseAddr1

Must configure this for UV plane when input pixel format is YUV422_2p.

uint16_t totalHeight

Total height for the actual fetch size.

uint16_t totalWidth

Total width for the actual fetch size.

uint16_t pitchBytes

Channel input pitch

uint16_t ulcX

X coordinate of upper left coordinate in pixels of the active area of the total input memory

uint16_t ulcY

Y coordinate of upper left coordinate in pixels of the active area of the total input memory

uint16_t lrcX

X coordinate of Lower right coordinate in pixels of the active area of the total input memory

uint16_t lrcY

Y coordinate of Lower right coordinate in pixels of the active area of the total input memory

uint32_t backGroundColor

Pixel value of the background color for the space outside the active area.

pxp_fetch_interface_mode_t interface

Interface mode, normal/bypass/handshake

pxp_active_bits_t activeBits

Input active bits.

pxp_fetch_pixel_format_t pixelFormat

Input pixel fetch format

bool expandEnable

If enabled, input pixel will be expanded to ARGB8888, RGB888 or YUV444 of 32-bit format at the output.

pxp_flip_mode_t flipMode

Flip the fetched input.

pxp_rotate_degree_t rotateDegree

Rotate the fetched input.

pxp_block_config_t fetchFormat

Block mode configuration. Make sure to enable block if rotate or flip mode is enabled.

pxp_fetch_shift_config_t shiftConfig

Shift operation configuration.

pxp_fetch_output_word_order_t wordOrder

Output word order when using 2 channels for 64-bit mode.

struct __pxp__store__shift__config

#include <fsl_pxp.h> Shift configuration for PXP store engine.

Public Members

bool shiftBypass

Bypass the data shift

uint64_t *pDataShiftMask

Pointer to mask0~mask7 to mask the 64-bit of output data, data is masked first then shifted according to width.

uint8_t *pDataShiftWidth

Pointer to width0~width7. Bit 7 is for shifted direction, 0 to right. Bit0~5 is for shift width.

uint8_t *pFlagShiftMask

Pointer to mask0~mask7 to mask the 8-bit of output flag, flag is masked first then shifted according to width.

uint8_t *pFlagShiftWidth

Pointer to width0~width7. Bit 6 is for shifted direction, 0 to right. Bit0~5 is for shift width.

struct __pxp__store__engine__config

#include <fsl_pxp.h> PXP store engine configuration for one of the channel.

Public Members

bool channelEnable

Enable channel.

uint32_t outputBaseAddr0

The channel 0 output address if using 2 channels. If using 1 channel(must be channel 0) and YUV422_2p output format, is for Y plane address.

uint32_t outputBaseAddr1

The channel 1 output address if using 2 channels. If using 1 channel(must be channel 0) and YUV422_2p output format, is for UV plane address.

uint16_t totalHeight

Total height for the actual store size.

uint16_t totalWidth

Total width for the actual store size.

uint16_t pitchBytes

Channel input pitch

pxp_store_interface_mode_t interface

Interface mode, normal/bypass/handshake/dual. Make sure 2 channels use the same mode if both enabled.

pxp_active_bits_t activeBits

Output active bits.

pxp_store_yuv_mode_t yuvMode

Whether to output YUV pixel format.

bool useFixedData

Whether to use fixed value for the output data. Can be used to write fixed value to specific memory location for memory initialization.

uint32_t fixedData

The value of the fixed data.

bool packInSelect

When enabled, channel 0 will select low 32 bit shift out data to pack while channel i select high 32 bit, otherwise all 64-bit of data will be selected.

pxp_block_config_t storeFormat

The format to store data, block or otherwise.

pxp_store_shift_config_t shiftConfig

Shift operation configuration.

struct __pxp__cfa__config

#include <fsl_pxp.h> PXP pre-dither CFA engine configuration.

Public Members

bool bypass

Bypass the CFA process

pxp_cfa_input_format_t pixelInFormat

The pixel input format for CFA.

uint8_t arrayWidth

CFA array vertical size in pixels, min 3 max 15.

uint8_t arrayHeight

CFA array horizontal size in pixels, min 3 max 15.

uint16_t totalHeight

Total height for the buffer size, make sure it is aligned with the dither fetch engine and dither engine.

uint16_t totalWidth

Total width for the buffer size, make sure it is aligned with the dither fetch engine and dither engine.

uint32_t *cfaValue

Pointer to the value for the CFA array. 2-bit per component: 00-R,01-G,10-B,11-W. For a 4x4 array, 32 bits are need.

struct __pxp_histogram_config

#include <fsl_pxp.h> PXP Histogram configuration.

Public Members

bool enable

Enable histogram process.

uint8_t *pParamValue

Pointer to the 62(2+4+8+16+32) byte of param value for 2-level, 4-level.....32-level parameters. Only low 5-bit of each byte is valid.

uint8_t lutValueOffset

The starting bit position of the LUT value.

uint8_t lutValueWidth

The bit width of the LUT value, should be no more than 6 bits since only 63 LUTs are supported.

bool enableMask

Enable mask operation.

uint8_t maskValue0

Value 0 for the condition judgement.

uint8_t maskValue1

Value 1 for the condition judgement.

uint8_t maskOffset

The starting bit position of the field to be checked against mask condition.

uint8_t maskWidth

The width of the field to be checked against mask condition.

pxp_histogram_mask_condition_t condition

The mask condition.

uint16_t totalHeight

Total height for the buffer size, make sure it is aligned with the output of legacy flow or the WFE-A/B engine.

uint16_t totalWidth

Total width for the buffer size, make sure it is aligned with the output of legacy flow or the WFE-A/B engine.

struct __pxp_histogram_mask_result

#include <fsl_pxp.h> PXP Histogram mask result.

Public Members

uint32_t pixelCount

The total count of the pixels that pass the mask(collided pixels).

uint32_t minX

The x offset of the ULC of the minimal histogram that covers all passed pixels.

uint32_t minY
: The y offset of the ULC of the minimal histogram that covers all passed pixels.

uint32_t maxX
: The x offset of the LRC of the minimal histogram that covers all passed pixels.

uint32_t maxY
: The y offset of the LRC of the minimal histogram that covers all passed pixels.

uint64_t lutlist
: The 64-bit LUT list of collided pixels, if pixel of LUT17 is collided, bit17 in the list is set.

struct __pxp__wfea__engine__config
: *#include <fsl_pxp.h>* PXP WFE-A engine configuration.

Public Members

uint32_t y4Addr
: Address for Y4 buffer.

uint32_t y4cAddr
: Address for Y4C buffer, {Y4[3:0],3'b000,collision}, 8bpp.

uint32_t wbAddr
: Address for EPDC working buffer.

uint16_t updateWidth
: Width of the update area.

uint16_t updateHeight
: Height of the update area.

uint16_t updatePitch
: Pitch of the update area.

uint16_t ulcX
: X coordinate of upper left coordinate of the total input memory

uint16_t ulcY
: Y coordinate of upper left coordinate of the total input memory

uint16_t resX
: Horizontal resolution in pixels.

uint8_t lutNum
: The EPDC LUT number for the update.

bool fullUpdateEnable
: Enable full update.

bool alphaEnable
: Enable alpha field, upd is {Y4[3:0],3'b000,alpha} format, otherwise its {Y4[3:0],4'b0000}.

bool detectionOnly
: Detection only, do not write working buffer.

2.98 QTMR: Quad Timer Driver

void QTMR_Init(TMR_Type *base, *qtmr_channel_selection_t* channel, const *qtmr_config_t* *config)

Ungates the Quad Timer clock and configures the peripheral for basic operation.

Note: This API should be called at the beginning of the application using the Quad Timer driver.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- config – Pointer to user's Quad Timer config structure

void QTMR_Deinit(TMR_Type *base, *qtmr_channel_selection_t* channel)

Stops the counter and gates the Quad Timer clock.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

void QTMR_GetDefaultConfig(*qtmr_config_t* *config)

Fill in the Quad Timer config struct with the default settings.

The default values are:

```
config->debugMode = kQTMR_RunNormalInDebug;
config->enableExternalForce = false;
config->enableMasterMode = false;
config->faultFilterCount = 0;
config->faultFilterPeriod = 0;
config->primarySource = kQTMR_ClockDivide_2;
config->secondarySource = kQTMR_Counter0InputPin;
```

Parameters

- config – Pointer to user's Quad Timer config structure.

void QTMR_EnableInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Enables the selected Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration qtmr_interrupt_enable_t

void QTMR_DisableInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Disables the selected Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base addres

- channel – Quad Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration qtmr_interrupt_enable_t

uint32_t QTMR_GetEnabledInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel)

Gets the enabled Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

The enabled interrupts. This is the logical OR of members of the enumeration qtmr_interrupt_enable_t

uint32_t QTMR_GetStatus(TMR_Type *base, *qtmr_channel_selection_t* channel)

Gets the Quad Timer status flags.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

The status flags. This is the logical OR of members of the enumeration qtmr_status_flags_t

void QTMR_ClearStatusFlags(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Clears the Quad Timer status flags.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The status flags to clear. This is a logical OR of members of the enumeration qtmr_status_flags_t

void QTMR_SetTimerPeriod(TMR_Type *base, *qtmr_channel_selection_t* channel, uint16_t ticks)

Sets the timer period in ticks.

Timers counts from initial value till it equals the count value set here. The counter will then reinitialize to the value specified in the Load register.

Note:

a. This function will write the time period in ticks to COMP1 or COMP2 register depending on the count direction

b. User can call the utility macros provided in fsl_common.h to convert to ticks

c. This function supports cases, providing only primary source clock without secondary source clock.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- ticks – Timer period in units of ticks

void QTMR_SetCompareValue(TMR_Type *base, *qtmr_channel_selection_t* channel, uint16_t ticks)

Set compare value.

This function sets the value used for comparison with the counter value.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- ticks – Timer period in units of ticks.

static inline void QTMR_SetLoadValue(TMR_Type *base, *qtmr_channel_selection_t* channel, uint16_t value)

Set load value.

This function sets the value used to initialize the counter after a counter comparison.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- value – Load register initialization value.

static inline uint16_t QTMR_GetCurrentTimerCount(TMR_Type *base, *qtmr_channel_selection_t* channel)

Reads the current timer counting value.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: User can call the utility macros provided in fsl_common.h to convert ticks to usec or msec

---

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current counter value in ticks

static inline void QTMR_StartTimer(TMR_Type *base, *qtmr_channel_selection_t* channel, *qtmr_counting_mode_t* clockSource)

Starts the Quad Timer counter.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- clockSource – Quad Timer clock source

static inline void QTMR_StopTimer(TMR_Type *base, *qtmr_channel_selection_t* channel)

Stops the Quad Timer counter.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

void QTMR_EnableDma(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Enable the Quad Timer DMA.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The DMA to enable. This is a logical OR of members of the enumeration qtmr_dma_enable_t

void QTMR_DisableDma(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Disable the Quad Timer DMA.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The DMA to enable. This is a logical OR of members of the enumeration qtmr_dma_enable_t

void QTMR_SetPwmOutputToIdle(TMR_Type *base, *qtmr_channel_selection_t* channel, bool idleStatus)

Set PWM output in idle status (high or low).

Note: When the PWM is set again, the counting needs to be restarted.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- idleStatus – True: PWM output is high in idle status; false: PWM output is low in idle status.

static inline *qtmr_pwm_out_state_t* QTMR_GetPwmOutputStatus(TMR_Type *base, *qtmr_channel_selection_t* channel)

Get the channel output status.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current channel output status.

uint8_t QTMR_GetPwmChannelStatus(TMR_Type *base, *qtmr_channel_selection_t* channel)

Get the PWM channel dutycycle value.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current channel dutycycle value.

void QTMR_SetPwmClockMode(TMR_Type *base, *qtmr_channel_selection_t* channel, *qtmr_primary_count_source_t* prescaler)

This function set the value of the prescaler on QTimer channels.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- prescaler – Set prescaler value

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enum _qtmr_primary_count_source

Quad Timer primary clock source selection.

Values:

enumerator kQTMR_ClockCounter0InputPin

Use counter 0 input pin

enumerator kQTMR_ClockCounter1InputPin

Use counter 1 input pin

enumerator kQTMR_ClockCounter2InputPin

Use counter 2 input pin

enumerator kQTMR_ClockCounter3InputPin

Use counter 3 input pin

enumerator kQTMR_ClockCounter0Output

Use counter 0 output

enumerator kQTMR_ClockCounter1Output

Use counter 1 output

enumerator kQTMR_ClockCounter2Output

Use counter 2 output

enumerator kQTMR_ClockCounter3Output

Use counter 3 output

enumerator kQTMR_ClockDivide_1

IP bus clock divide by 1 prescaler

enumerator kQTMR_ClockDivide_2

IP bus clock divide by 2 prescaler

enumerator kQTMR_ClockDivide_4

IP bus clock divide by 4 prescaler

enumerator kQTMR_ClockDivide_8

IP bus clock divide by 8 prescaler

enumerator kQTMR_ClockDivide_16

IP bus clock divide by 16 prescaler

enumerator kQTMR_ClockDivide_32

IP bus clock divide by 32 prescaler

enumerator kQTMR_ClockDivide_64

IP bus clock divide by 64 prescaler

enumerator kQTMR_ClockDivide_128
IP bus clock divide by 128 prescaler

enum _qtmr_input_source
Quad Timer input sources selection.

Values:

enumerator kQTMR_Counter0InputPin
Use counter 0 input pin

enumerator kQTMR_Counter1InputPin
Use counter 1 input pin

enumerator kQTMR_Counter2InputPin
Use counter 2 input pin

enumerator kQTMR_Counter3InputPin
Use counter 3 input pin

enum _qtmr_counting_mode
Quad Timer counting mode selection.

Values:

enumerator kQTMR_NoOperation
No operation

enumerator kQTMR_PriSrcRiseEdge
Count rising edges of primary source

enumerator kQTMR_PriSrcRiseAndFallEdge
Count rising and falling edges of primary source

enumerator kQTMR_PriSrcRiseEdgeSecInpHigh
Count rise edges of pri SRC while sec inp high active

enumerator kQTMR_QuadCountMode
Quadrature count mode, uses pri and sec sources

enumerator kQTMR_PriSrcRiseEdgeSecDir
Count rising edges of pri SRC; sec SRC specifies dir

enumerator kQTMR_SecSrcTrigPriCnt
Edge of sec SRC trigger primary count until compare

enumerator kQTMR_CascadeCount
Cascaded count mode (up/down)

enum _qtmr_pwm_out_state
Quad Timer PWM output state.

Values:

enumerator kQTMR_PwmLow
The output state of PWM channel is low

enumerator kQTMR_PwmHigh
The output state of PWM channel is low

enum _qtmr_output_mode
Quad Timer output mode selection.

Values:

enumerator kQTMR_AssertWhenCountActive
Assert OFLAG while counter is active

enumerator kQTMR_ClearOnCompare
Clear OFLAG on successful compare

enumerator kQTMR_SetOnCompare
Set OFLAG on successful compare

enumerator kQTMR_ToggleOnCompare
Toggle OFLAG on successful compare

enumerator kQTMR_ToggleOnAltCompareReg
Toggle OFLAG using alternating compare registers

enumerator kQTMR_SetOnCompareClearOnSecSrcInp
Set OFLAG on compare, clear on sec SRC input edge

enumerator kQTMR_SetOnCompareClearOnCountRoll
Set OFLAG on compare, clear on counter rollover

enumerator kQTMR_EnableGateClock
Enable gated clock output while count is active

enum _qtmr_input_capture_edge
Quad Timer input capture edge mode, rising edge, or falling edge.

Values:

enumerator kQTMR_NoCapture
Capture is disabled

enumerator kQTMR_RisingEdge
Capture on rising edge (IPS=0) or falling edge (IPS=1)

enumerator kQTMR_FallingEdge
Capture on falling edge (IPS=0) or rising edge (IPS=1)

enumerator kQTMR_RisingAndFallingEdge
Capture on both edges

enum _qtmr_preload_control
Quad Timer input capture edge mode, rising edge, or falling edge.

Values:

enumerator kQTMR_NoPreload
Never preload

enumerator kQTMR_LoadOnComp1
Load upon successful compare with value in COMP1

enumerator kQTMR_LoadOnComp2
Load upon successful compare with value in COMP2

enum _qtmr_debug_action
List of Quad Timer run options when in Debug mode.

Values:

enumerator kQTMR_RunNormalInDebug
Continue with normal operation

enumerator kQTMR_HaltCounter
Halt counter

enumerator kQTMR_ForceOutToZero
Force output to logic 0

enumerator kQTMR_HaltCountForceOutZero
Halt counter and force output to logic 0

enum _qtmr_interrupt_enable
List of Quad Timer interrupts.

Values:

enumerator kQTMR_CompareInterruptEnable
Compare interrupt.

enumerator kQTMR_Compare1InterruptEnable
Compare 1 interrupt.

enumerator kQTMR_Compare2InterruptEnable
Compare 2 interrupt.

enumerator kQTMR_OverflowInterruptEnable
Timer overflow interrupt.

enumerator kQTMR_EdgeInterruptEnable
Input edge interrupt.

enum _qtmr_status_flags
List of Quad Timer flags.

Values:

enumerator kQTMR_CompareFlag
Compare flag

enumerator kQTMR_Compare1Flag
Compare 1 flag

enumerator kQTMR_Compare2Flag
Compare 2 flag

enumerator kQTMR_OverflowFlag
Timer overflow flag

enumerator kQTMR_EdgeFlag
Input edge flag

enum _qtmr_channel_selection
List of channel selection.

Values:

enumerator kQTMR_Channel_0
TMR Channel 0

enumerator kQTMR_Channel_1
TMR Channel 1

enumerator kQTMR_Channel_2
TMR Channel 2

enumerator kQTMR_Channel_3
TMR Channel 3

enum _qtmr_dma_enable
List of Quad Timer DMA enable.

Values:

enumerator kQTMR_InputEdgeFlagDmaEnable
Input Edge Flag DMA Enable.

enumerator kQTMR_ComparatorPreload1DmaEnable
Comparator Preload Register 1 DMA Enable.

enumerator kQTMR_ComparatorPreload2DmaEnable
Comparator Preload Register 2 DMA Enable.

typedef enum *_qtmr_primary_count_source* qtmr_primary_count_source_t
Quad Timer primary clock source selection.

typedef enum *_qtmr_input_source* qtmr_input_source_t
Quad Timer input sources selection.

typedef enum *_qtmr_counting_mode* qtmr_counting_mode_t
Quad Timer counting mode selection.

typedef enum *_qtmr_pwm_out_state* qtmr_pwm_out_state_t
Quad Timer PWM output state.

typedef enum *_qtmr_output_mode* qtmr_output_mode_t
Quad Timer output mode selection.

typedef enum *_qtmr_input_capture_edge* qtmr_input_capture_edge_t
Quad Timer input capture edge mode, rising edge, or falling edge.

typedef enum *_qtmr_preload_control* qtmr_preload_control_t
Quad Timer input capture edge mode, rising edge, or falling edge.

typedef enum *_qtmr_debug_action* qtmr_debug_action_t
List of Quad Timer run options when in Debug mode.

typedef enum *_qtmr_interrupt_enable* qtmr_interrupt_enable_t
List of Quad Timer interrupts.

typedef enum *_qtmr_status_flags* qtmr_status_flags_t
List of Quad Timer flags.

typedef enum *_qtmr_channel_selection* qtmr_channel_selection_t
List of channel selection.

typedef enum *_qtmr_dma_enable* qtmr_dma_enable_t
List of Quad Timer DMA enable.

typedef struct *_qtmr_config* qtmr_config_t
Quad Timer config structure.

This structure holds the configuration settings for the Quad Timer peripheral. To initialize this structure to reasonable defaults, call the QTMR_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

status_t QTMR_SetupPwm(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t pwmFreqHz, uint8_t dutyCyclePercent, bool outputPolarity, uint32_t srcClock_Hz)

Sets up Quad timer module for PWM signal output.

The function initializes the timer module according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- pwmFreqHz – PWM signal frequency in Hz
- dutyCyclePercent – PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)
- outputPolarity – true: invert polarity of the output signal, false: no inversion
- srcClock_Hz – Main counter clock in Hz.

Returns

Returns an error if there was error setting up the signal.

void QTMR_SetupInputCapture(TMR_Type *base, *qtmr_channel_selection_t* channel, *qtmr_input_source_t* capturePin, bool inputPolarity, bool reloadOnCapture, *qtmr_input_capture_edge_t* captureMode)

Allows the user to count the source clock cycles until a capture event arrives.

The count is stored in the capture register.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- capturePin – Pin through which we receive the input signal to trigger the capture
- inputPolarity – true: invert polarity of the input signal, false: no inversion
- reloadOnCapture – true: reload the counter when an input capture occurs, false: no reload
- captureMode – Specifies which edge of the input signal triggers a capture

TMR_CSCTRL_OFLAG_MASK

TMR_CSCTRL_OFLAG_SHIFT

struct _qtmr_config

#include <fsl_qtmr.h> Quad Timer config structure.

This structure holds the configuration settings for the Quad Timer peripheral. To initialize this structure to reasonable defaults, call the QTMR_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

Public Members

qtmr_primary_count_source_t primarySource
Specify the primary count source

qtmr_input_source_t secondarySource
Specify the secondary count source

bool enableMasterMode
true: Broadcast compare function output to other counters; false no broadcast

bool enableExternalForce
true: Compare from another counter force state of OFLAG signal false: OFLAG controlled by local counter

uint8_t faultFilterCount
Fault filter count

uint8_t faultFilterPeriod
Fault filter period;value of 0 will bypass the filter

qtmr_debug_action_t debugMode
Operation in Debug mode

2.99 RDC: Resource Domain Controller

enum _rdc_interrupts
RDC interrupts.

Values:

enumerator kRDC_RestoreCompleteInterrupt
Interrupt generated when the RDC has completed restoring state to a recently repowered memory regions.

enum _rdc_flags
RDC status.

Values:

enumerator kRDC_PowerDownDomainOn
Power down domain is ON.

enum _rdc_access_policy
Access permission policy.

Values:

enumerator kRDC_NoAccess
Could not read or write.

enumerator kRDC_WriteOnly
Write only.

enumerator kRDC_ReadOnly
Read only.

enumerator kRDC_ReadWrite
Read and write.

typedef struct *_rdc_hardware_config* rdc_hardware_config_t
RDC hardware configuration.

typedef struct *_rdc_domain_assignment* rdc_domain_assignment_t

Master domain assignment.

typedef struct *_rdc_periph_access_config* rdc_periph_access_config_t

Peripheral domain access permission configuration.

typedef struct *_rdc_mem_access_config* rdc_mem_access_config_t

Memory region domain access control configuration.

Note that when setting the rdc_mem_access_config_t::baseAddress and rdc_mem_access_config_t::endAddress, should be aligned to the region resolution, see rdc_mem_t definitions.

typedef struct *_rdc_mem_status* rdc_mem_status_t

Memory region access violation status.

void RDC_Init(RDC_Type *base)

Initializes the RDC module.

This function enables the RDC clock.

Parameters

- base – RDC peripheral base address.

void RDC_Deinit(RDC_Type *base)

De-initializes the RDC module.

This function disables the RDC clock.

Parameters

- base – RDC peripheral base address.

void RDC_GetHardwareConfig(RDC_Type *base, *rdc_hardware_config_t* *config)

Gets the RDC hardware configuration.

This function gets the RDC hardware configurations, including number of bus masters, number of domains, number of memory regions and number of peripherals.

Parameters

- base – RDC peripheral base address.
- config – Pointer to the structure to get the configuration.

static inline void RDC_EnableInterrupts(RDC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – RDC peripheral base address.
- mask – Interrupts to enable, it is OR'ed value of enum _rdc_interrupts.

static inline void RDC_DisableInterrupts(RDC_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – RDC peripheral base address.
- mask – Interrupts to disable, it is OR'ed value of enum _rdc_interrupts.

static inline uint32_t RDC_GetInterruptStatus(RDC_Type *base)

Get the interrupt pending status.

Parameters

- base – RDC peripheral base address.

Returns
Interrupts pending status, it is OR'ed value of enum _rdc_interrupts.

static inline void RDC_ClearInterruptStatus(RDC_Type *base, uint32_t mask)

Clear interrupt pending status.

Parameters

- base – RDC peripheral base address.
- mask – Status to clear, it is OR'ed value of enum _rdc_interrupts.

static inline uint32_t RDC_GetStatus(RDC_Type *base)

Get RDC status.

Parameters

- base – RDC peripheral base address.

Returns
mask RDC status, it is OR'ed value of enum _rdc_flags.

static inline void RDC_ClearStatus(RDC_Type *base, uint32_t mask)

Clear RDC status.

Parameters

- base – RDC peripheral base address.
- mask – RDC status to clear, it is OR'ed value of enum _rdc_flags.

void RDC_SetMasterDomainAssignment(RDC_Type *base, rdc_master_t master, const *rdc_domain_assignment_t* *domainAssignment)

Set master domain assignment.

Parameters

- base – RDC peripheral base address.
- master – Which master to set.
- domainAssignment – Pointer to the assignment.

void RDC_GetDefaultMasterDomainAssignment(*rdc_domain_assignment_t* *domainAssignment)

Get default master domain assignment.

The default configuration is:

```
assignment->domainId = 0U;
assignment->lock = 0U;
```

Parameters

- domainAssignment – Pointer to the assignment.

static inline void RDC_LockMasterDomainAssignment(RDC_Type *base, rdc_master_t master)

Lock master domain assignment.

Once locked, it could not be unlocked until next reset.

Parameters

- base – RDC peripheral base address.
- master – Which master to lock.

void RDC_SetPeriphAccessConfig(RDC_Type *base, const *rdc_periph_access_config_t* *config)

Set peripheral access policy.

Parameters

- base – RDC peripheral base address.
- config – Pointer to the policy configuration.

void RDC_GetDefaultPeriphAccessConfig(*rdc_periph_access_config_t* *config)

Get default peripheral access policy.

The default configuration is:

```
config->lock = false;
config->enableSema = false;
config->policy = RDC_ACCESS_POLICY(0, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(1, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(2, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(3, kRDC_ReadWrite);
```

Parameters

- config – Pointer to the policy configuration.

static inline void RDC_LockPeriphAccessConfig(RDC_Type *base, rdc_periph_t periph)

Lock peripheral access policy configuration.

Once locked, it could not be unlocked until reset.

Parameters

- base – RDC peripheral base address.
- periph – Which peripheral to lock.

static inline uint8_t RDC_GetPeriphAccessPolicy(RDC_Type *base, rdc_periph_t periph, uint8_t domainId)

Get the peripheral access policy for specific domain.

Parameters

- base – RDC peripheral base address.
- periph – Which peripheral to get.
- domainId – Get policy for which domain.

Returns

Access policy, see _rdc_access_policy.

void RDC_SetMemAccessConfig(RDC_Type *base, const *rdc_mem_access_config_t* *config)

Set memory region access policy.

Note that when setting the baseAddress and endAddress in config, should be aligned to the region resolution, see rdc_mem_t definitions.

Parameters

- base – RDC peripheral base address.
- config – Pointer to the policy configuration.

void RDC_GetDefaultMemAccessConfig(*rdc_mem_access_config_t* *config)

Get default memory region access policy.

The default configuration is:

```
config->lock = false;
config->baseAddress = 0;
config->endAddress = 0;
config->policy = RDC_ACCESS_POLICY(0, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(1, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(2, kRDC_ReadWrite) |
                 RDC_ACCESS_POLICY(3, kRDC_ReadWrite);
```

Parameters

- config – Pointer to the policy configuration.

static inline void RDC_LockMemAccessConfig(RDC_Type *base, rdc_mem_t mem)

Lock memory access policy configuration.

Once locked, it could not be unlocked until reset. After locked, you can only call RDC_SetMemAccessValid to enable the configuration, but can not disable it or change other settings.

Parameters

- base – RDC peripheral base address.
- mem – Which memory region to lock.

static inline void RDC_SetMemAccessValid(RDC_Type *base, rdc_mem_t mem, bool valid)

Enable or disable memory access policy configuration.

Parameters

- base – RDC peripheral base address.
- mem – Which memory region to operate.
- valid – Pass in true to valid, false to invalid.

void RDC_GetMemViolationStatus(RDC_Type *base, rdc_mem_t mem, *rdc_mem_status_t* *status)

Get the memory region violation status.

The first access violation is captured. Subsequent violations are ignored until the status register is cleared. Contents are cleared upon reading the register. Clearing of contents occurs only when the status is read by the memory region's associated domain ID(s).

Parameters

- base – RDC peripheral base address.
- mem – Which memory region to get.
- status – The returned status.

static inline void RDC_ClearMemViolationFlag(RDC_Type *base, rdc_mem_t mem)

Clear the memory region violation flag.

Parameters

- base – RDC peripheral base address.
- mem – Which memory region to clear.

static inline uint8_t RDC_GetMemAccessPolicy(RDC_Type *base, rdc_mem_t mem, uint8_t domainId)

Get the memory region access policy for specific domain.

Parameters

- base – RDC peripheral base address.
- mem – Which memory region to get.

- domainId – Get policy for which domain.

Returns
Access policy, see _rdc_access_policy.

static inline uint8_t RDC_GetCurrentMasterDomainId(RDC_Type *base)

Gets the domain ID of the current bus master.

This function returns the domain ID of the current bus master.

Parameters

- base – RDC peripheral base address.

Returns
Domain ID of current bus master.

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RDC_ACCESS_POLICY(domainID, policy)

struct _rdc_hardware_config

#include <fsl_rdc.h> RDC hardware configuration.

Public Members

uint32_t domainNumber
Number of domains.

uint32_t masterNumber
Number of bus masters.

uint32_t periphNumber
Number of peripherals.

uint32_t memNumber
Number of memory regions.

struct _rdc_domain_assignment

#include <fsl_rdc.h> Master domain assignment.

Public Members

uint32_t domainId
Domain ID.

uint32_t ___pad0___
Reserved.

uint32_t lock
Lock the domain assignment.

struct _rdc_periph_access_config

#include <fsl_rdc.h> Peripheral domain access permission configuration.

Public Members

rdc_periph_t periph
Peripheral name.

bool lock
: Lock the permission until reset.

bool enableSema
: Enable semaphore or not, when enabled, master should call RDC_SEMA42_Lock to lock the semaphore gate accordingly before access the peripheral.

uint16_t policy
: Access policy.

struct __rdc_mem_access_config

#include <fsl_rdc.h> Memory region domain access control configuration.

Note that when setting the rdc_mem_access_config_t::baseAddress and rdc_mem_access_config_t::endAddress, should be aligned to the region resolution, see rdc_mem_t definitions.

Public Members

rdc_mem_t mem
: Memory region descriptor name.

bool lock
: Lock the configuration.

uint64_t baseAddress
: Start address of the memory region.

uint64_t endAddress
: End address of the memory region.

uint16_t policy
: Access policy.

struct __rdc_mem_status

#include <fsl_rdc.h> Memory region access violation status.

Public Members

bool hasViolation
: Violating happens or not.

uint8_t domainID
: Violating Domain ID.

uint64_t address
: Violating Address.

2.100 RDC_SEMA42: Hardware Semaphores Driver

FSL_RDC_SEMA42_DRIVER_VERSION
: RDC_SEMA42 driver version.

void RDC_SEMA42_Init(RDC_SEMAPHORE_Type *base)

Initializes the RDC_SEMA42 module.

This function initializes the RDC_SEMA42 module. It only enables the clock but does not reset the gates because the module might be used by other processors at the same time. To reset the gates, call either RDC_SEMA42_ResetGate or RDC_SEMA42_ResetAllGates function.

Parameters

- base – RDC_SEMA42 peripheral base address.

void RDC_SEMA42_Deinit(RDC_SEMAPHORE_Type *base)

De-initializes the RDC_SEMA42 module.

This function de-initializes the RDC_SEMA42 module. It only disables the clock.

Parameters

- base – RDC_SEMA42 peripheral base address.

status_t RDC_SEMA42_TryLock(RDC_SEMAPHORE_Type *base, uint8_t gateNum, uint8_t masterIndex, uint8_t domainId)

Tries to lock the RDC_SEMA42 gate.

This function tries to lock the specific RDC_SEMA42 gate. If the gate has been locked by another processor, this function returns an error code.

Parameters

- base – RDC_SEMA42 peripheral base address.
- gateNum – Gate number to lock.
- masterIndex – Current processor master index.
- domainId – Current processor domain ID.

Return values

- kStatus_Success – Lock the sema42 gate successfully.
- kStatus_Failed – Sema42 gate has been locked by another processor.

void RDC_SEMA42_Lock(RDC_SEMAPHORE_Type *base, uint8_t gateNum, uint8_t masterIndex, uint8_t domainId)

Locks the RDC_SEMA42 gate.

This function locks the specific RDC_SEMA42 gate. If the gate has been locked by other processors, this function waits until it is unlocked and then lock it.

Parameters

- base – RDC_SEMA42 peripheral base address.
- gateNum – Gate number to lock.
- masterIndex – Current processor master index.
- domainId – Current processor domain ID.

static inline void RDC_SEMA42_Unlock(RDC_SEMAPHORE_Type *base, uint8_t gateNum)

Unlocks the RDC_SEMA42 gate.

This function unlocks the specific RDC_SEMA42 gate. It only writes unlock value to the RDC_SEMA42 gate register. However, it does not check whether the RDC_SEMA42 gate is locked by the current processor or not. As a result, if the RDC_SEMA42 gate is not locked by the current processor, this function has no effect.

Parameters

- base – RDC_SEMA42 peripheral base address.

- gateNum – Gate number to unlock.

static inline int32_t RDC_SEMA42_GetLockMasterIndex(RDC_SEMAPHORE_Type *base, uint8_t gateNum)

Gets which master has currently locked the gate.

Parameters

- base – RDC_SEMA42 peripheral base address.
- gateNum – Gate number.

Returns

Return -1 if the gate is not locked by any master, otherwise return the master index.

int32_t RDC_SEMA42_GetLockDomainID(RDC_SEMAPHORE_Type *base, uint8_t gateNum)

Gets which domain has currently locked the gate.

Parameters

- base – RDC_SEMA42 peripheral base address.
- gateNum – Gate number.

Returns

Return -1 if the gate is not locked by any domain, otherwise return the domain ID.

status_t RDC_SEMA42_ResetGate(RDC_SEMAPHORE_Type *base, uint8_t gateNum)

Resets the RDC_SEMA42 gate to an unlocked status.

This function resets a RDC_SEMA42 gate to an unlocked status.

Parameters

- base – RDC_SEMA42 peripheral base address.
- gateNum – Gate number.

Return values

- kStatus_Success – RDC_SEMA42 gate is reset successfully.
- kStatus_Failed – Some other reset process is ongoing.

static inline *status_t* RDC_SEMA42_ResetAllGates(RDC_SEMAPHORE_Type *base)

Resets all RDC_SEMA42 gates to an unlocked status.

This function resets all RDC_SEMA42 gate to an unlocked status.

Parameters

- base – RDC_SEMA42 peripheral base address.

Return values

- kStatus_Success – RDC_SEMA42 is reset successfully.
- kStatus_RDC_SEMA42_Reseting – Some other reset process is ongoing.

RDC_SEMA42_GATE_NUM_RESET_ALL

The number to reset all RDC_SEMA42 gates.

RDC_SEMA42_GATEn(base, n)

RDC_SEMA42 gate n register address.

RDC_SEMA42_GATE_COUNT

RDC_SEMA42 gate count.

RDC_SEMAPHORE_GATE_GTFSM_MASK

2.101 Romapi

Flash Pad Definitions.

Values:

enumerator kSerialFlash_1Pad
1-wire communication

enumerator kSerialFlash_2Pads
2-wire communication

enumerator kSerialFlash_4Pads
4-wire communication

enumerator kSerialFlash_8Pads
8-wire communication

FLEXSPI clock configuration type.

Values:

enumerator kFLEXSPIClk_SDR
Clock configure for SDR mode

enumerator kFLEXSPIClk_DDR
Clock configure for DDR mode

enum _flexspi_read_sample_clk
FLEXSPI Read Sample Clock Source definition.

Values:

enumerator kFLEXSPIReadSampleClk_LoopbackInternally
FLEXSPI Read Sample Clock Source from the Internal loopback

enumerator kFLEXSPIReadSampleClk_LoopbackFromDqsPad
FLEXSPI Read Sample Clock Source from the Dqs Pad loopback

enumerator kFLEXSPIReadSampleClk_LoopbackFromSckPad
FLEXSPI Read Sample Clock Source from the Sck Pad loopback

enumerator kFLEXSPIReadSampleClk_ExternalInputFromDqsPad
FLEXSPI Read Sample Clock Source from the External Input by the Dqs Pad

Flash Type Definition.

Values:

enumerator kFLEXSPIDeviceType_SerialNOR
Flash device is Serial NOR

Flash Configuration Command Type.

Values:

enumerator kDeviceConfigCmdType_Generic
Generic command, for example: configure dummy cycles, drive strength, etc.

enumerator kDeviceConfigCmdType_QuadEnable
Quad Enable command

enumerator kDeviceConfigCmdType_Spi2Xpi
Switch from SPI to DPI/QPI/OPI mode

enumerator kDeviceConfigCmdType_Xpi2Spi
Switch from DPI/QPI/OPI to SPI mode

enumerator kDeviceConfigCmdType_Spi2NoCmd
Switch to 0-4-4/0-8-8 mode

enumerator kDeviceConfigCmdType_Reset
Reset device command

enum _flexspi_serial_clk_freq
Definitions for FLEXSPI Serial Clock Frequency.

Values:

enumerator kFLEXSPISerialClk_NoChange
FlexSPI serial clock no changed

enumerator kFLEXSPISerialClk_30MHz
FlexSPI serial clock 30MHz

enumerator kFLEXSPISerialClk_50MHz
FlexSPI serial clock 50MHz

enumerator kFLEXSPISerialClk_60MHz
FlexSPI serial clock 60MHz

enumerator kFLEXSPISerialClk_75MHz
FlexSPI serial clock 75MHz

enumerator kFLEXSPISerialClk_80MHz
FlexSPI serial clock 80MHz

enumerator kFLEXSPISerialClk_100MHz
FlexSPI serial clock 100MHz

enumerator kFLEXSPISerialClk_133MHz
FlexSPI serial clock 133MHz

enumerator kFLEXSPISerialClk_166MHz
FlexSPI serial clock 166MHz

Misc feature bit definitions.

Values:

enumerator kFLEXSPIMiscOffset_DiffClkEnable
Bit for Differential clock enable

enumerator kFLEXSPIMiscOffset_Ck2Enable
Bit for CK2 enable

enumerator kFLEXSPIMiscOffset_ParallelEnable
Bit for Parallel mode enable

enumerator kFLEXSPIMiscOffset_WordAddressableEnable
Bit for Word Addressable enable

enumerator kFLEXSPIMiscOffset_SafeConfigFreqEnable
Bit for Safe Configuration Frequency enable

enumerator kFLEXSPIMiscOffset_PadSettingOverrideEnable
Bit for Pad setting override enable

enumerator kFLEXSPIMiscOffset_DdrModeEnable
Bit for DDR clock configuration indication.

enumerator kFLEXSPIMiscOffset_UseValidTimeForAllFreq
Bit for DLLCR settings under all modes

Manufacturer ID.

Values:

enumerator kSerialFlash_ISSI_ManufacturerID
Manufacturer ID of the ISSI serial flash

enumerator kSerialFlash_Adesto_ManufacturerID
Manufacturer ID of the Adesto Technologies serial flash

enumerator kSerialFlash_Winbond_ManufacturerID
Manufacturer ID of the Winbond serial flash

enumerator kSerialFlash_Cypress_ManufacturerID
Manufacturer ID for Cypress

enum _flexspi_nor_status
ROM FLEXSPI NOR flash status.

Values:

enumerator kStatus_ROM_FLEXSPI_SequenceExecutionTimeout
Status for Sequence Execution timeout

enumerator kStatus_ROM_FLEXSPI_InvalidSequence
Status for Invalid Sequence

enumerator kStatus_ROM_FLEXSPI_DeviceTimeout
Status for Device timeout

enumerator kStatus_ROM_FLEXSPINOR_SFDP_NotFound
Status for SFDP read failure

enumerator kStatus_ROM_FLEXSPINOR_Flash_NotFound
Status for Flash detection failure

enumerator kStatus_FLEXSPINOR_DTRRead_DummyProbeFailed
Status for DDR Read dummy probe failure

enum _flexspi_operation
FLEXSPI Operation Context.

Values:

enumerator kFLEXSPIOperation_Command
FLEXSPI operation: Only command, both TX and RX buffer are ignored.

enumerator kFLEXSPIOperation_Config
FLEXSPI operation: Configure device mode, the TX FIFO size is fixed in LUT.

enumerator kFLEXSPIOperation_Write
FLEXSPI operation: Write, only TX buffer is effective

enumerator kFLEXSPIOperation_Read
FLEXSPI operation: Read, only Rx Buffer is effective.

typedef struct *_flexspi_lut_seq* flexspi_lut_seq_t
FLEXSPI LUT Sequence structure.

typedef struct *_flexspi_mem_config* flexspi_mem_config_t
FLEXSPI Memory Configuration Block.

typedef struct *_flexspi_nor_config* flexspi_nor_config_t
Serial NOR configuration block.

typedef enum *_flexspi_operation* flexspi_operation_t
FLEXSPI Operation Context.

typedef struct *_flexspi_xfer* flexspi_xfer_t
FLEXSPI Transfer Context.

void ROM_API_Init(void)
ROM API init.

Get the bootloader api entry address.

kFLEXSPIOperation_End

MISRA_CAST(to_type, to_var, from_type, from_var)
convert the type for MISRA

typedef struct *_serial_nor_config_option* serial_nor_config_option_t
Serial NOR Configuration Option.

void ROM_RunBootloader(void *arg)
Enter Bootloader.

Parameters

- arg – A pointer to the storage for the bootloader param. refer to System Boot Chapter in device reference manual for details.

status_t ROM_FLEXSPI_NorFlash_GetConfig(uint32_t instance, *flexspi_nor_config_t* *config, *serial_nor_config_option_t* *option)
Get FLEXSPI NOR Configuration Block based on specified option.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- option – A pointer to the storage Serial NOR Configuration Option Context.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Init(uint32_t instance, *flexspi_nor_config_t* *config)

Initialize Serial NOR devices via FLEXSPI.

This function checks and initializes the FLEXSPI module for the other FLEXSPI APIs.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_ProgramPage(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t dst_addr, const uint32_t *src)

Program data to Serial NOR via FLEXSPI.

This function programs the NOR flash memory with the dest address for a given flash area as determined by the dst address and the length.

Note: It is recommended that use page aligned access; If the dst_addr is not aligned to page, the driver automatically aligns address down with the page address.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- dst_addr – A pointer to the desired flash memory to be programmed.
- src – A pointer to the source buffer of data that is to be programmed into the NOR flash.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Read(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t *dst, uint32_t start, uint32_t lengthInBytes)

Read data from Serial NOR via FLEXSPI.

This function read the NOR flash memory with the start address for a given flash area as determined by the dst address and the length.

Note: It is recommended that use page aligned access; If the dstAddr is not aligned to page, the driver automatically aligns address down with the page address.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- dst – A pointer to the dest buffer of data that is to be read from the NOR flash.
- start – The start address of the desired NOR flash memory to be read.
- lengthInBytes – The length, given in bytes to be read.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Erase(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t start, uint32_t length)

Erase Flash Region specified by address and length.

This function erases the appropriate number of flash sectors based on the desired start address and length.

Note: It is recommended that use sector-aligned access nor device; If dstAddr is not aligned with the sector,the driver automatically aligns address down with the sector address.

Note: It is recommended that use sector-aligned access nor device; If length is not aligned with the sector,the driver automatically aligns up with the sector.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.
- length – The length, given in bytes to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_EraseSector(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t start)

Erase one sector specified by address.

This function erases one of NOR flash sectors based on the desired address.

Note: It is recommended that use sector-aligned access nor device; If dstAddr is not aligned with the sector, the driver automatically aligns address down with the sector address.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_EraseBlock(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t start)

Erase one block specified by address.

This function erases one block of NOR flash based on the desired address.

Note: It is recommended that use block-aligned access nor device; If dstAddr is not aligned with the block, the driver automatically aligns address down with the block address.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_EraseAll(uint32_t instance, *flexspi_nor_config_t* *config)

Erase all the Serial NOR devices connected on FLEXSPI.

Parameters

- instance – storage the instance of FLEXSPI.

- config – A pointer to the storage for the driver runtime state.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_CommandXfer(uint32_t instance, *flexspi_xfer_t* *xfer)

FLEXSPI command.

This function is used to perform the command write sequence to the NOR device.

Parameters

- instance – storage the index of FLEXSPI.
- xfer – A pointer to the storage FLEXSPI Transfer Context.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.

status_t ROM_FLEXSPI_NorFlash_UpdateLut(uint32_t instance, uint32_t seqIndex, const uint32_t *lutBase, uint32_t seqNumber)

Configure FLEXSPI Lookup table.

Parameters

- instance – storage the index of FLEXSPI.
- seqIndex – storage the sequence Id.
- lutBase – A pointer to the look-up-table for command sequences.
- seqNumber – storage sequence number.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.

status_t ROM_FLEXSPI_NorFlash_WaitBusy(uint32_t instance, *flexspi_nor_config_t* *config, bool isParallelMode, uint32_t address)

Wait until device is idle.

Parameters

- instance – Indicates the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state
- isParallelMode – Indicates whether NOR flash is in parallel mode.

- address – Indicates the operation(erase/program/read) address for serial NOR flash.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_DeviceTimeout – Device timeout.

void ROM_FLEXSPI_NorFlash_ClearCache(uint32_t instance)

Software reset for the FLEXSPI logic.

This function sets the software reset flags for both AHB and buffer domain and resets both AHB buffer and also IP FIFOs.

Parameters

- instance – storage the index of FLEXSPI.

FSL_ROM_HAS_FLEXSPINOR_API

ROM has FLEXSPI NOR API.

FSL_ROM_HAS_RUNBOOTLOADER_API

ROM has run bootloader API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_GET_CONFIG

ROM has FLEXSPI NOR get config API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_FLASH_INIT

ROM has flash init API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE

ROM has erase API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_SECTOR

ROM has erase sector API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_BLOCK

ROM has erase block API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_ALL

ROM has erase all API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_READ

ROM has read API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_UPDATE_LUT

ROM has update lut API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_CMD_XFER

ROM has FLEXSPI command API.

kROM_StatusGroup_FLEXSPINOR

ROM FLEXSPI NOR status group number.

FSL_ROM_FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)

FSL_ROM_FLEXSPI_BITMASK(bit_offset)

Generate bit mask.

FLEXSPI_CFG_BLK_TAG
: FLEXSPI memory config block related definitions.

  ascii “FCFB” Big Endian

FLEXSPI_CFG_BLK_VERSION
: V1.4.0

CMD_SDR

CMD_DDR

RADDR_SDR

RADDR_DDR

CADDR_SDR

CADDR_DDR

MODE1_SDR

MODE1_DDR

MODE2_SDR

MODE2_DDR

MODE4_SDR

MODE4_DDR

MODE8_SDR

MODE8_DDR

WRITE_SDR

WRITE_DDR

READ_SDR

READ_DDR

LEARN_SDR

LEARN_DDR

DATSZ_SDR

DATSZ_DDR

DUMMY_SDR

DUMMY_DDR

DUMMY_RWDS_SDR

DUMMY_RWDS_DDR

JMP_ON_CS

STOP

FLEXSPI_1PAD

FLEXSPI_2PAD

FLEXSPI_4PAD

FLEXSPI_8PAD

NOR_CMD_LUT_SEQ_IDX_READ
NOR LUT sequence index used for default LUT assignment.

Note: It will take effect if the lut sequences are not customized. READ LUT sequence id in lookupTable stored in config block

---

NOR_CMD_LUT_SEQ_IDX_READSTATUS
Read Status LUT sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_READSTATUS_XPI
Read status DPI/QPI/OPI sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_WRITEENABLE
Write Enable sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_WRITEENABLE_XPI
Write Enable DPI/QPI/OPI sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_ERASESECTOR
Erase Sector sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_READID

NOR_CMD_LUT_SEQ_IDX_ERASEBLOCK
Erase Block sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_PAGEPROGRAM
Program sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_CHIPERASE
Chip Erase sequence in lookupTable id stored in config block

NOR_CMD_LUT_SEQ_IDX_READ_SFDP
Read SFDP sequence in lookupTable id stored in config block

NOR_CMD_LUT_SEQ_IDX_RESTORE_NOCMD
Restore 0-4-4/0-8-8 mode sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_EXIT_NOCMD
Exit 0-4-4/0-8-8 mode sequence id in lookupTable stored in config block

uint32_t max_freq
Maximum supported Frequency

uint32_t misc_mode
miscellaneous mode

uint32_t quad_mode_setting
Quad mode setting

uint32_t cmd_pads
Command pads

uint32_t query_pads
SFDP read pads

uint32_t device_type
: Device type

uint32_t option_size
: Option size, in terms of uint32_t, size = (option_size + 1) * 4

uint32_t tag
: Tag, must be 0x0E

struct *_serial_nor_config_option* B

uint32_t U

union *_serial_nor_config_option* option0

uint32_t dummy_cycles
: Dummy cycles before read

uint32_t status_override
: Override status register value during device mode configuration

uint32_t pinmux_group
: The pinmux group selection

uint32_t dqs_pinmux_group
: The DQS Pinmux Group Selection

uint32_t drive_strength
: The Drive Strength of FlexSPI Pads

uint32_t flash_connection
: Flash connection option: 0 - Single Flash connected to port A, 1 - Parallel mode, 2 - Single Flash connected to Port B

struct *_serial_nor_config_option* B

uint32_t U

union *_serial_nor_config_option* option1

uint8_t seqNum
: Sequence Number, valid number: 1-16

uint8_t seqId
: Sequence Index, valid number: 0-15

uint16_t reserved

uint8_t time_100ps
: Data valid time, in terms of 100ps

uint8_t delay_cells
: Data valid time, in terms of delay cells

uint32_t tag
: [0x000-0x003] Tag, fixed value 0x42464346UL

uint32_t version
: [0x004-0x007] Version,[31:24] -'V', [23:16] - Major, [15:8] - Minor, [7:0] - bugfix

uint32_t reserved0
: [0x008-0x00b] Reserved for future use

uint8_t readSampleClkSrc

[0x00c-0x00c] Read Sample Clock Source, valid value: 0/1/3

uint8_t csHoldTime

[0x00d-0x00d] Data hold time, default value: 3

uint8_t csSetupTime

[0x00e-0x00e] Date setup time, default value: 3

uint8_t columnAddressWidth

[0x00f-0x00f] Column Address with, for HyperBus protocol, it is fixed to 3, For Serial NAND, need to refer to datasheet

uint8_t deviceModeCfgEnable

[0x010-0x010] Device Mode Configure enable flag, 1 - Enable, 0 - Disable

uint8_t deviceModeType

[0x011-0x011] Specify the configuration command type:Quad Enable, DPI/QPI/OPI switch, Generic configuration, etc.

uint16_t waitTimeCfgCommands

[0x012-0x013] Wait time for all configuration commands, unit: 100us, Used for DPI/QPI/OPI switch or reset command

flexspi_lut_seq_t deviceModeSeq

[0x014-0x017] Device mode sequence info, [7:0] - LUT sequence id, [15:8] - LUt sequence number, [31:16] Reserved

uint32_t deviceModeArg

[0x018-0x01b] Argument/Parameter for device configuration

uint8_t configCmdEnable

[0x01c-0x01c] Configure command Enable Flag, 1 - Enable, 0 - Disable

uint8_t configModeType[3]

[0x01d-0x01f] Configure Mode Type, similar as deviceModeTpe

flexspi_lut_seq_t configCmdSeqs[3]

[0x020-0x02b] Sequence info for Device Configuration command, similar as deviceModeSeq

uint32_t reserved1

[0x02c-0x02f] Reserved for future use

uint32_t configCmdArgs[3]

[0x030-0x03b] Arguments/Parameters for device Configuration commands

uint32_t reserved2

[0x03c-0x03f] Reserved for future use

uint32_t controllerMiscOption

[0x040-0x043] Controller Misc Options, see Misc feature bit definitions for more details

uint8_t deviceType

[0x044-0x044] Device Type: See Flash Type Definition for more details

uint8_t sflashPadType

[0x045-0x045] Serial Flash Pad Type: 1 - Single, 2 - Dual, 4 - Quad, 8 - Octal

uint8_t serialClkFreq

[0x046-0x046] Serial Flash Frequency, device specific definitions. See System Boot Chapter for more details

uint8_t lutCustomSeqEnable

[0x047-0x047] LUT customization Enable, it is required if the program/erase cannot be done using 1 LUT sequence, currently, only applicable to HyperFLASH

uint32_t reserved3[2]

[0x048-0x04f] Reserved for future use

uint32_t sflashA1Size

[0x050-0x053] Size of Flash connected to A1

uint32_t sflashA2Size

[0x054-0x057] Size of Flash connected to A2

uint32_t sflashB1Size

[0x058-0x05b] Size of Flash connected to B1

uint32_t sflashB2Size

[0x05c-0x05f] Size of Flash connected to B2

uint32_t csPadSettingOverride

[0x060-0x063] CS pad setting override value

uint32_t sclkPadSettingOverride

[0x064-0x067] SCK pad setting override value

uint32_t dataPadSettingOverride

[0x068-0x06b] data pad setting override value

uint32_t dqsPadSettingOverride

[0x06c-0x06f] DQS pad setting override value

uint32_t timeoutInMs

[0x070-0x073] Timeout threshold for read status command

uint32_t commandInterval

[0x074-0x077] CS deselect interval between two commands

flexspi_dll_time_t dataValidTime[2]

[0x078-0x07b] CLK edge to data valid time for PORT A and PORT B

uint16_t busyOffset

[0x07c-0x07d] Busy offset, valid value: 0-31

uint16_t busyBitPolarity

[0x07e-0x07f] Busy flag polarity, 0 - busy flag is 1 when flash device is busy, 1 - busy flag is 0 when flash device is busy

uint32_t lookupTable[64]

[0x080-0x17f] Lookup table holds Flash command sequences

flexspi_lut_seq_t lutCustomSeq[12]

[0x180-0x1af] Customizable LUT Sequences

uint32_t reserved4[4]

[0x1b0-0x1bf] Reserved for future use

flexspi_mem_config_t memConfig

Common memory configuration info via FLEXSPI

uint32_t pageSize

Page size of Serial NOR

uint32_t sectorSize
: Sector size of Serial NOR

uint8_t ipcmdSerialClkFreq
: Clock frequency for IP command

uint8_t isUniformBlockSize
: Sector/Block size is the same

uint8_t isDataOrderSwapped
: Data order (D0, D1, D2, D3) is swapped (D1,D0, D3, D2)

uint8_t reserved0[1]
: Reserved for future use

uint8_t serialNorType
: Serial NOR Flash type: 0/1/2/3

uint8_t needExitNoCmdMode
: Need to exit NoCmd mode before other IP command

uint8_t halfClkForNonReadCmd
: Half the Serial Clock for non-read command: true/false

uint8_t needRestoreNoCmdMode
: Need to Restore NoCmd mode after IP command execution

uint32_t blockSize
: Block size

uint32_t reserve2[11]
: Reserved for future use

flexspi_operation_t operation
: FLEXSPI operation

uint32_t baseAddress
: FLEXSPI operation base address

uint32_t seqId
: Sequence Id

uint32_t seqNum
: Sequence Number

bool isParallelModeEnable
: Is a parallel transfer

uint32_t *txBuffer
: Tx buffer

uint32_t txSize
: Tx size in bytes

uint32_t *rxBuffer
: Rx buffer

uint32_t rxSize
: Rx size in bytes

FSL_ROM_ROMAPI_VERSION
: ROM API version 1.1.2.

FSL_ROM_FLEXSPINOR_DRIVER_VERSION
ROM FLEXSPI NOR driver version 1.7.0.

struct _serial_nor_config_option
#include <fsl_romapi.h> Serial NOR Configuration Option.

struct _flexspi_lut_seq
#include <fsl_romapi.h> FLEXSPI LUT Sequence structure.

struct flexspi_dll_time_t
#include <fsl_romapi.h> FLEXSPI DLL time.

struct _flexspi_mem_config
#include <fsl_romapi.h> FLEXSPI Memory Configuration Block.

struct _flexspi_nor_config
#include <fsl_romapi.h> Serial NOR configuration block.

struct _flexspi_xfer
#include <fsl_romapi.h> FLEXSPI Transfer Context.

union option0

Public Members

struct *_serial_nor_config_option* B

uint32_t U

struct B

Public Members

uint32_t max_freq
Maximum supported Frequency

uint32_t misc_mode
miscellaneous mode

uint32_t quad_mode_setting
Quad mode setting

uint32_t cmd_pads
Command pads

uint32_t query_pads
SFDP read pads

uint32_t device_type
Device type

uint32_t option_size
Option size, in terms of uint32_t, size = (option_size + 1) * 4

uint32_t tag
Tag, must be 0x0E

union option1

Public Members

struct *_serial_nor_config_option* B

uint32_t U

struct B

Public Members

uint32_t dummy_cycles

Dummy cycles before read

uint32_t status_override

Override status register value during device mode configuration

uint32_t pinmux_group

The pinmux group selection

uint32_t dqs_pinmux_group

The DQS Pinmux Group Selection

uint32_t drive_strength

The Drive Strength of FlexSPI Pads

uint32_t flash_connection

Flash connection option: 0 - Single Flash connected to port A, 1 - Parallel mode, 2 - Single Flash connected to Port B

2.102 RTWDOG: 32-bit Watchdog Timer

void RTWDOG_GetDefaultConfig(*rtwdog_config_t* *config)

Initializes the RTWDOG configuration structure.

This function initializes the RTWDOG configuration structure to default values. The default values are:

```
rtwdogConfig->enableRtwdog = true;
rtwdogConfig->clockSource = kRTWDOG_ClockSource1;
rtwdogConfig->prescaler = kRTWDOG_ClockPrescalerDivide1;
rtwdogConfig->workMode.enableWait = true;
rtwdogConfig->workMode.enableStop = false;
rtwdogConfig->workMode.enableDebug = false;
rtwdogConfig->testMode = kRTWDOG_TestModeDisabled;
rtwdogConfig->enableUpdate = true;
rtwdogConfig->enableInterrupt = false;
rtwdogConfig->enableWindowMode = false;
rtwdogConfig->windowValue = 0U;
rtwdogConfig->timeoutValue = 0xFFFFU;
```

See also:

rtwdog_config_t

Parameters

- config – Pointer to the RTWDOG configuration structure.

AT_QUICKACCESS_SECTION_CODE (void RTWDOG_Init(RTWDOG_Type *base, const rtwdog_config_t *config))

Initializes the RTWDOG module.

This function initializes the RTWDOG. To reconfigure the RTWDOG without forcing a reset first, enableUpdate must be set to true in the configuration.

Example:

```
rtwdog_config_t config;
RTWDOG_GetDefaultConfig(&config);
config.timeoutValue = 0x7ffU;
config.enableUpdate = true;
RTWDOG_Init(wdog_base,&config);
```

Parameters

- base – RTWDOG peripheral base address.
- config – The configuration of the RTWDOG.

void RTWDOG_Deinit(RTWDOG_Type *base)

De-initializes the RTWDOG module.

This function shuts down the RTWDOG. Ensure that the WDOG_CS.UPDATE is 1, which means that the register update is enabled.

Parameters

- base – RTWDOG peripheral base address.

static inline void RTWDOG_Enable(RTWDOG_Type *base)

Enables the RTWDOG module.

This function writes a value into the WDOG_CS register to enable the RTWDOG. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.

static inline void RTWDOG_Disable(RTWDOG_Type *base)

Disables the RTWDOG module.

This function writes a value into the WDOG_CS register to disable the RTWDOG. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address

static inline void RTWDOG_EnableInterrupts(RTWDOG_Type *base, uint32_t mask)

Enables the RTWDOG interrupt.

This function writes a value into the WDOG_CS register to enable the RTWDOG interrupt. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.
- mask – The interrupts to enable. The parameter can be a combination of the following source if defined:
  - kRTWDOG_InterruptEnable

static inline void RTWDOG_DisableInterrupts(RTWDOG_Type *base, uint32_t mask)

Disables the RTWDOG interrupt.

This function writes a value into the WDOG_CS register to disable the RTWDOG interrupt. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.
- mask – The interrupts to disabled. The parameter can be a combination of the following source if defined:
  - kRTWDOG_InterruptEnable

static inline uint32_t RTWDOG_GetStatusFlags(RTWDOG_Type *base)

Gets the RTWDOG all status flags.

This function gets all status flags.

Example to get the running flag:

```
uint32_t status;
status = RTWDOG_GetStatusFlags(wdog_base) & kRTWDOG_RunningFlag;
```

See also:

_rtwdog_status_flags_t

- true: related status flag has been set.
- false: related status flag is not set.

Parameters

- base – RTWDOG peripheral base address

Returns

State of the status flag: asserted (true) or not-asserted (false).

static inline void RTWDOG_EnableWindowMode(RTWDOG_Type *base, bool enable)

Enables/disables the window mode.

Parameters

- base – RTWDOG peripheral base address.
- enable – Enables(true) or disables(false) the feature.

static inline uint32_t RTWDOG_CountToMesec(RTWDOG_Type *base, uint32_t count, uint32_t clockFreqInHz)

Converts raw count value to millisecond.

Note that if the clock frequency is too high the timeout period can be less than 1 ms. In this case this api will return 0 value.

Parameters

- base – RTWDOG peripheral base address.
- count – Raw count value.
- clockFreqInHz – The frequency of the clock source RTWDOG uses.

Returns

Return converted time. Will return 0 if result is larger than 0xFFFFFFFF.

void RTWDOG_ClearStatusFlags(RTWDOG_Type *base, uint32_t mask)

Clears the RTWDOG flag.

This function clears the RTWDOG status flag.

Example to clear an interrupt flag:

```
RTWDOG_ClearStatusFlags(wdog_base,kRTWDOG_InterruptFlag);
```

Parameters

- base – RTWDOG peripheral base address.
- mask – The status flags to clear. The parameter can be any combination of the following values:
  - kRTWDOG_InterruptFlag

static inline void RTWDOG_SetTimeoutValue(RTWDOG_Type *base, uint16_t timeoutCount)

Sets the RTWDOG timeout value.

This function writes a timeout value into the WDOG_TOVAL register. The WDOG_TOVAL register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address
- timeoutCount – RTWDOG timeout value, count of RTWDOG clock ticks.

static inline void RTWDOG_SetWindowValue(RTWDOG_Type *base, uint16_t windowValue)

Sets the RTWDOG window value.

This function writes a window value into the WDOG_WIN register. The WDOG_WIN register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.
- windowValue – RTWDOG window value.

___STATIC_FORCEINLINE void RTWDOG_Unlock (RTWDOG_Type *base)

Unlocks the RTWDOG register written.

This function unlocks the RTWDOG register written.

Before starting the unlock sequence and following the configuration, disable the global interrupts. Otherwise, an interrupt could effectively invalidate the unlock sequence and the WCT may expire. After the configuration finishes, re-enable the global interrupts.

Parameters

- base – RTWDOG peripheral base address

static inline void RTWDOG_Refresh(RTWDOG_Type *base)

Refreshes the RTWDOG timer.

This function feeds the RTWDOG. This function should be called before the Watchdog timer is in timeout. Otherwise, a reset is asserted.

Parameters

- base – RTWDOG peripheral base address

static inline uint32_t RTWDOG_GetCounterValue(RTWDOG_Type *base)

Gets the RTWDOG counter value.

This function gets the RTWDOG counter value.

Parameters

- base – RTWDOG peripheral base address.

Returns

Current RTWDOG counter value.

WDOG_FIRST_WORD_OF_UNLOCK

First word of unlock sequence

WDOG_SECOND_WORD_OF_UNLOCK

Second word of unlock sequence

WDOG_FIRST_WORD_OF_REFRESH

First word of refresh sequence

WDOG_SECOND_WORD_OF_REFRESH

Second word of refresh sequence

FSL_RTWDOG_DRIVER_VERSION

RTWDOG driver version.

enum _rtwdog_clock_source

Describes RTWDOG clock source.

Values:

enumerator kRTWDOG_ClockSource0

Clock source 0

enumerator kRTWDOG_ClockSource1

Clock source 1

enumerator kRTWDOG_ClockSource2

Clock source 2

enumerator kRTWDOG_ClockSource3

Clock source 3

enum _rtwdog_clock_prescaler

Describes the selection of the clock prescaler.

Values:

enumerator kRTWDOG_ClockPrescalerDivide1

Divided by 1

enumerator kRTWDOG_ClockPrescalerDivide256

Divided by 256

enum _rtwdog_test_mode

Describes RTWDOG test mode.

Values:

enumerator kRTWDOG_TestModeDisabled

Test Mode disabled

enumerator kRTWDOG_UserModeEnabled

User Mode enabled

enumerator kRTWDOG_LowByteTest
Test Mode enabled, only low byte is used

enumerator kRTWDOG_HighByteTest
Test Mode enabled, only high byte is used

enum _rtwdog_interrupt_enable_t
RTWDOG interrupt configuration structure.

This structure contains the settings for all of the RTWDOG interrupt configurations.

Values:

enumerator kRTWDOG_InterruptEnable
Interrupt is generated before forcing a reset

enum _rtwdog_status_flags_t
RTWDOG status flags.

This structure contains the RTWDOG status flags for use in the RTWDOG functions.

Values:

enumerator kRTWDOG_RunningFlag
Running flag, set when RTWDOG is enabled

enumerator kRTWDOG_InterruptFlag
Interrupt flag, set when interrupt occurs

typedef enum *_rtwdog_clock_source* rtwdog_clock_source_t
Describes RTWDOG clock source.

typedef enum *_rtwdog_clock_prescaler* rtwdog_clock_prescaler_t
Describes the selection of the clock prescaler.

typedef struct *_rtwdog_work_mode* rtwdog_work_mode_t
Defines RTWDOG work mode.

typedef enum *_rtwdog_test_mode* rtwdog_test_mode_t
Describes RTWDOG test mode.

typedef struct *_rtwdog_config* rtwdog_config_t
Describes RTWDOG configuration structure.

struct _rtwdog_work_mode
#include <fsl_rtwdog.h> Defines RTWDOG work mode.

Public Members

bool enableWait
Enables or disables RTWDOG in wait mode

bool enableStop
Enables or disables RTWDOG in stop mode

bool enableDebug
Enables or disables RTWDOG in debug mode

struct _rtwdog_config
#include <fsl_rtwdog.h> Describes RTWDOG configuration structure.

Public Members

bool enableRtwdog
: Enables or disables RTWDOG

rtwdog_clock_source_t clockSource
: Clock source select

rtwdog_clock_prescaler_t prescaler
: Clock prescaler value

rtwdog_work_mode_t workMode
: Configures RTWDOG work mode in debug stop and wait mode

rtwdog_test_mode_t testMode
: Configures RTWDOG test mode

bool enableUpdate
: Update write-once register enable

bool enableInterrupt
: Enables or disables RTWDOG interrupt

bool enableWindowMode
: Enables or disables RTWDOG window mode

uint16_t windowValue
: Window value

uint16_t timeoutValue
: Timeout value

2.103 SAI: Serial Audio Interface

2.104 SAI Driver

void SAI_Init(I2S_Type *base)
: Initializes the SAI peripheral.

  This API gates the SAI clock. The SAI module can't operate unless SAI_Init is called to enable the clock.

  Parameters

  - base – SAI base pointer.

void SAI_Deinit(I2S_Type *base)
: De-initializes the SAI peripheral.

  This API gates the SAI clock. The SAI module can't operate unless SAI_TxInit or SAI_RxInit is called to enable the clock.

  Parameters

  - base – SAI base pointer.

void SAI_TxReset(I2S_Type *base)
: Resets the SAI Tx.

  This function enables the software reset and FIFO reset of SAI Tx. After reset, clear the reset bit.

Parameters

- base – SAI base pointer

void SAI_RxReset(I2S_Type *base)

Resets the SAI Rx.

This function enables the software reset and FIFO reset of SAI Rx. After reset, clear the reset bit.

Parameters

- base – SAI base pointer

void SAI_TxEnable(I2S_Type *base, bool enable)

Enables/disables the SAI Tx.

Parameters

- base – SAI base pointer.
- enable – True means enable SAI Tx, false means disable.

void SAI_RxEnable(I2S_Type *base, bool enable)

Enables/disables the SAI Rx.

Parameters

- base – SAI base pointer.
- enable – True means enable SAI Rx, false means disable.

static inline void SAI_TxSetBitClockDirection(I2S_Type *base, *sai_master_slave_t* masterSlave)

Set Rx bit clock direction.

Select bit clock direction, master or slave.

Parameters

- base – SAI base pointer.
- masterSlave – reference sai_master_slave_t.

static inline void SAI_RxSetBitClockDirection(I2S_Type *base, *sai_master_slave_t* masterSlave)

Set Rx bit clock direction.

Select bit clock direction, master or slave.

Parameters

- base – SAI base pointer.
- masterSlave – reference sai_master_slave_t.

static inline void SAI_RxSetFrameSyncDirection(I2S_Type *base, *sai_master_slave_t* masterSlave)

Set Rx frame sync direction.

Select frame sync direction, master or slave.

Parameters

- base – SAI base pointer.
- masterSlave – reference sai_master_slave_t.

static inline void SAI_TxSetFrameSyncDirection(I2S_Type *base, *sai_master_slave_t* masterSlave)

Set Tx frame sync direction.

Select frame sync direction, master or slave.

Parameters

- base – SAI base pointer.
- masterSlave – reference sai_master_slave_t.

void SAI_TxSetBitClockRate(I2S_Type *base, uint32_t sourceClockHz, uint32_t sampleRate, uint32_t bitWidth, uint32_t channelNumbers)

Transmitter bit clock rate configurations.

Parameters

- base – SAI base pointer.
- sourceClockHz – Bit clock source frequency.
- sampleRate – Audio data sample rate.
- bitWidth – Audio data bitWidth.
- channelNumbers – Audio channel numbers.

void SAI_RxSetBitClockRate(I2S_Type *base, uint32_t sourceClockHz, uint32_t sampleRate, uint32_t bitWidth, uint32_t channelNumbers)

Receiver bit clock rate configurations.

Parameters

- base – SAI base pointer.
- sourceClockHz – Bit clock source frequency.
- sampleRate – Audio data sample rate.
- bitWidth – Audio data bitWidth.
- channelNumbers – Audio channel numbers.

void SAI_TxSetBitclockConfig(I2S_Type *base, *sai_master_slave_t* masterSlave, *sai_bit_clock_t* *config)

Transmitter Bit clock configurations.

Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – bit clock other configurations, can be NULL in slave mode.

void SAI_RxSetBitclockConfig(I2S_Type *base, *sai_master_slave_t* masterSlave, *sai_bit_clock_t* *config)

Receiver Bit clock configurations.

Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – bit clock other configurations, can be NULL in slave mode.

void SAI_SetMasterClockConfig(I2S_Type *base, *sai_master_clock_t* *config)

Master clock configurations.

Parameters

- base – SAI base pointer.
- config – master clock configurations.

void SAI_TxSetFifoConfig(I2S_Type *base, *sai_fifo_t* *config)

SAI transmitter fifo configurations.

Parameters

- base – SAI base pointer.
- config – fifo configurations.

void SAI_RxSetFifoConfig(I2S_Type *base, *sai_fifo_t* *config)

SAI receiver fifo configurations.

Parameters

- base – SAI base pointer.
- config – fifo configurations.

void SAI_TxSetFrameSyncConfig(I2S_Type *base, *sai_master_slave_t* masterSlave, *sai_frame_sync_t* *config)

SAI transmitter Frame sync configurations.

Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – frame sync configurations, can be NULL in slave mode.

void SAI_RxSetFrameSyncConfig(I2S_Type *base, *sai_master_slave_t* masterSlave, *sai_frame_sync_t* *config)

SAI receiver Frame sync configurations.

Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – frame sync configurations, can be NULL in slave mode.

void SAI_TxSetSerialDataConfig(I2S_Type *base, *sai_serial_data_t* *config)

SAI transmitter Serial data configurations.

Parameters

- base – SAI base pointer.
- config – serial data configurations.

void SAI_RxSetSerialDataConfig(I2S_Type *base, *sai_serial_data_t* *config)

SAI receiver Serial data configurations.

Parameters

- base – SAI base pointer.
- config – serial data configurations.

void SAI_TxSetConfig(I2S_Type *base, *sai_transceiver_t* *config)

SAI transmitter configurations.

Parameters

- base – SAI base pointer.
- config – transmitter configurations.

void SAI_RxSetConfig(I2S_Type *base, *sai_transceiver_t* *config)

SAI receiver configurations.

Parameters

- base – SAI base pointer.
- config – receiver configurations.

void SAI_GetClassicI2SConfig(*sai_transceiver_t* *config, *sai_word_width_t* bitWidth, *sai_mono_stereo_t* mode, uint32_t saiChannelMask)

Get classic I2S mode configurations.

Parameters

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI_GetLeftJustifiedConfig(*sai_transceiver_t* *config, *sai_word_width_t* bitWidth, *sai_mono_stereo_t* mode, uint32_t saiChannelMask)

Get left justified mode configurations.

Parameters

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI_GetRightJustifiedConfig(*sai_transceiver_t* *config, *sai_word_width_t* bitWidth, *sai_mono_stereo_t* mode, uint32_t saiChannelMask)

Get right justified mode configurations.

Parameters

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI_GetTDMConfig(*sai_transceiver_t* *config, *sai_frame_sync_len_t* frameSyncWidth, *sai_word_width_t* bitWidth, uint32_t dataWordNum, uint32_t saiChannelMask)

Get TDM mode configurations.

Parameters

- config – transceiver configurations.
- frameSyncWidth – length of frame sync.
- bitWidth – audio data word width.
- dataWordNum – word number in one frame.
- saiChannelMask – mask value of the channel to be enable.

void SAI_GetDSPConfig(*sai_transceiver_t* *config, *sai_frame_sync_len_t* frameSyncWidth, *sai_word_width_t* bitWidth, *sai_mono_stereo_t* mode, uint32_t saiChannelMask)

Get DSP mode configurations.

DSP/PCM MODE B configuration flow for TX. RX is similiar but uses SAI_RxSetConfig instead of SAI_TxSetConfig:

```
SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth, kSAI_Stereo, channelMask)
SAI_TxSetConfig(base, config)
```

Note: DSP mode is also called PCM mode which support MODE A and MODE B, DSP/PCM MODE A configuration flow. RX is similiar but uses SAI_RxSetConfig instead of SAI_TxSetConfig:

```
SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth, kSAI_Stereo, channelMask)
config->frameSync.frameSyncEarly    = true;
SAI_TxSetConfig(base, config)
```

Parameters

- config – transceiver configurations.
- frameSyncWidth – length of frame sync.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to enable.

static inline uint32_t SAI_TxGetStatusFlag(I2S_Type *base)

Gets the SAI Tx status flag state.

Parameters

- base – SAI base pointer

Returns

SAI Tx status flag value. Use the Status Mask to get the status value needed.

static inline void SAI_TxClearStatusFlags(I2S_Type *base, uint32_t mask)

Clears the SAI Tx status flag state.

Parameters

- base – SAI base pointer
- mask – State mask. It can be a combination of the following source if defined:
  - kSAI_WordStartFlag
  - kSAI_SyncErrorFlag
  - kSAI_FIFOErrorFlag

static inline uint32_t SAI_RxGetStatusFlag(I2S_Type *base)

Gets the SAI Tx status flag state.

Parameters

- base – SAI base pointer

Returns

SAI Rx status flag value. Use the Status Mask to get the status value needed.

static inline void SAI_RxClearStatusFlags(I2S_Type *base, uint32_t mask)

Clears the SAI Rx status flag state.

Parameters

- base – SAI base pointer
- mask – State mask. It can be a combination of the following sources if defined.
  - kSAI_WordStartFlag
  - kSAI_SyncErrorFlag
  - kSAI_FIFOErrorFlag

void SAI_TxSoftwareReset(I2S_Type *base, *sai_reset_type_t* resetType)

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Tx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like TCR1~TCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

void SAI_RxSoftwareReset(I2S_Type *base, *sai_reset_type_t* resetType)

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Rx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like RCR1~RCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

void SAI_TxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)

Set the Tx channel FIFO enable mask.

Parameters

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

void SAI_RxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)

Set the Rx channel FIFO enable mask.

Parameters

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

void SAI_TxSetDataOrder(I2S_Type *base, *sai_data_order_t* order)

Set the Tx data order.

Parameters

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI_RxSetDataOrder(I2S_Type *base, *sai_data_order_t* order)

Set the Rx data order.

Parameters

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI_TxSetBitClockPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Tx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_RxSetBitClockPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Rx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_TxSetFrameSyncPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Tx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_RxSetFrameSyncPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Rx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_TxSetFIFOPacking(I2S_Type *base, *sai_fifo_packing_t* pack)

Set Tx FIFO packing feature.

Parameters

- base – SAI base pointer.
- pack – FIFO pack type. It is element of sai_fifo_packing_t.

void SAI_RxSetFIFOPacking(I2S_Type *base, *sai_fifo_packing_t* pack)

Set Rx FIFO packing feature.

Parameters

- base – SAI base pointer.
- pack – FIFO pack type. It is element of sai_fifo_packing_t.

static inline void SAI_TxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)

Set Tx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in TCSR register.

Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

static inline void SAI_RxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)

Set Rx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in RCSR register.

Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

static inline void SAI_TxEnableInterrupts(I2S_Type *base, uint32_t mask)

Enables the SAI Tx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI_WordStartInterruptEnable
  - kSAI_SyncErrorInterruptEnable
  - kSAI_FIFOWarningInterruptEnable
  - kSAI_FIFORequestInterruptEnable
  - kSAI_FIFOErrorInterruptEnable

static inline void SAI_RxEnableInterrupts(I2S_Type *base, uint32_t mask)

Enables the SAI Rx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI_WordStartInterruptEnable
  - kSAI_SyncErrorInterruptEnable
  - kSAI_FIFOWarningInterruptEnable
  - kSAI_FIFORequestInterruptEnable
  - kSAI_FIFOErrorInterruptEnable

static inline void SAI_TxDisableInterrupts(I2S_Type *base, uint32_t mask)

Disables the SAI Tx interrupt requests.

Parameters

- base – SAI base pointer

- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI_WordStartInterruptEnable
  - kSAI_SyncErrorInterruptEnable
  - kSAI_FIFOWarningInterruptEnable
  - kSAI_FIFORequestInterruptEnable
  - kSAI_FIFOErrorInterruptEnable

static inline void SAI_RxDisableInterrupts(I2S_Type *base, uint32_t mask)

Disables the SAI Rx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI_WordStartInterruptEnable
  - kSAI_SyncErrorInterruptEnable
  - kSAI_FIFOWarningInterruptEnable
  - kSAI_FIFORequestInterruptEnable
  - kSAI_FIFOErrorInterruptEnable

static inline void SAI_TxEnableDMA(I2S_Type *base, uint32_t mask, bool enable)

Enables/disables the SAI Tx DMA requests.

Parameters

- base – SAI base pointer
- mask – DMA source The parameter can be combination of the following sources if defined.
  - kSAI_FIFOWarningDMAEnable
  - kSAI_FIFORequestDMAEnable
- enable – True means enable DMA, false means disable DMA.

static inline void SAI_RxEnableDMA(I2S_Type *base, uint32_t mask, bool enable)

Enables/disables the SAI Rx DMA requests.

Parameters

- base – SAI base pointer
- mask – DMA source The parameter can be a combination of the following sources if defined.
  - kSAI_FIFOWarningDMAEnable
  - kSAI_FIFORequestDMAEnable
- enable – True means enable DMA, false means disable DMA.

static inline uintptr_t SAI_TxGetDataRegisterAddress(I2S_Type *base, uint32_t channel)

Gets the SAI Tx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

- base – SAI base pointer.

- channel – Which data channel used.

Returns
data register address.

static inline uintptr_t SAI_RxGetDataRegisterAddress(I2S_Type *base, uint32_t channel)

Gets the SAI Rx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

- base – SAI base pointer.
- channel – Which data channel used.

Returns
data register address.

void SAI_WriteBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer, uint32_t size)

Sends data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

void SAI_WriteMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask, uint32_t bitWidth, uint8_t *buffer, uint32_t size)

Sends data to multi channel using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

static inline void SAI_WriteData(I2S_Type *base, uint32_t channel, uint32_t data)

Writes data into SAI FIFO.

Parameters

- base – SAI base pointer.
- channel – Data channel used.

- data – Data needs to be written.

void SAI_ReadBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer, uint32_t size)

Receives data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

void SAI_ReadMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask, uint32_t bitWidth, uint8_t *buffer, uint32_t size)

Receives multi channel data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

static inline uint32_t SAI_ReadData(I2S_Type *base, uint32_t channel)

Reads data from the SAI FIFO.

Parameters

- base – SAI base pointer.
- channel – Data channel used.

Returns

Data in SAI FIFO.

void SAI_TransferTxCreateHandle(I2S_Type *base, *sai_handle_t* *handle, *sai_transfer_callback_t* callback, void *userData)

Initializes the SAI Tx handle.

This function initializes the Tx handle for the SAI Tx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SAI base pointer
- handle – SAI handle pointer.
- callback – Pointer to the user callback function.

- userData – User parameter passed to the callback function

void SAI_TransferRxCreateHandle(I2S_Type *base, *sai_handle_t* *handle, *sai_transfer_callback_t* callback, void *userData)

Initializes the SAI Rx handle.

This function initializes the Rx handle for the SAI Rx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

void SAI_TransferTxSetConfig(I2S_Type *base, *sai_handle_t* *handle, *sai_transceiver_t* *config)

SAI transmitter transfer configurations.

This function initializes the Tx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.
- config – tranmitter configurations.

void SAI_TransferRxSetConfig(I2S_Type *base, *sai_handle_t* *handle, *sai_transceiver_t* *config)

SAI receiver transfer configurations.

This function initializes the Rx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.
- config – receiver configurations.

status_t SAI_TransferSendNonBlocking(I2S_Type *base, *sai_handle_t* *handle, *sai_transfer_t* *xfer)

Performs an interrupt non-blocking send transfer on SAI.

Note: This API returns immediately after the transfer initiates. Call the SAI_TxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SAI_Busy, the transfer is finished.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- xfer – Pointer to the sai_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.

- kStatus_SAI_TxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SAI_TransferReceiveNonBlocking(I2S_Type *base, *sai_handle_t* *handle, *sai_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on SAI.

Note: This API returns immediately after the transfer initiates. Call the SAI_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SAI_Busy, the transfer is finished.

Parameters

- base – SAI base pointer
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- xfer – Pointer to the sai_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_SAI_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SAI_TransferGetSendCount(I2S_Type *base, *sai_handle_t* *handle, size_t *count)

Gets a set byte count.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- count – Bytes count sent.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

status_t SAI_TransferGetReceiveCount(I2S_Type *base, *sai_handle_t* *handle, size_t *count)

Gets a received byte count.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- count – Bytes count received.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void SAI_TransferAbortSend(I2S_Type *base, *sai_handle_t* *handle)

Aborts the current send.

Note: This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure which stores the transfer state.

void SAI_TransferAbortReceive(I2S_Type *base, *sai_handle_t* *handle)

Aborts the current IRQ receive.

Note: This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SAI base pointer
- handle – Pointer to the sai_handle_t structure which stores the transfer state.

void SAI_TransferTerminateSend(I2S_Type *base, *sai_handle_t* *handle)

Terminate all SAI send.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortSend.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferTerminateReceive(I2S_Type *base, *sai_handle_t* *handle)

Terminate all SAI receive.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortReceive.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferTxHandleIRQ(I2S_Type *base, *sai_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure.

void SAI_TransferRxHandleIRQ(I2S_Type *base, *sai_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – SAI base pointer.

- handle – Pointer to the sai_handle_t structure.

void SAI_DriverIRQHandler(uint32_t instance)

SAI driver IRQ handler common entry.

This function provides the common IRQ request entry for SAI.

Parameters

- instance – SAI instance.

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_sai_status_t, SAI return status.

Values:

enumerator kStatus_SAI_TxBusy
SAI Tx is busy.

enumerator kStatus_SAI_RxBusy
SAI Rx is busy.

enumerator kStatus_SAI_TxError
SAI Tx FIFO error.

enumerator kStatus_SAI_RxError
SAI Rx FIFO error.

enumerator kStatus_SAI_QueueFull
SAI transfer queue is full.

enumerator kStatus_SAI_TxIdle
SAI Tx is idle

enumerator kStatus_SAI_RxIdle
SAI Rx is idle

_sai_channel_mask,.sai channel mask value, actual channel numbers is depend soc specific

Values:

enumerator kSAI_Channel0Mask
channel 0 mask value

enumerator kSAI_Channel1Mask
channel 1 mask value

enumerator kSAI_Channel2Mask
channel 2 mask value

enumerator kSAI_Channel3Mask
channel 3 mask value

enumerator kSAI_Channel4Mask
channel 4 mask value

enumerator kSAI_Channel5Mask
channel 5 mask value

enumerator kSAI_Channel6Mask
channel 6 mask value

enumerator kSAI_Channel7Mask
channel 7 mask value

enum _sai_protocol
Define the SAI bus type.

Values:

enumerator kSAI_BusLeftJustified
Uses left justified format.

enumerator kSAI_BusRightJustified
Uses right justified format.

enumerator kSAI_BusI2S
Uses I2S format.

enumerator kSAI_BusPCMA
Uses I2S PCM A format.

enumerator kSAI_BusPCMB
Uses I2S PCM B format.

enum _sai_master_slave
Master or slave mode.

Values:

enumerator kSAI_Master
Master mode include bclk and frame sync

enumerator kSAI_Slave
Slave mode include bclk and frame sync

enumerator kSAI_Bclk_Master_FrameSync_Slave
bclk in master mode, frame sync in slave mode

enumerator kSAI_Bclk_Slave_FrameSync_Master
bclk in slave mode, frame sync in master mode

enum _sai_mono_stereo
Mono or stereo audio format.

Values:

enumerator kSAI_Stereo
Stereo sound.

enumerator kSAI_MonoRight
Only Right channel have sound.

enumerator kSAI_MonoLeft
Only left channel have sound.

enum _sai_data_order
SAI data order, MSB or LSB.

Values:

enumerator kSAI_DataLSB
LSB bit transferred first

enumerator kSAI_DataMSB
MSB bit transferred first

enum _sai_clock_polarity

SAI clock polarity, active high or low.

Values:

enumerator kSAI_PolarityActiveHigh

Drive outputs on rising edge

enumerator kSAI_PolarityActiveLow

Drive outputs on falling edge

enumerator kSAI_SampleOnFallingEdge

Sample inputs on falling edge

enumerator kSAI_SampleOnRisingEdge

Sample inputs on rising edge

enum _sai_sync_mode

Synchronous or asynchronous mode.

Values:

enumerator kSAI_ModeAsync

Asynchronous mode

enumerator kSAI_ModeSync

Synchronous mode (with receiver or transmit)

enumerator kSAI_ModeSyncWithOtherTx

Synchronous with another SAI transmit

enumerator kSAI_ModeSyncWithOtherRx

Synchronous with another SAI receiver

enum _sai_bclk_source

Bit clock source.

Values:

enumerator kSAI_BclkSourceBusclk

Bit clock using bus clock

enumerator kSAI_BclkSourceMclkOption1

Bit clock MCLK option 1

enumerator kSAI_BclkSourceMclkOption2

Bit clock MCLK option2

enumerator kSAI_BclkSourceMclkOption3

Bit clock MCLK option3

enumerator kSAI_BclkSourceMclkDiv

Bit clock using master clock divider

enumerator kSAI_BclkSourceOtherSai0

Bit clock from other SAI device

enumerator kSAI_BclkSourceOtherSai1

Bit clock from other SAI device

_sai_interrupt_enable_t, The SAI interrupt enable flag

Values:

enumerator kSAI_WordStartInterruptEnable
Word start flag, means the first word in a frame detected

enumerator kSAI_SyncErrorInterruptEnable
Sync error flag, means the sync error is detected

enumerator kSAI_FIFOWarningInterruptEnable
FIFO warning flag, means the FIFO is empty

enumerator kSAI_FIFOErrorInterruptEnable
FIFO error flag

enumerator kSAI_FIFORequestInterruptEnable
FIFO request, means reached watermark

_sai_dma_enable_t, The DMA request sources

Values:

enumerator kSAI_FIFOWarningDMAEnable
FIFO warning caused by the DMA request

enumerator kSAI_FIFORequestDMAEnable
FIFO request caused by the DMA request

_sai_flags, The SAI status flag

Values:

enumerator kSAI_WordStartFlag
Word start flag, means the first word in a frame detected

enumerator kSAI_SyncErrorFlag
Sync error flag, means the sync error is detected

enumerator kSAI_FIFOErrorFlag
FIFO error flag

enumerator kSAI_FIFORequestFlag
FIFO request flag.

enumerator kSAI_FIFOWarningFlag
FIFO warning flag

enum __sai_reset_type
The reset type.

Values:

enumerator kSAI_ResetTypeSoftware
Software reset, reset the logic state

enumerator kSAI_ResetTypeFIFO
FIFO reset, reset the FIFO read and write pointer

enumerator kSAI_ResetAll
All reset.

enum __sai_fifo_packing
The SAI packing mode The mode includes 8 bit and 16 bit packing.

Values:

enumerator kSAI_FifoPackingDisabled
Packing disabled

enumerator kSAI_FifoPacking8bit
8 bit packing enabled

enumerator kSAI_FifoPacking16bit
16bit packing enabled

enum _sai_sample_rate
Audio sample rate.

Values:

enumerator kSAI_SampleRate8KHz
Sample rate 8000 Hz

enumerator kSAI_SampleRate11025Hz
Sample rate 11025 Hz

enumerator kSAI_SampleRate12KHz
Sample rate 12000 Hz

enumerator kSAI_SampleRate16KHz
Sample rate 16000 Hz

enumerator kSAI_SampleRate22050Hz
Sample rate 22050 Hz

enumerator kSAI_SampleRate24KHz
Sample rate 24000 Hz

enumerator kSAI_SampleRate32KHz
Sample rate 32000 Hz

enumerator kSAI_SampleRate44100Hz
Sample rate 44100 Hz

enumerator kSAI_SampleRate48KHz
Sample rate 48000 Hz

enumerator kSAI_SampleRate96KHz
Sample rate 96000 Hz

enumerator kSAI_SampleRate192KHz
Sample rate 192000 Hz

enumerator kSAI_SampleRate384KHz
Sample rate 384000 Hz

enum _sai_word_width
Audio word width.

Values:

enumerator kSAI_WordWidth8bits
Audio data width 8 bits

enumerator kSAI_WordWidth16bits
Audio data width 16 bits

enumerator kSAI_WordWidth24bits
Audio data width 24 bits

enumerator kSAI_WordWidth32bits
Audio data width 32 bits

enum _sai_data_pin_state
sai data pin state definition

Values:

enumerator kSAI_DataPinStateTriState
transmit data pins are tri-stated when slots are masked or channels are disabled

enumerator kSAI_DataPinStateOutputZero
transmit data pins are never tri-stated and will output zero when slots are masked or channel disabled

enum _sai_fifo_combine
sai fifo combine mode definition

Values:

enumerator kSAI_FifoCombineDisabled
sai TX/RX fifo combine mode disabled

enumerator kSAI_FifoCombineModeEnabledOnRead
sai TX fifo combine mode enabled on FIFO reads

enumerator kSAI_FifoCombineModeEnabledOnWrite
sai TX fifo combine mode enabled on FIFO write

enumerator kSAI_RxFifoCombineModeEnabledOnWrite
sai RX fifo combine mode enabled on FIFO write

enumerator kSAI_RXFifoCombineModeEnabledOnRead
sai RX fifo combine mode enabled on FIFO reads

enumerator kSAI_FifoCombineModeEnabledOnReadWrite
sai TX/RX fifo combined mode enabled on FIFO read/writes

enum _sai_transceiver_type
sai transceiver type

Values:

enumerator kSAI_Transmitter
sai transmitter

enumerator kSAI_Receiver
sai receiver

enum _sai_frame_sync_len
sai frame sync len

Values:

enumerator kSAI_FrameSyncLenOneBitClk
1 bit clock frame sync len for DSP mode

enumerator kSAI_FrameSyncLenPerWordWidth
Frame sync length decided by word width

typedef enum *_sai_protocol* sai_protocol_t
Define the SAI bus type.

typedef enum *_sai_master_slave* sai_master_slave_t
Master or slave mode.

typedef enum *_sai_mono_stereo* sai_mono_stereo_t
Mono or stereo audio format.

typedef enum *_sai_data_order* sai_data_order_t
SAI data order, MSB or LSB.

typedef enum *_sai_clock_polarity* sai_clock_polarity_t
SAI clock polarity, active high or low.

typedef enum *_sai_sync_mode* sai_sync_mode_t
Synchronous or asynchronous mode.

typedef enum *_sai_bclk_source* sai_bclk_source_t
Bit clock source.

typedef enum *_sai_reset_type* sai_reset_type_t
The reset type.

typedef enum *_sai_fifo_packing* sai_fifo_packing_t
The SAI packing mode The mode includes 8 bit and 16 bit packing.

typedef struct *_sai_config* sai_config_t
SAI user configuration structure.

typedef enum *_sai_sample_rate* sai_sample_rate_t
Audio sample rate.

typedef enum *_sai_word_width* sai_word_width_t
Audio word width.

typedef enum *_sai_data_pin_state* sai_data_pin_state_t
sai data pin state definition

typedef enum *_sai_fifo_combine* sai_fifo_combine_t
sai fifo combine mode definition

typedef enum *_sai_transceiver_type* sai_transceiver_type_t
sai transceiver type

typedef enum *_sai_frame_sync_len* sai_frame_sync_len_t
sai frame sync len

typedef struct *_sai_transfer_format* sai_transfer_format_t
sai transfer format

typedef struct *_sai_master_clock* sai_master_clock_t
master clock configurations

typedef struct *_sai_fifo* sai_fifo_t
sai fifo configurations

typedef struct *_sai_bit_clock* sai_bit_clock_t
sai bit clock configurations

typedef struct *_sai_frame_sync* sai_frame_sync_t
sai frame sync configurations

typedef struct *_sai_serial_data* sai_serial_data_t
sai serial data configurations

typedef struct *_sai_transceiver* sai_transceiver_t
sai transceiver configurations

typedef struct *_sai_transfer* sai_transfer_t
SAI transfer structure.

typedef struct *_sai_handle* sai_handle_t

typedef void (*sai_transfer_callback_t)(I2S_Type *base, *sai_handle_t* *handle, *status_t* status, void *userData)
SAI transfer callback prototype.

SAI_XFER_QUEUE_SIZE
SAI transfer queue size, user can refine it according to use case.

FSL_SAI_HAS_FIFO_EXTEND_FEATURE
sai fifo feature

struct _sai_config
#include <fsl_sai.h> SAI user configuration structure.

Public Members

sai_protocol_t protocol
Audio bus protocol in SAI

sai_sync_mode_t syncMode
SAI sync mode, control Tx/Rx clock sync

bool mclkOutputEnable
Master clock output enable, true means master clock divider enabled

sai_bclk_source_t bclkSource
Bit Clock source

sai_master_slave_t masterSlave
Master or slave

struct _sai_transfer_format
#include <fsl_sai.h> sai transfer format

Public Members

uint32_t sampleRate_Hz
Sample rate of audio data

uint32_t bitWidth
Data length of audio data, usually 8/16/24/32 bits

sai_mono_stereo_t stereo
Mono or stereo

uint32_t masterClockHz
Master clock frequency in Hz

uint8_t watermark
Watermark value

uint8_t channel
Transfer start channel

uint8_t channelMask
: enabled channel mask value, reference _sai_channel_mask

uint8_t endChannel
: end channel number

uint8_t channelNums
: Total enabled channel numbers

sai_protocol_t protocol
: Which audio protocol used

bool isFrameSyncCompact
: True means Frame sync length is configurable according to bitWidth, false means frame sync length is 64 times of bit clock.

struct __sai__master__clock
: *#include <fsl_sai.h>* master clock configurations

Public Members

bool mclkOutputEnable
: master clock output enable

uint32_t mclkHz
: target mclk frequency

uint32_t mclkSourceClkHz
: mclk source frequency

struct __sai__fifo
: *#include <fsl_sai.h>* sai fifo configurations

Public Members

bool fifoContinueOneError
: fifo continues when error occur

sai_fifo_combine_t fifoCombine
: fifo combine mode

sai_fifo_packing_t fifoPacking
: fifo packing mode

uint8_t fifoWatermark
: fifo watermark

struct __sai__bit__clock
: *#include <fsl_sai.h>* sai bit clock configurations

Public Members

bool bclkInputDelay
: bit clock actually used by the transmitter is delayed by the pad output delay, this has effect of decreasing the data input setup time, but increasing the data output valid time .

sai_clock_polarity_t bclkPolarity
bit clock polarity

sai_bclk_source_t bclkSource
bit Clock source

struct __sai__frame__sync
#include <fsl_sai.h> sai frame sync configurations

Public Members

uint8_t frameSyncWidth
frame sync width in number of bit clocks

bool frameSyncEarly
TRUE is frame sync assert one bit before the first bit of frame FALSE is frame sync assert with the first bit of the frame

bool frameSyncGenerateOnDemand
internal frame sync is generated when FIFO waring flag is clear

sai_clock_polarity_t frameSyncPolarity
frame sync polarity

struct __sai__serial__data
#include <fsl_sai.h> sai serial data configurations

Public Members

sai_data_pin_state_t dataMode
sai data pin state when slots masked or channel disabled

sai_data_order_t dataOrder
configure whether the LSB or MSB is transmitted first

uint8_t dataWord0Length
configure the number of bits in the first word in each frame

uint8_t dataWordNLength
configure the number of bits in the each word in each frame, except the first word

uint8_t dataWordLength
used to record the data length for dma transfer

uint8_t dataFirstBitShifted
Configure the bit index for the first bit transmitted for each word in the frame

uint8_t dataWordNum
configure the number of words in each frame

uint32_t dataMaskedWord
configure whether the transmit word is masked

struct __sai__transceiver
#include <fsl_sai.h> sai transceiver configurations

Public Members

sai_serial_data_t serialData
: serial data configurations

sai_frame_sync_t frameSync
: ws configurations

sai_bit_clock_t bitClock
: bit clock configurations

sai_fifo_t fifo
: fifo configurations

sai_master_slave_t masterSlave
: transceiver is master or slave

sai_sync_mode_t syncMode
: transceiver sync mode

uint8_t startChannel
: Transfer start channel

uint8_t channelMask
: enabled channel mask value, reference _sai_channel_mask

uint8_t endChannel
: end channel number

uint8_t channelNums
: Total enabled channel numbers

struct __sai__transfer
: *#include <fsl_sai.h>* SAI transfer structure.

Public Members

uint8_t *data
: Data start address to transfer.

size_t dataSize
: Transfer size.

struct __sai__handle
: *#include <fsl_sai.h>* SAI handle structure.

Public Members

I2S_Type *base
: base address

uint32_t state
: Transfer status

sai_transfer_callback_t callback
: Callback function called at transfer event

void *userData
: Callback parameter passed to callback function

uint8_t bitWidth
: Bit width for transfer, 8/16/24/32 bits

uint8_t channel
: Transfer start channel

uint8_t channelMask
: enabled channel mask value, refernece _sai_channel_mask

uint8_t endChannel
: end channel number

uint8_t channelNums
: Total enabled channel numbers

sai_transfer_t saiQueue[(4U)]
: Transfer queue storing queued transfer

size_t transferSize[(4U)]
: Data bytes need to transfer

volatile uint8_t queueUser
: Index for user to queue transfer

volatile uint8_t queueDriver
: Index for driver to get the transfer data and size

uint8_t watermark
: Watermark value

2.105 SAI EDMA Driver

void SAI_TransferTxCreateHandleEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_edma_callback_t* callback, void *userData, *edma_handle_t* *txDmaHandle)

Initializes the SAI eDMA handle.

This function initializes the SAI master DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- txDmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

void SAI_TransferRxCreateHandleEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_edma_callback_t* callback, void *userData, *edma_handle_t* *rxDmaHandle)

Initializes the SAI Rx eDMA handle.

This function initializes the SAI slave DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- rxDmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

void SAI_TransferSetInterleaveType(*sai_edma_handle_t* *handle, *sai_edma_interleave_t* interleaveType)

Initializes the SAI interleave type.

This function initializes the SAI DMA handle member interleaveType, it shall be called only when application would like to use type kSAI_EDMAInterleavePerChannelBlock, since the default interleaveType is kSAI_EDMAInterleavePerChannelSample always

Parameters

- handle – SAI eDMA handle pointer.
- interleaveType – Multi channel interleave type.

void SAI_TransferTxSetConfigEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transceiver_t* *saiConfig)

Configures the SAI Tx.

Note: SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of sai_transceiver_t with the corresponding values of _sai_channel_mask enum, enable the FIFO Combine mode by assigning kSAI_FifoCombineModeEnabledOnWrite to the fifoCombine member of sai_fifo_combine_t which is a member of sai_transceiver_t. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_
↪Channel1Mask);
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnWrite;
SAI_TransferTxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

void SAI_TransferRxSetConfigEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transceiver_t* *saiConfig)

Configures the SAI Rx.

Note: SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of sai_transceiver_t with the corresponding values of _sai_channel_mask enum, enable the FIFO Combine mode by assigning kSAI_FifoCombineModeEnabledOnRead to the fifoCombine member of sai_fifo_combine_t

which is a member of sai_transceiver_t. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_
↪Channel1Mask);
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnRead;
SAI_TransferRxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

status_t SAI_TransferSendEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transfer_t* *xfer)

Performs a non-blocking SAI transfer using DMA.

This function support multi channel transfer,

a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Note: This interface returns immediately after the transfer initiates. Call SAI_GetTransferStatus to poll the transfer status and check whether the SAI transfer is finished.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- kStatus_Success – Start a SAI eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_TxBusy – SAI is busy sending data.

status_t SAI_TransferReceiveEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transfer_t* *xfer)

Performs a non-blocking SAI receive using eDMA.

This function support multi channel transfer,

a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Note: This interface returns immediately after the transfer initiates. Call the SAI_GetReceiveRemainingBytes to poll the transfer status and check whether the SAI transfer is finished.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a SAI eDMA receive successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_RxBusy – SAI is busy receiving data.

status_t SAI_TransferSendLoopEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transfer_t* *xfer, uint32_t loopTransferCount)

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function SAI_TransferAbortSendEDMA to stop the loop transfer.

Note: This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in sai_edma_handle_t, so application could redefine the SAI_XFER_QUEUE_SIZE to determine the proper TCD pool size. This function support one sai channel only.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure, should be a array with elements counts >=1(loopTransferCount).
- loopTransferCount – the counts of xfer array.

Return values

- kStatus_Success – Start a SAI eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.

status_t SAI_TransferReceiveLoopEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transfer_t* *xfer, uint32_t loopTransferCount)

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function SAI_TransferAbortReceiveEDMA to stop the loop transfer.

Note: This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required,

as the function use the tcd pool in sai_edma_handle_t, so application could redefine the SAI_XFER_QUEUE_SIZE to determine the proper TCD pool size. This function support one sai channel only.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure, should be a array with elements counts >=1(loopTransferCount).
- loopTransferCount – the counts of xfer array.

Return values

- kStatus_Success – Start a SAI eDMA receive successfully.
- kStatus_InvalidArgument – The input argument is invalid.

void SAI_TransferTerminateSendEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Terminate all SAI send.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortSendEDMA.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferTerminateReceiveEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Terminate all SAI receive.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortReceiveEDMA.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferAbortSendEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Aborts a SAI transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call SAI_TransferTerminateSendEDMA.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferAbortReceiveEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Aborts a SAI receive using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call SAI_TransferTerminateReceiveEDMA.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.

status_t SAI_TransferGetSendCountEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, size_t *count)

Gets byte count sent by SAI.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- count – Bytes count sent by SAI.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

status_t SAI_TransferGetReceiveCountEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, size_t *count)

Gets byte count received by SAI.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.
- count – Bytes count received by SAI.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

uint32_t SAI_TransferGetValidTransferSlotsEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Gets valid transfer slot.

This function can be used to query the valid transfer request slot that the application can submit. It should be called in the critical section, that means the application could call it in the corresponding callback function or disable IRQ before calling it in the application, otherwise, the returned value may not correct.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.

Return values

valid – slot count that application submit.

FSL_SAI_EDMA_DRIVER_VERSION

Version 2.7.3

enum _sai_edma_interleave

sai interleave type

Values:

enumerator kSAI_EDMAInterleavePerChannelSample

enumerator kSAI_EDMAInterleavePerChannelBlock

typedef struct *sai_edma_handle* sai_edma_handle_t

typedef void (*sai_edma_callback_t)(I2S_Type *base, *sai_edma_handle_t* *handle, *status_t* status, void *userData)

SAI eDMA transfer callback function for finish and error.

typedef enum *_sai_edma_interleave* sai_edma_interleave_t

sai interleave type

MCUX_SDK_SAI_EDMA_RX_ENABLE_INTERNAL

the SAI enable position When calling SAI_TransferReceiveEDMA

MCUX_SDK_SAI_EDMA_TX_ENABLE_INTERNAL

the SAI enable position When calling SAI_TransferSendEDMA

struct sai_edma_handle

#include <fsl_sai_edma.h> SAI DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaHandle

DMA handler for SAI send

uint8_t nbytes

eDMA minor byte transfer count initially configured.

uint8_t bytesPerFrame

Bytes in a frame

uint8_t channelMask

Enabled channel mask value, reference _sai_channel_mask

uint8_t channelNums

total enabled channel nums

uint8_t channel

Which data channel

uint8_t count

The transfer data count in a DMA request

uint32_t state

Internal state for SAI eDMA transfer

sai_edma_callback_t callback

Callback for users while transfer finish or error occurs

void *userData

User callback parameter

uint8_t tcd[((4U) + 1U) * sizeof(*edma_tcd_t*)]

TCD pool for eDMA transfer.

sai_transfer_t saiQueue[(4U)]

Transfer queue storing queued transfer.

size_t transferSize[(4U)]

Data bytes need to transfer

sai_edma_interleave_t interleaveType

Transfer interleave type

volatile uint8_t queueUser

Index for user to queue transfer.

volatile uint8_t queueDriver

Index for driver to get the transfer data and size

2.106 SEMA4: Hardware Semaphores Driver

FSL_SEMA4_DRIVER_VERSION

SEMA4 driver version.

void SEMA4_Init(SEMA4_Type *base)

Initializes the SEMA4 module.

This function initializes the SEMA4 module. It only enables the clock but does not reset the gates because the module might be used by other processors at the same time. To reset the gates, call either SEMA4_ResetGate or SEMA4_ResetAllGates function.

Parameters

- base – SEMA4 peripheral base address.

void SEMA4_Deinit(SEMA4_Type *base)

De-initializes the SEMA4 module.

This function de-initializes the SEMA4 module. It only disables the clock.

Parameters

- base – SEMA4 peripheral base address.

status_t SEMA4_TryLock(SEMA4_Type *base, uint8_t gateNum, uint8_t procNum)

Tries to lock the SEMA4 gate.

This function tries to lock the specific SEMA4 gate. If the gate has been locked by another processor, this function returns an error code.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number to lock.
- procNum – Current processor number.

Return values

- kStatus_Success – Lock the sema4 gate successfully.
- kStatus_Fail – Sema4 gate has been locked by another processor.

status_t SEMA4_Lock(SEMA4_Type *base, uint8_t gateNum, uint8_t procNum)

Locks the SEMA4 gate.

This function locks the specific SEMA4 gate. If the gate has been locked by other processors, this function waits until it is unlocked and then lock it.

If SEMA4_BUSY_POLL_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus_Timeout.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number to lock.
- procNum – Current processor number.

Return values

- kStatus_Success – The gate was successfully locked.
- kStatus_Timeout – Timeout occurred while waiting for the gate to be unlocked.

Returns
status_t

static inline void SEMA4_Unlock(SEMA4_Type *base, uint8_t gateNum)

Unlocks the SEMA4 gate.

This function unlocks the specific SEMA4 gate. It only writes unlock value to the SEMA4 gate register. However, it does not check whether the SEMA4 gate is locked by the current processor or not. As a result, if the SEMA4 gate is not locked by the current processor, this function has no effect.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number to unlock.

static inline int32_t SEMA4_GetLockProc(SEMA4_Type *base, uint8_t gateNum)

Gets the status of the SEMA4 gate.

This function checks the lock status of a specific SEMA4 gate.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number.

Returns
Return -1 if the gate is unlocked, otherwise return the processor number which has locked the gate.

status_t SEMA4_ResetGate(SEMA4_Type *base, uint8_t gateNum)

Resets the SEMA4 gate to an unlocked status.

This function resets a SEMA4 gate to an unlocked status.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number.

Return values

- kStatus_Success – SEMA4 gate is reset successfully.
- kStatus_Fail – Some other reset process is ongoing.

static inline *status_t* SEMA4_ResetAllGates(SEMA4_Type *base)

Resets all SEMA4 gates to an unlocked status.

This function resets all SEMA4 gate to an unlocked status.

Parameters

- base – SEMA4 peripheral base address.

Return values

- kStatus_Success – SEMA4 is reset successfully.
- kStatus_Fail – Some other reset process is ongoing.

static inline void SEMA4_EnableGateNotifyInterrupt(SEMA4_Type *base, uint8_t procNum, uint16_t mask)

Enable the gate notification interrupt.

Gate notification provides such feature, when core tried to lock the gate and failed, it could get notification when the gate is idle.

Parameters

- base – SEMA4 peripheral base address.
- procNum – Current processor number.
- mask – OR'ed value of the gate index, for example: (1«0) | (1«1) means gate 0 and gate 1.

static inline void SEMA4_DisableGateNotifyInterrupt(SEMA4_Type *base, uint8_t procNum, uint16_t mask)

Disable the gate notification interrupt.

Gate notification provides such feature, when core tried to lock the gate and failed, it could get notification when the gate is idle.

Parameters

- base – SEMA4 peripheral base address.
- procNum – Current processor number.
- mask – OR'ed value of the gate index, for example: (1«0) | (1«1) means gate 0 and gate 1.

static inline uint32_t SEMA4_GetGateNotifyStatus(SEMA4_Type *base, uint8_t procNum)

Get the gate notification flags.

Gate notification provides such feature, when core tried to lock the gate and failed, it could get notification when the gate is idle. The status flags are cleared automatically when the gate is locked by current core or locked again before the other core.

Parameters

- base – SEMA4 peripheral base address.
- procNum – Current processor number.

Returns

OR'ed value of the gate index, for example: (1«0) | (1«1) means gate 0 and gate 1 flags are pending.

status_t SEMA4_ResetGateNotify(SEMA4_Type *base, uint8_t gateNum)

Resets the SEMA4 gate IRQ notification.

This function resets a SEMA4 gate IRQ notification.

Parameters

- base – SEMA4 peripheral base address.
- gateNum – Gate number.

Return values

- kStatus_Success – Reset successfully.
- kStatus_Fail – Some other reset process is ongoing.

static inline *status_t* SEMA4_ResetAllGateNotify(SEMA4_Type *base)

Resets all SEMA4 gates IRQ notification.

This function resets all SEMA4 gate IRQ notifications.

Parameters

- base – SEMA4 peripheral base address.

Return values

- kStatus_Success – Reset successfully.
- kStatus_Fail – Some other reset process is ongoing.

SEMA4_GATE_NUM_RESET_ALL

The number to reset all SEMA4 gates.

SEMA4_GATEn(base, n)

SEMA4 gate n register address.

SEMA4_BUSY_POLL_COUNT

Maximum polling iterations for SEMA4 waiting loops.

This parameter defines the maximum number of iterations for any polling loop in the SEMA4 driver code before timing out and returning an error.

It applies to all waiting loops in SEMA4 driver, such as waiting for a gate to be unlocked, waiting for a reset to complete, or waiting for a resource to become available.

This is a count of loop iterations, not a time-based value.

If defined as 0, polling loops will continue indefinitely until their exit condition is met, which could potentially cause the system to hang if hardware doesn't respond or if a resource is never released.

2.107 SEMC: Smart External DRAM Controller Driver

void SEMC_GetDefaultConfig(*semc_config_t* *config)

Gets the SEMC default basic configuration structure.

The purpose of this API is to get the default SEMC configure structure for SEMC_Init(). User may use the initialized structure unchanged in SEMC_Init(), or modify some fields of the structure before calling SEMC_Init(). Example:

```
semc_config_t config;
SEMC_GetDefaultConfig(&config);
```

Parameters

- config – The SEMC configuration structure pointer.

void SEMC_Init(SEMC_Type *base, *semc_config_t* *configure)

Initializes SEMC. This function ungates the SEMC clock and initializes SEMC. This function must be called before calling any other SEMC driver functions.

Parameters

- base – SEMC peripheral base address.
- configure – The SEMC configuration structure pointer.

void SEMC_Deinit(SEMC_Type *base)

Deinitializes the SEMC module and gates the clock.

This function gates the SEMC clock. As a result, the SEMC module doesn't work after calling this function, for some IDE, calling this API may cause the next downloading operation failed. so, please call this API cautiously. Additional, users can using "#define

FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL (1)" to disable the clock control operation in drivers.

Parameters

- base – SEMC peripheral base address.

status_t SEMC_ConfigureSDRAM(SEMC_Type *base, *semc_sdram_cs_t* cs, *semc_sdram_config_t* *config, uint32_t clkSrc_Hz)

Configures SDRAM controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- cs – The chip selection.
- config – The sdram configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureNAND(SEMC_Type *base, *semc_nand_config_t* *config, uint32_t clkSrc_Hz)

Configures NAND controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- config – The nand configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureNOR(SEMC_Type *base, *semc_nor_config_t* *config, uint32_t clkSrc_Hz)

Configures NOR controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- config – The nor configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureSRAMWithChipSelection(SEMC_Type *base, *semc_sram_cs_t* cs, *semc_sram_config_t* *config, uint32_t clkSrc_Hz)

Configures SRAM controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- cs – The chip selection.
- config – The sram configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureSRAM(SEMC_Type *base, *semc_sram_config_t* *config, uint32_t clkSrc_Hz)

Configures SRAM controller in SEMC.

Deprecated:

Do not use this function. It has been superceded by SEMC_ConfigureSRAMWithChipSelection.

Parameters

- base – SEMC peripheral base address.
- config – The sram configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureDBI(SEMC_Type *base, *semc_dbi_config_t* *config, uint32_t clkSrc_Hz)

Configures DBI controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- config – The dbi configuration.
- clkSrc_Hz – The SEMC clock frequency.

static inline void SEMC_EnableInterrupts(SEMC_Type *base, uint32_t mask)

Enables the SEMC interrupt.

This function enables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See semc_interrupt_enable_t. For example, to enable the IP command done and error interrupt, do the following.

```
SEMC_EnableInterrupts(ENET, kSEMC_IPCmdDoneInterrupt | kSEMC_IPCmdErrInterrupt);
```

Parameters

- base – SEMC peripheral base address.
- mask – SEMC interrupts to enable. This is a logical OR of the enumeration :: semc_interrupt_enable_t.

static inline void SEMC_DisableInterrupts(SEMC_Type *base, uint32_t mask)

Disables the SEMC interrupt.

This function disables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See semc_interrupt_enable_t. For example, to disable the IP command done and error interrupt, do the following.

```
SEMC_DisableInterrupts(ENET, kSEMC_IPCmdDoneInterrupt | kSEMC_IPCmdErrInterrupt);
```

Parameters

- base – SEMC peripheral base address.
- mask – SEMC interrupts to disable. This is a logical OR of the enumeration :: semc_interrupt_enable_t.

static inline bool SEMC_GetStatusFlag(SEMC_Type *base)

Gets the SEMC status.

This function gets the SEMC interrupts event status. User can use the a logical OR of enumeration member as a mask. See semc_interrupt_enable_t.

Parameters

- base – SEMC peripheral base address.

Returns

status flag, use status flag in semc_interrupt_enable_t to get the related status.

static inline void SEMC_ClearStatusFlags(SEMC_Type *base, uint32_t mask)

Clears the SEMC status flag state.

The following status register flags can be cleared SEMC interrupt status.

Parameters

- base – SEMC base pointer
- mask – The status flag mask, a logical OR of enumeration member semc_interrupt_enable_t.

static inline bool SEMC_IsInIdle(SEMC_Type *base)

Check if SEMC is in idle.

Parameters

- base – SEMC peripheral base address.

Returns

True SEMC is in idle, false is not in idle.

status_t SEMC_SendIPCommand(SEMC_Type *base, *semc_mem_type_t* memType, uint32_t address, uint32_t command, uint32_t write, uint32_t *read)

SEMC IP command access.

Parameters

- base – SEMC peripheral base address.
- memType – SEMC memory type. refer to "semc_mem_type_t"
- address – SEMC device address.
- command – SEMC IP command. For NAND device, we should use the SEMC_BuildNandIPCommand to get the right nand command. For NOR/DBI device, take refer to "semc_ipcmd_nor_dbi_t". For SRAM device, take refer to "semc_ipcmd_sram_t". For SDRAM device, take refer to "semc_ipcmd_sdram_t".
- write – Data for write access.
- read – Data pointer for read data out.

static inline uint16_t SEMC_BuildNandIPCommand(uint8_t userCommand, *semc_ipcmd_nand_addrmode_t* addrMode, *semc_ipcmd_nand_cmdmode_t* cmdMode)

Build SEMC IP command for NAND.

This function build SEMC NAND IP command. The command is build of user command code, SEMC address mode and SEMC command mode.

Parameters

- userCommand – NAND device normal command.
- addrMode – NAND address mode. Refer to "semc_ipcmd_nand_addrmode_t".
- cmdMode – NAND command mode. Refer to "semc_ipcmd_nand_cmdmode_t".

static inline bool SEMC_IsNandReady(SEMC_Type *base)

Check if the NAND device is ready.

Parameters

- base – SEMC peripheral base address.

Returns

True NAND is ready, false NAND is not ready.

status_t SEMC_IPCommandNandWrite(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)

SEMC NAND device memory write through IP command.

Parameters

- base – SEMC peripheral base address.
- address – SEMC NAND device address.
- data – Data for write access.
- size_bytes – Data length.

status_t SEMC_IPCommandNandRead(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)

SEMC NAND device memory read through IP command.

Parameters

- base – SEMC peripheral base address.
- address – SEMC NAND device address.
- data – Data pointer for data read out.
- size_bytes – Data length.

status_t SEMC_IPCommandNorWrite(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)

SEMC NOR device memory write through IP command.

Parameters

- base – SEMC peripheral base address.
- address – SEMC NOR device address.
- data – Data for write access.
- size_bytes – Data length.

status_t SEMC_IPCommandNorRead(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)

SEMC NOR device memory read through IP command.

Parameters

- base – SEMC peripheral base address.
- address – SEMC NOR device address.
- data – Data pointer for data read out.
- size_bytes – Data length.

FSL_SEMC_DRIVER_VERSION

SEMC driver version.

SEMC status, _semc_status.

Values:

enumerator kStatus_SEMC_InvalidDeviceType

Invalid device type.

enumerator kStatus_SEMC_IpCommandExecutionError

IP command execution error.

enumerator kStatus_SEMC_AxiCommandExecutionError

AXI command execution error.

enumerator kStatus_SEMC_InvalidMemorySize
Invalid memory sie.

enumerator kStatus_SEMC_InvalidIpcmdDataSize
Invalid IP command data size.

enumerator kStatus_SEMC_InvalidAddressPortWidth
Invalid address port width.

enumerator kStatus_SEMC_InvalidDataPortWidth
Invalid data port width.

enumerator kStatus_SEMC_InvalidSwPinmuxSelection
Invalid SW pinmux selection.

enumerator kStatus_SEMC_InvalidBurstLength
Invalid burst length

enumerator kStatus_SEMC_InvalidColumnAddressBitWidth
Invalid column address bit width.

enumerator kStatus_SEMC_InvalidBaseAddress
Invalid base address.

enumerator kStatus_SEMC_InvalidTimerSetting
Invalid timer setting.

enum _semc_mem_type
SEMC memory device type.

Values:

enumerator kSEMC_MemType_SDRAM
SDRAM

enumerator kSEMC_MemType_SRAM
SRAM

enumerator kSEMC_MemType_NOR
NOR

enumerator kSEMC_MemType_NAND
NAND

enumerator kSEMC_MemType_8080

i.

enum _semc_waitready_polarity
SEMC WAIT/RDY polarity.

Values:

enumerator kSEMC_LowActive
Low active.

enumerator kSEMC_HighActive
High active.

enum _semc_sdram_cs
SEMC SDRAM Chip selection .

Values:

enumerator kSEMC_SDRAM_CS0
SEMC SDRAM CS0.

enumerator kSEMC_SDRAM_CS1
SEMC SDRAM CS1.

enumerator kSEMC_SDRAM_CS2
SEMC SDRAM CS2.

enumerator kSEMC_SDRAM_CS3
SEMC SDRAM CS3.

enum _semc_sram_cs
SEMC SRAM Chip selection .

Values:

enumerator kSEMC_SRAM_CS0
SEMC SRAM CS0.

enum _semc_nand_access_type
SEMC NAND device type.

Values:

enumerator kSEMC_NAND_ACCESS_BY_AXI
Access to NAND flash by AXI bus.

enumerator kSEMC_NAND_ACCESS_BY_IPCMD
Access to NAND flash by IP bus.

enum _semc_interrupt_enable
SEMC interrupts .

Values:

enumerator kSEMC_IPCmdDoneInterrupt
Ip command done interrupt.

enumerator kSEMC_IPCmdErrInterrupt
Ip command error interrupt.

enumerator kSEMC_AXICmdErrInterrupt
AXI command error interrupt.

enumerator kSEMC_AXIBusErrInterrupt
AXI bus error interrupt.

enum _semc_ipcmd_datasize
SEMC IP command data size in bytes.

Values:

enumerator kSEMC_IPcmdDataSize_1bytes
The IP command data size 1 byte.

enumerator kSEMC_IPcmdDataSize_2bytes
The IP command data size 2 byte.

enumerator kSEMC_IPcmdDataSize_3bytes
The IP command data size 3 byte.

enumerator kSEMC_IPcmdDataSize_4bytes
The IP command data size 4 byte.

enum _semc_refresh_time

SEMC auto-refresh timing.

Values:

enumerator kSEMC_RefreshThreeClocks

The refresh timing with three bus clocks.

enumerator kSEMC_RefreshSixClocks

The refresh timing with six bus clocks.

enumerator kSEMC_RefreshNineClocks

The refresh timing with nine bus clocks.

enum _semc_caslatency

CAS latency.

Values:

enumerator kSEMC_LatencyOne

Latency 1.

enumerator kSEMC_LatencyTwo

Latency 2.

enumerator kSEMC_LatencyThree

Latency 3.

enum _semc_sdram_column_bit_num

SEMC sdram column address bit number.

Values:

enumerator kSEMC_SdramColunm_12bit

12 bit.

enumerator kSEMC_SdramColunm_11bit

11 bit.

enumerator kSEMC_SdramColunm_10bit

10 bit.

enumerator kSEMC_SdramColunm_9bit

9 bit.

enumerator kSEMC_SdramColunm_8bit

8 bit.

enum _semc_sdram_burst_len

SEMC sdram burst length.

Values:

enumerator kSEMC_Sdram_BurstLen1

According to ERR050577, Auto-refresh command may possibly fail to be triggered during long time back-to-back write (or read) when SDRAM controller's burst length is greater than 1. Burst length 1

enum _semc_nand_column_bit_num

SEMC nand column address bit number.

Values:

enumerator kSEMC_NandColum_16bit

16 bit.

enumerator kSEMC_NandColum_15bit
15 bit.

enumerator kSEMC_NandColum_14bit
14 bit.

enumerator kSEMC_NandColum_13bit
13 bit.

enumerator kSEMC_NandColum_12bit
12 bit.

enumerator kSEMC_NandColum_11bit
11 bit.

enumerator kSEMC_NandColum_10bit
10 bit.

enumerator kSEMC_NandColum_9bit
9 bit.

enum _semc_nand_burst_len
SEMC nand burst length.

Values:

enumerator kSEMC_Nand_BurstLen1
Burst length 1

enumerator kSEMC_Nand_BurstLen2
Burst length 2

enumerator kSEMC_Nand_BurstLen4
Burst length 4

enumerator kSEMC_Nand_BurstLen8
Burst length 8

enumerator kSEMC_Nand_BurstLen16
Burst length 16

enumerator kSEMC_Nand_BurstLen32
Burst length 32

enumerator kSEMC_Nand_BurstLen64
Burst length 64

enum _semc_norsram_column_bit_num
SEMC nor/sram column address bit number.

Values:

enumerator kSEMC_NorColum_12bit
12 bit.

enumerator kSEMC_NorColum_11bit
11 bit.

enumerator kSEMC_NorColum_10bit
10 bit.

enumerator kSEMC_NorColum_9bit
9 bit.

enumerator kSEMC_NorColum_8bit
8 bit.

enumerator kSEMC_NorColum_7bit
7 bit.

enumerator kSEMC_NorColum_6bit
6 bit.

enumerator kSEMC_NorColum_5bit
5 bit.

enumerator kSEMC_NorColum_4bit
4 bit.

enumerator kSEMC_NorColum_3bit
3 bit.

enumerator kSEMC_NorColum_2bit
2 bit.

enum _semc_norsram_burst_len
SEMC nor/sram burst length.

Values:

enumerator kSEMC_Nor_BurstLen1
Burst length 1

enumerator kSEMC_Nor_BurstLen2
Burst length 2

enumerator kSEMC_Nor_BurstLen4
Burst length 4

enumerator kSEMC_Nor_BurstLen8
Burst length 8

enumerator kSEMC_Nor_BurstLen16
Burst length 16

enumerator kSEMC_Nor_BurstLen32
Burst length 32

enumerator kSEMC_Nor_BurstLen64
Burst length 64

enum _semc_dbi_column_bit_num
SEMC dbi column address bit number.

Values:

enumerator kSEMC_Dbi_Colum_12bit
12 bit.

enumerator kSEMC_Dbi_Colum_11bit
11 bit.

enumerator kSEMC_Dbi_Colum_10bit
10 bit.

enumerator kSEMC_Dbi_Colum_9bit
9 bit.

enumerator kSEMC_Dbi_Colum_8bit
8 bit.

enumerator kSEMC_Dbi_Colum_7bit
7 bit.

enumerator kSEMC_Dbi_Colum_6bit
6 bit.

enumerator kSEMC_Dbi_Colum_5bit
5 bit.

enumerator kSEMC_Dbi_Colum_4bit
4 bit.

enumerator kSEMC_Dbi_Colum_3bit
3 bit.

enumerator kSEMC_Dbi_Colum_2bit
2 bit.

enum _semc_dbi_burst_len
SEMC dbi burst length.

Values:

enumerator kSEMC_Dbi_BurstLen1
Burst length 1

enumerator kSEMC_Dbi_BurstLen2
Burst length 2

enumerator kSEMC_Dbi_Dbi_BurstLen4
Burst length 4

enumerator kSEMC_Dbi_BurstLen8
Burst length 8

enumerator kSEMC_Dbi_BurstLen16
Burst length 16

enumerator kSEMC_Dbi_BurstLen32
Burst length 32

enumerator kSEMC_Dbi_BurstLen64
Burst length 64

enum _semc_iomux_pin
SEMC IOMUXC.

Values:

enumerator kSEMC_MUXA8
MUX A8 pin.

enumerator kSEMC_MUXCSX0
MUX CSX0 pin

enumerator kSEMC_MUXCSX1
MUX CSX1 Pin.

enumerator kSEMC_MUXCSX2
MUX CSX2 Pin.

enumerator kSEMC_MUXCSX3
MUX CSX3 Pin.

enumerator kSEMC_MUXRDY
MUX RDY pin.

enum _semc_iomux_nora27_pin
SEMC NOR/PSRAM Address bit 27 A27.

Values:

enumerator kSEMC_MORA27_NONE
No NOR/SRAM A27 pin.

enumerator kSEMC_NORA27_MUXCSX3
MUX CSX3 Pin.

enumerator kSEMC_NORA27_MUXRDY
MUX RDY pin.

enum _semc_port_size
SEMC port size.

Values:

enumerator kSEMC_PortSize8Bit
8-Bit port size.

enumerator kSEMC_PortSize16Bit
16-Bit port size.

enum _semc_addr_mode
SEMC address mode.

Values:

enumerator kSEMC_AddrDataMux
SEMC address/data mux mode.

enumerator kSEMC_AdvAddrdataMux
Advanced address/data mux mode.

enumerator kSEMC_AddrDataNonMux
Address/data non-mux mode.

enum _semc_dqs_mode
SEMC DQS read strobe mode.

Values:

enumerator kSEMC_Loopbackinternal
Dummy read strobe loopbacked internally.

enumerator kSEMC_Loopbackdqspad
Dummy read strobe loopbacked from DQS pad.

enum _semc_adv_polarity
SEMC ADV signal active polarity.

Values:

enumerator kSEMC_AdvActiveLow
Adv active low.

enumerator kSEMC_AdvActiveHigh
Adv active high.

enum _semc_sync_mode
SEMC sync mode.

Values:

enumerator kSEMC_AsyncMode
Async mode.

enumerator kSEMC_SyncMode
Sync mode.

enum _semc_adv_level_control
SEMC ADV signal level control.

Values:

enumerator kSEMC_AdvHigh
Adv is high during address hold state.

enumerator kSEMC_AdvLow
Adv is low during address hold state.

enum _semc_rdy_polarity
SEMC RDY signal active polarity.

Values:

enumerator kSEMC_RdyActiveLow
Adv active low.

enumerator kSEMC_RdyActivehigh
Adv active low.

enum _semc_ipcmd_nand_addrmode
SEMC IP command for NAND: address mode.

Values:

enumerator kSEMC_NANDAM_ColumnRow
Address mode: column and row address(5Byte-CA0/CA1/RA0/RA1/RA2).

enumerator kSEMC_NANDAM_ColumnCA0
Address mode: column address only(1 Byte-CA0).

enumerator kSEMC_NANDAM_ColumnCA0CA1
Address mode: column address only(2 Byte-CA0/CA1).

enumerator kSEMC_NANDAM_RawRA0
Address mode: row address only(1 Byte-RA0).

enumerator kSEMC_NANDAM_RawRA0RA1
Address mode: row address only(2 Byte-RA0/RA1).

enumerator kSEMC_NANDAM_RawRA0RA1RA2
Address mode: row address only(3 Byte-RA0).

enum _semc_ipcmd_nand_cmdmode
SEMC IP command for NAND command mode.

Values:

enumerator kSEMC_NANDCM_Command
command.

enumerator kSEMC_NANDCM_CommandHold
Command hold.

enumerator kSEMC_NANDCM_CommandAddress
Command address.

enumerator kSEMC_NANDCM_CommandAddressHold
Command address hold.

enumerator kSEMC_NANDCM_CommandAddressRead
Command address read.

enumerator kSEMC_NANDCM_CommandAddressWrite
Command address write.

enumerator kSEMC_NANDCM_CommandRead
Command read.

enumerator kSEMC_NANDCM_CommandWrite
Command write.

enumerator kSEMC_NANDCM_Read
Read.

enumerator kSEMC_NANDCM_Write
Write.

enum _semc_nand_address_option
SEMC NAND address option.

Values:

enumerator kSEMC_NandAddrOption_5byte_CA2RA3
CA0+CA1+RA0+RA1+RA2

enumerator kSEMC_NandAddrOption_4byte_CA2RA2
CA0+CA1+RA0+RA1

enumerator kSEMC_NandAddrOption_3byte_CA2RA1
CA0+CA1+RA0

enumerator kSEMC_NandAddrOption_4byte_CA1RA3
CA0+RA0+RA1+RA2

enumerator kSEMC_NandAddrOption_3byte_CA1RA2
CA0+RA0+RA1

enumerator kSEMC_NandAddrOption_2byte_CA1RA1
CA0+RA0

enum _semc_ipcmd_nor_dbi
SEMC IP command for NOR.

Values:

enumerator kSEMC_NORDBICM_Read
NOR read.

enumerator kSEMC_NORDBICM_Write
NOR write.

enum _semc_ipcmd_sram

SEMC IP command for SRAM.

Values:

enumerator kSEMC_SRAMCM_ArrayRead

SRAM memory array read.

enumerator kSEMC_SRAMCM_ArrayWrite

SRAM memory array write.

enumerator kSEMC_SRAMCM_RegRead

SRAM memory register read.

enumerator kSEMC_SRAMCM_RegWrite

SRAM memory register write.

enum _semc_ipcmd_sdram

SEMC IP command for SDARM.

Values:

enumerator kSEMC_SDRAMCM_Read

SDRAM memory read.

enumerator kSEMC_SDRAMCM_Write

SDRAM memory write.

enumerator kSEMC_SDRAMCM_Modeset

SDRAM MODE SET.

enumerator kSEMC_SDRAMCM_Active

SDRAM active.

enumerator kSEMC_SDRAMCM_AutoRefresh

SDRAM auto-refresh.

enumerator kSEMC_SDRAMCM_SelfRefresh

SDRAM self-refresh.

enumerator kSEMC_SDRAMCM_Precharge

SDRAM precharge.

enumerator kSEMC_SDRAMCM_Prechargeall

SDRAM precharge all.

typedef enum *_semc_mem_type* semc_mem_type_t

SEMC memory device type.

typedef enum *_semc_waitready_polarity* semc_waitready_polarity_t

SEMC WAIT/RDY polarity.

typedef enum *_semc_sdram_cs* semc_sdram_cs_t

SEMC SDRAM Chip selection .

typedef enum *_semc_sram_cs* semc_sram_cs_t

SEMC SRAM Chip selection .

typedef enum *_semc_nand_access_type* semc_nand_access_type_t

SEMC NAND device type.

typedef enum *_semc_interrupt_enable* semc_interrupt_enable_t

SEMC interrupts .

typedef enum *_semc_ipcmd_datasize* semc_ipcmd_datasize_t
SEMC IP command data size in bytes.

typedef enum *_semc_refresh_time* semc_refresh_time_t
SEMC auto-refresh timing.

typedef enum *_semc_caslatency* semc_caslatency_t
CAS latency.

typedef enum *_semc_sdram_column_bit_num* semc_sdram_column_bit_num_t
SEMC sdram column address bit number.

typedef enum *_semc_sdram_burst_len* sem_sdram_burst_len_t
SEMC sdram burst length.

typedef enum *_semc_nand_column_bit_num* semc_nand_column_bit_num_t
SEMC nand column address bit number.

typedef enum *_semc_nand_burst_len* sem_nand_burst_len_t
SEMC nand burst length.

typedef enum *_semc_norsram_column_bit_num* semc_norsram_column_bit_num_t
SEMC nor/sram column address bit number.

typedef enum *_semc_norsram_burst_len* sem_norsram_burst_len_t
SEMC nor/sram burst length.

typedef enum *_semc_dbi_column_bit_num* semc_dbi_column_bit_num_t
SEMC dbi column address bit number.

typedef enum *_semc_dbi_burst_len* sem_dbi_burst_len_t
SEMC dbi burst length.

typedef enum *_semc_iomux_pin* semc_iomux_pin
SEMC IOMUXC.

typedef enum *_semc_iomux_nora27_pin* semc_iomux_nora27_pin
SEMC NOR/PSRAM Address bit 27 A27.

typedef enum *_semc_port_size* smec_port_size_t
SEMC port size.

typedef enum *_semc_addr_mode* semc_addr_mode_t
SEMC address mode.

typedef enum *_semc_dqs_mode* semc_dqs_mode_t
SEMC DQS read strobe mode.

typedef enum *_semc_adv_polarity* semc_adv_polarity_t
SEMC ADV signal active polarity.

typedef enum *_semc_sync_mode* semc_sync_mode_t
SEMC sync mode.

typedef enum *_semc_adv_level_control* semc_adv_level_control_t
SEMC ADV signal level control.

typedef enum *_semc_rdy_polarity* semc_rdy_polarity_t
SEMC RDY signal active polarity.

typedef enum *_semc_ipcmd_nand_addrmode* semc_ipcmd_nand_addrmode_t
SEMC IP command for NAND: address mode.

typedef enum *_semc_ipcmd_nand_cmdmode* semc_ipcmd_nand_cmdmode_t
SEMC IP command for NAND command mode.

typedef enum *_semc_nand_address_option* semc_nand_address_option_t
SEMC NAND address option.

typedef enum *_semc_ipcmd_nor_dbi* semc_ipcmd_nor_dbi_t
SEMC IP command for NOR.

typedef enum *_semc_ipcmd_sram* semc_ipcmd_sram_t
SEMC IP command for SRAM.

typedef enum *_semc_ipcmd_sdram* semc_ipcmd_sdram_t
SEMC IP command for SDARM.

typedef struct *_semc_sdram_config* semc_sdram_config_t
SEMC SDRAM configuration structure.

a. The memory size in the configuration is in the unit of KB. So memsize_kbytes should be set as 2^2, 2^3, 2^4 .etc which is base 2KB exponential function. Take refer to BR0~BR3 register in RM for details.

b. The prescalePeriod_N16Cycle is in unit of 16 clock cycle. It is a exception for prescaleTimer_n16cycle = 0, it means the prescaler timer period is 256 * 16 clock cycles. For precalerIf precalerTimer_n16cycle not equal to 0, The prescaler timer period is prescalePeriod_N16Cycle * 16 clock cycles. idleTimeout_NprescalePeriod, refreshUrgThreshold_NprescalePeriod, refreshPeriod_NprescalePeriod are similar to prescalePeriod_N16Cycle.

typedef struct *_semc_nand_timing_config* semc_nand_timing_config_t
SEMC NAND device timing configuration structure.

typedef struct *_semc_nand_config* semc_nand_config_t
SEMC NAND configuration structure.

typedef struct *_semc_nor_config* semc_nor_config_t
SEMC NOR configuration structure.

typedef struct *_semc_sram_config* semc_sram_config_t
SEMC SRAM configuration structure.

typedef struct *_semc_dbi_config* semc_dbi_config_t
SEMC DBI configuration structure.

typedef struct *_semc_queuea_weight_struct* semc_queuea_weight_struct_t
SEMC AXI queue a weight setting structure.

typedef union *_semc_queuea_weight* semc_queuea_weight_t
SEMC AXI queue a weight setting union.

typedef struct *_semc_queueb_weight_struct* semc_queueb_weight_struct_t
SEMC AXI queue b weight setting structure.

typedef union *_semc_queueb_weight* semc_queueb_weight_t
SEMC AXI queue b weight setting union.

typedef struct *_semc_axi_queueweight* semc_axi_queueweight_t
SEMC AXI queue weight setting.

typedef struct *_semc_config_t* semc_config_t

SEMC configuration structure.

busTimeoutCycles: when busTimeoutCycles is zero, the bus timeout cycle is 255*1024. otherwise the bus timeout cycles is busTimeoutCycles*1024. cmdTimeoutCycles: is used for command execution timeout cycles. it's similar to the busTimeoutCycles.

struct semc_sdram_config

#include <fsl_semc.h> SEMC SDRAM configuration structure.

a. The memory size in the configuration is in the unit of KB. So memsize_kbytes should be set as 2^2, 2^3, 2^4 .etc which is base 2KB exponential function. Take refer to BR0~BR3 register in RM for details.

b. The prescalePeriod_N16Cycle is in unit of 16 clock cycle. It is a exception for prescaleTimer_n16cycle = 0, it means the prescaler timer period is 256 * 16 clock cycles. For precalerIf precalerTimer_n16cycle not equal to 0, The prescaler timer period is prescalePeriod_N16Cycle * 16 clock cycles. idleTimeout_NprescalePeriod, refreshUrgThreshold_NprescalePeriod, refreshPeriod_NprescalePeriod are similar to prescalePeriod_N16Cycle.

Public Members

semc_iomux_pin csxPinMux

CS pin mux. The kSEMC_MUXA8 is not valid in sdram pin mux setting.

uint32_t address

The base address.

uint32_t memsize_kbytes

The memory size in unit of kbytes.

smec_port_size_t portSize

Port size.

sem_sdram_burst_len_t burstLen

Burst length.

semc_sdram_column_bit_num_t columnAddrBitNum

Column address bit number.

semc_caslatency_t casLatency

CAS latency.

uint8_t tPrecharge2Act_Ns

Precharge to active wait time in unit of nanosecond.

uint8_t tAct2ReadWrite_Ns

Act to read/write wait time in unit of nanosecond.

uint8_t tRefreshRecovery_Ns

Refresh recovery time in unit of nanosecond.

uint8_t tWriteRecovery_Ns

write recovery time in unit of nanosecond.

uint8_t tCkeOff_Ns

CKE off minimum time in unit of nanosecond.

uint8_t tAct2Prechage_Ns
: Active to precharge in unit of nanosecond.

uint8_t tSelfRefRecovery_Ns
: Self refresh recovery time in unit of nanosecond.

uint8_t tRefresh2Refresh_Ns
: Refresh to refresh wait time in unit of nanosecond.

uint8_t tAct2Act_Ns
: Active to active wait time in unit of nanosecond.

uint32_t tPrescalePeriod_Ns
: Prescaler timer period should not be larger than 256 * 16 * clock cycle.

uint32_t tIdleTimeout_Ns
: Idle timeout in unit of prescale time period.

uint32_t refreshPeriod_nsPerRow
: Refresh timer period like 64ms * 1000000/8192 .

uint32_t refreshUrgThreshold
: Refresh urgent threshold.

uint8_t refreshBurstLen
: Refresh burst length.

uint8_t delayChain
: Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

uint8_t autofreshTimes
: Auto Refresh cycles times.

struct _semc_nand_timing_config
: *#include <fsl_semc.h>* SEMC NAND device timing configuration structure.

Public Members

uint8_t tCeSetup_Ns
: CE setup time: tCS.

uint8_t tCeHold_Ns
: CE hold time: tCH.

uint8_t tCeInterval_Ns
: CE interval time:tCEITV.

uint8_t tWeLow_Ns
: WE low time: tWP.

uint8_t tWeHigh_Ns
: WE high time: tWH.

uint8_t tReLow_Ns
: RE low time: tRP.

uint8_t tReHigh_Ns
: RE high time: tREH.

uint8_t tTurnAround_Ns
: Turnaround time for async mode: tTA.

uint8_t tWehigh2Relow_Ns
: WE# high to RE# wait time: tWHR.

uint8_t tRehigh2Welow_Ns
: RE# high to WE# low wait time: tRHW.

uint8_t tAle2WriteStart_Ns
: ALE to write start wait time: tADL.

uint8_t tReady2Relow_Ns
: Ready to RE# low min wait time: tRR.

uint8_t tWehigh2Busy_Ns
: WE# high to busy wait time: tWB.

struct _semc_nand_config
: *#include <fsl_semc.h>* SEMC NAND configuration structure.

Public Members

semc_iomux_pin cePinMux
: The CE pin mux setting. The kSEMC_MUXRDY is not valid for CE pin setting.

uint32_t axiAddress
: The base address for AXI nand.

uint32_t axiMemsize_kbytes
: The memory size in unit of kbytes for AXI nand.

uint32_t ipgAddress
: The base address for IPG nand .

uint32_t ipgMemsize_kbytes
: The memory size in unit of kbytes for IPG nand.

semc_rdy_polarity_t rdyactivePolarity
: Wait ready polarity.

bool edoModeEnabled
: EDO mode enabled.

semc_nand_column_bit_num_t columnAddrBitNum
: Column address bit number.

semc_nand_address_option_t arrayAddrOption
: Address option.

sem_nand_burst_len_t burstLen
: Burst length.

smec_port_size_t portSize
: Port size.

semc_nand_timing_config_t *timingConfig
: SEMC nand timing configuration.

struct _semc_nor_config
: *#include <fsl_semc.h>* SEMC NOR configuration structure.

Public Members

semc_iomux_pin cePinMux
The CE# pin mux setting.

semc_iomux_nora27_pin addr27
The Addr bit 27 pin mux setting.

uint32_t address
The base address.

uint32_t memsize_kbytes
The memory size in unit of kbytes.

uint8_t addrPortWidth
The address port width.

semc_rdy_polarity_t rdyactivePolarity
Wait ready polarity.

semc_adv_polarity_t advActivePolarity
ADV# polarity.

semc_norsram_column_bit_num_t columnAddrBitNum
Column address bit number.

semc_addr_mode_t addrMode
Address mode.

sem_norsram_burst_len_t burstLen
Burst length.

smec_port_size_t portSize
Port size.

uint8_t tCeSetup_Ns
The CE setup time.

uint8_t tCeHold_Ns
The CE hold time.

uint8_t tCeInterval_Ns
CE interval minimum time.

uint8_t tAddrSetup_Ns
The address setup time.

uint8_t tAddrHold_Ns
The address hold time.

uint8_t tWeLow_Ns
WE low time for async mode.

uint8_t tWeHigh_Ns
WE high time for async mode.

uint8_t tReLow_Ns
RE low time for async mode.

uint8_t tReHigh_Ns
RE high time for async mode.

uint8_t tTurnAround_Ns
: Turnaround time for async mode.

uint8_t tAddr2WriteHold_Ns
: Address to write data hold time for async mode.

uint8_t tWriteSetup_Ns
: Write data setup time for sync mode.

uint8_t tWriteHold_Ns
: Write hold time for sync mode.

uint8_t latencyCount
: Latency count for sync mode.

uint8_t readCycle
: Read cycle time for sync mode.

uint8_t delayChain
: Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

struct _semc_sram_config
: *#include <fsl_semc.h>* SEMC SRAM configuration structure.

Public Members

semc_iomux_pin cePinMux
: The CE# pin mux setting.

semc_iomux_nora27_pin addr27
: The Addr bit 27 pin mux setting.

uint32_t address
: The base address.

uint32_t memsize_kbytes
: The memory size in unit of kbytes.

uint8_t addrPortWidth
: The address port width.

semc_adv_polarity_t advActivePolarity
: ADV# polarity 1: active high, 0: active low.

semc_addr_mode_t addrMode
: Address mode.

sem_norsram_burst_len_t burstLen
: Burst length.

smec_port_size_t portSize
: Port size.

semc_sync_mode_t syncMode
: Sync mode.

bool waitEnable
: Wait enable.

uint8_t waitSample
: Wait sample.

semc_adv_level_control_t advLevelCtrl
: ADV# level control during address hold state, 1: low, 0: high.

uint8_t tCeSetup_Ns
: The CE setup time.

uint8_t tCeHold_Ns
: The CE hold time.

uint8_t tCeInterval_Ns
: CE interval minimum time.

uint8_t readHoldTime_Ns
: read hold time.

uint8_t tAddrSetup_Ns
: The address setup time.

uint8_t tAddrHold_Ns
: The address hold time.

uint8_t tWeLow_Ns
: WE low time for async mode.

uint8_t tWeHigh_Ns
: WE high time for async mode.

uint8_t tReLow_Ns
: RE low time for async mode.

uint8_t tReHigh_Ns
: RE high time for async mode.

uint8_t tTurnAround_Ns
: Turnaround time for async mode.

uint8_t tAddr2WriteHold_Ns
: Address to write data hold time for async mode.

uint8_t tWriteSetup_Ns
: Write data setup time for sync mode.

uint8_t tWriteHold_Ns
: Write hold time for sync mode.

uint8_t latencyCount
: Latency count for sync mode.

uint8_t readCycle
: Read cycle time for sync mode.

uint8_t delayChain
: Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

struct _semc_dbi_config
: *#include <fsl_semc.h>* SEMC DBI configuration structure.

Public Members

semc_iomux_pin csxPinMux
The CE# pin mux.

uint32_t address
The base address.

uint32_t memsize_kbytes
The memory size in unit of 4kbytes.

semc_dbi_column_bit_num_t columnAddrBitNum
Column address bit number.

sem_dbi_burst_len_t burstLen
Burst length.

smec_port_size_t portSize
Port size.

uint8_t tCsxSetup_Ns
The CSX setup time.

uint8_t tCsxHold_Ns
The CSX hold time.

uint8_t tWexLow_Ns
WEX low time.

uint8_t tWexHigh_Ns
WEX high time.

uint8_t tRdxLow_Ns
RDX low time.

uint8_t tRdxHigh_Ns
RDX high time.

uint8_t tCsxInterval_Ns
Write data setup time.

struct __semc_queuea_weight_struct
#include <fsl_semc.h> SEMC AXI queue a weight setting structure.

Public Members

uint32_t qos
weight of qos for queue 0 .

uint32_t aging
weight of aging for queue 0.

uint32_t slaveHitNoswitch
weight of read/write no switch for queue 0 .

uint32_t slaveHitSwitch
weight of read/write switch for queue 0.

union __semc_queuea_weight
#include <fsl_semc.h> SEMC AXI queue a weight setting union.

Public Members

semc_queuea_weight_struct_t queueaConfig
Structure configuration for queueA.

uint32_t queueaValue
Configuration value for queueA which could directly write to the reg.

struct __semc__queueb__weight__struct
#include <fsl_semc.h> SEMC AXI queue b weight setting structure.

Public Members

uint32_t qos
weight of qos for queue 1.

uint32_t aging
weight of aging for queue 1.

uint32_t weightPagehit
weight of page hit for queue 1 only .

uint32_t slaveHitNoswitch
weight of read/write no switch for queue 1.

uint32_t bankRotation
weight of bank rotation for queue 1 only .

union __semc__queueb__weight
#include <fsl_semc.h> SEMC AXI queue b weight setting union.

Public Members

semc_queueb_weight_struct_t queuebConfig
Structure configuration for queueB.

uint32_t queuebValue
Configuration value for queueB which could directly write to the reg.

struct __semc__axi__queueweight
#include <fsl_semc.h> SEMC AXI queue weight setting.

Public Members

bool queueaEnable
Enable queue a.

semc_queuea_weight_t queueaWeight
Weight settings for queue a.

bool queuebEnable
Enable queue b.

semc_queueb_weight_t queuebWeight
Weight settings for queue b.

struct _semc_config_t

#include <fsl_semc.h> SEMC configuration structure.

busTimeoutCycles: when busTimeoutCycles is zero, the bus timeout cycle is 255*1024. otherwise the bus timeout cycles is busTimeoutCycles*1024. cmdTimeoutCycles: is used for command execution timeout cycles. it's similar to the busTimeoutCycles.

Public Members

semc_dqs_mode_t dqsMode

Dummy read strobe mode: use enum in "semc_dqs_mode_t".

uint8_t cmdTimeoutCycles

Command execution timeout cycles.

uint8_t busTimeoutCycles

Bus timeout cycles.

semc_axi_queueweight_t queueWeight

AXI queue weight.

2.108 Smart Card

FSL_SMARTCARD_DRIVER_VERSION

Smart card driver version 2.3.0.

Smart card Error codes.

Values:

enumerator kStatus_SMARTCARD_Success

Transfer ends successfully

enumerator kStatus_SMARTCARD_TxBusy

Transmit in progress

enumerator kStatus_SMARTCARD_RxBusy

Receiving in progress

enumerator kStatus_SMARTCARD_NoTransferInProgress

No transfer in progress

enumerator kStatus_SMARTCARD_Timeout

Transfer ends with time-out

enumerator kStatus_SMARTCARD_Initialized

Smart card driver is already initialized

enumerator kStatus_SMARTCARD_PhyInitialized

Smart card PHY drive is already initialized

enumerator kStatus_SMARTCARD_CardNotActivated

Smart card is not activated

enumerator kStatus_SMARTCARD_InvalidInput

Function called with invalid input arguments

enumerator kStatus_SMARTCARD_OtherError
Some other error occur

enum _smartcard_control
Control codes for the Smart card protocol timers and misc.

Values:

enumerator kSMARTCARD_EnableADT

enumerator kSMARTCARD_DisableADT

enumerator kSMARTCARD_EnableGTV

enumerator kSMARTCARD_DisableGTV

enumerator kSMARTCARD_ResetWWT

enumerator kSMARTCARD_EnableWWT

enumerator kSMARTCARD_DisableWWT

enumerator kSMARTCARD_ResetCWT

enumerator kSMARTCARD_EnableCWT

enumerator kSMARTCARD_DisableCWT

enumerator kSMARTCARD_ResetBWT

enumerator kSMARTCARD_EnableBWT

enumerator kSMARTCARD_DisableBWT

enumerator kSMARTCARD_EnableInitDetect

enumerator kSMARTCARD_EnableAnack

enumerator kSMARTCARD_DisableAnack

enumerator kSMARTCARD_ConfigureBaudrate

enumerator kSMARTCARD_SetupATRMode

enumerator kSMARTCARD_SetupT0Mode

enumerator kSMARTCARD_SetupT1Mode

enumerator kSMARTCARD_EnableReceiverMode

enumerator kSMARTCARD_DisableReceiverMode

enumerator kSMARTCARD_EnableTransmitterMode

enumerator kSMARTCARD_DisableTransmitterMode

enumerator kSMARTCARD_ResetWaitTimeMultiplier

enum _smartcard_card_voltage_class
Defines Smart card interface voltage class values.

Values:

enumerator kSMARTCARD_VoltageClassUnknown

enumerator kSMARTCARD_VoltageClassA5_0V

enumerator kSMARTCARD_VoltageClassB3_3V

enumerator kSMARTCARD_VoltageClassC1_8V

enum _smartcard_transfer_state

Defines Smart card I/O transfer states.

Values:

enumerator kSMARTCARD_IdleState

enumerator kSMARTCARD_WaitingForTSState

enumerator kSMARTCARD_InvalidTSDetecetedState

enumerator kSMARTCARD_ReceivingState

enumerator kSMARTCARD_TransmittingState

enum _smartcard_reset_type

Defines Smart card reset types.

Values:

enumerator kSMARTCARD_ColdReset

enumerator kSMARTCARD_WarmReset

enumerator kSMARTCARD_NoColdReset

enumerator kSMARTCARD_NoWarmReset

enum _smartcard_transport_type

Defines Smart card transport protocol types.

Values:

enumerator kSMARTCARD_T0Transport

enumerator kSMARTCARD_T1Transport

enum _smartcard_parity_type

Defines Smart card data parity types.

Values:

enumerator kSMARTCARD_EvenParity

enumerator kSMARTCARD_OddParity

enum _smartcard_card_convention

Defines data Convention format.

Values:

enumerator kSMARTCARD_DirectConvention

enumerator kSMARTCARD_InverseConvention

enum _smartcard_interface_control

Defines Smart card interface IC control types.

Values:

enumerator kSMARTCARD_InterfaceSetVcc

enumerator kSMARTCARD_InterfaceSetClockToResetDelay

enumerator kSMARTCARD_InterfaceReadStatus

enum _smartcard_direction
Defines transfer direction.

Values:

enumerator kSMARTCARD_Receive

enumerator kSMARTCARD_Transmit

typedef enum *_smartcard_control* smartcard_control_t
Control codes for the Smart card protocol timers and misc.

typedef enum *_smartcard_card_voltage_class* smartcard_card_voltage_class_t
Defines Smart card interface voltage class values.

typedef enum *_smartcard_transfer_state* smartcard_transfer_state_t
Defines Smart card I/O transfer states.

typedef enum *_smartcard_reset_type* smartcard_reset_type_t
Defines Smart card reset types.

typedef enum *_smartcard_transport_type* smartcard_transport_type_t
Defines Smart card transport protocol types.

typedef enum *_smartcard_parity_type* smartcard_parity_type_t
Defines Smart card data parity types.

typedef enum *_smartcard_card_convention* smartcard_card_convention_t
Defines data Convention format.

typedef enum *_smartcard_interface_control* smartcard_interface_control_t
Defines Smart card interface IC control types.

typedef enum *_smartcard_direction* smartcard_direction_t
Defines transfer direction.

typedef void (*smartcard_interface_callback_t)(void *smartcardContext, void *param)
Smart card interface interrupt callback function type.

typedef void (*smartcard_transfer_callback_t)(void *smartcardContext, void *param)
Smart card transfer interrupt callback function type.

typedef void (*smartcard_time_delay_t)(uint32_t us)
Time Delay function used to passive waiting using RTOS [us].

typedef struct *_smartcard_card_params* smartcard_card_params_t
Defines card-specific parameters for Smart card driver.

typedef struct *_smartcard_timers_state* smartcard_timers_state_t
Smart card defines the state of the EMV timers in the Smart card driver.

typedef struct *_smartcard_interface_config* smartcard_interface_config_t
Defines user specified configuration of Smart card interface.

typedef struct *_smartcard_xfer* smartcard_xfer_t
Defines user transfer structure used to initialize transfer.

typedef struct *_smartcard_context* smartcard_context_t
Runtime state of the Smart card driver.

SMARTCARD_INIT_DELAY_CLOCK_CYCLES
: Smart card global define which specify number of clock cycles until initial 'TS' character has to be received.

SMARTCARD_EMV_ATR_DURATION_ETU
: Smart card global define which specify number of clock cycles during which ATR string has to be received.

SMARTCARD_TS_DIRECT_CONVENTION
: Smart card specification initial TS character definition of direct convention.

SMARTCARD_TS_INVERSE_CONVENTION
: Smart card specification initial TS character definition of inverse convention.

struct _smartcard_card_params
: *#include <fsl_smartcard.h>* Defines card-specific parameters for Smart card driver.

Public Members

uint16_t Fi
: 4 bits Fi - clock rate conversion integer

uint8_t fMax
: Maximum Smart card frequency in MHz

uint8_t WI
: 8 bits WI - work wait time integer

uint8_t Di
: 4 bits DI - baud rate divisor

uint8_t BWI
: 4 bits BWI - block wait time integer

uint8_t CWI
: 4 bits CWI - character wait time integer

uint8_t BGI
: 4 bits BGI - block guard time integer

uint8_t GTN
: 8 bits GTN - extended guard time integer

uint8_t IFSC
: Indicates IFSC value of the card

uint8_t modeNegotiable
: Indicates if the card acts in negotiable or a specific mode.

uint8_t currentD
: 4 bits DI - current baud rate divisor

uint8_t status
: Indicates smart card status

bool t0Indicated
: Indicates ff T=0 indicated in TD1 byte

bool t1Indicated
: Indicates if T=1 indicated in TD2 byte

bool atrComplete
: Indicates whether the ATR received from the card was complete or not

bool atrValid
: Indicates whether the ATR received from the card was valid or not

bool present
: Indicates if a smart card is present

bool active
: Indicates if the smart card is activated

bool faulty
: Indicates whether smart card/interface is faulty

smartcard_card_convention_t convention
: Card convention, kSMARTCARD_DirectConvention for direct convention, kSMARTCARD_InverseConvention for inverse convention

struct __smartcard__timers__state
: *#include <fsl_smartcard.h>* Smart card defines the state of the EMV timers in the Smart card driver.

Public Members

volatile bool adtExpired
: Indicates whether ADT timer expired

volatile bool wwtExpired
: Indicates whether WWT timer expired

volatile bool cwtExpired
: Indicates whether CWT timer expired

volatile bool bwtExpired
: Indicates whether BWT timer expired

volatile bool initCharTimerExpired
: Indicates whether reception timer for initialization character (TS) after the RST has expired

struct __smartcard__interface__config
: *#include <fsl_smartcard.h>* Defines user specified configuration of Smart card interface.

Public Members

uint32_t smartCardClock
: Smart card interface clock [Hz]

uint32_t clockToResetDelay
: Indicates clock to RST apply delay [smart card clock cycles]

uint8_t clockModule
: Smart card clock module number

uint8_t clockModuleChannel
: Smart card clock module channel number

uint8_t clockModuleSourceClock
: Smart card clock module source clock [e.g., BusClk]

smartcard_card_voltage_class_t vcc
Smart card voltage class

uint8_t controlPort
Smart card PHY control port instance

uint8_t controlPin
Smart card PHY control pin instance

uint8_t irqPort
Smart card PHY Interrupt port instance

uint8_t irqPin
Smart card PHY Interrupt pin instance

uint8_t resetPort
Smart card reset port instance

uint8_t resetPin
Smart card reset pin instance

uint8_t vsel0Port
Smart card PHY Vsel0 control port instance

uint8_t vsel0Pin
Smart card PHY Vsel0 control pin instance

uint8_t vsel1Port
Smart card PHY Vsel1 control port instance

uint8_t vsel1Pin
Smart card PHY Vsel1 control pin instance

uint8_t dataPort
Smart card PHY data port instance

uint8_t dataPin
Smart card PHY data pin instance

uint8_t dataPinMux
Smart card PHY data pin mux option

uint8_t tsTimerId
Numerical identifier of the External HW timer for Initial character detection

struct __smartcard_xfer
#include <fsl_smartcard.h> Defines user transfer structure used to initialize transfer.

Public Members

smartcard_direction_t direction
Direction of communication. (RX/TX)

uint8_t *buff
The buffer of data.

size_t size
The number of transferred units.

struct __smartcard_context
#include <fsl_smartcard.h> Runtime state of the Smart card driver.

Public Members

void *base
: Smart card module base address

smartcard_direction_t direction
: Direction of communication. (RX/TX)

uint8_t *xBuff
: The buffer of data being transferred.

volatile size_t xSize
: The number of bytes to be transferred.

volatile bool xIsBusy
: True if there is an active transfer.

uint8_t txFifoEntryCount
: Number of data word entries in transmit FIFO.

uint8_t rxFifoThreshold
: The max value of the receiver FIFO threshold.

smartcard_interface_callback_t interfaceCallback
: Callback to invoke after interface IC raised interrupt.

smartcard_transfer_callback_t transferCallback
: Callback to invoke after transfer event occur.

void *interfaceCallbackParam
: Interface callback parameter pointer.

void *transferCallbackParam
: Transfer callback parameter pointer.

smartcard_time_delay_t timeDelay
: Function which handles time delay defined by user or RTOS.

smartcard_reset_type_t resetType
: Indicates whether a Cold reset or Warm reset was requested.

smartcard_transport_type_t tType
: Indicates current transfer protocol (T0 or T1)

volatile *smartcard_transfer_state_t* transferState
: Indicates the current transfer state

smartcard_timers_state_t timersState
: Indicates the state of different protocol timers used in driver

smartcard_card_params_t cardParams
: Smart card parameters(ATR and current) and interface slots states(ATR and current)

uint8_t IFSD
: Indicates the terminal IFSD

smartcard_parity_type_t parity
: Indicates current parity even/odd

volatile bool rxtCrossed
: Indicates whether RXT thresholds has been crossed

volatile bool txtCrossed
: Indicates whether TXT thresholds has been crossed

volatile bool wtxRequested
: Indicates whether WTX has been requested or not

volatile bool parityError
: Indicates whether a parity error has been detected

uint8_t statusBytes[2]
: Used to store Status bytes SW1, SW2 of the last executed card command response

smartcard_interface_config_t interfaceConfig
: Smart card interface configuration structure

bool abortTransfer
: Used to abort transfer.

2.109 Smart Card EMVSIM Driver

void SMARTCARD_EMVSIM_GetDefaultConfig(*smartcard_card_params_t* *cardParams)

Fills in the smartcard_card_params structure with default values according to the EMV 4.3 specification.

Parameters

- cardParams – The configuration structure of type smartcard_interface_config_t. Function fill in members: Fi = 372; Di = 1; currentD = 1; WI = 0x0A; GTN = 0x00; with default values.

status_t SMARTCARD_EMVSIM_Init(EMVSIM_Type *base, *smartcard_context_t* *context, uint32_t srcClock_Hz)

Initializes an EMVSIM peripheral for the Smart card/ISO-7816 operation.

This function un-gates the EMVSIM clock, initializes the module to EMV default settings, configures the IRQ, enables the module-level interrupt to the core and, initializes the driver context.

Parameters

- base – The EMVSIM peripheral base address.
- context – A pointer to the smart card driver context structure.
- srcClock_Hz – Smart card clock generation module source clock.

Returns

An error code or kStatus_SMARTCARD_Success.

void SMARTCARD_EMVSIM_Deinit(EMVSIM_Type *base)

This function disables the EMVSIM interrupts, disables the transmitter and receiver, flushes the FIFOs, and gates EMVSIM clock in SIM.

Parameters

- base – The EMVSIM module base address.

int32_t SMARTCARD_EMVSIM_GetTransferRemainingBytes(EMVSIM_Type *base, *smartcard_context_t* *context)

Returns whether the previous EMVSIM transfer has finished.

When performing an async transfer, call this function to ascertain the context of the current transfer: in progress (or busy) or complete (success). If the transfer is still in progress, the user can obtain the number of words that have not been transferred.

Parameters

- base – The EMVSIM module base address.
- context – A pointer to a smart card driver context structure.

Returns
The number of bytes not transferred.

status_t SMARTCARD_EMVSIM_AbortTransfer(EMVSIM_Type *base, *smartcard_context_t* *context)

Terminates an asynchronous EMVSIM transfer early.

During an async EMVSIM transfer, the user can terminate the transfer early if the transfer is still in progress.

Parameters

- base – The EMVSIM peripheral address.
- context – A pointer to a smart card driver context structure.

Return values

- kStatus_SMARTCARD_Success – The transmit abort was successful.
- kStatus_SMARTCARD_NoTransmitInProgress – No transmission is currently in progress.

status_t SMARTCARD_EMVSIM_TransferNonBlocking(EMVSIM_Type *base, *smartcard_context_t* *context, *smartcard_xfer_t* *xfer)

Transfer data using interrupts.

A non-blocking (also known as asynchronous) function means that the function returns immediately after initiating the transfer function. The application has to get the transfer status to see when the transfer is complete. In other words, after calling the non-blocking (asynchronous) transfer function, the application must get the transfer status to check if the transmit is completed or not.

Parameters

- base – The EMVSIM peripheral base address.
- context – A pointer to a smart card driver context structure.
- xfer – A pointer to the smart card transfer structure where the linked buffers and sizes are stored.

Returns
An error code or kStatus_SMARTCARD_Success.

status_t SMARTCARD_EMVSIM_Control(EMVSIM_Type *base, *smartcard_context_t* *context, *smartcard_control_t* control, uint32_t param)

Controls the EMVSIM module per different user request.

return kStatus_SMARTCARD_Success in success. return kStatus_SMARTCARD_OtherError in case of error.

Parameters

- base – The EMVSIM peripheral base address.
- context – A pointer to a smart card driver context structure.
- control – Control type.
- param – Integer value of specific to control command.

void SMARTCARD_EMVSIM_IRQHandler(EMVSIM_Type *base, *smartcard_context_t* *context)

Handles EMVSIM module interrupts.

Parameters

- base – The EMVSIM peripheral base address.
- context – A pointer to a smart card driver context structure.

enum _emvsim_gpc_clock_select

General Purpose Counter clock selections.

Values:

enumerator kEMVSIM_GPCClockDisable

Disabled

enumerator kEMVSIM_GPCCardClock

Card clock

enumerator kEMVSIM_GPCRxClock

Receive clock

enumerator kEMVSIM_GPCTxClock

Transmit ETU clock

enum _presence_detect_edge

EMVSIM card presence detection edge control.

Values:

enumerator kEMVSIM_DetectOnFallingEdge

Presence detected on the falling edge

enumerator kEMVSIM_DetectOnRisingEdge

Presence detected on the rising edge

enum _presence_detect_status

EMVSIM card presence detection status.

Values:

enumerator kEMVSIM_DetectPinIsLow

Presence detected pin is logic low

enumerator kEMVSIM_DetectPinIsHigh

Presence detected pin is logic high

typedef enum *_emvsim_gpc_clock_select* emvsim_gpc_clock_select_t

General Purpose Counter clock selections.

typedef enum *_presence_detect_edge* emvsim_presence_detect_edge_t

EMVSIM card presence detection edge control.

typedef enum *_presence_detect_status* emvsim_presence_detect_status_t

EMVSIM card presence detection status.

SMARTCARD_EMV_RX_NACK_THRESHOLD

EMV RX NACK interrupt generation threshold.

SMARTCARD_EMV_TX_NACK_THRESHOLD

EMV TX NACK interrupt generation threshold.

SMARTCARD_WWT_ADJUSTMENT

Smart card Word Wait Timer adjustment value.

SMARTCARD_CWT_ADJUSTMENT
Smart card Character Wait Timer adjustment value.

2.110 Smart Card PHY Driver

void SMARTCARD_PHY_GetDefaultConfig(*smartcard_interface_config_t* *config)
Fills in the configuration structure with default values.

Parameters

- config – The Smart card user configuration structure which contains configuration structure of type smartcard_interface_config_t. Function fill in members: clockToResetDelay = 42000, vcc = kSmartcardVoltageClassB3_3V, with default values.

status_t SMARTCARD_PHY_Init(void *base, *smartcard_interface_config_t* const *config, uint32_t srcClock_Hz)
Initializes a Smart card interface instance.

Parameters

- base – The Smart card peripheral base address.
- config – The user configuration structure of type smartcard_interface_config_t. Call the function SMARTCARD_PHY_GetDefaultConfig() to fill the configuration structure.
- srcClock_Hz – Smart card clock generation module source clock.

Return values
kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

void SMARTCARD_PHY_Deinit(void *base, *smartcard_interface_config_t* const *config)
De-initializes a Smart card interface, stops the Smart card clock, and disables the VCC.

Parameters

- base – The Smart card peripheral module base address.
- config – The user configuration structure of type smartcard_interface_config_t.

status_t SMARTCARD_PHY_Activate(void *base, *smartcard_context_t* *context, *smartcard_reset_type_t* resetType)
Activates the Smart card IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- resetType – type of reset to be performed, possible values = kSmartcardColdReset, kSmartcardWarmReset

Return values
kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

status_t SMARTCARD_PHY_Deactivate(void *base, *smartcard_context_t* *context)
De-activates the Smart card IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

status_t SMARTCARD_PHY_Control(void *base, *smartcard_context_t* *context, *smartcard_interface_control_t* control, uint32_t param)

Controls the Smart card interface IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- control – A interface command type.
- param – Integer value specific to control type

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

SMARTCARD_ATR_DURATION_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles during which an ATR string has to be received.

SMARTCARD_INIT_DELAY_CLOCK_CYCLES_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles until an initial 'TS' character has to be received.

2.111 Smart Card PHY EMVSIM Driver

2.112 SNVS: Secure Non-Volatile Storage

2.113 Secure Non-Volatile Storage High-Power

void SNVS_HP_Init(SNVS_Type *base)

Initialize the SNVS.

Note: This API should be called at the beginning of the application using the SNVS driver.

Parameters

- base – SNVS peripheral base address

void SNVS_HP_Deinit(SNVS_Type *base)

Deinitialize the SNVS.

Parameters

- base – SNVS peripheral base address

void SNVS_HP_RTC_Init(SNVS_Type *base, const *snvs_hp_rtc_config_t* *config)

Ungates the SNVS clock and configures the peripheral for basic operation.

Note: This API should be called at the beginning of the application using the SNVS driver.

Parameters

- base – SNVS peripheral base address
- config – Pointer to the user's SNVS configuration structure.

void SNVS_HP_RTC_Deinit(SNVS_Type *base)

Stops the RTC and SRTC timers.

Parameters

- base – SNVS peripheral base address

void SNVS_HP_RTC_GetDefaultConfig(*snvs_hp_rtc_config_t* *config)

Fills in the SNVS config struct with the default settings.

The default values are as follows.

```
config->rtccalenable = false;
config->rtccalvalue = 0U;
config->PIFreq = 0U;
```

Parameters

- config – Pointer to the user's SNVS configuration structure.

status_t SNVS_HP_RTC_SetDatetime(SNVS_Type *base, const *snvs_hp_rtc_datetime_t* *datetime)

Sets the SNVS RTC date and time according to the given time structure.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS RTC kStatus_InvalidArgument: Error because the datetime format is incorrect

void SNVS_HP_RTC_GetDatetime(SNVS_Type *base, *snvs_hp_rtc_datetime_t* *datetime)

Gets the SNVS RTC time and stores it in the given time structure.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

status_t SNVS_HP_RTC_SetAlarm(SNVS_Type *base, const *snvs_hp_rtc_datetime_t* *alarmTime)

Sets the SNVS RTC alarm time.

The function sets the RTC alarm. It also checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error.

Parameters

- base – SNVS peripheral base address

- alarmTime – Pointer to the structure where the alarm time is stored.

Returns

kStatus_Success: success in setting the SNVS RTC alarm kStatus_InvalidArgument: Error because the alarm datetime format is incorrect kStatus_Fail: Error because the alarm time has already passed

void SNVS_HP_RTC_GetAlarm(SNVS_Type *base, *snvs_hp_rtc_datetime_t* *datetime)

Returns the SNVS RTC alarm time.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the alarm date and time details are stored.

void SNVS_HP_RTC_TimeSynchronize(SNVS_Type *base)

The function synchronizes RTC counter value with SRTC.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_RTC_EnableInterrupts(SNVS_Type *base, uint32_t mask)

Enables the selected SNVS interrupts.

Parameters

- base – SNVS peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_hp_interrupts_t

static inline void SNVS_HP_RTC_DisableInterrupts(SNVS_Type *base, uint32_t mask)

Disables the selected SNVS interrupts.

Parameters

- base – SNVS peripheral base address
- mask – The interrupts to disable. This is a logical OR of members of the enumeration :: _snvs_hp_interrupts_t

uint32_t SNVS_HP_RTC_GetEnabledInterrupts(SNVS_Type *base)

Gets the enabled SNVS interrupts.

Parameters

- base – SNVS peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration :: _snvs_hp_interrupts_t

uint32_t SNVS_HP_RTC_GetStatusFlags(SNVS_Type *base)

Gets the SNVS status flags.

Parameters

- base – SNVS peripheral base address

Returns

The status flags. This is the logical OR of members of the enumeration :: _snvs_hp_status_flags_t

static inline void SNVS_HP_RTC_ClearStatusFlags(SNVS_Type *base, uint32_t mask)

Clears the SNVS status flags.

Parameters

- base – SNVS peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration :: _snvs_hp_status_flags_t

static inline void SNVS_HP_RTC_StartTimer(SNVS_Type *base)

Starts the SNVS RTC time counter.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_RTC_StopTimer(SNVS_Type *base)

Stops the SNVS RTC time counter.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_EnableHighAssuranceCounter(SNVS_Type *base, bool enable)

Enable or disable the High Assurance Counter (HAC)

Parameters

- base – SNVS peripheral base address
- enable – Pass true to enable, false to disable.

static inline void SNVS_HP_StartHighAssuranceCounter(SNVS_Type *base, bool start)

Start or stop the High Assurance Counter (HAC)

Parameters

- base – SNVS peripheral base address
- start – Pass true to start, false to stop.

static inline void SNVS_HP_SetHighAssuranceCounterInitialValue(SNVS_Type *base, uint32_t value)

Set the High Assurance Counter (HAC) initialize value.

Parameters

- base – SNVS peripheral base address
- value – The initial value to set.

static inline void SNVS_HP_LoadHighAssuranceCounter(SNVS_Type *base)

Load the High Assurance Counter (HAC)

This function loads the HAC initialize value to counter register.

Parameters

- base – SNVS peripheral base address

static inline uint32_t SNVS_HP_GetHighAssuranceCounter(SNVS_Type *base)

Get the current High Assurance Counter (HAC) value.

Parameters

- base – SNVS peripheral base address

Returns

HAC currnet value.

static inline void SNVS_HP_ClearHighAssuranceCounter(SNVS_Type *base)

Clear the High Assurance Counter (HAC)

This function can be called in a functional or soft fail state. When the HAC is enabled:

- If the HAC is cleared in the soft fail state, the SSM transitions to the hard fail state immediately;
- If the HAC is cleared in functional state, the SSM will transition to hard fail immediately after transitioning to soft fail.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_LockHighAssuranceCounter(SNVS_Type *base)

Lock the High Assurance Counter (HAC)

Once locked, the HAC initialize value could not be changed, the HAC enable status could not be changed. This could only be unlocked by system reset.

Parameters

- base – SNVS peripheral base address

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enum _snvs_hp_interrupts

List of SNVS interrupts.

Values:

enumerator kSNVS_RTC_AlarmInterrupt

RTC time alarm

enumerator kSNVS_RTC_PeriodicInterrupt

RTC periodic interrupt

enum _snvs_hp_status_flags

List of SNVS flags.

Values:

enumerator kSNVS_RTC_AlarmInterruptFlag

RTC time alarm flag

enumerator kSNVS_RTC_PeriodicInterruptFlag

RTC periodic interrupt flag

enumerator kSNVS_ZMK_ZeroFlag

The ZMK is zero

enumerator kSNVS_OTPMK_ZeroFlag

The OTPMK is zero

enum _snvs_hp_sv_status_flags

List of SNVS security violation flags.

Values:

enumerator kSNVS_LP_ViolationFlag

Low Power section Security Violation

enumerator kSNVS_ZMK_EccFailFlag

Zeroizable Master Key Error Correcting Code Check Failure

enumerator kSNVS_LP_SoftwareViolationFlag
LP Software Security Violation

enumerator kSNVS_FatalSoftwareViolationFlag
Software Fatal Security Violation

enumerator kSNVS_SoftwareViolationFlag
Software Security Violation

enumerator kSNVS_Violation0Flag
Security Violation 0

enumerator kSNVS_Violation1Flag
Security Violation 1

enumerator kSNVS_Violation2Flag
Security Violation 2

enumerator kSNVS_Violation4Flag
Security Violation 4

enumerator kSNVS_Violation5Flag
Security Violation 5

enum _snvs_hp_ssm_state
List of SNVS Security State Machine State.

Values:

enumerator kSNVS_SSMInit
Init

enumerator kSNVS_SSMHardFail
Hard Fail

enumerator kSNVS_SSMSoftFail
Soft Fail

enumerator kSNVS_SSMInitInter
Init Intermediate (transition state between Init and Check)

enumerator kSNVS_SSMCheck
Check

enumerator kSNVS_SSMNonSecure
Non-Secure

enumerator kSNVS_SSMTrusted
Trusted

enumerator kSNVS_SSMSecure
Secure

typedef enum *_snvs_hp_interrupts* snvs_hp_interrupts_t
List of SNVS interrupts.

typedef enum *_snvs_hp_status_flags* snvs_hp_status_flags_t
List of SNVS flags.

typedef enum *_snvs_hp_sv_status_flags* snvs_hp_sv_status_flags_t
List of SNVS security violation flags.

typedef struct *_snvs_hp_rtc_datetime* snvs_hp_rtc_datetime_t

Structure is used to hold the date and time.

typedef struct *_snvs_hp_rtc_config* snvs_hp_rtc_config_t

SNVS config structure.

This structure holds the configuration settings for the SNVS peripheral. To initialize this structure to reasonable defaults, call the SNVS_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

typedef enum *_snvs_hp_ssm_state* snvs_hp_ssm_state_t

List of SNVS Security State Machine State.

static inline void SNVS_HP_EnableMasterKeySelection(SNVS_Type *base, bool enable)

Enable or disable master key selection.

Parameters

- base – SNVS peripheral base address
- enable – Pass true to enable, false to disable.

static inline void SNVS_HP_ProgramZeroizableMasterKey(SNVS_Type *base)

Trigger to program Zeroizable Master Key.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_ChangeSSMState(SNVS_Type *base)

Trigger SSM State Transition.

Trigger state transition of the system security monitor (SSM). It results only the following transitions of the SSM:

- Check State -> Non-Secure (when Non-Secure Boot and not in Fab Configuration)
- Check State –> Trusted (when Secure Boot or in Fab Configuration)
- Trusted State –> Secure
- Secure State –> Trusted
- Soft Fail –> Non-Secure

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_SetSoftwareFatalSecurityViolation(SNVS_Type *base)

Trigger Software Fatal Security Violation.

The result SSM state transition is:

- Check State -> Soft Fail
- Non-Secure State -> Soft Fail
- Trusted State -> Soft Fail
- Secure State -> Soft Fail

Parameters

- base – SNVS peripheral base address

static inline void SNVS_HP_SetSoftwareSecurityViolation(SNVS_Type *base)

Trigger Software Security Violation.

The result SSM state transition is:

- Check -> Non-Secure
- Trusted -> Soft Fail
- Secure -> Soft Fail

Parameters

- base – SNVS peripheral base address

static inline *snvs_hp_ssm_state_t* SNVS_HP_GetSSMState(SNVS_Type *base)

Get current SSM State.

Parameters

- base – SNVS peripheral base address

Returns

Current SSM state

static inline void SNVS_HP_ResetLP(SNVS_Type *base)

Reset the SNVS LP section.

Reset the LP section except SRTC and Time alarm.

Parameters

- base – SNVS peripheral base address

static inline uint32_t SNVS_HP_GetStatusFlags(SNVS_Type *base)

Get the SNVS HP status flags.

The flags are returned as the OR'ed value f the enumeration :: _snvs_hp_status_flags_t.

Parameters

- base – SNVS peripheral base address

Returns

The OR'ed value of status flags.

static inline void SNVS_HP_ClearStatusFlags(SNVS_Type *base, uint32_t mask)

Clear the SNVS HP status flags.

The flags to clear are passed in as the OR'ed value of the enumeration :: _snvs_hp_status_flags_t. Only these flags could be cleared using this API.

- kSNVS_RTC_PeriodicInterruptFlag
- kSNVS_RTC_AlarmInterruptFlag

Parameters

- base – SNVS peripheral base address
- mask – OR'ed value of the flags to clear.

static inline uint32_t SNVS_HP_GetSecurityViolationStatusFlags(SNVS_Type *base)

Get the SNVS HP security violation status flags.

The flags are returned as the OR'ed value of the enumeration :: _snvs_hp_sv_status_flags_t.

Parameters

- base – SNVS peripheral base address

Returns

The OR'ed value of security violation status flags.

static inline void SNVS_HP_ClearSecurityViolationStatusFlags(SNVS_Type *base, uint32_t mask)

Clear the SNVS HP security violation status flags.

The flags to clear are passed in as the OR'ed value of the enumeration :: _snvs_hp_sv_status_flags_t. Only these flags could be cleared using this API.

- kSNVS_ZMK_EccFailFlag
- kSNVS_Violation0Flag
- kSNVS_Violation1Flag
- kSNVS_Violation2Flag
- kSNVS_Violation3Flag
- kSNVS_Violation4Flag
- kSNVS_Violation5Flag

Parameters

- base – SNVS peripheral base address
- mask – OR'ed value of the flags to clear.

SNVS_HPSVSR_SV0_MASK

SNVS_HPSVSR_SV1_MASK

SNVS_HPSVSR_SV2_MASK

SNVS_HPSVSR_SV4_MASK

SNVS_HPSVSR_SV5_MASK

SNVS_MAKE_HP_SV_FLAG(x)

Macro to make security violation flag.

Macro help to make security violation flag kSNVS_Violation0Flag to kSNVS_Violation5Flag, For example, SNVS_MAKE_HP_SV_FLAG(0) is kSNVS_Violation0Flag.

struct _snvs_hp_rtc_datetime

#include <fsl_snvs_hp.h> Structure is used to hold the date and time.

Public Members

uint16_t year

Range from 1970 to 2099.

uint8_t month

Range from 1 to 12.

uint8_t day

Range from 1 to 31 (depending on month).

uint8_t hour

Range from 0 to 23.

uint8_t minute

Range from 0 to 59.

uint8_t second

Range from 0 to 59.

struct _snvs_hp_rtc_config

#include <fsl_snvs_hp.h> SNVS config structure.

This structure holds the configuration settings for the SNVS peripheral. To initialize this structure to reasonable defaults, call the SNVS_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

Public Members

bool rtcCalEnable

true: RTC calibration mechanism is enabled; false:No calibration is used

uint32_t rtcCalValue

Defines signed calibration value for nonsecure RTC; This is a 5-bit 2's complement value, range from -16 to +15

uint32_t periodicInterruptFreq

Defines frequency of the periodic interrupt; Range from 0 to 15

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void SNVS_LP_Init(SNVS_Type *base)

Ungates the SNVS clock and configures the peripheral for basic operation.

Note: This API should be called at the beginning of the application using the SNVS driver.

Parameters

- base – SNVS peripheral base address

void SNVS_LP_Deinit(SNVS_Type *base)

Deinit the SNVS LP section.

Parameters

- base – SNVS peripheral base address

status_t SNVS_LP_SRTC_SetDatetime(SNVS_Type *base, const *snvs_lp_srtc_datetime_t* *datetime)

Sets the SNVS SRTC date and time according to the given time structure.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS SRTC kStatus_InvalidArgument: Error because the datetime format is incorrect

void SNVS_LP_SRTC_GetDatetime(SNVS_Type *base, *snvs_lp_srtc_datetime_t* *datetime)

Gets the SNVS SRTC time and stores it in the given time structure.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

status_t SNVS_LP_SRTC_SetAlarm(SNVS_Type *base, const *snvs_lp_srtc_datetime_t* *alarmTime)

Sets the SNVS SRTC alarm time.

The function sets the SRTC alarm. It also checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error. Please note, that SRTC alarm has limited resolution because only 32 most significant bits of SRTC counter are compared to SRTC Alarm register. If the alarm time is beyond SRTC resolution, the function does not set the alarm and returns an error.

Parameters

- base – SNVS peripheral base address
- alarmTime – Pointer to the structure where the alarm time is stored.

Returns

kStatus_Success: success in setting the SNVS SRTC alarm kStatus_InvalidArgument: Error because the alarm datetime format is incorrect kStatus_Fail: Error because the alarm time has already passed or is beyond resolution

void SNVS_LP_SRTC_GetAlarm(SNVS_Type *base, *snvs_lp_srtc_datetime_t* *datetime)

Returns the SNVS SRTC alarm time.

Parameters

- base – SNVS peripheral base address
- datetime – Pointer to the structure where the alarm date and time details are stored.

static inline void SNVS_LP_SRTC_EnableInterrupts(SNVS_Type *base, uint32_t mask)

Enables the selected SNVS interrupts.

Parameters

- base – SNVS peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_lp_srtc_interrupts

static inline void SNVS_LP_SRTC_DisableInterrupts(SNVS_Type *base, uint32_t mask)

Disables the selected SNVS interrupts.

Parameters

- base – SNVS peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_lp_srtc_interrupts

uint32_t SNVS_LP_SRTC_GetEnabledInterrupts(SNVS_Type *base)

Gets the enabled SNVS interrupts.

Parameters

- base – SNVS peripheral base address

Returns
The enabled interrupts. This is the logical OR of members of the enumeration :: _snvs_lp_srtc_interrupts

uint32_t SNVS_LP_SRTC_GetStatusFlags(SNVS_Type *base)

Gets the SNVS status flags.

Parameters

- base – SNVS peripheral base address

Returns
The status flags. This is the logical OR of members of the enumeration :: _snvs_lp_srtc_status_flags

static inline void SNVS_LP_SRTC_ClearStatusFlags(SNVS_Type *base, uint32_t mask)

Clears the SNVS status flags.

Parameters

- base – SNVS peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration :: _snvs_lp_srtc_status_flags

static inline void SNVS_LP_SRTC_StartTimer(SNVS_Type *base)

Starts the SNVS SRTC time counter.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_LP_SRTC_StopTimer(SNVS_Type *base)

Stops the SNVS SRTC time counter.

Parameters

- base – SNVS peripheral base address

void SNVS_LP_EnablePassiveTamper(SNVS_Type *base, *snvs_lp_external_tamper_t* pin, *snvs_lp_passive_tamper_t* config)

Enables the specified SNVS external tamper.

Parameters

- base – SNVS peripheral base address
- pin – SNVS external tamper pin
- config – Configuration structure of external passive tamper

status_t SNVS_LP_EnableTxActiveTamper(SNVS_Type *base, *snvs_lp_active_tx_tamper_t* pin, *tamper_active_tx_config_t* config)

Enable active tamper tx external pad.

Parameters

- base – SNVS peripheral base address
- pin – SNVS active tamper pin
- config – Configuration structure of external active tamper

status_t SNVS_LP_EnableRxActiveTamper(SNVS_Type *base, *snvs_lp_external_tamper_t* rx, *tamper_active_rx_config_t* config)

Enable active tamper rx external pad.

Parameters

- base – SNVS peripheral base address

- rx – SNVS external RX tamper pin
- config – SNVS RX tamper config structure

status_t SNVS_LP_SetVoltageTamper(SNVS_Type *base, bool enable)

Sets voltage tamper detect.

Parameters

- base – SNVS peripheral base address
- enable – True if enable false if disable

status_t SNVS_LP_SetTemperatureTamper(SNVS_Type *base, bool enable)

Sets temperature tamper detect.

Parameters

- base – SNVS peripheral base address
- enable – True if enable false if disable

status_t SNVS_LP_SetClockTamper(SNVS_Type *base, bool enable)

Sets clock tamper detect.

Parameters

- base – SNVS peripheral base address
- enable – True if enable false if disable

snvs_lp_external_tamper_status_t SNVS_LP_CheckVoltageTamper(SNVS_Type *base)

brief Check voltage tamper

param base SNVS peripheral base address

snvs_lp_external_tamper_status_t SNVS_LP_CheckTemperatureTamper(SNVS_Type *base)

Check temperature tamper.

Parameters

- base – SNVS peripheral base address

snvs_lp_external_tamper_status_t SNVS_LP_CheckClockTamper(SNVS_Type *base)

brief Check clock tamper

param base SNVS peripheral base address

void SNVS_LP_TamperPinTx_GetDefaultConfig(*tamper_active_tx_config_t* *config)

Fills in the SNVS tamper pin config struct with the default settings.

The default values are as follows. code config->clock = kSNVS_ActiveTamper16HZ; config->seed = 0U; config->polynomial = 0U; endcode

Parameters

- config – Pointer to the user's SNVS configuration structure.

void SNVS_LP_TamperPinRx_GetDefaultConfig(*tamper_active_rx_config_t* *config)

brief Fills in the SNVS tamper pin config struct with the default settings.

The default values are as follows. code config->filterenable = 0U; config->filter = 0U; config->tx = kSNVS_ActiveTamper1; endcode param config Pointer to the user's SNVS configuration structure.

void SNVS_LP_PassiveTamperPin_GetDefaultConfig(*snvs_lp_passive_tamper_t* *config)

Fills in the SNVS tamper pin config struct with the default settings.

The default values are as follows. code config->polarity = 0U; config->filterenable = 0U; if available on SoC config->filter = 0U; if available on SoC endcode

Parameters

- config – Pointer to the user's SNVS configuration structure.

void SNVS_LP_DisableExternalTamper(SNVS_Type *base, *snvs_lp_external_tamper_t* pin)

Disables the specified SNVS external tamper.

Parameters

- base – SNVS peripheral base address
- pin – SNVS external tamper pin

void SNVS_LP_DisableAllExternalTamper(SNVS_Type *base)

Disable all external tamper.

Parameters

- base – SNVS peripheral base address

snvs_lp_external_tamper_status_t SNVS_LP_GetExternalTamperStatus(SNVS_Type *base, *snvs_lp_external_tamper_t* pin)

Returns status of the specified external tamper.

Parameters

- base – SNVS peripheral base address
- pin – SNVS external tamper pin

Returns

The status flag. This is the enumeration :: _snvs_lp_external_tamper_status

void SNVS_LP_ClearExternalTamperStatus(SNVS_Type *base, *snvs_lp_external_tamper_t* pin)

Clears status of the specified external tamper.

Parameters

- base – SNVS peripheral base address
- pin – SNVS external tamper pin

void SNVS_LP_ClearAllExternalTamperStatus(SNVS_Type *base)

Clears status of the all external tamper.

Parameters

- base – SNVS peripheral base address

static inline void SNVS_LP_EnableMonotonicCounter(SNVS_Type *base, bool enable)

Enable or disable the Monotonic Counter.

Parameters

- base – SNVS peripheral base address
- enable – Pass true to enable, false to disable.

uint64_t SNVS_LP_GetMonotonicCounter(SNVS_Type *base)

Get the current Monotonic Counter.

Parameters

- base – SNVS peripheral base address

Returns

Current Monotonic Counter value.

static inline void SNVS_LP_IncreaseMonotonicCounter(SNVS_Type *base)

Increase the Monotonic Counter.

Increase the Monotonic Counter by 1.

Parameters

- base – SNVS peripheral base address

void SNVS_LP_WriteZeroizableMasterKey(SNVS_Type *base, uint32_t ZMKey[8U])

Write Zeroizable Master Key (ZMK) to the SNVS registers.

Parameters

- base – SNVS peripheral base address
- ZMKey – The ZMK write to the SNVS register.

static inline void SNVS_LP_SetZeroizableMasterKeyValid(SNVS_Type *base, bool valid)

Set Zeroizable Master Key valid.

This API could only be called when using software programming mode. After writing ZMK using SNVS_LP_WriteZeroizableMasterKey, call this API to make the ZMK valid.

Parameters

- base – SNVS peripheral base address
- valid – Pass true to set valid, false to set invalid.

static inline bool SNVS_LP_GetZeroizableMasterKeyValid(SNVS_Type *base)

Get Zeroizable Master Key valid status.

In hardware programming mode, call this API to check whether the ZMK is valid.

Parameters

- base – SNVS peripheral base address

Returns

true if valid, false if invalid.

static inline void SNVS_LP_SetZeroizableMasterKeyProgramMode(SNVS_Type *base, *snvs_lp_zmk_program_mode_t* mode)

Set Zeroizable Master Key programming mode.

Parameters

- base – SNVS peripheral base address
- mode – ZMK programming mode.

static inline void SNVS_LP_EnableZeroizableMasterKeyECC(SNVS_Type *base, bool enable)

Enable or disable Zeroizable Master Key ECC.

Parameters

- base – SNVS peripheral base address
- enable – Pass true to enable, false to disable.

static inline void SNVS_LP_SetMasterKeyMode(SNVS_Type *base, *snvs_lp_master_key_mode_t* mode)

Set SNVS Master Key mode.

Note: When kSNVS_ZMK or kSNVS_CMK used, the SNVS_HP must be configured to enable the master key selection.

Parameters

- base – SNVS peripheral base address
- mode – Master Key mode.

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enum _snvs_lp_srtc_interrupts

List of SNVS_LP interrupts.

Values:

enumerator kSNVS_SRTC_AlarmInterrupt

SRTC time alarm.

enum _snvs_lp_srtc_status_flags

List of SNVS_LP flags.

Values:

enumerator kSNVS_SRTC_AlarmInterruptFlag

SRTC time alarm flag

enum _snvs_lp_external_tamper

List of SNVS_LP external tampers.

Values:

enumerator kSNVS_ExternalTamper1

enum _snvs_lp_active_tamper

List of SNVS_LP active tampers.

Values:

enumerator kSNVS_ActiveTamper1

enumerator kSNVS_ActiveTamper2

enumerator kSNVS_ActiveTamper3

enumerator kSNVS_ActiveTamper4

enumerator kSNVS_ActiveTamper5

enum _snvs_lp_active_clock

List of SNVS_LP external tampers.

Values:

enumerator kSNVS_ActiveTamper16HZ

enumerator kSNVS_ActiveTamper8HZ

enumerator kSNVS_ActiveTamper4HZ

enumerator kSNVS_ActiveTamper2HZ

enum _snvs_lp_external_tamper_status

List of SNVS_LP external tampers status.

Values:

enumerator kSNVS_TamperNotDetected

enumerator kSNVS_TamperDetected

enum _snvs_lp_external_tamper_polarity
SNVS_LP external tamper polarity.

Values:

enumerator kSNVS_ExternalTamperActiveLow

enumerator kSNVS_ExternalTamperActiveHigh

enum _snvs_lp_zmk_program_mode
SNVS_LP Zeroizable Master Key programming mode.

Values:

enumerator kSNVS_ZMKSoftwareProgram
Software programming mode.

enumerator kSNVS_ZMKHardwareProgram
Hardware programming mode.

enum _snvs_lp_master_key_mode
SNVS_LP Master Key mode.

Values:

enumerator kSNVS_OTPMK
One Time Programmable Master Key.

enumerator kSNVS_ZMK
Zeroizable Master Key.

enumerator kSNVS_CMK
Combined Master Key, it is XOR of OPTMK and ZMK.

typedef enum *_snvs_lp_srtc_interrupts* snvs_lp_srtc_interrupts_t
List of SNVS_LP interrupts.

typedef enum *_snvs_lp_srtc_status_flags* snvs_lp_srtc_status_flags_t
List of SNVS_LP flags.

typedef enum *_snvs_lp_external_tamper* snvs_lp_external_tamper_t
List of SNVS_LP external tampers.

typedef enum *_snvs_lp_active_tamper* snvs_lp_active_tx_tamper_t
List of SNVS_LP active tampers.

typedef enum *_snvs_lp_active_clock* snvs_lp_active_clock_t
List of SNVS_LP external tampers.

typedef enum *_snvs_lp_external_tamper_status* snvs_lp_external_tamper_status_t
List of SNVS_LP external tampers status.

typedef enum *_snvs_lp_external_tamper_polarity* snvs_lp_external_tamper_polarity_t
SNVS_LP external tamper polarity.

typedef struct *_snvs_lp_srtc_datetime* snvs_lp_srtc_datetime_t
Structure is used to hold the date and time.

typedef struct *_snvs_lp_srtc_config* snvs_lp_srtc_config_t

SNVS_LP config structure.

This structure holds the configuration settings for the SNVS_LP peripheral. To initialize this structure to reasonable defaults, call the SNVS_LP_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

typedef enum *_snvs_lp_zmk_program_mode* snvs_lp_zmk_program_mode_t

SNVS_LP Zeroizable Master Key programming mode.

typedef enum *_snvs_lp_master_key_mode* snvs_lp_master_key_mode_t

SNVS_LP Master Key mode.

void SNVS_LP_SRTC_Init(SNVS_Type *base, const *snvs_lp_srtc_config_t* *config)

Ungates the SNVS clock and configures the peripheral for basic operation.

Note: This API should be called at the beginning of the application using the SNVS driver.

Parameters

- base – SNVS peripheral base address
- config – Pointer to the user's SNVS configuration structure.

void SNVS_LP_SRTC_Deinit(SNVS_Type *base)

Stops the SRTC timer.

Parameters

- base – SNVS peripheral base address

void SNVS_LP_SRTC_GetDefaultConfig(*snvs_lp_srtc_config_t* *config)

Fills in the SNVS_LP config struct with the default settings.

The default values are as follows.

```
config->srtccalenable = false;
config->srtccalvalue = 0U;
```

Parameters

- config – Pointer to the user's SNVS configuration structure.

SNVS_ZMK_REG_COUNT

Define of SNVS_LP Zeroizable Master Key registers.

SNVS_LP_MAX_TAMPER

Define of SNVS_LP Max possible tamper.

struct tamper_active_tx_config_t

#include <fsl_snvs_lp.h> Structure is used to configure SNVS LP active TX tamper pins.

struct tamper_active_rx_config_t

#include <fsl_snvs_lp.h> Structure is used to configure SNVS LP active RX tamper pins.

struct snvs_lp_passive_tamper_t

#include <fsl_snvs_lp.h> Structure is used to configure SNVS LP passive tamper pins.

struct _snvs_lp_srtc_datetime

#include <fsl_snvs_lp.h> Structure is used to hold the date and time.

Public Members

uint16_t year
: Range from 1970 to 2099.

uint8_t month
: Range from 1 to 12.

uint8_t day
: Range from 1 to 31 (depending on month).

uint8_t hour
: Range from 0 to 23.

uint8_t minute
: Range from 0 to 59.

uint8_t second
: Range from 0 to 59.

struct __snvs_lp_srtc_config
: *#include <fsl_snvs_lp.h>* SNVS_LP config structure.

This structure holds the configuration settings for the SNVS_LP peripheral. To initialize this structure to reasonable defaults, call the SNVS_LP_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

Public Members

bool srtcCalEnable
: true: SRTC calibration mechanism is enabled; false: No calibration is used

uint32_t srtcCalValue
: Defines signed calibration value for SRTC; This is a 5-bit 2's complement value, range from -16 to +15

2.115 Soc_mipi_csi2rx

void MIPI_CSI2RX_SoftwareReset(MIPI_CSI2RX_Type *base, bool reset)
: Assert or deassert CSI2RX reset in system level.

Note: Don't call this function directly.

Parameters

- base – The CSI2RX peripheral base address.
- reset – Pass in true to set to reset state, false to release reset.

void MIPI_CSI2RX_InitInterface(MIPI_CSI2RX_Type *base, uint8_t tHsSettle_EscClk)
: Initialize the CSI2RX interface.

Note: Don't call this function directly.

Parameters

- base – The CSI2RX peripheral base address.
- tHsSettle_EscClk – t-HS_SETTLE in esc clock period.

void MIPI_CSI2RX_DeinitInterface(MIPI_CSI2RX_Type *base)

Deinitialize the CSI2RX interface.

Note: Don't call this function directly.

Parameters

- base – The CSI2RX peripheral base address.

FSL_SOC_MIPI_CSI2RX_DRIVER_VERSION

Driver version.

2.116 Soc_mipi_dsi

FSL_SOC_MIPI_DSI_DRIVER_VERSION

Driver version 2.0.0.

DSI_DPHY_PLL_VCO_MAX

DSI_DPHY_PLL_VCO_MIN

FSL_COMPONENT_ID

2.117 Soc_src

enum _src_core_name

System core.

Values:

enumerator kSRC_CM7Core

System Core CM4.

enumerator kSRC_CM4Core

System Core CM7.

enum _src_boot_fuse_selection

The enumeration of the boot fuse selection.

Values:

enumerator kSRC_SerialDownloaderBootFlow

The Boot flow jumps directly to the serial downloader.

enumerator kSRC_NormalBootFlow

The Boot flow follows the Normal Boot flow.

enum _src_global_system_reset_source

The enumeration of global system reset sources.

Values:

enumerator kSRC_WdogReset
WDOG triggers the global system reset.

enumerator kSRC_Wdog3Reset
WDOG3 triggers the global system reset.

enumerator kSRC_Wdog4Reset
WODG4 triggers the global system reset.

enumerator kSRC_M4LockUpReset
M4 core lockup triggers the global system reset.

enumerator kSRC_M7LockUpReset
M7 core lockup triggers the global system reset.

enumerator kSRC_M4RequestReset
M4 core request triggers the global system reset.

enumerator kSRC_M7RequestReset
M7 core request triggers the global system reset.

enumerator kSRC_TempsenseReset
Tempsense trigggers the global system reset.

enumerator kSRC_CSUReset
CSU triggers the global system reset.

enumerator kSRC_JageSoftwareReset
JATG software triggers the global system reset.

enumerator kSRC_OverVoltageReset
Over voltage triggers the global system reset.

enum _src_global_system_reset_status_flags
The enumeration of reset status flags.

Values:

enumerator kSRC_M7CoreIppResetFlag
The M7 Core reset is the result of ipp_reset_b pin.

enumerator kSRC_M7CoreM7RequestResetFlag
The M7 Core reset is the result of M7 core reset request.

enumerator kSRC_M7CoreM7LockUpResetFlag
The M7 Core reset is the result of M7 core lock up.

enumerator kSRC_M7CoreCSUResetFlag
The M7 Core reset is the result of csu_reset_b input.

enumerator kSRC_M7CoreIppUserResetFlag
The M7 Core reset is the result of ipp_user_reset_b qualified reset.

enumerator kSRC_M7CoreWdogResetFlag
The M7 Core reset is the result of the watchdog time-out event.

enumerator kSRC_M7CoreJtagResetFlag
The M7 Core reset is the result of HIGH-Z reset from JTAG.

enumerator kSRC_M7CoreJtagSWResetFlag
The M7 Core reset is the result of software reset from JTAG.

enumerator kSRC_M7CoreWdog3ResetFlag
The M7 Core reset is the result of watchdog3 time-out event.

enumerator kSRC_M7CoreWdog4ResetFlag
The M7 Core reset is the result of watchdog4 time-out event.

enumerator kSRC_M7CoreTempsenseResetFlag
The M7 Core reset is the result of on-chip temperature sensor.

enumerator kSRC_M7CoreM4RequestResetFlag
The M7 Core reset is the result of M4 CPU reset request.

enumerator kSRC_M7CoreM4LockUpResetFlag
The M7 Core reset is the result of M4 CPU lock up.

enumerator kSRC_M7CoreOverVoltageResetFlag
The M7 Core reset is the result of over voltage.

enumerator kSRC_M7CoreCdogResetFlag
The M7 Core reset is the result of Cdog.

enumerator kSRC_M4CoreIppResetFlag
The M4 Core reset is the result of ipp_reset_b pin.

enumerator kSRC_M4CoreM4RequestResetFlag
The M4 Core reset is the result of M4 core reset request.

enumerator kSRC_M4CoreM4LockUpResetFlag
The M4 Core reset is the result of M4 core lock up.

enumerator kSRC_M4CoreCSUResetFlag
The M4 Core reset is the result of csu_reset_b input.

enumerator kSRC_M4CoreIppUserResetFlag
The M4 Core reset is the result of ipp_user_reset_b qualified reset.

enumerator kSRC_M4CoreWdogResetFlag
The M4 Core reset is the result of the watchdog time-out event.

enumerator kSRC_M4CoreJtagResetFlag
The M4 Core reset is the result of HIGH-Z reset from JTAG.

enumerator kSRC_M4CoreJtagSWResetFlag
The M4 Core reset is the result of software reset from JTAG.

enumerator kSRC_M4CoreWdog3ResetFlag
The M4 Core reset is the result of watchdog3 time-out event.

enumerator kSRC_M4CoreWdog4ResetFlag
The M4 Core reset is the result of watchdog4 time-out event.

enumerator kSRC_M4CoreTempsenseResetFlag
The M4 Core reset is the result of on-chip temperature sensor.

enumerator kSRC_M4CoreM7RequestResetFlag
The M4 Core reset is the result of M7 CPU reset request.

enumerator kSRC_M4CoreM7LockUpResetFlag
The M4 Core reset is the result of M7 CPU lock up.

enumerator kSRC_M4CoreOverVoltageResetFlag
The M4 Core reset is the result of over voltage.

enumerator kSRC_M4CoreCdogResetFlag
The M4 Core reset is the result of Cdog.

enum _src_global_system_reset_mode
The enumeration of global system reset mode.

Values:

enumerator kSRC_ResetSystem
Generate the global system reset.

enumerator kSRC_DoNotResetSystem
Do not generate the global system reset.

enum _src_reset_slice_name
The enumeration of the slice name.

Values:

enumerator kSRC_MegaSlice
Megamix reset slice.

enumerator kSRC_DisplaySlice
Displaymix reset slice.

enumerator kSRC_WakeUpSlice
Wakeupmix reset slice.

enumerator kSRC_LpsrSlice
Lpsrmix reset slice.

enumerator kSRC_M4CoreSlice
M4 core reset slice.

enumerator kSRC_M7CoreSlice
M7 core reset slice.

enumerator kSRC_M4DebugSlice
M4 debug reset slice.

enumerator kSRC_M7DebugSlice
M7 debug reset slice.

enumerator kSRC_Usbphy1Slice
USBPHY1 reset slice.

enumerator kSRC_Usbphy2Slice
USBPHY2 reset slice.

enum _src_domain_mode_selection
The enumeration of the domain mode.

Values:

enumerator kSRC_Cpu0RunModeAssertReset
CPU0 in run mode will assert slice reset.

enumerator kSRC_Cpu0WaitModeAssertReset
CPU0 in wait mode will assert reset.

enumerator kSRC_Cpu0StopModeAssertReset
CPU0 in stop mode will assert reset.

enumerator kSRC_Cpu0SuspendModeAssertReset
CPU0 in suspend mode will assert reset.

enumerator kSRC_Cpu1RunModeAssertReset
CPU1 in run mode will assert slice reset.

enumerator kSRC_Cpu1WaitModeAssertReset
CPU1 in wait mode will assert reset.

enumerator kSRC_Cpu1StopModeAssertReset
CPU1 in stop mode will assert reset.

enumerator kSRC_Cpu1SuspendModeAssertReset
CPU1 in suspend mode will assert reset.

enum _src_setpoint_selection
The enumeration of setpoint.

Values:

enumerator kSRC_SetPoint0AssertReset
In setpoint0 will assert slice reset.

enumerator kSRC_SetPoint1AssertReset
In setpoint1 will assert slice reset.

enumerator kSRC_SetPoint2AssertReset
In setpoint2 will assert slice reset.

enumerator kSRC_SetPoint3AssertReset
In setpoint3 will assert slice reset.

enumerator kSRC_SetPoint4AssertReset
In setpoint4 will assert slice reset.

enumerator kSRC_SetPoint5AssertReset
In setpoint5 will assert slice reset.

enumerator kSRC_SetPoint6AssertReset
In setpoint6 will assert slice reset.

enumerator kSRC_SetPoint7AssertReset
In setpoint7 will assert slice reset.

enumerator kSRC_SetPoint8AssertReset
In setpoint8 will assert slice reset.

enumerator kSRC_SetPoint9AssertReset
In setpoint9 will assert slice reset.

enumerator kSRC_SetPoint10AssertReset
In setpoint10 will assert slice reset.

enumerator kSRC_SetPoint11AssertReset
In setpoint11 will assert slice reset.

enumerator kSRC_SetPoint12AssertReset
In setpoint12 will assert slice reset.

enumerator kSRC_SetPoint13AssertReset
In setpoint13 will assert slice reset.

enumerator kSRC_SetPoint14AssertReset
In setpoint14 will assert slice reset.

enumerator kSRC_SetPoint15AssertReset
In setpoint15 will assert slice reset.

enum _src_general_purpose_register_index
The index of each general purpose register.

Values:

enumerator kSRC_GeneralPurposeRegister1
The index of General Purpose Register1.

enumerator kSRC_GeneralPurposeRegister2
The index of General Purpose Register2.

enumerator kSRC_GeneralPurposeRegister3
The index of General Purpose Register3.

enumerator kSRC_GeneralPurposeRegister4
The index of General Purpose Register4.

enumerator kSRC_GeneralPurposeRegister5
The index of General Purpose Register5.

enumerator kSRC_GeneralPurposeRegister6
The index of General Purpose Register6.

enumerator kSRC_GeneralPurposeRegister7
The index of General Purpose Register7.

enumerator kSRC_GeneralPurposeRegister8
The index of General Purpose Register8.

enumerator kSRC_GeneralPurposeRegister9
The index of General Purpose Register9.

enumerator kSRC_GeneralPurposeRegister10
The index of General Purpose Register10.

enumerator kSRC_GeneralPurposeRegister11
The index of General Purpose Register11.

enumerator kSRC_GeneralPurposeRegister12
The index of General Purpose Register12.

enumerator kSRC_GeneralPurposeRegister13
The index of General Purpose Register13.

enumerator kSRC_GeneralPurposeRegister14
The index of General Purpose Register14.

enumerator kSRC_GeneralPurposeRegister15
The index of General Purpose Register15.

enumerator kSRC_GeneralPurposeRegister16
The index of General Purpose Register16.

enumerator kSRC_GeneralPurposeRegister17
The index of General Purpose Register17.

enumerator kSRC_GeneralPurposeRegister18
The index of General Purpose Register18.

enumerator kSRC_GeneralPurposeRegister19
The index of General Purpose Register19.

enumerator kSRC_GeneralPurposeRegister20
The index of General Purpose Register20.

enum _src_slice_reset_source
The enumeration of the reset source of each slice.

Values:

enumerator kSRC_SoftwareReset
Reset is caused by software setting.

enumerator kSRC_PowerModeTransferReset
Reset is caused by the power mode transfer.

enum _src_slice_reset_state
The enumeration of the reset state of each slice.

Values:

enumerator kSRC_SliceResetFinished
The reset is finished.

enumerator kSRC_SliceResetInProcess
The reset is in process.

typedef enum *_src_core_name* src_core_name_t
System core.

typedef enum *_src_boot_fuse_selection* src_boot_fuse_selection_t
The enumeration of the boot fuse selection.

typedef enum *_src_global_system_reset_source* src_global_system_reset_source_t
The enumeration of global system reset sources.

typedef enum *_src_global_system_reset_mode* src_global_system_reset_mode_t
The enumeration of global system reset mode.

typedef enum *_src_reset_slice_name* src_reset_slice_name_t
The enumeration of the slice name.

typedef enum *_src_general_purpose_register_index* src_general_purpose_register_index_t
The index of each general purpose register.

typedef struct *_src_setpoint_authentication* src_setpoint_authentication_t
The structure of setpoint authentication.

typedef struct *_src_domain_mode_authentication* src_domain_mode_authentication_t
The stucture of domain mode authentication.

typedef enum *_src_slice_reset_state* src_slice_reset_state_t
The enumeration of the reset state of each slice.

FSL_SRC_DRIVER_VERSION
SRC driver version 2.1.1.

SRC_SLICE_ADDRESS_OFFSET

SRC_SLICE_AUTHENTICATION_REGISTER_OFFSET

SRC_SLICE_CONTROL_REGISTER_OFFSET

SRC_SLICE_SETPOINT_CONFIG_REGISTER_OFFSET

SRC_SLICE_DOMAIN_CONFIG_REGISTER_OFFSET

SRC_SLICE_STATUS_REGISTER_OFFSET

SRC_GET_SLICE_REGISTER_ADDRESS(base, sliceName, registerOffset)

SRC_SLICE_STAT_UNDER_RST_MASK

SRC_SLICE_STAT_RST_BY_HW_MASK

SRC_SLICE_STAT_RST_BY_SW_MASK

SRC_WHITE_LIST_VALUE(coreName)

SRC_ASSIGN_LIST_VALUE(coreName)

SRC_SLICE_AUTHEN_DOMAIN_MODE_MASK

SRC_SLICE_AUTHEN_SETPOINT_MODE_MASK

SRC_SLICE_AUTHEN_LOCK_MODE_MASK

SRC_SLICE_AUTHEN_LOCK_MODE_SHIFT

SRC_SLICE_AUTHEN_LOCK_MODE(x)

SRC_SLICE_AUTHEN_ASSIGN_LIST_MASK

SRC_SLICE_AUTHEN_ASSIGN_LIST_SHIFT

SRC_SLICE_AUTHEN_ASSIGN_LIST(x)

SRC_SLICE_AUTHEN_LOCK_ASSIGN_MASK

SRC_SLICE_AUTHEN_LOCK_ASSIGN_SHIFT

SRC_SLICE_AUTHEN_LOCK_ASSIGN(x)

SRC_SLICE_AUTHEN_WHITE_LIST_MASK

SRC_SLICE_AUTHEN_WHITE_LIST_SHIFT

SRC_SLICE_AUTHEN_WHITE_LIST(x)

SRC_SLICE_AUTHEN_LOCK_LIST_MASK

SRC_SLICE_AUTHEN_LOCK_LIST_SHIFT

SRC_SLICE_AUTHEN_LOCK_LIST(x)

SRC_SLICE_AUTHEN_USER_MASK

SRC_SLICE_AUTHEN_USER_SHIFT

SRC_SLICE_AUTHEN_USER(x)

SRC_SLICE_AUTHEN_NONSECURE_MASK

SRC_SLICE_AUTHEN_NONSECURE_SHIFT

SRC_SLICE_AUTHEN_NONSECURE(x)

SRC_SLICE_AUTHEN_LOCK_SETTING_MASK

SRC_SLICE_AUTHEN_LOCK_SETTING_SHIFT

SRC_SLICE_AUTHEN_LOCK_SETTING(x)

void SRC_ReleaseCoreReset(SRC_Type *base, *src_core_name_t* coreName)

Releases related core reset operation.

The core reset will be held until the boot core to release it.

Parameters

- base – SRC peripheral base address.
- coreName – The name of the reset core to be released.

static inline uint32_t SRC_GetBootConfig(SRC_Type *base)

Gets Boot configuration.

Parameters

- base – SRC peripheral base address.

Returns

Boot configuration. Please refer to fusemap.

static inline uint8_t SRC_GetBootMode(SRC_Type *base)

Gets the latched state of the BOOT_MODE1 and BOOT_MODE0 signals.

Parameters

- base – SRC peripheral base address.

Returns

Boot mode. Please refer to the Boot mode pin setting section of System Boot.

static inline *src_boot_fuse_selection_t* SRC_GetBootFuseSelection(SRC_Type *base)

Gets the state of the BT_FUSE_SEL fuse.

Parameters

- base – SRC peripheral base address.

Returns

The state of the BT_FUSE_SEL fuse, please refer to fusemap for more information.

static inline uint8_t SRC_GetSECConfigFuseState(SRC_Type *base)

Gets the state of the SECCONFIG[1] fuse.

Parameters

- base – SRC peripheral base address.

Returns

The state of the SECCONFIG[1] fuse. Please refer to fusemap for more information.

void SRC_SetGlobalSystemResetMode(SRC_Type *base, *src_global_system_reset_source_t* resetSource, *src_global_system_reset_mode_t* resetMode)

Sets the reset mode of global system reset source.

This function sets the selected mode of the input global system reset sources.

Parameters

- base – SRC peripheral base address.

- resetSource – The global system reset source. See src_global_system_reset_source_t for more details.
- resetMode – The reset mode of each reset source. See src_global_system_reset_mode_t for more details.

static inline uint32_t SRC_GetResetStatusFlags(SRC_Type *base)

Gets global system reset status flags.

Parameters

- base – SRC peripheral base address.

Returns

The status of global system reset status. See _src_global_system_reset_status_flags for more details.

static inline void SRC_ClearGlobalSystemResetStatus(SRC_Type *base, uint32_t mask)

Clears the status of global reset.

Parameters

- base – SRC peripheral base address.
- mask – The reset status flag to be cleared. See _src_global_system_reset_status_flags for more details.

void SRC_AssertSliceSoftwareReset(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Asserts software reset for the selected slice.

Note: This function will return as soon as the resset is finished.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice to be reset. See src_reset_slice_name_t for more details.

static inline void SRC_AllowUserModeAccess(SRC_Type *base, *src_reset_slice_name_t* sliceName, bool enable)

Allows/disallows user mode access.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.
- enable – Used to control user mode access.
  - **true** Allow user mode access.
  - **false** Disallow user mode access.

static inline void SRC_AllowNonSecureModeAccess(SRC_Type *base, *src_reset_slice_name_t* sliceName, bool enable)

Allows/disallows non secure mode access.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.

- enable – Used to control non secure mode access.
  - **true** Allow non secure mode access.
  - **false** Disallow non secure mode access.

static inline void SRC_LockAccessSetting(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Locks the setting of user mode access and non secure mode access.

Note: Once locked only reset can unlock related settings.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.

static inline void SRC_SetDomainIdWhiteList(SRC_Type *base, *src_reset_slice_name_t* sliceName, uint8_t domainId)

Sets the domain ID white list for the selected slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.
- domainId – The core to access registers, should be the OR'ed value of src_core_name_t.

static inline void SRC_LockDomainIdWhiteList(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Locks the value of white list.

Note: Once locked only reset can unlock related settings.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.

static inline void SRC_SetAssignList(SRC_Type *base, *src_reset_slice_name_t* sliceName, uint32_t assignList)

Sets the value of assign list.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.
- assignList – Cores that subject to corresponding core status transition, should be the OR'ed value of src_core_name_t.

static inline void SRC_LockAssignList(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Locks the value of assign list.

Note: Once locked only reset can unlock related settings.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.

static inline void SRC_EnableSetPointTransferReset(SRC_Type *base, *src_reset_slice_name_t* sliceName, bool enable)

Enable/disable setpoint transfer reset.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.
- enable – User to control setpoint transfer reset.
  - **true** Enable setpoint transfer reset.
  - **false** Disable setpoint transfer reset.

static inline void SRC_EnableDomainModeTransferReset(SRC_Type *base, *src_reset_slice_name_t* sliceName, bool enable)

Enable/disable domain mode transfer reset.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice name to set, please refer to src_reset_slice_name_t for details.
- enable – User to control domain mode reset.
  - **true** Enable domain mode reset.
  - **false** Disable domain mode reset.

void SRC_SetSliceSetPointConfig(SRC_Type *base, *src_reset_slice_name_t* sliceName, uint32_t setpointConfig)

Sets setpoint configuration for the selected reset slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The selected reset slice. See src_reset_slice_name_t for more details.
- setpointConfig – The logic OR'ed value of _src_setpoint_selection enumeration, when the system in the selected setpoint slice reset will be asserted.

void SRC_SetSliceDomainModeConfig(SRC_Type *base, *src_reset_slice_name_t* sliceName, uint32_t domainConfig)

Sets domain mode configuration for the selected reset slice.

Parameters

- base – SRC peripheral base address.

- sliceName – The selected reset slice. See src_reset_slice_name_t for more details.
- domainConfig – The logic OR'ed value of _src_domain_mode_selection enumerations.

void SRC_LockSliceMode(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Locks the value of SETPOINT_MODE and DOMAIN_MODE for the selected reset slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The selected reset slice. See src_reset_slice_name_t for more details.

static inline uint32_t SRC_GetSliceResetStatusFlags(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Gets the reset status flags of the selected slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The slice to be reset. See src_reset_slice_name_t for more details.

Returns

The reset status flags for the selected slice. Please refer to _src_slice_reset_source for details.

static inline void SRC_ClearSliceResetStatusFlags(SRC_Type *base, *src_reset_slice_name_t* sliceName, uint32_t mask)

Clears the reset status flags of the selected slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The selected slice. See src_reset_slice_name_t for more details.
- mask – The reset status flags to be cleared. Please refer to _src_slice_reset_source for more details.

src_slice_reset_state_t SRC_GetSliceResetState(SRC_Type *base, *src_reset_slice_name_t* sliceName)

Gets the reset state of the selected slice.

Parameters

- base – SRC peripheral base address.
- sliceName – The selected slice. See src_reset_slice_name_t for more details.

Return values

- kSRC_SliceResetInProcess – The reset is in process.
- kSRC_SliceResetFinished – The reset is finished.

static inline void SRC_SetGeneralPurposeRegister(SRC_Type *base, *src_general_purpose_register_index_t* index, uint32_t value)

Sets value to general purpose registers.

Parameters

- base – SRC peripheral base address.

- index – The index of GPRx register array. Please refer to src_general_purpose_register_index_t.
- value – Setting value for GPRx register.

static inline uint32_t SRC_GetGeneralPurposeRegister(SRC_Type *base, *src_general_purpose_register_index_t* index)

Gets the value from general purpose registers.

Parameters

- base – SRC peripheral base address.
- index – The index of GPRx register array. Please refer to src_general_purpose_register_index_t.

Returns

The setting value for GPRx register.

struct __src_setpoint_authentication

#include <fsl_soc_src.h> The structure of setpoint authentication.

Public Members

bool enableSetpointTranferReset

Control whether reset slice is in setpoint mode.

- **true** Slice hardware reset will be triggered by set point transition.
- **false** Slice hardware reset will not be trigged by set point transition.

uint32_t whiteList

Select the core to access set point control register. The logic OR'ed value of src_core_name_t enumeration.

bool lockWhiteList

Control whether lock the value in white list

bool lockSetting

Control whether lock the setpoint access setting.

bool allowNonSecureModeAccess

Allow both secure and non-secure modes to config setpoint.

bool allowUserModeAccess

Allow both privilege and user modes to config setpoint.

struct __src_domain_mode_authentication

#include <fsl_soc_src.h> The stucture of domain mode authentication.

Public Members

bool enableDomainModeTransferReset

Control whether reset slice is in domaim mode.

- **true** Slice hardware reset will be triggered by cpu power mode transition.
- **false** Slice hardware reset will not be trigged by cpu power mode transition.

uint32_t assignList

Select the core that reset of slice would be subject to the selected core status transition. The logic OR'ed value of src_core_name_t enumeration.

bool lockAssignList

Control whether lock the value in Assign list.

2.118 SPDIF: Sony/Philips Digital Interface

void SPDIF_Init(SPDIF_Type *base, const *spdif_config_t* *config)

Initializes the SPDIF peripheral.

Ungates the SPDIF clock, resets the module, and configures SPDIF with a configuration structure. The configuration structure can be custom filled or set with default values by SPDIF_GetDefaultConfig().

Note: This API should be called at the beginning of the application to use the SPDIF driver. Otherwise, accessing the SPDIF module can cause a hard fault because the clock is not enabled.

Parameters

- base – SPDIF base pointer
- config – SPDIF configuration structure.

void SPDIF_GetDefaultConfig(*spdif_config_t* *config)

Sets the SPDIF configuration structure to default values.

This API initializes the configuration structure for use in SPDIF_Init. The initialized structure can remain unchanged in SPDIF_Init, or it can be modified before calling SPDIF_Init. This is an example.

```
spdif_config_t config;
SPDIF_GetDefaultConfig(&config);
```

Parameters

- config – pointer to master configuration structure

void SPDIF_Deinit(SPDIF_Type *base)

De-initializes the SPDIF peripheral.

This API gates the SPDIF clock. The SPDIF module can't operate unless SPDIF_Init is called to enable the clock.

Parameters

- base – SPDIF base pointer

uint32_t SPDIF_GetInstance(SPDIF_Type *base)

Get the instance number for SPDIF.

Parameters

- base – SPDIF base pointer.

static inline void SPDIF_TxFIFOReset(SPDIF_Type *base)

Resets the SPDIF Tx.

This function makes Tx FIFO in reset mode.

Parameters

- base – SPDIF base pointer

static inline void SPDIF_RxFIFOReset(SPDIF_Type *base)

Resets the SPDIF Rx.

This function enables the software reset and FIFO reset of SPDIF Rx. After reset, clear the reset bit.

Parameters

- base – SPDIF base pointer

void SPDIF_TxEnable(SPDIF_Type *base, bool enable)

Enables/disables the SPDIF Tx.

Parameters

- base – SPDIF base pointer
- enable – True means enable SPDIF Tx, false means disable.

static inline void SPDIF_RxEnable(SPDIF_Type *base, bool enable)

Enables/disables the SPDIF Rx.

Parameters

- base – SPDIF base pointer
- enable – True means enable SPDIF Rx, false means disable.

static inline uint32_t SPDIF_GetStatusFlag(SPDIF_Type *base)

Gets the SPDIF status flag state.

Parameters

- base – SPDIF base pointer

Returns

SPDIF status flag value. Use the _spdif_interrupt_enable_t to get the status value needed.

static inline void SPDIF_ClearStatusFlags(SPDIF_Type *base, uint32_t mask)

Clears the SPDIF status flag state.

Parameters

- base – SPDIF base pointer
- mask – State mask. It can be a combination of the _spdif_interrupt_enable_t member. Notice these members cannot be included, as these flags cannot be cleared by writing 1 to these bits:
  - kSPDIF_UChannelReceiveRegisterFull
  - kSPDIF_QChannelReceiveRegisterFull
  - kSPDIF_TxFIFOEmpty
  - kSPDIF_RxFIFOFull

static inline void SPDIF_EnableInterrupts(SPDIF_Type *base, uint32_t mask)

Enables the SPDIF Tx interrupt requests.

Parameters

- base – SPDIF base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSPDIF_WordStartInterruptEnable
  - kSPDIF_SyncErrorInterruptEnable

- kSPDIF_FIFOWarningInterruptEnable
- kSPDIF_FIFORequestInterruptEnable
- kSPDIF_FIFOErrorInterruptEnable

static inline void SPDIF_DisableInterrupts(SPDIF_Type *base, uint32_t mask)

Disables the SPDIF Tx interrupt requests.

Parameters

- base – SPDIF base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSPDIF_WordStartInterruptEnable
  - kSPDIF_SyncErrorInterruptEnable
  - kSPDIF_FIFOWarningInterruptEnable
  - kSPDIF_FIFORequestInterruptEnable
  - kSPDIF_FIFOErrorInterruptEnable

static inline void SPDIF_EnableDMA(SPDIF_Type *base, uint32_t mask, bool enable)

Enables/disables the SPDIF DMA requests.

Parameters

- base – SPDIF base pointer
- mask – SPDIF DMA enable mask, The parameter can be a combination of the following sources if defined
  - kSPDIF_RxDMAEnable
  - kSPDIF_TxDMAEnable
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t SPDIF_TxGetLeftDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Tx left data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

static inline uint32_t SPDIF_TxGetRightDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Tx right data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

static inline uint32_t SPDIF_RxGetLeftDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Rx left data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns
data register address.

static inline uint32_t SPDIF_RxGetRightDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Rx right data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns
data register address.

void SPDIF_TxSetSampleRate(SPDIF_Type *base, uint32_t sampleRate_Hz, uint32_t sourceClockFreq_Hz)

Configures the SPDIF Tx sample rate.

The audio format can be changed at run-time. This function configures the sample rate.

Parameters

- base – SPDIF base pointer.
- sampleRate_Hz – SPDIF sample rate frequency in Hz.
- sourceClockFreq_Hz – SPDIF tx clock source frequency in Hz.

uint32_t SPDIF_GetRxSampleRate(SPDIF_Type *base, uint32_t clockSourceFreq_Hz)

Configures the SPDIF Rx audio format.

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – SPDIF base pointer.
- clockSourceFreq_Hz – SPDIF system clock frequency in hz.

void SPDIF_WriteBlocking(SPDIF_Type *base, uint8_t *buffer, uint32_t size)

Sends data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SPDIF base pointer.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

static inline void SPDIF_WriteLeftData(SPDIF_Type *base, uint32_t data)

Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteRightData(SPDIF_Type *base, uint32_t data)
Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteChannelStatusHigh(SPDIF_Type *base, uint32_t data)
Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteChannelStatusLow(SPDIF_Type *base, uint32_t data)
Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

void SPDIF_ReadBlocking(SPDIF_Type *base, uint8_t *buffer, uint32_t size)
Receives data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SPDIF base pointer.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

static inline uint32_t SPDIF_ReadLeftData(SPDIF_Type *base)
Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns
Data in SPDIF FIFO.

static inline uint32_t SPDIF_ReadRightData(SPDIF_Type *base)
Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns
Data in SPDIF FIFO.

static inline uint32_t SPDIF_ReadChannelStatusHigh(SPDIF_Type *base)
Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns
Data in SPDIF FIFO.

static inline uint32_t SPDIF_ReadChannelStatusLow(SPDIF_Type *base)

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

static inline uint32_t SPDIF_ReadQChannel(SPDIF_Type *base)

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

static inline uint32_t SPDIF_ReadUChannel(SPDIF_Type *base)

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

void SPDIF_TransferTxCreateHandle(SPDIF_Type *base, *spdif_handle_t* *handle, *spdif_transfer_callback_t* callback, void *userData)

Initializes the SPDIF Tx handle.

This function initializes the Tx handle for the SPDIF Tx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SPDIF base pointer
- handle – SPDIF handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function

void SPDIF_TransferRxCreateHandle(SPDIF_Type *base, *spdif_handle_t* *handle, *spdif_transfer_callback_t* callback, void *userData)

Initializes the SPDIF Rx handle.

This function initializes the Rx handle for the SPDIF Rx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

status_t SPDIF_TransferSendNonBlocking(SPDIF_Type *base, *spdif_handle_t* *handle, *spdif_transfer_t* *xfer)

Performs an interrupt non-blocking send transfer on SPDIF.

Note: This API returns immediately after the transfer initiates. Call the SPDIF_TxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SPDIF_Busy, the transfer is finished.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- xfer – Pointer to the spdif_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_SPDIF_TxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SPDIF_TransferReceiveNonBlocking(SPDIF_Type *base, *spdif_handle_t* *handle, *spdif_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on SPDIF.

Note: This API returns immediately after the transfer initiates. Call the SPDIF_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SPDIF_Busy, the transfer is finished.

Parameters

- base – SPDIF base pointer
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- xfer – Pointer to the spdif_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_SPDIF_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SPDIF_TransferGetSendCount(SPDIF_Type *base, *spdif_handle_t* *handle, size_t *count)

Gets a set byte count.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- count – Bytes count sent.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

status_t SPDIF_TransferGetReceiveCount(SPDIF_Type *base, *spdif_handle_t* *handle, size_t *count)

Gets a received byte count.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- count – Bytes count received.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void SPDIF_TransferAbortSend(SPDIF_Type *base, *spdif_handle_t* *handle)

Aborts the current send.

Note: This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.

void SPDIF_TransferAbortReceive(SPDIF_Type *base, *spdif_handle_t* *handle)

Aborts the current IRQ receive.

Note: This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SPDIF base pointer
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.

void SPDIF_TransferTxHandleIRQ(SPDIF_Type *base, *spdif_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure.

void SPDIF_TransferRxHandleIRQ(SPDIF_Type *base, *spdif_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure.

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SPDIF return status.

Values:

enumerator kStatus_SPDIF_RxDPLLLocked
SPDIF Rx PLL locked.

enumerator kStatus_SPDIF_TxFIFOError
SPDIF Tx FIFO error.

enumerator kStatus_SPDIF_TxFIFOResync
SPDIF Tx left and right FIFO resync.

enumerator kStatus_SPDIF_RxCnew
SPDIF Rx status channel value updated.

enumerator kStatus_SPDIF_ValidatyNoGood
SPDIF validaty flag not good.

enumerator kStatus_SPDIF_RxIllegalSymbol
SPDIF Rx receive illegal symbol.

enumerator kStatus_SPDIF_RxParityBitError
SPDIF Rx parity bit error.

enumerator kStatus_SPDIF_UChannelOverrun
SPDIF receive U channel overrun.

enumerator kStatus_SPDIF_QChannelOverrun
SPDIF receive Q channel overrun.

enumerator kStatus_SPDIF_UQChannelSync
SPDIF U/Q channel sync found.

enumerator kStatus_SPDIF_UQChannelFrameError
SPDIF U/Q channel frame error.

enumerator kStatus_SPDIF_RxFIFOError
SPDIF Rx FIFO error.

enumerator kStatus_SPDIF_RxFIFOResync
SPDIF Rx left and right FIFO resync.

enumerator kStatus_SPDIF_LockLoss
SPDIF Rx PLL clock lock loss.

enumerator kStatus_SPDIF_TxIdle
SPDIF Tx is idle

enumerator kStatus_SPDIF_RxIdle
SPDIF Rx is idle

enumerator kStatus_SPDIF_QueueFull
SPDIF queue full

enum _spdif_rxfull_select
SPDIF Rx FIFO full falg select, it decides when assert the rx full flag.

Values:

enumerator kSPDIF_RxFull1Sample
Rx full at least 1 sample in left and right FIFO

enumerator kSPDIF_RxFull4Samples
Rx full at least 4 sample in left and right FIFO

enumerator kSPDIF_RxFull8Samples
Rx full at least 8 sample in left and right FIFO

enumerator kSPDIF_RxFull16Samples
Rx full at least 16 sample in left and right FIFO

enum _spdif_txempty_select
SPDIF tx FIFO EMPTY falg select, it decides when assert the tx empty flag.

Values:

enumerator kSPDIF_TxEmpty0Sample
Tx empty at most 0 sample in left and right FIFO

enumerator kSPDIF_TxEmpty4Samples
Tx empty at most 4 sample in left and right FIFO

enumerator kSPDIF_TxEmpty8Samples
Tx empty at most 8 sample in left and right FIFO

enumerator kSPDIF_TxEmpty12Samples
Tx empty at most 12 sample in left and right FIFO

enum _spdif_uchannel_source
SPDIF U channel source.

Values:

enumerator kSPDIF_NoUChannel
No embedded U channel

enumerator kSPDIF_UChannelFromRx
U channel from receiver, it is CD mode

enumerator kSPDIF_UChannelFromTx
U channel from on chip tx

enum _spdif_gain_select
SPDIF clock gain.

Values:

enumerator kSPDIF_GAIN_24
Gain select is 24

enumerator kSPDIF_GAIN_16
Gain select is 16

enumerator kSPDIF_GAIN_12
Gain select is 12

enumerator kSPDIF_GAIN_8
Gain select is 8

enumerator kSPDIF_GAIN_6
Gain select is 6

enumerator kSPDIF_GAIN_4
Gain select is 4

enumerator kSPDIF_GAIN_3
Gain select is 3

enum _spdif_tx_source
SPDIF tx data source.

Values:

enumerator kSPDIF_txFromReceiver
Tx data directly through SPDIF receiver

enumerator kSPDIF_txNormal
Normal operation, data from processor

enum _spdif_validity_config
SPDIF tx data source.

Values:

enumerator kSPDIF_validityFlagAlwaysSet
Outgoing validity flags always set

enumerator kSPDIF_validityFlagAlwaysClear
Outgoing validity flags always clear

The SPDIF interrupt enable flag.

Values:

enumerator kSPDIF_RxDPLLLocked
SPDIF DPLL locked

enumerator kSPDIF_TxFIFOError
Tx FIFO underrun or overrun

enumerator kSPDIF_TxFIFOResync
Tx FIFO left and right channel resync

enumerator kSPDIF_RxControlChannelChange
SPDIF Rx control channel value changed

enumerator kSPDIF_ValidityFlagNoGood
SPDIF validity flag no good

enumerator kSPDIF_RxIllegalSymbol
SPDIF receiver found illegal symbol

enumerator kSPDIF_RxParityBitError
SPDIF receiver found parity bit error

enumerator kSPDIF_UChannelReceiveRegisterFull
SPDIF U channel revceive register full

enumerator kSPDIF_UChannelReceiveRegisterOverrun
SPDIF U channel receive register overrun

enumerator kSPDIF_QChannelReceiveRegisterFull
SPDIF Q channel receive reigster full

enumerator kSPDIF_QChannelReceiveRegisterOverrun
SPDIF Q channel receive register overrun

enumerator kSPDIF_UQChannelSync
SPDIF U/Q channel sync found

enumerator kSPDIF_UQChannelFrameError
SPDIF U/Q channel frame error

enumerator kSPDIF_RxFIFOError
SPDIF Rx FIFO underrun/overrun

enumerator kSPDIF_RxFIFOResync
SPDIF Rx left and right FIFO resync

enumerator kSPDIF_LockLoss
SPDIF receiver loss of lock

enumerator kSPDIF_TxFIFOEmpty
SPDIF Tx FIFO empty

enumerator kSPDIF_RxFIFOFull
SPDIF Rx FIFO full

enumerator kSPDIF_AllInterrupt
all interrupt

The DMA request sources.

Values:

enumerator kSPDIF_RxDMAEnable
Rx FIFO full

enumerator kSPDIF_TxDMAEnable
Tx FIFO empty

typedef enum *_spdif_rxfull_select* spdif_rxfull_select_t
SPDIF Rx FIFO full falg select, it decides when assert the rx full flag.

typedef enum *_spdif_txempty_select* spdif_txempty_select_t
SPDIF tx FIFO EMPTY falg select, it decides when assert the tx empty flag.

typedef enum *_spdif_uchannel_source* spdif_uchannel_source_t
SPDIF U channel source.

typedef enum *_spdif_gain_select* spdif_gain_select_t
SPDIF clock gain.

typedef enum *_spdif_tx_source* spdif_tx_source_t
SPDIF tx data source.

typedef enum *_spdif_validity_config* spdif_validity_config_t
SPDIF tx data source.

typedef struct *_spdif_config* spdif_config_t
SPDIF user configuration structure.

typedef struct *_spdif_transfer* spdif_transfer_t
SPDIF transfer structure.

typedef struct *_spdif_handle* spdif_handle_t

typedef void (*spdif_transfer_callback_t)(SPDIF_Type *base, *spdif_handle_t* *handle, *status_t* status, void *userData)

SPDIF transfer callback prototype.

SPDIF_XFER_QUEUE_SIZE

SPDIF transfer queue size, user can refine it according to use case.

struct _spdif_config

#include <fsl_spdif.h> SPDIF user configuration structure.

Public Members

bool isTxAutoSync

If auto sync mechanism open

bool isRxAutoSync

If auto sync mechanism open

uint8_t DPLLClkSource

SPDIF DPLL clock source, range from 0~15, meaning is chip-specific

uint8_t txClkSource

SPDIF tx clock source, range from 0~7, meaning is chip-specific

spdif_rxfull_select_t rxFullSelect

SPDIF rx buffer full select

spdif_txempty_select_t txFullSelect

SPDIF tx buffer empty select

spdif_uchannel_source_t uChannelSrc

U channel source

spdif_tx_source_t txSource

SPDIF tx data source

spdif_validity_config_t validityConfig

Validity flag config

spdif_gain_select_t gain

Rx receive clock measure gain parameter.

struct _spdif_transfer

#include <fsl_spdif.h> SPDIF transfer structure.

Public Members

uint8_t *data

Data start address to transfer.

uint8_t *qdata

Data buffer for Q channel

uint8_t *udata

Data buffer for C channel

size_t dataSize

Transfer size.

struct _spdif_handle

#include <fsl_spdif.h> SPDIF handle structure.

Public Members

uint32_t state
: Transfer status

spdif_transfer_callback_t callback
: Callback function called at transfer event

void *userData
: Callback parameter passed to callback function

spdif_transfer_t spdifQueue[(4U)]
: Transfer queue storing queued transfer

size_t transferSize[(4U)]
: Data bytes need to transfer

volatile uint8_t queueUser
: Index for user to queue transfer

volatile uint8_t queueDriver
: Index for driver to get the transfer data and size

uint8_t watermark
: Watermark value

2.119 SPDIF eDMA Driver

void SPDIF_TransferTxCreateHandleEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *spdif_edma_callback_t* callback, void *userData, *edma_handle_t* *dmaLeftHandle, *edma_handle_t* *dmaRightHandle)

Initializes the SPDIF eDMA handle.

This function initializes the SPDIF master DMA handle, which can be used for other SPDIF master transactional APIs. Usually, for a specified SPDIF instance, call this API once to get the initialized handle.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaLeftHandle – eDMA handle pointer for left channel, this handle shall be static allocated by users.
- dmaRightHandle – eDMA handle pointer for right channel, this handle shall be static allocated by users.

void SPDIF_TransferRxCreateHandleEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *spdif_edma_callback_t* callback, void *userData, *edma_handle_t* *dmaLeftHandle, *edma_handle_t* *dmaRightHandle)

Initializes the SPDIF Rx eDMA handle.

This function initializes the SPDIF slave DMA handle, which can be used for other SPDIF master transactional APIs. Usually, for a specified SPDIF instance, call this API once to get the initialized handle.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaLeftHandle – eDMA handle pointer for left channel, this handle shall be static allocated by users.
- dmaRightHandle – eDMA handle pointer for right channel, this handle shall be static allocated by users.

status_t SPDIF_TransferSendEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *spdif_edma_transfer_t* *xfer)

Performs a non-blocking SPDIF transfer using DMA.

Note: This interface returns immediately after the transfer initiates. Call SPDIF_GetTransferStatus to poll the transfer status and check whether the SPDIF transfer is finished.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- kStatus_Success – Start a SPDIF eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_TxBusy – SPDIF is busy sending data.

status_t SPDIF_TransferReceiveEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *spdif_edma_transfer_t* *xfer)

Performs a non-blocking SPDIF receive using eDMA.

Note: This interface returns immediately after the transfer initiates. Call the SPDIF_GetReceiveRemainingBytes to poll the transfer status and check whether the SPDIF transfer is finished.

Parameters

- base – SPDIF base pointer
- handle – SPDIF eDMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a SPDIF eDMA receive successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_RxBusy – SPDIF is busy receiving data.

void SPDIF_TransferAbortSendEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle)

Aborts a SPDIF transfer using eDMA.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.

void SPDIF_TransferAbortReceiveEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle)

Aborts a SPDIF receive using eDMA.

Parameters

- base – SPDIF base pointer
- handle – SPDIF eDMA handle pointer.

status_t SPDIF_TransferGetSendCountEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, size_t *count)

Gets byte count sent by SPDIF.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- count – Bytes count sent by SPDIF.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

status_t SPDIF_TransferGetReceiveCountEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, size_t *count)

Gets byte count received by SPDIF.

Parameters

- base – SPDIF base pointer
- handle – SPDIF eDMA handle pointer.
- count – Bytes count received by SPDIF.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

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Version 2.0.8

typedef struct *_spdif_edma_handle* spdif_edma_handle_t

typedef void (*spdif_edma_callback_t)(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *status_t* status, void *userData)

SPDIF eDMA transfer callback function for finish and error.

typedef struct *_spdif_edma_transfer* spdif_edma_transfer_t

SPDIF transfer structure.

struct _spdif_edma_transfer

#include <fsl_spdif_edma.h> SPDIF transfer structure.

Public Members

uint8_t *leftData
Data start address to transfer.

uint8_t *rightData
Data start address to transfer.

size_t dataSize
Transfer size.

struct __spdif_edma_handle
#include <fsl_spdif_edma.h> SPDIF DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaLeftHandle
DMA handler for SPDIF left channel

edma_handle_t *dmaRightHandle
DMA handler for SPDIF right channel

uint8_t nbytes
eDMA minor byte transfer count initially configured.

uint8_t count
The transfer data count in a DMA request

uint32_t state
Internal state for SPDIF eDMA transfer

spdif_edma_callback_t callback
Callback for users while transfer finish or error occurs

void *userData
User callback parameter

edma_tcd_t leftTcd[(4U) + 1U]
TCD pool for eDMA transfer.

edma_tcd_t rightTcd[(4U) + 1U]
TCD pool for eDMA transfer.

spdif_edma_transfer_t spdifQueue[(4U)]
Transfer queue storing queued transfer.

size_t transferSize[(4U)]
Data bytes need to transfer, left and right are the same, so use one

volatile uint8_t queueUser
Index for user to queue transfer.

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

2.120 SSARC: State Save and Restore Controller

static inline uint32_t SSARC_GetDescriptorRegisterAddress(SSARC_HP_Type *base, uint32_t index)

Gets the address of the register to be saved/restored.

Parameters

- base – SSARC_HP peripheral base address.
- index – The index of descriptor. Range from 0 to 1023.

Returns

The address of the register.

static inline uint32_t SSARC_GetDescriptorRegisterData(SSARC_HP_Type *base, uint32_t index)

Gets the value of the register to be saved/restored.

Parameters

- base – SSARC_HP peripheral base address.
- index – The index of descriptor. Range from 0 to 1023.

Returns

The value of the register.

void SSARC_SetDescriptorConfig(SSARC_HP_Type *base, uint32_t index, const *ssarc_descriptor_config_t* *config)

Sets the configuration of the descriptor.

Parameters

- base – SSARC_HP peripheral base address.
- index – The index of descriptor. Range from 0 to 1023.
- config – Pointer to the structure ssarc_descriptor_config_t. Please refer to ssarc_descriptor_config_t for details.

void SSARC_GroupInit(SSARC_LP_Type *base, uint8_t groupID, const *ssarc_group_config_t* *config)

Inits the selected group.

Note: For the groups with the same save priority or restore priority, the save/restore operation runs in the group order.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.
- config – Pointer to the structure ssarc_group_config_t. Please refer to ssarc_group_config_t for details.

static inline void SSARC_GroupDeinit(SSARC_LP_Type *base, uint8_t groupID)

De-inits the selected group.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.

static inline void SSARC_LockGroupDomain(SSARC_LP_Type *base, uint8_t groupID)

Locks the configuration of the domain.

This function locks the configuration of the domain. Once locked, only the access from the same domain is allowed, access from other domains will be blocked. Once locked, it can only be unlocked by a hardware reset.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.

static inline void SSARC_LockGroupWrite(SSARC_LP_Type *base, uint8_t groupID)

Locks the write access to the control registers and descriptors for the selected group.

This function Locks the write access to the control registers and descriptors for the selected group. All writes are blocked. Once locked, it can only be unlocked by a hardware reset.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.

static inline void SSARC_LockGroupRead(SSARC_LP_Type *base, uint8_t groupID)

Locks the read access to the control registers and descriptors for the selected group.

This function Locks the read access to the control registers and descriptors for the selected group. All reads are blocked. Once locked, it can only be unlocked by a hardware reset.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.

void SSARC_TriggerSoftwareRequest(SSARC_LP_Type *base, uint8_t groupID, *ssarc_software_trigger_mode_t* mode)

Triggers software request.

Note: Each group allows software to trigger the save/restore operation without getting the request from basic power controller.

Parameters

- base – SSARC_LP peripheral base address.
- groupID – The index of the group. Range from 0 to 15.
- mode – Software trigger mode. Please refer to ssarc_software_trigger_mode_t for details.

static inline void SSARC_ResetWholeBlock(SSARC_LP_Type *base)

Resets the whole SSARC block by software.

Note: Only reset the SSARC registers, not include the DESC in SRAM.

Parameters

- base – SSARC_LP peripheral base address.

static inline void SSARC_EnableHardwareRequest(SSARC_LP_Type *base, bool enable)

Enables/Disables save/restore request from the PGMC module.

Parameters

- base – SSARC_LP peripheral base address.
- enable – Used to enable/disable save/restore hardware request.
  - **true** Enable GPC save/restore requests.
  - **false** Disable GPC save/restore requests.

static inline uint32_t SSARC_GetStatusFlags(SSARC_LP_Type *base)

Gets status flags.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The value of status flags. See _ssarc_interrupt_status_flags for details.

static inline void SSARC_ClearStatusFlags(SSARC_LP_Type *base, uint32_t mask)

Clears status flags.

Note: Only kSSARC_AddressErrorFlag, kSSARC_AHBErrorFlag, kSSARC_TimeoutFlag and kSSARC_GroupConflictFlag can be cleared.

Parameters

- base – SSARC_LP peripheral base address.
- mask – The mask value for flags to be cleared. See _ssarc_interrupt_status_flags for details.

static inline uint32_t SSARC_GetErrorIndex(SSARC_LP_Type *base)

Gets the error index that indicates which descriptor will trigger the AHB_ERR or ADDR_ERR interrupt.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The error index.

static inline void SSARC_SetTimeoutValue(SSARC_LP_Type *base, uint32_t value)

Sets timeout value for the entire group to complete.

This function sets timeout value for the entire group to complete. Setting timeout value to 0 will disable this feature.

Parameters

- base – SSARC_LP peripheral base address.
- value – The timeout value, 0 means disable time out feature.

static inline uint32_t SSARC_GetTimeoutValue(SSARC_LP_Type *base)

Gets timeout value for AHB clock.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The timeout value.

static inline uint16_t SSARC_GetHardwareRequestRestorePendingGroup(SSARC_LP_Type *base)

Gets the value that indicates which groups are pending for restore from hardware request.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The value of the pending groups.

static inline uint16_t SSARC_GetHardwareRequestSavePendingGroup(SSARC_LP_Type *base)

Gets the value that indicates which groups are pending for save from hardware request.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The value of the pending groups.

static inline uint16_t SSARC_GetSoftwareRequestRestorePendingGroup(SSARC_LP_Type *base)

Gets the value that indicates which groups are pending for restore from software request.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The value of the pending groups.

static inline uint16_t SSARC_GetSoftwareRequestSavePendingGroup(SSARC_LP_Type *base)

Gets the value that indicates which groups are pending for save from software request.

Parameters

- base – SSARC_LP peripheral base address.

Returns

The value of the pending groups.

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SSARC driver version 2.1.0.

enum _ssarc_interrupt_status_flags

The enumeration of ssarc status flags.

Values:

enumerator kSSARC_AddressErrorFlag

If the descriptor is not in the range, assert address error.

enumerator kSSARC_AHBErrorFlag

If any AHB master access receives none-OKAY, assert AHB error.

enumerator kSSARC_SoftwareRequestDoneFlag

If a software triggered save or restore process is completed, assert sofware request done .

enumerator kSSARC_TimeoutFlag

If processing of a group has exceeded the timeout value, assert timeout.

enumerator kSSARC_GroupConflictFlag

Group conflict.

enum _ssarc_descriptor_register_size

The size of the register to be saved/restored.

Values:

enumerator kSSARC_DescriptorRegister8bitWidth
The register to be saved/restored is 8 bit width.

enumerator kSSARC_DescriptorRegister16bitWidth
The register to be saved/restored is 16 bit width.

enumerator kSSARC_DescriptorRegister32bitWidth
The register to be saved/restored is 32 bit width.

enum _ssarc_descriptor_operation
The operation of the descriptor.

Values:

enumerator kSSARC_SaveDisableRestoreDisable
Disable Save operation, disable restore operation.

enumerator kSSARC_SaveEnableRestoreDisable
Enable Save operation, disable restore operation.

enumerator kSSARC_SaveDisableRestoreEnable
Disable Save operation, enable restore operation.

enumerator kSSARC_SaveEnableRestoreEnable
Enable Save operation, enable restore operation.

enum _ssarc_descriptor_type
The type of operation.

Values:

enumerator kSSARC_ReadValueWriteBack
Read the register value on save operation and write it back on restore operation

enumerator kSSARC_WriteFixedValue
Always write a fixed value from DATA[31:0]

enumerator kSSARC_RMWOr
Read register, OR with the DATA[31:0], and write it back

enumerator kSSARC_RMWAnd
Read register, AND with the DATA[31:0], and write it back

enumerator kSSARC_DelayCycles
Delay for number of cycles based on the DATA[31:0]

enumerator kSSARC_Polling0
Read the register until read_data[31:0] & DATA[31:0] == 0

enumerator kSSARC_Polling1
Read the register until read_data[31:0] & DATA[31:0] != 0

enum _ssarc_save_restore_order
The order of the restore/save operation.

Values:

enumerator kSSARC_ProcessFromStartToEnd
Descriptors within the group are processed from start to end.

enumerator kSSARC_ProcessFromEndToStart
Descriptors within the group are processed from end to start.

enum _ssarc_software_trigger_mode

Software trigger mode.

Values:

enumerator kSSARC_TriggerSaveRequest

Don't trigger restore operation, trigger the save operation by software.

enumerator kSSARC_TriggerRestoreRequest

Trigger the restore operation, don't trigger the save operation.

typedef enum *_ssarc_descriptor_register_size* ssarc_descriptor_register_size_t

The size of the register to be saved/restored.

typedef enum *_ssarc_descriptor_operation* ssarc_descriptor_operation_t

The operation of the descriptor.

typedef enum *_ssarc_descriptor_type* ssarc_descriptor_type_t

The type of operation.

typedef enum *_ssarc_save_restore_order* ssarc_save_restore_order_t

The order of the restore/save operation.

typedef enum *_ssarc_software_trigger_mode* ssarc_software_trigger_mode_t

Software trigger mode.

typedef struct *_ssarc_descriptor_config* ssarc_descriptor_config_t

The configuration of descriptor.

typedef struct *_ssarc_group_config* ssarc_group_config_t

The configuration of the group.

SSARC_INT_STATUS_ALL

struct _ssarc_descriptor_config

#include <fsl_ssarc.h> The configuration of descriptor.

Public Members

uint32_t address

The address of the register/memory to be saved/restored.

uint32_t data

The value of the register/memory to be saved/restored, please note that if the type is selected as kSSARC_ReadValueWriteBack, this data field is useless.

ssarc_descriptor_register_size_t size

The size of register to be saved/restored.

ssarc_descriptor_operation_t operation

The operation mode of descriptor.

ssarc_descriptor_type_t type

The type of operation.

struct _ssarc_group_config

#include <fsl_ssarc.h> The configuration of the group.

Public Members

ssarc_cpu_domain_name_t cpuDomain
CPU domain, define the ownership of this group.

uint32_t startIndex
The index of the first descriptor of the group.

uint32_t endIndex
The index of the last descriptor of the group.

ssarc_save_restore_order_t restoreOrder
The restore order.

ssarc_save_restore_order_t saveOrder
The save order.

uint8_t restorePriority
Restore priority of current group. 0 is the highest priority, 15 is the lowest priority

uint8_t savePriority
Save priority of current group. 0 is the highest priority, 15 is the lowest priority.

ssarc_power_domain_name_t powerDomain
Power domain.

uint32_t highestAddress
Highest address that can be accessed for the descriptors in the group.

uint32_t lowestAddress
Lowest address that can be accessed for the descriptors in the group.

2.121 TEMPSENSOR: Temperature Sensor Module

FSL_TMPSNS_DRIVER_VERSION

TMPSNS interrupt status enable type, tmpsns_interrupt_status_enable_t.

Values:

enumerator kTEMPSENSOR_HighTempInterruptStatusEnable
High temperature interrupt status enable.

enumerator kTEMPSENSOR_LowTempInterruptStatusEnable
Low temperature interrupt status enable.

enumerator kTEMPSENSOR_PanicTempInterruptStatusEnable
Panic temperature interrupt status enable.

enumerator kTEMPSENSOR_FinishInterruptStatusEnable
Finish interrupt enable.

TMPSNS interrupt status type, tmpsns_interrupt_status_t.

Values:

enumerator kTEMPSENSOR_HighTempInterruptStatus
High temperature interrupt status.

enumerator kTEMPSENSOR_LowTempInterruptStatus
Low temperature interrupt status.

enumerator kTEMPSENSOR_PanicTempInterruptStatus
Panic temperature interrupt status.

enum tmpsns_measure_mode_t
TMPSNS measure mode, tempsensor_measure_mode.

Values:

enumerator kTEMPSENSOR_SingleMode
Single measurement mode.

enumerator kTEMPSENSOR_ContinuousMode
Continuous measurement mode.

enum _tmpsns_alarm_mode
TMPSNS alarm mode.

Values:

enumerator kTEMPMON_HighAlarmMode
The high alarm temperature interrupt mode.

enumerator kTEMPMON_PanicAlarmMode
The panic alarm temperature interrupt mode.

enumerator kTEMPMON_LowAlarmMode
The low alarm temperature interrupt mode.

typedef struct *_tmpsns_config* tmpsns_config_t
TMPSNS temperature structure.

typedef enum *_tmpsns_alarm_mode* tmpsns_alarm_mode_t
TMPSNS alarm mode.

void TMPSNS_Init(TMPSNS_Type *base, const *tmpsns_config_t* *config)
Initializes the TMPSNS module.

Parameters

- base – TMPSNS base pointer
- config – Pointer to configuration structure.

void TMPSNS_Deinit(TMPSNS_Type *base)
Deinitializes the TMPSNS module.

Parameters

- base – TMPSNS base pointer

void TMPSNS_GetDefaultConfig(*tmpsns_config_t* *config)
Gets the default configuration structure.

This function initializes the TMPSNS configuration structure to a default value. The default values are: tempmonConfig->frequency = 0x02U; tempmonConfig->highAlarmTemp = 44U; tempmonConfig->panicAlarmTemp = 90U; tempmonConfig->lowAlarmTemp = 39U;

Parameters

- config – Pointer to a configuration structure.

void TMPSNS_StartMeasure(TMPSNS_Type *base)

start the temperature measurement process.

Parameters

- base – TMPSNS base pointer.

void TMPSNS_StopMeasure(TMPSNS_Type *base)

stop the measurement process.

Parameters

- base – TMPSNS base pointer

float TMPSNS_GetCurrentTemperature(TMPSNS_Type *base)

Get current temperature with the fused temperature calibration data.

Parameters

- base – TMPSNS base pointer

Returns

current temperature with degrees Celsius.

void TMPSNS_SetTempAlarm(TMPSNS_Type *base, int32_t tempVal, *tmpsns_alarm_mode_t* alarmMode)

Set the temperature count (raw sensor output) that will generate an alarm interrupt.

Parameters

- base – TMPSNS base pointer
- tempVal – The alarm temperature with degrees Celsius
- alarmMode – The alarm mode.

void TMPSNS_EnableInterrupt(TMPSNS_Type *base, uint32_t mask)

Enable interrupt status.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to enable from tmpsns_interrupt_status_enable_t.

void TMPSNS_DisableInterrupt(TMPSNS_Type *base, uint32_t mask)

Disable interrupt status.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to disable from tmpsns_interrupt_status_enable_t.

static inline uint32_t TMPSNS_GetInterruptFlags(TMPSNS_Type *base)

Get interrupt status flag.

Parameters

- base – TMPSNS base pointer

static inline void TMPSNS_ClearInterruptFlags(TMPSNS_Type *base, uint32_t mask)

Clear interrupt status flag.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to disable from tmpsns_interrupt_status_t.

struct _tmpsns_config

#include <fsl_tempsensor.h> TMPSNS temperature structure.

Public Members

tmpsns_measure_mode_t measureMode

The temperature measure mode.

uint16_t frequency

The temperature measure frequency.

int32_t highAlarmTemp

The high alarm temperature.

int32_t panicAlarmTemp

The panic alarm temperature.

int32_t lowAlarmTemp

The low alarm temperature.

2.122 USDHC: Ultra Secured Digital Host Controller Driver

void USDHC_Init(USDHC_Type *base, const *usdhc_config_t* *config)

USDHC module initialization function.

Configures the USDHC according to the user configuration.

Example:

```
usdhc_config_t config;
config.cardDetectDat3 = false;
config.endianMode = kUSDHC_EndianModeLittle;
config.dmaMode = kUSDHC_DmaModeAdma2;
config.readWatermarkLevel = 128U;
config.writeWatermarkLevel = 128U;
USDHC_Init(USDHC, &config);
```

Parameters

- base – USDHC peripheral base address.
- config – USDHC configuration information.

Return values

kStatus_Success – Operate successfully.

void USDHC_Deinit(USDHC_Type *base)

Deinitializes the USDHC.

Parameters

- base – USDHC peripheral base address.

bool USDHC_Reset(USDHC_Type *base, uint32_t mask, uint32_t timeout)

Resets the USDHC.

Parameters

- base – USDHC peripheral base address.
- mask – The reset type mask(_usdhc_reset).

- timeout – Timeout for reset.

Return values

- true – Reset successfully.
- false – Reset failed.

status_t USDHC_SetAdmaTableConfig(USDHC_Type *base, *usdhc_adma_config_t* *dmaConfig, *usdhc_data_t* *dataConfig, uint32_t flags)

Sets the DMA descriptor table configuration. A high level DMA descriptor configuration function.

Parameters

- base – USDHC peripheral base address.
- dmaConfig – ADMA configuration
- dataConfig – Data descriptor
- flags – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

- kStatus_OutOfRange – ADMA descriptor table length isn't enough to describe data.
- kStatus_Success – Operate successfully.

status_t USDHC_SetInternalDmaConfig(USDHC_Type *base, *usdhc_adma_config_t* *dmaConfig, const uint32_t *dataAddr, bool enAutoCmd23)

Internal DMA configuration. This function is used to config the USDHC DMA related registers.

Parameters

- base – USDHC peripheral base address.
- dmaConfig – ADMA configuration.
- dataAddr – Transfer data address, a simple DMA parameter, if ADMA is used, leave it to NULL.
- enAutoCmd23 – Flag to indicate Auto CMD23 is enable or not, a simple DMA parameter, if ADMA is used, leave it to false.

Return values

- kStatus_OutOfRange – ADMA descriptor table length isn't enough to describe data.
- kStatus_Success – Operate successfully.

status_t USDHC_SetADMA2Descriptor(uint32_t *admaTable, uint32_t admaTableWords, const uint32_t *dataBufferAddr, uint32_t dataBytes, uint32_t flags)

Sets the ADMA2 descriptor table configuration.

Parameters

- admaTable – ADMA table address.
- admaTableWords – ADMA table length.
- dataBufferAddr – Data buffer address.
- dataBytes – Data Data length.

- flags – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

- kStatus_OutOfRange – ADMA descriptor table length isn't enough to describe data.
- kStatus_Success – Operate successfully.

status_t USDHC_SetADMA1Descriptor(uint32_t *admaTable, uint32_t admaTableWords, const uint32_t *dataBufferAddr, uint32_t dataBytes, uint32_t flags)

Sets the ADMA1 descriptor table configuration.

Parameters

- admaTable – ADMA table address.
- admaTableWords – ADMA table length.
- dataBufferAddr – Data buffer address.
- dataBytes – Data length.
- flags – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

- kStatus_OutOfRange – ADMA descriptor table length isn't enough to describe data.
- kStatus_Success – Operate successfully.

static inline void USDHC_EnableInternalDMA(USDHC_Type *base, bool enable)

Enables internal DMA.

Parameters

- base – USDHC peripheral base address.
- enable – enable or disable flag

static inline void USDHC_EnableInterruptStatus(USDHC_Type *base, uint32_t mask)

Enables the interrupt status.

Parameters

- base – USDHC peripheral base address.
- mask – Interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline void USDHC_DisableInterruptStatus(USDHC_Type *base, uint32_t mask)

Disables the interrupt status.

Parameters

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline void USDHC_EnableInterruptSignal(USDHC_Type *base, uint32_t mask)

Enables the interrupt signal corresponding to the interrupt status flag.

Parameters

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline void USDHC_DisableInterruptSignal(USDHC_Type *base, uint32_t mask)

Disables the interrupt signal corresponding to the interrupt status flag.

Parameters

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline uint32_t USDHC_GetEnabledInterruptStatusFlags(USDHC_Type *base)

Gets the enabled interrupt status.

Parameters

- base – USDHC peripheral base address.

Returns

Current interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline uint32_t USDHC_GetInterruptStatusFlags(USDHC_Type *base)

Gets the current interrupt status.

Parameters

- base – USDHC peripheral base address.

Returns

Current interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline void USDHC_ClearInterruptStatusFlags(USDHC_Type *base, uint32_t mask)

Clears a specified interrupt status. write 1 clears.

Parameters

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(_usdhc_interrupt_status_flag).

static inline uint32_t USDHC_GetAutoCommand12ErrorStatusFlags(USDHC_Type *base)

Gets the status of auto command 12 error.

Parameters

- base – USDHC peripheral base address.

Returns

Auto command 12 error status flags mask(_usdhc_auto_command12_error_status_flag).

static inline uint32_t USDHC_GetAdmaErrorStatusFlags(USDHC_Type *base)

Gets the status of the ADMA error.

Parameters

- base – USDHC peripheral base address.

Returns

ADMA error status flags mask(_usdhc_adma_error_status_flag).

static inline uint32_t USDHC_GetPresentStatusFlags(USDHC_Type *base)

Gets a present status.

This function gets the present USDHC's status except for an interrupt status and an error status.

Parameters

- base – USDHC peripheral base address.

Returns

Present USDHC's status flags mask(_usdhc_present_status_flag).

void USDHC_GetCapability(USDHC_Type *base, *usdhc_capability_t* *capability)

Gets the capability information.

Parameters

- base – USDHC peripheral base address.
- capability – Structure to save capability information.

static inline void USDHC_ForceClockOn(USDHC_Type *base, bool enable)

Forces the card clock on.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

uint32_t USDHC_SetSdClock(USDHC_Type *base, uint32_t srcClock_Hz, uint32_t busClock_Hz)

Sets the SD bus clock frequency.

Parameters

- base – USDHC peripheral base address.
- srcClock_Hz – USDHC source clock frequency united in Hz.
- busClock_Hz – SD bus clock frequency united in Hz.

Returns

The nearest frequency of busClock_Hz configured for SD bus.

bool USDHC_SetCardActive(USDHC_Type *base, uint32_t timeout)

Sends 80 clocks to the card to set it to the active state.

This function must be called each time the card is inserted to ensure that the card can receive the command correctly.

Parameters

- base – USDHC peripheral base address.
- timeout – Timeout to initialize card.

Return values

- true – Set card active successfully.
- false – Set card active failed.

static inline void USDHC_AssertHardwareReset(USDHC_Type *base, bool high)

Triggers a hardware reset.

Parameters

- base – USDHC peripheral base address.
- high – 1 or 0 level

static inline void USDHC_SetDataBusWidth(USDHC_Type *base, *usdhc_data_bus_width_t* width)

Sets the data transfer width.

Parameters

- base – USDHC peripheral base address.
- width – Data transfer width.

static inline void USDHC_WriteData(USDHC_Type *base, uint32_t data)

Fills the data port.

This function is used to implement the data transfer by Data Port instead of DMA.

Parameters

- base – USDHC peripheral base address.
- data – The data about to be sent.

static inline uint32_t USDHC_ReadData(USDHC_Type *base)

Retrieves the data from the data port.

This function is used to implement the data transfer by Data Port instead of DMA.

Parameters

- base – USDHC peripheral base address.

Returns

The data has been read.

void USDHC_SendCommand(USDHC_Type *base, *usdhc_command_t* *command)

Sends command function.

Parameters

- base – USDHC peripheral base address.
- command – configuration

static inline void USDHC_EnableWakeupEvent(USDHC_Type *base, uint32_t mask, bool enable)

Enables or disables a wakeup event in low-power mode.

Parameters

- base – USDHC peripheral base address.
- mask – Wakeup events mask(_usdhc_wakeup_event).
- enable – True to enable, false to disable.

static inline void USDHC_CardDetectByData3(USDHC_Type *base, bool enable)

Detects card insert status.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

static inline bool USDHC_DetectCardInsert(USDHC_Type *base)

Detects card insert status.

Parameters

- base – USDHC peripheral base address.

static inline void USDHC_EnableSdioControl(USDHC_Type *base, uint32_t mask, bool enable)

Enables or disables the SDIO card control.

Parameters

- base – USDHC peripheral base address.
- mask – SDIO card control flags mask(_usdhc_sdio_control_flag).
- enable – True to enable, false to disable.

static inline void USDHC_SetContinueRequest(USDHC_Type *base)

Restarts a transaction which has stopped at the block GAP for the SDIO card.

Parameters

- base – USDHC peripheral base address.

static inline void USDHC_RequestStopAtBlockGap(USDHC_Type *base, bool enable)

Request stop at block gap function.

Parameters

- base – USDHC peripheral base address.
- enable – True to stop at block gap, false to normal transfer.

void USDHC_SetMmcBootConfig(USDHC_Type *base, const *usdhc_boot_config_t* *config)

Configures the MMC boot feature.

Example:

```
usdhc_boot_config_t config;
config.ackTimeoutCount = 4;
config.bootMode = kUSDHC_BootModeNormal;
config.blockCount = 5;
config.enableBootAck = true;
config.enableBoot = true;
config.enableAutoStopAtBlockGap = true;
USDHC_SetMmcBootConfig(USDHC, &config);
```

Parameters

- base – USDHC peripheral base address.
- config – The MMC boot configuration information.

static inline void USDHC_EnableMmcBoot(USDHC_Type *base, bool enable)

Enables or disables the mmc boot mode.

Parameters

- base – USDHC peripheral base address.
- enable – True to enable, false to disable.

static inline void USDHC_SetForceEvent(USDHC_Type *base, uint32_t mask)

Forces generating events according to the given mask.

Parameters

- base – USDHC peripheral base address.
- mask – The force events bit posistion (_usdhc_force_event).

static inline bool USDHC_RequestTuningForSDR50(USDHC_Type *base)

Checks the SDR50 mode request tuning bit. When this bit set, application shall perform tuning for SDR50 mode.

Parameters

- base – USDHC peripheral base address.

static inline bool USDHC_RequestReTuning(USDHC_Type *base)

Checks the request re-tuning bit. When this bit is set, user should do manual tuning or standard tuning function.

Parameters

- base – USDHC peripheral base address.

static inline void USDHC_EnableAutoTuning(USDHC_Type *base, bool enable)

The SDR104 mode auto tuning enable and disable. This function should be called after tuning function execute pass, auto tuning will handle by hardware.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

void USDHC_EnableAutoTuningForCmdAndData(USDHC_Type *base)

The auto tuning enbale for CMD/DATA line.

Parameters

- base – USDHC peripheral base address.

void USDHC_EnableManualTuning(USDHC_Type *base, bool enable)

Manual tuning trigger or abort. User should handle the tuning cmd and find the boundary of the delay then calucate a average value which will be configured to the **CLK_TUNE_CTRL_STATUS** This function should be called before function USDHC_AdjustDelayForManualTuning.

Parameters

- base – USDHC peripheral base address.
- enable – tuning enable flag

static inline uint32_t USDHC_GetTuningDelayStatus(USDHC_Type *base)

Get the tuning delay cell setting.

Parameters

- base – USDHC peripheral base address.

Return values

CLK – Tuning Control and Status register value.

status_t USDHC_SetTuningDelay(USDHC_Type *base, uint32_t preDelay, uint32_t outDelay, uint32_t postDelay)

The tuning delay cell setting.

Parameters

- base – USDHC peripheral base address.
- preDelay – Set the number of delay cells on the feedback clock between the feedback clock and CLK_PRE.
- outDelay – Set the number of delay cells on the feedback clock between CLK_PRE and CLK_OUT.
- postDelay – Set the number of delay cells on the feedback clock between CLK_OUT and CLK_POST.

Return values

- kStatus_Fail – config the delay setting fail
- kStatus_Success – config the delay setting success

status_t USDHC_AdjustDelayForManualTuning(USDHC_Type *base, uint32_t delay)

Adjusts delay for mannual tuning.

Deprecated:

Do not use this function. It has been superceded by USDHC_SetTuingDelay

Parameters

- base – USDHC peripheral base address.
- delay – setting configuration

Return values

- kStatus_Fail – config the delay setting fail
- kStatus_Success – config the delay setting success

static inline void USDHC_SetStandardTuningCounter(USDHC_Type *base, uint8_t counter)

set tuning counter tuning.

Parameters

- base – USDHC peripheral base address.
- counter – tuning counter

Return values

- kStatus_Fail – config the delay setting fail
- kStatus_Success – config the delay setting success

void USDHC_EnableStandardTuning(USDHC_Type *base, uint32_t tuningStartTap, uint32_t step, bool enable)

The enable standard tuning function. The standard tuning window and tuning counter using the default config tuning cmd is sent by the software, user need to check whether the tuning result can be used for SDR50, SDR104, and HS200 mode tuning.

Parameters

- base – USDHC peripheral base address.
- tuningStartTap – start tap
- step – tuning step
- enable – enable/disable flag

static inline uint32_t USDHC_GetExecuteStdTuningStatus(USDHC_Type *base)

Gets execute STD tuning status.

Parameters

- base – USDHC peripheral base address.

static inline uint32_t USDHC_CheckStdTuningResult(USDHC_Type *base)

Checks STD tuning result.

Parameters

- base – USDHC peripheral base address.

static inline uint32_t USDHC_CheckTuningError(USDHC_Type *base)

Checks tuning error.

Parameters

- base – USDHC peripheral base address.

void USDHC_EnableDDRMode(USDHC_Type *base, bool enable, uint32_t nibblePos)

The enable/disable DDR mode.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag
- nibblePos – nibble position

static inline void USDHC_EnableHS400Mode(USDHC_Type *base, bool enable)

The enable/disable HS400 mode.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

static inline void USDHC_ResetStrobeDLL(USDHC_Type *base)

Resets the strobe DLL.

Parameters

- base – USDHC peripheral base address.

static inline void USDHC_EnableStrobeDLL(USDHC_Type *base, bool enable)

Enables/disables the strobe DLL.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

void USDHC_ConfigStrobeDLL(USDHC_Type *base, uint32_t delayTarget, uint32_t updateInterval)

Configs the strobe DLL delay target and update interval.

Parameters

- base – USDHC peripheral base address.
- delayTarget – delay target
- updateInterval – update interval

static inline void USDHC_SetStrobeDllOverride(USDHC_Type *base, uint32_t delayTaps)

Enables manual override for slave delay chain using **STROBE_SLV_OVERRIDE_VAL**.

Parameters

- base – USDHC peripheral base address.
- delayTaps – Valid delay taps range from 1 - 128 taps. A value of 0 selects tap 1, and a value of 0x7F selects tap 128.

static inline uint32_t USDHC_GetStrobeDLLStatus(USDHC_Type *base)

Gets the strobe DLL status.

Parameters

- base – USDHC peripheral base address.

void USDHC_SetDataConfig(USDHC_Type *base, *usdhc_transfer_direction_t* dataDirection, uint32_t blockCount, uint32_t blockSize)

USDHC data configuration.

Parameters

- base – USDHC peripheral base address.
- dataDirection – Data direction, tx or rx.
- blockCount – Data block count.
- blockSize – Data block size.

void USDHC_TransferCreateHandle(USDHC_Type *base, *usdhc_handle_t* *handle, const *usdhc_transfer_callback_t* *callback, void *userData)

Creates the USDHC handle.

Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle pointer.
- callback – Structure pointer to contain all callback functions.
- userData – Callback function parameter.

status_t USDHC_TransferNonBlocking(USDHC_Type *base, *usdhc_handle_t* *handle, *usdhc_adma_config_t* *dmaConfig, *usdhc_transfer_t* *transfer)

Transfers the command/data using an interrupt and an asynchronous method.

This function sends a command and data and returns immediately. It doesn't wait for the transfer to complete or to encounter an error. The application must not call this API in multiple threads at the same time. Because of that this API doesn't support the re-entry mechanism.

Note: Call API USDHC_TransferCreateHandle when calling this API.

Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle.
- dmaConfig – ADMA configuration.
- transfer – Transfer content.

Return values

- kStatus_InvalidArgument – Argument is invalid.
- kStatus_USDHC_BusyTransferring – Busy transferring.
- kStatus_USDHC_PrepareAdmaDescriptorFailed – Prepare ADMA descriptor failed.
- kStatus_Success – Operate successfully.

status_t USDHC_TransferBlocking(USDHC_Type *base, *usdhc_adma_config_t* *dmaConfig, *usdhc_transfer_t* *transfer)

Transfers the command/data using a blocking method.

This function waits until the command response/data is received or the USDHC encounters an error by polling the status flag.

The application must not call this API in multiple threads at the same time. Because this API doesn't support the re-entry mechanism.

Note: There is no need to call API USDHC_TransferCreateHandle when calling this API.

Parameters

- base – USDHC peripheral base address.
- dmaConfig – adma configuration
- transfer – Transfer content.

Return values

- kStatus_InvalidArgument – Argument is invalid.
- kStatus_USDHC_PrepareAdmaDescriptorFailed – Prepare ADMA descriptor failed.
- kStatus_USDHC_SendCommandFailed – Send command failed.
- kStatus_USDHC_TransferDataFailed – Transfer data failed.
- kStatus_Success – Operate successfully.

void USDHC_TransferHandleIRQ(USDHC_Type *base, *usdhc_handle_t* *handle)

IRQ handler for the USDHC.

This function deals with the IRQs on the given host controller.

Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle.

FSL_USDHC_DRIVER_VERSION

Driver version 2.8.5.

Enum _usdhc_status. USDHC status.

Values:

enumerator kStatus_USDHC_BusyTransferring

Transfer is on-going.

enumerator kStatus_USDHC_PrepareAdmaDescriptorFailed

Set DMA descriptor failed.

enumerator kStatus_USDHC_SendCommandFailed

Send command failed.

enumerator kStatus_USDHC_TransferDataFailed

Transfer data failed.

enumerator kStatus_USDHC_DMADataAddrNotAlign

Data address not aligned.

enumerator kStatus_USDHC_ReTuningRequest

Re-tuning request.

enumerator kStatus_USDHC_TuningError

Tuning error.

enumerator kStatus_USDHC_NotSupport

Not support.

enumerator kStatus_USDHC_TransferDataComplete
Transfer data complete.

enumerator kStatus_USDHC_SendCommandSuccess
Transfer command complete.

enumerator kStatus_USDHC_TransferDMAComplete
Transfer DMA complete.

Enum _usdhc_capability_flag. Host controller capabilities flag mask. .

Values:

enumerator kUSDHC_SupportAdmaFlag
Support ADMA.

enumerator kUSDHC_SupportHighSpeedFlag
Support high-speed.

enumerator kUSDHC_SupportDmaFlag
Support DMA.

enumerator kUSDHC_SupportSuspendResumeFlag
Support suspend/resume.

enumerator kUSDHC_SupportV330Flag
Support voltage 3.3V.

enumerator kUSDHC_SupportV300Flag
Support voltage 3.0V.

enumerator kUSDHC_Support4BitFlag
Flag in HTCAPBLT_MBL's position, supporting 4-bit mode.

enumerator kUSDHC_Support8BitFlag
Flag in HTCAPBLT_MBL's position, supporting 8-bit mode.

enumerator kUSDHC_SupportDDR50Flag
SD version 3.0 new feature, supporting DDR50 mode.

enumerator kUSDHC_SupportSDR104Flag
Support SDR104 mode.

enumerator kUSDHC_SupportSDR50Flag
Support SDR50 mode.

Enum _usdhc_wakeup_event. Wakeup event mask. .

Values:

enumerator kUSDHC_WakeupEventOnCardInt
Wakeup on card interrupt.

enumerator kUSDHC_WakeupEventOnCardInsert
Wakeup on card insertion.

enumerator kUSDHC_WakeupEventOnCardRemove
Wakeup on card removal.

enumerator kUSDHC_WakeupEventsAll
All wakeup events

Enum _usdhc_reset. Reset type mask. .

Values:

enumerator kUSDHC_ResetAll
Reset all except card detection.

enumerator kUSDHC_ResetCommand
Reset command line.

enumerator kUSDHC_ResetData
Reset data line.

enumerator kUSDHC_ResetTuning
Reset tuning circuit.

enumerator kUSDHC_ResetsAll
All reset types

Enum _usdhc_transfer_flag. Transfer flag mask.

Values:

enumerator kUSDHC_EnableDmaFlag
Enable DMA.

enumerator kUSDHC_CommandTypeSuspendFlag
Suspend command.

enumerator kUSDHC_CommandTypeResumeFlag
Resume command.

enumerator kUSDHC_CommandTypeAbortFlag
Abort command.

enumerator kUSDHC_EnableBlockCountFlag
Enable block count.

enumerator kUSDHC_EnableAutoCommand12Flag
Enable auto CMD12.

enumerator kUSDHC_DataReadFlag
Enable data read.

enumerator kUSDHC_MultipleBlockFlag
Multiple block data read/write.

enumerator kUSDHC_EnableAutoCommand23Flag
Enable auto CMD23.

enumerator kUSDHC_ResponseLength136Flag
136-bit response length.

enumerator kUSDHC_ResponseLength48Flag
48-bit response length.

enumerator kUSDHC_ResponseLength48BusyFlag
48-bit response length with busy status.

enumerator kUSDHC_EnableCrcCheckFlag
Enable CRC check.

enumerator kUSDHC_EnableIndexCheckFlag
Enable index check.

enumerator kUSDHC_DataPresentFlag
Data present flag.

Enum _usdhc_present_status_flag. Present status flag mask. .

Values:

enumerator kUSDHC_CommandInhibitFlag
Command inhibit.

enumerator kUSDHC_DataInhibitFlag
Data inhibit.

enumerator kUSDHC_DataLineActiveFlag
Data line active.

enumerator kUSDHC_SdClockStableFlag
SD bus clock stable.

enumerator kUSDHC_WriteTransferActiveFlag
Write transfer active.

enumerator kUSDHC_ReadTransferActiveFlag
Read transfer active.

enumerator kUSDHC_BufferWriteEnableFlag
Buffer write enable.

enumerator kUSDHC_BufferReadEnableFlag
Buffer read enable.

enumerator kUSDHC_ReTuningRequestFlag
Re-tuning request flag, only used for SDR104 mode.

enumerator kUSDHC_DelaySettingFinishedFlag
Delay setting finished flag.

enumerator kUSDHC_CardInsertedFlag
Card inserted.

enumerator kUSDHC_CommandLineLevelFlag
Command line signal level.

enumerator kUSDHC_Data0LineLevelFlag
Data0 line signal level.

enumerator kUSDHC_Data1LineLevelFlag
Data1 line signal level.

enumerator kUSDHC_Data2LineLevelFlag
Data2 line signal level.

enumerator kUSDHC_Data3LineLevelFlag
Data3 line signal level.

enumerator kUSDHC_Data4LineLevelFlag
Data4 line signal level.

enumerator kUSDHC_Data5LineLevelFlag
Data5 line signal level.

enumerator kUSDHC_Data6LineLevelFlag
Data6 line signal level.

enumerator kUSDHC_Data7LineLevelFlag
Data7 line signal level.

Enum _usdhc_interrupt_status_flag. Interrupt status flag mask. .

Values:

enumerator kUSDHC_CommandCompleteFlag
Command complete.

enumerator kUSDHC_DataCompleteFlag
Data complete.

enumerator kUSDHC_BlockGapEventFlag
Block gap event.

enumerator kUSDHC_DmaCompleteFlag
DMA interrupt.

enumerator kUSDHC_BufferWriteReadyFlag
Buffer write ready.

enumerator kUSDHC_BufferReadReadyFlag
Buffer read ready.

enumerator kUSDHC_CardInsertionFlag
Card inserted.

enumerator kUSDHC_CardRemovalFlag
Card removed.

enumerator kUSDHC_CardInterruptFlag
Card interrupt.

enumerator kUSDHC_ReTuningEventFlag
Re-Tuning event, only for SD3.0 SDR104 mode.

enumerator kUSDHC_TuningPassFlag
SDR104 mode tuning pass flag.

enumerator kUSDHC_TuningErrorFlag
SDR104 tuning error flag.

enumerator kUSDHC_CommandTimeoutFlag
Command timeout error.

enumerator kUSDHC_CommandCrcErrorFlag
Command CRC error.

enumerator kUSDHC_CommandEndBitErrorFlag
Command end bit error.

enumerator kUSDHC_CommandIndexErrorFlag
Command index error.

enumerator kUSDHC_DataTimeoutFlag
Data timeout error.

enumerator kUSDHC_DataCrcErrorFlag
Data CRC error.

enumerator kUSDHC_DataEndBitErrorFlag
Data end bit error.

enumerator kUSDHC_AutoCommand12ErrorFlag
Auto CMD12 error.

enumerator kUSDHC_DmaErrorFlag
DMA error.

enumerator kUSDHC_CommandErrorFlag
Command error

enumerator kUSDHC_DataErrorFlag
Data error

enumerator kUSDHC_ErrorFlag
All error

enumerator kUSDHC_DataFlag
Data interrupts

enumerator kUSDHC_DataDMAFlag
Data interrupts

enumerator kUSDHC_CommandFlag
Command interrupts

enumerator kUSDHC_CardDetectFlag
Card detection interrupts

enumerator kUSDHC_SDR104TuningFlag
SDR104 tuning flag.

enumerator kUSDHC_AllInterruptFlags
All flags mask

Enum _usdhc_auto_command12_error_status_flag. Auto CMD12 error status flag mask. .

Values:

enumerator kUSDHC_AutoCommand12NotExecutedFlag
Not executed error.

enumerator kUSDHC_AutoCommand12TimeoutFlag
Timeout error.

enumerator kUSDHC_AutoCommand12EndBitErrorFlag
End bit error.

enumerator kUSDHC_AutoCommand12CrcErrorFlag
CRC error.

enumerator kUSDHC_AutoCommand12IndexErrorFlag
Index error.

enumerator kUSDHC_AutoCommand12NotIssuedFlag
Not issued error.

Enum _usdhc_standard_tuning. Standard tuning flag.

Values:

enumerator kUSDHC_ExecuteTuning
Used to start tuning procedure.

enumerator kUSDHC_TuningSampleClockSel
When **std_tuning_en** bit is set, this bit is used to select sampleing clock.

Enum _usdhc_adma_error_status_flag. ADMA error status flag mask. .

Values:

enumerator kUSDHC_AdmaLenghMismatchFlag
Length mismatch error.

enumerator kUSDHC_AdmaDescriptorErrorFlag
Descriptor error.

Enum _usdhc_adma_error_state. ADMA error state.

This state is the detail state when ADMA error has occurred.

Values:

enumerator kUSDHC_AdmaErrorStateStopDma
Stop DMA, previous location set in the ADMA system address is errored address.

enumerator kUSDHC_AdmaErrorStateFetchDescriptor
Fetch descriptor, current location set in the ADMA system address is errored address.

enumerator kUSDHC_AdmaErrorStateChangeAddress
Change address, no DMA error has occurred.

enumerator kUSDHC_AdmaErrorStateTransferData
Transfer data, previous location set in the ADMA system address is errored address.

enumerator kUSDHC_AdmaErrorStateInvalidLength
Invalid length in ADMA descriptor.

enumerator kUSDHC_AdmaErrorStateInvalidDescriptor
Invalid descriptor fetched by ADMA.

enumerator kUSDHC_AdmaErrorState
ADMA error state

Enum _usdhc_force_event. Force event bit position. .

Values:

enumerator kUSDHC_ForceEventAutoCommand12NotExecuted
Auto CMD12 not executed error.

enumerator kUSDHC_ForceEventAutoCommand12Timeout
Auto CMD12 timeout error.

enumerator kUSDHC_ForceEventAutoCommand12CrcError
Auto CMD12 CRC error.

enumerator kUSDHC_ForceEventEndBitError
Auto CMD12 end bit error.

enumerator kUSDHC_ForceEventAutoCommand12IndexError
Auto CMD12 index error.

enumerator kUSDHC_ForceEventAutoCommand12NotIssued
Auto CMD12 not issued error.

enumerator kUSDHC_ForceEventCommandTimeout
Command timeout error.

enumerator kUSDHC_ForceEventCommandCrcError
Command CRC error.

enumerator kUSDHC_ForceEventCommandEndBitError
Command end bit error.

enumerator kUSDHC_ForceEventCommandIndexError
Command index error.

enumerator kUSDHC_ForceEventDataTimeout
Data timeout error.

enumerator kUSDHC_ForceEventDataCrcError
Data CRC error.

enumerator kUSDHC_ForceEventDataEndBitError
Data end bit error.

enumerator kUSDHC_ForceEventAutoCommand12Error
Auto CMD12 error.

enumerator kUSDHC_ForceEventCardInt
Card interrupt.

enumerator kUSDHC_ForceEventDmaError
Dma error.

enumerator kUSDHC_ForceEventTuningError
Tuning error.

enumerator kUSDHC_ForceEventsAll
All force event flags mask.

enum _usdhc_transfer_direction
Data transfer direction.

Values:

enumerator kUSDHC_TransferDirectionReceive
USDHC transfer direction receive.

enumerator kUSDHC_TransferDirectionSend
USDHC transfer direction send.

enum _usdhc_data_bus_width
Data transfer width.

Values:

enumerator kUSDHC_DataBusWidth1Bit
1-bit mode

enumerator kUSDHC_DataBusWidth4Bit
4-bit mode

enumerator kUSDHC_DataBusWidth8Bit
8-bit mode

enum _usdhc_endian_mode
Endian mode.

Values:

enumerator kUSDHC_EndianModeBig
Big endian mode.

enumerator kUSDHC_EndianModeHalfWordBig
Half word big endian mode.

enumerator kUSDHC_EndianModeLittle
Little endian mode.

enum _usdhc_dma_mode
DMA mode.

Values:

enumerator kUSDHC_DmaModeSimple
External DMA.

enumerator kUSDHC_DmaModeAdma1
ADMA1 is selected.

enumerator kUSDHC_DmaModeAdma2
ADMA2 is selected.

enumerator kUSDHC_ExternalDMA
External DMA mode selected.

Enum _usdhc_sdio_control_flag. SDIO control flag mask. .

Values:

enumerator kUSDHC_StopAtBlockGapFlag
Stop at block gap.

enumerator kUSDHC_ReadWaitControlFlag
Read wait control.

enumerator kUSDHC_InterruptAtBlockGapFlag
Interrupt at block gap.

enumerator kUSDHC_ReadDoneNo8CLK
Read done without 8 clk for block gap.

enumerator kUSDHC_ExactBlockNumberReadFlag
Exact block number read.

enum _usdhc_boot_mode
MMC card boot mode.

Values:

enumerator kUSDHC_BootModeNormal
Normal boot

enumerator kUSDHC_BootModeAlternative
Alternative boot

enum _usdhc_card_command_type
The command type.

Values:

enumerator kCARD_CommandTypeNormal
Normal command

enumerator kCARD_CommandTypeSuspend
Suspend command

enumerator kCARD_CommandTypeResume
Resume command

enumerator kCARD_CommandTypeAbort
Abort command

enumerator kCARD_CommandTypeEmpty
Empty command

enum _usdhc_card_response_type
The command response type.

Defines the command response type from card to host controller.

Values:

enumerator kCARD_ResponseTypeNone
Response type: none

enumerator kCARD_ResponseTypeR1
Response type: R1

enumerator kCARD_ResponseTypeR1b
Response type: R1b

enumerator kCARD_ResponseTypeR2
Response type: R2

enumerator kCARD_ResponseTypeR3
Response type: R3

enumerator kCARD_ResponseTypeR4
Response type: R4

enumerator kCARD_ResponseTypeR5
Response type: R5

enumerator kCARD_ResponseTypeR5b
Response type: R5b

enumerator kCARD_ResponseTypeR6
Response type: R6

enumerator kCARD_ResponseTypeR7
Response type: R7

Enum _usdhc_adma1_descriptor_flag. The mask for the control/status field in ADMA1 descriptor.

Values:

enumerator kUSDHC_Adma1DescriptorValidFlag
Valid flag.

enumerator kUSDHC_Adma1DescriptorEndFlag
End flag.

enumerator kUSDHC_Adma1DescriptorInterrupFlag
Interrupt flag.

enumerator kUSDHC_Adma1DescriptorActivity1Flag
Activity 1 flag.

enumerator kUSDHC_Adma1DescriptorActivity2Flag
Activity 2 flag.

enumerator kUSDHC_Adma1DescriptorTypeNop
No operation.

enumerator kUSDHC_Adma1DescriptorTypeTransfer
Transfer data.

enumerator kUSDHC_Adma1DescriptorTypeLink
Link descriptor.

enumerator kUSDHC_Adma1DescriptorTypeSetLength
Set data length.

Enum _usdhc_adma2_descriptor_flag. ADMA1 descriptor control and status mask.

Values:

enumerator kUSDHC_Adma2DescriptorValidFlag
Valid flag.

enumerator kUSDHC_Adma2DescriptorEndFlag
End flag.

enumerator kUSDHC_Adma2DescriptorInterruptFlag
Interrupt flag.

enumerator kUSDHC_Adma2DescriptorActivity1Flag
Activity 1 mask.

enumerator kUSDHC_Adma2DescriptorActivity2Flag
Activity 2 mask.

enumerator kUSDHC_Adma2DescriptorTypeNop
No operation.

enumerator kUSDHC_Adma2DescriptorTypeReserved
Reserved.

enumerator kUSDHC_Adma2DescriptorTypeTransfer
Transfer type.

enumerator kUSDHC_Adma2DescriptorTypeLink
Link type.

Enum _usdhc_adma_flag. ADMA descriptor configuration flag. .

Values:

enumerator kUSDHC_AdmaDescriptorSingleFlag

Try to finish the transfer in a single ADMA descriptor. If transfer size is bigger than one ADMA descriptor's ability, new another descriptor for data transfer.

enumerator kUSDHC_AdmaDescriptorMultipleFlag

Create multiple ADMA descriptors within the ADMA table, this is used for mmc boot mode specifically, which need to modify the ADMA descriptor on the fly, so the flag should be used combining with stop at block gap feature.

enum _usdhc_burst_len

DMA transfer burst len config.

Values:

enumerator kUSDHC_EnBurstLenForINCR

Enable burst len for INCR.

enumerator kUSDHC_EnBurstLenForINCR4816

Enable burst len for INCR4/INCR8/INCR16.

enumerator kUSDHC_EnBurstLenForINCR4816WRAP

Enable burst len for INCR4/8/16 WRAP.

Enum _usdhc_transfer_data_type. Tansfer data type definition.

Values:

enumerator kUSDHC_TransferDataNormal

Transfer normal read/write data.

enumerator kUSDHC_TransferDataTuning

Transfer tuning data.

enumerator kUSDHC_TransferDataBoot

Transfer boot data.

enumerator kUSDHC_TransferDataBootcontinous

Transfer boot data continuously.

typedef enum *_usdhc_transfer_direction* usdhc_transfer_direction_t

Data transfer direction.

typedef enum *_usdhc_data_bus_width* usdhc_data_bus_width_t

Data transfer width.

typedef enum *_usdhc_endian_mode* usdhc_endian_mode_t

Endian mode.

typedef enum *_usdhc_dma_mode* usdhc_dma_mode_t

DMA mode.

typedef enum *_usdhc_boot_mode* usdhc_boot_mode_t

MMC card boot mode.

typedef enum *_usdhc_card_command_type* usdhc_card_command_type_t

The command type.

typedef enum *_usdhc_card_response_type* usdhc_card_response_type_t
: The command response type.

  Defines the command response type from card to host controller.

typedef enum *_usdhc_burst_len* usdhc_burst_len_t
: DMA transfer burst len config.

typedef uint32_t usdhc_adma1_descriptor_t
: Defines the ADMA1 descriptor structure.

typedef struct *_usdhc_adma2_descriptor* usdhc_adma2_descriptor_t
: Defines the ADMA2 descriptor structure.

typedef struct *_usdhc_capability* usdhc_capability_t
: USDHC capability information.

  Defines a structure to save the capability information of USDHC.

typedef struct *_usdhc_boot_config* usdhc_boot_config_t
: Data structure to configure the MMC boot feature.

typedef struct *_usdhc_config* usdhc_config_t
: Data structure to initialize the USDHC.

typedef struct *_usdhc_command* usdhc_command_t
: Card command descriptor.

  Defines card command-related attribute.

typedef struct *_usdhc_adma_config* usdhc_adma_config_t
: ADMA configuration.

typedef struct *_usdhc_scatter_gather_data_list* usdhc_scatter_gather_data_list_t
: Card scatter gather data list.

  Allow application register uncontinuous data buffer for data transfer.

typedef struct *_usdhc_scatter_gather_data* usdhc_scatter_gather_data_t
: Card scatter gather data descriptor.

  Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

typedef struct *_usdhc_scatter_gather_transfer* usdhc_scatter_gather_transfer_t
: usdhc scatter gather transfer.

typedef struct *_usdhc_data* usdhc_data_t
: Card data descriptor.

  Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

typedef struct *_usdhc_transfer* usdhc_transfer_t
: Transfer state.

typedef struct *_usdhc_handle* usdhc_handle_t
: USDHC handle typedef.

typedef struct *_usdhc_transfer_callback* usdhc_transfer_callback_t
: USDHC callback functions.

typedef *status_t* (*usdhc_transfer_function_t)(USDHC_Type *base, *usdhc_transfer_t* *content)

USDHC transfer function.

typedef struct *_usdhc_host* usdhc_host_t

USDHC host descriptor.

USDHC_MAX_BLOCK_COUNT

Maximum block count can be set one time.

FSL_USDHC_ENABLE_SCATTER_GATHER_TRANSFER

USDHC scatter gather feature control macro.

USDHC_ADMA1_ADDRESS_ALIGN

The alignment size for ADDRESS filed in ADMA1's descriptor.

USDHC_ADMA1_LENGTH_ALIGN

The alignment size for LENGTH field in ADMA1's descriptor.

USDHC_ADMA2_ADDRESS_ALIGN

The alignment size for ADDRESS field in ADMA2's descriptor.

USDHC_ADMA2_LENGTH_ALIGN

The alignment size for LENGTH filed in ADMA2's descriptor.

USDHC_ADMA1_DESCRIPTOR_ADDRESS_SHIFT

The bit shift for ADDRESS filed in ADMA1's descriptor.

Address/page field	Reserved	Attribute					
31 12	11 6	05	04	03	02	01	00
address or data length	000000	Act2	Act1	0	Int	End	Valid

Act2	Act1	Comment	31-28	27-12
0	0	No op	Don't care	
0	1	Set data length	0000	Data Length
1	0	Transfer data	Data address	
1	1	Link descriptor	Descriptor address	

USDHC_ADMA1_DESCRIPTOR_ADDRESS_MASK

The bit mask for ADDRESS field in ADMA1's descriptor.

USDHC_ADMA1_DESCRIPTOR_LENGTH_SHIFT

The bit shift for LENGTH filed in ADMA1's descriptor.

USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK

The mask for LENGTH field in ADMA1's descriptor.

USDHC_ADMA1_DESCRIPTOR_MAX_LENGTH_PER_ENTRY

The maximum value of LENGTH filed in ADMA1's descriptor. Since the max transfer size ADMA1 support is 65535 which is indivisible by 4096, so to make sure a large data load transfer (>64KB) continuously (require the data address be always align with 4096), software will set the maximum data length for ADMA1 to (64 - 4)KB.

USDHC_ADMA2_DESCRIPTOR_LENGTH_SHIFT

The bit shift for LENGTH field in ADMA2's descriptor.

Address field	Length	Reserved	Attribute					
63 32	31 16	15 06	05	04	03	02	01	00
32-bit address	16-bit length	0000000000	Act2	Act1	0	Int	End	Valid

Act2	Act1	Comment	Operation
0	0	No op	Don't care
0	1	Reserved	Read this line and go to next one
1	0	Transfer data	Transfer data with address and length set in this descriptor line
1	1	Link descriptor	Link to another descriptor

USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK

The bit mask for LENGTH field in ADMA2's descriptor.

USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY

The maximum value of LENGTH field in ADMA2's descriptor.

struct _usdhc_adma2_descriptor

#include <fsl_usdhc.h> Defines the ADMA2 descriptor structure.

Public Members

uint32_t attribute

The control and status field.

uint32_t address

The address field.

struct _usdhc_capability

#include <fsl_usdhc.h> USDHC capability information.

Defines a structure to save the capability information of USDHC.

Public Members

uint32_t sdVersion

Support SD card/sdio version.

uint32_t mmcVersion

Support EMMC card version.

uint32_t maxBlockLength

Maximum block length united as byte.

uint32_t maxBlockCount

Maximum block count can be set one time.

uint32_t flags
: Capability flags to indicate the support information(_usdhc_capability_flag).

struct _usdhc_boot_config
: *#include <fsl_usdhc.h>* Data structure to configure the MMC boot feature.

Public Members

uint32_t ackTimeoutCount
: Timeout value for the boot ACK. The available range is 0 ~ 15.

usdhc_boot_mode_t bootMode
: Boot mode selection.

uint32_t blockCount
: Stop at block gap value of automatic mode. Available range is 0 ~ 65535.

size_t blockSize
: Block size.

bool enableBootAck
: Enable or disable boot ACK.

bool enableAutoStopAtBlockGap
: Enable or disable auto stop at block gap function in boot period.

struct _usdhc_config
: *#include <fsl_usdhc.h>* Data structure to initialize the USDHC.

Public Members

uint32_t dataTimeout
: Data timeout value.

usdhc_endian_mode_t endianMode
: Endian mode.

uint8_t readWatermarkLevel
: Watermark level for DMA read operation. Available range is 1 ~ 128.

uint8_t writeWatermarkLevel
: Watermark level for DMA write operation. Available range is 1 ~ 128.

struct _usdhc_command
: *#include <fsl_usdhc.h>* Card command descriptor.

Defines card command-related attribute.

Public Members

uint32_t index
: Command index.

uint32_t argument
: Command argument.

usdhc_card_command_type_t type
: Command type.

usdhc_card_response_type_t responseType
Command response type.

uint32_t response[4U]
Response for this command.

uint32_t responseErrorFlags
Response error flag, which need to check the command reponse.

uint32_t flags
Cmd flags.

struct __usdhc_adma_config
#include <fsl_usdhc.h> ADMA configuration.

Public Members

usdhc_dma_mode_t dmaMode
DMA mode.

uint32_t *admaTable
ADMA table address, can't be null if transfer way is ADMA1/ADMA2.

uint32_t admaTableWords
ADMA table length united as words, can't be 0 if transfer way is ADMA1/ADMA2.

struct __usdhc_scatter_gather_data_list
#include <fsl_usdhc.h> Card scatter gather data list.

Allow application register uncontinuous data buffer for data transfer.

struct __usdhc_scatter_gather_data
#include <fsl_usdhc.h> Card scatter gather data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

Public Members

bool enableAutoCommand12
Enable auto CMD12.

bool enableAutoCommand23
Enable auto CMD23.

bool enableIgnoreError
Enable to ignore error event to read/write all the data.

usdhc_transfer_direction_t dataDirection
data direction

uint8_t dataType
this is used to distinguish the normal/tuning/boot data.

size_t blockSize
Block size.

usdhc_scatter_gather_data_list_t sgData
scatter gather data

struct _usdhc_scatter_gather_transfer

#include <fsl_usdhc.h> usdhc scatter gather transfer.

Public Members

usdhc_scatter_gather_data_t *data

Data to transfer.

usdhc_command_t *command

Command to send.

struct _usdhc_data

#include <fsl_usdhc.h> Card data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

Public Members

bool enableAutoCommand12

Enable auto CMD12.

bool enableAutoCommand23

Enable auto CMD23.

bool enableIgnoreError

Enable to ignore error event to read/write all the data.

uint8_t dataType

this is used to distinguish the normal/tuning/boot data.

size_t blockSize

Block size.

uint32_t blockCount

Block count.

uint32_t *rxData

Buffer to save data read.

const uint32_t *txData

Data buffer to write.

struct _usdhc_transfer

#include <fsl_usdhc.h> Transfer state.

Public Members

usdhc_data_t *data

Data to transfer.

usdhc_command_t *command

Command to send.

struct _usdhc_transfer_callback

#include <fsl_usdhc.h> USDHC callback functions.

Public Members

void (*CardInserted)(USDHC_Type *base, void *userData)
Card inserted occurs when DAT3/CD pin is for card detect

void (*CardRemoved)(USDHC_Type *base, void *userData)
Card removed occurs

void (*SdioInterrupt)(USDHC_Type *base, void *userData)
SDIO card interrupt occurs

void (*BlockGap)(USDHC_Type *base, void *userData)
stopped at block gap event

void (*TransferComplete)(USDHC_Type *base, *usdhc_handle_t* *handle, *status_t* status, void *userData)
Transfer complete callback.

void (*ReTuning)(USDHC_Type *base, void *userData)
Handle the re-tuning.

struct __usdhc__handle
#include <fsl_usdhc.h> USDHC handle.

Defines the structure to save the USDHC state information and callback function.

Note: All the fields except interruptFlags and transferredWords must be allocated by the user.

Public Members

usdhc_data_t *volatile data
Transfer parameter. Data to transfer.

usdhc_command_t *volatile command
Transfer parameter. Command to send.

volatile uint32_t transferredWords
Transfer status. Words transferred by DATAPORT way.

usdhc_transfer_callback_t callback
Callback function.

void *userData
Parameter for transfer complete callback.

struct __usdhc__host
#include <fsl_usdhc.h> USDHC host descriptor.

Public Members

USDHC_Type *base
USDHC peripheral base address.

uint32_t sourceClock__Hz
USDHC source clock frequency united in Hz.

usdhc_config_t config
USDHC configuration.

usdhc_capability_t capability
USDHC capability information.

usdhc_transfer_function_t transfer
USDHC transfer function.

2.123 WDOG: Watchdog Timer Driver

void WDOG_GetDefaultConfig(*wdog_config_t* *config)
Initializes the WDOG configuration structure.

This function initializes the WDOG configuration structure to default values. The default values are as follows.

```
wdogConfig->enableWdog = true;
wdogConfig->workMode.enableWait = true;
wdogConfig->workMode.enableStop = true;
wdogConfig->workMode.enableDebug = true;
wdogConfig->enableInterrupt = false;
wdogConfig->enablePowerdown = false;
wdogConfig->resetExtension = flase;
wdogConfig->timeoutValue = 0xFFU;
wdogConfig->interruptTimeValue = 0x04u;
```

See also:

wdog_config_t

Parameters

- config – Pointer to the WDOG configuration structure.

void WDOG_Init(WDOG_Type *base, const *wdog_config_t* *config)
Initializes the WDOG.

This function initializes the WDOG. When called, the WDOG runs according to the configuration.

This is an example.

```
wdog_config_t config;
WDOG_GetDefaultConfig(&config);
config.timeoutValue = 0xffU;
config->interruptTimeValue = 0x04u;
WDOG_Init(wdog_base,&config);
```

Parameters

- base – WDOG peripheral base address
- config – The configuration of WDOG

void WDOG_Deinit(WDOG_Type *base)
Shuts down the WDOG.

This function shuts down the WDOG. Watchdog Enable bit is a write one once only bit. It is not possible to clear this bit by a software write, once the bit is set. This bit(WDE) can be set/reset only in debug mode(exception).

static inline void WDOG_Enable(WDOG_Type *base)

Enables the WDOG module.

This function writes a value into the WDOG_WCR register to enable the WDOG. This is a write one once only bit. It is not possible to clear this bit by a software write, once the bit is set. only debug mode exception.

Parameters

- base – WDOG peripheral base address

static inline void WDOG_Disable(WDOG_Type *base)

Disables the WDOG module.

This function writes a value into the WDOG_WCR register to disable the WDOG. This is a write one once only bit. It is not possible to clear this bit by a software write,once the bit is set. only debug mode exception

Parameters

- base – WDOG peripheral base address

static inline void WDOG_TriggerSystemSoftwareReset(WDOG_Type *base)

Trigger the system software reset.

This function will write to the WCR[SRS] bit to trigger a software system reset. This bit will automatically resets to "1" after it has been asserted to "0". Note: Calling this API will reset the system right now, please using it with more attention.

Parameters

- base – WDOG peripheral base address

static inline void WDOG_TriggerSoftwareSignal(WDOG_Type *base)

Trigger an output assertion.

This function will write to the WCR[WDA] bit to trigger WDOG_B signal assertion. The WDOG_B signal can be routed to external pin of the chip, the output pin will turn to assertion along with WDOG_B signal. Note: The WDOG_B signal will remain assert until a power on reset occurred, so, please take more attention while calling it.

Parameters

- base – WDOG peripheral base address

static inline void WDOG_EnableInterrupts(WDOG_Type *base, uint16_t mask)

Enables the WDOG interrupt.

This bit is a write once only bit. Once the software does a write access to this bit, it will get locked and cannot be reprogrammed until the next system reset assertion

Parameters

- base – WDOG peripheral base address
- mask – The interrupts to enable The parameter can be combination of the following source if defined.
  - kWDOG_InterruptEnable

uint16_t WDOG_GetStatusFlags(WDOG_Type *base)

Gets the WDOG all reset status flags.

This function gets all reset status flags.

```
uint16_t status;
status = WDOG_GetStatusFlags (wdog_base);
```

See also:

_wdog_status_flags

- true: a related status flag has been set.
- false: a related status flag is not set.

Parameters

- base – WDOG peripheral base address

Returns

State of the status flag: asserted (true) or not-asserted (false).

void WDOG_ClearInterruptStatus(WDOG_Type *base, uint16_t mask)

Clears the WDOG flag.

This function clears the WDOG status flag.

This is an example for clearing the interrupt flag.

```
WDOG_ClearStatusFlags(wdog_base,KWDOG_InterruptFlag);
```

Parameters

- base – WDOG peripheral base address
- mask – The status flags to clear. The parameter could be any combination of the following values. kWDOG_TimeoutFlag

static inline void WDOG_SetTimeoutValue(WDOG_Type *base, uint16_t timeoutCount)

Sets the WDOG timeout value.

This function sets the timeout value. This function writes a value into WCR registers. The time-out value can be written at any point of time but it is loaded to the counter at the time when WDOG is enabled or after the service routine has been performed.

Parameters

- base – WDOG peripheral base address
- timeoutCount – WDOG timeout value; count of WDOG clock tick.

static inline void WDOG_SetInterrputTimeoutValue(WDOG_Type *base, uint16_t timeoutCount)

Sets the WDOG interrupt count timeout value.

This function sets the interrupt count timeout value. This function writes a value into WIC registers which are wirte-once. This field is write once only. Once the software does a write access to this field, it will get locked and cannot be reprogrammed until the next system reset assertion.

Parameters

- base – WDOG peripheral base address
- timeoutCount – WDOG timeout value; count of WDOG clock tick.

static inline void WDOG_DisablePowerDownEnable(WDOG_Type *base)

Disable the WDOG power down enable bit.

This function disable the WDOG power down enable(PDE). This function writes a value into WMCR registers which are wirte-once. This field is write once only. Once software sets this bit it cannot be reset until the next system reset.

Parameters

- base – WDOG peripheral base address

void WDOG_Refresh(WDOG_Type *base)

Refreshes the WDOG timer.

This function feeds the WDOG. This function should be called before the WDOG timer is in timeout. Otherwise, a reset is asserted.

Parameters

- base – WDOG peripheral base address

FSL_WDOG_DRIVER_VERSION

Defines WDOG driver version.

WDOG_REFRESH_KEY

enum _wdog_interrupt_enable

WDOG interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the WDOG interrupt configurations.

Values:

enumerator kWDOG_InterruptEnable

WDOG timeout generates an interrupt before reset

enum _wdog_status_flags

WDOG status flags.

This structure contains the WDOG status flags for use in the WDOG functions.

Values:

enumerator kWDOG_RunningFlag

Running flag, set when WDOG is enabled

enumerator kWDOG_PowerOnResetFlag

Power On flag, set when reset is the result of a powerOnReset

enumerator kWDOG_TimeoutResetFlag

Timeout flag, set when reset is the result of a timeout

enumerator kWDOG_SoftwareResetFlag

Software flag, set when reset is the result of a software

enumerator kWDOG_InterruptFlag

interrupt flag,whether interrupt has occurred or not

typedef struct *_wdog_work_mode* wdog_work_mode_t

Defines WDOG work mode.

typedef struct *_wdog_config* wdog_config_t

Describes WDOG configuration structure.

struct _wdog_work_mode

#include <fsl_wdog.h> Defines WDOG work mode.

Public Members

bool enableWait

If set to true, WDOG continues in wait mode

bool enableStop

If set to true, WDOG continues in stop mode

bool enableDebug
: If set to true, WDOG continues in debug mode

struct _wdog_config
: *#include <fsl_wdog.h>* Describes WDOG configuration structure.

Public Members

bool enableWdog
: Enables or disables WDOG

wdog_work_mode_t workMode
: Configures WDOG work mode in debug stop and wait mode

bool enableInterrupt
: Enables or disables WDOG interrupt

uint16_t timeoutValue
: Timeout value

uint16_t interruptTimeValue
: Interrupt count timeout value

bool softwareResetExtension
: software reset extension

bool enablePowerDown
: power down enable bit

bool enableTimeOutAssert
: Enable WDOG_B timeout assertion.

2.124 XBARA: Inter-Peripheral Crossbar Switch

void XBARA_Init(XBARA_Type *base)
: Initializes the XBARA module.

This function un-gates the XBARA clock.

Parameters

- base – XBARA peripheral address.

void XBARA_Deinit(XBARA_Type *base)
: Shuts down the XBARA module.

This function disables XBARA clock.

Parameters

- base – XBARA peripheral address.

void XBARA_SetSignalsConnection(XBARA_Type *base, xbar_input_signal_t input, xbar_output_signal_t output)
: Sets a connection between the selected XBARA_IN[*] input and the XBARA_OUT[*] output signal.

This function connects the XBARA input to the selected XBARA output. If more than one XBARA module is available, only the inputs and outputs from the same module can be connected.

Example:

```
XBARA_SetSignalsConnection(XBARA, kXBARA_InputPIT_TRG0, kXBARA_
↪OutputDMAMUX18);
```

Parameters

- base – XBARA peripheral address.
- input – XBARA input signal.
- output – XBARA output signal.

uint32_t XBARA_GetStatusFlags(XBARA_Type *base)

Gets the active edge detection status.

This function gets the active edge detect status of all XBARA_OUTs. If the active edge occurs, the return value is asserted. When the interrupt or the DMA functionality is enabled for the XBARA_OUTx, this field is 1 when the interrupt or DMA request is asserted and 0 when the interrupt or DMA request has been cleared.

Parameters

- base – XBARA peripheral address.

Returns

the mask of these status flag bits.

void XBARA_ClearStatusFlags(XBARA_Type *base, uint32_t mask)

Clears the edge detection status flags of relative mask.

Parameters

- base – XBARA peripheral address.
- mask – the status flags to clear.

void XBARA_SetOutputSignalConfig(XBARA_Type *base, xbar_output_signal_t output, const *xbara_control_config_t* *controlConfig)

Configures the XBARA control register.

This function configures an XBARA control register. The active edge detection and the DMA/IRQ function on the corresponding XBARA output can be set.

Example:

```
xbara_control_config_t userConfig;
userConfig.activeEdge = kXBARA_EdgeRising;
userConfig.requestType = kXBARA_RequestInterruptEnalbe;
XBARA_SetOutputSignalConfig(XBARA, kXBARA_OutputDMAMUX18, &userConfig);
```

Parameters

- base – XBARA peripheral address.
- output – XBARA output number.
- controlConfig – Pointer to structure that keeps configuration of control register.

enum _xbara_active_edge

XBARA active edge for detection.

Values:

enumerator kXBARA_EdgeNone

Edge detection status bit never asserts.

enumerator kXBARA_EdgeRising
Edge detection status bit asserts on rising edges.

enumerator kXBARA_EdgeFalling
Edge detection status bit asserts on falling edges.

enumerator kXBARA_EdgeRisingAndFalling
Edge detection status bit asserts on rising and falling edges.

enum _xbar_request
Defines the XBARA DMA and interrupt configurations.

Values:

enumerator kXBARA_RequestDisable
Interrupt and DMA are disabled.

enumerator kXBARA_RequestDMAEnable
DMA enabled, interrupt disabled.

enumerator kXBARA_RequestInterruptEnable
Interrupt enabled, DMA disabled.

enum _xbara_status_flag_t
XBARA status flags.

This provides constants for the XBARA status flags for use in the XBARA functions.

Values:

enumerator kXBARA_EdgeDetectionOut0
XBAR_OUT0 active edge interrupt flag, sets when active edge detected.

enumerator kXBARA_EdgeDetectionOut1
XBAR_OUT1 active edge interrupt flag, sets when active edge detected.

enumerator kXBARA_EdgeDetectionOut2
XBAR_OUT2 active edge interrupt flag, sets when active edge detected.

enumerator kXBARA_EdgeDetectionOut3
XBAR_OUT3 active edge interrupt flag, sets when active edge detected.

typedef enum *_xbara_active_edge* xbara_active_edge_t
XBARA active edge for detection.

typedef enum *_xbar_request* xbara_request_t
Defines the XBARA DMA and interrupt configurations.

typedef enum *_xbara_status_flag_t* xbara_status_flag_t
XBARA status flags.

This provides constants for the XBARA status flags for use in the XBARA functions.

typedef struct *XBARAControlConfig* xbara_control_config_t
Defines the configuration structure of the XBARA control register.

This structure keeps the configuration of XBARA control register for one output. Control registers are available only for a few outputs. Not every XBARA module has control registers.

FSL_XBARA_DRIVER_VERSION

XBARA_SELx(base, output)

XBARA_WR_SELx_SELx(base, input, output)

kXBARA_RequestInterruptEnalbe

struct XBARAControlConfig

#include <fsl_xbara.h> Defines the configuration structure of the XBARA control register.

This structure keeps the configuration of XBARA control register for one output. Control registers are available only for a few outputs. Not every XBARA module has control registers.

Public Members

xbara_active_edge_t activeEdge

Active edge to be detected.

xbara_request_t requestType

Selects DMA/Interrupt request.

2.125 XBARB: Inter-Peripheral Crossbar Switch

void XBARB_Init(XBARB_Type *base)

Initializes the XBARB module.

This function un-gates the XBARB clock.

Parameters

- base – XBARB peripheral address.

void XBARB_Deinit(XBARB_Type *base)

Shuts down the XBARB module.

This function disables XBARB clock.

Parameters

- base – XBARB peripheral address.

void XBARB_SetSignalsConnection(XBARB_Type *base, xbar_input_signal_t input, xbar_output_signal_t output)

Configures a connection between the selected XBARB_IN[*] input and the XBARB_OUT[*] output signal.

This function configures which XBARB input is connected to the selected XBARB output. If more than one XBARB module is available, only the inputs and outputs from the same module can be connected.

Parameters

- base – XBARB peripheral address.
- input – XBARB input signal.
- output – XBARB output signal.

FSL_XBARB_DRIVER_VERSION

XBARB_SELx(base, output)

XBARB_WR_SELx_SELx(base, input, output)

2.126 XECC: external error correction code controller

void XECC_Init(XECC_Type *base, const *xecc_config_t* *config)
XECC module initialization function.

Parameters

- base – XECC base address.
- config – pointer to the XECC configuration structure.

void XECC_Deinit(XECC_Type *base)
Deinitializes the XECC.

Parameters

- base – XECC base address.

void XECC_GetDefaultConfig(*xecc_config_t* *config)
Sets the XECC configuration structure to default values.

Parameters

- config – pointer to the XECC configuration structure.

static inline uint32_t XECC_GetStatusFlags(XECC_Type *base)
Gets XECC status flags.

Parameters

- base – XECC peripheral base address.

Returns
XECC status flags.

static inline void XECC_ClearStatusFlags(XECC_Type *base, uint32_t mask)
XECC module clear interrupt status.

Parameters

- base – XECC base address.
- mask – status to clear from xecc_interrupt_status_t.

static inline void XECC_EnableInterruptStatus(XECC_Type *base, uint32_t mask)
XECC module enable interrupt status.

Parameters

- base – XECC base address.
- mask – status to enable from xecc_interrupt_status_enable_t.

static inline void XECC_DisableInterruptStatus(XECC_Type *base, uint32_t mask)
XECC module disable interrupt status.

Parameters

- base – XECC base address.
- mask – status to disable from xecc_interrupt_status_enable_t.

static inline void XECC_EnableInterrupts(XECC_Type *base, uint32_t mask)
XECC module enable interrupt.

Parameters

- base – XECC base address.
- mask – The interrupts to enable from xecc_interrupt_enable_t.

static inline void XECC_DisableInterrupts(XECC_Type *base, uint32_t mask)

XECC module disable interrupt.

Parameters

- base – XECC base address.
- mask – The interrupts to disable from xecc_interrupt_enable_t.

static inline void XECC_WriteECCEnable(XECC_Type *base, bool enable)

XECC module write ECC function enable.

Parameters

- base – XECC base address.
- enable – enable or disable.

static inline void XECC_ReadECCEnable(XECC_Type *base, bool enable)

XECC module read ECC function enable.

Parameters

- base – XECC base address.
- enable – enable or disable.

static inline void XECC_SwapECCEnable(XECC_Type *base, bool enable)

XECC module swap data enable.

Parameters

- base – XECC base address.
- enable – enable or disable.

status_t XECC_ErrorInjection(XECC_Type *base, uint32_t errordata, uint8_t erroreccdata)

XECC module error injection.

Parameters

- base – XECC base address.
- errordata – error data.
- erroreccdata – ecc code.

Return values

kStatus_Success. –

void XECC_GetSingleErrorInfo(XECC_Type *base, *xecc_single_error_info_t* *info)

XECC module get single error information.

Parameters

- base – XECC base address.
- info – single error information.

void XECC_GetMultiErrorInfo(XECC_Type *base, *xecc_multi_error_info_t* *info)

XECC module get multiple error information.

Parameters

- base – XECC base address.
- info – multiple error information.

FSL_XECC_DRIVER_VERSION

Driver version 2.0.0.

XECC interrupt configuration structure, , xecc_interrupt_enable_t.

This structure contains the settings for all of the XECC interrupt configurations.

Values:

enumerator kXECC_SingleErrorInterruptEnable
Single bit error interrupt enable

enumerator kXECC_MultiErrorInterruptEnable
Multiple bit error interrupt enable

enumerator kXECC_AllInterruptsEnable
all interrupts enable

XECC interrupt status configuration structure, xecc_interrupt_status_enable_t.

This structure contains the settings for all of the XECC interrupt status configurations.

Values:

enumerator kXECC_SingleErrorInterruptStatusEnable
Single bit error interrupt status enable

enumerator kXECC_MultiErrorInterruptStatusEnable
Multiple bits error interrupt status enable

enumerator kXECC_AllInterruptsStatusEnable
all interrupts enable

XECC status flags, xecc_interrupt_status_t.

This provides constants for the XECC status flags for use in the XECC functions.

Values:

enumerator kXECC_SingleErrorInterruptFlag
Single bit error interrupt happens on read data

enumerator kXECC_MultiErrorInterruptFlag
Multiple bits error interrupt happens on read data

enumerator kXECC_AllInterruptsFlag
all interrupts happens on read data

typedef struct *_xecc_config* xecc_config_t
XECC user configuration.

typedef struct *_xecc_single_error_info* xecc_single_error_info_t
XECC single error information, including single error address, ECC code, error data, error bit position and error bit field.

typedef struct *_xecc_multi_error_info* xecc_multi_error_info_t
XECC multiple error information, including multiple error address, ECC code, error data and error bit field.

struct _xecc_config
#include <fsl_xecc.h> XECC user configuration.

Public Members

bool enableXECC
: Enable the XECC function.

bool enableWriteECC
: Enable write ECC function.

bool enableReadECC
: Enable read ECC function.

bool enableSwap
: Enable swap function. The minimum ECC region range is 4k, so the lower 12 bits of this register must be 0.

uint32_t Region0BaseAddress
: ECC region 0 base address.

uint32_t Region0EndAddress
: ECC region 0 end address.

uint32_t Region1BaseAddress
: ECC region 1 base address.

uint32_t Region1EndAddress
: ECC region 1 end address.

uint32_t Region2BaseAddress
: ECC region 2 base address.

uint32_t Region2EndAddress
: ECC region 2 end address.

uint32_t Region3BaseAddress
: ECC region 3 base address.

uint32_t Region3EndAddress
: ECC region 3 end address.

struct __xecc_single_error_info
: *#include <fsl_xecc.h>* XECC single error information, including single error address, ECC code, error data, error bit position and error bit field.

Public Members

uint32_t singleErrorAddress
: Single error address

uint32_t singleErrorData
: Single error read data

uint32_t singleErrorEccCode
: Single error ECC code

uint32_t singleErrorBitPos
: Single error bit postion

uint32_t singleErrorBitField
: Single error bit field

struct __xecc_multi_error_info
: *#include <fsl_xecc.h>* XECC multiple error information, including multiple error address, ECC code, error data and error bit field.

Public Members

uint32_t multiErrorAddress
: Multiple error address

uint32_t multiErrorData
: Multiple error read data

uint32_t multiErrorEccCode
: Multiple error ECC code

uint32_t multiErrorBitField
: Single error bit field

2.127 XRDC2: Extended Resource Domain Controller 2

void XRDC2_SetGlobalValid(XRDC2_Type *base, bool valid)

Sets the XRDC2 global valid.

This function sets the XRDC2 global valid or invalid. When the XRDC2 is global invalid, all accesses from all bus masters to all slaves are allowed.

Parameters

- base – XRDC2 peripheral base address.
- valid – True to valid XRDC2.

static inline uint8_t XRDC2_GetCurrentMasterDomainId(XRDC2_Type *base)

Gets the domain ID of the current bus master.

This function returns the domain ID of the current bus master.

Parameters

- base – XRDC2 peripheral base address.

Returns

Domain ID of current bus master.

static inline void XRDC2_SetGlobalConfigLock(XRDC2_Type *base, *xrdc2_global_config_lock_t* mode)

Set the global configuration lock mode.

Once change the lock mode, it could not be changed until next reset.

Parameters

- base – XRDC2 peripheral base address.
- mode – The lock mode.

static inline uint8_t XRDC2_GetCurrentGlobalConfigLockOwnerDomainId(XRDC2_Type *base)

Gets the domain ID of global configuration lock owner.

Parameters

- base – XRDC2 peripheral base address.

Returns

Domain ID of the global configuration lock owner.

void XRDC2_GetDefaultMasterDomainAssignment(*xrdc2_master_domain_assignment_t* *assignment)

Gets the default master domain assignment.

This function sets the assignment as follows:

```
config->lock = false;
config->privilegeAttr = kXRDC2_MasterPrivilege;
config->secureAttr = kXRDC2_MasterSecure;
config->domainId = 0U;
config->mask = 0U;
config->match = 0U;
```

Parameters

- assignment – Pointer to the assignment structure.

void XRDC2_SetMasterDomainAssignment(XRDC2_Type *base, xrdc2_master_t master, uint8_t assignIndex, const *xrdc2_master_domain_assignment_t* *assignment)

Sets the processor bus master domain assignment.

Parameters

- base – XRDC2 peripheral base address.
- master – Which master to configure.
- assignIndex – Which assignment register to set.
- assignment – Pointer to the assignment structure.

static inline void XRDC2_LockMasterDomainAssignment(XRDC2_Type *base, xrdc2_master_t master, uint8_t assignIndex)

Locks the bus master domain assignment register.

This function locks the master domain assignment. One bus master might have multiple domain assignment registers. The parameter assignIndex specifies which assignment register to lock. After it is locked, the register can't be changed until next reset.

Parameters

- base – XRDC2 peripheral base address.
- master – Which master to configure.
- assignIndex – Which assignment register to lock.

static inline void XRDC2_SetMasterDomainAssignmentValid(XRDC2_Type *base, xrdc2_master_t master, uint8_t assignIndex, bool valid)

Sets the master domain assignment as valid or invalid.

This function sets the master domain assignment as valid or invalid. One bus master might have multiple domain assignment registers. The parameter assignIndex specifies which assignment register to configure.

Parameters

- base – XRDC2 peripheral base address.
- master – Which master to configure.
- assignIndex – Index for the domain assignment register.
- valid – True to set valid, false to set invalid.

void XRDC2_GetMemSlotAccessDefaultConfig(*xrdc2_mem_slot_access_config_t* *config)

Gets the default memory slot access configuration.

This function sets the assignment as follows:

```
config->lockMode = kXRDC2_AccessConfigLockDisabled;
config->policy[0] = kXRDC2_AccessPolicyNone;
config->policy[1] = kXRDC2_AccessPolicyNone;
...
```

Parameters

- config – Pointer to the configuration.

void XRDC2_SetMemSlotAccessConfig(XRDC2_Type *base, xrdc2_mem_slot_t memSlot, const *xrdc2_mem_slot_access_config_t* *config)

Sets the memory slot access policy.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – Which memory slot descriptor to set.
- config – Pointer to the access policy configuration structure.

void XRDC2_SetMemSlotAccessValid(XRDC2_Type *base, xrdc2_mem_slot_t memSlot, bool valid)

Sets the memory slot descriptor as valid or invalid.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – Which memory slot descriptor to set.
- valid – True to set valid, false to set invalid.

void XRDC2_SetMemSlotAccessLockMode(XRDC2_Type *base, xrdc2_mem_slot_t memSlot, *xrdc2_access_config_lock_t* lockMode)

Sets the memory slot descriptor lock mode.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – Which memory slot descriptor to set.
- lockMode – The lock mode to set.

void XRDC2_SetMemSlotDomainAccessPolicy(XRDC2_Type *base, xrdc2_mem_slot_t memSlot, uint8_t domainId, *xrdc2_access_policy_t* policy)

Sets the memory slot access policy for specific domain.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.
- domainId – The ID of the domain whose policy will be changed.
- policy – The access policy to set.

void XRDC2_EnableMemSlotExclAccessLock(XRDC2_Type *base, xrdc2_mem_slot_t memSlot, bool enable)

Enable or disable the memory slot exclusive access lock.

The lock must be enabled first before use. Once disabled, it could not be enabled until reset.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.
- enable – True to enable, false to disable.

uint8_t XRDC2_GetMemSlotExclAccessLockDomainOwner(XRDC2_Type *base, xrdc2_mem_slot_t memSlot)

Get current memory slot exclusive access lock owner.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.

Returns

The domain ID of the lock owner.

status_t XRDC2_TryLockMemSlotExclAccess(XRDC2_Type *base, xrdc2_mem_slot_t memSlot)

Try to lock the memory slot exclusive access.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.

Return values

- kStatus_Fail – Failed to lock.
- kStatus_Success – Locked successfully.

void XRDC2_LockMemSlotExclAccess(XRDC2_Type *base, xrdc2_mem_slot_t memSlot)

Lock the memory slot exclusive access using blocking method.

Note: This function must be called when the lock is not disabled.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.

static inline void XRDC2_UnlockMemSlotExclAccess(XRDC2_Type *base, xrdc2_mem_slot_t memSlot)

Unlock the memory slot exclusive access.

Note: This function must be called by the lock owner.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.

static inline void XRDC2_ForceMemSlotExclAccessLockRelease(XRDC2_Type *base, xrdc2_mem_slot_t memSlot)

Force the memory slot exclusive access lock release.

The master does not own the lock could call this function to force release the lock.

Parameters

- base – XRDC2 peripheral base address.
- memSlot – The memory slot to operate.

void XRDC2_GetMemAccessDefaultConfig(*xrdc2_mem_access_config_t* *config)

Gets the default memory access configuration.

This function sets the assignment as follows:

```
config->startAddr = 0U;
config->endAddr = 0xFFFFFFFFU;
config->lockMode = kXRDC2_AccessConfigLockDisabled;
config->policy[0] = kXRDC2_AccessPolicyNone;
config->policy[1] = kXRDC2_AccessPolicyNone;
...
```

Parameters

- config – Pointer to the configuration.

void XRDC2_SetMemAccessConfig(XRDC2_Type *base, xrdc2_mem_t mem, const *xrdc2_mem_access_config_t* *config)

Sets the memory region access policy.

Parameters

- base – XRDC2 peripheral base address.
- mem – Which memory region descriptor to set.
- config – Pointer to the access policy configuration structure.

void XRDC2_SetMemAccessValid(XRDC2_Type *base, xrdc2_mem_t mem, bool valid)

Sets the memory region descriptor as valid or invalid.

Parameters

- base – XRDC2 peripheral base address.
- mem – Which memory region descriptor to set.
- valid – True to set valid, false to set invalid.

void XRDC2_SetMemAccessLockMode(XRDC2_Type *base, xrdc2_mem_t mem, *xrdc2_access_config_lock_t* lockMode)

Sets the memory descriptor lock mode.

Parameters

- base – XRDC2 peripheral base address.
- mem – Which memory descriptor to set.
- lockMode – The lock mode to set.

void XRDC2_SetMemDomainAccessPolicy(XRDC2_Type *base, xrdc2_mem_t mem, uint8_t domainId, *xrdc2_access_policy_t* policy)

Sets the memory region access policy for specific domain.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.
- domainId – The ID of the domain whose policy will be changed.
- policy – The access policy to set.

void XRDC2_EnableMemExclAccessLock(XRDC2_Type *base, xrdc2_mem_t mem, bool enable)

Enable or disable the memory region exclusive access lock.

Once disabled, it could not be enabled until reset.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.
- enable – True to enable, false to disable.

uint8_t XRDC2_GetMemExclAccessLockDomainOwner(XRDC2_Type *base, xrdc2_mem_t mem)

Get current memory region exclusive access lock owner.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.

Returns

The domain ID of the lock owner.

status_t XRDC2_TryLockMemExclAccess(XRDC2_Type *base, xrdc2_mem_t mem)

Try to lock the memory region exclusive access.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.

Return values

- kStatus_Fail – Failed to lock.
- kStatus_Success – Locked successfully.

void XRDC2_LockMemExclAccess(XRDC2_Type *base, xrdc2_mem_t mem)

Lock the memory region exclusive access using blocking method.

Note: This function must be called when the lock is not disabled.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.

void XRDC2_UnlockMemExclAccess(XRDC2_Type *base, xrdc2_mem_t mem)

Unlock the memory region exclusive access.

Note: This function must be called by the lock owner.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.

void XRDC2_ForceMemExclAccessLockRelease(XRDC2_Type *base, xrdc2_mem_t mem)

Force the memory region exclusive access lock release.

The master does not own the lock could call this function to force release the lock.

Parameters

- base – XRDC2 peripheral base address.
- mem – The memory region to operate.

void XRDC2_GetPeriphAccessDefaultConfig(*xrdc2_periph_access_config_t* *config)

Gets the default peripheral access configuration.

The default configuration is set as follows:

```
config->lockMode      = kXRDC2_AccessConfigLockWritable;
config->policy[0]     = kXRDC2_AccessPolicyNone;
config->policy[1]     = kXRDC2_AccessPolicyNone;
...
config->policy[15]    = kXRDC2_AccessPolicyNone;
```

Parameters

- config – Pointer to the configuration structure.

void XRDC2_SetPeriphAccessConfig(XRDC2_Type *base, xrdc2_periph_t periph, const *xrdc2_periph_access_config_t* *config)

Sets the peripheral access policy.

Parameters

- base – XRDC2 peripheral base address.
- periph – Which peripheral descriptor to set.
- config – Pointer to the access policy configuration structure.

void XRDC2_SetPeriphAccessValid(XRDC2_Type *base, xrdc2_periph_t periph, bool valid)

Sets the peripheral descriptor as valid or invalid.

Parameters

- base – XRDC2 peripheral base address.
- periph – Which peripheral descriptor to set.
- valid – True to set valid, false to set invalid.

void XRDC2_SetPeriphAccessLockMode(XRDC2_Type *base, xrdc2_periph_t periph, *xrdc2_access_config_lock_t* lockMode)

Sets the peripheral descriptor lock mode.

Parameters

- base – XRDC2 peripheral base address.
- periph – Which peripheral descriptor to set.
- lockMode – The lock mode to set.

void XRDC2_SetPeriphDomainAccessPolicy(XRDC2_Type *base, xrdc2_periph_t periph, uint8_t domainId, *xrdc2_access_policy_t* policy)

Sets the peripheral access policy for specific domain.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.

- domainId – The ID of the domain whose policy will be changed.
- policy – The access policy to set.

void XRDC2_EnablePeriphExclAccessLock(XRDC2_Type *base, xrdc2_periph_t periph, bool enable)

Disable the peripheral exclusive access lock.

Once disabled, it could not be enabled until reset.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.
- enable – True to enable, false to disable.

uint8_t XRDC2_GetPeriphExclAccessLockDomainOwner(XRDC2_Type *base, xrdc2_periph_t periph)

Get current peripheral exclusive access lock owner.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.

Returns

The domain ID of the lock owner.

status_t XRDC2_TryLockPeriphExclAccess(XRDC2_Type *base, xrdc2_periph_t periph)

Try to lock the peripheral exclusive access.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.

Return values

- kStatus_Fail – Failed to lock.
- kStatus_Success – Locked successfully.

void XRDC2_LockPeriphExclAccess(XRDC2_Type *base, xrdc2_periph_t periph)

Lock the peripheral exclusive access using blocking method.

Note: This function must be called when the lock is not disabled.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.

void XRDC2_UnlockPeriphExclAccess(XRDC2_Type *base, xrdc2_periph_t periph)

Unlock the peripheral exclusive access.

Note: This function must be called by the lock owner.

Parameters

- base – XRDC2 peripheral base address.

- periph – The peripheral to operate.

void XRDC2_ForcePeriphExclAccessLockRelease(XRDC2_Type *base, xrdc2_periph_t periph)

Force the peripheral exclusive access lock release.

The master does not own the lock could call this function to force release the lock.

Parameters

- base – XRDC2 peripheral base address.
- periph – The peripheral to operate.

enum _xrdc2_global_config_lock

Global configuration lock.

Values:

enumerator kXRDC2_GlobalConfigLockDisabled

Lock disabled, registers can be written by any domain.

enumerator kXRDC2_GlobalConfigLockDisabledUntilReset

Lock disabled until the next reset.

enumerator kXRDC2_GlobalConfigLockOwnerOnly

Lock enabled, only the lock owner can write.

enumerator kXRDC2_GlobalConfigLockEnabledUntilReset

Lock enabled, all registers are read only until the next reset.

enum _xrdc2_secure_attr

XRDC2 secure attribute, the register bit MDACi_MDAj_W0[SA], secure/nonsecure attribute output on a hit.

Values:

enumerator kXRDC2_MasterSecure

Use the bus master's secure/nonsecure attribute directly.

enumerator kXRDC2_ForceSecure

Force the bus attribute for this master to secure.

enumerator kXRDC2_ForceNonSecure

Force the bus attribute for this master to non-secure.

enum _xrdc2_privilege_attr

XRDC2 privileged attribute, the register bit MDACi_MDAj_W0[PA], defines the privileged/user attribute on a hit.

Values:

enumerator kXRDC2_MasterPrivilege

Use the bus master's attribute directly.

enumerator kXRDC2_ForceUser

Force the bus attribute for this master to user.

enumerator kXRDC2_ForcePrivilege

Force the bus attribute for this master to privileged.

enum _xrdc2_access_policy

XRDC2 domain access control policy.

Values:

enumerator kXRDC2_AccessPolicyNone

enumerator kXRDC2_AccessPolicyAlt1

enumerator kXRDC2_AccessPolicyAlt2

enumerator kXRDC2_AccessPolicyAlt3

enumerator kXRDC2_AccessPolicyAlt4

enumerator kXRDC2_AccessPolicyAlt5

enumerator kXRDC2_AccessPolicyAlt6

enumerator kXRDC2_AccessPolicyAll

enum _xrdc2_access_config_lock

Access configuration lock mode, the register field PDAC and MRGD LK2.

Values:

enumerator kXRDC2_AccessConfigLockDisabled

Entire PDACn/MRGDn/MSC can be written.

enumerator kXRDC2_AccessConfigLockDisabledUntilReset

Entire PDACn/MRGDn/MSC can be written until next reset.

enumerator kXRDC2_AccessConfigLockDomainXOnly

Domain x only write the DxACP field.

enumerator kXRDC2_AccessConfigLockEnabledUntilReset

PDACn/MRGDn/MSC is read-only until the next reset.

typedef enum *_xrdc2_global_config_lock* xrdc2_global_config_lock_t

Global configuration lock.

typedef enum *_xrdc2_secure_attr* xrdc2_secure_attr_t

XRDC2 secure attribute, the register bit MDACi_MDAj_W0[SA], secure/nonsecure attribute output on a hit.

typedef enum *_xrdc2_privilege_attr* xrdc2_privilege_attr_t

XRDC2 privileged attribute, the register bit MDACi_MDAj_W0[PA], defines the privileged/user attribute on a hit.

typedef struct *_xrdc2_master_domain_assignment* xrdc2_master_domain_assignment_t

Domain assignment for the bus master.

XRDC2 compares the bus master *match input* with the parameter xrdc2_master_domain_assignment_t::mask and xrdc2_master_domain_assignment_t::match in this structure. If hit, the domain ID, privilege attribute, and secure attribute are used for the access.

typedef enum *_xrdc2_access_policy* xrdc2_access_policy_t

XRDC2 domain access control policy.

typedef enum *_xrdc2_access_config_lock* xrdc2_access_config_lock_t

Access configuration lock mode, the register field PDAC and MRGD LK2.

typedef struct *_xrdc2_periph_access_config* xrdc2_periph_access_config_t

XRDC2 peripheral domain access control configuration.

typedef struct *_xrdc2_mem_access_config* xrdc2_mem_access_config_t

XRDC2 memory region domain access control configuration.

typedef struct *_xrdc2_mem_slot_access_config* xrdc2_mem_slot_access_config_t

XRDC2 memory slot domain access control configuration.

void XRDC2_Init(XRDC2_Type *base)

Initializes the XRDC2 module.

Parameters

- base – XRDC2 peripheral base address.

void XRDC2_Deinit(XRDC2_Type *base)

De-initializes the XRDC2 module.

Parameters

- base – XRDC2 peripheral base address.

FSL_XRDC2_DRIVER_VERSION

Driver version.

XRDC2_EAL_FORCE_RELEASE_MAGIC_0

XRDC2_EAL_FORCE_RELEASE_MAGIC_1

XRDC2_EAL_DISABLE

XRDC2_EAL_DISABLE_UNTIL_RESET

XRDC2_EAL_UNLOCKED

XRDC2_EAL_LOCKED

XRDC2_EAL_MASK

struct _xrdc2_master_domain_assignment

#include <fsl_xrdc2.h> Domain assignment for the bus master.

XRDC2 compares the bus master *match input* with the parameter xrdc2_master_domain_assignment_t::mask and xrdc2_master_domain_assignment_t::match in this structure. If hit, the domain ID, privilege attribute, and secure attribute are used for the access.

Public Members

bool lock

Set true to lock the descriptor.

xrdc2_privilege_attr_t privilegeAttr

Privilege attribute.

xrdc2_secure_attr_t secureAttr

Secure attribute.

uint8_t domainId

Domain ID used when this descriptor hit.

uint16_t mask

Mask used for descriptor hit.

uint16_t match

Match used for descriptor hit.

struct _xrdc2_periph_access_config

#include <fsl_xrdc2.h> XRDC2 peripheral domain access control configuration.

Public Members

xrdc2_access_config_lock_t lockMode
PDACn lock configuration.

xrdc2_access_policy_t policy[1]
Access policy for each domain.

struct __xrdc2__mem__access__config
#include <fsl_xrdc2.h> XRDC2 memory region domain access control configuration.

Public Members

uint32_t startAddr
Memory region start address, should be 4k aligned.

uint32_t endAddr
Memory region end address, (endAddr + 1) should be 4k aligned.

xrdc2_access_config_lock_t lockMode
MRGDn lock configuration.

xrdc2_access_policy_t policy[1]
Access policy for each domain.

struct __xrdc2__mem__slot__access__config
#include <fsl_xrdc2.h> XRDC2 memory slot domain access control configuration.

Public Members

xrdc2_access_config_lock_t lockMode
Descriptor lock configuration.

xrdc2_access_policy_t policy[1]
Access policy for each domain.

Chapter 3

Middleware

3.1 Boot

3.1.1 MCUXpresso SDK : mcuxsdk-middleware-mcuboot_opensource

Overview

This repository is a fork of MCUboot (https://github.com/mcu-tools/mcuboot) for MCUXpresso SDK delivery and it contains the components officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository (mcuxsdk-manifests) for the complete delivery of MCUXpresso SDK.

Documentation

Overall details can be reviewed here: MCUXpresso SDK Online Documentation

Visit MCUboot - Documentation to review details on the contents in this sub-repo.

Setup

Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution

Contributions are not currently accepted. If the intended contribution is not related to NXP specific code, consider contributing directly to the upstream MCUboot project. Once this MCUboot fork is synchronized with the upstream project, such contributions will end up here as well. If the intended contribution is a bugfix or improvement for NXP porting layer or for code added or modified by NXP, please open an issue or contact NXP support.

NXP Fork

This fork of MCUboot contains specific modifications and enhancements for NXP MCUXpresso SDK integration.

See *changelog* for details.

3.1.2 MCUboot



This is MCUboot version 2.1.0

MCUboot is a secure bootloader for 32-bits microcontrollers. It defines a common infrastructure for the bootloader and the system flash layout on microcontroller systems, and provides a secure bootloader that enables easy software upgrade.

MCUboot is not dependent on any specific operating system and hardware and relies on hardware porting layers from the operating system it works with. Currently, MCUboot works with the following operating systems and SoCs:

- Zephyr
- Apache Mynewt
- Apache NuttX
- RIOT
- Mbed OS
- Espressif
- Cypress/Infineon

RIOT is supported only as a boot target. We will accept any new port contributed by the community once it is good enough.

MCUboot How-tos

See the following pages for instructions on using MCUboot with different operating systems and SoCs:

- Zephyr
- Apache Mynewt
- Apache NuttX
- RIOT
- Mbed OS
- Espressif
- *Cypress/Infineon*

There are also instructions for the *Simulator*.

Roadmap

The issues being planned and worked on are tracked using GitHub issues. To give your input, visit MCUboot GitHub Issues.

Source files

You can find additional documentation on the bootloader in the source files. For more information, use the following links:

- boot/bootutil - The core of the bootloader itself.
- boot/boot_serial - Support for serial upgrade within the bootloader itself.
- boot/zephyr - Port of the bootloader to Zephyr.
- boot/mynewt - Bootloader application for Apache Mynewt.
- boot/nuttx - Bootloader application and port of MCUboot interfaces for Apache NuttX.
- boot/mbed - Port of the bootloader to Mbed OS.
- boot/espressif - Bootloader application and MCUboot port for Espressif SoCs.
- boot/cypress - Bootloader application and MCUboot port for Cypress/Infineon SoCs.
- imgtool - A tool to securely sign firmware images for booting by MCUboot.
- sim - A bootloader simulator for testing and regression.

Joining the project

Developers are welcome!

Use the following links to join or see more about the project:

- Our developer mailing list
- Our Slack channel Get your invite

3.2 Cloud

3.2.1 AWS IoT

Device Shadow Library

AWS IoT Device Shadow library The AWS IoT Device Shadow library enables you to store and retrieve the current state (the "shadow") of every registered device. The device's shadow is a persistent, virtual representation of your device that you can interact with from AWS IoT Core even if the device is offline. The device state is captured as its "shadow" within a JSON document. The device can send commands over MQTT to get, update and delete its latest state as well as receive notifications over MQTT about changes in its state. Each device's shadow is uniquely identified by the name of the corresponding "thing", a representation of a specific device or logical entity on the AWS Cloud. See Managing Devices with AWS IoT for more information on IoT "thing". More details about AWS IoT Device Shadow can be found in AWS IoT documentation. This library is distributed under the *MIT Open Source License*.

Note: From v1.1.0 release onwards, you can used named shadow, a feature of the AWS IoT Device Shadow service that allows you to create multiple shadows for a single IoT device.

This library has gone through code quality checks including verification that no function has a GNU Complexity score over 8, and checks against deviations from mandatory rules in the MISRA coding standard. Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from Coverity static analysis, and validation of memory safety through the CBMC automated reasoning tool.

See memory requirements for this library here.

AWS IoT Device Shadow v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Device Shadow v1.0.2 source code is part of the FreeRTOS 202012.00 LTS release.

AWS IoT Device Shadow Config File The AWS IoT Device Shadow library exposes configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *shadow_config_defaults.h*. To provide custom values for the configuration macros, a custom config file named shadow_config.h can be provided by the user application to the library.

By default, a shadow_config.h custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide SHADOW_DO_NOT_USE_CUSTOM_CONFIG as a compile time preprocessor macro.

Building the Library The *shadowFilePaths.cmake* file contains the information of all source files and the header include path required to build the AWS IoT Device Shadow library.

As mentioned in the *previous section*, either a custom config file (i.e. shadow_config.h) OR the SHADOW_DO_NOT_USE_CUSTOM_CONFIG macro needs to be provided to build the AWS IoT Device Shadow library.

For a CMake example of building the AWS IoT Device Shadow library with the shadowFilePaths.cmake file, refer to the coverity_analysis library target in *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule By default, the submodules in this repository are configured with update=none in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like amazon-freertos that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive --test/unit-test/CMock
```

Platform Prerequisites

- For building the library, **CMake 3.13.0** or later and a **C90 compiler**.
- For running unit tests, **Ruby 2.0.0** or later is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build unit tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described *above*.)
2. Run the *cmake* command: cmake -S test -B build

3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material here.

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions here.

Reference examples Please refer to the demos of the AWS IoT Device Shadow library in the following locations for reference examples on POSIX and FreeRTOS platforms:

Platform	Location	Transport Interface Implementation (for coreMQTT stack)
POSIX	AWS IoT Device SDK for Embedded C	POSIX sockets for TCP/IP and OpenSSL for TLS stack
FreeRTOS	FreeRTOS/FreeRTOS	FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack
FreeRTOS	FreeRTOS AWS Reference Integrations	Based on Secure Sockets Abstraction

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of IoT Device Shadow library may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

Device Defender Library

AWS IoT Device Defender Library The Device Defender library enables you to send device metrics to the AWS IoT Device Defender Service. This library also supports custom metrics, a feature that helps you monitor operational health metrics that are unique to your fleet or use case. For example, you can define a new metric to monitor the memory usage or CPU usage

on your devices. This library has no dependencies on any additional libraries other than the standard C library, and therefore, can be used with any MQTT client library. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a GNU Complexity score over 8, and checks against deviations from mandatory rules in the MISRA coding standard. Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone static code analysis using Coverity static analysis, and validation of memory safety through the CBMC automated reasoning tool.

See memory requirements for this library *here*.

AWS IoT Device Defender v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Device Defender v1.1.0 source code is part of the FreeRTOS 202012.01 LTS release.

AWS IoT Device Defender Client Config File The AWS IoT Device Defender Client Library exposes build configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *defender_config_defaults.h*. To provide custom values for the configuration macros, a config file named defender_config.h can be provided by the application to the library.

By default, a defender_config.h config file is required to build the library. To disable this requirement and build the library with default configuration values, provide DEFENDER_DO_NOT_USE_CUSTOM_CONFIG as a compile time preprocessor macro.

Thus, the Device Defender client library can be built by either:

- Defining a defender_config.h file in the application, and adding it to the include directories list of the library.

OR

- Defining the DEFENDER_DO_NOT_USE_CUSTOM_CONFIG preprocessor macro for the library build.

Building the Library The *defenderFilePaths.cmake* file contains the information of all source files and the header include paths required to build the Device Defender client library.

As mentioned in the previous section, either a custom config file (i.e. defender_config.h) or DEFENDER_DO_NOT_USE_CUSTOM_CONFIG macro needs to be provided to build the Device Defender client library.

For a CMake example of building the Device Defender client library with the defenderFilePaths.cmake file, refer to the coverity_analysis library target in *test/CMakeLists.txt* file.

Building Unit Tests

Platform Prerequisites

- For running unit tests:
  - **C90 compiler** like gcc.
  - **CMake 3.13.0 or later**.
  - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository.
2. Run the *cmake* command: `cmake -S test -B build -DBUILD_CLONE_SUBMODULES=ON`.
3. Run this command to build the library and unit tests: `make -C build all`.
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material here.

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions here.

Reference examples The AWS IoT Embedded C-SDK repository contains a demo showing the use of AWS IoT Device Defender Client Library here on a POSIX platform.

Documentation

Existing documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of the AWS IoT Device Defender library may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

Jobs Library

README

AWS IoT Jobs library The AWS IoT Jobs library helps you notify connected IoT devices of a pending Job. A Job can be used to manage your fleet of devices, update firmware and security certificates on your devices, or perform administrative tasks such as restarting devices and performing diagnostics. It interacts with the AWS IoT Jobs service using MQTT, a lightweight publish-subscribe protocol. This library provides a convenience API to compose and recognize the MQTT topic strings used by the Jobs service. The library is written in C compliant with ISO C90 and MISRA C:2012, and is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a GNU Complexity score over 8, and checks against deviations from mandatory rules in the MISRA coding standard . Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from Coverity, and validation of memory safety with the CBMC bounded model checker.

See memory requirements for this library *here*.

AWS IoT Jobs v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Jobs v1.1.0 source code is part of the FreeRTOS 202012.01 LTS release.

Building the Jobs library A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Given an application in a file named `example.c`, *gcc* can be used like so:

```
gcc -I source/include example.c source/jobs.c -o example
```

gcc can also produce an object file to be linked later:

```
gcc -I source/include -c source/jobs.c
```

CBMC To learn more about CBMC and proofs specifically, review the training material here.

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions here.

Reference example The AWS IoT Device SDK for Embedded C repository contains a demo using the jobs library on a POSIX platform. https://github.com/aws/aws-iot-device-sdk-embedded-C/tree/main/demos/jobs/jobs_demo_mosquitto

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of the AWS IoT Jobs library may differ across repositories.

Generating Documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Building unit tests

Checkout Unity Submodule By default, the submodules in this repository are configured with `update=none` in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories that submodule this repository.

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive --test/unit-test/Unity
```

Platform Prerequisites

- For running unit tests
  - C90 compiler like gcc
  - CMake 3.13.0 or later
  - Ruby 2.0.0 or later is additionally required for the Unity test framework (that we use).
- For running the coverage target, lcov is additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described *above*.)
2. Create build directory: `mkdir build && cd build`
3. Run *cmake* while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

Contributing See *CONTRIBUTING.md* for information on contributing.

Over-the-air Update Library

AWS IoT Over-the-air Update Library The OTA library enables you to manage the notification of a newly available update, download the update, and perform cryptographic verification of the firmware update. Using the library, you can logically separate firmware updates from the application running on your devices. The OTA library can share a network connection with the application, saving memory in resource-constrained devices. In addition, the OTA library lets you define application-specific logic for testing, committing, or rolling back a firmware update. The library supports different application protocols like Message Queuing Telemetry Transport (MQTT) and Hypertext Transfer Protocol (HTTP), and provides various configuration options you can fine tune depending on network type and conditions. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a GNU Complexity score over 8. This library has also undergone static code analysis from Coverity static analysis.

See memory requirements for this library *here*.

AWS IoT Over-the-air Update Library v3.4.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Over-the-air Update Library v3.3.0 source code is part of the FreeRTOS 202012.01 LTS release.

AWS IoT Over-the-air Updates Config File The AWS IoT Over-the-air Updates library exposes configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *ota_config_defaults.h*. To provide custom values for the configuration macros, a custom config file named ota_config.h can be provided by the user application to the library.

By default, a ota_config.h custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide OTA_DO_NOT_USE_CUSTOM_CONFIG as a compile time preprocessor macro.

Building the Library The *otaFilePaths.cmake* file contains the information of all source files and the header include paths required to build the AWS IoT Over-the-air Updates library.

As mentioned in the previous section, either a custom config file (i.e. ota_config.h) OR the OTA_DO_NOT_USE_CUSTOM_CONFIG macro needs to be provided to build the AWS IoT Over-the-air Updates library.

For a CMake example of building the AWS IoT Over-the-air Updates library with the otaFilePaths.cmake file, refer to the coverity_analysis library target in the *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule By default, the submodules in this repository are configured with update=none in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like AWS IoT Device SDK for Embedded C that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

Platform Prerequisites

- For building the library, **CMake 3.13.0** or later and a **C90 compiler**.
- For running unit tests, **Ruby 2.0.0** or later is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build unit tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described *above*.)
2. Run the *cmake* command: cmake -S test -B build

3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

Migration Guide

How to migrate from v2.0.0 (Release Candidate) to v3.4.0 The following table lists equivalent API function signatures in v2.0.0 (Release Candidate) and v3.4.0 declared in *ota.h*

v2.0.0 (Release Candidate)	v3.4.0	Notes
OtaState_t OTA_Shutdown(uint32_t ticksToWait);	OtaState_t OTA_Shutdown(uint32_t ticksToWait, uint8_t unsubscribeFlag);	unsubscribeFlag indicates if unsubscribe operations should be performed from the job topics when shutdown is called. Set this as 1 to unsubscribe, 0 otherwise.

How to migrate from version 1.0.0 to version 3.4.0 for OTA applications Refer to OTA Migration document for the summary of updates to the API. Migration document for OTA PAL also provides a summary of updates required for upgrading the OTA-PAL to work with v3.4.0 of the library.

Porting In order to support AWS IoT Over-the-air Updates on your device, it is necessary to provide the following components:

1. Port for the OTA Portable Abstraction Layer (PAL).
2. OS Interface
3. MQTT Interface

For enabling data transfer over HTTP dataplane the following component should also be provided:

1. HTTP Interface

NOTE When using OTA over HTTP dataplane, MQTT is required for control plane operations and should also be provided.

CBMC To learn more about CBMC and proofs specifically, review the training material here.

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions here.

Reference examples Please refer to the demos of the AWS IoT Over-the-air Updates library in the following location for reference examples on POSIX and FreeRTOS:

Platform	Location
POSIX	AWS IoT Device SDK for Embedded C
FreeRTOS	FreeRTOS/FreeRTOS
FreeRTOS	FreeRTOS AWS Reference Integrations

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of coreMQTT may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

3.3 Connectivity

3.3.1 lwIP

This is the NXP fork of the lwIP networking stack.

- For details about changes and additions made by NXP, see CHANGELOG.
- For details about the NXP porting layer, see *The NXP lwIP Port*.
- For usage and API of lwIP, use official documentation at http://www.nongnu.org/lwip/.

The NXP lwIP Port

Below is description of possible settings of the port layer and an overview of a few helper functions.

The best place for redefinition of any mentioned macro is lwipopts.h.

The declaration of every mentioned function is in ethernetif.h. Please check the doxygen comments of those functions before.

Link state Physical link state (up/down) and its speed and duplex must be read out from PHY over MDIO bus. Especially link information is useful for lwIP stack so it can for example send DHCP discovery immediately when a link becomes up.

To simplify this port layer offers a function ethernetif_probe_link() which reads those data from PHY and forwards them into lwIP stack.

In almost all examples this function is called every ETH_LINK_POLLING_INTERVAL_MS (1500ms) by a function probe_link_cyclic().

By setting ETH_LINK_POLLING_INTERVAL_MS to 0 polling will be disabled. On FreeRTOS, probe_link_cyclic() will be then called on an interrupt generated by PHY. GPIO port and pin for

the interrupt line must be set in the ethernetifConfig struct passed to ethernetif_init(). On bare metal interrupts are not supported right now.

Rx task To improve the reaction time of the app, reception of packets is done in a dedicated task. The rx task stack size can be set by ETH_RX_TASK_STACK_SIZE macro, its priority by ETH_RX_TASK_PRIO.

If you want to save memory you can set reception to be done in an interrupt by setting ETH_DO_RX_IN_SEPARATE_TASK macro to 0.

Disabling Rx interrupt when out of buffers If ETH_DISABLE_RX_INT_WHEN_OUT_OF_BUFFERS is set to 1, then when the port gets out of Rx buffers, Rx enet interrupt will be disabled for a particular controller. Everytime Rx buffer is freed, Rx interrupt will be enabled.

This prevents your app from never getting out of Rx interrupt when the network is flooded with traffic.

ETH_DISABLE_RX_INT_WHEN_OUT_OF_BUFFERS is by default turned on, on FreeRTOS and off on bare metal.

Limit the number of packets read out from the driver at once on bare metal. You may define macro ETH_MAX_RX_PKTS_AT_ONCE to limit the number of received packets read out from the driver at once.

In case of heavy Rx traffic, lowering this number improves the realtime behaviour of an app. Increasing improves Rx throughput.

Setting it to value < 1 or not defining means “no limit”.

Helper functions If your application needs to wait for the link to become up you can use one of the following functions:

- ethernetif_wait_linkup()- Blocks until the link on the passed netif is not up.
- ethernetif_wait_linkup_array() - Blocks until the link on at least one netif from the passed list of netifs becomes up.

If your app needs to wait for the IPv4 address on a particular netif to become different than “ANY” address (255.255.255.255) function ethernetif_wait_ipv4_valid() does this.

3.4 eIQ

3.4.1 eIQ

eIQ TensorFlow Lite for Micro Library User Guide

- *Overview*
- *TensorFlow Lite for Microcontrollers*
- *Build Status*
  - *Official Builds*
  - *Community Supported TFLM Examples*
  - *Community Supported Kernels and Unit Tests*
- *Contributing*

- *Getting Help*
- *Additional Documentation*
- *RFCs*

Overview TensorFlow Lite is an open source software library for running machine learning models on mobile and embedded devices. For more information, see www.tensorflow.org/lite.

For memory constrained devices, the library contains TensorFlow Lite for Microcontrollers. For more information, see *www.tensorflow.org/lite/microcontrollers*.

The MCUXpresso Software Development Kit (MCUXpresso SDK) provides a comprehensive software package with a pre-integrated TensorFlow Lite for Microcontrollers based on version 25-04-08 (from the 8th of April 2025 with commit). This document describes the steps required to download and start using the library. Additionally, the document describes the steps required to create an application for running pre-trained models.

Note: The document also assumes knowledge of machine learning frameworks for model training.

TensorFlow Lite for Microcontrollers TensorFlow Lite for Microcontrollers is a port of TensorFlow Lite designed to run machine learning models on DSPs, microcontrollers and other devices with limited memory.

Additional Links:

- Tensorflow github repository
- TFLM at tensorflow.org

Build Status

- GitHub Status

Official Builds

Build Type	Status
CI (Linux)	Run-CI passing
Code Sync	Sync from Upstream TF passing

Community Supported TFLM Examples This table captures platforms that TFLM has been ported to. Please see *New Platform Support* for additional documentation.

Platform	Status
Arduino	CI no status Arduino examples tests no status
Coral Dev Board Micro	TFLM + EdgeTPU Examples for Coral Dev Board Micro
Espressif Systems Dev Boards	CI passing
Renesas Boards	TFLM Examples for Renesas Boards
Silicon Labs Dev Kits	TFLM Examples for Silicon Labs Dev Kits
Sparkfun Edge	CI no status
Texas Instruments Dev Boards	

Community Supported Kernels and Unit Tests This is a list of targets that have optimized kernel implementations and/or run the TFLM unit tests using software emulation or instruction set simulators.

Build Type	Status
Cortex-M	Cortex-M passing
Hexagon	Run-Hexagon passing
RISC-V	RISC-V passing
Xtensa	Run-Xtensa passing
Generate Integration Test	Generate Integration Tests passing

Contributing See our *contribution documentation*.

Getting Help A Github issue should be the primary method of getting in touch with the TensorFlow Lite Micro (TFLM) team.

The following resources may also be useful:

1. SIG Micro email group and monthly meetings.
2. SIG Micro gitter chat room.
3. For questions that are not specific to TFLM, please consult the broader TensorFlow project, e.g.:
   - Create a topic on the TensorFlow Discourse forum
   - Send an email to the TensorFlow Lite mailing list
   - Create a TensorFlow issue
   - Create a Model Optimization Toolkit issue

Additional Documentation

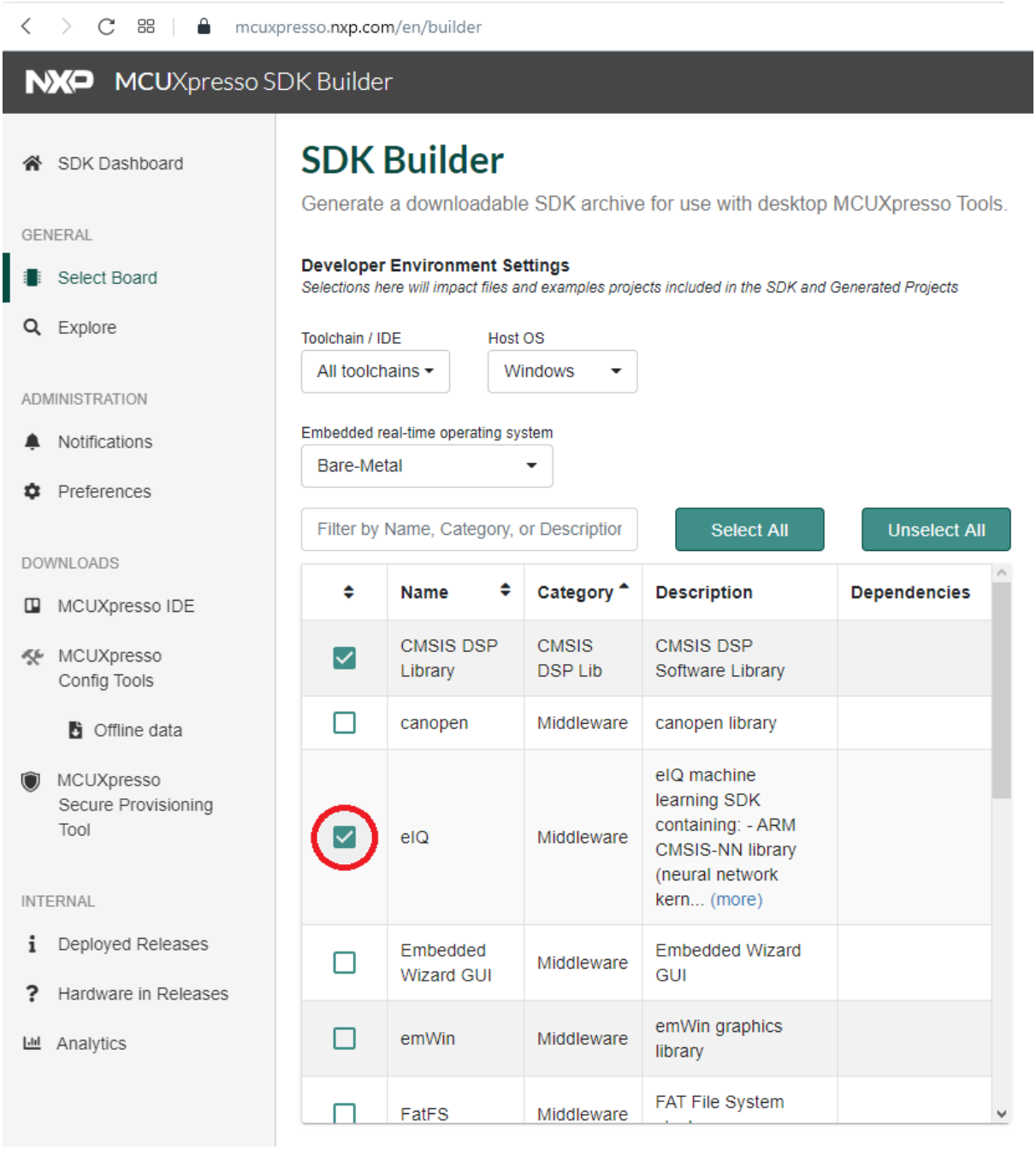
- *Continuous Integration*

- *Benchmarks*
- *Profiling*
- *Memory Management*
- *Logging*
- *Porting Reference Kernels from TfLite to TFLM*
- *Optimized Kernel Implementations*
- *New Platform Support*
- Platform/IP support
  - *Arm IP support*
- *Software Emulation with Renode*
- *Software Emulation with QEMU*
- *Python Dev Guide*
- *Automatically Generated Files*
- *Python Interpreter Guide*

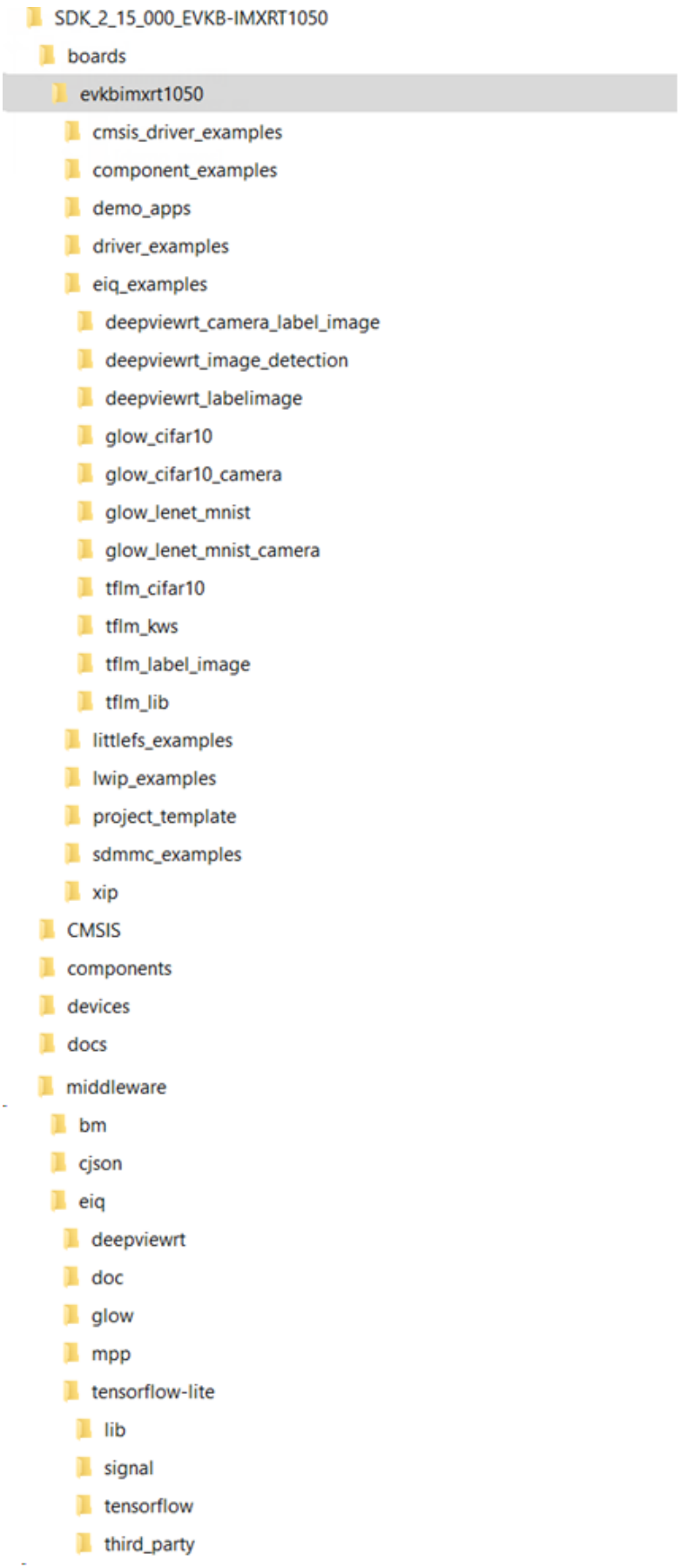
RFCs

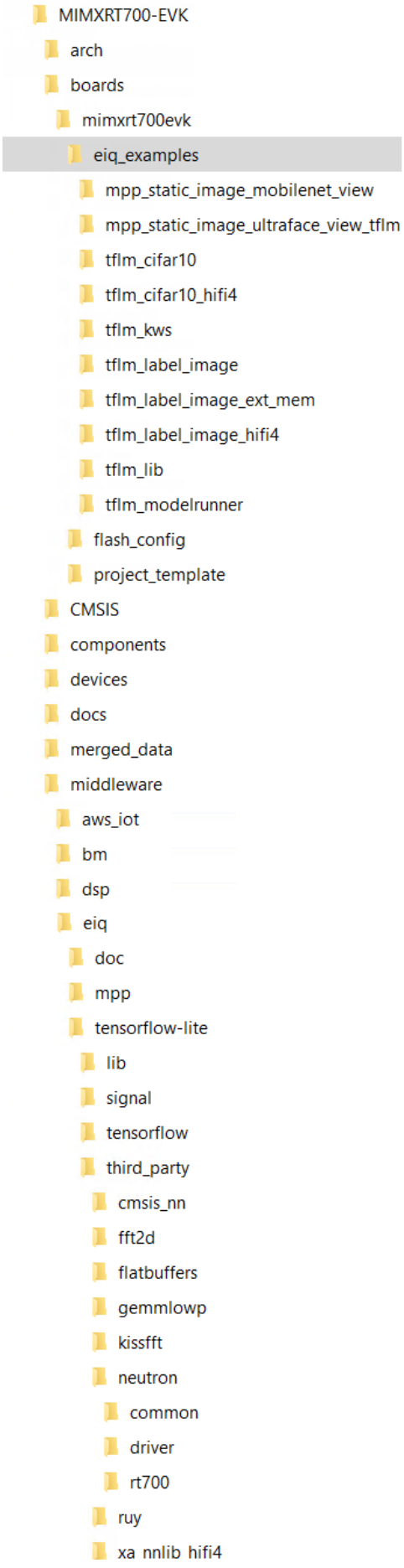
1. *Pre-allocated tensors*
2. *TensorFlow Lite for Microcontrollers Port of 16x8 Quantized Operators*

Deployment The eIQ TensorFlow Lite for Microcontrollers library is part of the eIQ machine learning software package, which is an optional middleware component of MCUXpresso SDK. The eIQ component is integrated into the MCUXpresso SDK Builder delivery system available on mcuxpresso.nxp.com. To include eIQ machine learning into the MCUXpresso SDK package, the eIQ middleware component is selected in the software component selector on the SDK Builder page when building a new package. See *Figure 1*.



Once the MCUXpresso SDK package is downloaded, it can be extracted on a local machine or imported into the MCUXpresso IDE. For more information on the MCUXpresso SDK folder structure, see the Getting Started with MCUXpresso SDK User's Guide (document: MCUXSDKGSUG). The package directory structure is similar to *Figure 2*. The eIQ TensorFlow Lite library directories are highlighted in red.


SDK_2_15_000_EVKB-IMXRT1050
boards
evkbimxrt1050
cmsis_driver_examples
component_examples
demo_apps
driver_examples
eiq_examples
deepviewrt_camera_label_image
deepviewrt_image_detection
deepviewrt_labelimage
glow_cifar10
glow_cifar10_camera
glow_lenet_mnist
glow_lenet_mnist_camera
tflm_cifar10
tflm_kws
tflm_label_image
tflm_lib
littlefs_examples
lwip_examples
project_template
sdmmc_examples
xip
CMSIS
components
devices
docs
middleware
bm
cjson
eiq
deepviewrt
doc
glow
mpp
tensorflow-lite
lib
signal
tensorflow
third_party


MIMXRT700-EVK
arch
boards
mimxrt700evk
eiq_examples
mpp_static_image_mobilenet_view
mpp_static_image_ultraface_view_tflm
tflm_cifar10
tflm_cifar10_hifi4
tflm_kws
tflm_label_image
tflm_label_image_ext_mem
tflm_label_image_hifi4
tflm_lib
tflm_modelrunner
flash_config
project_template
CMSIS
components
devices
docs
merged_data
middleware
aws_iot
bm
dsp
eiq
doc
mpp
tensorflow-lite
lib
signal
tensorflow
third_party
cmsis_nn
fft2d
flatbuffers
gemmlowp
kissfft
neutron
common
driver
rt700
ruy
xa_nnlib_hifi4

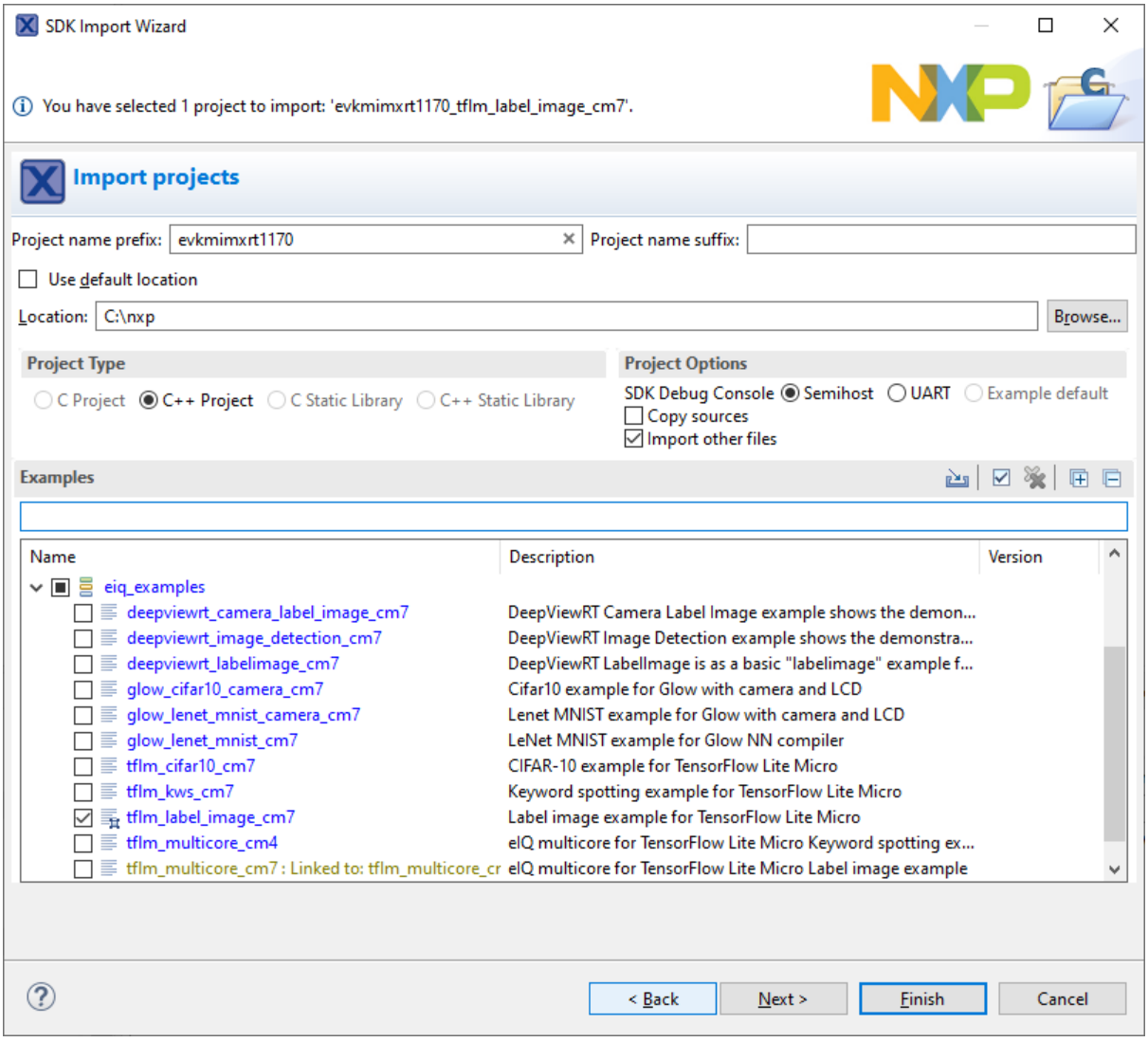
|

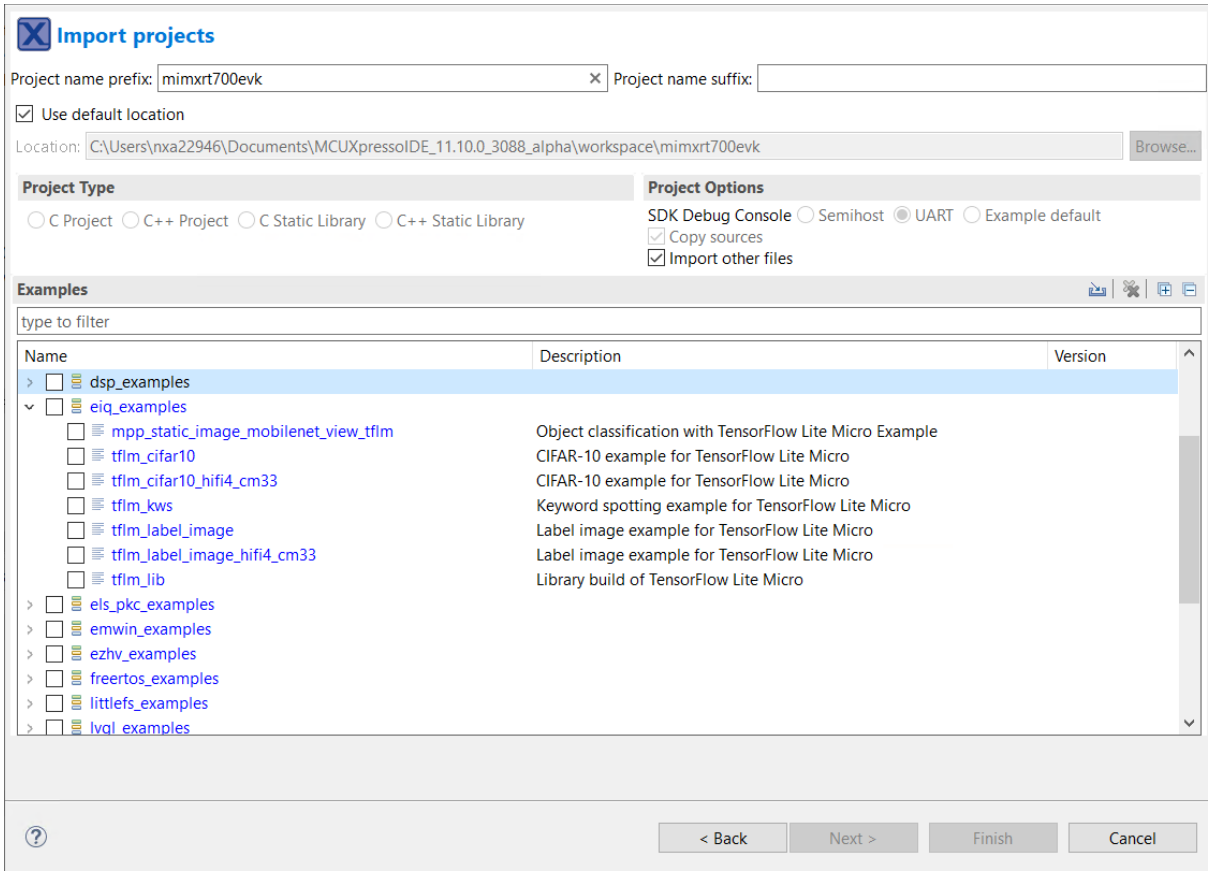
The *boards* directory contains example application projects for supported toolchains. For the list of supported toolchains, see the *MCUXpresso SDK Release Notes*. The *middleware* directory contains the eIQ library source code and example application source code and data.

Example applications The eIQ TensorFlow Lite library is provided with a set of example applications. For details, see *Table 1*. The applications demonstrate the usage of the library in several use cases.

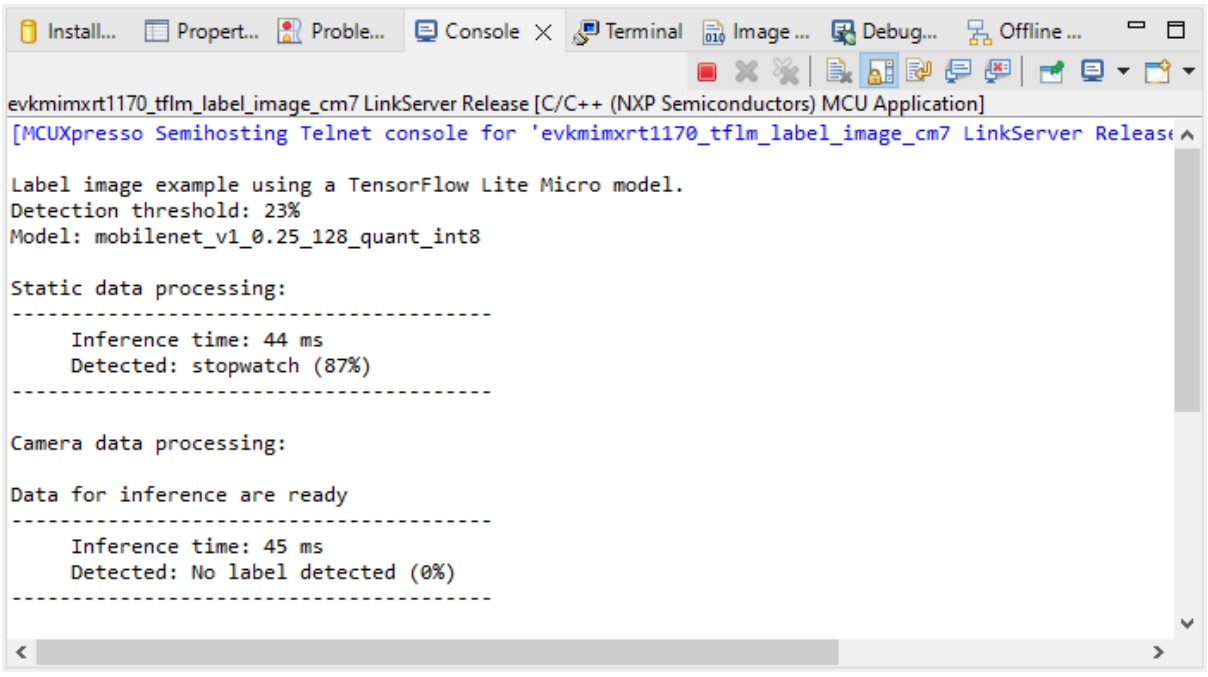
Name	Description	Availability
tflm_c	CIFAR-10 classification of 32 × 32 RGB pixel images into 10 categories using a small Convolutional Neural Network (CNN).	MCX-N947-EVK (no camera and display support) MCX-N947-FRDM (no camera and display support) MCX-N547-EVK (no camera and display support) MIMXRT700-EVK (no camera and display support)
tflm_k	Keyword spotting application using a neural network for word detection in pre-processed audio input.	MCX-N947-EVK (no audio support) MCX-N947-FRDM (no audio support) MCX-N547-EVK (no audio support) MIMXRT700-EVK (no audio support)
tflm_l	Image recognition application using a MobileNet model architecture to classify 128 × 128 RGB pixel images into 1000 categorieswith eIQ Neutron NPU.	MCX-N947-EVK (no camera and display support) MCX-N947-FRDM (no camera and display support) MCX-N547-EVK (no camera and display support) MIMXRT700-EVK (no camera and display support)
tflm_l	Image recognition application using a MobileNet model architecture to classify 224 × 224 RGB pixel images into 1000 categorieswith eIQ Neutron NPU. In this example, it demonstrates how to fetch model's weight from external memory(xSPI flash) to internal SRAM for Neutron NPU execution.	MIMXRT700-EVK (no camera and display support)
tflm_c	CIFAR-10 classification of 32 × 32 RGBpixel images into 10 categories using a small Convolutional Neural Network. In this example, M33 core0 starts HiFi4 DSP core with HiFi4 DSP image. HiFi4 DSP does the inference for CIFAR-10 classification.	MIMXRT700-EVK (no camera and display support)
tflm_l	Image recognition application using a MobileNet model architecture to classify 128 × 128 RGB pixel images into 1000 categories. In this example, M33 core0 starts HiFi4 DSP core with HiFi4 DSP image. HiFi4 DSP does the inference for image recognition application.	MIMXRT700-EVK (no camera and display support)

For details on how to build and run the example applications with supported toolchains, see *Getting Started with MCUXpresso SDK User's Guide* (document: MCUXSDKGSUG). When using MCUXpresso IDE, the example applications can be imported through the SDK Import Wizard as shown in *Figure 1*.


SDK Import Wizard
You have selected 1 project to import: 'evkmimxrt1170_tflm_label_image_cm7'.
Import projects
Project name prefix: evkmimxrt1170
Project name suffix:
Use default location
Location: C:\nxp
Browse...
Project Type
C Project
C++ Project
C Static Library
C++ Static Library
Project Options
SDK Debug Console
Semihost
UART
Example default
Copy sources
Import other files
Examples
Name
Description
Version
eiq_examples
deepviewrt_camera_label_image_cm7
DeepViewRT Camera Label Image example shows the demon...
deepviewrt_image_detection_cm7
DeepViewRT Image Detection example shows the demonstra...
deepviewrt_labelimage_cm7
DeepViewRT LabelImage is as a basic "labelimage" example f...
glow_cifar10_camera_cm7
Cifar10 example for Glow with camera and LCD
glow_lenet_mnist_camera_cm7
Lenet MNIST example for Glow with camera and LCD
glow_lenet_mnist_cm7
LeNet MNIST example for Glow NN compiler
tflm_cifar10_cm7
CIFAR-10 example for TensorFlow Lite Micro
tflm_kws_cm7
Keyword spotting example for TensorFlow Lite Micro
tflm_label_image_cm7
Label image example for TensorFlow Lite Micro
tflm_multicore_cm4
eIQ multicore for TensorFlow Lite Micro Keyword spotting ex...
tflm_multicore_cm7 : Linked to: tflm_multicore_cr
eIQ multicore for TensorFlow Lite Micro Label image example
< Back
Next >
Finish
Cancel



After building the example application and downloading it to the target, the execution stops in the *main* function. When the execution resumes, an output message displays on the connected terminal. For example, *Figure 2* shows the output of the tflm_label_image_cm7``tflm_label_image example application printed to the MCUXpresso IDE Console window when semihosting debug console is selected in the SDK Import Wizard.



```
Label image example using a TensorFlow Lite Micro model.
Detection threshold: 23%
Model: mobilenet_v1_0.25_128_quant_int8_npu

Static data processing:
---------------------------------------
     Inference time: 3987 us
     Detected: stopwatch (87%)
---------------------------------------
```

|

Model Conversion to TensorFlow Lite Format The eIQ® Toolkit provides a comprehensive end-to-end environment for machine learning (ML) model development and deployment. Designed for NXP EdgeVerse processors, the toolkit includes both an intuitive GUI-based tool (eIQ Portal) and command-line utilities for advanced workflows.

One key component, the eIQ ModelTool, enables seamless conversion of ML models from popular formats such as TensorFlow, PyTorch, and ONNX into the TensorFlow Lite (TFLite) format. These converted models can be further optimized and deployed on NXP platforms for inference acceleration.

Model Conversion for NXP eIQ Neutron NPU To leverage the NXP eIQ Neutron NPU for hardware acceleration, models must undergo additional processing using the Neutron Converter Tool. This tool transforms standard quantized TensorFlow Lite models into a format optimized for execution on the Neutron NPU.

The key steps involved in this process are as follows:

1. Convert to Quantized TensorFlow Lite Model: Ensure the model is in a quantized TFLite format before running the Neutron Converter.
2. Run the Neutron Converter Tool: The Neutron Converter analyzes the TFLite model, identifies supported operators, and replaces them with specialized NPU-compatible nodes. Unsupported operations are executed using fallback mechanisms, such as:

- CMSIS-NN for optimized CPU execution
- Reference Operators for unsupported cases

3. Execute on Target Platform: The converted model runs efficiently on the Neutron NPU using a custom TFLite Micro-operator implementation.

Example: Converting a Quantized TensorFlow Lite Model for Neutron NPU The following is a sample command-line invocation for the Neutron Converter tool:

```
neutron-converter --input mobilenet_v1_0.25_128_quant.tflite \
                  --output mobilenet_v1_0.25_128_quant_npu.tflite \
                  --target imxrt700 \
                  --dump-header-file-output
```

Note: This will convert the source tflite model to neutron compatable model, meanwhile, it will dump the model as one headfile name as “mobilenet_v1_0.25_128_quant_npu.h”.

Run and debug eIQ HiFi4 and HiFi1 DSP examples using Xplorer IDE This section lists the steps to Prepare CM33 Core for the examples and Prepare DSP core for the examples.

Prepare CM33 Core for the examples

1. The tflm_cifar10_hifi4 and tflm_label_image_hifi4 examples consist of two separate applications that run on the CM33 core0 and DSP core. The CM33 core0 application initializes the DSP core and starts it.

   To debug the application:

   1. Set up and execute the CM33 application using an environment of your choice.
   2. Build and execute the examples located in:

      <SDK_ROOT>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi4/cm33/

      <SDK_ROOT>/ boards/mimxrt700evk/eiq_examples/tflm_label_image_hifi4/cm33/

2. The tflm_cifar10_hifi1 example consists of three separate applications that run on the CM33 core0, CM33 core1, and DSP core. The CM33 core0 application initializes the CM33 core1 core and starts it. The CM33 core1 application initializes the DSP core and starts it.

   To debug the application:

   1. Set up and build the CM33 core1 application using an environment of your choice.
   2. Set up and execute the CM33 core0 application using an environment of your choice.
   3. Build and execute the example located in:

      <SDK_ROOT>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi1/cm33_core1/

      <SDK_ROOT>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi1/cm33_core0/

      Note: ARMGCC toolchain and IAR Embedded Workbench are both supported. To enable compatibility with RT700, IAR Embedded Workbench may require a patch. There are default DSP core images in the SDK. For details on how to build the examples, refer to Prepare DSP core for the examples.

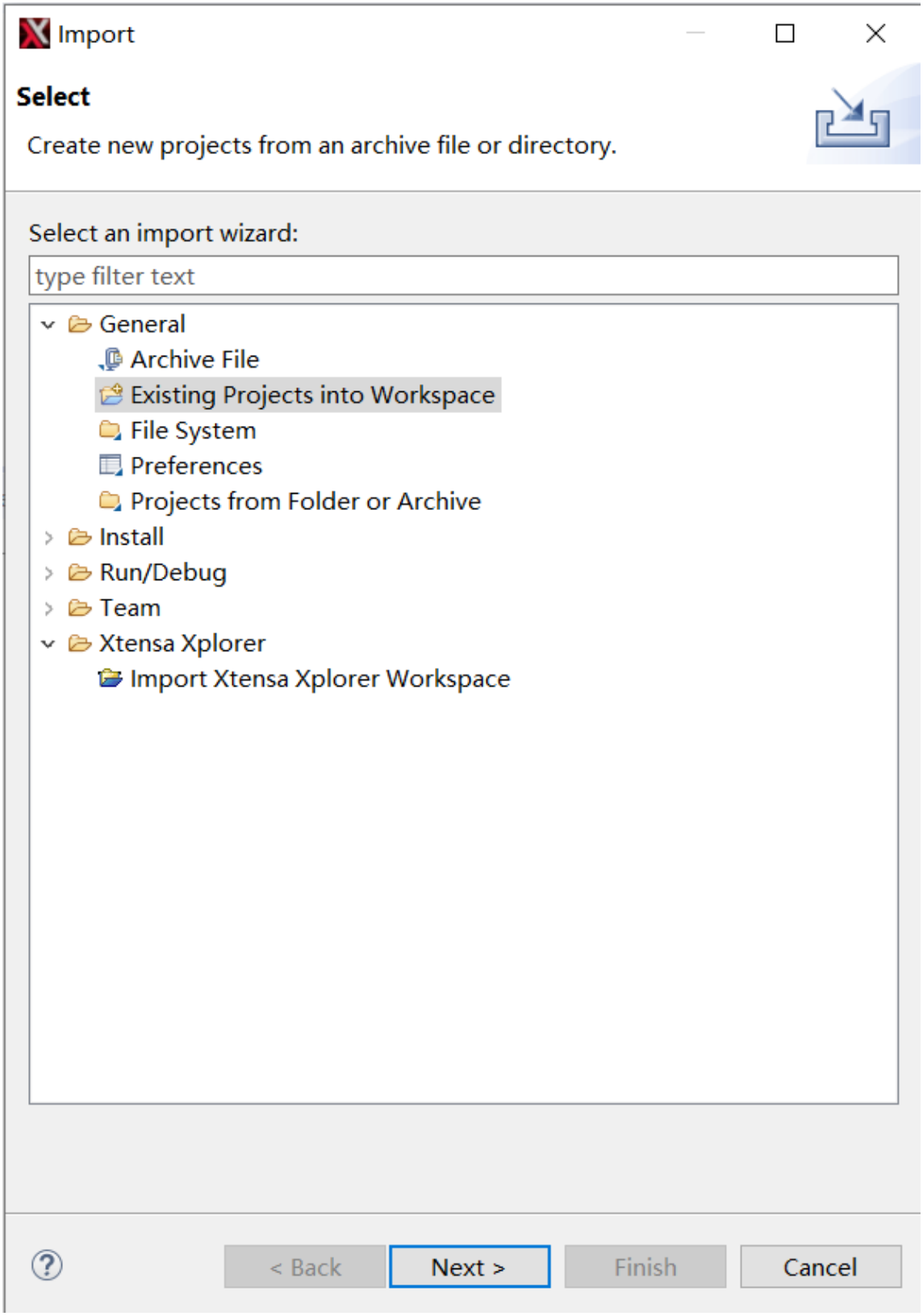
Parent topic:*Run and debug eIQ HiFi4 and HiFi1 DSP examples using Xplorer IDE*

Prepare DSP core for the examples

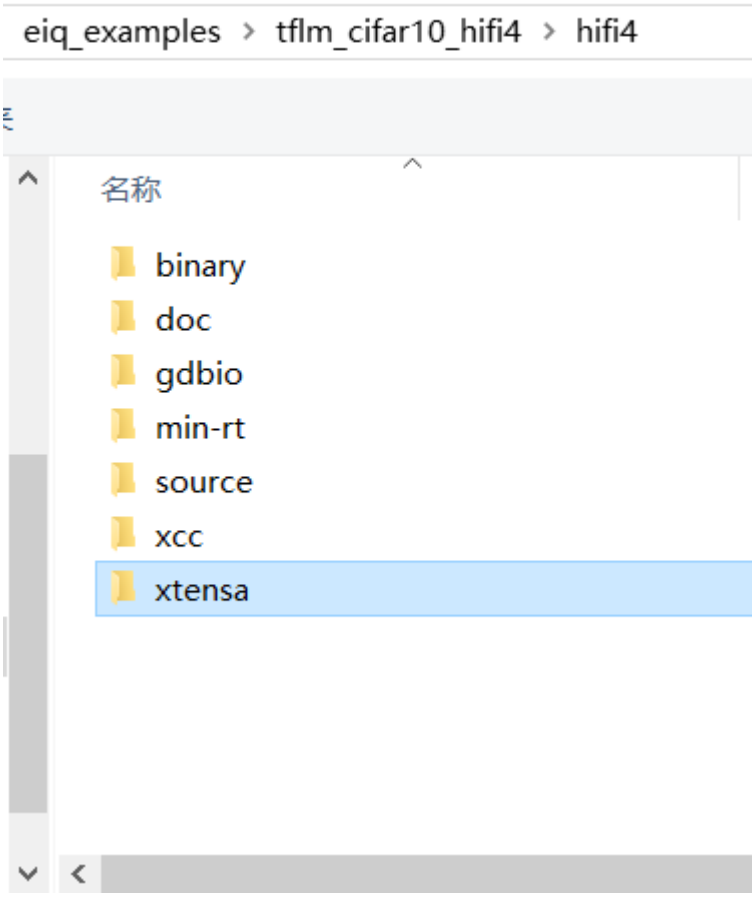
The projects for different supported toolchains are built. The “xcc” project builds on the command line and the “xtensa” directory is an Xplorer IDE project.

To run the tflm_cifar10_hifi4 example, import the SDK sources into the Xplorer IDE.

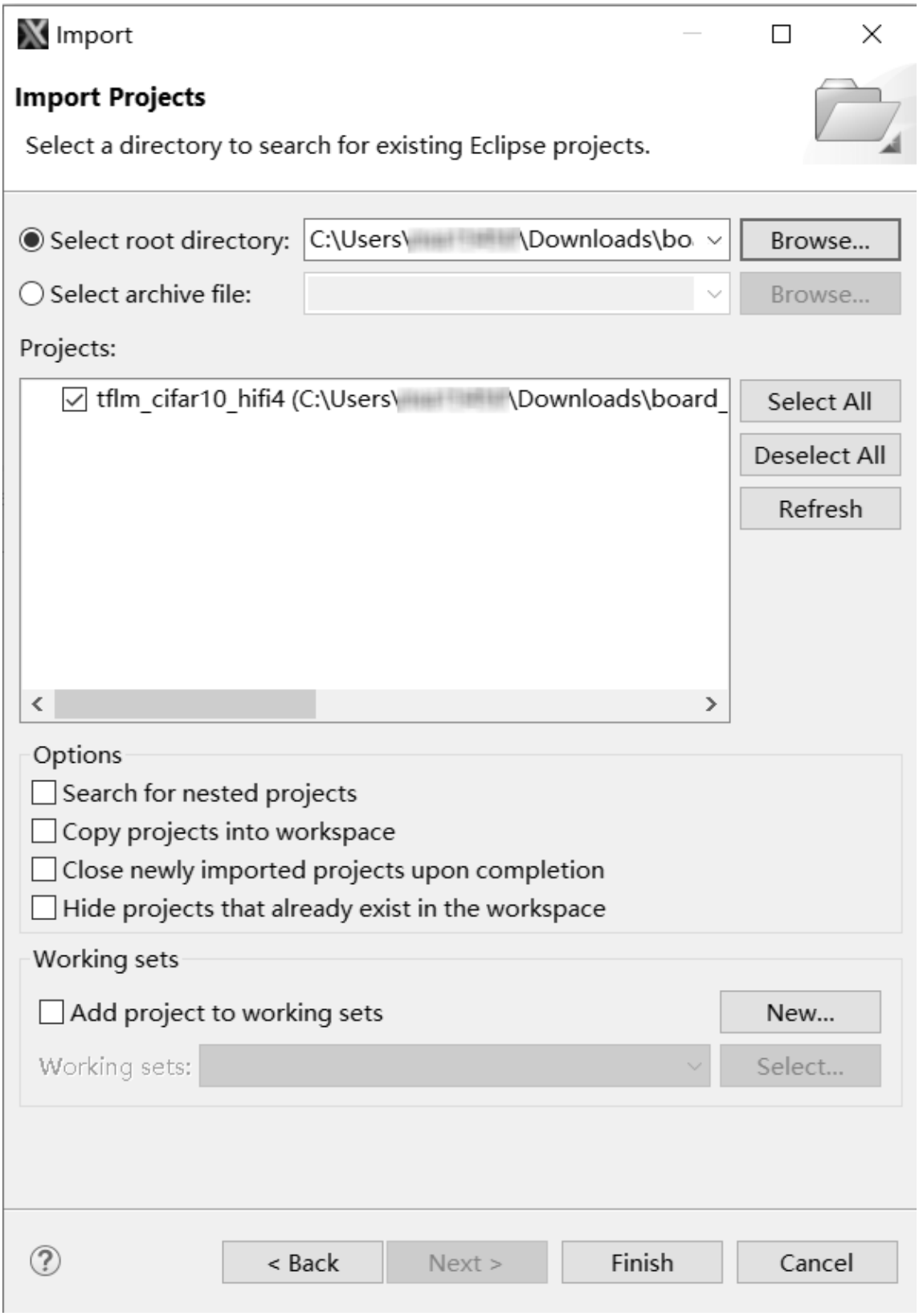
1. Select **File** > **Import** > **General** > **Existing Projects into Workspace**.



2. Click **Next**.
3. Select the SDK directory/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi4/hifi4/xtensa as the root directory.

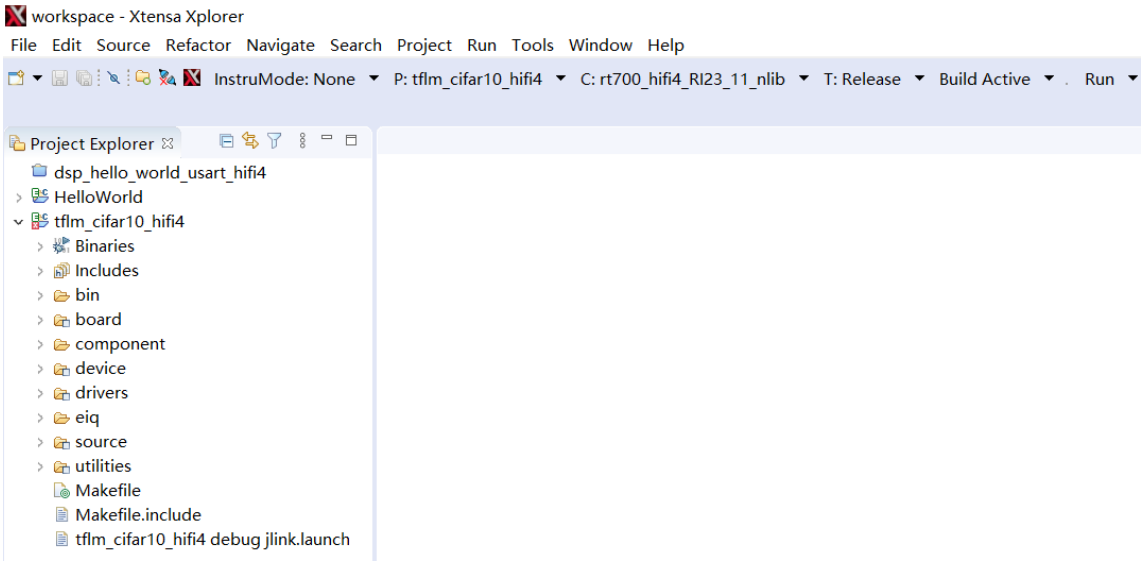


4. Click **Select Folder**.
5. Leave all the other options check boxes blank.

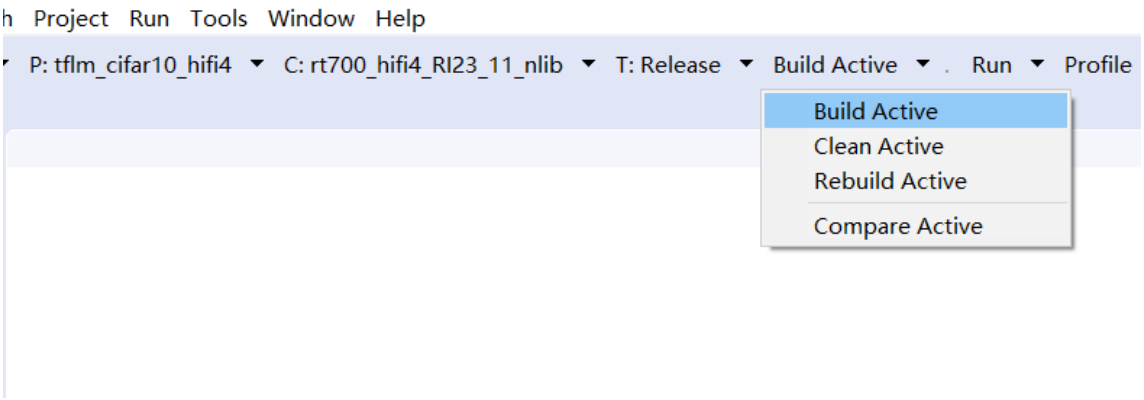


Once imported, the tflm_cifar10_hifi4 example appears in the **Project Explorer**.

6. To make a build selection for the project and hardware target configuration, use the drop-down buttons on the menu bar.



7. To build the DSP application image for the CM33 application, select the **Release target** option in the Xplorer IDE as below.



8. Three DSP binaries are generated and are loaded into different TCM or SRAM address segments:
   - <SDK_ROOT/>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi4/hifi4/binary/dsp_data_release.bin
   - <SDK_ROOT/>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi4/hifi4/binary/dsp_literal_release.bin
   - <SDK_ROOT/>/boards/mimxrt700evk/eiq_examples/tflm_cifar10_hifi4/hifi4/binary/dsp_text_release.bin

Parent topic:*Run and debug eIQ HiFi4 and HiFi1 DSP examples using Xplorer IDE*

Running an inference After converting the model to the TensorFlow Lite format, it is converted into a C language array to include it in the application source code. The *xxd* utility can be used for this purpose (distributed with the *Vim* editor for many platforms on https://www.vim.org/) as shown in *Converting a model to a C language header file*. The utility converts a TensorFlow Lite model into a C header file with an array definition containing the binary image of the model and a variable containing the data size.

Converting a model to a C language header file {#EXAMPLE_4 .section}

```
xxd -i mobilenet_v1_0.25_128_quant.tflite > mobilenet_v1_0.25_128_quant_model.h
```

After the header file is generated, the type of the array is changed from unsigned char to const char to match the library API input parameters and the default array name can be changed to a more convenient one. The user must align the buffer to at least 64-bit boundary (the size of a double-precision floating-point number) to avoid misaligned memory access. The alignment can be achieved by using the __ALIGNED(16) macro from the cmsis_compiler.h header file (available in the MCUXpresso SDK) in the array declaration before the data assignment.

The easiest way to create an application with the proper configuration is to copy and modify an existing example application. To learn where to find the example applications and how to build them, see the *Example applications*.

Running an inference using TensorFlow Lite for Microcontrollers involves several steps (shown for quantized model with signed 8-bit values as input and 32-floating point values as output):

1. Include the necessary eIQ TensorFlow Lite Micro library header files and the converted model.

   Including header files

   ```
   #include "tensorflow/lite/micro/micro_error_reporter.h"
   #include "tensorflow/lite/micro/micro_interpreter.h"
   #include "tensorflow/lite/micro/all_ops_resolver.h"
   #include "mobilenet_v1_0.25_128_quant_model.h"
   ```

2. Allocate a static memory buffer for input and output tensors and intermediate arrays. Load the FlatBuffer model image (assuming the mobilenet_v1_0.25_128_quant_model.h file generated in *Converting a model to a C language header file* defines an array named mobilenet_model and a size variable named mobilenet_model_len), build the interpreter object and allocate memory for tensors.

   Loading the FlatBuffer model

   ```
   constexpr int kTensorArenaSize = 1024 * 1024;
   static uint8_t tensorArena[kTensorArenaSize];
   const tflite::Model* model = tflite::GetModel(mobilenet_model);
   // TODO: Report an error if model->version() != TFLITE_SCHEMA_VERSION
   static tflite::AllOpsResolver microOpResolver;
   static tflite::MicroErrorReporter microErrorReporter;
   static tflite::MicroInterpreter interpreter(model,
     microOpResolver, tensorArena, kTensorArenaSize,
     microErrorReporter);
   interpreter->AllocateTensors();
   // TODO: Check return value for kTfLiteOk
   ```

3. Fillhe input data into the input tensor. For example, if a speech recognition model, image data from a camera or audio data from a microphone. The dimensions of the input data must be the same as the dimensions of the input tensor. These dimensions were specified when the model was created.

   Fill-in input data

   ```
   // Get access to the input tensor data
   TfLiteTensor* inputTensor = interpreter->input(0);
   // Copy the input tensor data from an application buffer
   for (int i = 0; i < inputTensor->bytes; i++)
     inputTensor->data.int8[i] = input_data[i];
   ```

4. Run the inference and read the output data from the output tensor. The dimensions of the output data must be the same as the dimensions of the output tensor. These dimensions were specified when the model was created.

   Running inference and reading output data

```
// Run the inference
interpreter->Invoke();
// TODO: Check the return value for TfLiteOk
// Get access to the output tensor data
TfLiteTensor* outputTensor = interpreter->output(0);
// Copy the output tensor data to an application buffer
for (int i = 0; i < outputTensor->bytes / sizeof(float32); i++)
  output_data[i] = outputTensor->data.f[i];
```

NPU inference {#npu_infer .section} Running an inference using a model converted for the NPU requires registration of a custom operator implementation. First the header file with the custom operator implementation interface must be included.

```
#include "tensorflow/lite/micro/kernels/micro_ops.h"
#include "tensorflow/lite/micro/all_ops_resolver.h"
#include "tensorflow/lite/micro/kernels/neutron/neutron.h"
```

Next, the specialized implemetation has to be registered in the operator resolver object.

```
static tflite::AllOpsResolver microOpResolver;
microOpResolver.AddCustom(tflite::GetString_NEUTRON_GRAPH(),
      tflite::Register_NEUTRON_GRAPH());
```

The specialized NPU nodes from the converted model are the executed using this newly registered implementation.

Adjusting the tensor arena size {#adjust_arena .section} The tensor arena is a static memory buffer used for intermediate tensor and scratch buffer allocation. The size of the tensor arena buffer is set by the kTensorArenaSize constant in the example above. The value depends on the tensor sizes used in the model and on the hardware-specific implementations of kernels, which may require various sizes of scratch buffers for intermediate computations. The value can be determined experimentally by running an inference with a small value, so the library fails with an insufficient tensor memory error and prints the missing amount. Continue adjusting the size until the error stops being reported. If the target hardware changes, readjust the value.

Code size optimization Typically, models do not use all the operators that are available in TensorFlow Lite. However, because of the default operator registration mechanism used in the library, the toolchain linker is not able to remove the code of unused operators. In order to reduce code size, it is possible to only register the specific operators used by a model. To determine which operators are used by a particular model, a model visualizer tool like Netron can be used. Then a mutable operator resolver object can be created that only registers the operators that are used by the model being inferenced.

Use the tflite::MicroMutableOpResolver object template, which is later passed to the tflite::MicroInterpreter object. Depending on the list of used operators, the result should be similar to the following code snippet. Make sure to update the MicroMutableOpResolver template parameter to reflect the number of operators that need to be registered.

Register only used operators in TensorFlow Lite Micro {#SECTION_SS1_DJQ_QPB .section}

```
#include "tensorflow/lite/micro/kernels/micro_ops.h"
      #include "tensorflow/lite/micro/micro_mutable_op_resolver.h"
      tflite::MicroMutableOpResolver<6> microOpResolver;
      microOpResolver.AddAveragePool2D();
      microOpResolver.AddConv2D();
      microOpResolver.AddDepthwiseConv2D();
```

(continues on next page)

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```
microOpResolver.AddDequantize();
microOpResolver.AddReshape();
microOpResolver.AddSoftmax();
static tflite::MicroInterpreter interpreter(
model, microOpResolver, tensorArena, kTensorArenaSize, microErrorReporter);
```

Note about the source code in the document Example code shown in this document has the following copyright and BSD-3-Clause license:

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eIQ ExecuTorch Library User Guide

Overview ExecuTorch is an end-to-end solution for enabling on-device inference capabilities across mobile and edge devices including wearables, embedded devices and microcontrollers. It is part of the PyTorch Edge ecosystem and enables efficient deployment of PyTorch models to edge devices. For more information, see https://pytorch.org/executorch-overview.

The MCUXpresso Software Development Kit (MCUXpresso SDK) provides a comprehensive software package with a pre-integrated ExecuTorch based on version v0.5.0 with initial support for Neutron Backend. Neutron Backend enables acceleration of ML models on the eIQ® Neutron Neural Processing Unit (NPU).

This document describes the steps required to download and start using the ExecuTorch. Additionally, the document describes the steps required to create an application for running pretrained models.

Note: The document also assumes knowledge of machine learning frameworks for model training.

Supported platforms:

- i.MX RT700

Installation The ExecuTorch, with the Neutron Backend consists of:

- ExecuTorch with Neutron Backend for Ahead of Time ML Model Compilation
- Neutron Converter
- MCUXpresso SDK

Here we briefly describe each components purpose and steps to install them.

The **ExecuTorch AoT** and **Neutron Converter** are needed to convert a PyTorch model to ExecuTorch and Delegate it to eIQ Neutron NPU using the Neutron Backend. The **MCUXpresso SDK** provides project to build the ExecuTorch Runtime Library, the example application with simple CNN, toolchains and other middleware libraries to build and deploy the application on the target platform.

If you want run to prepared example application on the i.MX RT700 platform, and skip the model preparation phase continue with the *MCUXpresso SDK Part*.

ExecuTorch for Ahead of Time model preparation The ExecuTorch enables to deploy PyTorch models on edge devices. For this purpose the PyTorch model must be processed and converter by the ExecuTorch Ahead of Time (AoT) part. You can obtain the full ExecuTorch including the AoT part aligned with this version of MCUX SDK from the mcuxsdk-middleware-executorch release/mcux-full branch.

Installation Prerequisities:

- x86 Linux Machine with GLIBC-2.29 or higher (e.g. Ubuntu 20.04 or higher)
- Python 3.10, 3.11 or 3.12

To build and install the ExecuTorch follow these steps:

1. (Optional) Setup python virtual environment on desired location and activate it.

```
$ python3 -m venv venv
$ source venv/bin/activate
```

2. Clone the ExecuTorch from mcuxsdk-middleware-executorch

```
$ git clone --branch release/mcux-full https://github.com/nxp-mcuxpresso/mcuxsdk-middleware-executorch.git
$ cd mcuxsdk-middleware-executorch
$ git submodule update --init --recursive
```

3. Build and install the ExecuTorch and its dependencies:

```
$ ./install_requirements.sh
```

[!WARNING] The install_requirements.sh installs the CPU version of torch from https://download.pytorch.org/whl/cpu. If you are behind corporate proxy, it might have issues accessing it and you will see warnings like:

```
WARNING: Retrying (Retry(total=4, connect=None, read=None, redirect=None,␣
↪status=None)) after connection broken by 'SSLError(SSLCertVerificationError(1, '[SSL:␣
↪CERTIFICATE_VERIFY_FAILED] certificate verify failed: unable to get local issuer␣
↪certificate (_ssl.c:1006)'))': /whl/test/cpu/torch/
```

In this case the CUDA version of torch is installed and the install_requirements.sh script fails with:

```
PyTorch: CUDA cannot be found.  Depending on whether you are building
```

Make sure the pip can access the https://download.pytorch.org/whl/cpu PyPI.

Next continue with installation of the *Neutron Converter*

Neutron Converter The eIQ Neutron Backend uses the Neutron Converter to convert the ExecuTorch program to the eIQ Neutron NPU microcode.

Installation The Neutron Converter is available as a Python package and can be installed by the pip command from eiq.nxp.com/repository:

```
pip install --extra-index-url eiq.nxp.com/repository neutron_converter_SDK_25_06==1.0.0
```

The Neutron Converter is used internally by the ExecuTorch, and it is tight to the particular BSP you are using - the suffix of the python package name. In the code snippet above the flavor is the SDK_25_06. In the *aot_neutron_convert.py* example script by the --neutron_converter_flavor parameter.

MCUXpresso SDK The MCUXpresso SDK is used to build, debug and deploy the application using the ExecuTorch on the target platform.

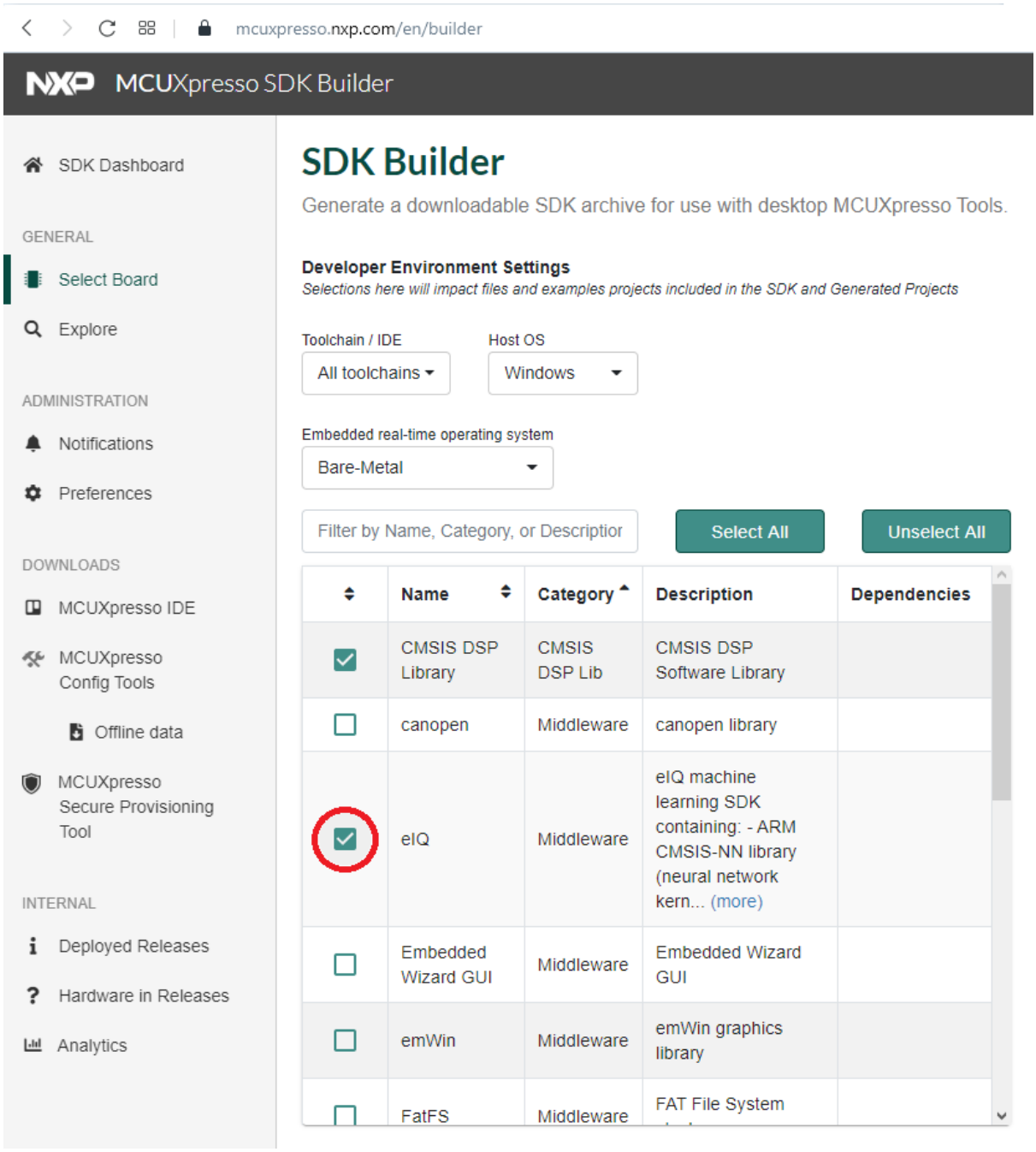
You can obtain the MCUXpresso SDK from MCUXpresso SDK Builder including the IDE. See the *getting_mcuxpress* for details.

In the MCUXpresso SDK, there are 2 project available related to ExecuTorch:

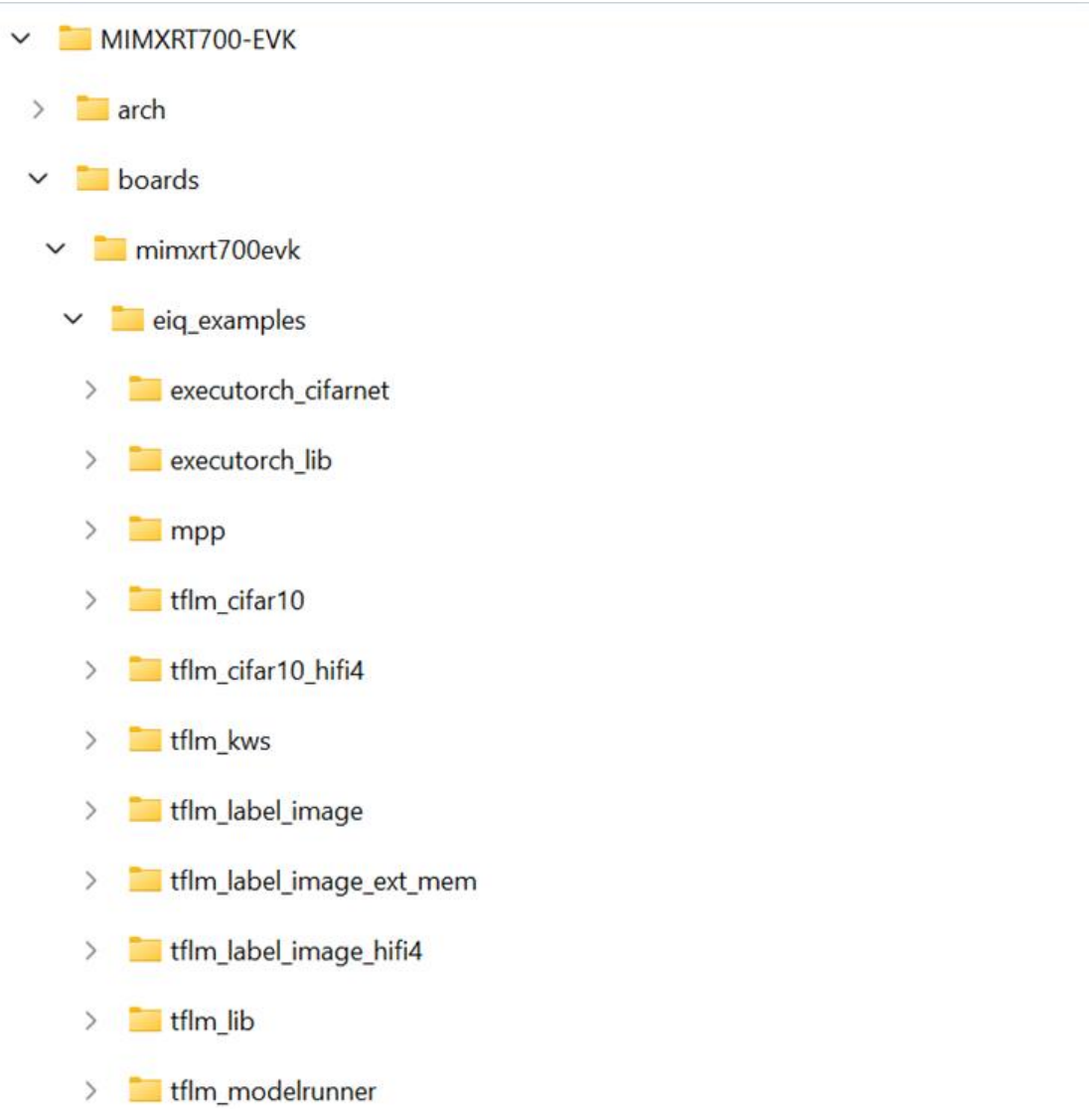
- executorch_lib
- executorch_cifarnet

For more details see *example_applications*. Here you will find the details to run build and run the demo applications.

Getting the MCUXpresso SDK with eIQ ExecuTorch The eIQ ExecuTorch library is part of the eIQ machine learning software package, which is an optional middleware component of MCUXpresso SDK. The eIQ component is integrated into the MCUXpresso SDK Builder delivery system available on mcuxpresso.nxp.com. To include eIQ machine learning into the MCUXpresso SDK package, the eIQ middleware component is selected in the software component selector on the SDK Builder page when building a new package. See *Figure 1*.



Once the MCUXpresso SDK package is downloaded, it can be extracted on a local machine or imported into the MCUXpresso IDE. For more information on the MCUXpresso SDK folder structure, see the Getting Started with MCUXpresso SDK User's Guide (document: MCUXSDKGSUG). The package directory structure is similar to *Figure 2*.



The *boards* directory contains example application projects for supported toolchains. For the list of supported toolchains, see the *MCUXpresso SDK Release Notes*. The *middleware* directory contains the eIQ library source code and example application source code and data.

PyTorch Model Conversion to ExecuTorch Format In this guideline we will show how to use the ExecuTorch AoT part to convert a PyTorch model to ExecuTorch format and delegate the model computation to eIQ Neutron NPU using the eIQ Neutron Backend.

First we will start with an example script converting the model. This example show the CifarNet model preparation. It is the same model which is part of the example_cifarnet

The steps are expected to be executed from the executorch root folder, in our case the mcuxsdk-middleware-executorch

1. After building the ExecuTorch you shall have the libquantized_ops_aot_lib.so located in the pip-out folder. We will need this library when generating the quantized cifarnet ExecuTorch model. So as first step we will find it:

```
$ find ./pip-out -name 'libquantized_ops_aot_lib.so'
./pip-out/temp.linux-x86_64-cpython-310/cmake-out/kernels/quantized/libquantized_ops_aot_lib.so
./pip-out/lib.linux-x86_64-cpython-310/executorch/kernels/quantized/libquantized_ops_aot_lib.so
```

2. Now run the aot_neutron_compile.py example with the cifar10 model

```
$ python examples/nxp/aot_neutron_compile.py \
   --quantize --so_library ./pip-out/lib.linux-x86_64-cpython-310/executorch/kernels/quantized/libquantized_
↪ops_aot_lib.so \
   --delegate --neutron_converter_flavor SDK_25_06 -m cifar10
```

3. It will generate you cifar10_nxp_delegate.pte file which can be used with the MXUXpresso SDK cifarnet_example project.

The generated PTE file is used in the executorch_cifarnet example application, see *example_application*.

MCUXpresso SDK Example applications The MCUXpresso SDK provides a set of projects and example application with the eIQ ExecuTorch. For details, see *Table 1*.

The eIQ ExecuTorch library is provided with a set of example applications. For details, see *Table 1*. The applications demonstrate the usage of the library in several use cases.

Name	Description	Availability
executorch_	This project contains the ExecuTorch Runtime Library source code and is used to build the ExecuTorch Runtime Library. The library is further used to build a full application using the leveraging ExecuTorch.	MIMXRT700-EVK (no camera and display support)
executorch_	Example application demonstrating the use of the ExecuTorch running a CifarNet classification model accelerated on the eIQ Neutron NPU. The Cifarnet is a small Convolutional Neural Network (CNN), trained on CIFAR-10 [1] dataset. The model clasifies the input images into 10 caterories.	MIMXRT700-EVK (no camera and display support)

For details on how to build and run the example applications with supported toolchains, see *Getting Started with MCUXpresso SDK User's Guide* (document: MCUXSDKGSUG).

How to build and run executorch_cifarnet example The example needs ExecuTorch Runtime Library and Neutron Libraries.

ExecuTorch Runtime Library:

- middleware/eiq/executorch/lib/cm33/armgcc/libexecutorch.a

Neutron Libraries:

- middleware/eiq/executorch/third-party/neutron/rt700/libNeutronDriver.a and
- middleware/eiq/executorch/third-party/neutron/rt700/libNeutronFirmware.a

In the example the model and the input image is already embedded into the program and ready to build and deploy to i.MX RT700, so you can continue right to the *building and deployment* section.

Convert the model and example input to C array In this section we describe where the model and example input is located in the example application sources, and how it was generated.

The **cifar10 model** ExecuTorch model is stored in boards/mimxrt700evk/eiq_examples/executorch_cifarnet/cm33_core0/model_pte.h. and was generated from the cifar10_nxp_delegate.pte (see *convert_model*).

We use the xxd command to get the C array containing the model data and array size:

```
$ xxd -i cifar10_nxp_delegate.pte > model_pte_data.h
```

then use the array data and size in the model_pte.h.

As **input image** we use the image from CIFAR-10 dataset [1]. After preprocessing and normalization it is converted to bytes and located here boards/mimxrt700evk/eiq_examples/executorch_cifarnet/cm33_core0/image_data.h. The preprocessing is performed as follows:

```
import torch
import torchvision
import numpy as np

batch_size = 1

transform = torchvision.transforms.Compose([
  torchvision.transforms.ToTensor(),
  torchvision.transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))
])

test_set = torchvision.datasets.CIFAR10(root='./data', train=False, download=True, transform=transform)
test_loader = torch.utils.data.DataLoader(test_set, batch_size=batch_size, shuffle=False, num_workers=0)

index = 0
num_images = 10
for data in test_loader:
  images, labels = data
  for image, label in zip(images,labels):
    arr = image.numpy().astype(np.float32)
    arr.tofile("img" + str(index) + "_" + str(int(label)) + ".bin")
    index = index + 1
    if index >= num_images:
      break
  if index >= num_images:
    break
```

This generates the num_images count of images from Cifar10 dataset, as input tensors for the cifar10 model and store them in corresponding .bin files. Then we use the xxd command to get the C array data and size:

```
$ xxd -i img0_3.bin > image_data_base.h
```

and again copy the array data and size in the image_data.h

Note, the img0 is the image picturing a cat, what is a class number 3.

Build, Deploy and Run

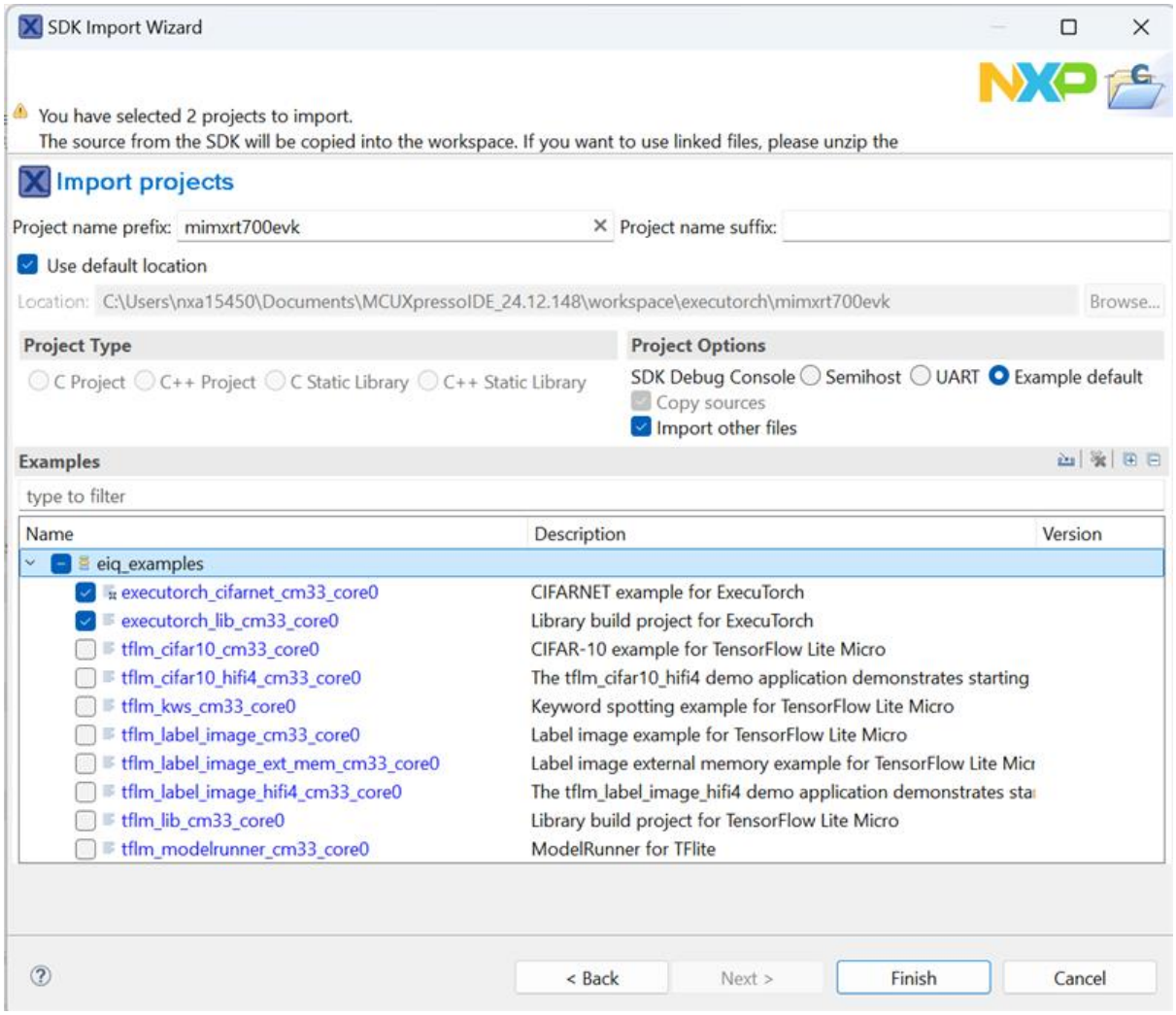
1. When using ARMGCC toolchain, the example application can be built as below. After building the example application, download it to the target with JLink as shown in *Figure 3*, an output message displays on the connected terminal as *Figure 4*.

```
$ boards/mimxrt700evk/eiq_examples/executorch_cifarnet/cm33_core0/armgcc$ ./build_flash_release.sh
```

```
J-Link>loadfile C:\rt700\executorch_cifarnet_cm33_core0.elf
'loadfile': Performing implicit reset & halt of MCU.
ResetTarget() start
-- JLINK ResetTarget --
Set CM33_SYSRESETREQ_EN
CPU0 CSW: 0x03000002
ResetTarget() end - Took 88.9ms
Downloading file [C:\rt700\executorch_cifarnet_cm33_core0.elf]...
J-Link: Flash download: Bank 0 @ 0x28000000: 1 range affected (315392 bytes)
J-Link: Flash download: Total: 20.220s (Prepare: 0.145s, Compare: 2.874s, Erase: 2.558s, Program: 13.212s, Verify: 1.392s, Restore: 0
.036s)
J-Link: Flash download: Program speed: 22 KB/s
O.K.
J-Link>reset
Reset delay: 0 ms
Reset type NORMAL: Resets core & peripherals via SYSRESETREQ & VECTRESET bit.
ResetTarget() start
-- JLINK ResetTarget --
Set CM33_SYSRESETREQ_EN
CPU0 CSW: 0x03000002
ResetTarget() end - Took 71.5ms
J-Link>go
Memory map 'after startup completion point' is active
```

```
Model PTE file loaded. Size: 99376 bytes.
Model buffer loaded, has 1 methods
Running method forward
Setting up planned buffer 0, size 53760.
Method loaded.
Preparing inputs...
Input prepared.
Starting the model execution...
Model executed successfully.
---------------------------------------
     Inference time: 11950 us
---------------------------------------
1 outputs:
Output[0][0]: 0
Output[0][1]: 0
Output[0][2]: 0
Output[0][3]: 0.996094
Output[0][4]: 0
Output[0][5]: 0
Output[0][6]: 0
Output[0][7]: 0
Output[0][8]: 0
Output[0][9]: 0
Program complete, exiting.
```

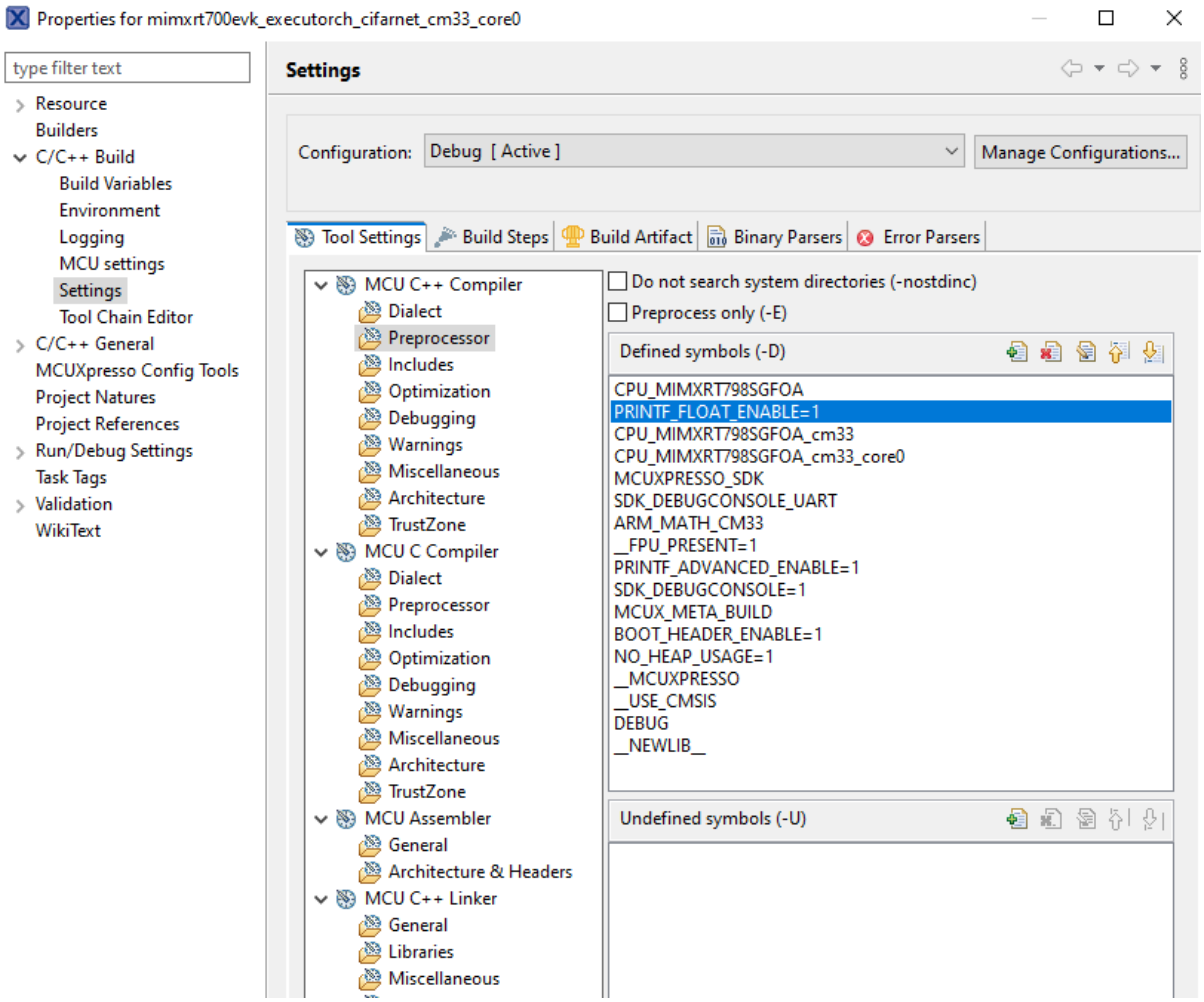
2. When using MCUXpresso IDE, the example applications can be imported through the SDK Import Wizard as shown in *Figure 5*.



After building the example application and downloading it to the target, the execution stops in the *main* function. When the execution resumes, an output message displays on the connected terminal. For example, *Figure 6* shows the output of the executorch_cifarnet example application.

```
Model PTE file loaded. Size: 99376 bytes.
Model buffer loaded, has 1 methods
Running method forward
Setting up planned buffer 0, size 53760.
Method loaded.
Preparing inputs...
Input prepared.
Starting the model execution...
Model executed successfully.
---------------------------------------
     Inference time: 14855 us
---------------------------------------
1 outputs:
Output[0][0]: 0
Output[0][1]: 0
Output[0][2]: 0
Output[0][3]: 0.996094
Output[0][4]: 0
Output[0][5]: 0
Output[0][6]: 0
Output[0][7]: 0
Output[0][8]: 0
Output[0][9]: 0
Program complete, exiting.
```

In case of missing probabilities in the printed output, add PRINTF_FLOAT_ENABLE=1 to the Preprocessor settings for C++ and C compiler:



How to build executorch_lib **example** If you want to build a new ExecuTorch Runtime Library, follow the commands as below and use the new library to replace the default Runtime library middleware/eiq/executorch/lib/cm33/armgcc/libexecutorch.a.

1. When using ARMGCC toolchain, the example application can be built as below.

```
$ boards/mimxrt700evk/eiq_examples/executorch_lib/cm33_core0/armgcc$ ./build_release.sh
$ boards/mimxrt700evk/eiq_examples/executorch_lib/cm33_core0/armgcc$ cp release/libexecutorch_lib_
↪cm33_core0.a.a ../../../../../../middleware/eiq/executorch/lib/cm33/armgcc/libexecutorch.a
```

2. When using MCUXpresso IDE, the example applications can be imported through the SDK Import Wizard as shown in the above *Figure 5*.

After building the example application, copy the new library mimxrt700evk_executorch_lib_cm33_core0\Debug\libmimxrt700evk_executorch_lib_cm33_core0.a to replace the default Runtime library mimxrt700evk_executorch_cifarnet_cm33_core0\eiq\executorch\lib\cm33\armgcc\libexecutorch.a.

[1] Learning Multiple Layers of Features from Tiny Images, Alex Krizhevsky, 2009

3.5 Motor Control

3.5.1 FreeMASTER

Communication Driver User Guide

Introduction

What is FreeMASTER? FreeMASTER is a PC-based application developed by NXP for NXP customers. It is a versatile tool usable as a real-time monitor, visualization tool, and a graphical control panel of embedded applications based on the NXP processing units.

This document describes the embedded-side software driver which implements an interface between the application and the host PC. The interface covers the following communication:

- **Serial** UART communication either over plain RS232 interface or more typically over a USB-to-Serial either external or built in a debugger probe.
- **USB** direct connection to target microcontroller
- **CAN bus**
- **TCP/IP network** wired or WiFi
- **Segger J-Link RTT**
- **JTAG** debug port communication
- ...and all of the above also using a **Zephyr** generic drivers.

The driver also supports so-called "packet-driven BDM" interface which enables a protocol-based communication over a debugging port. The BDM stands for Background Debugging Module and its physical implementation is different on each platform. Some platforms leverage a semi-standard JTAG interface, other platforms provide a custom implementation called BDM. Regardless of the name, this debugging interface enables non-intrusive access to the memory space while the target CPU is running. For basic memory read and write operations, there is no communication driver required on the target when communicating with the host PC. Use this driver to get more advanced FreeMASTER protocol features over the BDM interface. The driver must be configured for the packet-driven BDM mode, in which the host PC uses the debugging interface to write serial command frames directly to the target memory buffer. The same method is then used to read response frames from that memory buffer.

Similar to "packet-driven BDM", the FreeMASTER also supports a communication over [J-Link RTT]((https://www.segger.com/products/debug-probes/j-link/technology/about-real-time-transfer/) interface defined by SEGGER Microcontroller GmbH for ARM CortexM-based microcontrollers. This method also uses JTAG physical interface and enables high-speed real time communication to run over the same channel as used for application debugging.

Driver version 3 This document describes version 3 of the FreeMASTER Communication Driver. This version features the implementation of the new Serial Protocol, which significantly extends the features and security of its predecessor. The new protocol internal number is v4 and its specification is available in the documentation accompanying the driver code.

Driver V3 is deployed to modern 32-bit MCU platforms first, so the portfolio of supported platforms is smaller than for the previous V2 versions. It is recommended to keep using the V2 driver for legacy platforms, such as S08, S12, ColdFire, or Power Architecture. Reach out to FreeMASTER community or to the local NXP representative with requests for more information or to port the V3 driver to legacy MCU devices.

Thanks to a layered approach, the new driver simplifies the porting of the driver to new UART, CAN or networking communication interfaces significantly. Users are encouraged to port the driver to more NXP MCU platforms and contribute the code back to NXP for integration into future releases. Existing code and low-level driver layers may be used as an example when porting to new targets.

Note: Using the FreeMASTER tool and FreeMASTER Communication Driver is only allowed in systems based on NXP microcontroller or microprocessor unit. Use with non-NXP MCU platforms is **not permitted** by the license terms.

Target platforms The driver implementation uses the following abstraction mechanisms which simplify driver porting and supporting new communication modules:

- **General CPU Platform** (see source code in the src/platforms directory). The code in this layer is only specific to native data type sizes and CPU architectures (for example; alignment-aware memory copy routines). This driver version brings two generic implementations of 32-bit platforms supporting both little-endian and big-endian architectures. There are also implementations customized for the 56F800E family of digital signal controllers and S12Z MCUs. **Zephyr** is treated as a specific CPU platform as it brings unified user configuration (Kconfig) and generic hardware device drivers. With Zephyr, the transport layer and low-level communication layers described below are configured automatically using Kconfig and Device Tree technologies.
- **Transport Communication Layer** - The Serial, CAN, Networking, PD-BDM, and other methods of transport logic are implemented as a driver layer called FMSTR_TRANSPORT with a uniform API. A support of the Network transport also extends single-client modes of operation which are native for Serial, USB and CAN by a concept of multiple client sessions.
- **Low-level Communication Driver** - Each type of transport further defines a low-level API used to access the physical communication module. For example, the Serial transport defines a character-oriented API implemented by different serial communication modules like UART, LPUART, USART, and also USB-CDC. Similarly, the CAN transport defines a message-oriented API implemented by the FlexCAN or MCAN modules. Moreover, there are multiple different implementations for the same kind of communication peripherals. The difference between the implementation is in the way the low-level hardware registers are accessed. The *mcuxsdk* folder contains implementations which use MCUXpresso SDK drivers. These drivers should be used in applications based on the NXP MCUXpresso SDK. The “ampsdk” drivers target automotive-specific MCUs and their respective SDKs. The “dreg” implementations use a plain C-language access to hardware register addresses which makes it a universal and the most portable solution. In this case, users are encouraged to add more drivers for other communication modules or other respective SDKs and contribute the code back to NXP for integration.

  The low-level drivers defined for the Networking transport enable datagram-oriented UDP and stream TCP communication. This implementation is demonstrated using the lwIP software stack but shall be portable to other TCP/IP stacks. It may sound surprisingly, but also the Segger J-Link RTT communication driver is linked to the Networking transport (RTT is stream oriented communication handled similarly to TCP).

Replacing existing drivers For all supported platforms, the driver described in this document replaces the V2 implementation and also older driver implementations that were available separately for individual platforms (PC Master SCI drivers).

Clocks, pins, and peripheral initialization The FreeMASTER communication driver is only responsible for runtime processing of the communication and must be integrated with an user application code to function properly. The user application code is responsible for general initialization of clock sources, pin multiplexers, and peripheral registers related to the communication speed. Such initialization should be done before calling the FMSTR_Init function.

It is recommended to develop the user application using one of the Software Development Kits (SDKs) available from third parties or directly from NXP, such as MCUXpresso SDK, MCUXpresso IDE, and related tools. This approach simplifies the general configuration process significantly.

MCUXpresso SDK The MCUXpresso SDK is a software package provided by NXP which contains the device initialization code, linker files, and software drivers with example applications for the NXP family of MCUs. The MCUXpresso Config Tools may be used to generate the clock-setup and pin-multiplexer setup code suitable for the selected processor.

The MCUXpresso SDK also contains this FreeMASTER communication driver as a "middleware" component which may be downloaded along with the example applications from https://mcuxpresso.nxp.com/en/welcome.

MCUXpresso SDK on GitHub The FreeMASTER communication driver is also released as one of the middleware components of the MCUXpresso SDK on the GitHub. This release enables direct integration of the FreeMASTER source code Git repository into a target applications including Zephyr applications.

Related links:

- The official FreeMASTER middleware repository.
- Online version of this document

FreeMASTER in Zephyr The FreeMASTER middleware repository can be used with MCUXpresso SDK as well as a Zephyr module. Zephyr-specific samples which include examples of Kconfig and Device Tree configurations for Serial, USB and Network communications are available in separate repository. West manifest in this sample repository fetches the full Zephyr package including the FreeMASTER middleware repository used as a Zephyr module.

Example applications

MCUX SDK Example applications There are several example applications available for each supported MCU platform.

- **fmstr_uart** demonstrates a plain serial transmission, typically connecting to a computer's physical or virtual COM port. The typical transmission speed is 115200 bps.
- **fmstr_can** demonstrates CAN bus communication. This requires a suitable CAN interface connected to the computer and interconnected with the target MCU using a properly terminated CAN bus. The typical transmission speed is 500 kbps. A FreeMASTER-over-CAN communication plug-in must be used.
- **fmstr_usb_cdc** uses an on-chip USB controller to implement a CDC communication class. It is connected directly to a computer's USB port and creates a virtual COM port device. The typical transmission speed is above 1 Mbps.
- **fmstr_net** demonstrates the Network communication over UDP or TCP protocol. Existing examples use lwIP stack to implement the communication, but in general, it shall be possible to use any other TCP/IP stack to achieve the same functionality.
- **fmstr_wifi** is the fmstr_net application modified to use a WiFi network interface instead of a wired Ethernet connection.
- **fmstr_rtt** demonstrates the communication over SEGGER J-Link RTT interface. Both fmstr_net and fmstr_rtt examples require the FreeMASTER TCP/UDP communication plug-in to be used on the PC host side.
- **fmstr_eonce** uses the real-time data unit on the JTAG EOnCE module of the 56F800E family to implement pseudo-serial communication over the JTAG port. The typical transmission speed is around 10 kbps. This communication requires FreeMASTER JTAG/EOnCE communication plug-in.

- **fmstr_pdbdm** uses JTAG or BDM debugging interface to access the target RAM directly while the CPU is running. Note that such approach can be used with any MCU application, even without any special driver code. The computer reads from and writes into the RAM directly without CPU intervention. The Packet-Driven BDM (PD-BDM) communication uses the same memory access to exchange command and response frames. With PD-BDM, the FreeMASTER tool is able to go beyond basic memory read/write operations and accesses also advanced features like Recorder, TSA, or Pipes. The typical transmission speed is around 10 kbps. A PD-BDM communication plug-in must be used in FreeMASTER and configured properly for the selected debugging interface. Note that this communication cannot be used while a debugging interface is used by a debugger session.
- **fmstr_any** is a special example application which demonstrates how the NXP MCUXpresso Config Tools can be used to configure pins, clocks, peripherals, interrupts, and even the FreeMASTER "middleware" driver features in a graphical and user friendly way. The user can switch between the Serial, CAN, and other ways of communication and generate the required initialization code automatically.

Zephyr sample spplications Zephyr sample applications demonstrate Kconfig and Device Tree configuration which configure the FreeMASTER middleware module for a selected communication option (Serial, CAN, Network or RTT).

Refer to *readme.md* files in each sample directory for description of configuration options required to implement FreeMASTER connectivity.

Description

This section shows how to add the FreeMASTER Communication Driver into application and how to configure the connection to the FreeMASTER visualization tool.

Features The FreeMASTER driver implements the FreeMASTER protocol V4 and provides the following features which may be accessed using the FreeMASTER visualization tool:

- Read/write access to any memory location on the target.
- Optional password protection of the read, read/write, and read/write/flash access levels.
- Atomic bit manipulation on the target memory (bit-wise write access).
- Optimal size-aligned access to memory which is also suitable to access the peripheral register space.
- Oscilloscope access—real-time access to target variables. The sample rate may be limited by the communication speed.
- Recorder— access to the fast transient recorder running on the board as a part of the FreeMASTER driver. The sample rate is only limited by the MCU CPU speed. The length of the data recorded depends on the amount of available memory.
- Multiple instances of Oscilloscopes and Recorders without the limitation of maximum number of variables.
- Application commands—high-level message delivery from the PC to the application.
- TSA tables—describing the data types, variables, files, or hyperlinks exported by the target application. The TSA newly supports also non-memory mapped resources like external EEPROM or SD Card files.
- Pipes—enabling the buffered stream-oriented data exchange for a general-purpose terminal-like communication, diagnostic data streaming, or other data exchange.

The FreeMASTER driver features:

- Full FreeMASTER protocol V4 implementation with a new V4 style of CRC used.
- Layered approach supporting Serial, CAN, Network, PD-BDM, and other transports.
- Layered low-level Serial transport driver architecture enabling to select UART, LPUART, USART, and other physical implementations of serial interfaces, including USB-CDC.
- Layered low-level CAN transport driver architecture enabling to select FlexCAN, msCAN, MCAN, and other physical implementations of the CAN interface.
- Layered low-level Networking transport enabling to select TCP, UDP or J-Link RTT communication.
- TSA support to write-protect memory regions or individual variables and to deny the access to the unsafe memory.
- The pipe callback handlers are invoked whenever new data is available for reading from the pipe.
- Two Serial Single-Wire modes of operation are enabled. The “external” mode has the RX and TX shorted on-board. The “true” single-wire mode interconnects internally when the MCU or UART modules support it.

The following sections briefly describe all FreeMASTER features implemented by the driver. See the PC-based FreeMASTER User Manual for more details on how to use the features to monitor, tune, or control an embedded application.

Board Detection The FreeMASTER protocol V4 defines the standard set of configuration values which the host PC tool reads to identify the target and to access other target resources properly. The configuration includes the following parameters:

- Version of the driver and the version of the protocol implemented.
- MTU as the Maximum size of the Transmission Unit (for example; communication buffer size).
- Application name, description, and version strings.
- Application build date and time as a string.
- Target processor byte ordering (little/big endian).
- Protection level that requires password authentication.
- Number of the Recorder and Oscilloscope instances.
- RAM Base Address for optimized memory access commands.

Memory Read This basic feature enables the host PC to read any data memory location by specifying the address and size of the required memory area. The device response frame must be shorter than the MTU to fit into the outgoing communication buffer. To read a device memory of any size, the host uses the information retrieved during the Board Detection and splits the large-block request to multiple partial requests.

The driver uses size-aligned operations to read the target memory (for example; uses proper read-word instruction when an address is aligned to 4 bytes).

Memory Write Similarly to the Memory Read operation, the Memory Write feature enables to write to any RAM memory location on the target device. A single write command frame must be shorter than the MTU to fit into the target communication buffer. Larger requests must be split into smaller ones.

The driver uses size-aligned operations to write to the target memory (for example; uses proper write-word instruction when an address is aligned to 4 bytes).

Masked Memory Write To implement the write access to a single bit or a group of bits of target variables, the Masked Memory Write feature is available in the FreeMASTER protocol and it is supported by the driver using the Read-Modify-Write approach.

Be careful when writing to bit fields of volatile variables that are also modified in an application interrupt. The interrupt may be serviced in the middle of a read-modify-write operation and it may cause data corruption.

Oscilloscope The protocol and driver enables any number of variables to be read at once with a single request from the host. This feature is called Oscilloscope and the FreeMASTER tool uses it to display a real-time graph of variable values.

The driver can be configured to support any number of Oscilloscope instances and enable simultaneously running graphs to be displayed on the host computer screen.

Recorder The protocol enables the host to select target variables whose values are then periodically recorded into a dedicated on-board memory buffer. After such data sampling stops (either on a host request or by evaluating a threshold-crossing condition), the data buffer is downloaded to the host and displayed as a graph. The data sampling rate is not limited by the speed of the communication line, so it enables displaying the variable transitions in a very high resolution.

The driver can be configured to support multiple Recorder instances and enable multiple recorder graphs to be displayed on the host screen. Having multiple recorders also enables setting the recording point differently for each instance. For example; one instance may be recording data in a general timer interrupt while another instance may record at a specific control algorithm time in the PWM interrupt.

TSA With the TSA feature, data types and variables can be described directly in the application source code. Such information is later provided to the FreeMASTER tool which may use it instead of reading symbol data from the application ELF executable file.

The information is encoded as so-called TSA tables which become direct part of the application code. The TSA tables contain descriptors of variables that shall be visible to the host tool. The descriptors can describe the memory areas by specifying the address and size of the memory block or more conveniently using the C variable names directly. Different set of TSA descriptors can be used to encode information about the structure types, unions, enumerations, or arrays.

The driver also supports special types of TSA table entries to describe user resources like external EEPROM and SD Card files, memory-mapped files, virtual directories, web URL hyperlinks, and constant enumerations.

TSA Safety When the TSA is enabled in the application, the TSA Safety can be enabled and validate the memory accesses directly by the embedded-side driver. When the TSA Safety is turned on, any memory request received from the host is validated and accepted only if it belongs to a TSA-described object. The TSA entries can be declared as Read-Write or Read-Only so that the driver can actively deny the write access to the Read-Only objects.

Application commands The Application Commands are high-level messages that can be delivered from the PC Host to the embedded application for further processing. The embedded application can either poll the status, or be called back when a new Application Command arrives to be processed. After the embedded application acknowledges that the command is handled, the host receives the Result Code and reads the other return data from memory. Both the Application Commands and the Result Codes are specific to a given application and it is user's responsibility to define them. The FreeMASTER protocol and the FreeMASTER driver only implement the delivery channel and a set of API calls to enable the Application Command processing in general.

Pipes The Pipes enable buffered and stream-oriented data exchange between the PC Host and the target application. Any pipe can be written to and read from at both ends (either on the PC or the MCU). The data transmission is acknowledged using the special FreeMASTER protocol commands. It is guaranteed that the data bytes are delivered from the writer to the reader in a proper order and without losses.

Serial single-wire operation The MCU Serial Communication Driver natively supports normal dual-wire operation. Because the protocol is half-duplex only, the driver can also operate in two single-wire modes:

- "External" single-wire operation where the Receiver and Transmitter pins are shorted on the board. This mode is supported by default in the MCU driver because the Receiver and Transmitter units are enabled or disabled whenever needed. It is also easy to extend this operation for the RS485 communication.
- "True" single-wire mode which uses only a single pin and the direction switching is made by the UART module. This mode of operation must be enabled by defining the FMSTR_SERIAL_SINGLEWIRE configuration option.

Multi-session support With networking interface it is possible for multiple clients to access the target MCU simultaneously. Reading and writing of target memory is processed atomically so there is no risk of data corruption. The state-full resources such as Recorders or Oscilloscopes are locked to a client session upon first use and access is denied to other clients until lock is released..

Zephyr-specific

Dedicated communication task FreeMASTER communication may run isolated in a dedicated task. The task automates the FMSTR_Init and FMSTR_Poll calls together with periodic activities enabling the FreeMASTER UI to fetch information about tasks and CPU utilization. The task can be started automatically or manually, and it must be assigned a priority to be able to react on interrupts and other communication events. Refer to Zephyr FreeMASTER sample applications which all use this communication task.

Zephyr shell and logging over FreeMASTER pipe FreeMASTER implements a shell backend which may use FreeMASTER pipe as a I/O terminal and logging output. Refer to Zephyr FreeMASTER sample applications which all use this feature.

Automatic TSA tables TSA tables can be declared as "automatic" in Zephyr which make them automatically registered in the table list. This may be very useful when there are many TSA tables or when the tables are defined in different (often unrelated) libraries linked together. In this case user does not need to build a list of all tables manually.

Driver files The driver source files can be found in a top-level src folder, further divided into the sub-folders:

- ***src/platforms*** platform-specific folder—one folder exists for each supported processor platform (for example; 32-bit Little Endian platform). Each such folder contains a platform header file with data types and a code which implements the potentially platform-specific operations, such as aligned memory access.
- ***src/common*** folder—contains the common driver source files shared by the driver for all supported platforms. All the *.c* files must be added to the project, compiled, and linked together with the application.

- *freemaster.h* - master driver header file, which declares the common data types, macros, and prototypes of the FreeMASTER driver API functions.
- *freemaster_cfg.h.example* - this file can serve as an example of the FreeMASTER driver configuration file. Save this file into a project source code folder and rename it to *freemaster_cfg.h*. The FreeMASTER driver code includes this file to get the project-specific configuration options and to optimize the compilation of the driver.
- *freemaster_defcfg.h* - defines the default values for each FreeMASTER configuration option if the option is not set in the *freemaster_cfg.h* file.
- *freemaster_protocol.h* - defines the FreeMASTER protocol constants used internally by the driver.
- *freemaster_protocol.c* - implements the FreeMASTER protocol decoder and handles the basic Get Configuration Value, Memory Read, and Memory Write commands.
- *freemaster_rec.c* - handles the Recorder-specific commands and implements the Recorder sampling and triggering routines. When the Recorder is disabled by the FreeMASTER driver configuration file, this file only compiles to empty API functions.
- *freemaster_scope.c* - handles the Oscilloscope-specific commands. If the Oscilloscope is disabled by the FreeMASTER driver configuration file, this file compiles as void.
- *freemaster_pipes.c* - implements the Pipes functionality when the Pipes feature is enabled.
- *freemaster_appcmd.c* - handles the communication commands used to deliver and execute the Application Commands within the context of the embedded application. When the Application Commands are disabled by the FreeMASTER driver configuration file, this file only compiles to empty API functions.
- *freemaster_tsa.c* - handles the commands specific to the TSA feature. This feature enables the FreeMASTER host tool to obtain the TSA memory descriptors declared in the embedded application. If the TSA is disabled by the FreeMASTER driver configuration file, this file compiles as void.
- *freemaster_tsa.h* - contains the declaration of the macros used to define the TSA memory descriptors. This file is indirectly included into the user application code (via *freemaster.h*).
- *freemaster_sha.c* - implements the SHA-1 hash code used in the password authentication algorithm.
- *freemaster_private.h* - contains the declarations of functions and data types used internally in the driver. It also contains the C pre-processor statements to perform the compile-time verification of the user configuration provided in the *freemaster_cfg.h* file.
- *freemaster_serial.c* - implements the serial protocol logic including the CRC, FIFO queuing, and other communication-related operations. This code calls the functions of the low-level communication driver indirectly via a character-oriented API exported by the specific low-level driver.
- *freemaster_serial.h* - defines the low-level character-oriented Serial API.
- *freemaster_can.c* - implements the CAN protocol logic including the CAN message preparation, signalling using the first data byte in the CAN frame, and other communication-related operations. This code calls the functions of the low-level communication driver indirectly via a message-oriented API exported by the specific low-level driver.
- *freemaster_can.h* - defines the low-level message-oriented CAN API.
- *freemaster_net.c* - implements the Network protocol transport logic including multiple session management code.

  - *freemaster_net.h* - definitions related to the Network transport.
  - *freemaster_pdbdm.c* - implements the packet-driven BDM communication buffer and other communication-related operations.
  - *freemaster_utils.c* - aligned memory copy routines, circular buffer management and other utility functions
  - *freemaster_utils.h* - definitions related to utility code.
- ***src/drivers/[sdk]/serial*** - contains the code related to the serial communication implemented using one of the supported SDK frameworks.
  - *freemaster_serial_XXX.c* and *.h* - implement low-level access to the communication peripheral registers. Different files exist for the UART, LPUART, USART, and other kinds of Serial communication modules.
- ***src/drivers/[sdk]/can*** - contains the code related to the serial communication implemented using one of the supported SDK frameworks.
  - *freemaster_XXX.c* and *.h* - implement low-level access to the communication peripheral registers. Different files exist for the FlexCAN, msCAN, MCAN, and other kinds of CAN communication modules.
- ***src/drivers/[sdk]/network*** - contains low-level code adapting the FreeMASTER Network transport to an underlying TCP/IP or RTT stack.
  - *freemaster_net_lwip_tcp.c* and *_udp.c* - default networking implementation of TCP and UDP transports using lwIP stack.
  - *freemaster_net_segger_rtt.c* - implementation of network transport using Segger J-Link RTT interface

Driver configuration The driver is configured using a single header file (*freemaster_cfg.h*). Create this file and save it together with other project source files before compiling the driver code. All FreeMASTER driver source files include the *freemaster_cfg.h* file and use the macros defined here for the conditional and parameterized compilation. The C compiler must locate the configuration file when compiling the driver files. Typically, it can be achieved by putting this file into a folder where the other project-specific included files are stored.

As a starting point to create the configuration file, get the *freemaster_cfg.h.example* file, rename it to *freemaster_cfg.h*, and save it into the project area.

Note: It is NOT recommended to leave the *freemaster_cfg.h* file in the FreeMASTER driver source code folder. The configuration file must be placed at a project-specific location, so that it does not affect the other applications that use the same driver.

Configurable items This section describes the configuration options which can be defined in *freemaster_cfg.h*.

Interrupt modes

```
#define FMSTR_LONG_INTR   [0|1]
#define FMSTR_SHORT_INTR  [0|1]
#define FMSTR_POLL_DRIVEN [0|1]
```

Value Type boolean (0 or 1)

Description Exactly one of the three macros must be defined to non-zero. The others must be defined to zero or left undefined. The non-zero-defined constant selects the interrupt mode of the driver. See *Driver interrupt modes*.

- FMSTR_LONG_INTR — long interrupt mode
- FMSTR_SHORT_INTR — short interrupt mode
- FMSTR_POLL_DRIVEN — poll-driven mode

Note: Some options may not be supported by all communication interfaces. For example, the FMSTR_SHORT_INTR option is not supported by the USB_CDC interface.

Protocol transport

```
#define FMSTR_TRANSPORT [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER source code. Specify one of existing instances to make use of the protocol transport.

Description Use one of the pre-defined constants, as implemented by the FreeMASTER code. The current driver supports the following transports:

- **FMSTR_SERIAL** - serial communication protocol
- **FMSTR_CAN** - using CAN communication
- **FMSTR_PDBDM** - using packet-driven BDM communication
- **FMSTR_NET** - network communication using TCP or UDP protocol

Serial transport This section describes configuration parameters used when serial transport is used:

```
#define FMSTR_TRANSPORT FMSTR_SERIAL
```

FMSTR_SERIAL_DRV Select what low-level driver interface will be used when implementing the Serial communication.

```
#define FMSTR_SERIAL_DRV [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing serial driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/serial* implementation):

- **FMSTR_SERIAL_MCUX_UART** - UART driver
- **FMSTR_SERIAL_MCUX_LPUART** - LPUART driver
- **FMSTR_SERIAL_MCUX_USART** - USART driver
- **FMSTR_SERIAL_MCUX_MINIUSART** - miniUSART driver
- **FMSTR_SERIAL_MCUX_QSCI** - DSC QSCI driver
- **FMSTR_SERIAL_MCUX_USB** - USB/CDC class driver (also see code in the */support/mcuxsdk_usb* folder)

- **FMSTR_SERIAL_56F800E_EONCE** - DSC JTAG EOnCE driver

Other SDKs or BSPs may define custom low-level driver interface structure which may be used as FMSTR_SERIAL_DRV. For example:

- **FMSTR_SERIAL_DREG_UART** - demonstrates the low-level interface implemented without the MCUXpresso SDK and using direct access to peripheral registers.

FMSTR_SERIAL_BASE

```
#define FMSTR_SERIAL_BASE [address|symbol]
```

Value Type Optional address value (numeric or symbolic)

Description Specify the base address of the UART, LPUART, USART, or other serial peripheral module to be used for the communication. This value is not defined by default. User application should call FMSTR_SetSerialBaseAddress() to select the peripheral module.

FMSTR_COMM_BUFFER_SIZE

```
#define FMSTR_COMM_BUFFER_SIZE [number]
```

Value Type 0 or a value in range 32...255

Description Specify the size of the communication buffer to be allocated by the driver. Default value, which suits all driver features, is used when this option is defined as 0.

FMSTR_COMM_RQUEUE_SIZE

```
#define FMSTR_COMM_RQUEUE_SIZE [number]
```

Value Type Value in range 0...255

Description Specify the size of the FIFO receiver queue used to quickly receive and store characters in the FMSTR_SHORT_INTR interrupt mode.
The default value is 32 B.

FMSTR_SERIAL_SINGLEWIRE

```
#define FMSTR_SERIAL_SINGLEWIRE [0|1]
```

Value Type Boolean 0 or 1.

Description Set to non-zero to enable the “True” single-wire mode which uses a single MCU pin to communicate. The low-level driver enables the pin direction switching when the MCU peripheral supports it.

CAN Bus transport This section describes configuration parameters used when CAN transport is used:

```
#define FMSTR_TRANSPORT FMSTR_CAN
```

FMSTR_CAN_DRV Select what low-level driver interface will be used when implementing the CAN communication.

```
#define FMSTR_CAN_DRV [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing CAN driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/can implementation*):

- **FMSTR_CAN_MCUX_FLEXCAN** - FlexCAN driver
- **FMSTR_CAN_MCUX_MCAN** - MCAN driver
- **FMSTR_CAN_MCUX_MSCAN** - msCAN driver
- **FMSTR_CAN_MCUX_DSCFLEXCAN** - DSC FlexCAN driver
- **FMSTR_CAN_MCUX_DSCMSCAN** - DSC msCAN driver

Other SDKs or BSPs may define the custom low-level driver interface structure which may be used as FMSTR_CAN_DRV.

FMSTR_CAN_BASE

```
#define FMSTR_CAN_BASE [address|symbol]
```

Value Type Optional address value (numeric or symbolic)

Description Specify the base address of the FlexCAN, msCAN, or other CAN peripheral module to be used for the communication. This value is not defined by default. User application should call FMSTR_SetCanBaseAddress() to select the peripheral module.

FMSTR_CAN_CMDID

```
#define FMSTR_CAN_CMDID [number]
```

Value Type CAN identifier (11-bit or 29-bit number)

Description CAN message identifier used for FreeMASTER commands (direction from PC Host tool to target application). When declaring 29-bit identifier, combine the numeric value with FMSTR_CAN_EXTID bit. Default value is 0x7AA.

FMSTR_CAN_RSPID

```
#define FMSTR_CAN_RSPID [number]
```

Value Type CAN identifier (11-bit or 29-bit number)

Description CAN message identifier used for responding messages (direction from target application to PC Host tool). When declaring 29-bit identifier, combine the numeric value with FMSTR_CAN_EXTID bit. Note that both *CMDID* and *RSPID* values may be the same. Default value is 0x7AA.

FMSTR_FLEXCAN_TXMB

```
#define FMSTR_FLEXCAN_TXMB [number]
```

Value Type Number in range of 0..N where N is number of CAN message-buffers supported by HW module.

Description Only used when the FlexCAN low-level driver is used. Define the FlexCAN message buffer for CAN frame transmission. Default value is 0.

FMSTR_FLEXCAN_RXMB

```
#define FMSTR_FLEXCAN_RXMB [number]
```

Value Type Number in range of 0..N where N is number of CAN message-buffers supported by HW module.

Description Only used when the FlexCAN low-level driver is used. Define the FlexCAN message buffer for CAN frame reception. Note that the FreeMASTER driver may also operate with a common message buffer used by both TX and RX directions. Default value is 1.

Network transport This section describes configuration parameters used when Network transport is used:

```
#define FMSTR_TRANSPORT FMSTR_NET
```

FMSTR_NET_DRV Select network interface implementation.

```
#define FMSTR_NET_DRV [identifier]
```

Value Type Identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing NET driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/network implementation*):

- **FMSTR_NET_LWIP_TCP** - TCP communication using lwIP stack
- **FMSTR_NET_LWIP_UDP** - UDP communication using lwIP stack
- **FMSTR_NET_SEGGER_RTT** - Communication using SEGGER J-Link RTT interface

Other SDKs or BSPs may define the custom networking interface which may be used as FMSTR_CAN_DRV.

Add another row below:

FMSTR_NET_PORT

```
#define FMSTR_NET_PORT [number]
```

Value Type TCP or UDP port number (short integer)

Description Specifies the server port number used by TCP or UDP protocols.

FMSTR_NET_BLOCKING_TIMEOUT

```
#define FMSTR_NET_BLOCKING_TIMEOUT [number]
```

Value Type Timeout as number of milliseconds

Description This value specifies a timeout in milliseconds for which the network socket operations may block the execution inside *FMSTR_Poll*. This may be set high (e.g. 250) when a dedicated RTOS task is used to handle FreeMASTER protocol polling. Set to a lower value when the polling task is also responsible for other operations. Set to 0 to attempt to use non-blocking socket operations.

FMSTR_NET_AUTODISCOVERY

```
#define FMSTR_NET_AUTODISCOVERY [0|1]
```

Value Type Boolean 0 or 1.

Description This option enables the FreeMASTER driver to use a separate UDP socket to broadcast auto-discovery messages to network. This helps the FreeMASTER tool to discover the target device address, port and protocol options.

Debugging options

FMSTR_DISABLE

```
#define FMSTR_DISABLE [0|1]
```

Value Type boolean (0 or 1)

Description Define as non-zero to disable all FreeMASTER features, exclude the driver code from build, and compile all its API functions empty. This may be useful to remove FreeMASTER without modifying any application source code. Default value is 0 (false).

FMSTR_DEBUG_TX

```
#define FMSTR_DEBUG_TX [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to enable the driver to periodically transmit test frames out on the selected communication interface (SCI or CAN). With the debug transmission enabled, it is simpler to detect problems in the baudrate or other communication configuration settings.

The test frames are transmitted until the first valid command frame is received from the PC Host tool. The test frame is a valid error status frame, as defined by the protocol format. On the serial line, the test frame consists of three printable characters (+©W) which are easy to capture using the serial terminal tools.

This feature requires the FMSTR_Poll() function to be called periodically. Default value is 0 (false).

FMSTR_APPLICATION_STR

```
#define FMSTR_APPLICATION_STR
```

Value Type String.

Description Name of the application visible in FreeMASTER host application.

Memory access

FMSTR_USE_READMEM

```
#define FMSTR_USE_READMEM [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Memory Read command and enable FreeMASTER to have read access to memory and variables. The access can be further restricted by using a TSA feature.
Default value is 1 (true).

FMSTR_USE_WRITEMEM

```
#define FMSTR_USE_WRITEMEM [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Memory Write command.
The default value is 1 (true).

Oscilloscope options

FMSTR_USE_SCOPE

```
#define FMSTR_USE_SCOPE [number]
```

Value Type Integer number.

Description Number of Oscilloscope instances to be supported. Set to 0 to disable the Oscilloscope feature.
Default value is 0.

FMSTR_MAX_SCOPE_VARS

```
#define FMSTR_MAX_SCOPE_VARS [number]
```

Value Type Integer number larger than 2.

Description Number of variables to be supported by each Oscilloscope instance.
Default value is 8.

Recorder options

FMSTR_USE_RECORDER

```
#define FMSTR_USE_RECORDER [number]
```

Value Type Integer number.

Description Number of Recorder instances to be supported. Set to 0 to disable the Recorder feature.
Default value is 0.

FMSTR_REC_BUFF_SIZE

```
#define FMSTR_REC_BUFF_SIZE [number]
```

Value Type Integer number larger than 2.

Description Defines the size of the memory buffer used by the Recorder instance #0.
Default: not defined, user shall call 'FMSTR_RecorderCreate()" API function to specify this parameter in run time.

FMSTR_REC_TIMEBASE

```
#define FMSTR_REC_TIMEBASE [time specification]
```

Value Type Number (nanoseconds time).

Description Defines the base sampling rate in nanoseconds (sampling speed) Recorder instance #0.

Use one of the following macros:

- FMSTR_REC_BASE_SECONDS(x)
- FMSTR_REC_BASE_MILLISEC(x)
- FMSTR_REC_BASE_MICROSEC(x)
- FMSTR_REC_BASE_NANOSEC(x)

Default: not defined, user shall call 'FMSTR_RecorderCreate()" API function to specify this parameter in run time.

FMSTR_REC_FLOAT_TRIG

```
#define FMSTR_REC_FLOAT_TRIG [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the floating-point triggering. Be aware that floating-point triggering may grow the code size by linking the floating-point standard library.

Default value is 0 (false).

Application Commands options

FMSTR_USE_APPCMD

```
#define FMSTR_USE_APPCMD [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Application Commands feature.
Default value is 0 (false).

FMSTR_APPCMD_BUFF_SIZE

```
#define FMSTR_APPCMD_BUFF_SIZE [size]
```

Value Type Numeric buffer size in range 1..255

Description The size of the Application Command data buffer allocated by the driver. The buffer stores the (optional) parameters of the Application Command which waits to be processed.

FMSTR_MAX_APPCMD_CALLS

```
#define FMSTR_MAX_APPCMD_CALLS [number]
```

Value Type Number in range 0..255

Description The number of different Application Commands that can be assigned a callback handler function using FMSTR_RegisterAppCmdCall(). Default value is 0.

TSA options

FMSTR_USE_TSA

```
#define FMSTR_USE_TSA [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the FreeMASTER TSA feature to be used. With this option enabled, the TSA tables defined in the applications are made available to the FreeMASTER host tool.
Default value is 0 (false).

FMSTR_USE_TSA_SAFETY

```
#define FMSTR_USE_TSA_SAFETY [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the memory access validation in the FreeMASTER driver. With this option, the host tool is not able to access the memory which is not described by at least one TSA descriptor. Also a write access is denied for objects defined as read-only in TSA tables.
Default value is 0 (false).

FMSTR_USE_TSA_INROM

```
#define FMSTR_USE_TSA_INROM [0|1]
```

Value Type Boolean 0 or 1.

Description Declare all TSA descriptors as *const*, which enables the linker to put the data into the flash memory. The actual result depends on linker settings or the linker commands used in the project.
Default value is 0 (false).

FMSTR_USE_TSA_DYNAMIC

```
#define FMSTR_USE_TSA_DYNAMIC [0|1]
```

Value Type Boolean 0 or 1.

Description Enable runtime-defined TSA entries to be added to the TSA table by the FMSTR_SetUpTsaBuff() and FMSTR_TsaAddVar() functions.
Default value is 0 (false).

Pipes options

FMSTR_USE_PIPES

```
#define FMSTR_USE_PIPES [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the FreeMASTER Pipes feature to be used.
Default value is 0 (false).

FMSTR_MAX_PIPES_COUNT

```
#define FMSTR_MAX_PIPES_COUNT [number]
```

Value Type Number in range 1..63.

Description The number of simultaneous pipe connections to support.
The default value is 1.

Driver interrupt modes To implement the communication, the FreeMASTER driver handles the Serial or CAN module's receive and transmit requests. Use the *freemaster_cfg.h* configuration file to select whether the driver processes the communication automatically in the interrupt service routine handler or if it only polls the status of the module (typically during the application idle time).

This section describes each of the interrupt mode in more details.

Completely Interrupt-Driven operation Activated using:

```
#define FMSTR_LONG_INTR 1
```

In this mode, both the communication and the FreeMASTER protocol decoding is done in the *FMSTR_SerialIsr*, *FMSTR_CanIsr*, or other interrupt service routine. Because the protocol execution may be a lengthy task (especially with the TSA-Safety enabled) it is recommended to use this mode only if the interrupt prioritization scheme is possible in the application and the FreeMASTER interrupt is assigned to a lower (the lowest) priority.

In this mode, the application code must register its own interrupt handler for all interrupt vectors related to the selected communication interface and call the FMSTR_SerialIsr or FMSTR_CanIsr functions from that handler.

Mixed Interrupt and Polling Modes Activated using:

```
#define FMSTR_SHORT_INTR 1
```

In this mode, the communication processing time is split between the interrupt routine and the main application loop or task. The raw communication is handled by the *FMSTR_SerialIsr, FMSTR_CanIsr*, or other interrupt service routine, while the protocol decoding and execution is handled by the *FMSTR_Poll* routine. Call *FMSTR_Poll* during the idle time in the application main loop.

The interrupt processing in this mode is relatively fast and deterministic. Upon a serial-receive event, the received character is only placed into a FIFO-like queue and it is not further processed. Upon a CAN receive event, the received frame is stored into a receive buffer. When transmitting, the characters are fetched from the prepared transmit buffer.

In this mode, the application code must register its own interrupt handler for all interrupt vectors related to the selected communication interface and call the *FMSTR_SerialIsr* or *FMSTR_CanIsr* functions from that handler.

When the serial interface is used as the serial communication interface, ensure that the *FMSTR_Poll* function is called at least once per *N* character time periods. *N* is the length of the FreeMASTER FIFO queue (*FMSTR_COMM_RQUEUE_SIZE*) and the character time is the time needed to transmit or receive a single byte over the SCI line.

Completely Poll-driven

```
#define FMSTR_POLL_DRIVEN 1
```

In this mode, both the communication and the FreeMASTER protocol decoding are done in the *FMSTR_Poll* routine. No interrupts are needed and the *FMSTR_SerialIsr*, *FMSTR_CanIsr*, and similar handlers compile to an empty code.

When using this mode, ensure that the *FMSTR_Poll* function is called by the application at least once per the serial "character time" which is the time needed to transmit or receive a single character.

In the latter two modes (*FMSTR_SHORT_INTR* and *FMSTR_POLL_DRIVEN*), the protocol handling takes place in the FMSTR_Poll routine. An application interrupt can occur in the middle of the Read Memory or Write Memory commands' execution and corrupt the variable being accessed by the FreeMASTER driver. In these two modes, some issues or glitches may occur when using FreeMASTER to visualize or monitor volatile variables modified in interrupt servicing code.

The same issue may appear even in the full interrupt mode (FMSTR_LONG_INTR), if volatile variables are modified in the interrupt code with a priority higher than the priority of the communication interrupt.

Data types Simple portability was one of the main requirements when writing the FreeMASTER driver. This is why the driver code uses the privately-declared data types and the vast majority of the platform-dependent code is separated in the platform-dependent source files. The data types used in the driver API are all defined in the platform-specific header file.

To prevent name conflicts with the symbols used in the application, all data types, macros, and functions have the FMSTR_ prefix. The only global variables used in the driver are the transport and low-level API structures exported from the driver-implementation layer to upper layers. Other than that, all private variables are declared as static and named using the fmstr_ prefix.

Communication interface initialization The FreeMASTER driver does not perform neither the initialization nor the configuration of the peripheral module that it uses to communicate. It is the application startup code responsibility to configure the communication module before the FreeMASTER driver is initialized by the FMSTR_Init call.

When the Serial communication module is used as the FreeMASTER communication interface, configure the UART receive and transmit pins, the serial communication baud rate, parity (no-parity), the character length (eight bits), and the number of stop bits (one) before initializing the FreeMASTER driver. For either the long or the short interrupt modes of the driver (see *Driver interrupt modes*), configure the interrupt controller and register an application-specific interrupt handler for all interrupt sources related to the selected serial peripheral module. Call the FMSTR_SerialIsr function from the application handler.

When a CAN module is used as the FreeMASTER communication interface, configure the CAN receive and transmit pins and the CAN module bit rate before initializing the FreeMASTER driver. For either the long or the short interrupt modes of the driver (see *Driver interrupt modes*), configure the interrupt controller and register an application-specific interrupt handler for all interrupt sources related to the selected CAN peripheral module. Call the FMSTR_CanIsr function from the application handler.

Note: It is not necessary to enable or unmask the serial nor the CAN interrupts before initializing the FreeMASTER driver. The driver enables or disables the interrupts and communication lines, as required during runtime.

FreeMASTER Recorder calls When using the FreeMASTER Recorder in the application (FMSTR_USE_RECORDER > 0), call the FMSTR_RecorderCreate function early after FMSTR_Init to set up each recorder instance to be used in the application. Then call the FMSTR_Recorder function periodically in the code where the data recording should occur. A typical place to call the Recorder routine is at the timer or PWM interrupts, but it can be anywhere else. The example applications provided together with the driver code call the FMSTR_Recorder in the main application loop.

In applications where FMSTR_Recorder is called periodically with a constant period, specify the period in the Recorder configuration structure before calling FMSTR_RecorderCreate. This setting enables the PC Host FreeMASTER tool to display the X-axis of the Recorder graph properly scaled for the time domain.

Driver usage Start using or evaluating FreeMASTER by opening some of the example applications available in the driver setup package.

Follow these steps to enable the basic FreeMASTER connectivity in the application:

- Make sure that all **.c* files of the FreeMASTER driver from the *src/common/platforms/[your_platform]* folder are a part of the project. See *Driver files* for more details.
- Configure the FreeMASTER driver by creating or editing the *freemaster_cfg.h* file and by saving it into the application project directory. See *Driver configuration* for more details.
- Include the *freemaster.h* file into any application source file that makes the FreeMASTER API calls.
- Initialize the Serial or CAN modules. Set the baud rate, parity, and other parameters of the communication. Do not enable the communication interrupts in the interrupt mask registers.
- For the FMSTR_LONG_INTR and FMSTR_SHORT_INTR modes, install the application-specific interrupt routine and call the FMSTR_SerialIsr or FMSTR_CanIsr functions from this handler.
- Call the FMSTR_Init function early on in the application initialization code.
- Call the FMSTR_RecorderCreate functions for each Recorder instance to enable the Recorder feature.
- In the main application loop, call the FMSTR_Poll API function periodically when the application is idle.
- For the FMSTR_SHORT_INTR and FMSTR_LONG_INTR modes, enable the interrupts globally so that the interrupts can be handled by the CPU.

Communication troubleshooting The most common problem that causes communication issues is a wrong baud rate setting or a wrong pin multiplexer setting of the target MCU. When

a communication between the PC Host running FreeMASTER and the target MCU cannot be established, try enabling the FMSTR_DEBUG_TX option in the *freemaster_cfg.h* file and call the FMSTR_Poll function periodically in the main application task loop.

With this feature enabled, the FreeMASTER driver periodically transmits a test frame through the Serial or CAN lines. Use a logic analyzer or an oscilloscope to monitor the signals at the communication pins of the CPU device to examine whether the bit rate and signal polarity are configured properly.

Driver API

This section describes the driver Application Programmers' Interface (API) needed to initialize and use the FreeMASTER serial communication driver.

Control API There are three key functions to initialize and use the driver.

FMSTR_Init

Prototype

```
FMSTR_BOOL FMSTR_Init(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_protocol.c*

Description This function initializes the internal variables of the FreeMASTER driver and enables the communication interface. This function does not change the configuration of the selected communication module. The hardware module must be initialized before the *FMSTR_Init* function is called.

A call to this function must occur before calling any other FreeMASTER driver API functions.

FMSTR_Poll

Prototype

```
void FMSTR_Poll(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_protocol.c*

Description In the poll-driven or short interrupt modes, this function handles the protocol decoding and execution (see *Driver interrupt modes*). In the poll-driven mode, this function also handles the communication interface with the PC. Typically, the *FMSTR_Poll* function is called during the "idle" time in the main application task loop.

To prevent the receive data overflow (loss) on a serial interface, make sure that the FMSTR_Poll function is called at least once per the time calculated as:

*N * Tchar*

where:

- *N* is equal to the length of the receive FIFO queue (configured by the FMSTR_COMM_RQUEUE_SIZE macro). *N* is 1 for the poll-driven mode.
- *Tchar* is the character time, which is the time needed to transmit or receive a single byte over the SCI line.

Note: In the long interrupt mode, this function typically compiles as an empty function and can still be called. It is worthwhile to call this function regardless of the interrupt mode used in the application. This approach enables a convenient switching between the different interrupt modes only by changing the configuration macros in the *freemaster_cfg.h* file.

FMSTR_SerialIsr / FMSTR_CanIsr

Prototype

```
void FMSTR_SerialIsr(void);
void FMSTR_CanIsr(void);
```

- Declaration: *freemaster.h*
- Implementation: *hw-specific low-level driver C file*

Description This function contains the interrupt-processing code of the FreeMASTER driver. In long or short interrupt modes (see *Driver interrupt modes*), this function must be called from the application interrupt service routine registered for the communication interrupt vector. On platforms where the communication module uses multiple interrupt vectors, the application should register a handler for all vectors and call this function at each interrupt.

Note: In a poll-driven mode, this function is compiled as an empty function and does not have to be used.

Recorder API

FMSTR_RecorderCreate

Prototype

```
FMSTR_BOOL FMSTR_RecorderCreate(FMSTR_INDEX recIndex, FMSTR_REC_BUFF* buffCfg);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function registers a recorder instance and enables it to be used by the PC Host tool. Call this function for all recorder instances from 0 to the maximum number defined by the FMSTR_USE_RECORDER configuration option (minus one). An exception to this requirement is the recorder of instance *0* which may be automatically configured by FMSTR_Init when the *freemaster_cfg.h* configuration file defines the *FMSTR_REC_BUFF_SIZE* and *FMSTR_REC_TIMEBASE* options.

For more information, see *Configurable items*.

FMSTR_Recorder

Prototype

```
void FMSTR_Recorder(FMSTR_INDEX recIndex);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function takes a sample of the variables being recorded using the FreeMASTER Recorder instance *recIndex*. If the selected Recorder is not active when the *FMSTR_Recorder* function is being called, the function returns immediately. When the Recorder is active, the values of the variables being recorded are copied into the recorder buffer and the trigger conditions are evaluated.

If a trigger condition is satisfied, the Recorder enters the post-trigger mode, where it counts down the follow-up samples (number of *FMSTR_Recorder* function calls) and de-activates the Recorder when the required post-trigger samples are finished.

The *FMSTR_Recorder* function is typically called in the timer or PWM interrupt service routines. This function can also be called in the application main loop (for testing purposes).

FMSTR_RecorderTrigger

Prototype

```
void FMSTR_RecorderTrigger(FMSTR_INDEX recIndex);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function forces the Recorder trigger condition to happen, which causes the Recorder to be automatically deactivated after the post-trigger samples are sampled. Use this function in the application code for programmatic control over the Recorder triggering. This can be useful when a more complex triggering conditions need to be used.

Fast Recorder API The Fast Recorder feature is not available in the FreeMASTER driver version 3. This feature was heavily dependent on the target platform and it was only available for the 56F8xxxx DSCs.

TSA Tables When the TSA is enabled in the FreeMASTER driver configuration file (by setting the FMSTR_USE_TSA macro to a non-zero value), it defines the so-called TSA tables in the application. This section describes the macros that must to be used to define the TSA tables.

There can be any number of TSA tables spread across the application source files. There must be always exactly one TSA Table List defined, which informs the FreeMASTER driver about the active TSA tables.

When there is at least one TSA table and one TSA Table List defined in the application, the TSA information automatically appears in the FreeMASTER symbols list. The symbols can then be used to create FreeMASTER variables for visualization or control.

TSA table definition The TSA table describes the static or global variables together with their address, size, type, and access-protection information. If the TSA-described variables are of a structure type, the TSA table may also describe this type and provide an access to the individual structure members of the variable.

The TSA table definition begins with the FMSTR_TSA_TABLE_BEGIN macro with a *table_id* identifying the table. The *table_id* shall be a valid C-langiage symbol.

```
FMSTR_TSA_TABLE_BEGIN(table_id)
```

After this opening macro, the TSA descriptors are placed using these macros:

```
/* Adding variable descriptors */
FMSTR_TSA_RW_VAR(name, type)  /* read/write variable entry */
FMSTR_TSA_RO_VAR(name, type)  /* read-only variable entry */

/* Description of complex data types */
FMSTR_TSA_STRUCT(struct_name) /* structure or union type entry */
FMSTR_TSA_MEMBER(struct_name, member_name, type)  /* structure member entry */

/* Memory blocks */
FMSTR_TSA_RW_MEM(name, type, address, size) /* read/write memory block */
FMSTR_TSA_RO_MEM(name, type, address, size) /* read-only memory block */
```

The table is closed using the FMSTR_TSA_TABLE_END macro:

```
FMSTR_TSA_TABLE_END()
```

TSA descriptor parameters The TSA descriptor macros accept these parameters:

- *name* — variable name. The variable must be defined before the TSA descriptor references it.
- *type* — variable or member type. Only one of the pre-defined type constants may be used (see below).
- *struct_name* — structure type name. The type must be defined (typedef) before the TSA descriptor references it.
- *member_name* — structure member name.

Note: The structure member descriptors (FMSTR_TSA_MEMBER) must immediately follow the parent structure descriptor (FMSTR_TSA_STRUCT) in the table.

Note: To write-protect the variables in the FreeMASTER driver (FMSTR_TSA_RO_VAR), enable the TSA-Safety feature in the configuration file.

TSA variable types The table lists *type* identifiers which can be used in TSA descriptors:

Constant	Description
FMSTR_TSA_UINT*n*	Unsigned integer type of size *n* bits (n=8,16,32,64)
FMSTR_TSA_SINT*n*	Signed integer type of size *n* bits (n=8,16,32,64)
FMSTR_TSA_FRAC*n*	Fractional number of size *n* bits (n=16,32,64).
FMSTR_TSA_FRAC_Q(*m,n*)	Signed fractional number in general Q form (m+n+1 total bits)
FMSTR_TSA_FRAC_UQ(*m,n*)	Unsigned fractional number in general UQ form (m+n total bits)
FMSTR_TSA_FLOAT	4-byte standard IEEE floating-point type
FMSTR_TSA_DOUBLE	8-byte standard IEEE floating-point type
FMSTR_TSA_POINTER	Generic pointer type defined (platform-specific 16 or 32 bit)
FMSTR_TSA_USERTYPE(*name*)	Structure or union type declared with FMSTR_TSA_STRUCT record

TSA table list There shall be exactly one TSA Table List in the application. The list contains one entry for each TSA table defined anywhere in the application.

The TSA Table List begins with the FMSTR_TSA_TABLE_LIST_BEGIN macro and continues with the TSA table entries for each table.

```
FMSTR_TSA_TABLE_LIST_BEGIN()

FMSTR_TSA_TABLE(table_id)
FMSTR_TSA_TABLE(table_id2)
FMSTR_TSA_TABLE(table_id3)
...
```

The list is closed with the FMSTR_TSA_TABLE_LIST_END macro:

```
FMSTR_TSA_TABLE_LIST_END()
```

TSA Active Content entries FreeMASTER v2.0 and higher supports TSA Active Content, enabling the TSA tables to describe the memory-mapped files, virtual directories, and URL hyperlinks. FreeMASTER can access such objects similarly to accessing the files and folders on the local hard drive.

With this set of TSA entries, the FreeMASTER pages can be embedded directly into the target MCU flash and accessed by FreeMASTER directly over the communication line. The HTML-coded pages rendered inside the FreeMASTER window can access the TSA Active Content resources using a special URL referencing the *fmstr:* protocol.

This example provides an overview of the supported TSA Active Content entries:

```
FMSTR_TSA_TABLE_BEGIN(files_and_links)

/* Directory entry applies to all subsequent MEMFILE entries */
FMSTR_TSA_DIRECTORY("/text_files")     /* entering a new virtual directory */

/* The readme.txt file will be accessible at the fmstr://text_files/readme.txt URL */
FMSTR_TSA_MEMFILE("readme.txt", readme_txt, sizeof(readme_txt)) /* memory-mapped file */

/* Files can also be specified with a full path so the DIRECTORY entry does not apply */
FMSTR_TSA_MEMFILE("/index.htm", index, sizeof(index))          /* memory-mapped file */
FMSTR_TSA_MEMFILE("/prj/demo.pmp", demo_pmp, sizeof(demo_pmp)) /* memory-mapped file */

/* Hyperlinks can point to a local MEMFILE object or to the Internet */
FMSTR_TSA_HREF("Board's Built-in Welcome Page", "/index.htm")
FMSTR_TSA_HREF("FreeMASTER Home Page", "http://www.nxp.com/freemaster")
```

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```
/* Project file links simplify opening the projects from any URLs */
FMSTR_TSA_PROJECT("Demonstration Project (embedded)", "/prj/demo.pmp")
FMSTR_TSA_PROJECT("Full Project (online)", "http://mycompany.com/prj/demo.pmp")

FMSTR_TSA_TABLE_END()
```

TSA API

FMSTR_SetUpTsaBuff

Prototype

```
FMSTR_BOOL FMSTR_SetUpTsaBuff(FMSTR_ADDR buffAddr, FMSTR_SIZE buffSize);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_tsa.c*

Arguments

- *buffAddr* [in] - address of the memory buffer for the dynamic TSA table
- *buffSize* [in] - size of the memory buffer which determines the maximum number of TSA entries to be added in the runtime

Description This function must be used to assign the RAM memory buffer to the TSA subsystem when FMSTR_USE_TSA_DYNAMIC is enabled. The memory buffer is then used to store the TSA entries added dynamically to the runtime TSA table using the FMSTR_TsaAddVar function call. The runtime TSA table is processed by the FreeMASTER PC Host tool along with all static tables as soon as the communication port is open.

The size of the memory buffer determines the number of TSA entries that can be added dynamically. Depending on the MCU platform, one TSA entry takes either 8 or 16 bytes.

FMSTR_TsaAddVar

Prototype

```
FMSTR_BOOL FMSTR_TsaAddVar(FMSTR_TSATBL_STRPTR tsaName, FMSTR_TSATBL_STRPTR␣
↪tsaType,
    FMSTR_TSATBL_VOIDPTR varAddr, FMSTR_SIZE32 varSize,
    FMSTR_SIZE flags);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_tsa.c*

Arguments

- *tsaName* [in] - name of the object
- *tsaType* [in] - name of the object type
- *varAddr* [in] - address of the object

- *varSize* [in] - size of the object
- *flags* [in] - access flags; a combination of these values:
  - *FMSTR_TSA_INFO_RO_VAR* — read-only memory-mapped object (typically a variable)
  - *FMSTR_TSA_INFO_RW_VAR* — read/write memory-mapped object
  - *FMSTR_TSA_INFO_NON_VAR* — other entry, describing structure types, structure members, enumerations, and other types

Description This function can be called only when the dynamic TSA table is enabled by the FMSTR_USE_TSA_DYNAMIC configuration option and when the FMSTR_SetUpTsaBuff function call is made to assign the dynamic TSA table memory. This function adds an entry into the dynamic TSA table. It can be used to register a read-only or read/write memory object or describe an item of the user-defined type.

See *TSA table definition* for more details about the TSA table entries.

Application Commands API

FMSTR_GetAppCmd

Prototype

```
FMSTR_APPCMD_CODE FMSTR_GetAppCmd(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Description This function can be used to detect if there is an Application Command waiting to be processed by the application. If no command is pending, this function returns the FMSTR_APPCMDRESULT_NOCMD constant. Otherwise, this function returns the code of the Application Command that must be processed. Use the FMSTR_AppCmdAck call to acknowledge the Application Command after it is processed and to return the appropriate result code to the host.

The FMSTR_GetAppCmd function does not report the commands for which a callback handler function exists. If the FMSTR_GetAppCmd function is called when a callback-registered command is pending (and before it is actually processed by the callback function), this function returns FMSTR_APPCMDRESULT_NOCMD.

FMSTR_GetAppCmdData

Prototype

```
FMSTR_APPCMD_PDATA FMSTR_GetAppCmdData(FMSTR_SIZE* dataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *dataLen* [out] - pointer to the variable that receives the length of the data available in the buffer. It can be NULL when this information is not needed.

Description This function can be used to retrieve the Application Command data when the application determines that an Application Command is pending (see *FMSTR_GetAppCmd*).

There is just a single buffer to hold the Application Command data (the buffer length is FMSTR_APPCMD_BUFF_SIZE bytes). If the data are to be used in the application after the command is processed by the FMSTR_AppCmdAck call, copy the data out to a private buffer.

FMSTR_AppCmdAck

Prototype

```
void FMSTR_AppCmdAck(FMSTR_APPCMD_RESULT resultCode);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultCode* [in] - the result code which is to be returned to FreeMASTER

Description This function is used when the Application Command processing finishes in the application. The resultCode passed to this function is returned back to the host and the driver is re-initialized to expect the next Application Command.

After this function is called and before the next Application Command arrives, the return value of the FMSTR_GetAppCmd function is FMSTR_APPCMDRESULT_NOCMD.

FMSTR_AppCmdSetResponseData

Prototype

```
void FMSTR_AppCmdSetResponseData(FMSTR_ADDR resultDataAddr, FMSTR_SIZE resultDataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultDataAddr* [in] - pointer to the data buffer that is to be copied to the Application Command data buffer
- *resultDataLen* [in] - length of the data to be copied. It must not exceed the FMSTR_APPCMD_BUFF_SIZE value.

Description This function can be used before the Application Command processing finishes, when there are data to be returned back to the PC.

The response data buffer is copied into the Application Command data buffer, from where it is accessed when the host requires it. Do not use FMSTR_GetAppCmdData and the data buffer after FMSTR_AppCmdSetResponseData is called.

Note: The current version of FreeMASTER does not support the Application Command response data.

FMSTR_RegisterAppCmdCall

Prototype

```
FMSTR_BOOL FMSTR_RegisterAppCmdCall(FMSTR_APPCMD_CODE appCmdCode, FMSTR_
↪PAPPCMDFUNC callbackFunc);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *appCmdCode* [in] - the Application Command code for which the callback is to be registered
- *callbackFunc* [in] - pointer to the callback function that is to be registered. Use NULL to unregister a callback registered previously with this Application Command.

Return value This function returns a non-zero value when the callback function was successfully registered or unregistered. It can return zero when trying to register a callback function for more than FMSTR_MAX_APPCMD_CALLS different Application Commands.

Description This function can be used to register the given function as a callback handler for the Application Command. The Application Command is identified using single-byte code. The callback function is invoked automatically by the FreeMASTER driver when the protocol decoder obtains a request to get the application command result code.

The prototype of the callback function is

```
FMSTR_APPCMD_RESULT HandlerFunction(FMSTR_APPCMD_CODE nAppcmd,
    FMSTR_APPCMD_PDATA pData, FMSTR_SIZE nDataLen);
```

Where:

- *nAppcmd* -Application Command code
- *pData* —points to the Application Command data received (if any)
- *nDataLen* —information about the Application Command data length

The return value of the callback function is used as the Application Command Result Code and returned to FreeMASTER.

Note: The FMSTR_MAX_APPCMD_CALLS configuration macro defines how many different Application Commands may be handled by a callback function. When FMSTR_MAX_APPCMD_CALLS is undefined or defined as zero, the FMSTR_RegisterAppCmdCall function always fails.

Pipes API

FMSTR_PipeOpen

Prototype

```
FMSTR_HPIPE FMSTR_PipeOpen(FMSTR_PIPE_PORT pipePort, FMSTR_PPIPEFUNC pipeCallback,
↪
    FMSTR_ADDR pipeRxBuff, FMSTR_PIPE_SIZE pipeRxSize,
    FMSTR_ADDR pipeTxBuff, FMSTR_PIPE_SIZE pipeTxSize,
    FMSTR_U8 type, const FMSTR_CHAR *name);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipePort* [in] - port number that identifies the pipe for the client
- *pipeCallback* [in] - pointer to the callback function that is called whenever a pipe data status changes
- *pipeRxBuff* [in] - address of the receive memory buffer
- *pipeRxSize* [in] - size of the receive memory buffer
- *pipeTxBuff* [in] - address of the transmit memory buffer
- *pipeTxSize* [in] - size of the transmit memory buffer
- *type* [in] - a combination of FMSTR_PIPE_MODE_xxx and FMSTR_PIPE_SIZE_xxx constants describing primary pipe data format and usage. This type helps FreeMASTER decide how to access the pipe by default. Optional, use 0 when undetermined.
- *name* [in] - user name of the pipe port. This name is visible to the FreeMASTER user when creating the graphical pipe interface.

Description This function initializes a new pipe and makes it ready to accept or send the data to the PC Host client. The receive memory buffer is used to store the received data before they are read out by the FMSTR_PipeRead call. When this buffer gets full, the PC Host client denies the data transmission into this pipe until there is enough free space again. The transmit memory buffer is used to store the data transmitted by the application to the PC Host client using the FMSTR_PipeWrite call. The transmit buffer can get full when the PC Host is disconnected or when it is slow in receiving and reading out the pipe data.

The function returns the pipe handle which must be stored and used in the subsequent calls to manage the pipe object.

The callback function (if specified) is called whenever new data are received through the pipe and available for reading. This callback is also called when the data waiting in the transmit buffer are successfully pushed to the PC Host and the transmit buffer free space increases. The prototype of the callback function provided by the user application must be as follows. The *PipeHandler* name is only a placeholder and must be defined by the application.

```
void PipeHandler(FMSTR_HPIPE pipeHandle);
```

FMSTR_PipeClose

Prototype

```
void FMSTR_PipeClose(FMSTR_HPIPE pipeHandle);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call

Description This function de-initializes the pipe object. No data can be received or sent on the pipe after this call.

FMSTR_PipeWrite

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeWrite(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE writeGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data to be written
- *pipeDataLen* [in] - length of the data to be written
- *writeGranularity* [in] - size of the minimum unit of data which is to be written

Description This function puts the user-specified data into the pipe's transmit memory buffer and schedules it for transmission. This function returns the number of bytes that were successfully written into the buffer. This number may be smaller than the number of the requested bytes if there is not enough free space in the transmit buffer.

The *writeGranularity* argument can be used to split the data into smaller chunks, each of the size given by the *writeGranularity* value. The FMSTR_PipeWrite function writes as many data chunks as possible into the transmit buffer and does not attempt to write an incomplete chunk. This feature can prove to be useful to avoid the intermediate caching when writing an array of integer values or other multi-byte data items. When making the nGranularity value equal to the nLength value, all data are considered as one chunk which is either written successfully as a whole or not at all. The nGranularity value of 0 or 1 disables the data-chunk approach.

FMSTR_PipeRead

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeRead(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE readGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data buffer to be filled with the received data
- *pipeDataLen* [in] - length of the data to be read
- *readGranularity* [in] - size of the minimum unit of data which is to be read

Description This function copies the data received from the pipe from its receive buffer to the user buffer for further processing. The function returns the number of bytes that were successfully copied to the buffer. This number may be smaller than the number of the requested bytes if there is not enough data bytes available in the receive buffer.

The readGranularity argument can be used to copy the data in larger chunks in the same way as described in the FMSTR_PipeWrite function.

API data types This section describes the data types used in the FreeMASTER driver. The information provided here can be useful when modifying or porting the FreeMASTER Communication Driver to new NXP platforms.

Note: The licensing conditions prohibit use of FreeMASTER and the FreeMASTER Communication Driver with non-NXP MPU or MCU products.

Public common types The table below describes the public data types used in the FreeMASTER driver API calls. The data types are declared in the *freemaster.h* header file.

Type name	Description
FMSTR_ADDR	Data type used to hold the memory address. On most platforms, this is normally a C-pointer, but it may also be a pure integer type.
For example, this type is defined as long integer on the 56F8xxx platform where the 24-bit addresses must be supported, but the C-pointer may be only 16 bits wide in some compiler configurations.	
FMSTR_SIZE	Data type used to hold the memory block size.
It is required that this type is unsigned and at least 16 bits wide integer.	
FMSTR_BOOL	Data type used as a general boolean type.
This type is used only in zero/non-zero conditions in the driver code.	
FMSTR_APPCM	Data type used to hold the Application Command code.
Generally, this is an unsigned 8-bit value.	
FMSTR_APPCM	Data type used to create the Application Command data buffer.
Generally, this is an unsigned 8-bit value.	
FMSTR_APPCM	Data type used to hold the Application Command result code.
Generally, this is an unsigned 8-bit value.	

Public TSA types The table describes the TSA-specific public data types. These types are declared in the *freemaster_tsa.h* header file, which is included in the user application indirectly by the *freemaster.h* file.

FMSTR_TSA_TI	Data type used to hold a descriptor index in the TSA table or a table index in the list of TSA tables.
By default, this is defined as FMSTR_SIZE.	
FMSTR_TSA_TS	Data type used to hold a memory block size, as used in the TSA descriptors.
By default, this is defined as FMSTR_SIZE.	

Public Pipes types The table describes the data types used by the FreeMASTER Pipes API:

FMSTR_HPIPE	Pipe handle that identifies the open-pipe object.
Generally, this is a pointer to a void type.	
FMSTR_PIPE_P	Integer type required to hold at least 7 bits of data.
Generally, this is an unsigned 8-bit or 16-bit type.	
FMSTR_PIPE_SI	Integer type required to hold at least 16 bits of data.
This is used to store the data buffer sizes.	
FMSTR_PPIPEF	Pointer to the pipe handler function.
See *FMSTR_PipeOpen* for more details.	

Internal types The table describes the data types used internally by the FreeMASTER driver. The data types are declared in the platform-specific header file and they are not available in the application code.

FMSTR_U8	The smallest memory entity. On the vast majority of platforms, this is an unsigned 8-bit integer. On the 56F8xx DSP platform, this is defined as an unsigned 16-bit integer.
FMSTR_U16	Unsigned 16-bit integer.
FMSTR_U32	Unsigned 32-bit integer.
FMSTR_S8	Signed 8-bit integer.
FMSTR_S16	Signed 16-bit integer.
FMSTR_S32	Signed 32-bit integer.
FMSTR_FLOAT	4-byte standard IEEE floating-point type.
FMSTR_FLAGS	Data type forming a union with a structure of flag bit-fields.
FMSTR_SIZE8	Data type holding a general size value, at least 8 bits wide.
FMSTR_INDEX	General for-loop index. Must be signed, at least 16 bits wide.
FMSTR_BCHR	A single character in the communication buffer. Typically, this is an 8-bit unsigned integer, except for the DSP platforms where it is a 16-bit integer.
FMSTR_BPTR	A pointer to the communication buffer (an array of FMSTR_BCHR).

Document references

Links

- This document online: https://mcuxpresso.nxp.com/mcuxsdk/latest/html/middleware/freemaster/doc/index.html

- FreeMASTER tool home: www.nxp.com/freemaster
- FreeMASTER community area: community.nxp.com/community/freemaster
- FreeMASTER GitHub code repo: https://github.com/nxp-mcuxpresso/mcux-freemaster
- MCUXpresso SDK home: www.nxp.com/mcuxpresso
- MCUXpresso SDK builder: mcuxpresso.nxp.com/en

Documents

- *FreeMASTER Usage Serial Driver Implementation* (document AN4752)
- *Integrating FreeMASTER Time Debugging Tool With CodeWarrior For Microcontrollers v10.X Project* (document AN4771)
- *Flash Driver Library For MC56F847xx And MC56F827xx DSC Family* (document AN4860)

Revision history This Table summarizes the changes done to this document since the initial release.

Revision	Date	Description
1.0	03/2006	Limited initial release
2.0	09/2007	Updated for FreeMASTER version. New Freescale document template used.
2.1	12/2007	Added description of the new Fast Recorder feature and its API.
2.2	04/2010	Added support for MPC56xx platform, Added new API for use CAN interface.
2.3	04/2011	Added support for Kxx Kinetis platform and MQX operating system.
2.4	06/2011	Serial driver update, adds support for USB CDC interface.
2.5	08/2011	Added Packet Driven BDM interface.
2.7	12/2013	Added FLEXCAN32 interface, byte access and isr callback configuration option.
2.8	06/2014	Removed obsolete license text, see the software package content for up-to-date license.
2.9	03/2015	Update for driver version 1.8.2 and 1.9: FreeMASTER Pipes, TSA Active Content, LIN Transport Layer support, DEBUG-TX communication troubleshooting, Kinetis SDK support.
3.0	08/2016	Update for driver version 2.0: Added support for MPC56xx, MPC57xx, KEAxx and S32Kxx platforms. New NXP document template as well as new license agreement used. added MCAN interface. Folders structure at the installation destination was rearranged.
4.0	04/2019	Update for driver released as part of FreeMASTER v3.0 and MCUXpresso SDK 2.6. Updated to match new V4 serial communication protocol and new configuration options. This version of the document removes substantial portion of outdated information related to S08, S12, ColdFire, Power and other legacy platforms.
4.1	04/2020	Minor update for FreeMASTER driver included in MCUXpresso SDK 2.8.
4.2	09/2020	Added example applications description and information about the MCUXpresso Config Tools. Fixed the pipe-related API description.
4.3	10/2024	Added description of Network and Segger J-Link RTT interface configuration. Accompanying the MCUXpresso SDK version 24.12.00.
4.4	04/2025	Added Zephyr-specific information. Accompanying the MCUXpresso SDK version 25.06.00.

3.6 MultiCore

3.6.1 Multicore SDK

Multicore Software Development Kit (MCSDK) is a Software Development Kit that provides comprehensive software support for NXP dual/multicore devices. The MCSDK is combined with the MCUXpresso SDK to make the software framework for easy development of multicore applications.

Multicore SDK (MCSDK) Release Notes

Overview These are the release notes for the NXP Multicore Software Development Kit (MCSDK) version 25.06.00.
This software package contains components for efficient work with multicore devices as well as for the
multiprocessor communication.

What is new

- eRPC CHANGELOG
- RPMsg-Lite CHANGELOG
- MCMgr CHANGELOG
- Supported evaluation boards (multicore examples):
  - LPCXpresso55S69
  - FRDM-K32L3A6
  - MIMXRT1170-EVKB
  - MIMXRT1160-EVK
  - MIMXRT1180-EVK
  - MCX-N5XX-EVK
  - MCX-N9XX-EVK
  - FRDM-MCXN947
  - MIMXRT700-EVK
  - KW47-EVK
  - KW47-LOC
  - FRDM-MCXW72
  - MCX-W72-EVK
- Supported evaluation boards (multiprocessor examples):
  - LPCXpresso55S36
  - FRDM-K22F
  - FRDM-K32L2B
  - MIMXRT685-EVK
  - MIMXRT1170-EVKB
  - MIMXRT1180
  - FRDM-MCXN236
  - FRDM-MCXC242
  - FRDM-MCXC444
  - MCX-N9XX-EVK
  - FRDM-MCXN947
  - MIMXRT700-EVK

Development tools The Multicore SDK (MCSDK) was compiled and tested with development tools referred in: Development tools

Release contents This table describes the release contents. Not all MCUXpresso SDK packages contain the whole set of these components.

Deliverable	Location
Multicore SDK location <MCSDK_dir>	<MCUXpressoSDK_install_dir>/middleware/multicore/
Documentation	<MCSDK_dir>/mcuxsdk-doc/
Embedded Remote Procedure Call component	<MCSDK_dir>/erpc/
Multicore Manager component	<MCSDK_dir>/mcmgr/
RPMsg-Lite	<MCSDK_dir>/rpmsg_lite/
Multicore demo applications	<MCUXpressoSDK_install_dir>/examples/multicore_examples/
Multiprocessor demo applications	<MCUXpressoSDK_install_dir>/examples/multiprocessor_examples/

Multicore SDK release overview Together, the Multicore SDK (MCSDK) and the MCUXpresso SDK (SDK) form a framework for the development of software for NXP multicore devices. The MCSDK release consists of the following elementary software components for multicore:

- Embedded Remote Procedure Call (eRPC)
- Multicore Manager (MCMGR) - included just in SDK for multicore devices
- Remote Processor Messaging - Lite (RPMsg-Lite) - included just in SDK for multicore devices

The MCSDK is also accompanied with documentation and several multicore and multiprocessor demo applications.

Demo applications The multicore demo applications demonstrate the usage of the MCSDK software components on supported multicore development boards.
The following multicore demo applications are located together with other MCUXpresso SDK examples in
the <MCUXpressoSDK_install_dir>/examples/multicore_examples subdirectories.

- erpc_matrix_multiply_mu
- erpc_matrix_multiply_mu_rtos
- erpc_matrix_multiply_rpmsg
- erpc_matrix_multiply_rpmsg_rtos
- erpc_two_way_rpc_rpmsg_rtos
- freertos_message_buffers
- hello_world
- multicore_manager
- rpmsg_lite_pingpong
- rpmsg_lite_pingpong_rtos
- rpmsg_lite_pingpong_tzm

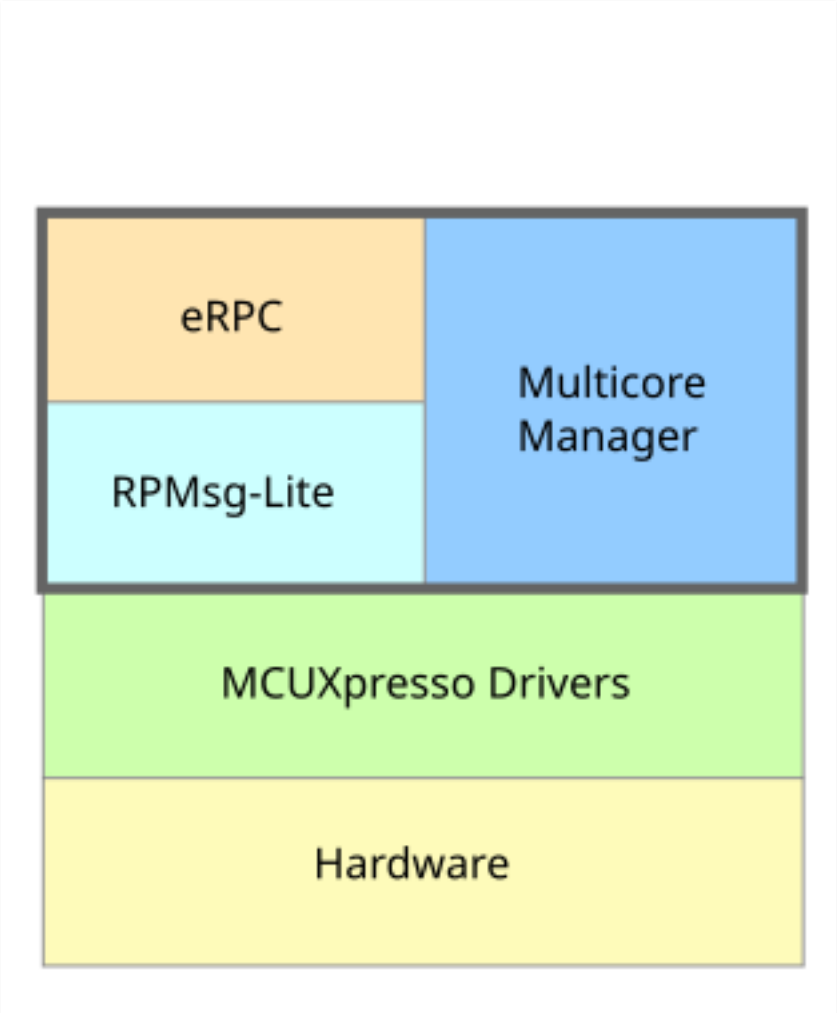
The eRPC multicore component can be leveraged for inter-processor communication and remote procedure calls between SoCs / development boards.
The following multiprocessor demo applications are located together with other MCUXpresso SDK examples in
the <MCUXpressoSDK_install_dir>/examples/multiprocessor_examples subdirectories.

- erpc_client_matrix_multiply_spi
- erpc_server_matrix_multiply_spi
- erpc_client_matrix_multiply_uart
- erpc_server_matrix_multiply_uart
- erpc_server_dac_adc
- erpc_remote_control

Getting Started with Multicore SDK (MCSDK)

Overview Multicore Software Development Kit (MCSDK) is a Software Development Kit that provides comprehensive software support for NXP dual/multicore devices. The MCSDK is combined with the MCUXpresso SDK to make the software framework for easy development of multicore applications.

The following figure highlights the layers and main software components of the MCSDK.

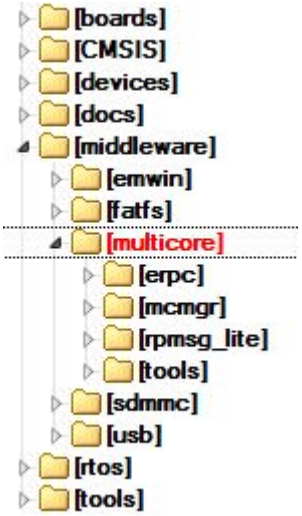


All the MCSDK-related files are located in <MCUXpressoSDK_install_dir>/middleware/multicore folder.

For supported toolchain versions, see the *Multicore SDK v25.06.00 Release Notes* (document MCSDKRN). For the latest version of this and other MCSDK documents, visit www.nxp.com.

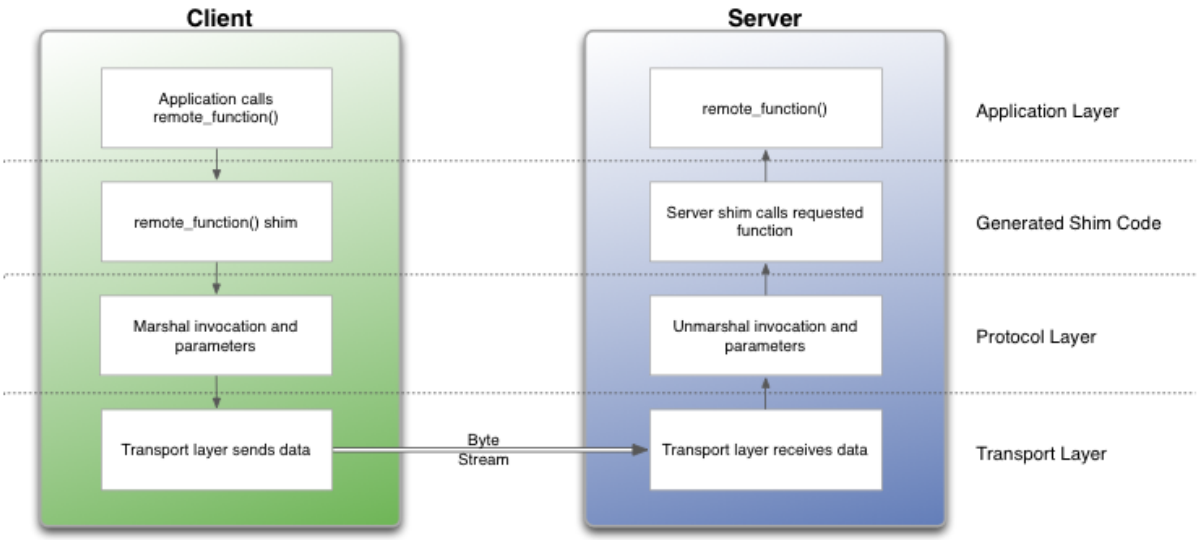
Multicore SDK (MCSDK) components The MCSDK consists of the following software components:

- **Embedded Remote Procedure Call (eRPC):** This component is a combination of a library and code generator tool that implements a transparent function call interface to remote services (running on a different core).
- **Multicore Manager (MCMGR):** This library maintains information about all cores and starts up secondary/auxiliary cores.
- **Remote Processor Messaging - Lite (RPMsg-Lite):** Inter-Processor Communication library.



Embedded Remote Procedure Call (eRPC) The Embedded Remote Procedure Call (eRPC) is the RPC system created by NXP. The RPC is a mechanism used to invoke a software routine on a remote system via a simple local function call.

When a remote function is called by the client, the function's parameters and an identifier for the called routine are marshaled (or serialized) into a stream of bytes. This byte stream is transported to the server through a communications channel (IPC, TPC/IP, UART, and so on). The server unmarshaled the parameters, determines which function was invoked, and calls it. If the function returns a value, it is marshaled and sent back to the client.



RPC implementations typically use a combination of a tool (erpcgen) and IDL (interface definition language) file to generate source code to handle the details of marshaling a function's parameters and building the data stream.

Main eRPC features:

- Scalable from BareMetal to Linux OS - configurable memory and threading policies.
- Focus on embedded systems - intrinsic support for C, modular, and lightweight implementation.
- Abstracted transport interface - RPMsg is the primary transport for multicore, UART, or SPI-based solutions can be used for multichip.

The eRPC library is located in the <MCUXpressoSDK_install_dir>/middleware/multicore/erpc folder. For detailed information about the eRPC, see the documentation available in the <MCUXpressoSDK_install_dir>/middleware/multicore/erpc/doc folder.

Multicore Manager (MCMGR) The Multicore Manager (MCMGR) software library provides a number of services for multicore systems.

The main MCMGR features:

- Maintains information about all cores in system.
- Secondary/auxiliary cores startup and shutdown.
- Remote core monitoring and event handling.

The MCMGR library is located in the <MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr folder. For detailed information about the MCMGR library, see the documentation available in the <MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/doc folder.

Remote Processor Messaging Lite (RPMsg-Lite) RPMsg-Lite is a lightweight implementation of the RPMsg protocol. The RPMsg protocol defines a standardized binary interface used to communicate between multiple cores in a heterogeneous multicore system. Compared to the legacy OpenAMP implementation, RPMsg-Lite offers a code size reduction, API simplification, and improved modularity.

The main RPMsg protocol features:

- Shared memory interprocessor communication.
- Virtio-based messaging bus.
- Application-defined messages sent between endpoints.

- Portable to different environments/platforms.
- Available in upstream Linux OS.

The RPMsg-Lite library is located in the <MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg-lite folder. For detailed information about the RPMsg-Lite, see the RPMsg-Lite User's Guide located in the <MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/doc folder.

MCSDK demo applications Multicore and multiprocessor example applications are stored together with other MCUXpresso SDK examples, in the dedicated multicore subfolder.

Location	Folder
Multicore example projects	<MCUXpressoSDK_install_dir>/examples/multicore_examples/<application_name>/
Multiprocessor example projects	<MCUXpressoSDK_install_dir>/examples/multiprocessor_examples/<application_name>/

See the *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) and *Getting Started with MCUXpresso SDK for XXX Derivatives* documents for more information about the MCUXpresso SDK example folder structure and the location of individual files that form the example application projects. These documents also contain information about building, running, and debugging multicore demo applications in individual supported IDEs. Each example application also contains a readme file that describes the operation of the example and required setup steps.

Inter-Processor Communication (IPC) levels The MCSDK provides several mechanisms for Inter-Processor Communication (IPC). Particular ways and levels of IPC are described in this chapter.

IPC using low-level drivers

The NXP multicore SoCs are equipped with peripheral modules dedicated for data exchange between individual cores. They deal with the Mailbox peripheral for LPC parts and the Messaging Unit (MU) peripheral for Kinetis and i.MX parts. The common attribute of both modules is the ability to provide a means of IPC, allowing multiple CPUs to share resources and communicate with each other in a simple manner.

The most lightweight method of IPC uses the MCUXpresso SDK low-level drivers for these peripherals. Using the Mailbox/MU driver API functions, it is possible to pass a value from core to core via the dedicated registers (could be a scalar or a pointer to shared memory) and also to trigger inter-core interrupts for notifications.

For details about individual driver API functions, see the MCUXpresso SDK API Reference Manual of the specific multicore device. The MCUXpresso SDK is accompanied with the RPMsg-Lite documentation that shows how to use this API in multicore applications.

Messaging mechanism

On top of Mailbox/MU drivers, a messaging system can be implemented, allowing messages to send between multiple endpoints created on each of the CPUs. The RPMsg-Lite library of the MCSDK provides this ability and serves as the preferred MCUXpresso SDK messaging library. It implements ring buffers in shared memory for messages exchange without the need of a locking mechanism.

The RPMsg-Lite provides the abstraction layer and can be easily ported to different multicore platforms and environments (Operating Systems). The advantages of such a messaging system are ease of use (there is no need to study behavior of the used underlying hardware) and smooth application code portability between platforms due to unified messaging API.

However, this costs several kB of code and data memory. The MCUXpresso SDK is accompanied by the RPMsg-Lite documentation and several multicore examples. You can also obtain the latest RPMsg-Lite code from the GitHub account github.com/nxp-mcuxpresso/rpmsg-lite.

Remote procedure calls

To facilitate the IPC even more and to allow the remote functions invocation, the remote procedure call mechanism can be implemented. The eRPC of the MCSDK serves for these purposes and allows the ability to invoke a software routine on a remote system via a simple local function call. Utilizing different transport layers, it is possible to communicate between individual cores of multicore SoCs (via RPMsg-Lite) or between separate processors (via SPI, UART, or TCP/IP). The eRPC is mostly applicable to the MPU parts with enough of memory resources like i.MX parts.

The eRPC library allows you to export existing C functions without having to change their prototypes (in most cases). It is accompanied by the code generator tool that generates the shim code for serialization and invocation based on the IDL file with definitions of data types and remote interfaces (API).

If the communicating peer is running as a Linux OS user-space application, the generated code can be either in C/C++ or Python.

Using the eRPC simplifies the access to services implemented on individual cores. This way, the following types of applications running on dedicated cores can be easily interfaced:

- Communication stacks (USB, Thread, Bluetooth Low Energy, Zigbee)
- Sensor aggregation/fusion applications
- Encryption algorithms
- Virtual peripherals

The eRPC is publicly available from the following GitHub account: github.com/EmbeddedRPC/erpc. Also, the MCUXpresso SDK is accompanied by the eRPC code and several multicore and multiprocessor eRPC examples.

The mentioned IPC levels demonstrate the scalability of the Multicore SDK library. Based on application needs, different IPC techniques can be used. It depends on the complexity, required speed, memory resources, system design, and so on. The MCSDK brings users the possibility for quick and easy development of multicore and multiprocessor applications.

Changelog Multicore SDK

All notable changes to this project will be documented in this file.

The format is based on Keep a Changelog, and this project adheres to Semantic Versioning.

[25.06.00]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.14.0
  - eRPC generator (erpcgen) v1.14.0
  - Multicore Manager (MCMgr) v5.0.0
  - RPMsg-Lite v5.2.0

[25.03.00]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.13.0

  - eRPC generator (erpcgen) v1.13.0
  - Multicore Manager (MCMgr) v4.1.7
  - RPMsg-Lite v5.1.4

[24.12.00]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.13.0
  - eRPC generator (erpcgen) v1.13.0
  - Multicore Manager (MCMgr) v4.1.6
  - RPMsg-Lite v5.1.3

[2.16.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.13.0
  - eRPC generator (erpcgen) v1.13.0
  - Multicore Manager (MCMgr) v4.1.5
  - RPMsg-Lite v5.1.2

[2.15.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.12.0
  - eRPC generator (erpcgen) v1.12.0
  - Multicore Manager (MCMgr) v4.1.5
  - RPMsg-Lite v5.1.1

[2.14.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.11.0
  - eRPC generator (erpcgen) v1.11.0
  - Multicore Manager (MCMgr) v4.1.4
  - RPMsg-Lite v5.1.0

[2.13.0_imxrt1180a0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.10.0
  - eRPC generator (erpcgen) v1.10.0
  - Multicore Manager (MCMgr) v4.1.3
  - RPMsg-Lite v5.0.0

[2.13.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.10.0
  - eRPC generator (erpcgen) v1.10.0
  - Multicore Manager (MCMgr) v4.1.3
  - RPMsg-Lite v5.0.0

[2.12.0_imx93]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.9.1
  - eRPC generator (erpcgen) v1.9.1
  - Multicore Manager (MCMgr) v4.1.2
  - RPMsg-Lite v4.0.1

[2.12.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.9.1
  - eRPC generator (erpcgen) v1.9.1
  - Multicore Manager (MCMgr) v4.1.2
  - RPMsg-Lite v4.0.0

[2.11.1]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.9.0
  - eRPC generator (erpcgen) v1.9.0
  - Multicore Manager (MCMgr) v4.1.1
  - RPMsg-Lite v3.2.1

[2.11.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.9.0
  - eRPC generator (erpcgen) v1.9.0
  - Multicore Manager (MCMgr) v4.1.1
  - RPMsg-Lite v3.2.0

[2.10.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.8.1
  - eRPC generator (erpcgen) v1.8.1
  - Multicore Manager (MCMgr) v4.1.1
  - RPMsg-Lite v3.1.2

[2.9.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.8.0
  - eRPC generator (erpcgen) v1.8.0
  - Multicore Manager (MCMgr) v4.1.1
  - RPMsg-Lite v3.1.1

[2.8.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.7.4
  - eRPC generator (erpcgen) v1.7.4
  - Multicore Manager (MCMgr) v4.1.0
  - RPMsg-Lite v3.1.0

[2.7.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.7.3
  - eRPC generator (erpcgen) v1.7.3
  - Multicore Manager (MCMgr) v4.1.0
  - RPMsg-Lite v3.0.0

[2.6.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.7.2
  - eRPC generator (erpcgen) v1.7.2
  - Multicore Manager (MCMgr) v4.0.3
  - RPMsg-Lite v2.2.0

[2.5.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.7.1
  - eRPC generator (erpcgen) v1.7.1
  - Multicore Manager (MCMgr) v4.0.2
  - RPMsg-Lite v2.0.2

[2.4.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.7.0
  - eRPC generator (erpcgen) v1.7.0
  - Multicore Manager (MCMgr) v4.0.1
  - RPMsg-Lite v2.0.1

[2.3.1]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.6.0
  - eRPC generator (erpcgen) v1.6.0
  - Multicore Manager (MCMgr) v4.0.0
  - RPMsg-Lite v1.2.0

[2.3.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.5.0
  - eRPC generator (erpcgen) v1.5.0
  - Multicore Manager (MCMgr) v3.0.0
  - RPMsg-Lite v1.2.0

[2.2.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.4.0
  - eRPC generator (erpcgen) v1.4.0
  - Multicore Manager (MCMgr) v2.0.1
  - RPMsg-Lite v1.1.0

[2.1.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.3.0
  - eRPC generator (erpcgen) v1.3.0

[2.0.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.2.0
  - eRPC generator (erpcgen) v1.2.0
  - Multicore Manager (MCMgr) v2.0.0
  - RPMsg-Lite v1.0.0

[1.1.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.1.0
  - Multicore Manager (MCMgr) v1.1.0
  - Open-AMP / RPMsg based on SHA1 ID 44b5f3c0a6458f3cf80 rev01

[1.0.0]

- Multicore SDK component versions:
  - embedded Remote Procedure Call (eRPC) v1.0.0
  - Multicore Manager (MCMgr) v1.0.0
  - Open-AMP / RPMsg based on SHA1 ID 44b5f3c0a6458f3cf80 rev00

Multicore SDK Components

RPMSG-Lite

MCUXpresso SDK : mcuxsdk-middleware-rpmsg-lite

Overview This repository is for MCUXpresso SDK RPMSG-Lite middleware delivery and it contains RPMSG-Lite component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk for the complete delivery of MCUXpresso SDK to be able to build and run RPMSG-Lite examples that are based on mcux-sdk-middleware-rpmsg-lite component.

Documentation Overall details can be reviewed here: MCUXpresso SDK Online Documentation

Visit RPMSG-Lite - Documentation to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution We welcome and encourage the community to submit patches directly to the rpmsg-lite project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

RPMSG-Lite This documentation describes the RPMsg-Lite component, which is a lightweight implementation of the Remote Processor Messaging (RPMsg) protocol. The RPMsg protocol defines a standardized binary interface used to communicate between multiple cores in a heterogeneous multicore system.

Compared to the RPMsg implementation of the Open Asymmetric Multi Processing (OpenAMP) framework (https://github.com/OpenAMP/open-amp), the RPMsg-Lite offers a code size reduction, API simplification, and improved modularity. On smaller Cortex-M0+ based systems, it is recommended to use RPMsg-Lite.

The RPMsg-Lite is an open-source component developed by NXP Semiconductors and released under the BSD-compatible license.

For Further documentation, please look at doxygen documentation at: https://nxp-mcuxpresso.github.io/rpmsg-lite/

Motivation to create RPMsg-Lite There are multiple reasons why RPMsg-Lite was developed. One reason is the need for the small footprint of the RPMsg protocol-compatible communication component, another reason is the simplification of extensive API of OpenAMP RPMsg implementation.

RPMsg protocol was not documented, and its only definition was given by the Linux Kernel and legacy OpenAMP implementations. This has changed with [1] which is a standardization protocol allowing multiple different implementations to coexist and still be mutually compatible.

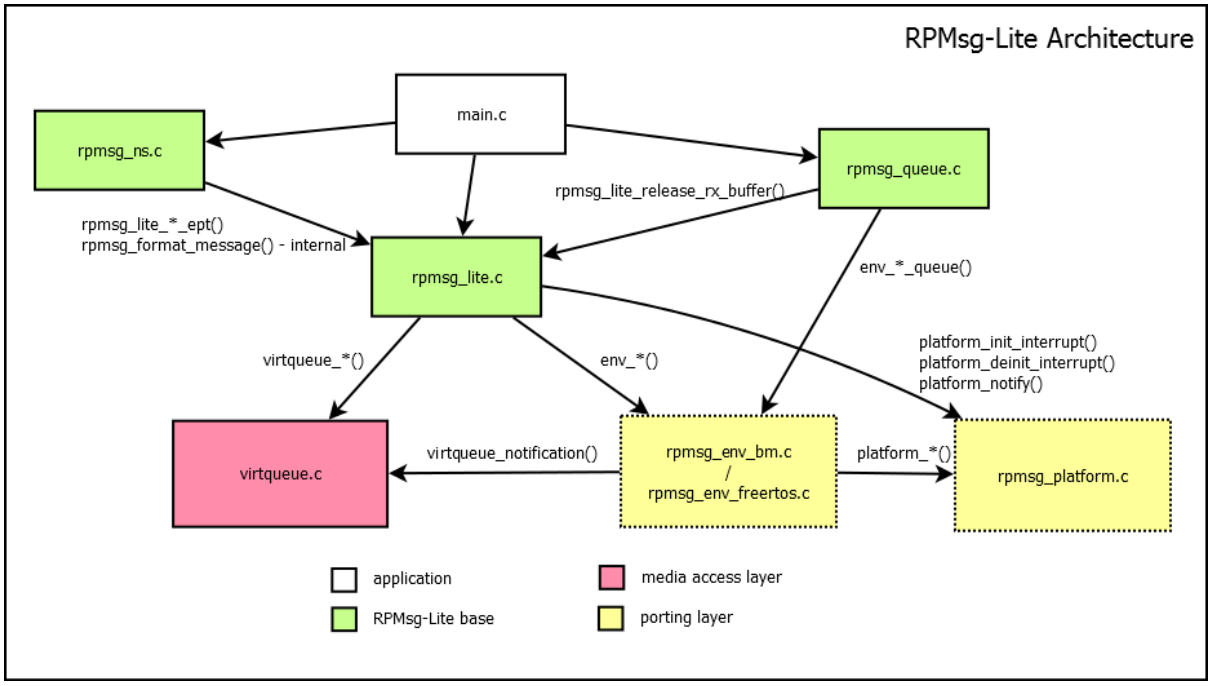
Small MCU-based systems often do not implement dynamic memory allocation. The creation of static API in RPMsg-Lite enables another reduction of resource usage. Not only does the dynamic allocation adds another 5 KB of code size, but also communication is slower and less deterministic, which is a property introduced by dynamic memory. The following table shows some rough comparison data between the OpenAMP RPMsg implementation and new RPMsg-Lite implementation:

Component / Configuration	Flash [B]	RAM [B]
OpenAMP RPMsg / Release (reference)	5547	456 + dynamic
RPMsg-Lite / Dynamic API, Release	3462	56 + dynamic
Relative Difference [%]	~62.4%	~12.3%
RPMsg-Lite / Static API (no malloc), Release	2926	352
Relative Difference [%]	~52.7%	~77.2%

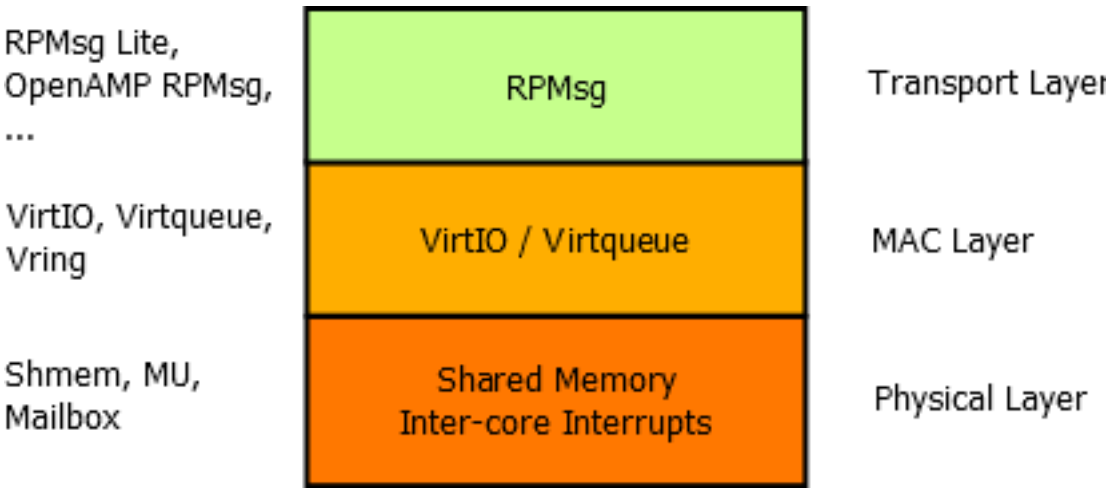
Implementation The implementation of RPMsg-Lite can be divided into three subcomponents, from which two are optional. The core component is situated in rpmsg_lite.c. Two optional components are used to implement a blocking receive API (in rpmsg_queue.c) and dynamic “named” endpoint creation and deletion announcement service (in rpmsg_ns.c).

The actual “media access” layer is implemented in virtqueue.c, which is one of the few files shared with the OpenAMP implementation. This layer mainly defines the shared memory model, and internally defines used components such as vring or virtqueue.

The porting layer is split into two sub-layers: the environment layer and the platform layer. The first sublayer is to be implemented separately for each environment. (The bare metal environment already exists and is implemented in rpmsg_env_bm.c, and the FreeRTOS environment is implemented in rpmsg_env_freertos.c etc.) Only the source file, which matches the used environment, is included in the target application project. The second sublayer is implemented in rpmsg_platform.c and defines low-level functions for interrupt enabling, disabling, and triggering mainly. The situation is described in the following figure:



RPMsg-Lite core sub-component This subcomponent implements a blocking send API and callback-based receive API. The RPMsg protocol is part of the transport layer. This is realized by using so-called endpoints. Each endpoint can be assigned a different receive callback function. However, it is important to notice that the callback is executed in an interrupt environment in current design. Therefore, certain actions like memory allocation are discouraged to execute in the callback. The following figure shows the role of RPMsg in an ISO/OSI-like layered model:



Queue sub-component (optional) This subcomponent is optional and requires implementation of the env_*_queue() functions in the environment porting layer. It uses a blocking receive API, which is common in RTOS-environments. It supports both copy and nocopy blocking receive functions.

Name Service sub-component (optional) This subcomponent is a minimum implementation of the name service which is present in the Linux Kernel implementation of RPMsg. It allows the communicating node both to send announcements about “named” endpoint (in other words, channel) creation or deletion and to receive these announcement taking any user-defined action

in an application callback. The endpoint address used to receive name service announcements is arbitrarily fixed to be 53 (0x35).

Usage The application should put the /rpmsg_lite/lib/include directory to the include path and in the application, include either the rpmsg_lite.h header file, or optionally also include the rpmsg_queue.h and/or rpmsg_ns.h files. Both porting sublayers should be provided for you by NXP, but if you plan to use your own RTOS, all you need to do is to implement your own environment layer (in other words, rpmsg_env_myrtos.c) and to include it in the project build.

The initialization of the stack is done by calling the rpmsg_lite_master_init() on the master side and the rpmsg_lite_remote_init() on the remote side. This initialization function must be called prior to any RPMsg-Lite API call. After the init, it is wise to create a communication endpoint, otherwise communication is not possible. This can be done by calling the rpmsg_lite_create_ept() function. It optionally accepts a last argument, where an internal context of the endpoint is created, just in case the RL_USE_STATIC_API option is set to 1. If not, the stack internally calls env_alloc() to allocate dynamic memory for it. In case a callback-based receiving is to be used, an ISR-callback is registered to each new endpoint with user-defined callback data pointer. If a blocking receive is desired (in case of RTOS environment), the rpmsg_queue_create() function must be called before calling rpmsg_lite_create_ept(). The queue handle is passed to the endpoint creation function as a callback data argument and the callback function is set to rpmsg_queue_rx_cb(). Then, it is possible to use rpmsg_queue_receive() function to listen on a queue object for incoming messages. The rpmsg_lite_send() function is used to send messages to the other side.

The RPMsg-Lite also implements no-copy mechanisms for both sending and receiving operations. These methods require specifics that have to be considered when used in an application.

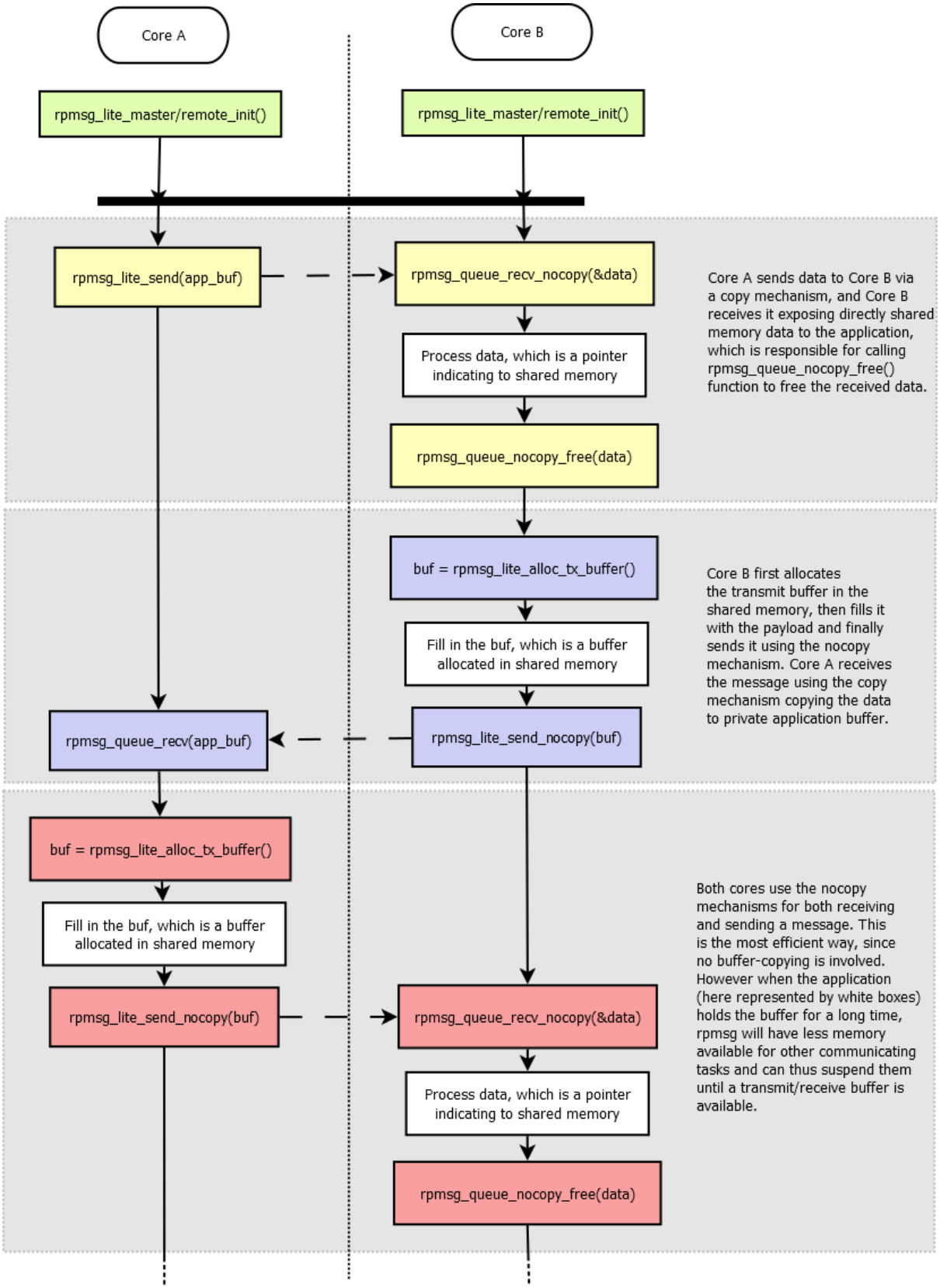
no-copy-send mechanism: This mechanism allows sending messages without the cost for copying data from the application buffer to the RPMsg/virtio buffer in the shared memory. The sequence of no-copy sending steps to be performed is as follows:

- Call the rpmsg_lite_alloc_tx_buffer() function to get the virtio buffer and provide the buffer pointer to the application.
- Fill the data to be sent into the pre-allocated virtio buffer. Ensure that the filled data does not exceed the buffer size (provided as the rpmsg_lite_alloc_tx_buffer() size output parameter).
- Call the rpmsg_lite_send_nocopy() function to send the message to the destination endpoint. Consider the cache functionality and the virtio buffer alignment. See the rpmsg_lite_send_nocopy() function description below.

no-copy-receive mechanism: This mechanism allows reading messages without the cost for copying data from the virtio buffer in the shared memory to the application buffer. The sequence of no-copy receiving steps to be performed is as follows:

- Call the rpmsg_queue_recv_nocopy() function to get the virtio buffer pointer to the received data.
- Read received data directly from the shared memory.
- Call the rpmsg_queue_nocopy_free() function to release the virtio buffer and to make it available for the next data transfer.

The user is responsible for destroying any RPMsg-Lite objects he has created in case of deinitialization. In order to do this, the function rpmsg_queue_destroy() is used to destroy a queue, rpmsg_lite_destroy_ept() is used to destroy an endpoint and finally, rpmsg_lite_deinit() is used to deinitialize the RPMsg-Lite intercore communication stack. Deinitialize all endpoints using a queue before deinitializing the queue. Otherwise, you are actively invalidating the used queue handle, which is not allowed. RPMsg-Lite does not check this internally, since its main aim is to be lightweight.



Examples RPMsg_Lite multicore examples are part of NXP MCUXpressoSDK packages. Visit https://mcuxpresso.nxp.com to configure, build and download these packages. To get the board list with multicore support (RPMsg_Lite included) use filtering based on Middleware and search for 'multicore' string. Once the selected package with the multicore middleware is downloaded,

see

<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples for RPMsg_Lite multicore examples with 'rpmsg_lite_' name prefix.

Another way of getting NXP MCUXpressoSDK RPMsg_Lite multicore examples is using the mcuxsdk-manifests Github repo. Follow the description how to use the West tool to clone and update the mcuxsdk-manifests repo in readme section. Once done the armgcc rpmsg_lite examples can be found in

mcuxsdk/examples/_<board_name>/multicore_examples

You can use the evkmimxrt1170 as the board_name for instance. Similar to MCUXpressoSDK packages the RPMsg_Lite examples use the 'rpmsg_lite_' name prefix.

Notes

Environment layers implementation Several environment layers are provided in lib/rpmsg_lite/porting/environment folder. Not all of them are fully tested however. Here is the list of environment layers that passed testing:

- rpmsg_env_bm.c
- rpmsg_env_freertos.c
- rpmsg_env_xos.c
- rpmsg_env_threadx.c

The rest of environment layers has been created and used in some experimental projects, it has been running well at the time of creation but due to the lack of unit testing there is no guarantee it is still fully functional.

Shared memory configuration It is important to correctly initialize/configure the shared memory for data exchange in the application. The shared memory must be accessible from both the master and the remote core and it needs to be configured as Non-Cacheable memory. Dedicated shared memory section in liker file is also a good practise, it is recommended to use linker files from MCUXpressSDK packages for NXP devices based applications. It needs to be ensured no other application part/component is unintentionally accessing this part of memory.

Configuration options The RPMsg-Lite can be configured at the compile time. The default configuration is defined in the rpmsg_default_config.h header file. This configuration can be customized by the user by including rpmsg_config.h file with custom settings. The following table summarizes all possible RPMsg-Lite configuration options.

Configuration option	Default value	Usage
RL_MS_PE	(1)	Delay in milliseconds used in non-blocking API functions for polling.
RL_BUFFE	(496)	Size of the buffer payload, it must be equal to (240, 496, 1008, ...) [2^n - 16]
RL_BUFFE	(2)	Number of the buffers, it must be power of two (2, 4, ...)
RL_API_H	(1)	Zero-copy API functions enabled/disabled.
RL_USE_S	(0)	Static API functions (no dynamic allocation) enabled/disabled.
RL_USE_D	(0)	Memory cache management of shared memory. Use in case of data cache is enabled for shared memory.
RL_CLEAF	(0)	Clearing used buffers before returning back to the pool of free buffers enabled/disabled.
RL_USE_M	(0)	When enabled IPC interrupts are managed by the Multicore Manager (IPC interrupts router), when disabled RPMsg-Lite manages IPC interrupts by itself.
RL_USE_E	(0)	When enabled the environment layer uses its own context. Required for some environments (QNX). The default value is 0 (no context, saves some RAM).
RL_DEBU(	(0)	When enabled buffer pointers passed to rpmsg_lite_send_nocopy() and rpmsg_lite_release_rx_buffer() functions (enabled by RL_API_HAS_ZEROCOPY config) are checked to avoid passing invalid buffer pointer. The default value is 0 (disabled). Do not use in RPMsg-Lite to Linux configuration.
RL_ALLO\	(0)	When enabled the opposite side is notified each time received buffers are consumed and put into the queue of available buffers. Enable this option in RPMsg-Lite to Linux configuration to allow unblocking of the Linux blocking send. The default value is 0 (RPMsg-Lite to RPMsg-Lite communication).
RL_ALLO\	(0)	It allows to define custom shared memory configuration and replacing the shared memory related global settings from rpmsg_config.h This is useful when multiple instances are running in parallel but different shared memory arrangement (vring size & alignment, buffers size & count) is required. The default value is 0 (all RPMsg_Lite instances use the same shared memory arrangement as defined by common config macros).
RL_ASSER	see rpmsg	Assert implementation.

How to format rpmsg-lite code To format code, use the application developed by Google, named *clang-format*. This tool is part of the llvm project. Currently, the clang-format 10.0.0 version is used for rpmsg-lite. The set of style settings used for clang-format is defined in the .clang-format file, placed in a root of the rpmsg-lite directory where Python script run_clang_format.py can be executed. This script executes the application named *clang-format.exe*. You need to have the path of this application in the OS's environment path, or you need to change the script.

References

[1] M. Novak, M. Cingel, Lockless Shared Memory Based Multicore Communication Protocol

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Changelog RPMSG-Lite All notable changes to this project will be documented in this file.

The format is based on Keep a Changelog, and this project adheres to Semantic Versioning.

v5.2.0

Added

- Add MCXL20 porting layer and unit testing
- New utility macro RL_CALCULATE_BUFFER_COUNT_DOWN_SAFE to safely determine maximum buffer count within shared memory while preventing integer underflow.
- RT700 platform add support for MCMGR in DSPs

Changed

- Change rpmsg_platform.c to support new MCMGR API
- Improved input validation in initialization functions to properly handle insufficient memory size conditions.
- Refactored repeated buffer count calculation pattern for better code maintainability.
- To make sure that remote has already registered IRQ there is required App level IPC mechanism to notify master about it

Fixed

- Fixed env_wait_for_link_up function to handle timeout in link state checks for baremetal and qnx environment, RL_BLOCK mode can be used to wait indefinitely.
- Fixed CERT-C INT31-C violation by adding compile-time check to ensure RL_PLATFORM_HIGHEST_LINK_ID remains within safe range for 16-bit casting in virtqueue ID creation.
- Fixed CERT-C INT30-C violations by adding protection against unsigned integer underflow in shared memory calculations, specifically in shmem_length - (uint32_t)RL_VRING_OVERHEAD and shmem_length - 2U * shmem_config.vring_size expressions.
- Fixed CERT INT31-C violation in platform_interrupt_disable() and similar functions by replacing unsafe cast from uint32_t to int32_t with a return of 0 constant.
- Fixed unsigned integer underflow in rpmsg_lite_alloc_tx_buffer() where subtracting header size from buffer size could wrap around if buffer was too small, potentially leading to incorrect buffer sizing.
- Fixed CERT-C INT31-C violation in rpmsg_lite.c where size parameter was cast from uint32_t to uint16_t without proper validation.
  - Applied consistent masking approach to both size and flags parameters: (uint16_t)(value & 0xFFFFU).
  - This fix prevents potential data loss when size values exceed 65535.
- Fixed CERT INT31-C violation in env_memset functions by explicitly converting int32_t values to unsigned char using bit masking. This prevents potential data loss or misinterpretation when passing values outside the unsigned char range (0-255) to the standard memset() function.
- Fixed CERT-C INT31-C violations in RPMsg-Lite environment porting: Added validation checks for signed-to-unsigned integer conversions to prevent data loss and misinterpretation.
  - rpmsg_env_freertos.c: Added validation before converting int32_t to UBaseType_t.
  - rpmsg_env_qnx.c: Fixed format string and added validation before assigning to mqstat fields.

  - rpmsg_env_threadx.c: Added validation to prevent integer overflow and negative values.
  - rpmsg_env_xos.c: Added range checking before casting to uint16_t.
  - rpmsg_env_zephyr.c: Added validation before passing values to k_msgq_init.
- Fixed a CERT INT31-C compliance issue in env_get_current_queue_size() function where an unsigned queue count was cast to a signed int32_t without proper validation, which could lead to lost or misinterpreted data if queue size exceeded INT32_MAX.
- Fixed CERT INT31-C violation in rpmsg_platform.c where memcmp() return value (signed int) was compared with unsigned constant without proper type handling.
- Fixed CERT INT31-C violation in rpmsg_platform.c where casting from uint32_t to uint16_t could potentially result in data loss. Changed length variable type from uint16_t to uint32_t to properly handle memory address differences without truncation.
- Fixed potential integer overflow in env_sleep_msec() function in ThreadX environment implementation by rearranging calculation order in the sleep duration formula.
- Fixed CERT-C INT31-C violation in RPMsg-Lite where bitwise NOT operations on integer constants were performed in signed integer context before being cast to unsigned. This could potentially lead to misinterpreted data on imx943 platform.
- Added RL_MAX_BUFFER_COUNT (32768U) and RL_MAX_VRING_ALIGN (65536U) limit to ensure alignment values cannot contribute to integer overflow
- Fixed CERT INT31-C violation in vring_need_event(), added cast to uint16_t for each operand.

v5.1.4 - 27-Mar-2025

Added

- Add KW43B43 porting layer

Changed

- Doxygen bump to version 1.9.6

v5.1.3 - 13-Jan-2025

Added

- Memory cache management of shared memory. Enable with #define RL_USE_DCACHE (1) in rpmsg_config.h in case of data cache is used.
- Cmake/Kconfig support added.
- Porting layers for imx95, imxrt700, mcmxw71x, mcmxw72x, kw47b42 added.

v5.1.2 - 08-Jul-2024

Changed

- Zephyr-related changes.
- Minor Misra corrections.

v5.1.1 - 19-Jan-2024

Added

- Test suite provided.
- Zephyr support added.

Changed

- Minor changes in platform and env. layers, minor test code updates.

v5.1.0 - 02-Aug-2023

Added

- RPMsg-Lite: Added aarch64 support.

Changed

- RPMsg-Lite: Increased the queue size to (2 * RL_BUFFER_COUNT) to cover zero copy cases.
- Code formatting using LLVM16.

Fixed

- Resolved issues in ThreadX env. layer implementation.

v5.0.0 - 19-Jan-2023

Added

- Timeout parameter added to rpmsg_lite_wait_for_link_up API function.

Changed

- Improved debug check buffers implementation - instead of checking the pointer fits into shared memory check the presence in the VirtIO ring descriptors list.
- VRING_SIZE is set based on number of used buffers now (as calculated in vring_init) - updated for all platforms that are not communicating to Linux rpmsg counterpart.

Fixed

- Fixed wrong RL_VRING_OVERHEAD macro comment in platform.h files
- Misra corrections.

v4.0.0 - 20-Jun-2022

Added

- Added support for custom shared memory arrangement per the RPMsg_Lite instance.
- Introduced new rpmsg_lite_wait_for_link_up() API function - this allows to avoid using busy loops in rtos environments, GitHub PR #21.

Changed

- Adjusted rpmsg_lite_is_link_up() to return RL_TRUE/RL_FALSE.

v3.2.0 - 17-Jan-2022

Added

- Added support for i.MX8 MP multicore platform.

Changed

- Improved static allocations - allow OS-specific objects being allocated statically, GitHub PR #14.
- Aligned rpmsg_env_xos.c and some platform layers to latest static allocation support.

Fixed

- Minor Misra and typo corrections, GitHub PR #19, #20.

v3.1.2 - 16-Jul-2021

Added

- Addressed MISRA 21.6 rule violation in rpmsg_env.h (use SDK's PRINTF in MCUXpressoSDK examples, otherwise stdio printf is used).
- Added environment layers for XOS.
- Added support for i.MX RT500, i.MX RT1160 and i.MX RT1170 multicore platforms.

Fixed

- Fixed incorrect description of the rpmsg_lite_get_endpoint_from_addr function.

Changed

- Updated RL_BUFFER_COUNT documentation (issue #10).
- Updated imxrt600_hifi4 platform layer.

v3.1.1 - 15-Jan-2021

Added

- Introduced RL_ALLOW_CONSUMED_BUFFERS_NOTIFICATION config option to allow opposite side notification sending each time received buffers are consumed and put into the queue of available buffers.
- Added environment layers for Threadx.
- Added support for i.MX8QM multicore platform.

Changed

- Several MISRA C-2012 violations addressed.

v3.1.0 - 22-Jul-2020

Added

- Added support for several new multicore platforms.

Fixed

- MISRA C-2012 violations fixed (7.4).
- Fixed missing lock in rpmsg_lite_rx_callback() for QNX env.
- Correction of rpmsg_lite_instance structure members description.
- Address -Waddress-of-packed-member warnings in GCC9.

Changed

- Clang update to v10.0.0, code re-formatted.

v3.0.0 - 20-Dec-2019

Added

- Added support for several new multicore platforms.

Fixed

- MISRA C-2012 violations fixed, incl. data types consolidation.
- Code formatted.

v2.2.0 - 20-Mar-2019

Added

- Added configuration macro RL_DEBUG_CHECK_BUFFERS.
- Several MISRA violations fixed.
- Added environment layers for QNX and Zephyr.
- Allow environment context required for some environment (controlled by the RL_USE_ENVIRONMENT_CONTEXT configuration macro).
- Data types consolidation.

v1.1.0 - 28-Apr-2017

Added

- Supporting i.MX6SX and i.MX7D MPU platforms.
- Supporting LPC5411x MCU platform.
- Baremental and FreeRTOS support.
- Support of copy and zero-copy transfer.
- Support of static API (without dynamic allocations).

Multicore Manager

MCUXpresso SDK : mcuxsdk-middleware-mcmgr (Multicore Manager)

Overview This repository is for MCUXpresso SDK Multicore Manager middleware delivery and it contains Multicore Manager component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk for the complete delivery of MCUXpresso SDK to be able to build and run Multicore Manager examples that are based on mcux-sdk-middleware-mcmgr component.

Documentation Overall details can be reviewed here: MCUXpresso SDK Online Documentation

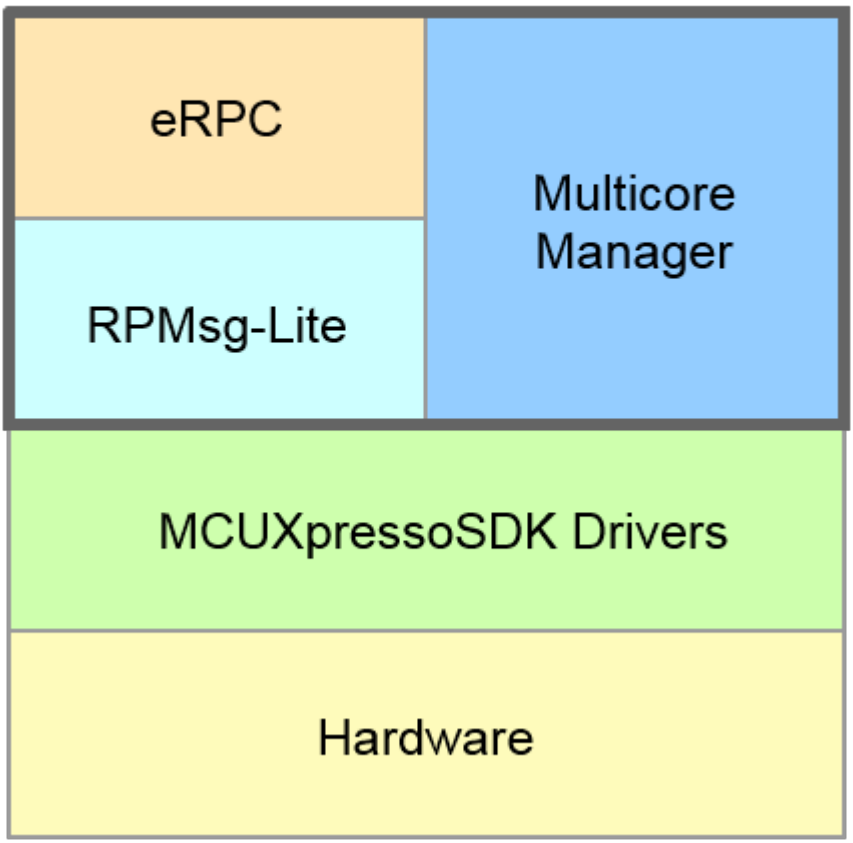
Visit Multicore Manager - Documentation to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution We welcome and encourage the community to submit patches directly to the mcmgr project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

Multicore Manager (MCMGR) The Multicore Manager (MCMGR) software library provides a number of services for multicore systems. This library is distributed as a part of the Multicore SDK (MCSDK). Together, the MCSDK and the MCUXpresso SDK (SDK) form a framework for development of software for NXP multicore devices.

The MCMGR component is located in the <MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr directory.



The Multicore Manager provides the following major functions:

- Maintains information about all cores in system.
- Secondary/auxiliary core(s) startup and shutdown.
- Remote core monitoring and event handling.

Usage of the MCMGR software component The main use case of MCMGR is the secondary/auxiliary core start. This functionality is performed by the public API function.

Example of MCMGR usage to start secondary core:

```
#include "mcmgr.h"

void main()
```

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```
{
    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* Initialize MCMGR, install generic event handlers */
    MCMGR_Init();

    /* Boot secondary core application from the CORE1_BOOT_ADDRESS, pass "1" as startup data,
    ↪starting synchronously. */
    MCMGR_StartCore(kMCMGR_Core1, CORE1_BOOT_ADDRESS, 1, kMCMGR_Start_Synchronous);
.
.
.
    /* Stop secondary core execution. */
    MCMGR_StopCore(kMCMGR_Core1);
}
```

Some platforms allow stopping and re-starting the secondary core application again, using the MCMGR_StopCore / MCMGR_StartCore API calls. It is necessary to ensure the initially loaded image is not corrupted before re-starting, especially if it deals with the RAM target. Cache coherence has to be considered/ensured as well.

Another important MCMGR feature is the ability for remote core monitoring and handling of events such as reset, exception, and application events. Application-specific callback functions for events are registered by the MCMGR_RegisterEvent() API. Triggering these events is done using the MCMGR_TriggerEvent() API. mcmgr_event_type_t enums all possible event types.

An example of MCMGR usage for remote core monitoring and event handling. Code for the primary side:

```
#include "mcmgr.h"

#define APP_RPMSG_READY_EVENT_DATA  (1)
#define APP_NUMBER_OF_CORES (2)
#define APP_SECONDARY_CORE kMCMGR_Core1

/* Callback function registered via the MCMGR_RegisterEvent() and triggered by MCMGR_TriggerEvent()
↪called on the secondary core side */
void RPMsgRemoteReadyEventHandler(mcmgr_core_t coreNum, uint16_t eventData, void *context)
{
    uint16_t *data = &((uint16_t *)context)[coreNum];

    *data = eventData;
}

void main()
{
    uint16_t RPMsgRemoteReadyEventData[NUMBER_OF_CORES] = {0};

    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* Initialize MCMGR, install generic event handlers */
    MCMGR_Init();

    /* Register the application event before starting the secondary core */
    MCMGR_RegisterEvent(kMCMGR_RemoteApplicationEvent, RPMsgRemoteReadyEventHandler, (void
```

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```
↪*)RPMsgRemoteReadyEventData);

    /* Boot secondary core application from the CORE1_BOOT_ADDRESS, pass rpmsg_lite_base address␣
↪as startup data, starting synchronously. */
    MCMGR_StartCore(APP_SECONDARY_CORE, CORE1_BOOT_ADDRESS, (uint32_t)rpmsg_lite_
↪base, kMCMGR_Start_Synchronous);

    /* Wait until the secondary core application signals the rpmsg remote has been initialized and is ready to␣
↪communicate. */
    while(APP_RPMSG_READY_EVENT_DATA != RPMsgRemoteReadyEventData[APP_SECONDARY_
↪CORE]) {};
.
.
.
}
```

Code for the secondary side:

```
#include "mcmgr.h"

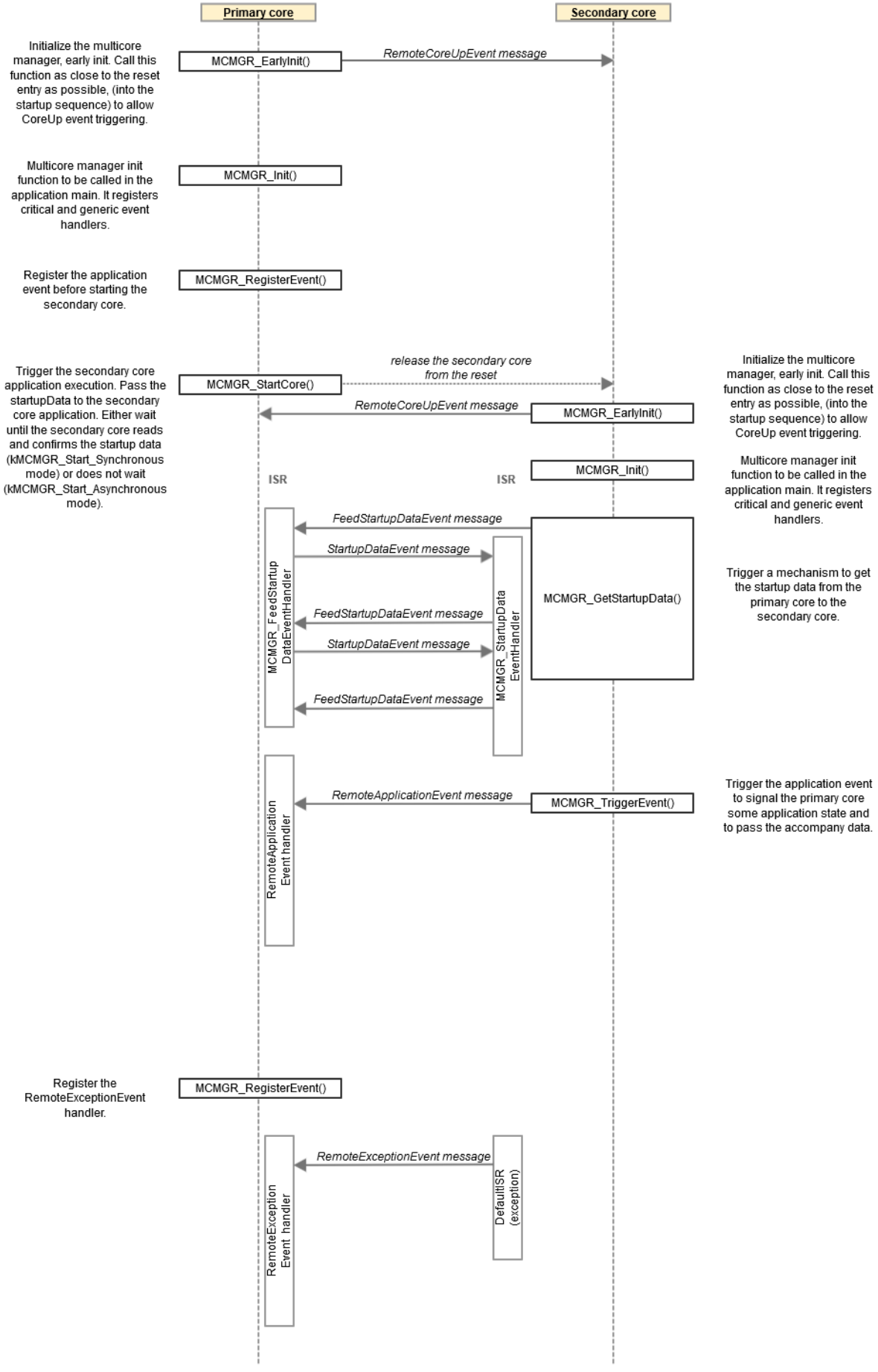
#define APP_RPMSG_READY_EVENT_DATA  (1)

void main()
{
    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* Initialize MCMGR, install generic event handlers */
    MCMGR_Init();
.
.
.

    /* Signal the to other core that we are ready by triggering the event and passing the APP_RPMSG_
↪READY_EVENT_DATA */
    MCMGR_TriggerEvent(kMCMGR_Core0, kMCMGR_RemoteApplicationEvent, APP_RPMSG_
↪READY_EVENT_DATA);
.
.
.
}
```

MCMGR Data Exchange Diagram The following picture shows how the handshakes are supposed to work between the two cores in the MCMGR software.


Primary core
Secondary core
Initialize the multicore manager, early init. Call this function as close to the reset entry as possible, (into the startup sequence) to allow CoreUp event triggering.
MCMGR_EarlyInit()
RemoteCoreUpEvent message
Multicore manager init function to be called in the application main. It registers critical and generic event handlers.
MCMGR_Init()
Register the application event before starting the secondary core.
MCMGR_RegisterEvent()
Trigger the secondary core application execution. Pass the startupData to the secondary core application. Either wait until the secondary core reads and confirms the startup data (kMCMGR_Start_Synchronous mode) or does not wait (kMCMGR_Start_Asynchronous mode).
MCMGR_StartCore()
release the secondary core from the reset
RemoteCoreUpEvent message
MCMGR_EarlyInit()
Initialize the multicore manager, early init. Call this function as close to the reset entry as possible, (into the startup sequence) to allow CoreUp event triggering.
MCMGR_Init()
Multicore manager init function to be called in the application main. It registers critical and generic event handlers.
ISR
ISR
FeedStartupDataEvent message
StartupDataEvent message
FeedStartupDataEvent message
StartupDataEvent message
FeedStartupDataEvent message
MCMGR_FeedStartup DataEventHandler
MCMGR_StartupData EventHandler
MCMGR_GetStartupData()
Trigger a mechanism to get the startup data from the primary core to the secondary core.
RemoteApplicationEvent message
MCMGR_TriggerEvent()
RemoteApplication Event handler
Trigger the application event to signal the primary core some application state and to pass the accompany data.
Register the RemoteExceptionEvent handler.
MCMGR_RegisterEvent()
RemoteExceptionEvent message
RemoteException Event handler
DefaultISR (exception)

Changelog Multicore Manager All notable changes to this project will be documented in this file.

The format is based on Keep a Changelog, and this project adheres to Semantic Versioning.

v5.0.0

Added

- Added MCMGR_BUSY_POLL_COUNT macro to prevent infinite polling loops in MCMGR operations.
- Implemented timeout mechanism for all polling loops in MCMGR code.
- Added support to handle more then two cores. Breaking API change by adding parameter coreNum specifying core number in functions bellow.
  - MCMGR_GetStartupData(uint32_t *startupData, mcmgr_core_t coreNum)
  - MCMGR_TriggerEvent(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
  - MCMGR_TriggerEventForce(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
  - typedef void (*mcmgr_event_callback_t)(uint16_t data, void *context, mcmgr_core_t coreNum);

  When registering the event with function MCMGR_RegisterEvent() user now needs to provide callbackData pointer to array of elements per every core in system (see README.md for example).In case of systems with only two cores the coreNum in callback can be ignored as events can arrive only from one core. Please see Porting guide for more details: Porting-GuideTo_v5.md
- Updated all porting files to support new MCMGR API.
- Added new platform specific include file mcmgr_platform.h. It will contain common platform specific macros that can be then used in mcmgr and application. e.g. platform core count MCMGR_CORECOUNT 4.
- Move all header files to new inc directory.
- Added new platform-specific include files inc/platform/<platform_name>/mcmgr_platform.h.

Added

- Add MCXL20 porting layer and unit testing

v4.1.7

Fixed

- mcmgr_stop_core_internal() function now returns kStatus_MCMGR_NotImplemented status code instead of kStatus_MCMGR_Success when device does not support stop of secondary core. Ports affected: kw32w1, kw45b41, kw45b42, mcxw716, mcxw727.

[v4.1.6]

Added

- Multicore Manager moved to standalone repository.
- Add porting layers for imxrt700, mcmxw727, kw47b42.
- New MCMGR_ProcessDeferredRxIsr() API added.

[v4.1.5]

Added

- Add notification into MCMGR_EarlyInit and mcmgr_early_init_internal functions to avoid using uninitialized data in their implementations.

[v4.1.4]

Fixed

- Avoid calling tx isr callbacks when respective Messaging Unit Transmit Interrupt Enable flag is not set in the CR/TCR register.
- Messaging Unit RX and status registers are cleared after the initialization.

[v4.1.3]

Added

- Add porting layers for imxrt1180.

Fixed

- mu_isr() updated to avoid calling tx isr callbacks when respective Transmit Interrupt Enable flag is not set in the CR/TCR register.
- mcmgr_mu_internal.c code adaptation to new supported SoCs.

[v4.1.2]

Fixed

- Update mcmgr_stop_core_internal() implementations to set core state to kMCMGR_ResetCoreState.

[v4.1.0]

Fixed

- Code adjustments to address MISRA C-2012 Rules

[v4.0.3]

Fixed

- Documentation updated to describe handshaking in a graphic form.
- Minor code adjustments based on static analysis tool findings

[v4.0.2]

Fixed

- Align porting layers to the updated MCUXpressoSDK feature files.

[v4.0.1]

Fixed

- Code formatting, removed unused code

[v4.0.0]

Added

- Add new MCMGR_TriggerEventForce() API.

[v3.0.0]

Removed

- Removed MCMGR_LoadApp(), MCMGR_MapAddress() and MCMGR_SignalReady()

Modified

- Modified MCMGR_GetStartupData()

Added

- Added MCMGR_EarlyInit(), MCMGR_RegisterEvent() and MCMGR_TriggerEvent()
- Added the ability for remote core monitoring and event handling

[v2.0.1]

Fixed

- Updated to be Misra compliant.

[v2.0.0]

Added

- Support for lpcxpresso54114 board.

[v1.1.0]

Fixed

- Ported to KSDK 2.0.0.

[v1.0.0]

Added

- Initial release.

eRPC

MCUXpresso SDK : mcuxsdk-middleware-erpc

Overview This repository is for MCUXpresso SDK eRPC middleware delivery and it contains eRPC component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk for the complete delivery of MCUXpresso SDK to be able to build and run eRPC examples that are based on mcux-sdk-middleware-erpc component.

Documentation Overall details can be reviewed here: MCUXpresso SDK Online Documentation

Visit eRPC - Documentation to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution We welcome and encourage the community to submit patches directly to the eRPC project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

---

eRPC

- *MCUXpresso SDK : mcuxsdk-middleware-erpc*
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  - *Documentation*
  - *Setup*
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    - *Make*
  - *Installing for Python*
- *Known issues and limitations*
- *Code providing*

About

eRPC (Embedded RPC) is an open source Remote Procedure Call (RPC) system for multichip embedded systems and heterogeneous multicore SoCs.

Unlike other modern RPC systems, such as the excellent Apache Thrift, eRPC distinguishes itself by being designed for tightly coupled systems, using plain C for remote functions, and having a small code size (<5kB). It is not intended for high performance distributed systems over a network.

eRPC does not force upon you any particular API style. It allows you to export existing C functions, without having to change their prototypes. (There are limits, of course.) And although the internal infrastructure is written in C++, most users will be able to use only the simple C setup APIs shown in the examples below.

A code generator tool called erpcgen is included. It accepts input IDL files, having an .erpc extension, that have definitions of your data types and remote interfaces, and generates the shim code that handles serialization and invocation. erpcgen can generate either C/C++ or Python code.

Example .erpc file:

```
// Define a data type.
enum LEDName { kRed, kGreen, kBlue }

// An interface is a logical grouping of functions.
interface IO {
    // Simple function declaration with an empty reply.
    set_led(LEDName whichLed, bool onOrOff) -> void
}
```

Client side usage:

```
void example_client(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_client_t client_manager;

    /* Init eRPC client infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    client_manager = erpc_client_init(transport, message_buffer_factory);

    /* init eRPC client IO service */
    initIO_client(client_manager);

    // Now we can call the remote function to turn on the green LED.
    set_led(kGreen, true);

    /* deinit objects */
    deinitIO_client();
    erpc_client_deinit(client_manager);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}
```

```
void example_client(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_client_t client_manager;

    /* Init eRPC client infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    client_manager = erpc_client_init(transport, message_buffer_factory);

    /* scope for client service */
    {
        /* init eRPC client IO service */
        IO_client client(client_manager);

        // Now we can call the remote function to turn on the green LED.
        client.set_led(kGreen, true);
    }

    /* deinit objects */
    erpc_client_deinit(client_manager);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}
```

Server side usage:

```
// Implement the remote function.
void set_led(LEDName whichLed, bool onOrOff) {
    // implementation goes here
}

void example_server(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_server_t server;
    erpc_service_t service = create_IO_service();
```

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```
    /* Init eRPC server infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    server = erpc_server_init(transport, message_buffer_factory);

    /* add custom service implementation to the server */
    erpc_add_service_to_server(server, service);

    // Run the server.
    erpc_server_run();

    /* deinit objects */
    destroy_IO_service(service);
    erpc_server_deinit(server);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}
```

```
// Implement the remote function.
class IO : public IO_interface
{
    /* eRPC call definition */
    void set_led(LEDName whichLed, bool onOrOff) override {
        // implementation goes here
    }
}

void example_server(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_server_t server;
    IO IOImpl;
    IO_service io(&IOImpl);

    /* Init eRPC server infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    server = erpc_server_init(transport, message_buffer_factory);

    /* add custom service implementation to the server */
    erpc_add_service_to_server(server, &io);

    /* poll for requests */
    erpc_status_t err = server.run();

    /* deinit objects */
    erpc_server_deinit(server);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}
```

A number of transports are supported, and new transport classes are easy to write.

Supported transports can be found in *erpc/erpc_c/transport* folder. E.g:

- CMSIS UART
- NXP Kinetis SPI and DSPI
- POSIX and Windows serial port
- TCP/IP (mostly for testing)

- NXP RPMsg-Lite / RPMsg TTY
- SPIdev Linux
- USB CDC
- NXP Messaging Unit

eRPC is available with an unrestrictive BSD 3-clause license. See the LICENSE file for the full license text.

Releases eRPC releases

Edge releases Edge releases can by found on eRPC CircleCI webpage. Choose build of interest, then platform target and choose ARTIFACTS tab. Here you can find binary application from chosen build.

Documentation Documentation is in the wiki section.

eRPC Infrastructure documentation

Examples *Example IDL* is available in the *examples/* folder.

Plenty of eRPC multicore and multiprocessor examples can be also found in NXP MCUXpressoSDK packages. Visit https://mcuxpresso.nxp.com to configure, build and download these packages.

To get the board list with multicore support (eRPC included) use filtering based on Middleware and search for 'multicore' string. Once the selected package with the multicore middleware is downloaded, see

<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples for eRPC multicore examples (RPMsg_Lite or Messaging Unit transports used) or

<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples for eRPC multiprocessor examples (UART or SPI transports used).

eRPC examples use the 'erpc_' name prefix.

Another way of getting NXP MCUXpressoSDK eRPC multicore and multiprocessor examples is using the mcux-sdk Github repo. Follow the description how to use the West tool to clone and update the mcuxsdk repo in readme Overview section. Once done the armgcc eRPC examples can be found in

mcuxsdk/examples/<board_name>/multicore_examples or in

mcuxsdk/examples/<board_name>/multiprocessor_examples folders.

You can use the evkmimxrt1170 as the board_name for instance. Similar to MCUXpressoSDK packages the eRPC examples use the 'erpc_' name prefix.

References This section provides links to interesting erpc-based projects, articles, blogs or guides:

- erpc (EmbeddedRPC) getting started notes
- ERPC Linux Local Environment Construction and Use
- The New Wio Terminal eRPC Firmware

Directories *doc* - Documentation.

doxygen - Configuration and support files for running Doxygen over the eRPC C++ infrastructure and erpcgen code.

erpc_c - Holds C/C++ infrastructure for eRPC. This is the code you will include in your application.

erpc_python - Holds Python version of the eRPC infrastructure.

erpcgen - Holds source code for erpcgen and makefiles or project files to build erpcgen on Windows, Linux, and OS X.

erpcsniffer - Holds source code for erpcsniffer application.

examples - Several example IDL files.

mk - Contains common makefiles for building eRPC components.

test - Client/server tests. These tests verify the entire communications path from client to server and back.

utilities - Holds utilities which bring additional benefit to eRPC apps developers.

Building and installing These build instructions apply to host PCs and embedded Linux. For bare metal or RTOS embedded environments, you should copy the *erpc_c* directory into your application sources.

CMake and KConfig build:

It builds a static library of the eRPC C/C++ infrastructure, the erpcgen executable, and optionally the unit tests and examples.

CMake is compatible with gcc and clang. On Windows local MingGW downloaded by *script* can be used.

Make build:

It builds a static library of the eRPC C/C++ infrastructure, the erpcgen executable, and optionally the unit tests.

The makefiles are compatible with gcc or clang on Linux, OS X, and Cygwin. A Windows build of erpcgen using Visual Studio is also available in the *erpcgen/VisualStudio_v14* directory. There is also an Xcode project file in the *erpcgen* directory, which can be used to build erpcgen for OS X.

Requirements eRPC now support building **erpcgen**, **erpc_lib**, **tests** and **C examples** using CMake.

Requirements when using CMake:

- **CMake** (minimal version 3.20.0)
- Generator - **Make**, **Ninja**, ...
- **C/C++ compiler** - **GCC**, **CLANG**, ...
- **Binson** - https://www.gnu.org/software/bison/
- **Flex** - https://github.com/westes/flex/

Requirements when using Make:

- **Make**
- **C/C++ compiler** - **GCC**, **CLANG**, ...
- **Binson** - https://www.gnu.org/software/bison/
- **Flex** - https://github.com/westes/flex/

Windows Related steps to build **erpcgen** using **Visual Studio** are described in erpcgen/VisualStudio_v14/readme_erpcgen.txt.

To install MinGW, Bison, Flex locally on Windows:

```
./install_dependencies.ps1
* ```

#### Linux

```bash
./install_dependencies.sh
```

Mandatory for case, when build for different architecture is needed

- gcc-multilib, g++-multilib

Mac OS X

```
./install_dependencies.sh
```

Building

CMake and KConfig eRPC use CMake and KConfig to configurate and build eRPC related targets. KConfig can be edited by *prj.conf* or *menuconfig* when building.

Generate project, config and build. In *erpc/* execute:

```
cmake -B ./build # in erpc/build generate cmake project
cmake --build ./build --target menuconfig # Build menuconfig and configurate erpcgen, erpc_lib, tests and␣
↪examples
cmake --build ./build # Build all selected target from prj.conf/menuconfig
```

**CMake will use the system's default compilers and generator

If you want to use Windows and locally installed MinGW, use *CMake preset* :

```
cmake --preset mingw64 # Generate project in ./build using mingw64's make and compilers
cmake --build ./build --target menuconfig # Build menuconfig and configurate erpcgen, erpc_lib, tests and␣
↪examples
cmake --build ./build # Build all selected target from prj.conf/menuconfig
```

Make To build the library and erpcgen, run from the repo root directory:

```
make
```

To install the library, erpcgen, and include files, run:

```
make install
```

You may need to sudo the make install.

By default this will install into /usr/local. If you want to install elsewhere, set the PREFIX environment variable. Example for installing into /opt:

```
make install PREFIX=/opt
```

List of top level Makefile targets:

- erpc: build the liberpc.a static library
```

- erpcgen: build the erpcgen tool
- erpcsniffer: build the sniffer tool
- test: build the unit tests under the *test* directory
- all: build all of the above
- install: install liberpc.a, erpcgen, and include files

eRPC code is validated with respect to the C++ 11 standard.

Installing for Python To install the Python infrastructure for eRPC see instructions in the *erpc python readme*.

Known issues and limitations

- Static allocations controlled by the ERPC_ALLOCATION_POLICY config macro are not fully supported yet, i.e. not all erpc objects can be allocated statically now. It deals with the ongoing process and the full static allocations support will be added in the future.

Code providing Repository on Github contains two main branches: **main** and **develop**. Code is developed on **develop** branch. Release version is created via merging **develop** branch into **main** branch.

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eRPC Getting Started

Overview This *Getting Started User Guide* shows software developers how to use Remote Procedure Calls (RPC) in embedded multicore microcontrollers (eRPC).

The eRPC documentation is located in the *<MCUXpressoSDK_install_dir>/ middleware/multicore/erpc/doc* folder.

Create an eRPC application This section describes a generic way to create a client/server eRPC application:

1. **Design the eRPC application:** Decide which data types are sent between applications, and define functions that send/receive this data.
2. **Create the IDL file:** The IDL file contains information about data types and functions used in an eRPC application, and is written in the IDL language.
3. **Use the eRPC generator tool:** This tool takes an IDL file and generates the shim code for the client and the server-side applications.
4. **Create an eRPC application:**
    1. Create two projects, where one project is for the client side (primary core) and the other project is for the server side (secondary core).
    2. Add generated files for the client application to the client project, and add generated files for the server application to the server project.
    3. Add infrastructure files.

4. Add user code for client and server applications.
5. Set the client and server project options.

5. **Run the eRPC application:** Run both the server and the client applications. Make sure that the server has been run before the client request was sent.

A specific example follows in the next section.

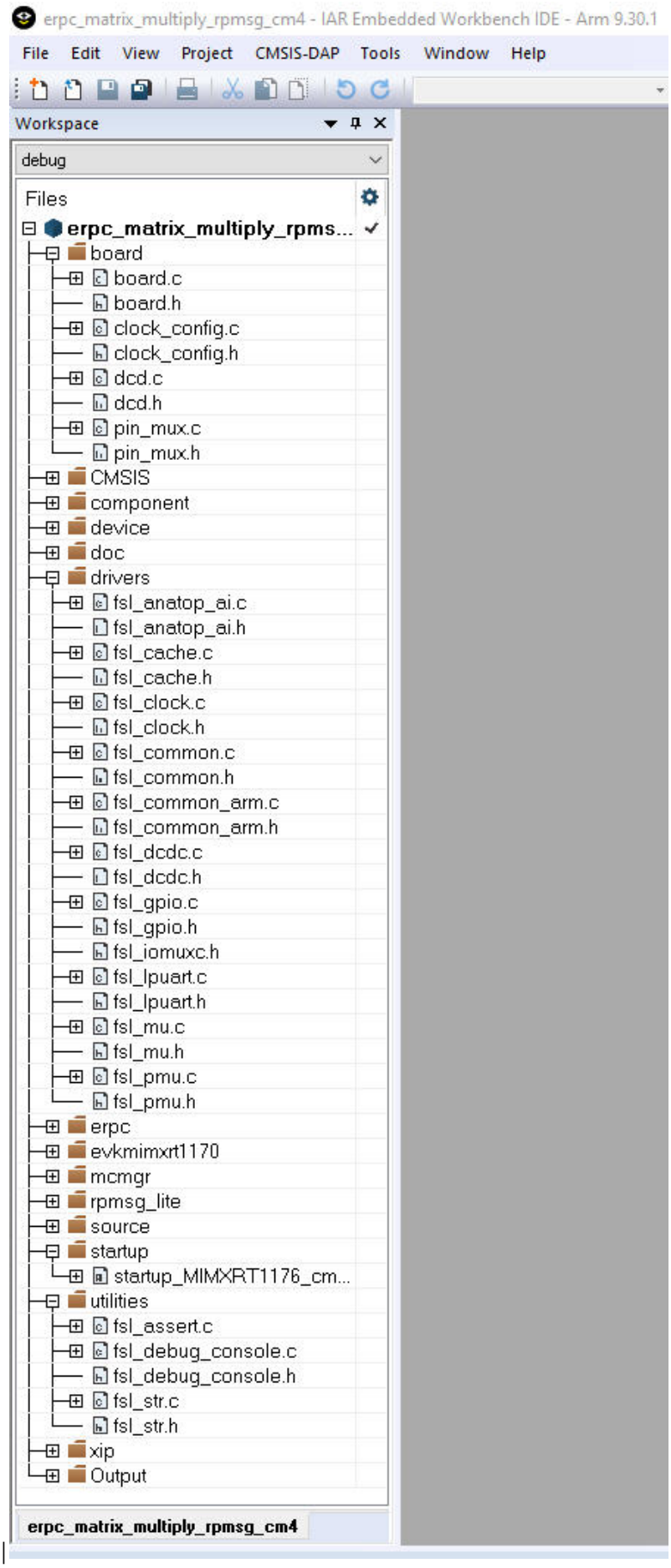
Multicore server application The "Matrix multiply" eRPC server project is located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4/iar

The project files for the eRPC server have the _cm4 suffix.

Server project basic source files The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in:

- *<MCUXpressoSDK_install_dir>/devices/<device>*
- *<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/*


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
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board
board.c
board.h
clock_config.c
clock_config.h
dcd.c
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fsl_anatop_ai.c
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fsl_common_arm.c
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fsl_dcdc.h
fsl_gpio.c
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fsl_iomuxc.h
fsl_lpuart.c
fsl_lpuart.h
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fsl_pmu.c
fsl_pmu.h
erpc
evkmimxrt1170
mcmgr
rpmsg_lite
source
startup
startup_MIMXRT1176_cm...
utilities
fsl_assert.c
fsl_debug_console.c
fsl_debug_console.h
fsl_str.c
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Output
erpc_matrix_multiply_rpmsg_cm4

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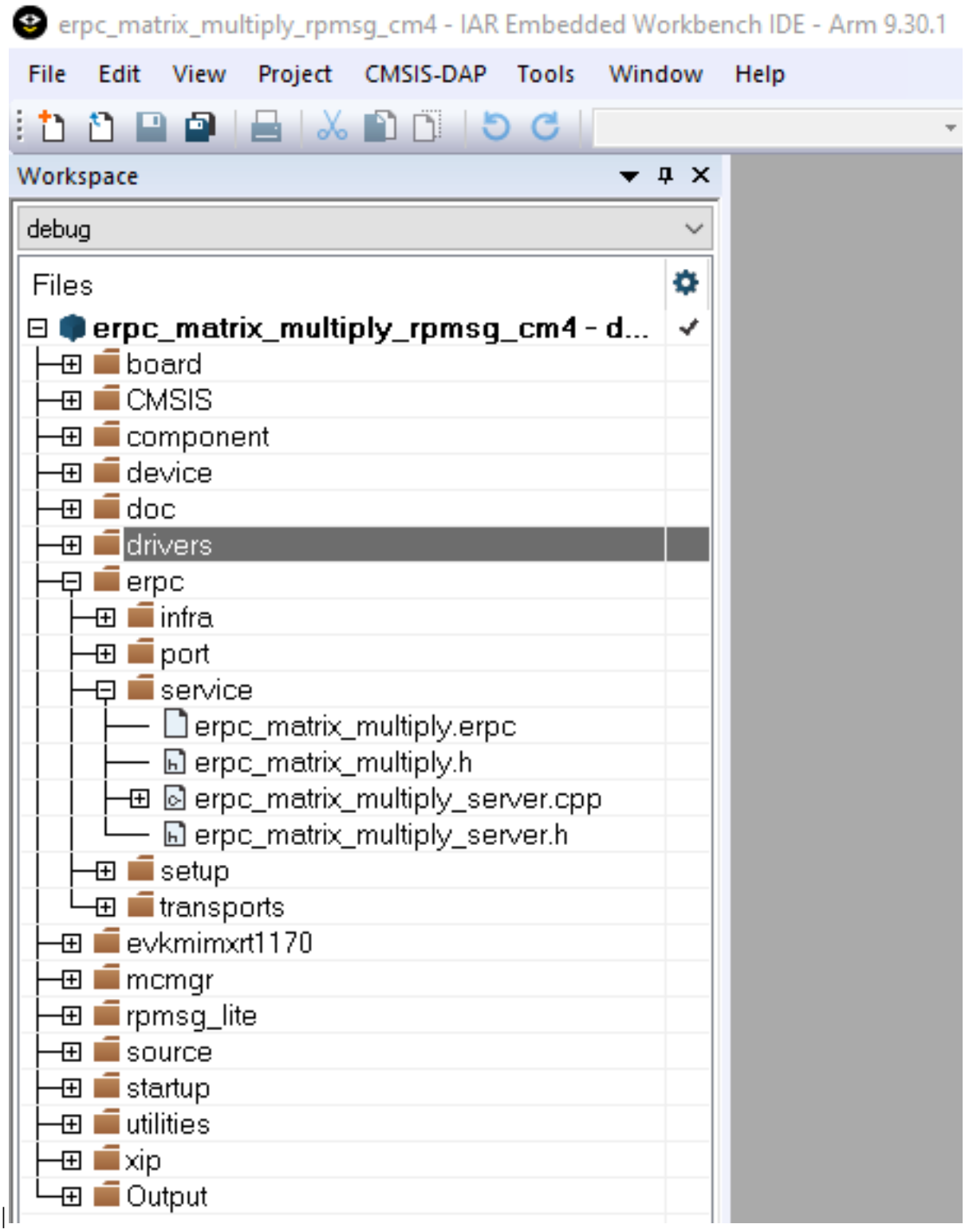
Parent topic: Multicore server application

Server related generated files The server-related generated files are:

- erpc_matric_multiply.h
- erpc_matrix_multiply_server.h
- erpc_matrix_multiply_server.cpp

The server-related generated files contain the shim code for functions and data types declared in the IDL file. These files also contain functions for the identification of client requested functions, data deserialization, calling requested function's implementations, and data serialization and return, if requested by the client. These shim code files can be found in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/s



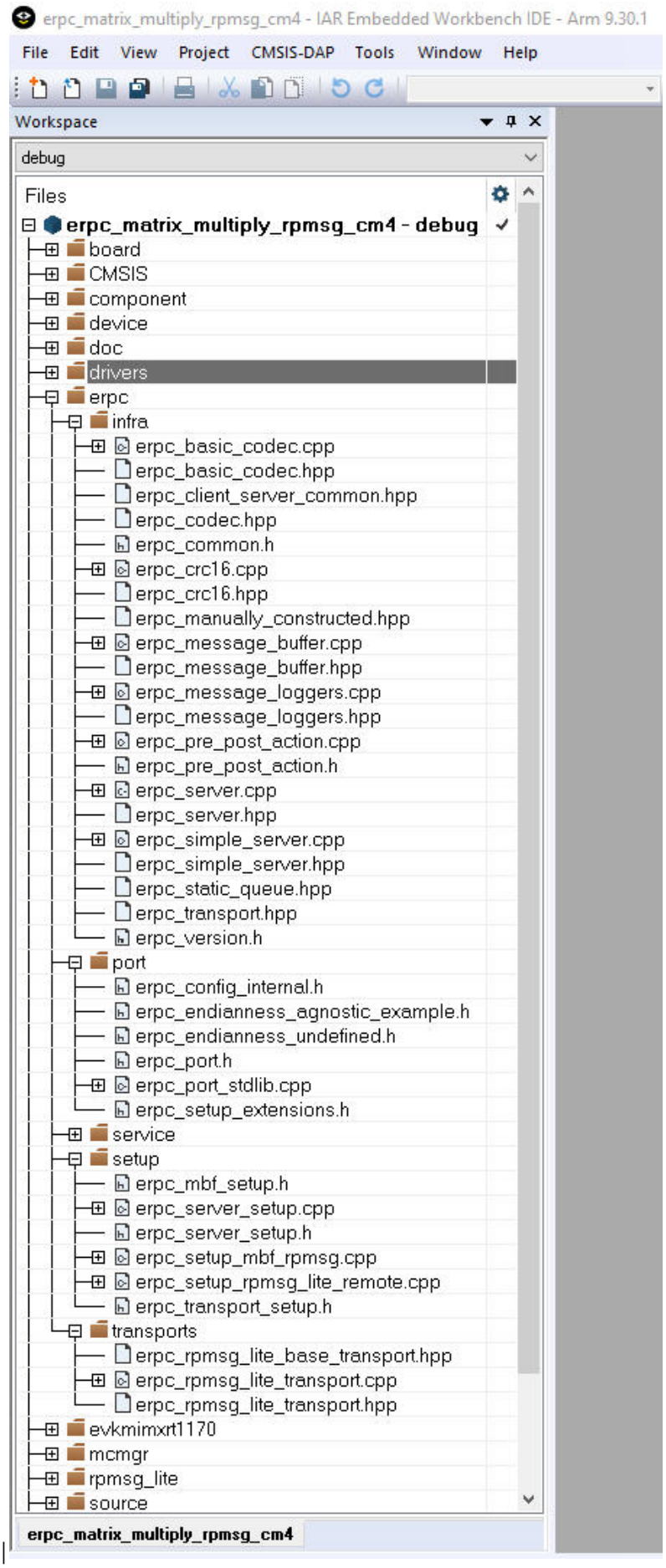
Parent topic: Multicore server application

Server infrastructure files The eRPC infrastructure files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c

The **erpc_c** folder contains files for creating eRPC client and server applications in the *C/C++* language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.
  - Four files, erpc_server.hpp, erpc_server.cpp, erpc_simple_server.hpp, and erpc_simple_server.cpp, are used for running the eRPC server on the server-side applications. The simple server is currently the only implementation of the server, and its role is to catch client requests, identify and call requested functions, and send data back when requested.
  - Three files (erpc_codec.hpp, erpc_basic_codec.hpp, and erpc_basic_codec.cpp) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
  - The erpc_common.hpp file is used for common eRPC definitions, typedefs, and enums.
  - The erpc_manually_constructed.hpp file is used for allocating static storage for the used objects.
  - Message buffer files are used for storing serialized data: erpc_message_buffer.h and erpc_message_buffer.cpp.
  - The erpc_transport.h file defines the abstract interface for transport layer.
- The **port** subfolder contains the eRPC porting layer to adapt to different environments.
  - erpc_port.h file contains definition of erpc_malloc() and erpc_free() functions.
  - erpc_port_stdlib.cpp file ensures adaptation to stdlib.
  - erpc_config_internal.h internal erpc configuration file.
- The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.
  - The erpc_server_setup.h and erpc_server_setup.cpp files needs to be added into the "Matrix multiply" example project to demonstrate the use of C-wrapped functions in this example.
  - The erpc_transport_setup.h and erpc_setup_rpmsg_lite_remote.cpp files needs to be added into the project in order to allow the C-wrapped function for transport layer setup.
  - The erpc_mbf_setup.h and erpc_setup_mbf_rpmsg.cpp files needs to be added into the project in order to allow message buffer factory usage.
- The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions in the setup folder.
  - RPMsg-Lite is used as the transport layer for the communication between cores, erpc_rpmsg_lite_base_transport.hpp, erpc_rpmsg_lite_transport.hpp, and erpc_rpmsg_lite_transport.cpp files need to be added into the server project.


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
File Edit View Project CMSIS-DAP Tools Window Help
Workspace
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Files
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CMSIS
component
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drivers
erpc
infra
erpc_basic_codec.cpp
erpc_basic_codec.hpp
erpc_client_server_common.hpp
erpc_codec.hpp
erpc_common.h
erpc_crc16.cpp
erpc_crc16.hpp
erpc_manually_constructed.hpp
erpc_message_buffer.cpp
erpc_message_buffer.hpp
erpc_message_loggers.cpp
erpc_message_loggers.hpp
erpc_pre_post_action.cpp
erpc_pre_post_action.h
erpc_server.cpp
erpc_server.hpp
erpc_simple_server.cpp
erpc_simple_server.hpp
erpc_static_queue.hpp
erpc_transport.hpp
erpc_version.h
port
erpc_config_internal.h
erpc_endianness_agnostic_example.h
erpc_endianness_undefined.h
erpc_port.h
erpc_port_stdlib.cpp
erpc_setup_extensions.h
service
setup
erpc_mbf_setup.h
erpc_server_setup.cpp
erpc_server_setup.h
erpc_setup_mbf_rpmsg.cpp
erpc_setup_rpmsg_lite_remote.cpp
erpc_transport_setup.h
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erpc_rpmsg_lite_base_transport.hpp
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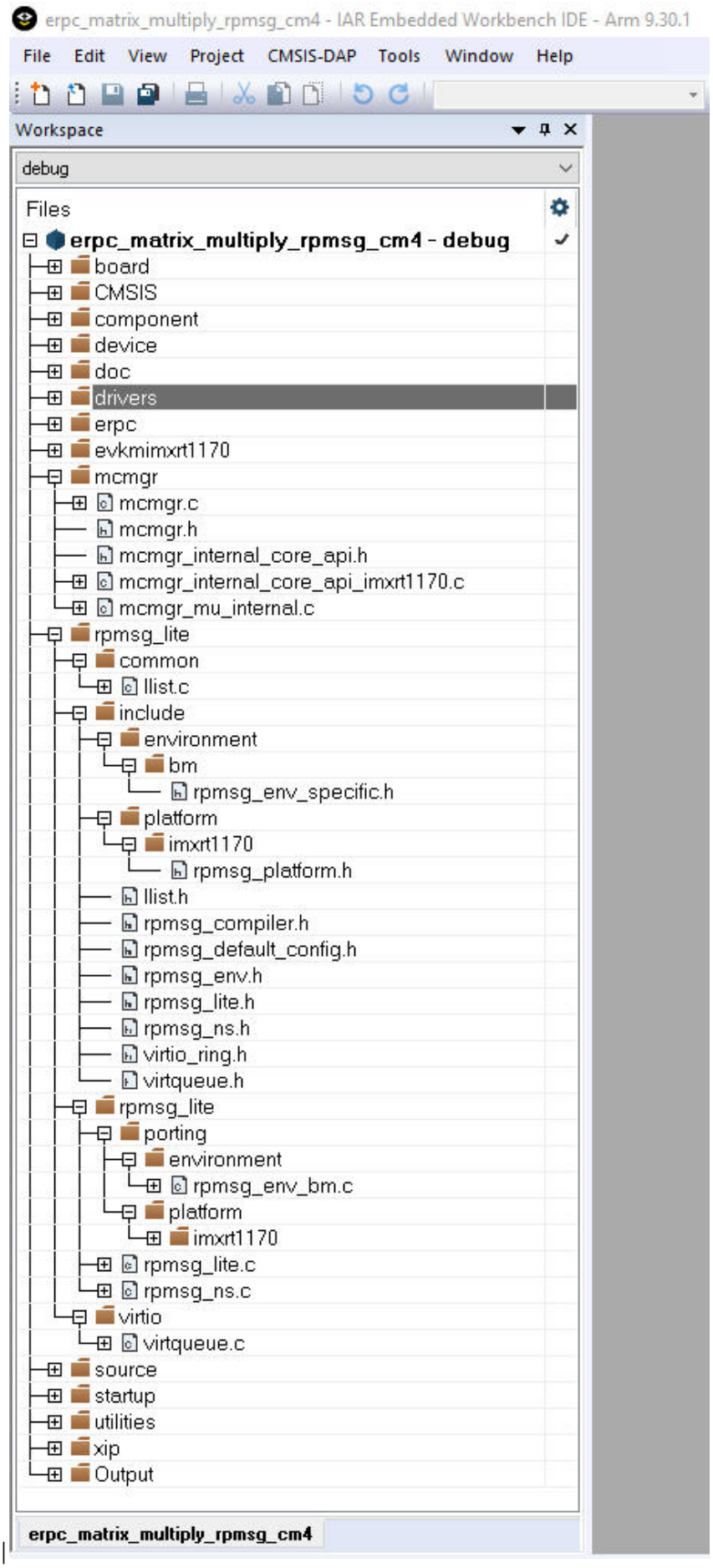
Parent topic: Multicore server application

Server multicore infrastructure files Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
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evkmimxrt1170
mcmgr
mcmgr.c
mcmgr.h
mcmgr_internal_core_api.h
mcmgr_internal_core_api_imxrt1170.c
mcmgr_mu_internal.c
rpmsg_lite
common
llist.c
include
environment
bm
rpmsg_env_specific.h
platform
imxrt1170
rpmsg_platform.h
llist.h
rpmsg_compiler.h
rpmsg_default_config.h
rpmsg_env.h
rpmsg_lite.h
rpmsg_ns.h
virtio_ring.h
virtqueue.h
rpmsg_lite
porting
environment
rpmsg_env_bm.c
platform
imxrt1170
rpmsg_lite.c
rpmsg_ns.c
virtio
virtqueue.c
source
startup
utilities
xip
Output
erpc_matrix_multiply_rpmsg_cm4

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Parent topic: Multicore server application

Server user code The server's user code is stored in the main_core1.c file, located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4

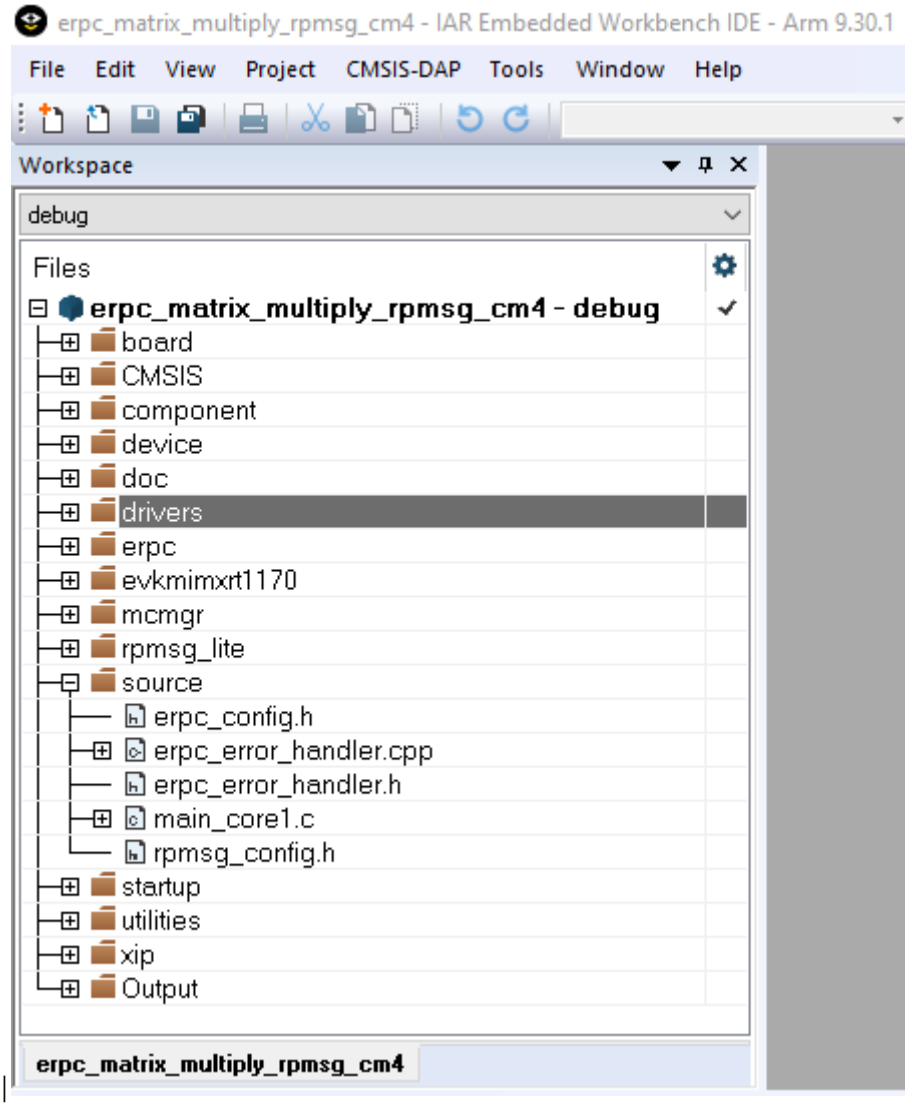
The main_core1.c file contains two functions:

- The **main()** function contains the code for the target board and eRPC server initialization. After the initialization, the matrix multiply service is added and the eRPC server waits for client's requests in the while loop.
- The **erpcMatrixMultiply()** function is the user implementation of the eRPC function defined in the IDL file.
- There is the possibility to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in the erpc_error_handler.h and erpc_error_handler.cpp files.

The eRPC-relevant code is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(const Matrix *matrix1, const Matrix *matrix2, Matrix *result_matrix)
{
  ...
}
int main()
{
  ...
  /* RPMsg-Lite transport layer initialization */
  erpc_transport_t transport;
  transport = erpc_transport_rpmsg_lite_remote_init(src, dst, (void*)startupData,
  ERPC_TRANSPORT_RPMSG_LITE_LINK_ID, SignalReady, NULL);
  ...
  /* MessageBufferFactory initialization */
  erpc_mbf_t message_buffer_factory;
  message_buffer_factory = erpc_mbf_rpmsg_init(transport);
  ...
  /* eRPC server side initialization */
  erpc_server_t server;
  server = erpc_server_init(transport, message_buffer_factory);
  ...
  /* Adding the service to the server */
  erpc_service_t service = create_MatrixMultiplyService_service();
  erpc_add_service_to_server(server, service);
  ...
  while (1)
  {
    /* Process eRPC requests */
    erpc_status_t status = erpc_server_poll(server);
    /* handle error status */
    if (status != kErpcStatus_Success)
    {
      /* print error description */
      erpc_error_handler(status, 0);
      ...
    }
    ...
  }
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg_config.h) and eRPC (erpc_config.h), located in the *<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg* folder.



Parent topic: Multicore server application

Parent topic:*Create an eRPC application*

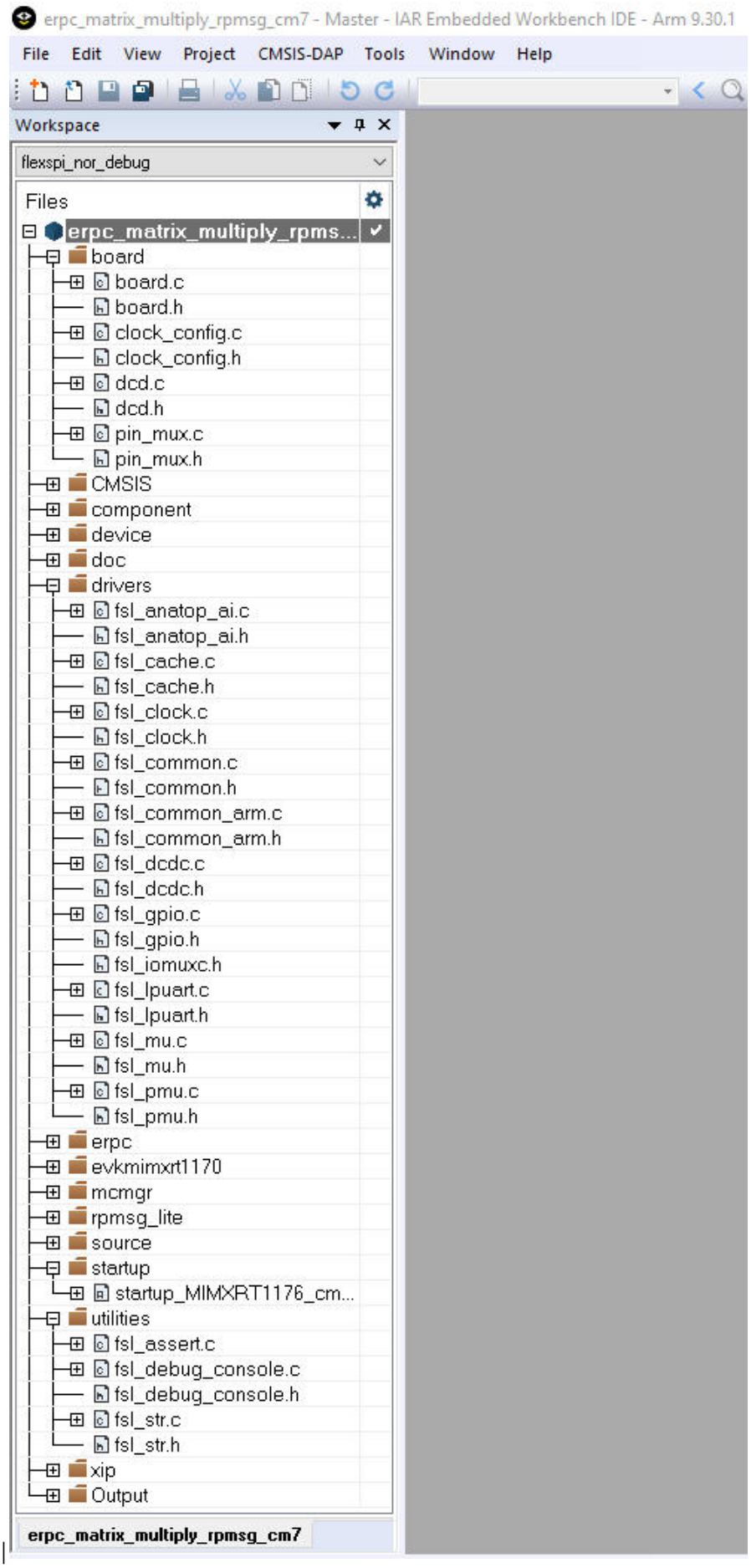
Multicore client application The "Matrix multiply" eRPC client project is located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm7/iar

Project files for the eRPC client have the _cm7 suffix.

Client project basic source files The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in the following folders:

- *<MCUXpressoSDK_install_dir>/devices/<device>*
- *<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/*


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
File Edit View Project CMSIS-DAP Tools Window Help
Workspace
flexspi_nor_debug
Files
erpc_matrix_multiply_rpms...
board
board.c
board.h
clock_config.c
clock_config.h
dcd.c
dcd.h
pin_mux.c
pin_mux.h
CMSIS
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device
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drivers
fsl_anatop_ai.c
fsl_anatop_ai.h
fsl_cache.c
fsl_cache.h
fsl_clock.c
fsl_clock.h
fsl_common.c
fsl_common.h
fsl_common_arm.c
fsl_common_arm.h
fsl_dcdc.c
fsl_dcdc.h
fsl_gpio.c
fsl_gpio.h
fsl_iomuxc.h
fsl_lpuart.c
fsl_lpuart.h
fsl_mu.c
fsl_mu.h
fsl_pmu.c
fsl_pmu.h
erpc
evkmimxrt1170
mcmgr
rpmsg_lite
source
startup
startup_MIMXRT1176_cm...
utilities
fsl_assert.c
fsl_debug_console.c
fsl_debug_console.h
fsl_str.c
fsl_str.h
xip
Output
erpc_matrix_multiply_rpmsg_cm7

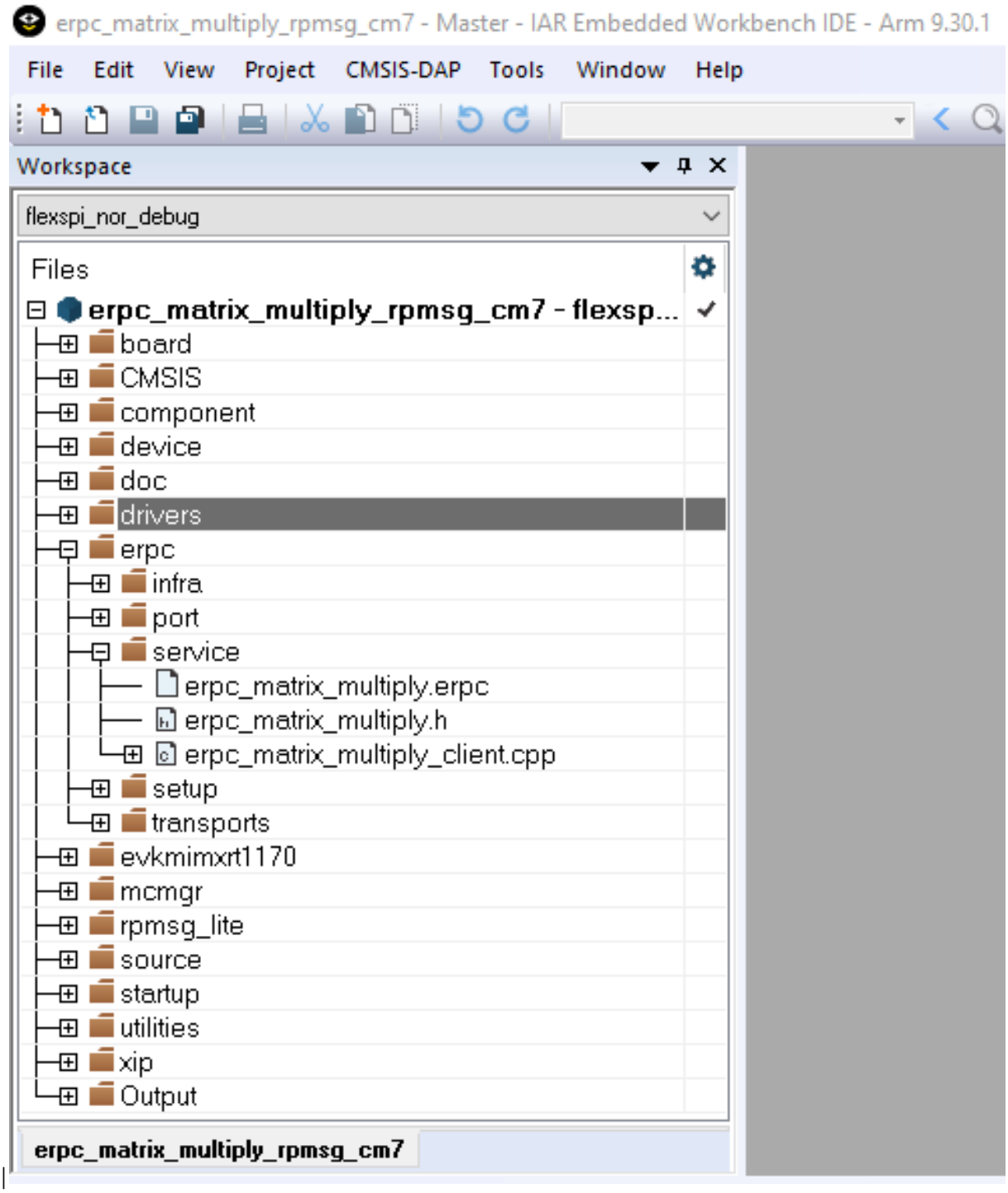
|

Parent topic: Multicore client application

Client-related generated files The client-related generated files are:

- erpc_matric_multiply.h
- erpc_matrix_multiply_client.cpp

These files contain the shim code for the functions and data types declared in the IDL file. These functions also call methods for codec initialization, data serialization, performing eRPC requests, and de-serializing outputs into expected data structures (if return values are expected). These shim code files can be found in the *<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/* folder.



Parent topic: Multicore client application

Client infrastructure files The eRPC infrastructure files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c

The **erpc_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.

- Two files, erpc_client_manager.h and erpc_client_manager.cpp, are used for managing the client-side application. The main purpose of the client files is to create, perform, and release eRPC requests.
- Three files (erpc_codec.hpp, erpc_basic_codec.hpp, and erpc_basic_codec.cpp) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
- erpc_common.h file is used for common eRPC definitions, typedefs, and enums.
- erpc_manually_constructed.hpp file is used for allocating static storage for the used objects.
- Message buffer files are used for storing serialized data: erpc_message_buffer.hpp and erpc_message_buffer.cpp.
- erpc_transport.hpp file defines the abstract interface for transport layer.

The **port** subfolder contains the eRPC porting layer to adapt to different environments.

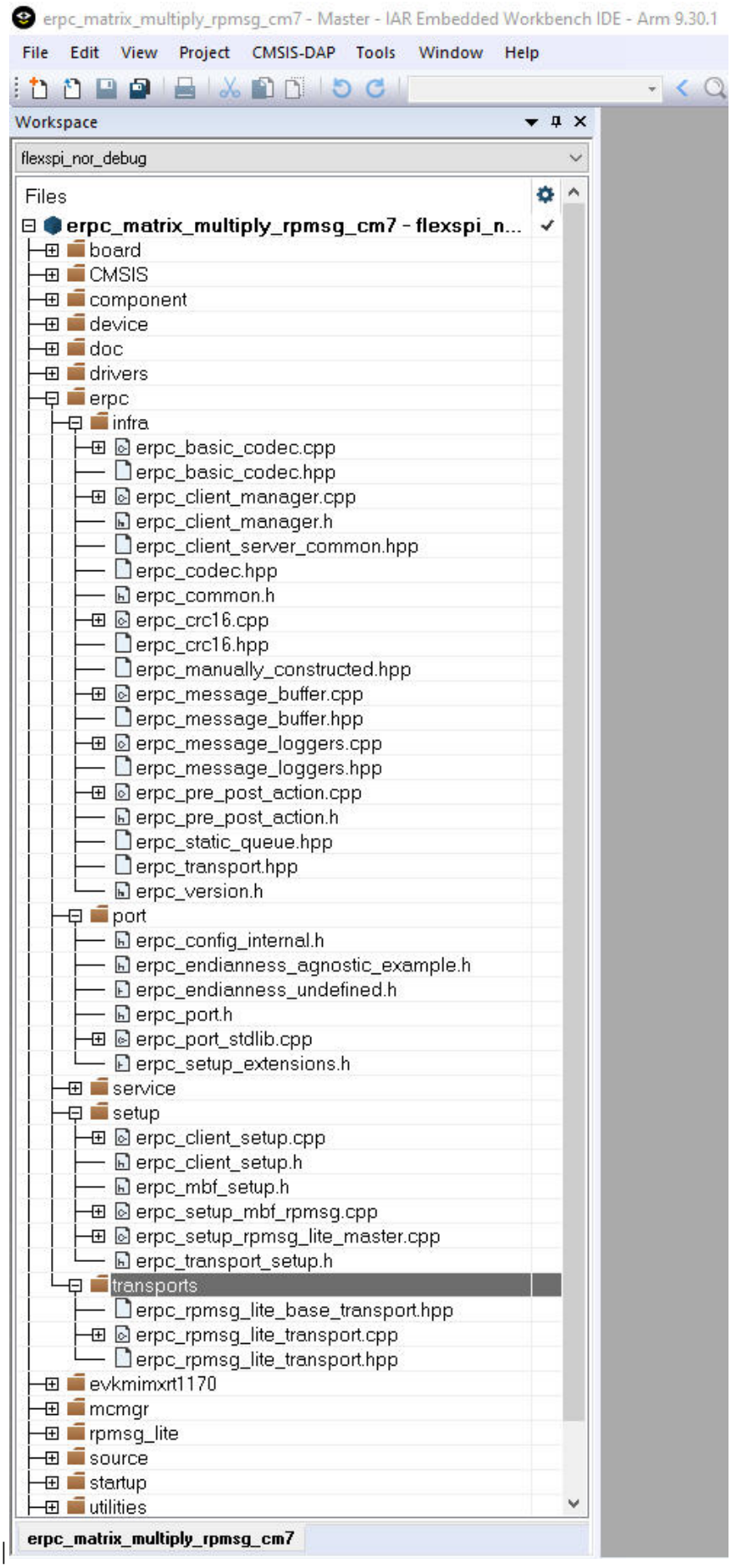
- erpc_port.h file contains definition of erpc_malloc() and erpc_free() functions.
- erpc_port_stdlib.cpp file ensures adaptation to stdlib.
- erpc_config_internal.h internal eRPC configuration file.

The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.

- erpc_client_setup.h and erpc_client_setup.cpp files needs to be added into the "Matrix multiply" example project to demonstrate the use of C-wrapped functions in this example.
- erpc_transport_setup.h and erpc_setup_rpmsg_lite_master.cpp files needs to be added into the project in order to allow C-wrapped function for transport layer setup.
- erpc_mbf_setup.h and erpc_setup_mbf_rpmsg.cpp files needs to be added into the project in order to allow message buffer factory usage.

The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions, in the setup folder.

- RPMsg-Lite is used as the transport layer for the communication between cores, erpc_rpmsg_lite_base_transport.hpp, erpc_rpmsg_lite_transport.hpp, and erpc_rpmsg_lite_transport.cpp files needs to be added into the client project.


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
File Edit View Project CMSIS-DAP Tools Window Help
Workspace
flexspi_nor_debug
Files
erpc_matrix_multiply_rpmsg_cm7 - flexspi_n...
board
CMSIS
component
device
doc
drivers
erpc
infra
erpc_basic_codec.cpp
erpc_basic_codec.hpp
erpc_client_manager.cpp
erpc_client_manager.h
erpc_client_server_common.hpp
erpc_codec.hpp
erpc_common.h
erpc_crc16.cpp
erpc_crc16.hpp
erpc_manually_constructed.hpp
erpc_message_buffer.cpp
erpc_message_buffer.hpp
erpc_message_loggers.cpp
erpc_message_loggers.hpp
erpc_pre_post_action.cpp
erpc_pre_post_action.h
erpc_static_queue.hpp
erpc_transport.hpp
erpc_version.h
port
erpc_config_internal.h
erpc_endianness_agnostic_example.h
erpc_endianness_undefined.h
erpc_port.h
erpc_port_stdlib.cpp
erpc_setup_extensions.h
service
setup
erpc_client_setup.cpp
erpc_client_setup.h
erpc_mbf_setup.h
erpc_setup_mbf_rpmsg.cpp
erpc_setup_rpmsg_lite_master.cpp
erpc_transport_setup.h
transports
erpc_rpmsg_lite_base_transport.hpp
erpc_rpmsg_lite_transport.cpp
erpc_rpmsg_lite_transport.hpp
evkmimxrt1170
mcmgr
rpmsg_lite
source
startup
utilities
erpc_matrix_multiply_rpmsg_cm7

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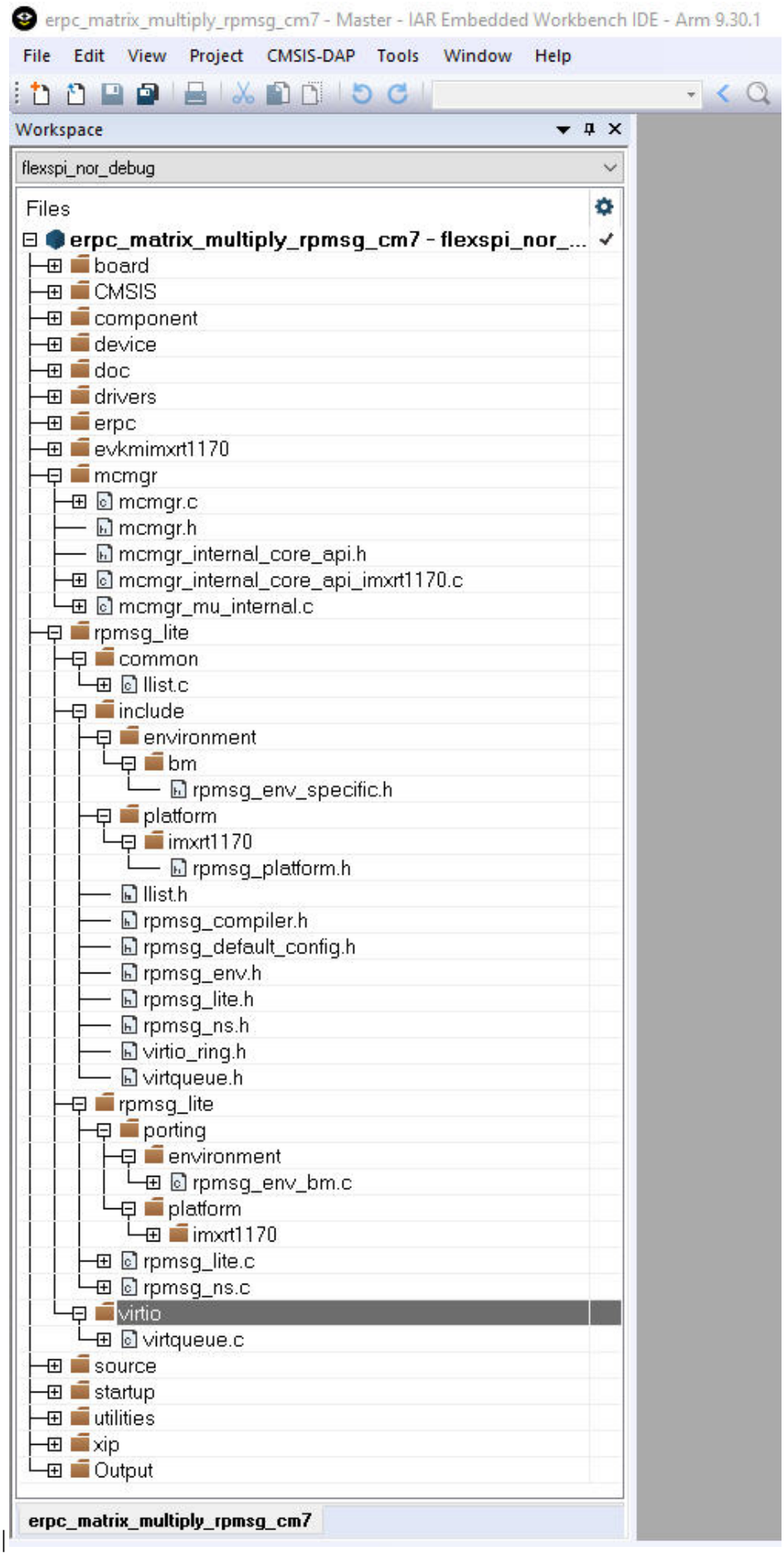
Parent topic: Multicore client application

Client multicore infrastructure files Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
File Edit View Project CMSIS-DAP Tools Window Help
Workspace
flexspi_nor_debug
Files
erpc_matrix_multiply_rpmsg_cm7 - flexspi_nor_...
board
CMSIS
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drivers
erpc
evkmimxrt1170
mcmgr
mcmgr.c
mcmgr.h
mcmgr_internal_core_api.h
mcmgr_internal_core_api_imxrt1170.c
mcmgr_mu_internal.c
rpmsg_lite
common
llist.c
include
environment
bm
rpmsg_env_specific.h
platform
imxrt1170
rpmsg_platform.h
llist.h
rpmsg_compiler.h
rpmsg_default_config.h
rpmsg_env.h
rpmsg_lite.h
rpmsg_ns.h
virtio_ring.h
virtqueue.h
rpmsg_lite
porting
environment
rpmsg_env_bm.c
platform
imxrt1170
rpmsg_lite.c
rpmsg_ns.c
virtio
virtqueue.c
source
startup
utilities
xip
Output
erpc_matrix_multiply_rpmsg_cm7

|

Parent topic: Multicore client application

Client user code The client's user code is stored in the main_core0.c file, located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_example/erpc_matrix_multiply_rpmsg/cm7

The main_core0.c file contains the code for target board and eRPC initialization.

- After initialization, the secondary core is released from reset.
- When the secondary core is ready, the primary core initializes two matrix variables.
- The erpcMatrixMultiply eRPC function is called to issue the eRPC request and get the result.

It is possible to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in erpc_error_handler.h and erpc_error_handler.cpp files.

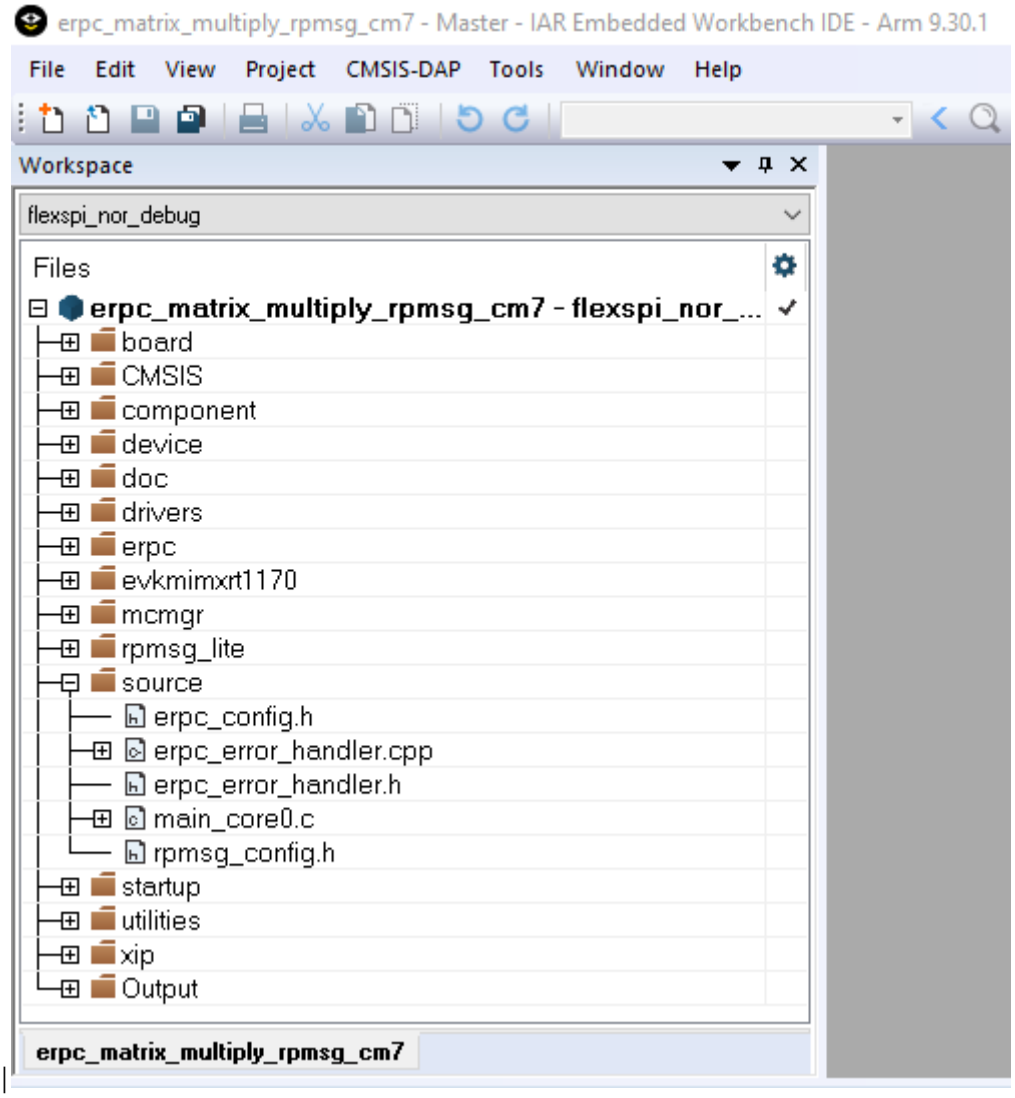
The matrix multiplication can be issued repeatedly, when pressing a software board button.

The eRPC-relevant code is captured in the following code snippet:

```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* RPMsg-Lite transport layer initialization */
erpc_transport_t transport;
transport = erpc_transport_rpmsg_lite_master_init(src, dst,
ERPC_TRANSPORT_RPMSG_LITE_LINK_ID);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_rpmsg_init(transport);
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport, message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
  /* Invoke the erpcMatrixMultiply function */
  erpcMatrixMultiply(matrix1, matrix2, result_matrix);
  ...
  /* Check if some error occured in eRPC */
  if (g_erpc_error_occurred)
  {
    /* Exit program loop */
    break;
  }
  ...
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg_config.h) and eRPC (erpc_config.h), located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg



Parent topic: Multicore client application

Parent topic:*Create an eRPC application*

Multiprocessor server application The "Matrix multiply" eRPC server project for multiprocessor applications is located in the *<MCUXpressoSDK_install_dir»/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>* folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires server-related generated files (server shim code), server infrastructure files, and the server user code. There is no need for server multicore infrastructure files (MCMGR and RPMsg-Lite). The RPMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|SPI|<eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_slave.cpp

<eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.cpp

| |UART|<eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.cpp

|

Server user code The server's user code is stored in the main_server.c file, located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>/* folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(Matrix matrix1, Matrix matrix2, Matrix result_matrix)
{
  ...
}
int main()
{
  ...
  /* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver␣
↪operations */
  erpc_transport_t transport;
  transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
  ...
  /* MessageBufferFactory initialization */
  erpc_mbf_t message_buffer_factory;
  message_buffer_factory = erpc_mbf_dynamic_init();
  ...
  /* eRPC server side initialization */
  erpc_server_t server;
  server = erpc_server_init(transport, message_buffer_factory);
  ...
  /* Adding the service to the server */
  erpc_service_t service = create_MatrixMultiplyService_service();
  erpc_add_service_to_server(server, service);
  ...
  while (1)
  {
    /* Process eRPC requests */
    erpc_status_t status = erpc_server_poll(server)
    /* handle error status */
    if (status != kErpcStatus_Success)
    {
      /* print error description */
      erpc_error_handler(status, 0);
      ...
    }
    ...
  }
}
```

Parent topic: Multiprocessor server application

Multiprocessor client application The "Matrix multiply" eRPC client project for multiprocessor applications is located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/iar/* folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires client-related generated files (server shim code),

client infrastructure files, and the client user code. There is no need for client multicore infrastructure files (MCMGR and RPMsg-Lite). The RPMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|SPI|<eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_master.cpp

<eRPC base directory>/erpc_c/transports/ erpc_(d)spi_master_transport.hpp

<eRPC base directory>/erpc_c/transports/ erpc_(d)spi_master_transport.cpp

| |UART|<eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.cpp

|

Client user code The client's user code is stored in the main_client.c file, located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/* folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

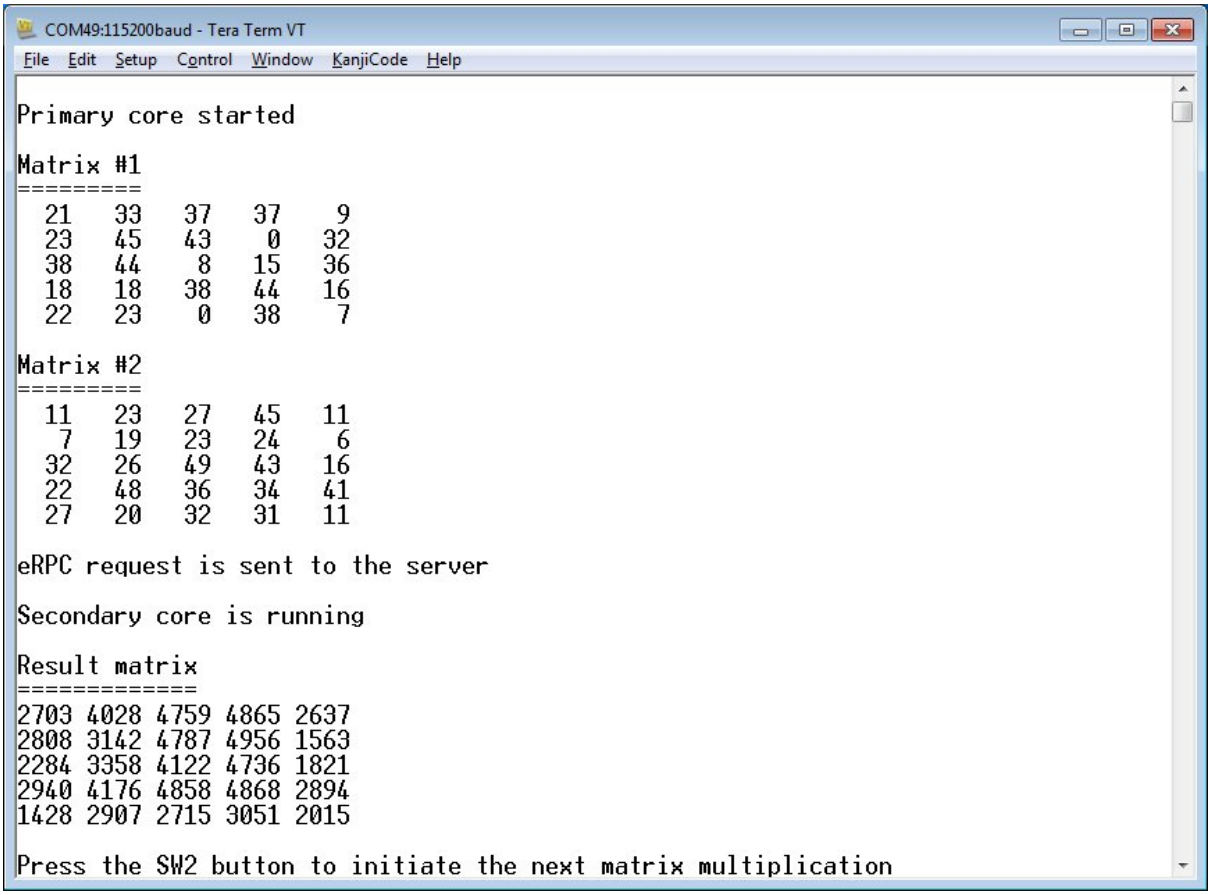
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver␣
↪operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_dynamic_init();
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport,message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
  /* Invoke the erpcMatrixMultiply function */
  erpcMatrixMultiply(matrix1, matrix2, result_matrix);
  ...
  /* Check if some error occured in eRPC */
  if (g_erpc_error_occurred)
  {
    /* Exit program loop */
    break;
  }
  ...
}
```

Parent topic: Multiprocessor client application

Parent topic: Multiprocessor server application

Parent topic:*Create an eRPC application*

Running the eRPC application Follow the instructions in *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) (located in the *<MCUXpressoSDK_install_dir>/docs* folder), to load both the primary and the secondary core images into the on-chip memory, and then effectively debug the dual-core application. After the application is running, the serial console should look like:



For multiprocessor applications that are running between PC and the target evaluation board or between two boards, follow the instructions in the accompanied example readme files that provide details about the proper board setup and the PC side setup (Python).

Parent topic:*Create an eRPC application*

Parent topic:*eRPC example*

eRPC example This section shows how to create an example eRPC application called “Matrix multiply”, which implements one eRPC function (matrix multiply) with two function parameters (two matrices). The client-side application calls this eRPC function, and the server side performs the multiplication of received matrices. The server side then returns the result.

For example, use the NXP MIMXRT1170-EVK board as the target dual-core platform, and the IAR Embedded Workbench for ARM (EWARM) as the target IDE for developing the eRPC example.

- The primary core (CM7) runs the eRPC client.
- The secondary core (CM4) runs the eRPC server.
- RPMsg-Lite (Remote Processor Messaging Lite) is used as the eRPC transport layer.

The “Matrix multiply” application can be also run in the multi-processor setup. In other words, the eRPC client running on one SoC comunicates with the eRPC server that runs on anothe SoC, utilizing different transport channels. It is possible to run the board-to-PC example (PC as the eRPC server and a board as the eRPC client, and vice versa) and also the board-to-board example. These multiprocessor examples are prepared for selected boards only.

|Multicore application source and project files|*<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore*
|Multiprocessor application source and project files|*<MCUXpressoSDK_install_dir>/boards/<board_name>/multi*

<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<tr

| |eRPC source files|*<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/*| |RPMsg-Lite source files|*<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/*|

Designing the eRPC application The matrix multiply application is based on calling single eRPC function that takes 2 two-dimensional arrays as input and returns matrix multiplication results as another 2 two-dimensional array. The IDL file syntax supports arrays with the dimension length set by the number only (in the current eRPC implementation). Because of this, a variable is declared in the IDL dedicated to store information about matrix dimension length, and to allow easy maintenance of the user and server code.

For a simple use of the two-dimensional array, the alias name (new type definition) for this data type has is declared in the IDL. Declaring this alias name ensures that the same data type can be used across the client and server applications.

Parent topic:*eRPC example*

Creating the IDL file The created IDL file is located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/s

The created IDL file contains the following code:

```
program erpc_matrix_multiply
/*! This const defines the matrix size. The value has to be the same as the
Matrix array dimension. Do not forget to re-generate the erpc code once the
matrix size is changed in the erpc file */
const int32 matrix_size = 5;
/*! This is the matrix array type. The dimension has to be the same as the
matrix size const. Do not forget to re-generate the erpc code once the
matrix size is changed in the erpc file */
type Matrix = int32[matrix_size][matrix_size];
interface MatrixMultiplyService {
erpcMatrixMultiply(in Matrix matrix1, in Matrix matrix2, out Matrix result_matrix) ->
void
}
```

Details:

- The IDL file starts with the program name (*erpc_matrix_multiply*), and this program name is used in the naming of all generated outputs.
- The declaration and definition of the constant variable named *matrix_size* follows next. The *matrix_size* variable is used for passing information about the length of matrix dimensions to the client/server user code.
- The alias name for the two-dimensional array type (*Matrix*) is declared.
- The interface group *MatrixMultiplyService* is located at the end of the IDL file. This interface group contains only one function declaration *erpcMatrixMultiply*.
- As shown above, the function’s declaration contains three parameters of Matrix type: *matrix1* and *matrix2* are input parameters, while *result_matrix* is the output parameter. Additionally, the returned data type is declared as void.

When writing the IDL file, the following order of items is recommended:

1. Program name at the top of the IDL file.
2. New data types and constants declarations.
3. Declarations of interfaces and functions at the end of the IDL file.

Parent topic:*eRPC example*

Using the eRPC generator tool |Windows OS|<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erp
|Linux OS|<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x64

<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x86

| |Mac OS|<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Mac|

The files for the "Matrix multiply" example are pre-generated and already a part of the application projects. The following section describes how they have been created.

- The easiest way to create the shim code is to copy the erpcgen application to the same folder where the IDL file (*.erpc) is located; then run the following command:

  erpcgen <IDL_file>.erpc

- In the "Matrix multiply" example, the command should look like:

  erpcgen erpc_matrix_multiply.erpc

Additionally, another method to create the shim code is to execute the eRPC application using input commands:

- "-?"/"—help" – Shows supported commands.
- "-o <filePath>"/"—output<filePath>" – Sets the output directory.

For example,

```
<path_to_erpcgen>/erpcgen –o <path_to_output>
<path_to_IDL>/<IDL_file_name>.erpc
```

For the "Matrix multiply" example, when the command is executed from the default erpcgen location, it looks like:

erpcgen –o

../../../../../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service
../../../../../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/erpc_matrix_mu

In both cases, the following four files are generated into the *<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service folder.*

- erpc_matrix_multiply.h
- erpc_matrix_multiply_client.cpp
- erpc_matrix_multiply_server.h
- erpc_matrix_multiply_server.cpp

For multiprocessor examples, the eRPC file and pre-generated files can be found in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_common/erpc_matrix_multiply/serv* folder.

For Linux OS users:

- Do not forget to set the permissions for the eRPC generator application.
- Run the application as ./erpcgen... instead of as erpcgen ....

Parent topic:*eRPC example*

Create an eRPC application This section describes a generic way to create a client/server eRPC application:

1. **Design the eRPC application:** Decide which data types are sent between applications, and define functions that send/receive this data.
2. **Create the IDL file:** The IDL file contains information about data types and functions used in an eRPC application, and is written in the IDL language.
3. **Use the eRPC generator tool:** This tool takes an IDL file and generates the shim code for the client and the server-side applications.
4. **Create an eRPC application:**
    1. Create two projects, where one project is for the client side (primary core) and the other project is for the server side (secondary core).
    2. Add generated files for the client application to the client project, and add generated files for the server application to the server project.
    3. Add infrastructure files.
    4. Add user code for client and server applications.
    5. Set the client and server project options.
5. **Run the eRPC application:** Run both the server and the client applications. Make sure that the server has been run before the client request was sent.

A specific example follows in the next section.

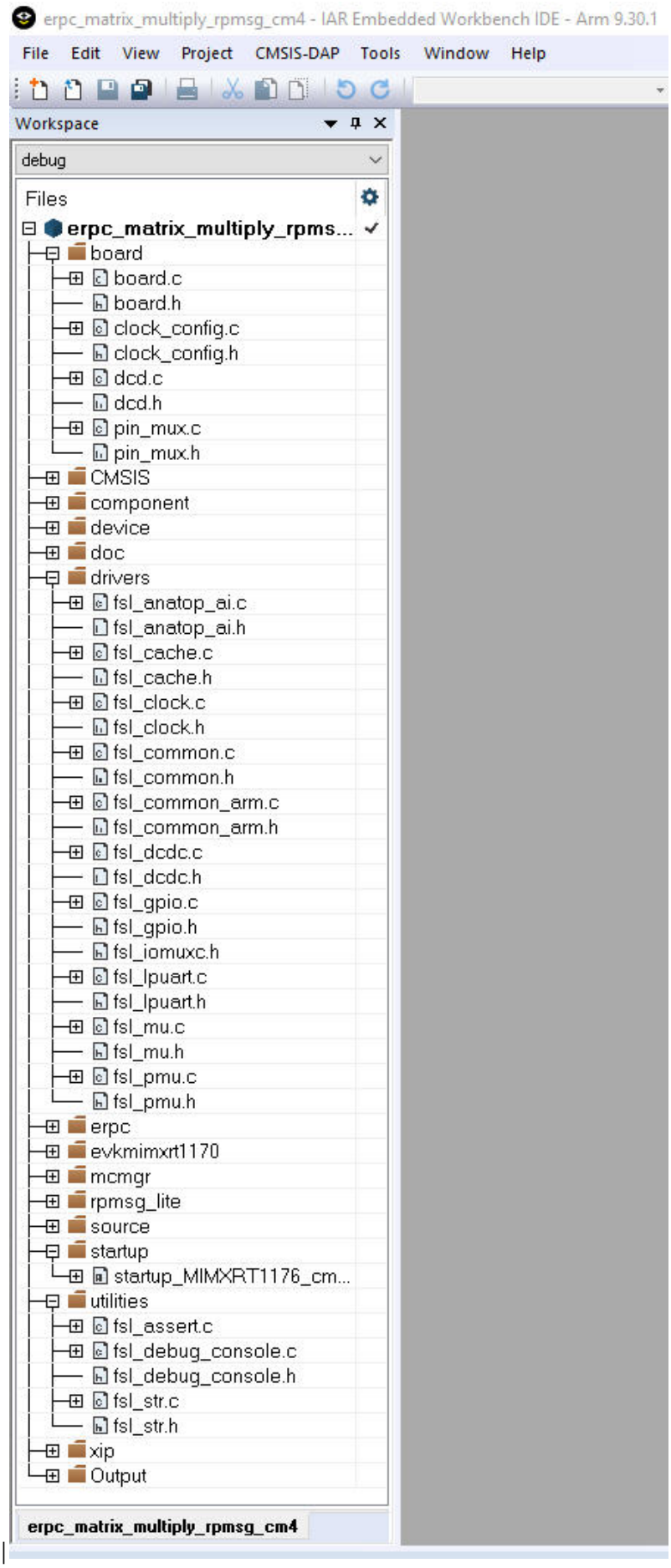
Multicore server application The “Matrix multiply” eRPC server project is located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4/iar

The project files for the eRPC server have the `_cm4` suffix.

Server project basic source files The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in:

- *<MCUXpressoSDK_install_dir>/devices/<device>*
- *<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/*


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
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board
board.c
board.h
clock_config.c
clock_config.h
dcd.c
dcd.h
pin_mux.c
pin_mux.h
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drivers
fsl_anatop_ai.c
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fsl_cache.c
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fsl_clock.c
fsl_clock.h
fsl_common.c
fsl_common.h
fsl_common_arm.c
fsl_common_arm.h
fsl_dcdc.c
fsl_dcdc.h
fsl_gpio.c
fsl_gpio.h
fsl_iomuxc.h
fsl_lpuart.c
fsl_lpuart.h
fsl_mu.c
fsl_mu.h
fsl_pmu.c
fsl_pmu.h
erpc
evkmimxrt1170
mcmgr
rpmsg_lite
source
startup
startup_MIMXRT1176_cm...
utilities
fsl_assert.c
fsl_debug_console.c
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fsl_str.c
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Output
erpc_matrix_multiply_rpmsg_cm4

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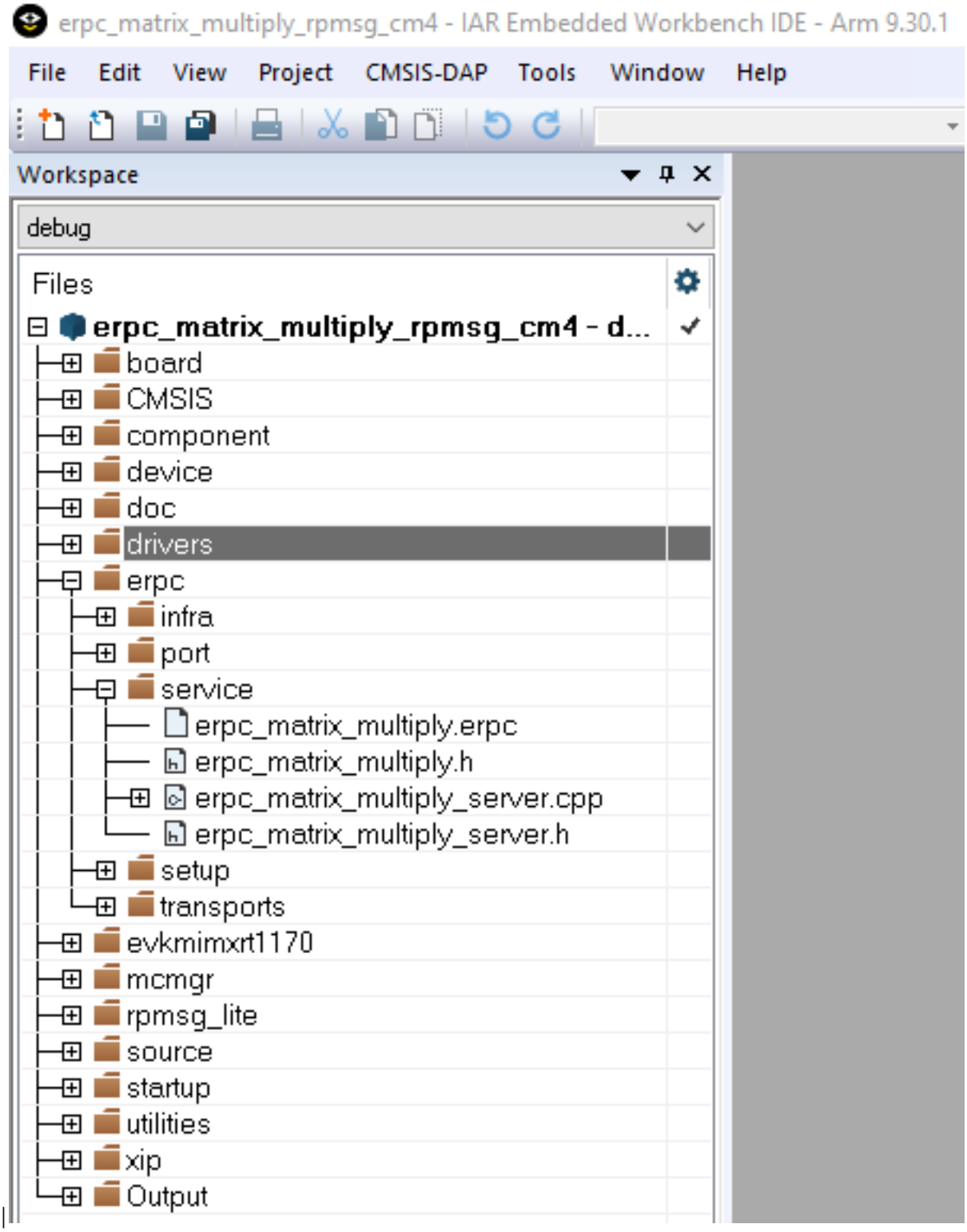
Parent topic: Multicore server application

Server related generated files The server-related generated files are:

- erpc_matric_multiply.h
- erpc_matrix_multiply_server.h
- erpc_matrix_multiply_server.cpp

The server-related generated files contain the shim code for functions and data types declared in the IDL file. These files also contain functions for the identification of client requested functions, data deserialization, calling requested function's implementations, and data serialization and return, if requested by the client. These shim code files can be found in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/s



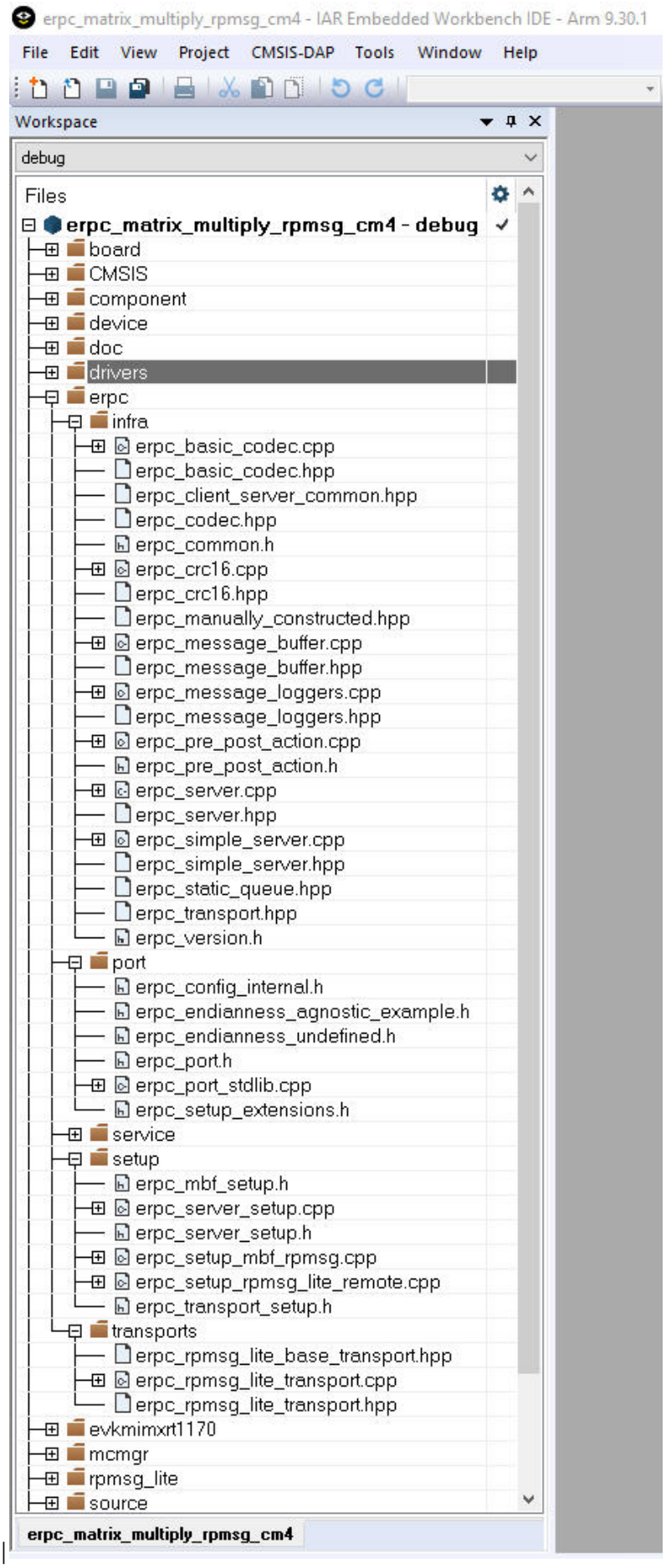
Parent topic: Multicore server application

Server infrastructure files The eRPC infrastructure files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c

The **erpc_c** folder contains files for creating eRPC client and server applications in the *C/C++* language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.
  - Four files, erpc_server.hpp, erpc_server.cpp, erpc_simple_server.hpp, and erpc_simple_server.cpp, are used for running the eRPC server on the server-side applications. The simple server is currently the only implementation of the server, and its role is to catch client requests, identify and call requested functions, and send data back when requested.
  - Three files (erpc_codec.hpp, erpc_basic_codec.hpp, and erpc_basic_codec.cpp) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
  - The erpc_common.hpp file is used for common eRPC definitions, typedefs, and enums.
  - The erpc_manually_constructed.hpp file is used for allocating static storage for the used objects.
  - Message buffer files are used for storing serialized data: erpc_message_buffer.h and erpc_message_buffer.cpp.
  - The erpc_transport.h file defines the abstract interface for transport layer.
- The **port** subfolder contains the eRPC porting layer to adapt to different environments.
  - erpc_port.h file contains definition of erpc_malloc() and erpc_free() functions.
  - erpc_port_stdlib.cpp file ensures adaptation to stdlib.
  - erpc_config_internal.h internal erpc configuration file.
- The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.
  - The erpc_server_setup.h and erpc_server_setup.cpp files needs to be added into the "Matrix multiply" example project to demonstrate the use of C-wrapped functions in this example.
  - The erpc_transport_setup.h and erpc_setup_rpmsg_lite_remote.cpp files needs to be added into the project in order to allow the C-wrapped function for transport layer setup.
  - The erpc_mbf_setup.h and erpc_setup_mbf_rpmsg.cpp files needs to be added into the project in order to allow message buffer factory usage.
- The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions in the setup folder.
  - RPMsg-Lite is used as the transport layer for the communication between cores, erpc_rpmsg_lite_base_transport.hpp, erpc_rpmsg_lite_transport.hpp, and erpc_rpmsg_lite_transport.cpp files need to be added into the server project.


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
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erpc_client_server_common.hpp
erpc_codec.hpp
erpc_common.h
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erpc_crc16.hpp
erpc_manually_constructed.hpp
erpc_message_buffer.cpp
erpc_message_buffer.hpp
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erpc_message_loggers.hpp
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erpc_port.h
erpc_port_stdlib.cpp
erpc_setup_extensions.h
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erpc_mbf_setup.h
erpc_server_setup.cpp
erpc_server_setup.h
erpc_setup_mbf_rpmsg.cpp
erpc_setup_rpmsg_lite_remote.cpp
erpc_transport_setup.h
transports
erpc_rpmsg_lite_base_transport.hpp
erpc_rpmsg_lite_transport.cpp
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rpmsg_lite
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erpc_matrix_multiply_rpmsg_cm4

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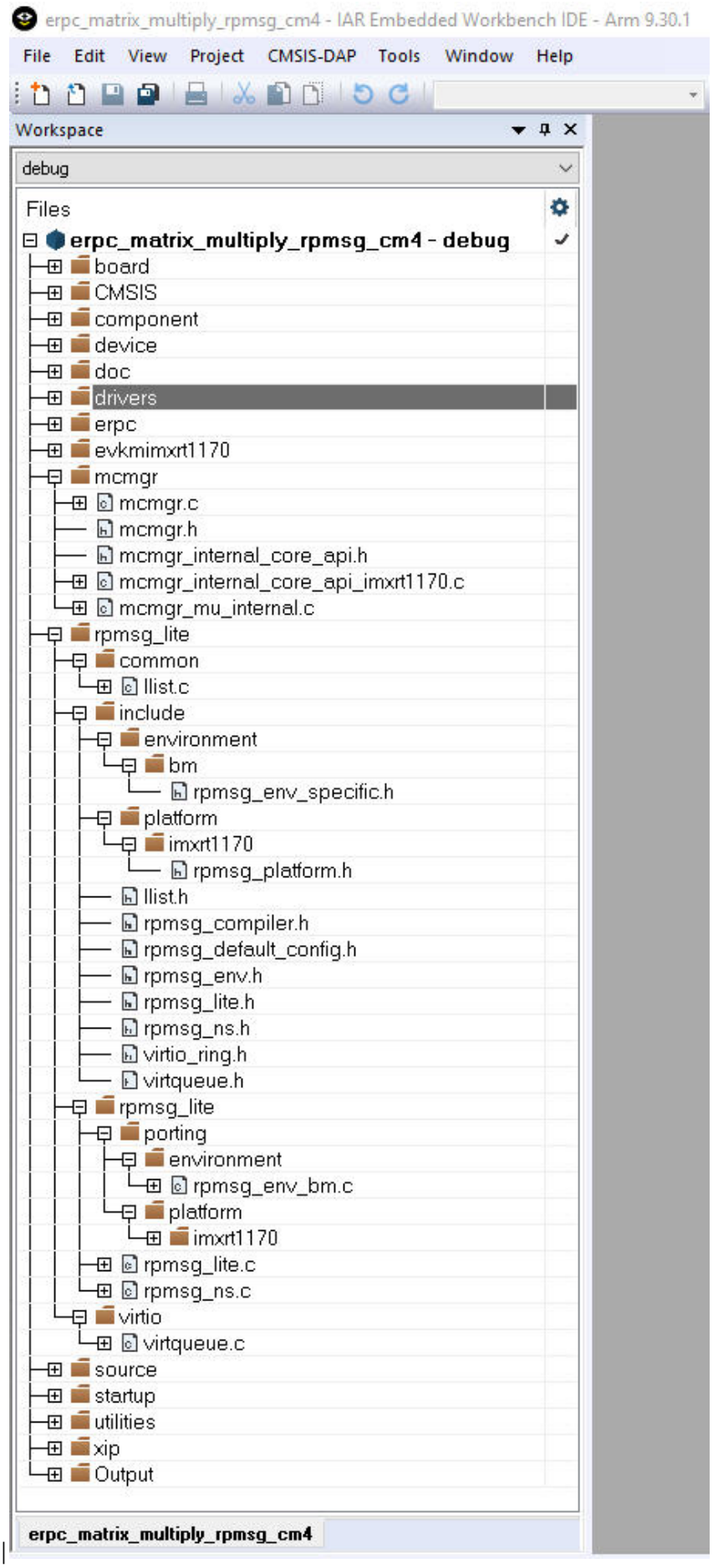
Parent topic: Multicore server application

Server multicore infrastructure files Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/


erpc_matrix_multiply_rpmsg_cm4 - IAR Embedded Workbench IDE - Arm 9.30.1
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mcmgr.h
mcmgr_internal_core_api.h
mcmgr_internal_core_api_imxrt1170.c
mcmgr_mu_internal.c
rpmsg_lite
common
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bm
rpmsg_env_specific.h
platform
imxrt1170
rpmsg_platform.h
llist.h
rpmsg_compiler.h
rpmsg_default_config.h
rpmsg_env.h
rpmsg_lite.h
rpmsg_ns.h
virtio_ring.h
virtqueue.h
rpmsg_lite
porting
environment
rpmsg_env_bm.c
platform
imxrt1170
rpmsg_lite.c
rpmsg_ns.c
virtio
virtqueue.c
source
startup
utilities
xip
Output
erpc_matrix_multiply_rpmsg_cm4

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Parent topic: Multicore server application

Server user code The server's user code is stored in the main_core1.c file, located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4

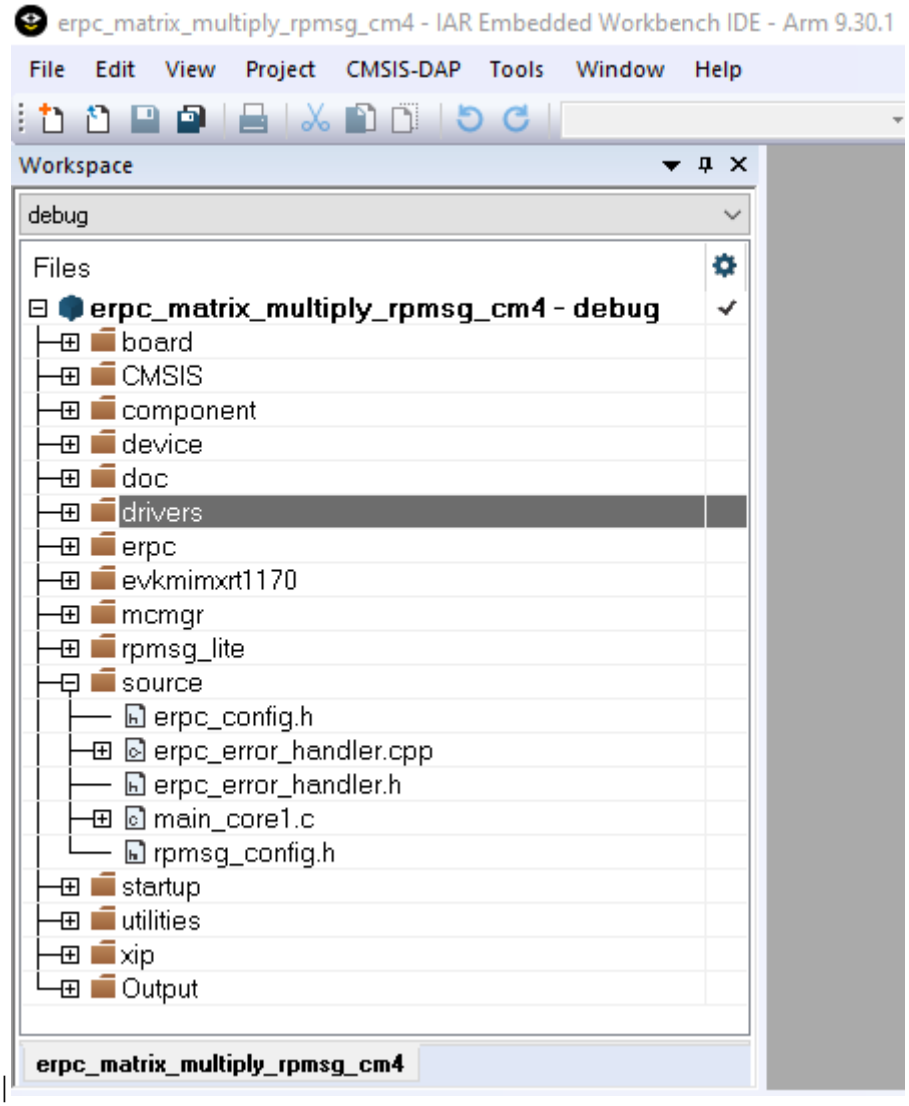
The main_core1.c file contains two functions:

- The **main()** function contains the code for the target board and eRPC server initialization. After the initialization, the matrix multiply service is added and the eRPC server waits for client's requests in the while loop.
- The **erpcMatrixMultiply()** function is the user implementation of the eRPC function defined in the IDL file.
- There is the possibility to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in the erpc_error_handler.h and erpc_error_handler.cpp files.

The eRPC-relevant code is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(const Matrix *matrix1, const Matrix *matrix2, Matrix *result_matrix)
{
  ...
}
int main()
{
  ...
  /* RPMsg-Lite transport layer initialization */
  erpc_transport_t transport;
  transport = erpc_transport_rpmsg_lite_remote_init(src, dst, (void*)startupData,
  ERPC_TRANSPORT_RPMSG_LITE_LINK_ID, SignalReady, NULL);
  ...
  /* MessageBufferFactory initialization */
  erpc_mbf_t message_buffer_factory;
  message_buffer_factory = erpc_mbf_rpmsg_init(transport);
  ...
  /* eRPC server side initialization */
  erpc_server_t server;
  server = erpc_server_init(transport, message_buffer_factory);
  ...
  /* Adding the service to the server */
  erpc_service_t service = create_MatrixMultiplyService_service();
  erpc_add_service_to_server(server, service);
  ...
  while (1)
  {
    /* Process eRPC requests */
    erpc_status_t status = erpc_server_poll(server);
    /* handle error status */
    if (status != kErpcStatus_Success)
    {
      /* print error description */
      erpc_error_handler(status, 0);
      ...
    }
    ...
  }
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg_config.h) and eRPC (erpc_config.h), located in the *<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg* folder.



Parent topic: Multicore server application

Parent topic:*Create an eRPC application*

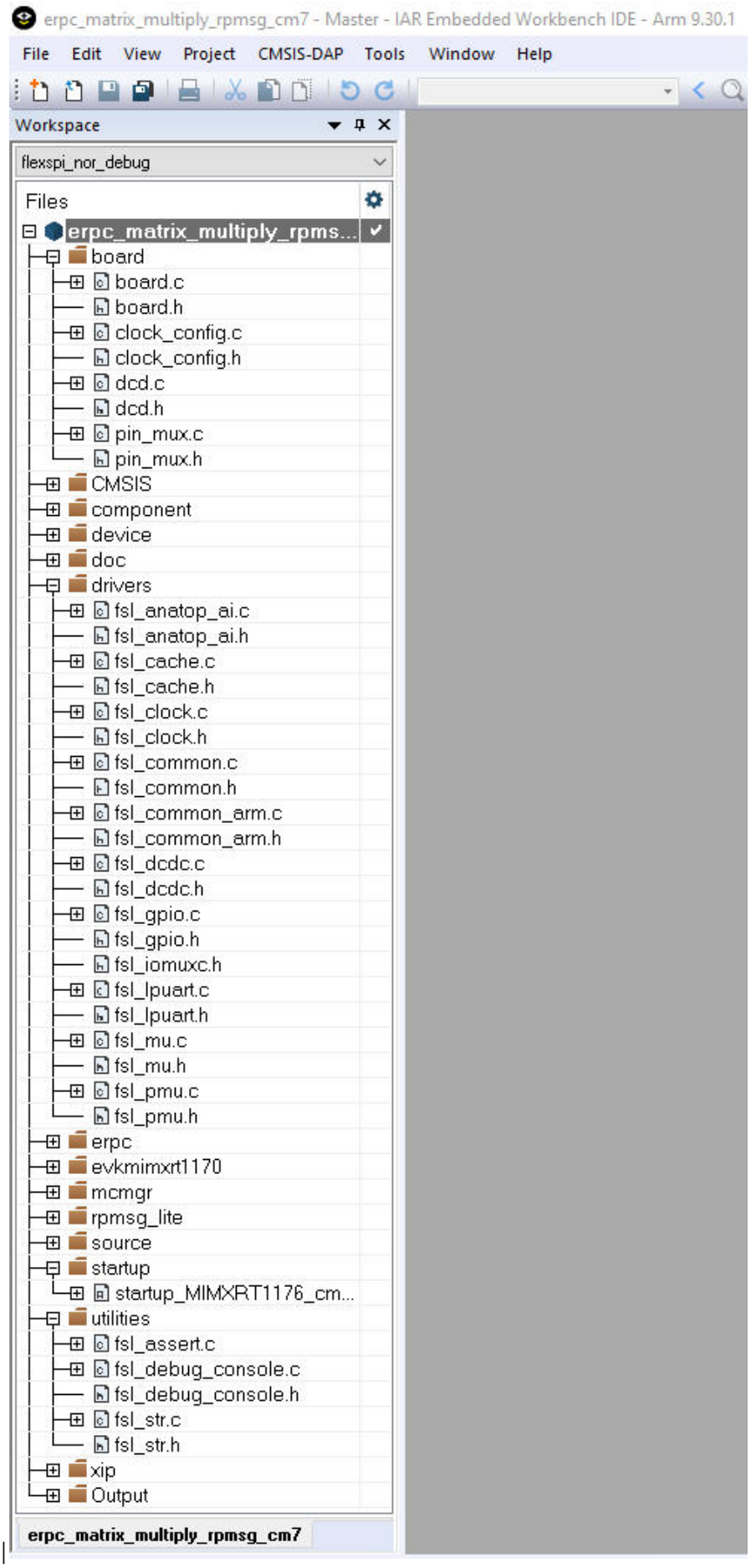
Multicore client application The "Matrix multiply" eRPC client project is located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm7/iar

Project files for the eRPC client have the _cm7 suffix.

Client project basic source files The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in the following folders:

- *<MCUXpressoSDK_install_dir>/devices/<device>*
- *<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/*


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
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pin_mux.c
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CMSIS
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drivers
fsl_anatop_ai.c
fsl_anatop_ai.h
fsl_cache.c
fsl_cache.h
fsl_clock.c
fsl_clock.h
fsl_common.c
fsl_common.h
fsl_common_arm.c
fsl_common_arm.h
fsl_dcdc.c
fsl_dcdc.h
fsl_gpio.c
fsl_gpio.h
fsl_iomuxc.h
fsl_lpuart.c
fsl_lpuart.h
fsl_mu.c
fsl_mu.h
fsl_pmu.c
fsl_pmu.h
erpc
evkmimxrt1170
mcmgr
rpmsg_lite
source
startup
startup_MIMXRT1176_cm...
utilities
fsl_assert.c
fsl_debug_console.c
fsl_debug_console.h
fsl_str.c
fsl_str.h
xip
Output
erpc_matrix_multiply_rpmsg_cm7

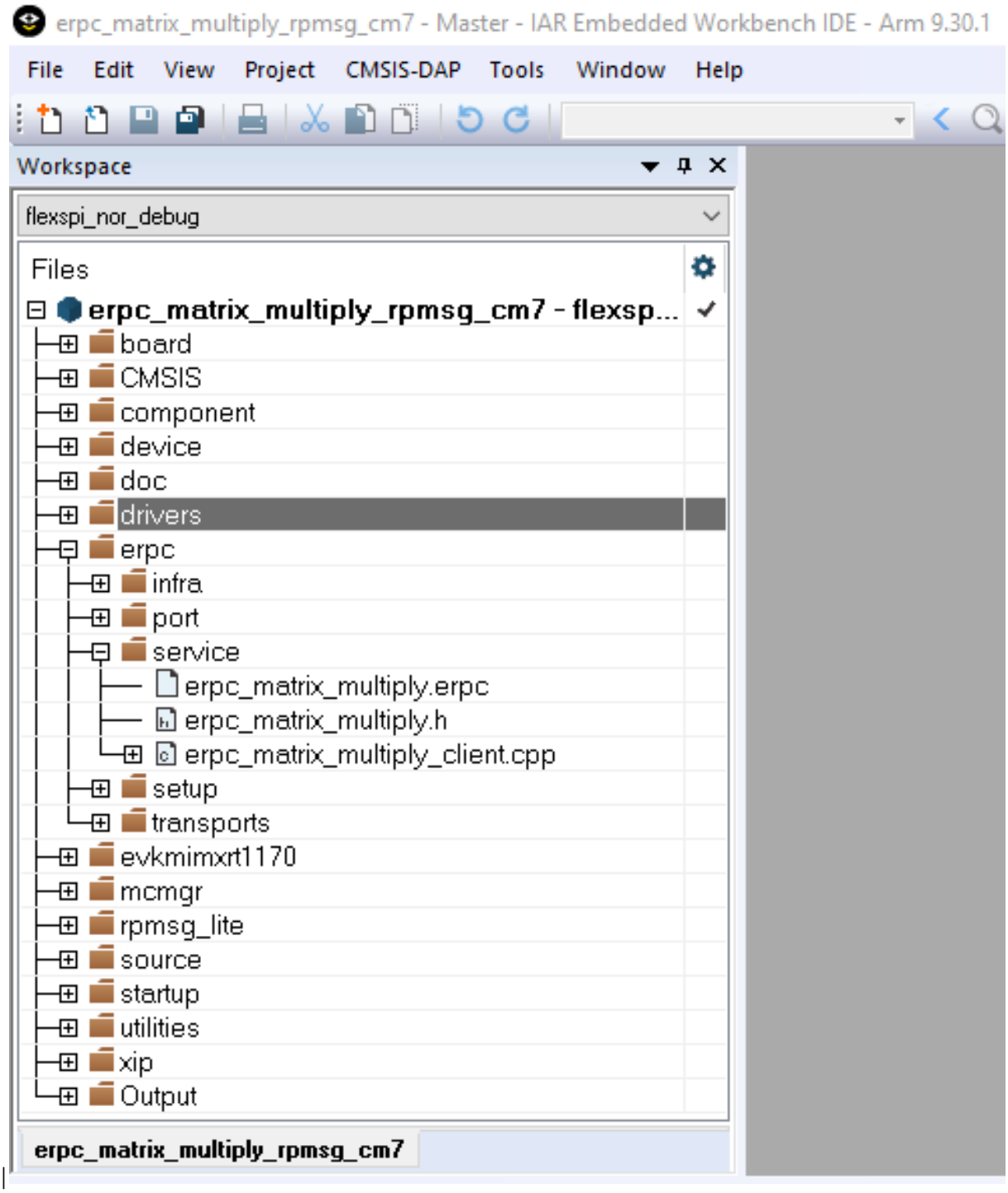
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Parent topic: Multicore client application

Client-related generated files The client-related generated files are:

- erpc_matric_multiply.h
- erpc_matrix_multiply_client.cpp

These files contain the shim code for the functions and data types declared in the IDL file. These functions also call methods for codec initialization, data serialization, performing eRPC requests, and de-serializing outputs into expected data structures (if return values are expected). These shim code files can be found in the *<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/* folder.



Parent topic: Multicore client application

Client infrastructure files The eRPC infrastructure files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c

The **erpc_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.

- Two files, erpc_client_manager.h and erpc_client_manager.cpp, are used for managing the client-side application. The main purpose of the client files is to create, perform, and release eRPC requests.
- Three files (erpc_codec.hpp, erpc_basic_codec.hpp, and erpc_basic_codec.cpp) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
- erpc_common.h file is used for common eRPC definitions, typedefs, and enums.
- erpc_manually_constructed.hpp file is used for allocating static storage for the used objects.
- Message buffer files are used for storing serialized data: erpc_message_buffer.hpp and erpc_message_buffer.cpp.
- erpc_transport.hpp file defines the abstract interface for transport layer.

The **port** subfolder contains the eRPC porting layer to adapt to different environments.

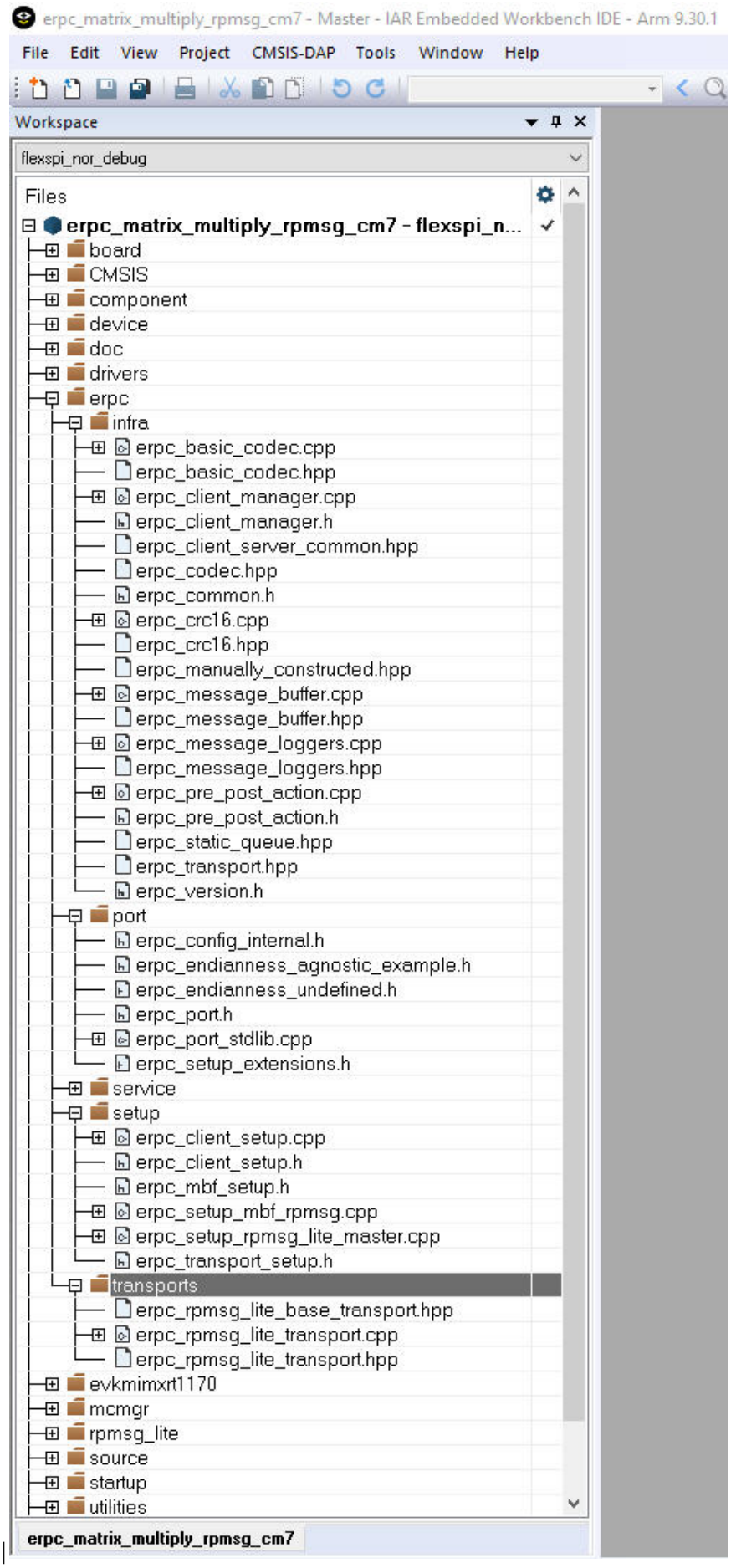
- erpc_port.h file contains definition of erpc_malloc() and erpc_free() functions.
- erpc_port_stdlib.cpp file ensures adaptation to stdlib.
- erpc_config_internal.h internal eRPC configuration file.

The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.

- erpc_client_setup.h and erpc_client_setup.cpp files needs to be added into the "Matrix multiply" example project to demonstrate the use of C-wrapped functions in this example.
- erpc_transport_setup.h and erpc_setup_rpmsg_lite_master.cpp files needs to be added into the project in order to allow C-wrapped function for transport layer setup.
- erpc_mbf_setup.h and erpc_setup_mbf_rpmsg.cpp files needs to be added into the project in order to allow message buffer factory usage.

The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions, in the setup folder.

- RPMsg-Lite is used as the transport layer for the communication between cores, erpc_rpmsg_lite_base_transport.hpp, erpc_rpmsg_lite_transport.hpp, and erpc_rpmsg_lite_transport.cpp files needs to be added into the client project.


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
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erpc_basic_codec.cpp
erpc_basic_codec.hpp
erpc_client_manager.cpp
erpc_client_manager.h
erpc_client_server_common.hpp
erpc_codec.hpp
erpc_common.h
erpc_crc16.cpp
erpc_crc16.hpp
erpc_manually_constructed.hpp
erpc_message_buffer.cpp
erpc_message_buffer.hpp
erpc_message_loggers.cpp
erpc_message_loggers.hpp
erpc_pre_post_action.cpp
erpc_pre_post_action.h
erpc_static_queue.hpp
erpc_transport.hpp
erpc_version.h
port
erpc_config_internal.h
erpc_endianness_agnostic_example.h
erpc_endianness_undefined.h
erpc_port.h
erpc_port_stdlib.cpp
erpc_setup_extensions.h
service
setup
erpc_client_setup.cpp
erpc_client_setup.h
erpc_mbf_setup.h
erpc_setup_mbf_rpmsg.cpp
erpc_setup_rpmsg_lite_master.cpp
erpc_transport_setup.h
transports
erpc_rpmsg_lite_base_transport.hpp
erpc_rpmsg_lite_transport.cpp
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erpc_matrix_multiply_rpmsg_cm7

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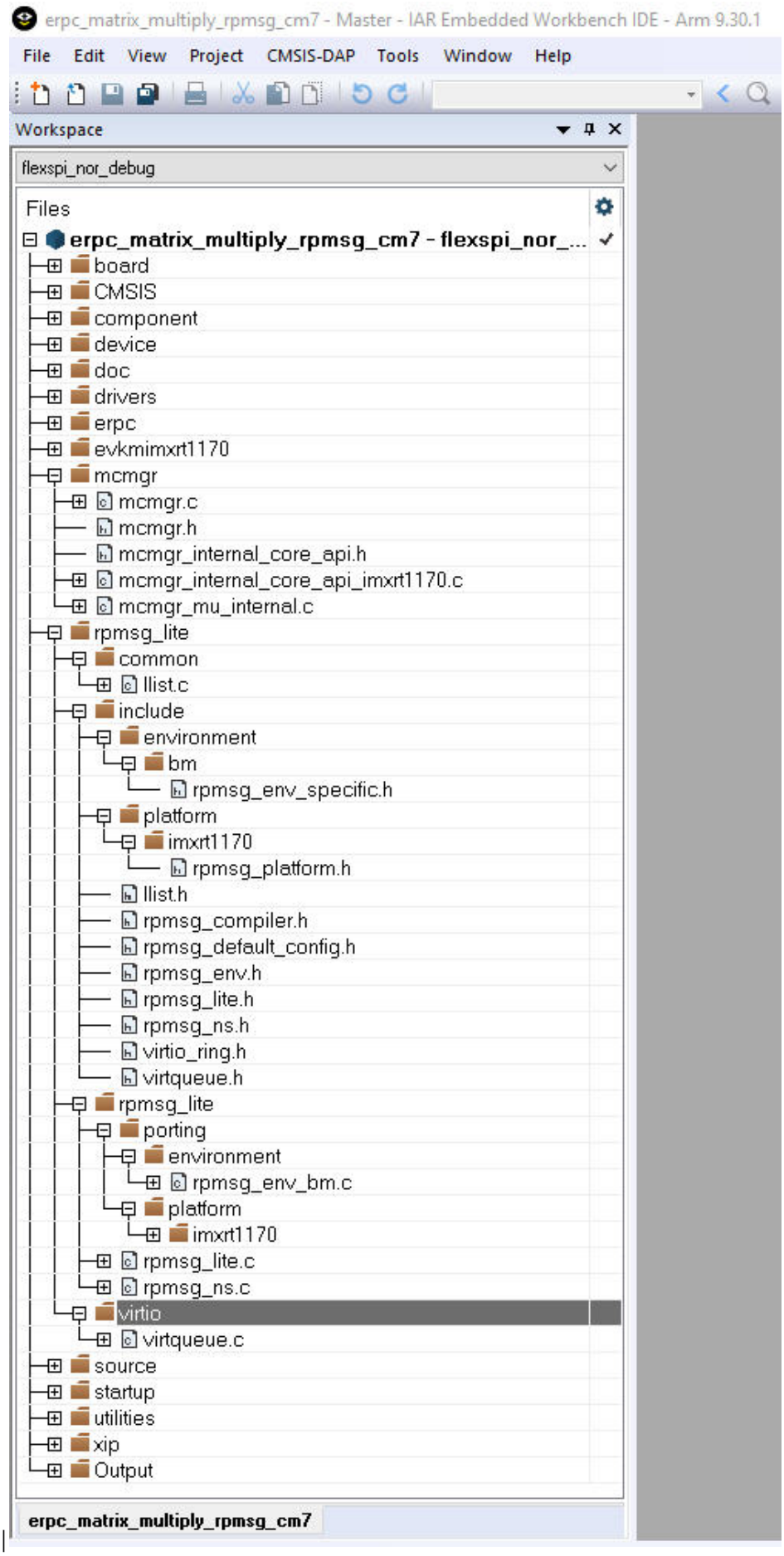
Parent topic: Multicore client application

Client multicore infrastructure files Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/


erpc_matrix_multiply_rpmsg_cm7 - Master - IAR Embedded Workbench IDE - Arm 9.30.1
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evkmimxrt1170
mcmgr
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mcmgr.h
mcmgr_internal_core_api.h
mcmgr_internal_core_api_imxrt1170.c
mcmgr_mu_internal.c
rpmsg_lite
common
llist.c
include
environment
bm
rpmsg_env_specific.h
platform
imxrt1170
rpmsg_platform.h
llist.h
rpmsg_compiler.h
rpmsg_default_config.h
rpmsg_env.h
rpmsg_lite.h
rpmsg_ns.h
virtio_ring.h
virtqueue.h
rpmsg_lite
porting
environment
rpmsg_env_bm.c
platform
imxrt1170
rpmsg_lite.c
rpmsg_ns.c
virtio
virtqueue.c
source
startup
utilities
xip
Output
erpc_matrix_multiply_rpmsg_cm7

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Parent topic: Multicore client application

Client user code The client's user code is stored in the main_core0.c file, located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_example/erpc_matrix_multiply_rpmsg/cm7

The main_core0.c file contains the code for target board and eRPC initialization.

- After initialization, the secondary core is released from reset.
- When the secondary core is ready, the primary core initializes two matrix variables.
- The erpcMatrixMultiply eRPC function is called to issue the eRPC request and get the result.

It is possible to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in erpc_error_handler.h and erpc_error_handler.cpp files.

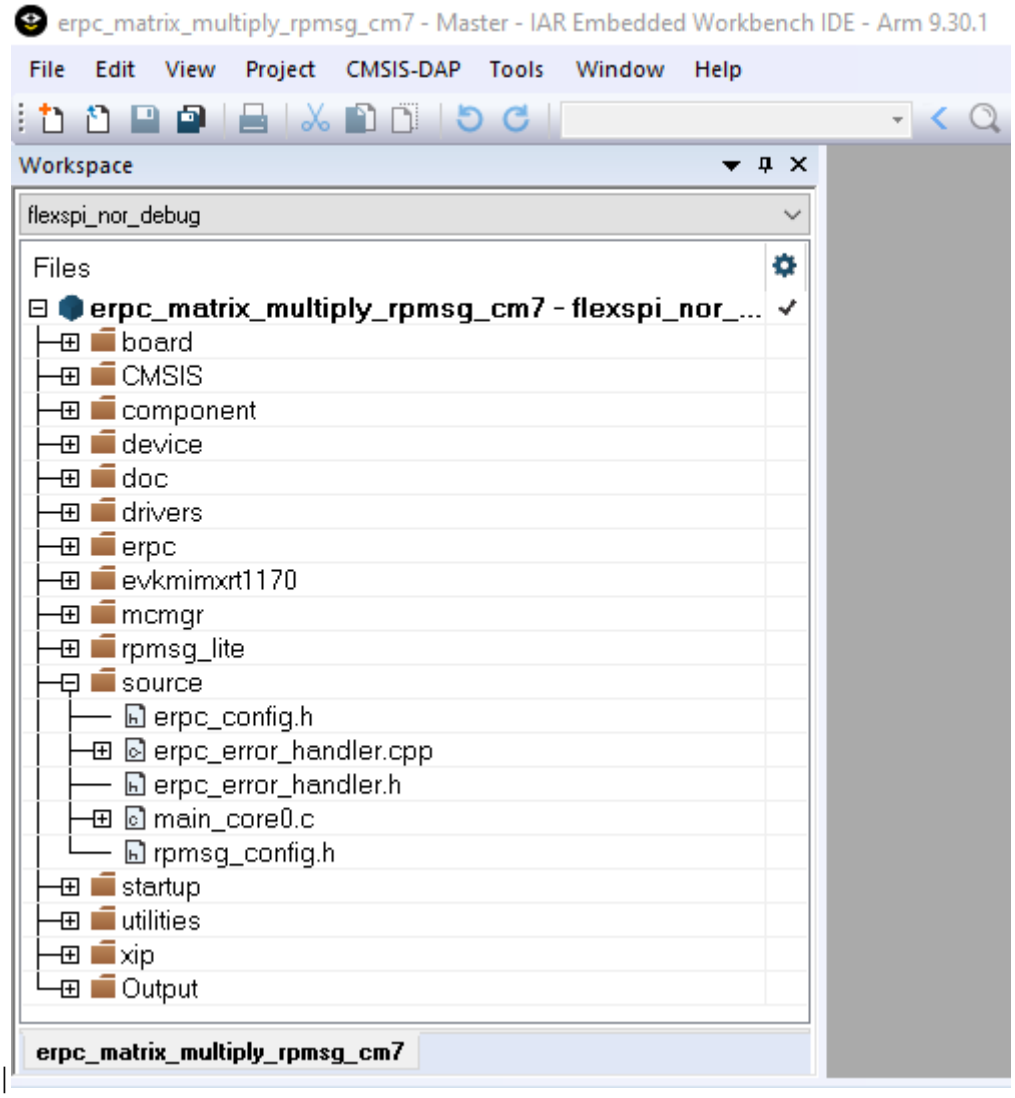
The matrix multiplication can be issued repeatedly, when pressing a software board button.

The eRPC-relevant code is captured in the following code snippet:

```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* RPMsg-Lite transport layer initialization */
erpc_transport_t transport;
transport = erpc_transport_rpmsg_lite_master_init(src, dst,
ERPC_TRANSPORT_RPMSG_LITE_LINK_ID);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_rpmsg_init(transport);
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport, message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
  /* Invoke the erpcMatrixMultiply function */
  erpcMatrixMultiply(matrix1, matrix2, result_matrix);
  ...
  /* Check if some error occured in eRPC */
  if (g_erpc_error_occurred)
  {
    /* Exit program loop */
    break;
  }
  ...
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg_config.h) and eRPC (erpc_config.h), located in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg



Parent topic: Multicore client application

Parent topic:*Create an eRPC application*

Multiprocessor server application The "Matrix multiply" eRPC server project for multiprocessor applications is located in the *<MCUXpressoSDK_install_dir»/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>* folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires server-related generated files (server shim code), server infrastructure files, and the server user code. There is no need for server multicore infrastructure files (MCMGR and RPMsg-Lite). The RPMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|SPI|<eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_slave.cpp

<eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.cpp

| |UART|<eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.cpp

|

Server user code The server's user code is stored in the main_server.c file, located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>/* folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(Matrix matrix1, Matrix matrix2, Matrix result_matrix)
{
  ...
}
int main()
{
  ...
  /* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver␣
↪operations */
  erpc_transport_t transport;
  transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
  ...
  /* MessageBufferFactory initialization */
  erpc_mbf_t message_buffer_factory;
  message_buffer_factory = erpc_mbf_dynamic_init();
  ...
  /* eRPC server side initialization */
  erpc_server_t server;
  server = erpc_server_init(transport, message_buffer_factory);
  ...
  /* Adding the service to the server */
  erpc_service_t service = create_MatrixMultiplyService_service();
  erpc_add_service_to_server(server, service);
  ...
  while (1)
  {
    /* Process eRPC requests */
    erpc_status_t status = erpc_server_poll(server)
    /* handle error status */
    if (status != kErpcStatus_Success)
    {
      /* print error description */
      erpc_error_handler(status, 0);
      ...
    }
    ...
  }
}
```

Parent topic: Multiprocessor server application

Multiprocessor client application The "Matrix multiply" eRPC client project for multiprocessor applications is located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/iar/* folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires client-related generated files (server shim code),

client infrastructure files, and the client user code. There is no need for client multicore infrastructure files (MCMGR and RPMsg-Lite). The RPMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|SPI|<eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_master.cpp

<eRPC base directory>/erpc_c/transports/ erpc_(d)spi_master_transport.hpp

<eRPC base directory>/erpc_c/transports/ erpc_(d)spi_master_transport.cpp

| |UART|<eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.hpp

<eRPC base directory>/erpc_c/transports/erpc_uart_cmsis_transport.cpp

|

Client user code The client's user code is stored in the main_client.c file, located in the *<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/* folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

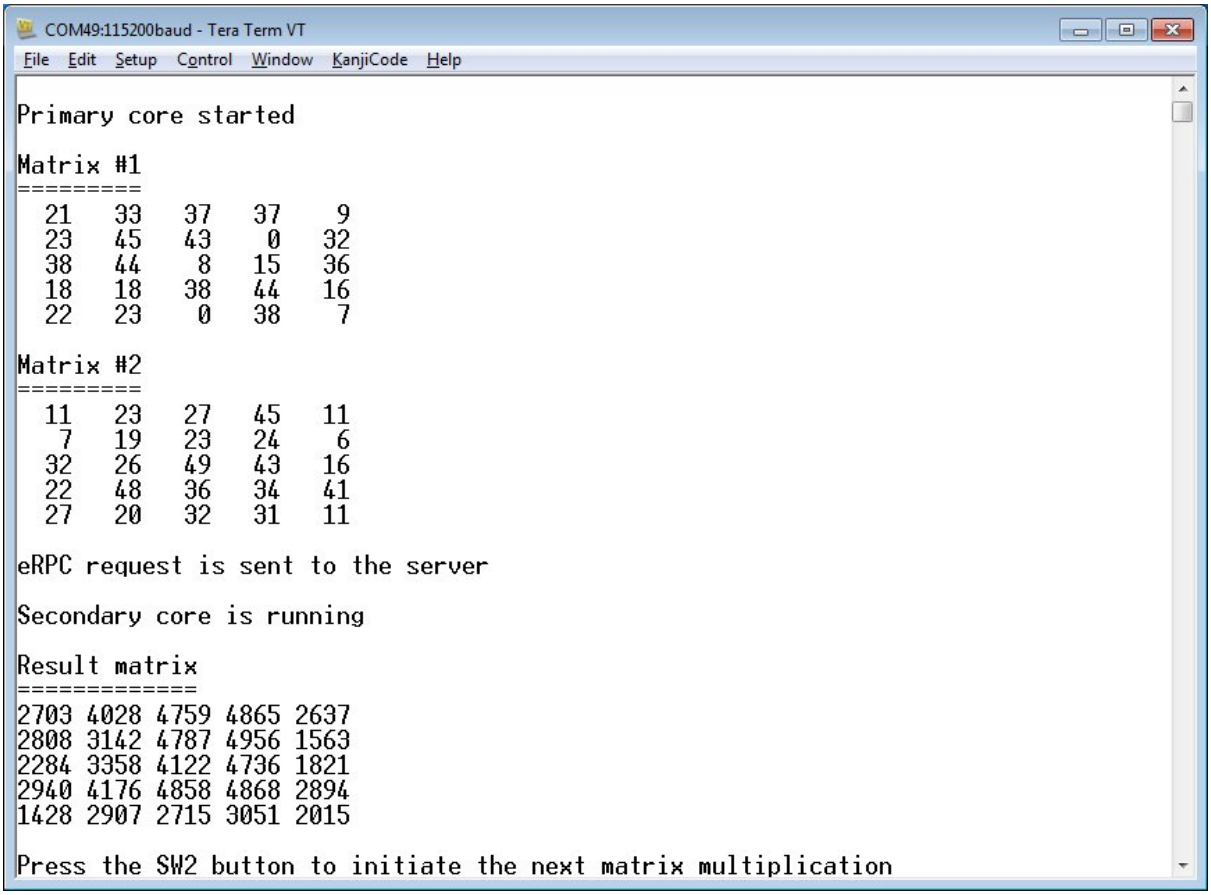
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver␣
↪operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_dynamic_init();
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport,message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
  /* Invoke the erpcMatrixMultiply function */
  erpcMatrixMultiply(matrix1, matrix2, result_matrix);
  ...
  /* Check if some error occured in eRPC */
  if (g_erpc_error_occurred)
  {
    /* Exit program loop */
    break;
  }
  ...
}
```

Parent topic: Multiprocessor client application

Parent topic: Multiprocessor server application

Parent topic:*Create an eRPC application*

Running the eRPC application Follow the instructions in *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) (located in the *<MCUXpressoSDK_install_dir>/docs* folder), to load both the primary and the secondary core images into the on-chip memory, and then effectively debug the dual-core application. After the application is running, the serial console should look like:



For multiprocessor applications that are running between PC and the target evaluation board or between two boards, follow the instructions in the accompanied example readme files that provide details about the proper board setup and the PC side setup (Python).

Parent topic:*Create an eRPC application*

Parent topic:*eRPC example*

Other uses for an eRPC implementation The eRPC implementation is generic, and its use is not limited to just embedded applications. When creating an eRPC application outside the embedded world, the same principles apply. For example, this manual can be used to create an eRPC application for a PC running the Linux operating system. Based on the used type of transport medium, existing transport layers can be used, or new transport layers can be implemented.

For more information and erpc updates see the github.com/EmbeddedRPC.

Note about the source code in the document Example code shown in this document has the following copyright and BSD-3-Clause license:

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Changelog eRPC All notable changes to this project will be documented in this file.

The format is based on Keep a Changelog, and this project adheres to Semantic Versioning.

Unreleased

1.14.0

Added

- Added Cmake/Kconfig support.
- Made java code jdk11 compliant, GitHub PR #432.
- Added imxrt1186 support into mu transport layer.
- erpcgen: Added assert for listType before usage, GitHub PR #406.

Fixed

- eRPC: Sources reformatted.
- erpc: Fixed typo in semaphore get (mutex -> semaphore), and write it can fail in case of timeout, GitHub PR #446.
- erpc: Free the arbitrated client token from client manager, GitHub PR #444.
- erpc: Fixed Makefile, install the erpc_simple_server header, GitHub PR #447.
- erpc_python: Fixed possible AttributeError and OSError on calling TCPTransport.close(), GitHub PR #438.
- Examples and tests consolidated.

1.13.0

Added

- erpc: Add BSD-3 license to endianness agnostic files, GitHub PR #417.
- eRPC: Add new Zephyr-related transports (zephyr_uart, zephyr_mbox).
- eRPC: Add new Zephyr-related examples.

Fixed

- eRPC,erpcgen: Fixing/improving markdown files, GitHub PR #395.
- eRPC: Fix Python client TCPTransports not being able to close, GitHub PR #390.
- eRPC,erpcgen: Align switch brackets, GitHub PR #396.
- erpc: Fix zephyr uart transport, GitHub PR #410.
- erpc: UART ZEPHYR Transport stop to work after a few transactions when using USB-CDC resolved, GitHub PR #420.

Removed

- eRPC,erpcgen: Remove cstbool library, GitHub PR #403.

1.12.0

Added

- eRPC: Add dynamic/static option for transport init, GitHub PR #361.
- eRPC,erpcgen: Winsock2 support, GitHub PR #365.
- eRPC,erpcgen: Feature/support multiple clients, GitHub PR #271.
- eRPC,erpcgen: Feature/buffer head - Framed transport header data stored in MessageBuffer, GitHub PR #378.
- eRPC,erpcgen: Add experimental Java support.

Fixed

- eRPC: Fix receive error value for spidev, GitHub PR #363.
- eRPC: UartTransport::init adaptation to changed driver.
- eRPC: Fix typo in assert, GitHub PR #371.
- eRPC,erpcgen: Move enums to enum classes, GitHub PR #379.
- eRPC: Fixed rpmsg tty transport to work with serial transport, GitHub PR #373.

1.11.0

Fixed

- eRPC: Makefiles update, GitHub PR #301.
- eRPC: Resolving warnings in Python, GitHub PR #325.
- eRPC: Python3.8 is not ready for usage of typing.Any type, GitHub PR #325.
- eRPC: Improved codec function to use reference instead of address, GitHub PR #324.

- eRPC: Fix NULL check for pending client creation, GitHub PR #341.
- eRPC: Replace sprintf with snprintf, GitHub PR #343.
- eRPC: Use MU_SendMsg blocking call in MU transport.
- eRPC: New LPSPI and LPI2C transport layers.
- eRPC: Freeing static objects, GitHub PR #353.
- eRPC: Fixed casting in deinit functions, GitHub PR #354.
- eRPC: Align LIBUSBSIO.GetNumPorts API use with libusbsio python module v. 2.1.11.
- erpcgen: Renamed temp variable to more generic one, GitHub PR #321.
- erpcgen: Add check that string read is not more than max length, GitHub PR #328.
- erpcgen: Move to g++ in pytest, GitHub PR #335.
- erpcgen: Use build=release for make, GitHub PR #334.
- erpcgen: Removed boost dependency, GitHub PR #346.
- erpcgen: Mingw support, GitHub PR #344.
- erpcgen: VS build update, GitHub PR #347.
- erpcgen: Modified name for common types macro scope, GitHub PR #337.
- erpcgen: Fixed memcpy for template, GitHub PR #352.
- eRPC,erpcgen: Change default build target to release + adding artefacts, GitHub PR #334.
- eRPC,erpcgen: Remove redundant includes, GitHub PR #338.
- eRPC,erpcgen: Many minor code improvements, GitHub PR #323.

1.10.0

Fixed

- eRPC: MU transport layer switched to blocking MU_SendMsg() API use.

1.10.0

Added

- eRPC: Add TCP_NODELAY option to python, GitHub PR #298.

Fixed

- eRPC: MUTransport adaptation to new supported SoCs.
- eRPC: Simplifying CI with installing dependencies using shell script, GitHub PR #267.
- eRPC: Using event for waiting for sock connection in TCP python server, formatting python code, C specific includes, GitHub PR #269.
- eRPC: Endianness agnostic update, GitHub PR #276.
- eRPC: Assertion added for functions which are returning status on freeing memory, GitHub PR #277.
- eRPC: Fixed closing arbitrator server in unit tests, GitHub PR #293.
- eRPC: Makefile updated to reflect the correct header names, GitHub PR #295.

- eRPC: Compare value length to used length() in reading data from message buffer, GitHub PR #297.
- eRPC: Replace EXPECT_TRUE with EXPECT_EQ in unit tests, GitHub PR #318.
- eRPC: Adapt rpmsg_lite based transports to changed rpmsg_lite_wait_for_link_up() API parameters.
- eRPC, erpcgen: Better distuingish which file can and cannot by linked by C linker, GitHub PR #266.
- eRPC, erpcgen: Stop checking if pointer is NULL before sending it to the erpc_free function, GitHub PR #275.
- eRPC, erpcgen: Changed api to count with more interfaces, GitHub PR #304.
- erpcgen: Check before reading from heap the buffer boundaries, GitHub PR #287.
- erpcgen: Several fixes for tests and CI, GitHub PR #289.
- erpcgen: Refactoring erpcgen code, GitHub PR #302.
- erpcgen: Fixed assigning const value to enum, GitHub PR #309.
- erpcgen: Enable runTesttest_enumErrorCode_allDirection, serialize enums as int32 instead of uint32.

1.9.1

Fixed

- eRPC: Construct the USB CDC transport, rather than a client, GitHub PR #220.
- eRPC: Fix premature import of package, causing failure when attempting installation of Python library in a clean environment, GitHub PR #38, #226.
- eRPC: Improve python detection in make, GitHub PR #225.
- eRPC: Fix several warnings with deprecated call in pytest, GitHub PR #227.
- eRPC: Fix freeing union members when only default need be freed, GitHub PR #228.
- eRPC: Fix making test under Linux, GitHub PR #229.
- eRPC: Assert costumizing, GitHub PR #148.
- eRPC: Fix corrupt clientList bug in TransportArbitrator, GitHub PR #199.
- eRPC: Fix build issue when invoking g++ with -Wno-error=free-nonheap-object, GitHub PR #233.
- eRPC: Fix inout cases, GitHub PR #237.
- eRPC: Remove ERPC_PRE_POST_ACTION dependency on return type, GitHub PR #238.
- eRPC: Adding NULL to ptr when codec function failed, fixing memcpy when fail is present during deserialization, GitHub PR #253.
- eRPC: MessageBuffer usage improvement, GitHub PR #258.
- eRPC: Get rid for serial and enum34 dependency (enum34 is in python3 since 3.4 (from 2014)), GitHub PR #247.
- eRPC: Several MISRA violations addressed.
- eRPC: Fix timeout for Freertos semaphore, GitHub PR #251.
- eRPC: Use of rpmsg_lite_wait_for_link_up() in rpmsg_lite based transports, GitHub PR #223.
- eRPC: Fix codec nullptr dereferencing, GitHub PR #264.

- erpcgen: Fix two syntax errors in erpcgen Python output related to non-encapsulated unions, improved test for union, GitHub PR #206, #224.
- erpcgen: Fix serialization of list/binary types, GitHub PR #240.
- erpcgen: Fix empty list parsing, GitHub PR #72.
- erpcgen: Fix templates for malloc errors, GitHub PR #110.
- erpcgen: Get rid of encapsulated union declarations in global scale, improve enum usage in unions, GitHub PR #249, #250.
- erpcgen: Fix compile error:UniqueIdChecker.cpp:156:104:'sort' was not declared, GitHub PR #265.

1.9.0

Added

- eRPC: Allow used LIBUSBSIO device index being specified from the Python command line argument.

Fixed

- eRPC: Improving template usage, GitHub PR #153.
- eRPC: run_clang_format.py cleanup, GitHub PR #177.
- eRPC: Build TCP transport setup code into liberpc, GitHub PR #179.
- eRPC: Fix multiple definitions of g_client error, GitHub PR #180.
- eRPC: Fix memset past end of buffer in erpc_setup_mbf_static.cpp, GitHub PR #184.
- eRPC: Fix deprecated error with newer pytest version, GitHub PR #203.
- eRPC, erpcgen: Static allocation support and usage of rpmsg static FreeRTOSs related APi, GitHub PR #168, #169.
- erpcgen: Remove redundant module imports in erpcgen, GitHub PR #196.

1.8.1

Added

- eRPC: New i2c_slave_transport trasnport introduced.

Fixed

- eRPC: Fix misra erpc c, GitHub PR #158.
- eRPC: Allow conditional compilation of message_loggers and pre_post_action.
- eRPC: (D)SPI slave transports updated to avoid busy loops in rtos environments.
- erpcgen: Re-implement EnumMember::hasValue(), GitHub PR #159.
- erpcgen: Fixing several misra issues in shim code, erpcgen and unit tests updated, GitHub PR #156.
- erpcgen: Fix bison file, GitHub PR #156.

1.8.0

Added

- eRPC: Support win32 thread, GitHub PR #108.
- eRPC: Add mbed support for malloc() and free(), GitHub PR #92.
- eRPC: Introduced pre and post callbacks for eRPC call, GitHub PR #131.
- eRPC: Introduced new USB CDC transport.
- eRPC: Introduced new Linux spidev-based transport.
- eRPC: Added formatting extension for VSC, GitHub PR #134.
- erpcgen: Introduce ustring type for unsigned char and force cast to char*, GitHub PR #125.

Fixed

- eRPC: Update makefile.
- eRPC: Fixed warnings and error with using MessageLoggers, GitHub PR #127.
- eRPC: Extend error msg for python server service handle function, GitHub PR #132.
- eRPC: Update CMSIS UART transport layer to avoid busy loops in rtos environments, introduce semaphores.
- eRPC: SPI transport update to allow usage without handshaking GPIO.
- eRPC: Native _WIN32 erpc serial transport and threading.
- eRPC: Arbitrator deadlock fix, TCP transport updated, TCP setup functions introduced, GitHub PR #121.
- eRPC: Update of matrix_multiply.py example: Add –serial and –baud argument, GitHub PR #137.
- eRPC: Update of .clang-format, GitHub PR #140.
- eRPC: Update of erpc_framed_transport.cpp: return error if received message has zero length, GitHub PR #141.
- eRPC, erpcgen: Fixed error messages produced by -Wall -Wextra -Wshadow -pedantic-errors compiler flags, GitHub PR #136, #139.
- eRPC, erpcgen: Core re-formatted using Clang version 10.
- erpcgen: Enable deallocation in server shim code when callback/function pointer used as out parameter in IDL.
- erpcgen: Removed '$' character from generated symbol name in '_$union' suffix, GitHub PR #103.
- erpcgen: Resolved mismatch between C++ and Python for callback index type, GitHub PR #111.
- erpcgen: Python generator improvements, GitHub PR #100, #118.
- erpcgen: Fixed error messages produced by -Wall -Wextra -Wshadow -pedantic-errors compiler flags, GitHub PR #136.

1.7.4

Added

- eRPC: Support MU transport unit testing.
- eRPC: Adding mbed os support.

Fixed

- eRPC: Unit test code updated to handle service add and remove operations.
- eRPC: Several MISRA issues in rpmsg-based transports addressed.
- eRPC: Fixed Linux/TCP acceptance tests in release target.
- eRPC: Minor documentation updates, code formatting.
- erpcgen: Whitespace removed from C common header template.

1.7.3

Fixed

- eRPC: Improved the test_callbacks logic to be more understandable and to allow requested callback execution on the server side.
- eRPC: TransportArbitrator::prepareClientReceive modified to avoid incorrect return value type.
- eRPC: The ClientManager and the ArbitratedClientManager updated to avoid performing client requests when the previous serialization phase fails.
- erpcgen: Generate the shim code for destroy of statically allocated services.

1.7.2

Added

- eRPC: Add missing doxygen comments for transports.

Fixed

- eRPC: Improved support of const types.
- eRPC: Fixed Mac build.
- eRPC: Fixed serializing python list.
- eRPC: Documentation update.

1.7.1

Fixed

- eRPC: Fixed semaphore in static message buffer factory.
- erpcgen: Fixed MU received error flag.
- erpcgen: Fixed tcp transport.

1.7.0

Added

- eRPC: List names are based on their types. Names are more deterministic.
- eRPC: Service objects are as a default created as global static objects.
- eRPC: Added missing doxygen comments.
- eRPC: Added support for 64bit numbers.
- eRPC: Added support of program language specific annotations.

Fixed

- eRPC: Improved code size of generated code.
- eRPC: Generating crc value is optional.
- eRPC: Fixed CMSIS Uart driver. Removed dependency on KSDK.
- eRPC: Forbid users use reserved words.
- eRPC: Removed outByref for function parameters.
- eRPC: Optimized code style of callback functions.

1.6.0

Added

- eRPC: Added @nullable support for scalar types.

Fixed

- eRPC: Improved code size of generated code.
- eRPC: Improved eRPC nested calls.
- eRPC: Improved eRPC list length variable serialization.

1.5.0

Added

- eRPC: Added support for unions type non-wrapped by structure.
- eRPC: Added callbacks support.
- eRPC: Added support @external annotation for functions.
- eRPC: Added support @name annotation.
- eRPC: Added Messaging Unit transport layer.
- eRPC: Added RPMSG Lite RTOS TTY transport layer.
- eRPC: Added version verification and IDL version verification between eRPC code and eRPC generated shim code.
- eRPC: Added support of shared memory pointer.

- eRPC: Added annotation to forbid generating const keyword for function parameters.
- eRPC: Added python matrix multiply example.
- eRPC: Added nested call support.
- eRPC: Added struct member “byref” option support.
- eRPC: Added support of forward declarations of structures
- eRPC: Added Python RPMsg Multiendpoint kernel module support
- eRPC: Added eRPC sniffer tool

1.4.0

Added

- eRPC: New RPMsg-Lite Zero Copy (RPMsgZC) transport layer.

Fixed

- eRPC: win_flex_bison.zip for windows updated.
- eRPC: Use one codec (instead of inCodec outCodec).

[1.3.0]

Added

- eRPC: New annotation types introduced (@length, @max_length, ...).
- eRPC: Support for running both erpc client and erpc server on one side.
- eRPC: New transport layers for (LP)UART, (D)SPI.
- eRPC: Error handling support.

[1.2.0]

Added

- eRPC source directory organization changed.
- Many eRPC improvements.

[1.1.0]

Added

- Multicore SDK 1.1.0 ported to KSDK 2.0.0.

[1.0.0]

Added

- Initial Release

3.7 Multimedia

3.7.1 Audio Voice

Audio Voice Components

MCUXpresso SDK : audio-voice-components

Overview This repository is for MCUXpresso SDK audio-voice-components middleware delivery and it contains the components officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository (mcuxsdk-manifests) for the complete delivery of MCUXpresso SDK.

Documentation Overall details can be reviewed here: MCUXpresso SDK Online Documentation

Visit Audio Voice Components - Documentation to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution Contributions are not currently accepted. Guidelines to contribute will be posted in the future.

Overview This repository allows users to add additional functionality to the Maestro Audio framework. This structure is designed for integration with Maestro and is not intended for standalone use. For information on the use of individual components, please refer to the Maestro programmer's guide.

This repository acts as Zephyr module, to be able to use these libraries in Zephyr build system.

Content

- *asrc* - Libraries and public files of Asynchronous Sample Rate Converter, version 1.0.0
- *ssrc* - Libraries and public files of Synchronous Sample Rate Converter, version 1.0.0
- *opus* - Source files of Opus decoder and encoder, version 1.3.1
- *opusfile* - Source files for Opus streams in the Ogg container, version 0.12
- *ogg* - Source files of Ogg container, version 1.3.5
- *decoders* - Libraries and public files of following audio decoders:
  - *aac* - AAC decoder, version 1.0.0
  - *flac* - FLAC decoder, version 1.0.0
  - *mp3* - MP3 decoder, version 1.0.0
  - *wav* - WAV decoder, version 1.0.0
- zephyr/ - Files allowing usage of the libraries in Zephyr build

Following table contains information about libraries and source files availability:

Asynchronous Sample Rate Converter The Asynchronous Sample Rate Converter (ASRC) software module compensates the drift between two mono audio signals. This is not a frequency converter and so the nominal signal frequency is the same before and after the ASRC. More details about ASRC are available in the User Guide, which is located in asrc\doc\.

Synchronous Sample Rate Converter The Synchronous Sample Rate Converter (SSRC) software module converts an audio signal (mono or stereo) with a certain sampling frequency to an audio signal with another sampling frequency. More details about SSRC are available in the *User Guide*.

Opus For Opus decoder and encoder documentation please see following link: opus.

Opus File The Opus File provides a API for decoding and basic manipulation of Opus streams in Ogg container and depends on *Opus* and *Ogg* libraries. For Opus File documentation please see following link: opusfile.

Ogg Container For Ogg container documentation please see following link: ogg.

Decoders Each decoder contains libraries for supported processor and toolchain (see table above), corresponding Public API file and documentation folder.

AAC For decoder features please see *aacdec*, for API Usage please see *aacd_ug*.

FLAC For decoder features please see *flacdec*, for API Usage please see *flacd_ug*.

MP3 For decoder features please see *mp3dec*, for API Usage please see *mp3d_ug*.

WAV For decoder features please see *wavdec*, for API Usage please see *wavd_ug*.

Zephyr build To add library into the Zephyr build, add CONFIG_NXP_AUDIO_VOICE_COMPONENTS_* for specific libraries into your prj.conf. For all configuration options, see *zephyr/Kconfig*.

List of supported libraries in Zephyr:

- Decoders:
  - AAC
  - FLAC
  - MP3
  - FLAC
  - OPUS
- Encoders
  - OPUS

AAC decoder

AAC decoder features

- The AAC decoder implementation supports the following:
- Supported profile : AAC-LC
- Sampling rate : 8 kHz, 11.025 kHz, 12 kHz, 16 kHz, 22.05 kHz, 24 kHz, 32 kHz, 44.1 kHz, 48 kHz
- Channel : stereo and mono
- Bits per samples : 16 bit
- Container format : (MPEG-2 Style)AAC transport format - ADTS and ADIF.

Specification and reference

Performance

Memory information The memory usage of the decoder in bytes is:

- Code/flash = 26332 + 19264 = 45596
- Data/RAM = 26832

Section	Size
.text	26332
.ro & .const	19264
.bss	26832

CPU usage

- CPU core clock in MHz: 20.97.

Track type	Duration of track in second	Frame size in bytes	Performance MIPS of codec (in MHz)
48 kHz, stereo	38 s	4096	12.2 MHz

API Usage of AAC Decoder

Overview

- This section describes the integration steps to call AAC decoder APIs by the application code. During each step, the used data structures and functions are explained. All CCI public APIs are defined in aac_cci.h header file. This file is located at \decoders\aac.

Configuration

Build Options AAC Decoder library is built with the following defined/enabled macros.

- There is no macro or define used to build the AAC decoder.

Buffer Allocation

- The AAC decoder does not perform dynamic memory allocation. The application calls the function AACDecoderGetMemorySize() to get the decoder memory requirements. This function must be called before all other decoder functions are invoked.
- The application first gets the required memory size for the decoder, then allocates memory for the decoder structures. Structures contain Main Decoder parameters and decoder information parameters.
- This function populates the required memory for the decoder and returns the required memory size in bytes.

Initialization

- AACDecoderInit() function must be called before decode API. This API allocates the memory to decoder main structure and also initializes the decoder main structure parameters.
- It also registers the call back functions to the decoder, which is used by the decoder to read or seek the input stream.

Decoding

- AACDecoderDecode() function is main decoding API of the decoder. This API decodes the encoded input stream and fills the PCM output samples into decoder output PCM buffer.
- This API gives the information about the number of samples produced by the decoder and also provides the pointer to the decoder output PCM samples buffer.

Seeking

- AACDecoderSeek() function calculates the actual frame boundary align offset from the unalign seek offset and returns the actual seek offset. It also resets the decoder internal states and variables.

Callback Usage All the callback functions are assigned to the respective pointers before the codec initialization is called. Callback APIs are described below.

Read Callback API AAC Decoder read call back API reads the bytes from the input stream and fills them into decoder internal bit stream buffer. It returns the number of bytes read from the input stream.

Seek Callback API This call back API is for the seek operation.

Get File Position Callback API This call back API gives the current file position.

FLAC decoder

FLAC decoder features

- The FLAC decoder implementation support the following:
- Sampling rate: 8 kHz, 11.05 kHz, 12 kHz, 16 kHz, 22.05 kHz, 32 kHz, 44.1 kHz, and 48 kHz.
- Channel : stereo and mono
- Bits per samples : 16 bits

Specification and reference

Official website

- FLAC lossless audio codec is at https://xiph.org/flac.

Inbound licensing

- For licensing information please refer to FLAC's official website: https://xiph.org/flac/license.html.

Performance

Memory information The memory usage of the decoder in bytes is:

- Code/flash = 15744 + 2080 = 17824
- Data/RAM = 27936

Section	Size
.text	15744
.ro & .const	2080
.bss	27936

CPU usage

- Output frame size: 16384 bytes.
- CPU core clock in MHz: 20.97.

Track type	Duration of track in second	Performance MIPS of codec (in MHz)
48 kHz, stereo	76 s	30.7 MHz
32 kHz, stereo	76 s	20.3 MHz
8 kHz, stereo	37 s	5.34 MHz

Following test cases are performed:

- Audio format listening test
- Audio quality test

For all above test cases, test tracks are played through the end without any distortion, glitching, hanging, or crashing.

API Usage of FLAC Decoder

Overview

- This section describes the integration steps to call FLAC decoder APIs by the application code. During each step the used data structures and functions are explained. All cci public APIs are defined in flac_cci.h header file. This file is located at \decoders\flac\include.

Configuration

Build Options

- SUPPORT_16_BITS_ONLY :- This macro is used to enable 16bits per sample flac decoder.
- *ASM* :- This macro is used to enable ARM assembly macros for 24bits per sample flac decoder.

Buffer Allocation

- The FLAC decoder does not perform dynamic memory allocation. The application calls the function FLACDecoderGetMemorySize() to get the decoder memory requirements. This function must be called before all other decoder functions are invoked.
- The application first gets the required memory size for the decoder and then allocates memory for the decoder structures. Structures contain Main Decoder parameters and decoder information parameters.
- This function populates the required memory for the decoder and returns the required memory size in bytes.

Initialization

- FLACDecoderInit() function must be called before decode API. This API allocates the memory to decoder main structure and also initializes the decoder main structure parameters.
- It also registers the call back functions to the decoder, which will be used by decoder to read or to seek the input stream.

Decoding

- FLACDecoderDecode() function is main decoding API of the decoder. This API decodes the encoded input stream and fills the PCM output samples into decoder output PCM buffer.
- This API gives the information about the number of samples produced by the decoder and also provides the pointer to the decoder output PCM samples buffer.

Seeking

- FLACDecoderSeek() function calculates the actual frame boundary align offset from the unalign seek offset and returns the actual seek offset. It also resets the decoder internal states and variables.

Callback Usage All the callback functions will be assigned to the respective pointers before the codec initialization is called. Callback APIs are described below.

Read Callback API FLAC Decoder read call back API reads the bytes from the input stream and fills them into decoder internal bit stream buffer. It returns the number of bytes read from the input stream.

Seek Callback API This call back API is for the seek operation.

Get File Position Callback API This call back API gives the current file position.

MP3 decoder

MP3 decoder features

- MP3 decoder supports mpeg-1, mpeg-2, mpeg-2.5.
- All MP3 features supported , including joint stereo, mid-side stereo, intensity stereo, and dual channel.
- Supported sampling rate: 8 kHz, 11.025 kHz, 12 kHz, 16 kHz, 22.05 kHz, 24 kHz, 32 kHz, 44.1 kHz and 48 kHz.
- Supported channel: stereo and mono
- Supported bits per samples: 16 bit
- Supported bit rate: 8, 16, 24, 32, 40, 48, 56, 64, 80, 96, 112, 128, 144, 160, 176, 192, 224, 256, 320, 384, 416, and 448.

Performance

Memory information The memory usage of the decoder (data obtained from IAR compiler) in bytes is:

- Code/flash = 26884 + 18372 = 45256
- RAM = 16200

Section	Size
.text	26884
.ro & .const	18372
.bss	16200

CPU usage The performance of the decoder was measured using the real hardware platform (RT1060).

- CPU core clock in MHz: 600.

Track type	Duration of track in second	Frame size in bytes	Performance MIPS of codec (in MHz)
320 Kbps, 44.1 kHz, stereo	358 s	2304	~24 MHz
192 Kbps, 48 kHz, stereo	10 s	2304	~18 MHz

API Usage of MP3 Decoder

Overview

- This section describes the integration steps to call MP3 decoder APIs by the application code. During each step the used data structures and functions are explained. All cci public APIs are defined in mp3_cci.h header file. This file is located at \decoders\mp3.

Configuration

Build Options MP3 Decoder library is built with the following defined/enabled macros.

- There is no macro or define used to build the MP3 decoder.

Buffer Allocation

- The MP3 decoder does not perform dynamic memory allocation. The application calls the function MP3DecoderGetMemorySize() to get the decoder memory requirements. This function must be called before all other decoder functions are invoked.
- The application first gets the required memory size for the decoder and then allocates memory for the decoder structures. Structures contain Main Decoder parameters and decoder information parameters.
- This function populates the required memory for the decoder and returns the required memory size in bytes.

Initialization

- MP3DecoderInit() function must be called before decode API. This API allocates the memory to decoder main structure and also initializes the decoder main structure parameters.
- It also registers the call back functions to the decoder, which will be used by decoder to read or to seek the input stream.

Decoding

- MP3DecoderDecode() function is main decoding API of the decoder. This API decodes the encoded input stream and fills the PCM output samples into decoder output PCM buffer.
- This API gives the information about the number of samples produced by the decoder and also provides the pointer to the decoder output PCM samples buffer.

Seeking

- MP3DecoderSeek() function calculates the actual frame boundary align offset from the unalign seek offset and returns the actual seek offset. It also resets the decoder internal states and variables.

Callback Usage All the callback functions will be assigned to the respective pointers before the codec initialization is called. Callback APIs are described below.

Read Callback API MP3 Decoder read call back API reads the bytes from the input stream and fills them into decoder internal bit stream buffer. It returns the number of bytes read from the input stream.

Seek Callback API This call back API is for the seek operation.

Get File Position Callback API This call back API gives the current file position.

WAV decoder

WAV decoder features

- The WAV decoder implementation support the following:
- Sampling rate: 8 kHz, 11.025kHz, 16 kHz, 22.05 kHz, 32 kHz, 44.1 kHz, and 48 kHz.
- Channel: stereo and mono
- PCM format with 8/16/24 bits per sample.

Performance

Memory information The memory usage of the decoder in bytes is:

- Code/flash = 6260 + 342 = 6602
- Data/RAM = 16 + 20696 = 20712

Section	Size
.text	6260
.ro & .const	342
.bss	20696
.data	16

CPU usage The performance of the decoder was measured using the decoder standalone unit test.

- CPU core clock in MHz: 20.97 MHz.

Track type	Duration of track in second	Frame size in bytes	Performance MIPS of codec (in MHz)
48 kHz, stereo, PCM	12 s	4096	9.68 MHz

Following test cases were performed:

- Audio format listening test
- Audio quality test

For all above test cases, test tracks are played through the end without any distortion, glitching, hanging, or crashing.

API Usage of WAV Decoder

Overview

- This section describes the integration steps to call MP3 decoder APIs by the application code. During each step the used data structures and functions are explained. All cci public APIs are defined in wav_cci.h header file. This file is located at \decoders\wav.

Configuration

Build Options WAV Decoder library is built with the following defined/enabled macros.

- There is no macro or define used to build the WAV decoder.

Buffer Allocation

- The WAV decoder does not perform dynamic memory allocation. The application calls the function WAVDecoderGetMemorySize() to get the decoder memory requirements. This function must be called before all other decoder functions are invoked.
- The application first gets the required memory size for the decoder and then allocates memory for the decoder structures. Structures contain Main Decoder parameters and decoder information parameters.
- This function populates the required memory for the decoder and returns the required memory size in bytes.

Initialization

- WAVDecoderInit() function must be called before decode API. This API allocates the memory to decoder main structure and also initializes the decoder main structure parameters.
- It also registers the call back functions to the decoder, which will be used by decoder to read or to seek the input stream.

Decoding

- WAVDecoderDecode() function is main decoding API of the decoder. This API decodes the encoded input stream and fills the PCM output samples into decoder output PCM buffer.
- This API gives the information about the number of samples produced by the decoder and also provides the pointer to the decoder output PCM samples buffer.

Seeking

- WAVDecoderSeek() function calculates the actual frame boundary align offset from the unalign seek offset and returns the actual seek offset. It also resets the decoder internal states and variables.

Callback Usage All the callback functions will be assigned to the respective pointers before the codec initialization is called. Callback APIs are described below.

Read Callback API WAV Decoder read call back API reads the bytes from the input stream and fills them into decoder internal bit stream buffer. It returns the number of bytes read from the input stream.

Seek Callback API This call back API is for the seek operation.

Get File Position Callback API This call back API gives the current file position.

Synchronous Sample Rate Converter

Introduction The Synchronous Sample Rate Converter (SSRC) software module converts a mono or stereo audio signal with a certain sampling frequency to an audio signal with a different sampling frequency. The sample rate converter works synchronously, meaning that input and output sampling rates are exactly known for a mutual clock reference.

To accomplish a professional sampling conversion quality and minimal system footprint, the SRC SW module contains highly optimized components.

The SSRC module supports the following features.

- Multiple instances of the sample rate converter can run at the same time.
- Supported sampling frequencies: 32 kHz, 44.1 kHz, and 48 kHz plus the halves and the quarters of these three sample rates. The input and output sample rates are freely selectable out of the supported sampling rates
- Selectable Mono/Stereo Input/Output.
- Selectable quality level: high quality/ very high quality.

Acronyms *Table 1* lists the acronyms used in this document.

Acror	Description
Fs	Sampling Frequency
Fs-LOW(	Lowest sample rate used for the conversion **Note:** Input sample rate for up sampling and the output sample rate for down sampling
FsIN	Input sample rate
FsOU	Output sample rate
MIPS	Million Instructions Per Second
SSRC	Synchronous sample rate converter
THD+	Total Harmonic Distortion plus Noise **Note:** The THD+N is defined as the total power of the unwanted signal divided by the power of the wanted signal. The wanted signal is defined as a full scale, 1 kHz sine wave.

Parent topic:*Introduction*

Performance figures The Total Harmonic Distortion Plus Noise (THD+N) of the converted signals is below - 76 (high-quality mode) and - 85 (very high-quality mode) for signal frequencies below 0.45*FsLOW (=90 % of the Nyquist range of the lowest sample clock)

Table 1 and *Table 2* give the THD+N performance (FsIN on the vertical axis and FsOUT on the horizontal axis) for the two supported quality levels. The numbers in the tables give the worst-case THD+N measured for signal frequencies below 0.45*FsLOW. For each conversion ratio, 100 THD+N measurements were executed with signal frequencies linearly spread over the complete Nyquist range.

FsIN/ FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	-92.1	-79.7	-80.1	-80.1	-79.6	-80.2	-79.4	-79.1	-79.2
11025	-79	-92.9	-80	-79.9	-80.2	-79.8	-79.9	-79.5	-78.9
12000	-79	-79.2	-92.7	-80.1	-79.8	-80.3	-79.8	-79.8	-79.5
16000	-81.7	-78.8	-80.2	-93	-78.3	-77.7	-78.3	-78.3	-77.9
22050	-77.5	-81.8	-78.2	-79	-93	-79.9	-79.8	-80.3	-79.9
24000	-77.4	-77.9	-81.2	-79.1	-79.2	-92.5	-80.1	-79.8	-79.9
32000	-81	-77.5	-78.9	-81.2	-78.7	-80.1	-92.9	-79.7	-79.2
44100	-79.1	-81.2	-76.7	-77.8	-82	-78.2	-79.1	-93	-79.7
48000	-78.7	-78.8	-81.1	-77.6	-77.9	-81.8	-79.1	-79.3	-93

FsIN/ FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	-92.1	-86.6	-88.6	-91.5	-86.4	-89	-89.7	-89.3	-89.3
11025	-89.1	-92.9	-86.3	-86.3	-91.6	-86.3	-86.5	-89.7	-89.3
12000	-91.4	-88.4	-92.7	-89.6	-86.6	-91.5	-86.8	-86.6	-89.7
16000	-93.1	-88.4	-90.4	-93	-86.6	-88.8	-91.5	-86.5	-89.4
22050	-90.7	-93.5	-89.7	-89.3	-93	-86.5	-86.3	-91.5	-86.6
24000	-93.8	-90.5	-93.5	-91.7	-88.4	-92.5	-89.7	-86.6	-91.5
32000	-93.8	-91	-91.2	-93.3	-88.4	-90.5	-92.9	-86.7	-89
44100	-93.7	-93.6	-91.5	-90.6	-93.8	-89.8	-89.3	-93	-86.5
48000	-94.1	-92.6	-94	-94	-90.1	-93.7	-91.8	-88.4	-93

Parent topic:*Introduction*

Resource usage This section lists the memory and processing requirements for the SSRC module.

Memory requirements The following are the memory requirements for the SSRC module.

Memory item	Size in bytes
Instance memory (persistent)	548
Scratch memory (non-persistent)	15.536 *1*
Program memory for Arm9E and XScale	14k
Program memory for Arm7	15k

Parent topic: Resource usage

1 Worst case number for I/O buffers of 40 ms. If smaller I/O buffers are used, this number is smaller. The required scratch memory is roughly equal to 2 times the buffer size on the highest sample rate.

Processing requirements The following tables give the MIPS performance of the SSRC module. The cycles are measured with zero wait state memory and for I/O buffers of 40 ms.

Note: The user processing 32-bit processing must refer to the very high-quality MIPS results.

On Arm7 and Arm9

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.13	4.77	5.17	1.84	6.75	7.33	3.55	9.1	9.89
11025	5.42	0.18	5.58	6.84	2.53	7.75	9.71	4.89	10.31
12000	5.85	6.39	0.2	7.01	8.97	2.76	9.89	12.94	5.32
16000	1.69	7.74	7.99	0.26	9.54	10.33	3.68	13.5	14.65
22050	7.2	2.33	10.09	10.83	0.36	11.17	13.67	5.07	15.49
24000	7.79	8.33	2.53	11.7	12.78	0.39	14.03	17.94	5.51
32000	3.12	10.32	10.58	3.38	15.48	15.98	0.52	19.08	20.66
44100	9.96	4.3	13.65	14.4	4.65	20.18	21.67	0.72	22.34
48000	10.8	11.34	4.68	15.58	16.67	5.06	23.4	25.56	0.78

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.07	7.71	8.24	2.28	10.5	11.28	4.41	13.44	14.48
11025	8.19	0.1	8.96	11.04	3.14	12	15.09	6.08	15.2
12000	8.76	9.52	0.1	11.3	14.48	3.41	15.36	20.07	6.61
16000	2.14	11.73	12.01	0.14	15.41	16.48	4.55	21	22.56
22050	10.78	2.94	15.39	16.38	0.19	17.92	22.08	6.27	24
24000	11.57	12.34	3.2	17.51	19.04	0.21	22.61	28.97	6.83
32000	4.19	15.48	15.77	4.27	23.46	24.01	0.28	30.83	32.96
44100	14.78	5.77	20.56	21.56	5.89	30.77	32.75	0.38	35.83
48000	15.92	16.7	6.28	23.15	24.69	6.41	35.02	38.08	0.42

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.13	13.61	14.52	4.43	19.03	20.43	8.8	25.06	26.99
11025	14.85	0.18	15.91	19.47	6.1	21.82	27.35	12.13	28.38
12000	15.84	17.36	0.2	19.97	25.4	6.64	27.85	36.26	13.21
16000	4.25	21.24	21.79	0.26	27.22	29.03	8.86	38.07	40.85
22050	20.02	5.85	27.72	29.7	0.36	31.81	38.94	12.2	43.63
24000	21.45	22.98	6.37	31.68	34.71	0.39	39.94	50.8	13.28
32000	8.39	28.74	29.29	8.5	42.48	43.58	0.52	54.43	58.07
44100	28.11	11.57	38.05	40.03	11.71	55.43	59.4	0.72	63.62
48000	30.19	31.71	12.59	42.9	45.96	12.74	63.36	69.42	0.78

Parent topic: Processing requirements

On Arm9e and XScale

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.03	1.14	1.25	0.54	1.95	2.14	1.04	3.85	4.23
11025	1.31	0.05	1.36	1.62	0.75	2.23	2.78	1.44	4.38
12000	1.43	1.57	0.05	1.68	2.13	0.82	2.84	3.72	1.57
16000	0.5	1.86	1.93	0.07	2.27	2.5	1.09	3.9	4.29
22050	2.19	0.69	2.42	2.61	0.1	2.72	3.24	1.5	4.46
24000	2.4	2.52	0.75	2.86	3.15	0.1	3.35	4.25	1.63
32000	0.92	3.12	3.18	1.01	3.72	3.86	0.14	4.55	4.99
44100	4.28	1.27	4.15	4.37	1.39	4.83	5.23	0.19	5.43
48000	4.7	4.9	1.39	4.8	5.03	1.51	5.72	6.3	0.21

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.06	1.87	2.02	1.07	3.09	3.36	2.07	6.09	6.63
11025	2.27	0.09	2.25	2.66	1.47	3.56	4.4	2.85	7.01
12000	2.45	2.76	0.09	2.75	3.43	1.6	4.5	5.83	3.1
16000	0.99	3.23	3.36	0.13	3.73	4.05	2.14	6.17	6.72
22050	3.69	1.36	4.14	4.55	0.17	4.51	5.31	2.95	7.13
24000	4.01	4.28	1.48	4.9	5.51	0.19	5.51	6.85	3.21
32000	1.83	5.26	5.39	1.98	6.46	6.71	0.25	7.47	8.09
44100	7.22	2.52	6.94	7.38	2.72	8.27	9.1	0.35	9.02
48000	7.85	8.33	2.74	8.02	8.57	2.97	9.81	11.03	0.38

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.03	1.21	1.33	0.61	2.08	2.29	1.17	4.1	4.51
11025	1.47	0.05	1.44	1.72	0.84	2.38	2.97	1.61	4.66
12000	1.62	1.76	0.05	1.78	2.26	0.91	3.03	3.98	1.75
16000	0.55	2.1	2.17	0.07	2.42	2.65	1.22	4.16	4.57
22050	2.49	0.76	2.73	2.95	0.1	2.88	3.45	1.68	4.75
24000	2.75	2.86	0.83	3.23	3.52	0.1	3.56	4.53	1.83
32000	1	3.56	3.63	1.11	4.2	4.34	0.14	4.84	5.3
44100	4.86	1.38	4.74	4.98	1.53	5.46	5.89	0.19	5.75
48000	5.38	5.55	1.5	5.5	5.71	1.66	6.47	7.05	0.21

FsIN / FsOUT	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	0.06	2.11	2.29	1.2	3.55	3.86	2.31	6.99	7.61
11025	2.62	0.09	2.52	3.01	1.66	4.07	5.07	3.19	8
12000	2.85	3.15	0.09	3.11	3.9	1.81	5.17	6.75	3.47
16000	1.09	3.73	3.85	0.13	4.22	4.57	2.41	7.1	7.72
22050	4.32	1.5	4.79	5.23	0.17	5.05	6.02	3.32	8.15
24000	4.74	4.99	1.64	5.69	6.3	0.19	6.22	7.8	3.61
32000	1.98	6.18	6.3	2.18	7.45	7.71	0.25	8.44	9.14
44100	8.43	2.72	8.18	8.64	3.01	9.59	10.47	0.35	10.1
48000	9.26	9.66	2.97	9.49	9.97	3.27	11.39	12.59	0.38

Parent topic: Processing requirements

On Cortex-A8 for worst case of 48000 Hz to 44100 Hz

Mode	MIPs
Mono at High Quality	3.13
Stereo at High Quality	3.61
Mono at Very High Quality	4.13
Stereo at Very High Quality	6.52

Parent topic: Processing requirements

Parent topic: Resource usage

Parent topic:*Introduction*

Application programmers interface (API) This section describes the application programming interface (API) libraries of the SSRC module.

Type definitions This section describes the type definitions of the SSRC module.

Types for allocation of instance and scratch memory The instance memory is the memory that contains the state of one instance of the SSRC module. Multiple instances of the SSRC module can exist, each with it is own instance memory. S memory is the memory that is only used temporarily by the process function of the SSRC module. This memory can be used as scratch memory by any other function running in the same thread as the SSRC module. Different threads cannot share the scratch memories.

The application must allocate both the instance and the scratch memory. The SSRC module does not allocate memory.

There is a data type available for both the instance and the scratch memory, namely SSRC_Instance_t and SSRC_Scratch_t. The instance type is defined as structures of the correct size in the SSRC header file. Both the instance and the scratch memory must be 4 bytes aligned.

Parent topic: Type definitions

LVM_Fs_en **Definition:**

```
typedef enum
{
    LVM_FS_8000    = 0,
    LVM_FS_11025   = 1,
    LVM_FS_12000   = 2,
    LVM_FS_16000   = 3,
    LVM_FS_22050   = 4,
    LVM_FS_24000   = 5,
    LVM_FS_32000   = 6,
    LVM_FS_44100   = 7,
    LVM_FS_48000   = 8
} LVM_Fs_en;
```

Description:

Used to pass the input and the output sample rate to the SSRC.

Parent topic: Type definitions

LVM_Format_en **Definition:**

```
typedef enum
{
    LVM_STEREO          = 0,
    LVM_MONOINSTEREO    = 1,
    LVM_MONO            = 2
} LVM_Format_en;
```

Description:

The LVM_Format_en enumerated type is used to set the value of the SSRC data format.

The SSRC supports input data in two formats Mono and Stereo. For an input buffer of NumSamples = N (meaning N sample pairs for Stereo and MonoInStereo or N samples for Mono), the format of data in the buffer is as listed in *Table 1*:

Sample Number	Stereo	MonoInStereo	Mono
0	Left(0)	Mono(0)	Mono(0)
1	Right(0)	Mono(0)	Mono(1)
2	Left(1)	Mono(1)	Mono(2)
3	Right(1)	Mono(1)	Mono(3)
4	Left(2)	Mono(2)	Mono(4)
“	“	“	“
“	“	“	“
N-2	Left(N/2-1)	Mono(N/2-1)	Mono(N-2)
N-1	Right(N/2-1)	Mono(N/2-1)	Mono(N-1)
N	Left(N/2)	Mono(N/2)	Not Used
N+1	Right(N/2)	Mono(N/2)	Not Used
N+2	Left(N/2+1)	Mono(N/2+1)	Not Used
N+3	Right(N/2+1)	Mono(N/2+1)	Not Used
“	“	“	Not Used
“	“	“	Not Used
2*N-2	Left(N-1)	Mono(N-1)	Not Used

Parent topic: Type definitions

SSRC_Quality_en **Definition:**

```
typedef enum
{
    SSRC_QUALITY_HIGH           = 0,
    SSRC_QUALITY_VERY_HIGH      = 1,
    SSRC_QUALITY_DUMMY          = LVM_MAXENUM
} SSRC_Quality_en;
```

Description:

Used to select the quality level of the SSRC. For details, see Performance figures. Selecting the highest-quality level, comes with a cost in the SSRC processing requirements. Therefore, it should only be done for critical applications.

Parent topic: Type definitions

Instance parameters **Definition:**

```
typedef struct
{
    SSRC_Quality_en     Quality;
    LVM_Fs_en           SSRC_Fs_In;
    LVM_Fs_en           SSRC_Fs_Out;
    LVM_Format_en       SSRC_NrOfChannels;
    short               NrSamplesIn;
    short               NrSamplesOut;
} SSRC_Params_t;
```

Description:

Used to pass the SSRC instance parameters to the SSRC module. It is a structure that contains the members for input sample rate, output sample rate, the number of channels, and the number of samples on the input and output audio stream.

Parent topic: Type definitions

Nr of samples mode **Definition:**

```
typedef enum
{
    SSRC_NR_SAMPLES_DEFAULT     = 0,
    SSRC_NR_SAMPLES_MIN         = 1,
    SSRC_NR_SAMPLES_DUMMY       = LVM_MAXENUM
} SSRC_NR_SAMPLES_MODE_en;
```

Description:

The SSRC_NR_SAMPLES_MODE_en enumerated type specifies the two different modes that can be used to retrieve the number of samples using the SSRC_GetNrSamples function.

Parent topic: Type definitions

Function return status **Definition:**

```
typedef enum
{
    SSRC_OK                     = 0,
    SSRC_INVALID_FS             = 1,
    SSRC_INVALID_NR_CHANNELS    = 2,
    SSRC_NULL_POINTER           = 3,
    SSRC_WRONG_NR_SAMPLES       = 4,
    SSRC_ALLINGMENT_ERROR       = 5,
    SSRC_INVALID_MODE           = 6,
    SSRC_INVALID_VALUE          = 7,
    SSRC_ALLINGMENT_ERROR       = 8,
    LVXXX_RETURNSTATUS_DUMMY = LVM_MAXENUM
} SSRC_ReturnStatus_en;
```

Description:

The SSRC_ReturnStatus_en enumerated type specifies the different error codes returned by the API functions. For the exact meaning, see the individual function descriptions.

Parent topic: Type definitions

Parent topic:*Application programmers interface (API)*

Functions This section lists all the API functions of the SSRC module and explains their parameters.

SSRC_GetNrSamples **Prototype:**

```
SSRC_ReturnStatus_en SSRC_GetNrSamples
  (SSRC_NR_SAMPLES_MODE_en  Mode,
   SSRC_Params_t*           pSSRC_Params );
```

Description:

This function retrieves the number of samples or sample pairs for stereo used as an input and as an output of the SSRC module.

Nam	Type	Description
Mod	SSRC_N	There are two modes: - SSRC_NR_SAMPLES_DEFAULT: In this mode, the function returns the number of samples for 40 ms blocks - SSRC_NR_SAMPLES_MIN: the function returns the minimal number of samples supported for this conversion ratio. The SSRC_Init function accepts each integer multiple of this ratio. Formula: $\text{blocksize (ms)} = 1/\text{gcd(Fs_In,Fs_Out)}$
pSSI	SSRC_P	Pointer to the instance parameters. The application fills in the values of the input sample rate, the output sample rate, and the number of channels. Based on this input, the SSRC_GetNrSamples fills in the values for the number of samples for the input and the output audio stream.

Returns:

SSRC_OK	When the function call succeeds.
SSRC_INVALID_FS	When the requested input or output sampling rates are invalid.
SSRC_INVALID_NR_CHANN	When the channel format is not equal to LVM_MONO or LVM_STEREO.
SSRC_NULL_POINTER	When pSSRC_Params is a NULL pointer.
SSRC_INVALID_MODE	When mode is not a valid setting.

Note: The SSRC_GetNrSamples function returns the values from the following tables. Instead of calling the SSRC_GetNrSamples function, use the values from these tables directly.

Sample rate	Nr of samples
8000	320
11025	441
12000	480
16000	640
22050	882
24000	960
32000	1280
44100	1764
48000	1920

In/Out	8000	11025	12000	16000	22050	24000	32000	44100	48000
8000	11	320441	23	12	160441	13	14	80441	16
11025	441320	11	147160	441640	12	147320	4411280	14	147640
12000	32	160147	11	34	80147	12	38	40147	14
16000	21	640441	43	11	320441	23	12	160441	13
22050	441160	21	14780	441320	11	147160	441640	12	147320
24000	31	320147	21	32	160147	11	34	80147	12
32000	41	1280441	83	21	640441	43	11	320441	23
44100	44180	41	14740	441160	21	14780	441320	11	147160
48000	61	640147	41	31	320147	21	32	160147	11

Parent topic: Functions

SSRC_GetScratchSize **Prototype:**

```
SSRC_ReturnStatus_en SSRC_GetScratchSize
  (SSRC_Params_t*     pSSRC_Params,
   LVM_INT32*         pScratchSize );
```

Description:

This function retrieves the scratch size for a given conversion ratio and for given buffer sizes at the input and at the output.

Name	Type	Description
pSSRC_Par	SSRC_Param	Pointer to the instance parameters. All members should have a valid value.
pScratch-Size	LVM_INT32*	Pointer to the scratch size. The SSRC_GetScratchSize function fills in the correct value (in bytes).

|

Returns:

SSRC_OK	When the function call succeeds.
SSRC_INVALID_FS	When the requested input or output sampling rates are invalid.
SSRC_INVALID_NR_CHANN	When the channel format is not equal to LVM_MONO or LVM_STEREO.
SSRC_NULL_POINTER	When pSSRC_Params or pScratchSize is a NULL pointer.
SSRC_WRONG_NR_SAMPLI	When the number of samples on the input or on the output are incorrect.

Parent topic: Functions

SSRC_Init **Prototype:**

```
SSRC_ReturnStatus_en SSRC_Init
  (SSRC_Instance_t* pSSRC_Instance,
   SSRC_Scratch_t*  pSSRC_Scratch,
   SSRC_Params_t*   pSSRC_Params,
   LVM_INT16**      ppInputInScratch,
   LVM_INT16**      ppOutputInScratch);
```

Description:

The SSRC_Init function initializes an instance of the SSRC module.

Name	Type	Description
pSSRC_	SSRC_	Pointer to the instance of the SSRC. This application must allocate the memory before calling the SSRC_Init function.
pSSRC_	SSRC_	Pointer to the scratch memory. The pointer is saved inside the instance and is used by the SSRC_Process function. The application must allocate the scratch memory before calling the SSRC_Init function.
pSSRC_	SSRC_	Pointer to the instance parameters.
ppInputInScratch	LVM_I	The SSRC module can be called with the input samples located in scratch. This pointer points to a location that holds the pointer to the location in the scratch memory that can be used to store the input samples. For example, to save memory.
ppOutputInScratch	LVM_I	The SSRC module can store the output samples in the scratch memory. This pointer points to a location that holds the pointer to the location in the scratch memory that can be used to store the output samples. For example, to save memory.

Returns:

SSRC_OK	When the function call succeeds.
SSRC_INVALID_FS	When the requested input or output sampling rates are invalid.
SSRC_INVALID_NR_CHANN	When the channel format is not equal to LVM_MONO or LVM_STEREO.
SSRC_NULL_POINTER	When pSSRC_Params or pScratchSize is a NULL pointer.
SSRC_WRONG_NR_SAMPLI	When the number of samples on the input or on the output are incorrect.
SSRC_ALIGNMENT_ERROR	When the instance memory or the scratch memory is not 4 bytes aligned.

Parent topic: Functions

SSRC_SetGains **Prototype:**

```
SSRC_ReturnStatus_en SSRC_SetGains
  (SSRC_Instance_t* pSSRC_Instance,
   LVM_Mode_en      bHeadroomGainEnabled,
   LVM_Mode_en      bOutputGainEnabled,
   LVM_INT16        OutputGain);
```

Description:

This function sets headroom gain and the post gain of the SSRC. The SSRC_SetGains function is an optional function that should be used only in rare cases. Preferably, use the default settings.

Name	Type	Description
pSSRC	SSRC_	Pointer to the instance of the SSRC.
bHeadroomGainEnabled	LVM_	Parameter to enable or disable the headroom gain of the SSRC. The default value is LVM_MODE_ON. LVM_MODE_OFF can be used if it can be guaranteed that the input level is below - 6 in all cases (the default headroom is -6 dB).
bOutputGainEnabled	LVM_	Parameter to enable or disable the output gain. The default value is LVM_MODE_ON.
OutputGain	LVM_	The value of the output gain. The output gain is a linear gain value. 0x7FFF is equal to +6 dB and 0x0000 corresponds to -inf dB. By default, a 3 dB gain is applied (OutputGain = 23197), resulting in an overall gain of -3 dB (-6 dB headroom +3 dB output gain). Unit Q format Data Range Default value Linear gain Q1.14 [0;32767] 23197

Returns:

SSRC_OK	When the function call succeeds
SSRC_NULL_POINT	When pSSRC_Instance is a NULL pointer
SSRC_INVALID_MO	Wrong value used for the bHeadroomGainEnabled or the OutputGainEnabled parameters.
SSRC_INVALID_VAI	When OutputGain is out of the range [0;32767].

Parent topic: Functions

SSRC_Process **Prototype:**

```
SSRC_ReturnStatus_en SSRC_Process
  (SSRC_Instance_t* pSSRC_Instance,
   LVM_INT16*       pSSRC_AudioIn,
   LVM_INT16*       pSSRC_AudioOut);
```

Description:

Process function for the SSRC module. The function takes pointers as input and output audio buffers.

The sample format used for the input and output buffers is 16-bit little-endian. Stereo buffers are interleaved (L1, R1, L2, R2, and so on), mono buffers are deinterleaved (L1, L2, and so on).

Name	Type	Description
pSSRC_Instance	SSRC_Instance_t*	Pointer to the instance of the SSRC.
pSSRC_AudioIn	LVM_INT16*	Pointer to the input samples.
pSSRC_AudioOut	LVM_INT16*	Pointer to the output samples.

Returns:

SSRC_OK	When the function call succeeds.
SSRC_NULL_POINTEI	When one of pSSRC_Instance, pSSRC_AudioIn, or pSSRC_AudioOut is NULL.

Parent topic: Functions

SSRC_Process_D32 **Prototype:**

```
SSRC_ReturnStatus_en SSRC_Process_D32
  (SSRC_Instance_t* pSSRC_Instance,
   LVM_INT32*       pSSRC_AudioIn,
   LVM_INT32*       pSSRC_AudioOut);
```

Description:

Process function for the SSRC module. The function takes pointers as input and output audio buffers.

The sample format used for the input and output buffers is 32-bit little-endian. Stereo buffers are interleaved (L1, R1, L2, R2, and so on), mono buffers are deinterleaved (L1, L2, and so on).

Name	Type	Description
pSSRC_Instance	SSRC_Instance_t*	Pointer to the instance of the SSRC.
pSSRC_AudioIn	LVM_INT32*	Pointer to the input samples.
pSSRC_AudioOut	LVM_INT32*	Pointer to the output samples.

Returns:

|SSRC_OK|When the function call succeeds.| |SSRC_NULL_POINTER|When one of pSSRC_Instance, pSSRC_AudioIn, or pSSRC_AudioOut is NULL.|

Parent topic: Functions

Parent topic:*Application programmers interface (API)*

Dynamic function usage This chapter explains how and when the SSRC functions are or can be used.

Define the number of samples to be used on input and output Call the function SSRC_GetNrSamples. Each integer multiple of the returned number of samples can be used.

Parent topic: Dynamic function usage

Allocate scratch memory To calculate the required size of the scratch memory, call the SSRC_GetScratchSize function. Allocate memory for the returned size.

Parent topic: Dynamic function usage

Initialize the SSRC instance Call the SSRC_Init function.

Parent topic: Dynamic function usage

Process samples The SSRC_Process function can now be called any number of times.

Parent topic: Dynamic function usage

Destroy the SSRC instance When the processing is completed, the allocated memory for the instance and the scratch can be freed.

Parent topic: Dynamic function usage

Parent topic:*Application programmers interface (API)*

Reentrancy None of the SSRC functions are re-entrant.

Parent topic:*Application programmers interface (API)*

Additional user information This section provides information on the Attenuation of the signal and Notes on integration.

Attenuation of the signal When a fully saturated or clipped input is applied to an SRC module, the aliases after the sample rate conversion, although sufficiently suppressed, can still result in a clipped output. To prevent clipped output, the output of the SSRC module is by default attenuated with 3 dB. Although not advised, this gain value can be changed using the SSRC_SetGains function.

Parent topic:*Additional user information*

Notes on integration Although the sample rate converter module works with audio signals on different sampling rates, it is a synchronous module. The module takes a block of input samples, consumes the input completely, and produces a full buffer with output samples. As a result, the SSRC only accepts a limited number of input and output block sizes. To flush last, incomplete, block of an audio stream, the block is padded with zeros until it is full before the SSRC processes it.

Parent topic:*Additional user information*

Example application The source code of the example application can be found in the .\EX_APP\APP_FileIO\SRC directory of the release package. The .\EX_APP\APP_FileIO\MAKE directory contains a make file that can be used to build the example application. When building the application, an executable is generated in the .\EX_APP\APP_FileIO\EXE directory.

The example application takes as command-line input parameters:

1. The path toward the input PCM file. It assumes raw 16 bit signed little-endian put. Stereo input samples should be interleaved (L1, L2 R1, R2,...), mono samples should be deinterleaved (L1, L2, and so on).
2. The path toward the output PCM file.
3. The input sample rate.
4. The output sample rate.
5. The channel format (mono or stereo).

Integration test A correct integration of the SSRC module can be verified in two ways.

- Bit accurate test
- THD+N measurement

Bit accurate test The TestFiles directory of the release package contains a test input (sampled at 44,100 Hz) and several expected output files (sample rates from 8000 Hz to 48,000 Hz). If the same test input file is applied to the SRC after integration in the target platform, the output is bit accurate with the expected output file that matches the output-sample rate

Parent topic:*Integration test*

THD+N measurement Produce a swept sine and feed it through the SSRC module. Do a THD+N measurement on the obtained output signal. The THD+N of the converted signals should be below - 77 in the interval [0 - 0.45] FsLOW.

Parent topic:*Integration test*

Maestro Audio Framework

MCUXpresso SDK : Maestro

Overview This repository is for MCUXpresso SDK maestro middleware delivery and it contains the components officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository (mcuxsdk-manifests) for the complete delivery of MCUXpresso SDK.

Documentation Overall details can be reviewed here: MCUXpresso SDK Online Documentation

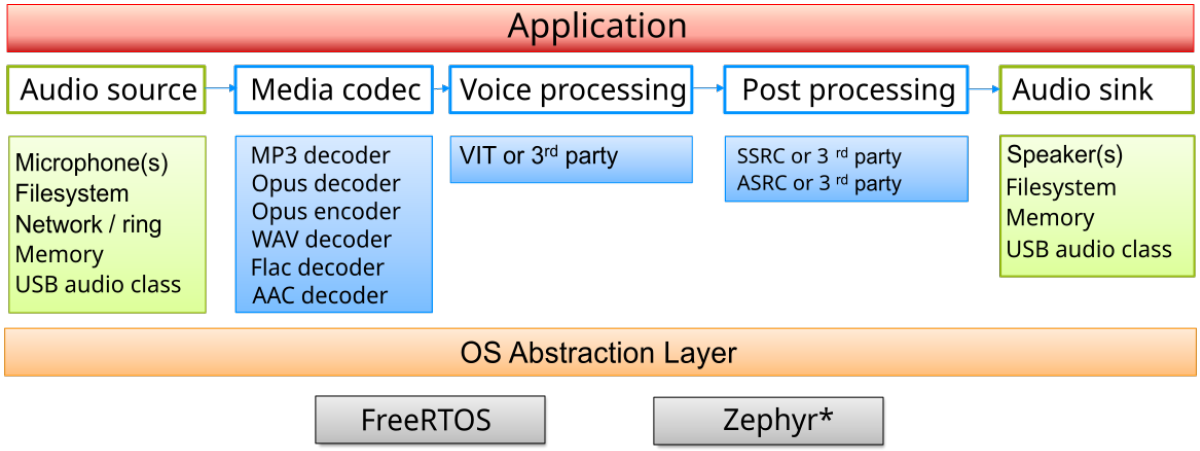
Visit Maestro - Documentation to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest Getting Started with SDK - Detailed Installation Instructions

Contribution We welcome and encourage the community to submit patches directly to the Maestro project placed on github. Contributing can be managed via pull-requests.

Introduction Maestro audio framework intends to enable chaining of basic audio processing blocks, called *elements*. These blocks then form stream processing objects, called *pipeline*. This pipeline can be used for multiple audio processing use cases.

The processing blocks can include (but are not limited to) different audio sources (for example file or microphone), decoders or encoders, filters or effects, and audio sinks. Framework overview is depicted in the following picture:



*not all elements and libraries are supported in Zephyr port. For more information, see *Maestro on Zephyr*

The Maestro audio framework is an open-source component developed by NXP Semiconductors and released under the BSD-compatible license. It is running on RTOS (Zephyr or FreeRTOS), abstracted by OSA layer.

For detailed description of the audio Maestro framework, please refer to the *programmer's guide*.

To see what is new, see *changelog*.

Maestro on Zephyr Getting started guide and further information for Maestro on Zephyr may be found *here*.

Maestro on FreeRTOS Maestro on FreeRTOS is supported in NXP's SDK. To get started, see mcuxsdk doc.

Supported examples The current version of the Maestro audio framework supports several optional *features*, some of which are used in these examples:

- *maestro_playback*
- *maestro_record*
- *maestro_usb_mic*
- *maestro_usb_speaker*
- *maestro_sync*

The examples can be found in the **audio_examples** folder of the desired board. The demo applications are based on FreeRTOS and use multiple tasks to form the application functionality.

Example applications overview To set up the audio framework properly, it is necessary to create a streamer with streamer_create API. It is also essential to set up the desired hardware peripherals using the functions described in streamer_pcm.h. The Maestro example projects consist of several files regarding the audio framework. The initial file is main.c with code to create multiple tasks. For features including SD card (in the maestro_playback examples, reading a file from SD card is supported and in maestro_record writing to SD card is currently supported) the APP_SDCARD_Task is created. The command prompt and connected functionalities are handled by APP_Shell_Task.

One of the most important parts of the configuration is the streamer_pcm.c where the initialization of the hardware peripherals, input and output buffer management can be found. For further information please see also streamer_pcm.h

In the Maestro USB examples (maestro_usb_mic and maestro_usb_speaker), the USB configuration is located in the usb_device_descriptor.c, audio_microphone.c and audio_speaker.c files. For further information please see also usb_device_descriptor.h, audio_microphone.h and audio_speaker.h.

In order to be able to get the messages from the audio framework, it is necessary to create a thread for receiving the messages from the streamer, which is usually called a Message Task. The message thread is placed in the app_streamer.c file, reads the streamer message queue, and reacts to the following messages:

- STREAM_MSG_ERROR - stops the streamer and exits the message thread
- STREAM_MSG_EOS - stops the streamer and exits the message thread
- STREAM_MSG_UPDATE_DURATION - prints info about the stream duration
- STREAM_MSG_UPDATE_POSITION - prints info about current stream position
- STREAM_MSG_CLOSE_TASK - exits the message thread

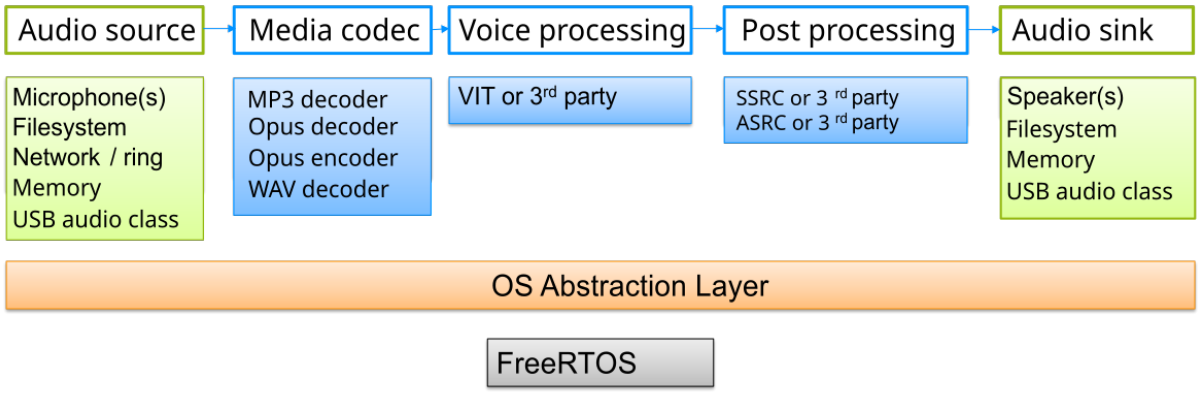
File structure

Folder	Description
src	Maestro audio framework sources
src/inc	Maestro include files
src/core	Maestro core sources
src/cci	Common decoder interface sources
src/cei	Common encoder interface sources
src/elements	Maestro elements sources
src/devices	External audio devices implementation (audio source & audio sink elements)
src/utils	Helper utilities utilized by Maestro
docs	Generated documentation
doxygen	Documentation sources
components	Glue for audio libraries, so they can be used in elements
tests	Maestro tests
zephyr/	Zephyr related files
zephyr/samples/	Zephyr samples
zephyr/tests/	Zephyr tests
zephyr/audioTracks/	Audio tracks for testing
zephyr/wrappers/	Zephyr NXP SDK Wrappers
zephyr/doc/	Zephyr documentation configuration for Sphinx
zephyr/scripts/	Zephyr helper scripts, mostly for testing

Maestro Audio Framework Programmer's Guide

Introduction Maestro audio framework provides instruments for playback and capture of different audio streams. In order to do that the framework uses API for creating various audio and voice pipelines with the support of media and track information. This document describes the framework in its detail, and the usage of API for pipeline creation using different elements. The framework needs an operating system in order to create different tasks for audio processing and communication with the application.

Architecture overview A high-level block diagram of the streamer used in Maestro is shown below. An element is the most important class of objects in the streamer (see streamer_element.c). A chain of elements will be created and linked together when a *pipeline* is created. Data flows through this chain of elements in form of data buffers. An element has one specific function, which can be the reading of data from a file, decoding of this data, or outputting this data to a sink device. By chaining together several such elements, a pipeline is created that can do a specific task, for example, the playback.



Pipeline

The pipeline is created within the streamer_create API using the streamer_create_pipeline call. In the example applications provided in the MCUXpresso SDK the pipeline is created in the app_streamer.c file. In order to create a pipeline user needs to provide a PipelineElements structure consisting of array of element indexes ElementIndex and the number of elements in the pipeline. Then the pipeline is built automatically and user can specify the properties of the elements using the streamer_set_property API. All the element properties can be found in the streamer_element_properties.h file.

The streamer can handle up to two pipelines within a single task. The first pipeline with index 0 can be created using the streamer_create function as described above. Then the streamer_create_pipeline function should be used to create the second pipeline (pipeline with index 1). An example creation can be found in the app_streamer.c file in the *maestro_sync_example*. Both pipelines are processed sequentially, so after the first pipeline is processed, the second pipeline is processed.

After the pipeline is sucessfully created, all elements and entire pipeline are in STATE_NULL state. A user can start the streamer by setting the pipeline state to STATE_PLAYING using the streamer_set_state function. The pipeline can also be paused or stopped using the same function. Use the STATE_PAUSED to pause and use STATE_NULL to stop. The function changes the state of each element that is in the pipeline in turn, and after all the elements have obtained the desired state, the state of entire pipeline is changed.

Elements The current version of the Maestro framework supports several types of elements (StreamElementType). In each pipeline should be used one source element (elements with the _SRC suffix) and one sink element (elements with the _SINK suffix). A decoder, encoder or audio_proc element can be connected between these two elements. The audio_proc element can be used more than once within the same pipeline.

Each element type (StreamElementType) has several functions that are determined by a unique element index (ElementIndex). These indexes are used to create a pipeline, and each element index can only be used once in the same pipeline. The type_lookup_table shows which StreamElementType supports which ElementIndex.

Each element index (ElementIndex) has its own properties and a list of these properties can be found in the streamer_element_properties.h file. These properties are divided into groups and each group is identified by a property mask (e.g. for speaker it is PROP_SPEAKER_MASK). Then the property_lookup_table in the streamer_msg.c file determines which property group relates to

which element index (ElementIndex). When an element is created and added to the pipeline, its properties are set to their defalut values. Default values can be seen in the initialization function of a particular element. The initialization functions are specified in the element_list array in the streamer_element.c file (e.g. for the audio_proc element it is the audio_proc_init_element function). The user can get the value of the property using the streamer_get_property function or change its value using the streamer_set_property function.

The source code of the elements can be found in the middleware\audio_voice\maestro\src\elements\ folder.

Add a new element type The user can add a new element type (StreamElementType) to the Maestro audio framework. For this, the following steps need to be done.

- Add a new element type to the StreamElementType enum type in the streamer_api.h.
- Create a new *.c and *.h files for the new element type in the middleware\audio_voice\maestro\src\elements\ folder. All necessary structures and functions (functions for src pads, sink pads and element itself) needs to be defined in these files. Inspiration can be found in other elements.
- Link the initialization function to the element type in the element_list array in the streamer_element.c file. To do this, a new definition that enables the element needs to be created (e.g. there is a STREAMER_ENABLE_AUDIO_PROC definition for the audio_proc element).
- Associate the newly created element type with an element index (ElementIndex) by adding a new pair to the type_lookup_table in the streamer.c file.
- If the user wants to use the newly created element in an application, the definiton that enables the element must be defined at the project level.

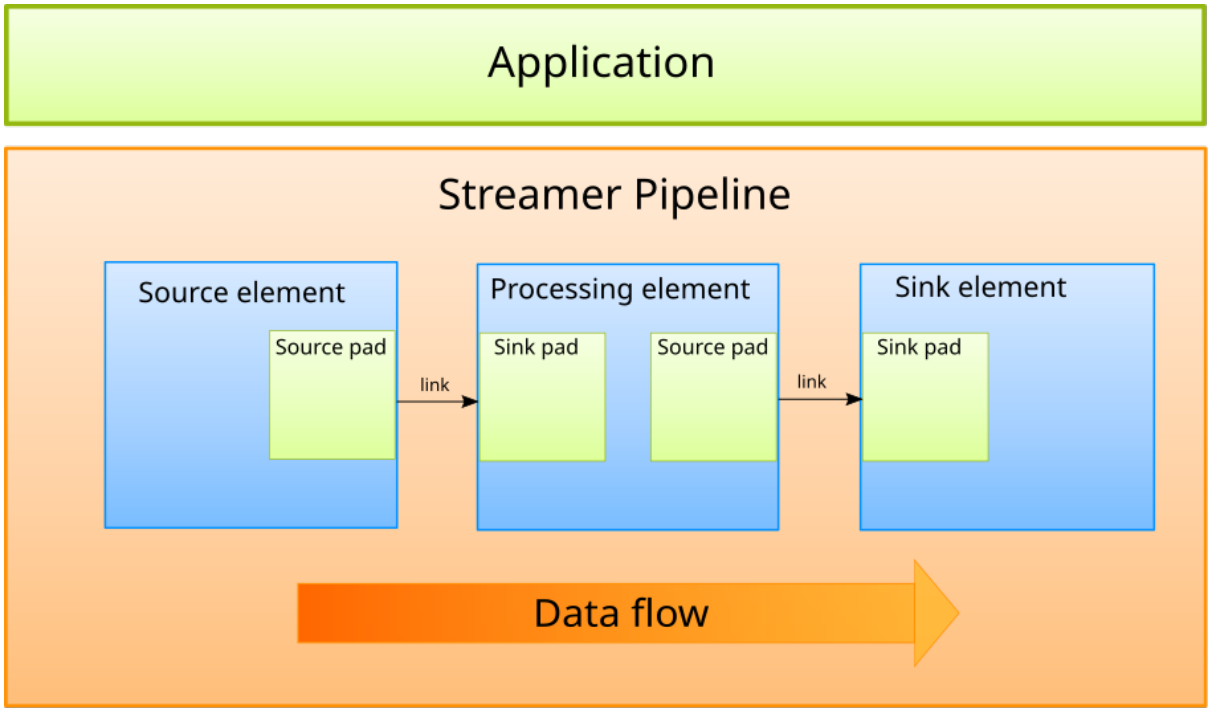
Mostly the user doesn't need to create a new element type, but just create an element index.

Add a new element index To create a new element index in the Maestro audio framework, follow these steps:

- Add a new element index to the ElementIndex enum type in the streamer_api.h.
- Create the required properties for the newly created element index in the streamer_element_properties.h file.
- Associate the newly created property group with newly created element index by adding a new pair to the property_lookup_table in the streamer_msg.c file.
- Associate the newly created element index with an element type (StreamElementType) by adding a new pair to the type_lookup_table in the streamer.c file.
- Add support for the created properties to functions of the associated element type. These functions are defined in files that correspond to a particular element type. The files are located in the middleware\audio_voice\maestro\src\elements\ folder.

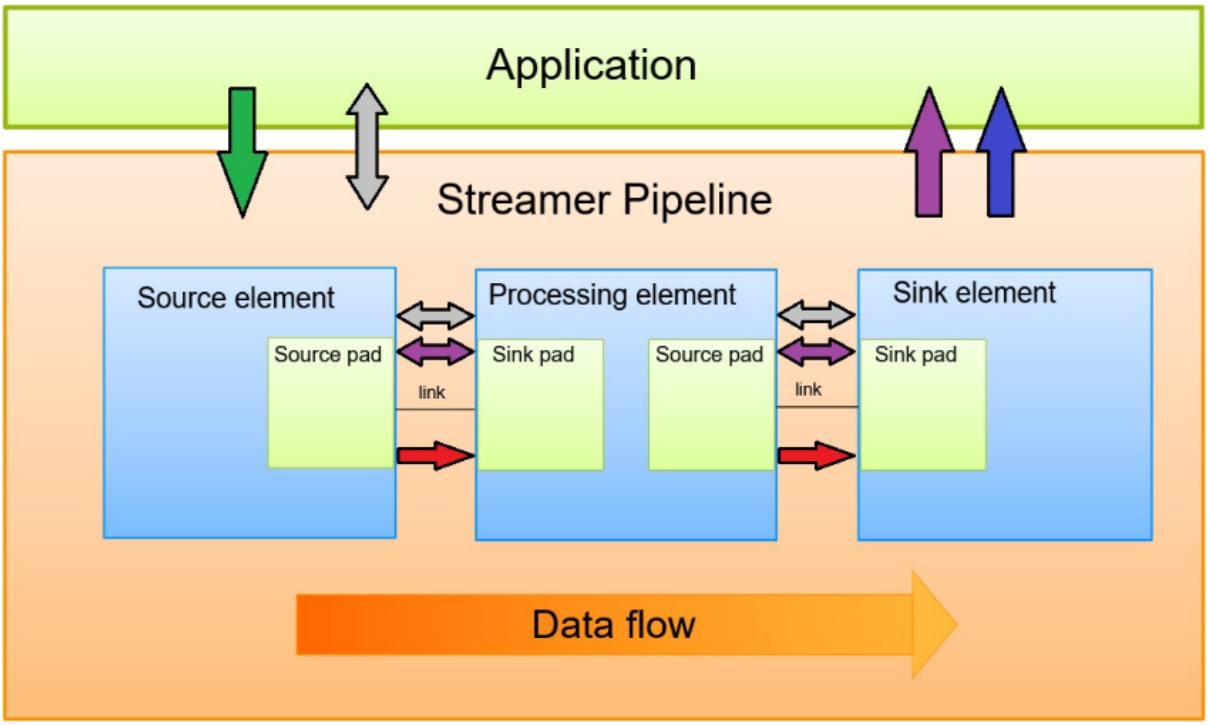
It is important to know that each element type (StreamElementType) can be associated with more than one element index (ElementIndex), but each element index (ElementIndex) can be associated with only one element type (StreamElementType).

Pads Pads are elements' inputs and outputs. A pad can be viewed as a "plug" or "port" on an element where links may be made with other elements, and through which data can flow to or from those elements. Data flows out of an element through a source pad, and elements accept incoming data through a sink pad. Source and sink elements have only source and sink pads, respectively. For detailed information about pads, please see the API reference from pad.c.



Internal communication The streamer (the core of the framework) provides several mechanisms for communication and data exchange between the application, a pipeline, and pipeline elements:

- Buffers are objects for passing streaming data between elements in the pipeline. Buffers always travel from sources to sinks (downstream).
- Messages are objects sent from the application to the streamer task to construct, configure, and control a streamer pipeline.
- Callbacks are used to transmit information such as errors, tags, state changes, etc. from the pipeline and elements to the application.
- Events are objects sent between elements. Events can travel upstream and downstream. Events may also be sent to the application
- Queries allow applications to request information such as duration or current playback position from the pipeline. Elements can also use queries to request information from their peer elements (such as the file size or duration). They can be used both ways within a pipeline, but upstream queries are more common



Decoders and encoders Maestro framework uses a common codec interface for decoding purposes and a common encoder interface for encoding. Those interfaces encapsulate the usage of specific codecs. Reference codecs are available in audio-voice-components repository which should be in \middleware\audio_voice\components\ folder.

Common codec interface The Common Codec Interface is the intended interface for all used **decoders**. The framework will integrate a CCI decoder element into the streamer to interface with all decoders.

Using the CCI to interface with Metadata

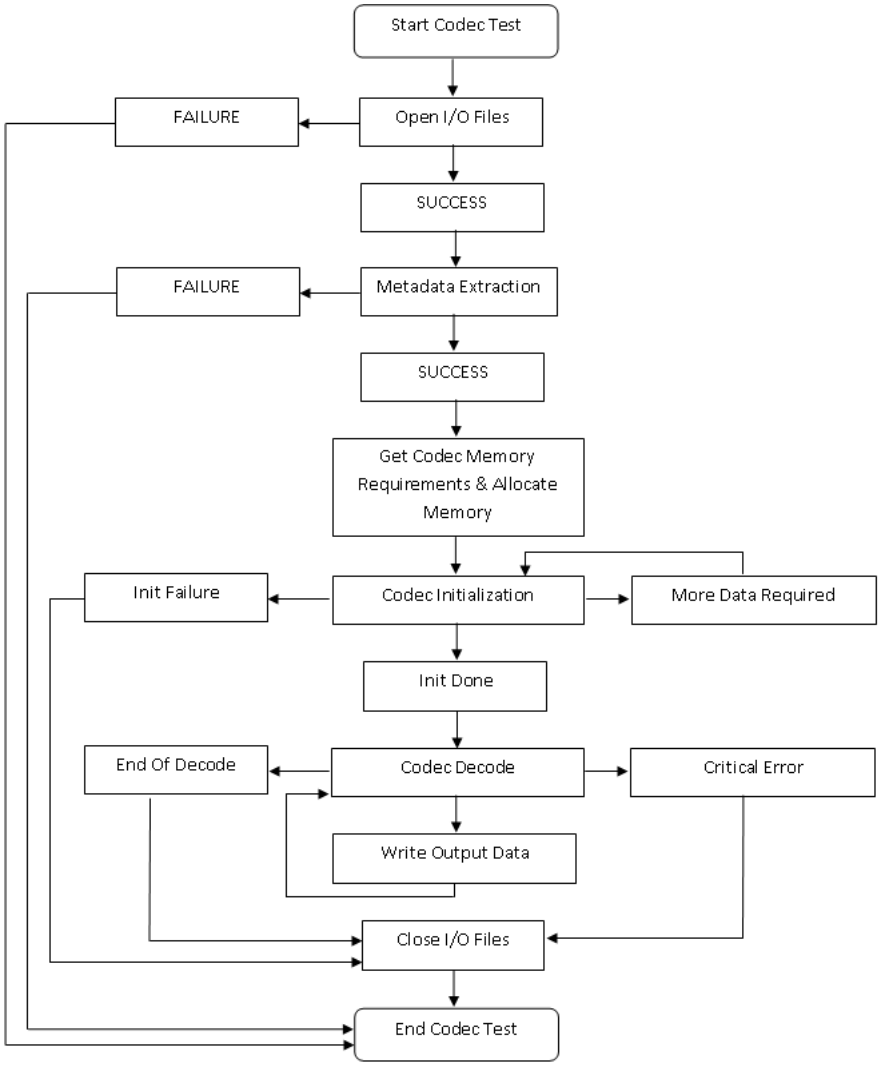
- cci_extract_meta_data must be called before any other Codec Interface APIs. This API extracts the metadata information of the codec and fills this information in the file_meta_data_t structure. The file_meta_data_t structure must be allocated by the application.
- This function first extracts the input file extension and based on that it calls the specific codec's metadata extraction function. If it finds an invalid extension or unsupported extension then it returns with META_DATA_FILE_NOT_SUPPORTED code for any unsupported file format.
- If this API finds the valid metadata then it returns with META_DATA_FOUND code. If this API does not find any metadata information then it returns with META_DATA_NOT_FOUND code. It also returns with META_DATA_FILE_NOT_SUPPORTED code for any unsupported file format.

Using the CCI to interface with Decoders

- codec_get_mem_info gets the memory requirement based on the specific decoder stream type. It returns the size in bytes of the specific codec. The user of the decoders must allocate memory of this size and this memory is used by the initialization API. The user or application must pass this allocated memory pointer to the init API.

- codec_init must be called before the codec's decode API. This API calls the codec-specific initialization function based on the codec stream type. This API allocates the memory to the codec main structure and also initializes the codec main structure parameters. It also registers the call back functions to the codec which will be used by the codec to read or seek the input stream.
- codec_decode is the main decoding API of the codec. This API calls the codec-specific decoding function based on the codec stream type. This API decodes the input raw stream and fills the PCM output samples into codec output PCM buffer. This API gives the information about the number of samples produced by the codec and also gives the pointer of the codec output PCM samples buffer.
- codec_get_pcm_samples must be called after the codec's decode API. This API calls the codec specific Get PCM Sample API based on the codec stream type. This API gets the PCM samples from the codec in constant block size and fills them into the output PCM buffer. It returns the number of samples get from the codec and also gives the pointer of the output PCM buffer.
- codec_reset calls the codec specific reset API base on stream type and resets the codec.
- codec_seek accepts the seek bytes offset converted from the time by application. This API calls the decoder's internal seek API to calculate the actual seek offset which frame boundary aligns. This API returns the actual seek offset.

The basic sequence to use a decoder with the CCI is shown below:



Adding new decoders to the CCI This section explains how to integrate a new decoder in the Common Codec Interface. The CCI assumes the decoder library to be used is in the \middleware\audio_voice\audiocomponents\decoders*decoder*\libs\ folder of the maestro framework. The CCI is just a wrapper around a specific implementation. The decoder is expected to be extended as needed to meet the APIs described above.

- Register Decoder Top level APIs in Common Codec Interface
  - Place the decoder lib in libs folder.
  - Add prototypes of the decoder top level APIs in codec_interface.h file (located at maestro\src\cci\inc\ folder).
  - In codec_interface.c file (located at maestro\src\cci\src\), add top level Decoder APIs in decoder function table.
  - Pseudo code for this is as described below.

```
const codec_interface_function_table_t g_codec_function_table[STREAM_TYPE_COUNT] = {
#ifdef VORBIS_CODEC
    {
        &VORBISDecoderGetMemorySize,
        &VORBISDecoderInit,
        &VORBISDecoderDecode,
        NULL,
        NULL,
        &VORBISDecoderSeek,
        &VORBISDecoderGetIOFrameSize,
    },
#else
    {
        NULL,
        NULL,
        NULL,
        NULL,
        NULL,
        NULL,
        NULL,
    }
#endif
};
```

- Enable or Disable Decoder
  - Define VORBIS_CODEC macro in audio_cfg.h file.
  - Comment this macro if you want to disable VORBIS Decoder otherwise keep it defined in order to enable the decoder.
- Add Extract Metadata API for the decoder
  - Add extract metadata API source file for the decoder at streamer/cci/metadata/src/vorbis folder.
  - Add this code in extract metadata lib project space.
  - Build the extract metadata lib and copy that lib to libs folder.
  - Add the desired stream type into ccidec_extract_meta_data API (in codecextractmetadata.c file) to call VORBIS Decoder extract metadata API.
- Add stream type of the new decoder in the stream type enum audio_stream_type_t in codec_interface_public_api.h
  - Stream type of the decoder in stream type enum and decoder APIs in decoder function table must be in the same sequence.

Common encoder interface Please see the following section about the *cei*.

Maestro performance

Memory information The memory usage of the framework components using reference codecs (data obtained from GNU ARM compiler) in bytes is:

text	data	bss	component
48790	2752	4	aac decoder
4348	16400	212	asrc
15512	0	4	flac decoder
76462	16	5013	maestro
34211	0	4	mp3 decoder
211974	0	0	opus
65446	0	4	ssrc
5850	16	12	wav decoder

Maestro framework uses dynamic allocation of audio buffers. The total amount of memory allocated for the pipeline depends on the following parameters:

- Number of elements in the pipeline
- Element types
- Audio stream properties
  - Sampling rate
  - Bit width
  - Channel number
  - Frame size

CPU usage The performance of the pipeline was measured using the real hardware platform (RT1060).

- CPU core clock in MHz: 600.

Pipeline type	Performance MIPS of pipeline (in MHz)
audio source -> audio sink	~10.26 MHz
audio source -> file sink	~9.84 MHz
file source (8-channel PCM) -> audio sink	~16.5 MHz

For performance details about the supported codecs please see audio-voice-components repository documentation.

CEI encoder The Maestro streamer contains an element adapting an extensible set of audio encoders in the form of functions conforming to the CEI (Common Encoder Interface). This element enables the user to choose and configure a suitable encoder at runtime.

Header files CEI itself and the CEI encoders are using following header files, in which you may be interested:

- cei.h - contains types used by the element itself and an encoder implementing the CEI
- cei_enctypes.h - contains a list of possible encoders and types used for interfacing with a CEI encoder
- cei_table.h - contains a table of functions implementing integrated CEI encoders

Instantiating the element This element's index is ELEMENT_ENCODER_INDEX and its type is TYPE_ELEMENT_ENCODER, as defined in streamer_api.h. It has one source pad (data input) and one sink pad (data output). It is initialized like any other element, meaning that it is instantiated and inserted into the pipeline using the create_element, add_element_pipeline and link_elements functions. Inversely, for destroying the element, the unlink_elements, remove_element_pipeline and destroy_element are used. This element alone does not depend on any additional software layers other than these required by the Maestro streamer itself, so no pre-initialization before this element instantiation is necessary.

Element properties Use Maestro streamer property API (streamer_set_property and streamer_get_property) for setting or getting these. The constants are defined in streamer_element_properties.h.

- PROP_ENCODER_CHUNK_SIZE
  - **Synopsis:** Determines the length of a chunk pulled from the sibling of the source pad and essentially influences the size of allocated buffers. If the actual amount of data pulled is smaller, the rest is zero-filled.
  - **Type:** unsigned 32-bit integer
  - **Default value:** 1920
  - **Constraints:**
    - Must be bigger than zero, otherwise STREAM_ERR_INVALID_ARGS is returned.
    - Cannot be changed if the actual encoder has been created. If done so, STREAM_ERR_ELEMENT_BAD_STATUS is returned.
- PROP_ENCODER_TYPE
  - **Synopsis:** Determines the exact encoder (CEI implementation) to be used.
  - **Type:** CeiEncoderType (cei_enctypes.h)
  - **Default value:** CEIENC_LAST
  - **Constraints:**
    - Must not be equal to CEIENC_LAST, otherwise STREAM_ERR_INVALID_ARGS will be returned.
    - Selected encoder must be implemented, otherwise STREAM_ERR_INVALID_ARGS will be returned.
    - Cannot be changed if the actual encoder has been created. If done so, STREAM_ERR_ELEMENT_BAD_STATUS will be returned.
  - **Behaviour influenced:** The encoder element process function will return FLOW_ERROR if this property isn't set.
- PROP_ENCODER_CONFIG
  - **Synopsis:** Determines encoder-specific configuration (application, bitrate, ...).
  - **Type:** Pointer to the encoder-specific configuration structure.

  - **Default value:** Determined by the encoder.
  - **Constraints**:
    * The encoder has to be configurable. If it is not, STREAM_ERR_ERR_GENERAL will be returned on any access.
    * The structure has to conform to the encoder requirements. If the encoder returns an error code, STREAM_ERR_GENERAL will be returned.

- PROP_ENCODER_BITSTREAMINFO
  - **Synopsis:** Specifies information about the incoming bitstream (sample rate, sample depth, ...).
  - **Type:** Pointer to CeiBitstreamInfo (cei_enctypes.h).
  - **Default value:**

```
(CeiBitstreamInfo) {
    .sample_rate = 0,
    .num_channels = 0,
    .endian = AF_LITTLE_ENDIAN,
    .sign = TRUE,
    .sample_size = 0,
    .interleaved = TRUE
}
```

  - **Constraints:**
    * Cannot be changed if the actual encoder has been created. If done so, STREAM_ERR_ELEMENT_BAD_STATUS will be returned.
    * As of now, only bitstreams containing 16-bit interleaved (if 2 or more channels will be encoded) samples are supported. If anything else was set to the sample_size and interleaved members, STREAM_ERR_INVALID_ARGS will be returned.
  - **Behaviour influenced:**
    * Given the characteristics of some elements available, different packets of data (header and payload, referred to as "chunk" above) may be pulled by this element. Each packet can contain a different header, which may or may not contain useful information about the bitstream. If a packet with the AudioPacketHeader (todofile.h) is pulled at first and any other iteration of the streamer pipeline, the bitstream parameters configured by this property are implicitly available and are not expected to be specified by the user. Other packet header types (such as RawPacketHeader) don't contain any bitstream parameters and require the user to specify the parameters manually using this property. Failure to do so will result in the element's process function returning FLOW_ERROR. Same situation will occur if a packet with the AudioPacketHeader is received and its contents differ from the already acquired bitstream parameters.
    * As of now, CEI is defined to work with 16-bit signed little-endian (s16le) samples, which are interleaved if the bitstream contains more than one channels. This element handles endianness and unsigned to signed conversion.

CEI definition - implementing your own encoder The CEI defines following function pointer types:

- CeiFnGetMemorySize: Returns number of bytes required for encoder state for a given number of channels.
- CeiFnEncoderInit: Initialize an encoder for a given sample rate and channel count.
- CeiFnEncoderGetConfig: Copy current or default configuration to a given structure pointer.

- CeiFnEncoderSetConfig: Configure the encoder from a given structure pointer.
- CeiFnEncode: Encode a given buffer to a given output buffer.

Detailed descriptions of function behaviour, parameters and expected return values are available as docblocks in the cei.h file.

Each encoder is implemented as a set of pointers pointing to functions conforming to these types, grouped in the CeiEncoderFunctions structure. Specifying the CeiEncoderGetConfig fnGetConfig and CeiFnEncoderSetConfig fnSetConfig members is optional, as an encoder does not have to be configurable. If so desired, specify NULL. Implementation of the remaining functions is mandatory, however. If at least one of these functions isn't implemented and NULL is specified instead, the encoder will be considered as not implemented.

To register an implemented encoder with the element, add a new entry to the CeiEncoderType enum and add the CeiEncoderFunctions struct value to the table CeiEncoderFunctions ceiEncTable[] located in the cei_table.h header file. Note and match the order of items in that table, as a CeiEncoderType value is used as an index. Same goes for the size_t ceiEncConfigSizeTable[]. If configuration is not applicable, specify 0 at the appropriate index. If configuration is applicable, describe the configuration structure in the cei_enctypes.h header file and add its size to that table.

Maestro playback example

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- *Hardware requirements*
- *Hardware modifications*
- *Preparation*
- *Running the demo*
- *Example configuration*
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Overview The Maestro playback example demonstrates audio processing on the ARM cortex core utilizing the Maestro Audio Framework library.

The application is controlled by commands from a shell interface using serial console and the audio files are read from the SD card.

Depending on target platform or development board there are different modes and features of the demo supported.

- **Standard** - The mode demonstrates playback of encoded files from an SD card with up to 2 channels, up to 48 kHz sample rate and up to 16 bit width. This mode is enabled by default.
- **Multi-channel** - The mode demonstrates playback of raw PCM files from an SD card with 2 or 8 channels, 96kHz sample rate and 32 bit width. The decoders and synchronous sample rate converter are not supported in this mode. The Multi-channel mode is only supported on selected platforms, see the table below. The *Example configuration* section contains information on how to enable it.

As shown in the table below, the application is supported on several development boards and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and *Hardware modifications* or *Example configuration* sections before running the demo.

Limitations:

- Note:
  - *LPCXPresso55s69* - MCUXpresso IDE project default debug console is semihost
- Decoder:
  - **AAC:**
    - The reference decoder is supported only in the MCUXpresso IDE and ARMGCC.
  - **FLAC:**
    - *LPCXpresso55s69* - When playing FLAC audio files with too small frame size (block size), the audio output may be distorted because the board is not fast enough.
  - **OPUS:**
    - *LPCXpresso55s69* - The decoder is disabled due to insufficient memory may be distorted because the board is not fast enough.
- Sample rate converter:
  - **SSRC:**
    - *LPCXpresso55s69* - When a memory allocation ERROR occurs, it is necessary to disable the SSRC element due to insufficient memory.

Known issues:

- Decoder:
  - **MP3:**
    - The reference decoder has issues with some of the files. One of the channels can be sometimes distorted or missing parts of the signal.
  - **OPUS:**
    - The decoder doesn't support all the combinations of frame sizes and sample rates. The application might crash when playing an unspupported file.

More information about supported features can be found on the *Supported features* page.

Hardware requirements

- Desired development board
- Micro USB cable
- Headphones with 3.5 mm stereo jack
- SD card with supported audio files
- Personal computer
- Optional:
  - Audio expansion board AUD-EXP-42448 (REV B)

Hardware modifications Some development boards need some hardware modifications to run the application. If the development board is not listed here, its default setting is required.

- *EVKB-MIMXRT1170:*
  1. Please remove below resistors if on board wifi chip is not DNP:
     - R228, R229, R232, R234
  2. Please make sure R136 is weld for GPIO card detect.

Preparation

1. Connect a micro USB cable between the PC host and the debug USB port on the development board.
2. Open a serial terminal with the following settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Download the program to the target board.
4. Insert the headphones into the Line-Out connector (headphone jack) on the development board.
5. Either press the reset button on your development board or launch the debugger in your IDE to begin running the demo.

Running the demo When the example runs successfully, you should see similar output on the serial terminal as below:

```
**********************************
Maestro audio playback demo start
**********************************

[APP_Main_Task] started

Copyright  2022  NXP
[APP_SDCARD_Task] start
[APP_Shell_Task] start

>> [APP_SDCARD_Task] SD card drive mounted
```

Type help to see the command list. Similar description will be displayed on serial console (*If multi-channel playback mode is enabled, the description is slightly different*):

```
>> help

"help": List all the registered commands

"exit": Exit program

"version": Display component versions

"file": Perform audio file decode and playback

  USAGE: file [stop|pause|volume|seek|play|list|info]
```

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```
stop              Stops actual playback.
pause             Pause actual track or resume if already paused.
volume <volume>   Set volume. The volume can be set from 0 to 100.
seek <seek_time>  Seek currently paused track. Seek time is absolute time in milliseconds.
play <filename>   Select audio track to play.
list              List audio files available on mounted SD card.
info              Prints playback info.
```

Details of commands can be found *here*.

Example configuration The example can be configured by user. Before configuration, please check the *table* to see if the feature is supported on the development board.

- **Enable Multi-channel mode:**
  - Add the MULTICHANNEL_EXAMPLE symbol to preprocessor defines on project level.
  - Connect AUD-EXP-42448 (see the point below).
- **Connect AUD-EXP-42448:**
  - *EVKC-MIMXRT1060:*
    1. Disconnect the power supply for safety reasons.
    2. Insert AUD-EXP-42448 into J19 to be able to use the CS42448 codec for multichannel output.
    3. Uninstall J99.
    4. Set the DEMO_CODEC_WM8962 macro to 0 in the app_definitions.h file
    5. Set the DEMO_CODEC_CS42448 macro to 1 in the app_definitions.h file.

Functionality The file play <filename> command calls the STREAMER_file_Create or STREAMER_PCM_Create function from the app_streamer.c file depending on the selected mode.

- When the *Standard* mode is enabled, the command calls the STREAMER_file_Create function that creates a pipeline with the following elements:
  - ELEMENT_FILE_SRC_INDEX
  - ELEMENT_DECODER_INDEX
  - ELEMENT_SRC_INDEX (If SSRC_PROC is defined)
  - ELEMENT_SPEAKER_INDEX
- When the *Multi-channel* mode is enabled, the command calls STREAMER_PCM_Create function, which creates a pipeline with the following elements:
  - ELEMENT_FILE_SRC_INDEX (PCM format only)
  - ELEMENT_SPEAKER_INDEX
  - *Note:*
    * If the input file is an 8 channel PCM file, output to all 8 channels is available. The properties of the PCM file are set in the app_streamer.c file using file source properties sent to the streamer:
      - PROP_FILESRC_SET_SAMPLE_RATE - default value is 96000 [Hz]
      - PROP_FILESRC_SET_NUM_CHANNELS - default value is 8
      - PROP_FILESRC_SET_BIT_WIDTH - default value is 32

Playback itself can be started with the STREAMER_Start function.

Each of the elements has several properties that can be accessed using the streamer_get_property or streamer_set_property function. These properties allow a user to change the values of the appropriate elements. The list of properties can be found in streamer_element_properties.h. See the example of setting property value in the following piece of code from the app_streamer.c file:

```
ELEMENT_PROPERTY_T prop;

EXT_PROCESS_DESC_T ssrc_proc = {SSRC_Proc_Init, SSRC_Proc_Execute, SSRC_Proc_Deinit,␣
↪&get_app_data()->proc_args};

prop.prop = PROP_SRC_PROC_FUNCPTR;
prop.val  = (uintptr_t)&ssrc_proc;

if (streamer_set_property(streamer, 0, prop, true) != 0)
{
    return -1;
}

prop.prop = PROP_AUDIOSINK_SET_VOLUME;
prop.val  = volume;
streamer_set_property(streamer, 0, prop, true);
```

Some of the predefined values can be found in the streamer_api.h.

States The application can be in 3 different states:

- Idle
- Running
- Paused

In each state, each command can have a different behavior. For more information, see *Commands in detail* section.

Commands in detail The applicatin is controlled by commands from the shell interface and the available commands for the selected mode can be displayed using the help command. Commands are processed in the cmd.c file.

- *help, version*
- *file stop*
- *file pause*
- *file volume <volume>*
- *file seek <seek_time>*
- *file play <filename>*
- *file list*
- *file info*

Legend for diagrams:

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
```

```
    classDef error fill:#F54D4D

    A((State)):::state
    B{Condition}:::condition
    C[Error message]:::error
    D[Process function]:::function
```

help, version

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> D[Write help or version]:::function
    B((Running)):::state --> D
    C((Paused)):::state --> D
    D-->E((No state
    change)):::state
```

file stop

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> B
    C((Running)):::state -->E((Idle)):::state
    D((Paused)):::state -->E
```

file pause

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> B
    C((Running)):::state -->E((Paused)):::state
    D((Paused)):::state -->F((Running)):::state
```

file volume <volume>

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> M[Error: Play a track first]:::error
    C((Running)):::state --> G{Volume
    parameter
```

```
    empty?}:::condition
    D((Paused)):::state --> G
    G -- Yes -->H[Error: Enter volume parameter]:::error
    G -- No -->I{Volume
    in range?}:::condition
    I -- No -->J[Error: invalid value]:::error
    I -- Yes -->K[Set volume]:::function
    J --> L((No state
    change)):::state
    K --> L
    H--> L
```

file seek <seek_time> The seek argument is only supported in the Standard mode.

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> E[Error: First select
    an audio track to play]:::error
    E-->B
    C((Running)):::state --> F[Error: First
    pause the track]:::error
    F --> C
    D((Paused)):::state --> G{Seek
    parameter
    empty?}:::condition
    G --No --> H{AAC file?}:::condition
    G --Yes --> I[Error: Enter
    a seek time value]:::error
    I-->N((Paused)):::state;
    H --Yes -->J[Error: The AAC decoder
    does not support
    the seek command]:::error
    J-->N
    H --No -->K{Seek
    parameter
    positive?}:::condition
    K --No -->L[Error: The seek
    time must be
    a positive value]:::error
    L-->N
    K --Yes -->M[Seek the file]:::function
    M-->N
```

file play <filename>

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    C((Running)):::state --> Z[Error: First stop
    current track]:::error
```

```
D((Paused)):::state --> Z
B((Idle)):::state --> E{SD Card
inserted?}:::condition
E -- No -->F[Error: Insert SD
card]:::error
E -- Yes -->G{File
name
empty?}:::condition
G -- Yes -->H[Error: Enter
file name]:::error
G -- No -->I{File exists?}:::condition
I -- No -->O[Error: File
doesn't exist]:::error
I -- Yes -->J{Supported
format?}:::condition
J -- Yes -->K[Play the track]:::function
J -- No -->L[Error: Unsupported
file]:::error
K -->M((Running)):::state
L --> W((No state
change)):::state
O --> W
H --> W
F --> W
Z --> W
```

file list

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> G{SD Card
    inserted?}:::condition
    C((Running)):::state --> G
    D((Paused)):::state --> G
    G -- Yes -->H[List supported files]:::function
    G -- No -->I[Error: Insert SD card]:::error
    I --> J((No state
    change)):::state
    H --> J
```

file info

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state -->E[Write file info]:::function
    C((Running)):::state -->E
    D((Paused)):::state -->E
    E --> F((No state
        change)):::state
```

Processing Time Typical streamer pipeline execution times and their individual elements for the EVKC-MIMXRT1060 development board are presented in the following tables. The time spent on output buffers is not included in the traversal measurements. However, file reading time is accounted for. In the case of the WAV codec, the audio file was accessed in every pipeline run. Therefore, during each run, the file was read from the SD card. However, for the MP3 codec, where data must be processed in complete MP3 frames, the file was not read in every run. Instead, it was read periodically only when the codec buffer did not contain a complete frame of data.

For further details, please refer to the *Processing Time* document.

WAV	streamer	file_src	codec	SSRC_proc	speaker
48kHz	1.1 ms	850 µs	150 µs	70 µs	40 µs
44kHz	1.75 ms	850 µs	180 µs	670 µs	40 µs

MP3	streamer	file_src	codec	SSRC_proc	speaker
48 kHz with file read	2.9 ms	2.3 µs	450 µs	60 µs	50 µs
48 kHz without file read	0.5 ms	x	400 µs	40 µs	40 µs
44 kHz with file read	3.2 ms	2.3 µs	440 µs	400 µs	50 µs
44 kHz without file read	0.9 ms	x	440 µs	390 µs	40 µs

Maestro record example

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Overview The Maestro record example demonstrates audio processing on the ARM cortex core utilizing the Maestro Audio Framework library.

The application is controlled by commands from a shell interface using serial console.

Depending on target platform or development board there are different modes and features of the demo supported.

- **Loopback** - The application demonstrates a loopback from the microphone to the speaker without any audio processing. Mono, stereo or multichannel mode can be used, depending on the hardware, see *table* below.
- **File recording** - The application takes audio samples from the microphone inputs and stores them to an SD card as an PCM file. The PCM file has following parameters:

  - Mono and stereo : 2 channels, 16kHz, 16bit width
  - Multi-channel (AUD-EXP-42448): 6 channels, 16kHz, 32bit width
- **Voice control** - The application takes audio samples from the microphone input and uses the VIT library to recognize wake words and voice commands. If a wake word or a voice command is recognized, the application write it to the serial terminal.
- **Encoding** - The application takes PCM samples from memory and sends them to the Opus encoder. The encoded data is stored in memory and compared to a reference. The result of the comparison is finally written into the serial terminal.

As shown in the table below, the application is supported on several development boards, and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and *Hardware modifications* or *Example configuration* sections before running the demo.

Limitations:

- Note:
  - *LPCXPresso55s69* - MCUXpresso IDE project default debug console is semihost
- Addition labraries
  - **VIT:**
    - The VIT is supported only in the MCUXpresso IDE and ARMGCC.
    - *LPCXpresso55s69* - The VIT is disabled by default due to insufficient memory. To enable it, see the *Example configuration* section.
    - *EVK-MCXN5XX* - Some VIT models can't fit into memory. In order to free some space it is necessary to disable SD card handling and opus encoder. To disable it, see the *Example configuration* section.
  - **VoiceSeeker:**
    - The VoiceSeeker is supported only in the MCUXpresso IDE and ARMGCC.
- Encoder
  - **OPUS:**
    - *LPCXpresso55s69* - The encoder is not supported due to insufficient memory.
- The File recording mode is not supported on *RW612BGA* development board due to missing SD card slot.

Known issues:

- *EVKB-MIMXRT1170* - After several tens of runs (the number of runs is not deterministic), the development board restarts because a power-up sequence is detected on the RESET pin (due to a voltage drop).

More information about supported features can be found on the *Supported features* page.

Hardware requirements

- Desired development board
- Micro USB cable
- Headphones with 3.5 mm stereo jack
- Personal computer
- Optional:
  - SD card for file output

  - Audio expansion board AUD-EXP-42448 (REV B)
- *LPCXpresso55s69:*
  - Source of sound with 3.5 mm stereo jack connector

Hardware modifications Some development boards need some hardware modifications to run the application. If the development board is not listed here, its default setting is required.

- *EVKB-MIMXRT1170:*
  1. Please remove below resistors if on board wifi chip is not DNP:
     - R228, R229, R232, R234
  2. Please make sure R136 is weld for GPIO card detect.
- *EVK-MCXN5XX:*
  - Short: JP7 2-3, JP8 2-3, JP10 2-3, JP11 2-3
- *RW612BGA:*
  - Connect: JP50; Disconnect JP9, JP11

Preparation

1. Connect a micro USB cable between the PC host and the debug USB port on the development board
2. Open a serial terminal with the following settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Download the program to the target board.
4. Insert the headphones into the Line-Out connector (headphone jack) on the development board.
5. *LPCXpresso55s69:*
   - Insert source of sound to audio Line-In connector (headphone jack) on the development board.
6. Either press the reset button on your development board or launch the debugger in your IDE to begin running the demo.

Running the demo When the example runs successfully, you should see similar output on the serial terminal as below:

```
******************************
Maestro audio record demo start
******************************

Copyright 2022 NXP
[APP_SDCARD_Task] start
[APP_Shell_Task] start

>> [APP_SDCARD_Task] SD card drive mounted
```

Type help to see the command list. Similar description will be displayed on serial console:

```
>> help

"help": List all the registered commands

"exit": Exit program

"version": Display component versions

"record_mic": Record MIC audio and perform one (or more) of following actions:
- playback on codec
- perform VoiceSeeker processing
- perform voice recognition (VIT)
- store samples to a file.

USAGE: record_mic [audio|file|<file_name>|vit] 20 [<language>]
The number defines length of recording in seconds.

Please see the project defined symbols for the languages supported.
Then specify one of: en/cn/de/es/fr/it/ja/ko/pt/tr as the language parameter.
For voice recognition say supported WakeWord and in 3s frame supported command.
Please note that this VIT demo is near-field and uses 1 on-board microphone.

NOTES: This command returns to shell after the recording is finished.
       To store samples to a file, the "file" option can be used to create a file
       with a predefined name, or any file name (without whitespaces) can be specified
       instead of the "file" option.

"opus_encode": Initializes the streamer with the Opus memory-to-memory pipeline and
encodes a hardcoded buffer.
```

Details of commands can be found *here*.

Example configuration The example can be configured by user. There are several options how to configure the example settings, depending on the environment. For configuration using west and Kconfig, please follow the instructions here. Before configuration, please check the *table* to see if the feature is supported on the development board.

- **Connect AUD-EXP-42448:**
  - *EVKC-MIMXRT1060:*
    1. Disconnect the power supply for safety reasons.
    2. Insert AUD-EXP-42448 into J19 to be able to use the CS42448 codec for multichannel output.
    3. Uninstall J99.
    4. Set the DEMO_CODEC_WM8962 macro to 0 in the app_definitions.h file
    5. Set the DEMO_CODEC_CS42448 macro to 1 in the app_definitions.h file.
    6. Enable VoiceSeeker, see point bellow.
  - *Note:*
    * The audio stream is as follows:
      - Stereo INPUT 1 (J12) -> LINE 1&2 OUTPUT (J6)
      - Stereo INPUT 2 (J15) -> LINE 3&4 OUTPUT (J7)
      - MIC1 & MIC2 (P1, P2) -> LINE 5&6 OUTPUT (J8)
      - Insert the headphones into the different line outputs to hear the inputs.

        - To use the Stereo INPUT 1, 2, connect an audio source LINE IN jack.

- **Enable VoiceSeeker:**
  - On some development boards the VoiceSeeker is enabled by default, see the *table* above.
  - If more than one channel is used and VIT is enabled, the VoiceSeeker that combines multiple channels into one must be used, as VIT can only work with mono signal.
  - Using MCUXPresso IDE:
    - It is necessary to add VOICE_SEEKER_PROC symbol to preprocessor defines on project level:
      - (Project -> Properties -> C/C++ Build -> Settings -> MCU C Compiler -> Preprocessor)
  - Using Kconfig:
    - Enable the VoiceSeeker in the guiconfig using MCUX_PRJSEG_middleware.audio_voice.components.voice_seeker
- **Enable VIT:**
  - *LPCXpresso55s69 and MCX-N5XX:*
    - In MCUXPresso IDE (SDK package):
      1. Remove SD_ENABLED and STREAMER_ENABLE_FILE_SINK symbols from preprocessor defines on project level.
      2. Add VIT_PROC symbol to preprocessor defines on project level:
         - (Project -> Properties -> C/C++ Build -> Settings -> MCU C Compiler -> Preprocessor)
    - In armgcc in SDK package:
      1. Remove SD_ENABLED and STREAMER_ENABLE_FILE_SINK symbols from preprocessor defines in flags.cmake file.
      2. Remove OPUS_ENCODE=1 and STREAMER_ENABLE_ENCODER preprocessor defines in flags.cmake file.
      3. Add VIT_PROC symbol to preprocessor defines in flags.cmake file.
      4. Remove sdmmc_config.c,.h files from CMakeLists.txt file.
    - In Kconfig:
      1. Disable File sink MCUX_COMPONENT_middleware.audio_voice.maestro.element.file_sink.enable
      2. Make sure SD card support is disabled MCUX_COMPONENT_middleware.sdmmc.sd and MCUX_COMPONENT_middleware.sdmmc.host.usdhc
      3. Make sure sdmmc_config files (.c, .h) is excluded from project build
         - remove mcux_add_source function that adds the sources in reconfig.cmake in maestro_record/cm33_core0 folder
      4. Disable fatfs MCUX_COMPONENT_middleware.fatfs and MCUX_COMPONENT_middleware.fatfs.sd
      5. Disable file utils MCUX_COMPONENT_middleware.audio_voice.maestro.file_utils.enable
      6. Make sure Opus encoder is disabled MCUX_COMPONENT_middleware.audio_voice.maestro.element.encoder.opus.enable
      7. Make sure VIT_PROC symbol is defined

        - remove mcux_remove_macro function that removes the VIT_PROC preprocessor definition in reconfig.cmake in maestro_record folder

    8. Make sure VIT processing is enabled MCUX_PRJSEG_middleware.audio_voice.components.vit

- **VIT model generation:**
  - For custom VIT model generation (defining own wake words and voice commands) please use https://vit.nxp.com/
- **Disable SD card handling:**
  - In MCUXPresso IDE:
    - Remove SD_ENABLED and STREAMER_ENABLE_FILE_SINK symbols from preprocessor defines on project level:
      - (Project -> Properties -> C/C++ Build -> Settings -> MCU C Compiler -> Preprocessor)
  - In armgcc in SDK package:
    - Remove SD_ENABLED and STREAMER_ENABLE_FILE_SINK symbols from preprocessor defines in flags.cmake file.
  - In Kconfig:
    1. Disable File sink MCUX_COMPONENT_middleware.audio_voice.maestro.element.file_sink.enable
    2. Make sure SD card support is disabled MCUX_COMPONENT_middleware.sdmmc.sd

Functionality The record_mic or opus_encode command calls the STREAMER_mic_Create or STREAMER_opusmem2mem_Create function from the app_streamer.c file depending on the selected mode.

- When the *Loopback* mode is selected, the command calls the STREAMER_mic_Create function that creates a pipeline with the following elements:
  - ELEMENT_MICROPHONE_INDEX
  - ELEMENT_SPEAKER_INDEX
- When the *File recording* mode is selected, the command calls the STREAMER_mic_Create function that creates a pipeline with the following elements: - ELEMENT_MICROPHONE_INDEX - ELEMENT_FILE_SINK_INDEX
- When the *Voice control* mode is selected, the command calls the STREAMER_mic_Create function that creates a pipeline with the following elements: - ELEMENT_MICROPHONE_INDEX - ELEMENT_VOICESEEKER_INDEX (If VOICE_SEEKER_PROC is defined) - ELEMENT_VIT_INDEX
- When the Encoding mode is selected, the command calls the STREAMER_opusmem2mem_Create function that creates a pipeline with the following elements: - ELEMENT_MEM_SRC_INDEX - ELEMENT_ENCODER_INDEX - ELEMENT_MEM_SINK_INDEX

Recording itself can be started with the STREAMER_Start function.

Each of the elements has several properties that can be accessed using the streamer_get_property or streamer_set_property function. These properties allow a user to change the values of the appropriate elements. The list of properties can be found in streamer_element_properties.h. See the example of setting property value in the following piece of code from the app_streamer.c file:

```
    ELEMENT_PROPERTY_T prop;

    prop.prop = PROP_MICROPHONE_SET_NUM_CHANNELS;
    prop.val  = DEMO_MIC_CHANNEL_NUM;
    streamer_set_property(handle->streamer, 0, prop, true);

    prop.prop = PROP_MICROPHONE_SET_BITS_PER_SAMPLE;
    prop.val  = DEMO_AUDIO_BIT_WIDTH;
    streamer_set_property(handle->streamer, 0, prop, true);

    prop.prop = PROP_MICROPHONE_SET_FRAME_MS;
    prop.val  = DEMO_MIC_FRAME_SIZE;
    streamer_set_property(handle->streamer, 0, prop, true);

    prop.prop = PROP_MICROPHONE_SET_SAMPLE_RATE;
    prop.val  = DEMO_AUDIO_SAMPLE_RATE;
    streamer_set_property(handle->streamer, 0, prop, true);
```

Some of the predefined values can be found in the streamer_api.h.

States The application can be in 2 different states:

- Idle
- Running

Commands in detail

- *help, version*
- *record_mic audio <time>*
- *record_mic file <time>*
- *record_mic <file_name> <time>*
- *record_mic vit <time> <language>*
- *opus_encode*

Legend for diagrams:

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((State)):::state
    B{Condition}:::condition
    C[Error message]:::error
    D[Process function]:::function
```

help, version

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> C[Write help or version]:::function
```

```
    B((Running)):::state --> C
    C --> E((No state
    change)):::state
```

record_mic audio <time>

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> D{time
    > 0 ?}:::condition
    D -- Yes --> F[recording]:::function
    D -- No --> E[Error: Record length
    must be greater than 0]:::error
    E --> B
    F --> C((Running)):::state
    C -->G{time
    expired?}:::condition
    G -- No --> C
    G -- Yes --> B
```

record_mic file <time>/record_mic <file_name> <time>

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> C{time
    > 0 ?}:::condition
    C -- Yes --> D{SD card
    inserted?}:::condition
    C -- No --> E[Error: Record length
    must be greater than 0]:::error
    E --> B
    D -- Yes --> G{Custom
    file name?}:::condition
    G -- Yes --> H[Create custom
    file name]:::function
    G -- No --> I[Create default
    file name]:::function
    H --> J[Recording]:::function
    I --> J
    J --> K((Running)):::state
    K -->L{time
    expired?}:::condition
    L -- No --> K
    L -- Yes --> B
    D -- No --> F[Error: Insert SD
    card first]:::error
    F --> B
```

record_mic vit <time> <language>

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state --> C{time
    > 0 ?}:::condition
    C -- Yes --> E{Selected
    language?}:::condition
    C -- No --> D[Error: Record length
    must be greater than 0]:::error
    D --> B
    E -- Yes --> G{Supported
    language?}:::condition
    E -- No --> F[Error: Language
    not selected]:::error
    F -->B
    G -- Yes -->I[Recording with
    voice recognition]:::function
    G -- No -->H[Error: Language not supported]:::error
    H --> B
    I --> J((Running)):::state
    J -->K{time
    expired?}:::condition
    K -- No --> J
    K -- Yes --> B
```

opus_encode

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    B((Idle)):::state -->C[Encode file]:::function
    C -->D[Check result]:::function
    D -->B
```

Processing Time Typical execution times of the streamer pipeline for the EVKC-MIMXRT1060 development board are detailed in the following table. The duration spent on output buffers and reading from the microphone is excluded from traversal measurements. Three measured pipelines were considered. The first involves a loopback from microphone to speaker, supporting both mono and stereo configurations. The second pipeline is a mono voice control setup, comprising microphone and VIT blocks. The final pipeline is a stereo voice control setup, integrating microphone, voice seeker, and VIT blocks.

For further details of execution times on individual elements, please refer to the *Processing Time* document.

	streamer
microphone -> speaker 1 channel	40 µs
microphone -> speaker 2 channels	115 µs
microphone -> VIT	7.4 ms
microphone -> voice seeker -> VIT	9.9 ms

Maestro sync example

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- *Hardware requirements*
- *Hardware modifications*
- *Preparation*
- *Running the demo*
- *Example configuration*
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- *States*
- *Commands in detail*

Overview The Maestro sync example demonstrates the use of synchronous pipelines (Tx and Rx in this case) processing in a single streamer task on the ARM cortex core utilizing the Maestro Audio Framework library.

The application is controlled by commands from a shell interface using serial console.

The feature is useful for testing the latency of the pipeline or implementing algorithms requiring reference signals such as echo cancellation. The VoiceSeeker library available in this example is not featuring AEC (Acoustic Echo Cancellation), but NXP is offering it in the premium version of the library. More information about the premium version can be found at VoiceSeeker. page. The demo uses two pipelines running synchronously in a single streamer task:

1. Playback (Tx) pipeline:
   - Playback of audio data in PCM format stored in flash memory to the audio Line-Out connector (speaker).
2. Recording (Rx) pipline:
   - Record audio data using a microphone.
   - VoiceSeeker processing.
   - Wake words + voice commands recognition.
   - Save the VoiceSeeker output to the voiceseeker_output.pcm file on the SD card.

As shown in the table below, the application is supported on several development boards, and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and *Hardware modifications* or *Example configuration* sections before running the demo.

Limitations:

- Addition labraries
  - **VIT:**
    * The VIT is supported only in the MCUXpresso IDE.
  - **VoiceSeeker:**
    * The VoiceSeeker is supported only in the MCUXpresso IDE.

Known issues:

- No known issues.

More information about supported features can be found on the *Supported features* page.

Hardware requirements

- Desired development board
- Micro USB cable
- Speaker with 3.5 mm stereo jack
- Personal computer
- Optional:
  - SD card for file output

Hardware modifications Some development boards need some hardware modifications to run the application. If the development board is not listed here, its default setting is required.

- *EVKC-MIMXRT1060:*
  1. Please make sure resistors below are removed to be able to use SD-Card.
     - R368, R347, R349, R365, R363
  2. Please Make sure J99 is installed.

Preparation

1. Connect a micro USB cable between the PC host and the debug USB port on the development board
2. Open a serial terminal with the following settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Download the program to the target board.
4. Insert the speaker into the Line-Out connector (headphone jack) on the development board.
5. *Optional:* Insert an SD card into the SD card slot to record to the VoiceSeeker output.
6. Either press the reset button on your development board or launch the debugger in your IDE to begin running the demo.

Running the demo When the example runs successfully, you should see similar output on the serial terminal as below:

```
****************************
Maestro audio sync demo start
****************************

Copyright 2022 NXP
[APP_SDCARD_Task] start
[APP_Shell_Task] start

>> [APP_SDCARD_Task] SD card drive mounted
```

Type help to see the command list. Similar description will be displayed on serial console:

```
>> help

"help": List all the registered commands

"exit": Exit program

"version": Display component versions

"start [nosdcard]": Starts a streamer task.
            - Initializes the streamer with the Memory->Speaker pipeline and with
              the Microphone->VoiceSeeker->VIT->SDcard pipeline.
            - Runs repeatedly until stop command.
    nosdcard - Doesn't use SD card to store data.

"stop": Stops a running streamer:

"debug [on|off]": Starts / stops debugging.
              - Starts / stops saving VoiceSeeker input data (reference and microphone data)
                to SDRAM.
              - After the stop command, this data is transferred to the SD card.
```

Details of commands can be found *here*.

Example configuration The example can be configured by user. Before configuration, please check the *table* to see if the feature is supported on the development board.

- **Enable the premium version of VoiceSeeker:**
  - The premium version of the VoiceSeeker library with AEC is API compatible with this example.
  - To get the premium version, please visit VoiceSeeker page.
  - The following steps are required to run this example with the VoiceSeeker&AEC library.
    - Link the voiceseeker.a library instead of voiceseeker_no_aec.a.
    - Set the RDSP_ENABLE_AEC definition to 1U in the voiceseeker.h file
- **VIT model generation:**
  - For custom VIT model generation (defining own wake words and voice commands) please use https://vit.nxp.com/

Functionality The start <nosdcard> command calls the STREAMER_Create function from the app_streamer.c file that creates pipelines with the following elements:

- Playback pipeline:

  - ELEMENT_MEM_SRC_INDEX
  - ELEMENT_SPEAKER_INDEX
- Record pipeline:
  - ELEMENT_MICROPHONE_INDEX
  - ELEMENT_VOICESEEKER_INDEX
  - ELEMENT_VIT_PROC_INDEX
  - ELEMENT_FILE_SINK_INDEX (If the nosdcard argument is not used)

Processing itself can be started with the STREAMER_Start function.

Each of the elements has several properties that can be accessed using the streamer_get_property or streamer_set_property function. These properties allow a user to change the values of the appropriate elements. The list of properties can be found in streamer_element_properties.h. See the example of setting property value in the following piece of code from the app_streamer.c file:

```
ELEMENT_PROPERTY_T prop;

MEMSRC_SET_BUFFER_T buf;
buf.location = (int8_t *)TESTAUDIO_DATA;
buf.size     = TESTAUDIO_LEN;

prop.prop = PROP_MEMSRC_SET_BUFF;
prop.val  = (uintptr_t)&buf;
if (STREAM_OK != streamer_set_property(handle->streamer, 0, prop, true))
{
    return kStatus_Fail;
}

prop.prop = PROP_MEMSRC_SET_MEM_TYPE;
prop.val  = AUDIO_DATA;
if (STREAM_OK != streamer_set_property(handle->streamer, 0, prop, true))
{
    return kStatus_Fail;
}

prop.prop = PROP_MEMSRC_SET_SAMPLE_RATE;
prop.val  = DEMO_SAMPLE_RATE;
if (STREAM_OK != streamer_set_property(handle->streamer, 0, prop, true))
{
    return kStatus_Fail;
}
```

Some of the predefined values can be found in the streamer_api.h.

States The application can be in 2 different states:

- Idle
- Running

Commands in detail

- *help, version*
- *start [nosdcard]*
- *stop*
- *debug [on|off]*

Legend for diagrams:

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((State)):::state
    B{Condition}:::condition
    C[Error message]:::error
    D[Process function]:::function
```

help, version

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> C[Write help or version]:::function
    B((Running)):::state --> C
    C --> E((No state
    change)):::state
```

start [nosdcard]

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> B{nosdcard
    parameter?}:::condition
    B -- Yes --> CH[Playing to Line-out and
    recording]:::function
    CH --> L((Running)):::state
    B -- No --> C{Is SD card
    inserted?}:::condition
    C -- Yes --> E[Playing to Line-out and
    recording to SD card]:::function
    E --> F((Running)):::state
    F --> G{Debugging
    is enabled?}:::condition
    G -- No --> F
    G -- Yes --> H[Save reference and
    microphone data to SDRAM]:::function
    H --> F
    C -- No --> D[Error: Insert SD
card first]:::error
    D --> A
    J((Running)):::state --> K[Error: The streamer task is
    already running]:::error
    K --> J
```

stop

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> A
    B((Running)):::state --> C{Is debugging
    enabled?}:::condition
    C --Yes -->E[Copy reference and
microphone data to
the SD card]:::function
    E --> G((Idle)):::state
    C -- No --> G
```

debug [on | off]

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> B[Error: First, start
    the streamer task]:::error
    C((Running)):::state --> D{Any
    parameter?}:::condition
    D -- Yes --> F{Started with
    nosdcard
    parameter?}:::condition
    F -- No --> H[Set debugging]:::function
    H --> C
    F --Yes --> G[Error: Debugging cannot be used]:::error
    G --> C
    D -- No --> E[Error: Use the parameter
    either on or off]:::error
    E --> C
```

Maestro USB microphone example

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- *Functionality*
- *States*
- *Commands in detail*

Overview The Maestro USB microphone example demonstrates audio processing on the ARM cortex core utilizing the Maestro Audio Framework library.

The application is controlled by commands from a shell interface using serial console.

The development board will be enumerated as a USB audio class 2.0 device on the USB host. The application takes audio samples from the microphone inputs and sends them to the USB host via the USB bus. User will see the volume levels obtained from the USB host but this is only an example application. To leverage the volume values, the demo has to be modified.

As shown in the table below, the application is supported on several development boards, and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and *Hardware modifications* or *Example configuration* sections before running the demo.

Limitations:

- *Note:*
  1. When connected to MacBook, change the PCM format from (0x02,0x00,) to (0x01,0x00,) in the g_config_descriptor[CONFIG_DESC_SIZE] in the usb_descriptor.c file. Otherwise, it can't be enumerated and noise is present when recording with the QuickTime player because the sampling frequency and bit resolution do not match.
  2. When device functionality is changed, please uninstall the previous PC driver to make sure the device with changed functionality can run normally.
  3. If you're having audio problems on Windows 10 for recorder, please disable signal enhancement as the following if it is enabled and have a try again.

Known issues:

- No known issues.

More information about supported features can be found on the *Supported features* page.

Hardware requirements

- Desired development board
- 2x Micro USB cable
- Personal Computer
- *LPCXpresso55s69:*
  - Source of sound with 3.5 mm stereo jack connector

Hardware modifications Some development boards need some hardware modifications to run the application. If the development board is not listed here, its default setting is required.

Preparation

1. Connect the first micro USB cable between the PC host and the debug USB port on the development board
2. Open a serial terminal with the following settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit

- No flow control

3. Download the program to the target board.
4. *LPCXpresso55s69:*
   - Insert source of sound to Audio Line-In connector (headphone jack) on the development board.
5. Connect the second micro USB cable between the PC host and the USB port on the development board.
6. Either press the reset button on your development board or launch the debugger in your IDE to begin running the demo.

Running the demo When the example runs successfully, you should see similar output on the serial terminal as below:

```
**************************************************
Maestro audio USB microphone solutions demo start
**************************************************

Copyright 2022 NXP
[APP_Shell_Task] start

>> usb_mic -1

Starting maestro usb microphone application
The application will run until the board restarts
[STREAMER] Message Task started
Starting recording
[STREAMER] start usb microphone
Set Cur Volume : 1f00
```

Type help to see the command list. Similar description will be displayed on serial console:

```
>> help

"help": List all the registered commands

"exit": Exit program

"version": Display component versions

"usb_mic": Record MIC audio and playback to the USB port as an audio 2.0
        microphone device.

  USAGE: usb_mic <seconds>
    <seconds> Time in seconds how long the application should run.
            When you enter a negative number the application will
            run until the board restarts.
  EXAMPLE: The application will run for 20 seconds: usb_mic 20
```

Details of commands can be found *here*.

Example configuration The example only supports one mode and do not support any additional libraries, so the example can't be configured by user.

Functionality The usb_mic command calls the STREAMER_mic_Create function from the app_streamer.cfile that creates pipeline with the following elements: - ELEMENT_MICROPHONE_INDEX - ELEMENT_USB_SINK_INDEX

Recording itself can be started with the STREAMER_Start function.

Each of the elements has several properties that can be accessed using the streamer_get_property or streamer_set_property function. These properties allow a user to change the values of the appropriate elements. The list of properties can be found in streamer_element_properties.h. See the example of setting property value in the following piece of code from the app_streamer.c file:

```
ELEMENT_PROPERTY_T prop;

prop.prop = PROP_MICROPHONE_SET_SAMPLE_RATE;
prop.val  = AUDIO_SAMPLING_RATE;

streamer_set_property(handle->streamer, 0, prop, true);

prop.prop = PROP_MICROPHONE_SET_NUM_CHANNELS;
prop.val  = 1;

streamer_set_property(handle->streamer, 0, prop, true);

prop.prop = PROP_MICROPHONE_SET_FRAME_MS;
prop.val  = 1;

streamer_set_property(handle->streamer, 0, prop, true);
```

Some of the predefined values can be found in the streamer_api.h.

States The application can be in 2 different states:

- Idle
- Running

Commands in detail

- *help, version*
- *usb_mic <seconds>*

Legend for diagrams:

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((State)):::state
    B{Condition}:::condition
    C[Error message]:::error
    D[Process function]:::function
```

help, version

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> C[Write help or version]:::function
    B((Running)):::state --> C
```

C --> E((No state
change)):::state

usb_mic <seconds>

flowchart TD
classDef function fill:#c6d22c
classDef condition fill:#7cb2de
classDef state fill:#fcb415
classDef error fill:#FF999C

B((Idle)):::state -->C{seconds
== 0?}:::condition
C -- No --> E{seconds
< 0?}:::condition
C -- Yes --> D[Error: Incorrect
command parameter]:::error
D -->B
E -- Yes --> G[recording]:::function
G --> H((Running)):::state
H --> H
E -- No --> F[recording]:::function
F --> I((Running)):::state
I --> J{seconds
expired?}:::condition
J -- No -->I
J -- Yes --> B

Maestro USB speaker example

Table of content

- *Overview*
- *Hardware requirements*
- *Hardware modifications*
- *Preparation*
- *Running the demo*
- *Example configuration*
- *Functionality*
- *States*
- *Commands in detail*

Overview The Maestro USB speaker example demonstrates audio processing on the ARM cortex core utilizing the Maestro Audio Framework library.

The application is controlled by commands from a shell interface using serial console.

The development board will be enumerated as a USB audio class 2.0 device on the USB host. The application takes audio samples from the USB host and sends them to the audio Line-Out port. User will see the volume levels obtained from the USB host but this is only an example application. To leverage the volume values, the demo has to be modified.

Depending on target platform or development board there are different modes and features of the demo supported.

- **Standard** - The mode demonstrates playback with up to 2 channels, up to 48 kHz sample rate and up to 16 bit width. This mode is enabled by default.
- **Multi-Channel** - In this mode the device is enumerated as a UAC 5.1. This mode is disabled by default. See the *Example configuration* section to see how to enable the mode.
  - When playing an 5.1 audio file, the example sends only the front-left and front-right channels to the audio Line-Out port (the other channels are ignored), since this example only supports on-board codecs with stereo audio output.

As shown in the table below, the application is supported on several development boards, and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and *Hardware modifications* or *Example configuration* sections before running the demo.

Limitations:

- *Note:*
  - If the USB device audio speaker example uses an ISO IN feedback endpoint, please attach the device to a host like PC which supports feedback function. Otherwise, there might be attachment issue or other problems.

Known issues:

- No known issues.

More information about supported features can be found on the *Supported features* page.

Hardware requirements

- Desired development board
- 2x Micro USB cable
- Personal Computer
- Headphones with 3.5 mm stereo jack

Hardware modifications Some development boards need some hardware modifications to run the application. If the development board is not listed here, its default setting is required.

Preparation

1. Connect the first micro USB cable between the PC host and the debug USB port on the development board
2. Open a serial terminal with the following settings:
   - 115200 baud rate
   - 8 data bits
   - No parity
   - One stop bit
   - No flow control
3. Download the program to the target board.
4. Connect the second micro USB cable between the PC host and the USB port on the development board.

5. Insert the headphones into Line-Out connector (headphone jack) on the development board.
6. Either press the reset button on your development board or launch the debugger in your IDE to begin running the demo.

Running the demo When the example runs successfully, you should see similar output on the serial terminal as below:

```
**********************************************
Maestro audio USB speaker solutions demo start
**********************************************

Copyright 2022 NXP
[APP_Shell_Task] start

>> usb_speaker -1

Starting maestro usb speaker application
The application will run until the board restarts
[STREAMER] Message Task started
Starting playing
[STREAMER] start usb speaker
Set Cur Volume : fbd5
```

Type help to see the command list. Similar description will be displayed on serial console:

```
>> help

"help": List all the registered commands

"exit": Exit program

"version": Display component versions

"usb_speaker": Play data from the USB port as an audio 2.0
               speaker device.

 USAGE:      usb_speaker <seconds>
  <seconds>  Time in seconds how long the application should run.
             When you enter a negative number the application will
             run until the board restarts.
  EXAMPLE:   The application will run for 20 seconds: usb_speaker 20
```

Details of commands can be found *here*.

Example configuration The example can be configured by user. Before configuration, please check the *table* to see if the feature is supported on the development board.

- **Enable Multi-channel mode:**
  - The feature can be enabled by set the USB_AUDIO_CHANNEL5_1 macro to 1U in the usb_device_descriptor.h file.
  - *Note:* When device functionality is changed, such as UAC 5.1, please uninstall the previous PC driver to make sure the device with changed functionality can run normally.

Functionality The Usb_speaker command calls the STREAMER_speaker_Create function from the app_streamer.cfile that creates pipeline with the following elements: - ELEMENT_USB_SRC_INDEX - ELEMENT_SPEAKER_INDEX

Playback itself can be started with the STREAMER_Start function.

Each of the elements has several properties that can be accessed using the streamer_get_property or streamer_set_property function. These properties allow a user to change the values of the appropriate elements. The list of properties can be found in streamer_element_properties.h. See the example of setting property value in the following piece of code from the app_streamer.c file:

```
ELEMENT_PROPERTY_T prop;

prop.prop = PROP_USB_SRC_SET_SAMPLE_RATE;
prop.val  = AUDIO_SAMPLING_RATE;

streamer_set_property(handle->streamer, 0, prop, true);

prop.prop = PROP_USB_SRC_SET_NUM_CHANNELS;
prop.val  = 2;

streamer_set_property(handle->streamer, 0, prop, true);

prop.prop = PROP_USB_SRC_SET_FRAME_MS;
prop.val  = 1;

streamer_set_property(handle->streamer, 0, prop, true);
```

Some of the predefined values can be found in the streamer_api.h.

States The application can be in 2 different states:

- Idle
- Running

Commands in detail

- *help, version*
- *usb_speaker <seconds>*

Legend for diagrams:

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((State)):::state
    B{Condition}:::condition
    C[Error message]:::error
    D[Process function]:::function
```

help, version

```
flowchart TD
    classDef function fill:#69CA00
    classDef condition fill:#0EAFE0
    classDef state fill:#F9B500
    classDef error fill:#F54D4D

    A((Idle)):::state --> C[Write help or version]:::function
    B((Running)):::state --> C
```

```
C --> E((No state
change)):::state
```

usb_speaker <seconds>

```
flowchart TD
    classDef function fill:#c6d22c
    classDef condition fill:#7cb2de
    classDef state fill:#fcb415
    classDef error fill:#FF999C

    B((Idle)):::state -->C{Duration
    == 0?}:::condition
    C -- No --> E{Duration
    < 0?}:::condition
    C -- Yes --> D[Error: Incorrect
    command parameter]:::error
    D -->B
    E -- Yes --> G[playing]:::function
    G --> H((Running)):::state
    H --> H
    E -- No --> F[playing]:::function
    F --> I((Running)):::state
    I --> J{Duration
    expired?}:::condition
    J -- No -->I
    J -- Yes --> B
```

Supported features The current version of the audio framework supports several optional features. These can be limited to some MCU cores or development boards variants. More information about support can be found on the specific example page:

- *maestro_playback*
- *maestro_record*
- *maestro_usb_mic*
- *maestro_usb_speaker*
- *maestro_sync*

Some features are delivered as prebuilt library and the binaries can be found in the \middleware\audio_voice\components*component*\libs folder. The source code of some features can be found in the \middleware\audio_voice\maestro\src folder.

Decoders Supported decoders and its options are:

Decoder	Sample rates [kHz]	Number of channels	Bit depth
AAC	8, 11.025, 12, 16, 22.05, 24, 32, 44.1, 48	1, 2 (mono/stereo)	16
FLAC	8, 11.025, 12, 16, 22.05, 32, 44.1, 48	1, 2 (mono/stereo)	16
MP3	8, 11.025, 12, 16, 22.05, 24, 32, 44.1, 48	1, 2 (mono/stereo)	16
OPUS	8, 16, 24, 48	1, 2 (mono/stereo)	16
WAV	8, 11.025, 16, 22.05, 32, 44.1, 48	1, 2 (mono/stereo)	8, 16, 24

For more details about the reference decoders please see audio-voice-components repository documentation \middleware\audio_voice\components\.

Encoders

- **OPUS encoder** - The current verion of the audio framework only supports a OPUS encoder. For more details about the encoder please see the following link.

Sample rate converters

- **SSRC** - Synchronous sample rate converter. More details about SSRC are available in the User Guide, which is located in middleware\audio_voice\components\ssrc\doc\.
- **ASRC** - Asynchronous sample rate converter is not used in our examples, but it is part of the maestro middleware and can be enabled. To enable ASRC, the maestro_framework_asrc and CMSIS_DSP_Library_Source components must be added to the project. Furthermore, it is necessary to switch from Redlib to Newlib (semihost) library and add a platform definition to the project (e.g. for RT1170: PLATFORM_RT1170_CORTEXM7). Supported platforms can be found in the PL_platformTypes.h file. More details about ASRC are available in the User Guide, which is located in middleware\audio_voice\components\asrc\doc\.

Additional libraries

- **VIT** - Voice Intelligent Technology (VIT) Wake Word and Voice Command Engines provide free, ready to use voice UI enablement for developers. It enables customer-defined wake words and commands using free online tools. More details about VIT are available in the VIT package, which is located in middleware\audio_voice\components\vit\{platform}\Doc\(depending on the platform) or via following link.
- **VoiceSeeker** - VoiceSeeker is a multi-microphone voice control audio front-end signal processing solution. More details about VoiceSeeker are available in the VoiceSeeker package, which is located in middleware\audio_voice\components\voice_seeker\{platform}\Doc\ (depending on the platform) or via following link.

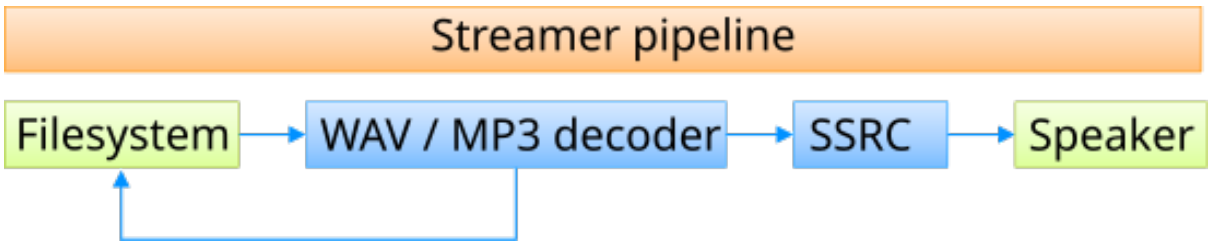
Processing Time

Table of content

- *Maestro playback example*
- *Maestro record example*

The individual time measurements were conducted using a logic analyzer by monitoring changes in the GPIO port levels on the EVKC-MIMXRT1060 development board. These measurements were executed for each individual pipeline run, capturing the timing at each corresponding element, and, when relevant, the interconnections between these elements.

Maestro playback example For the Maestro playback example the following reference audio file was used: test_48khz_16bit_2ch.wav. In this example, the pipeline depicted in the diagram was considered. Media codecs WAV and MP3 were taken into account. To compare the times spent on the SSRC block, sampling rates for both codecs were selected: 44.1 kHz and 48 kHz.



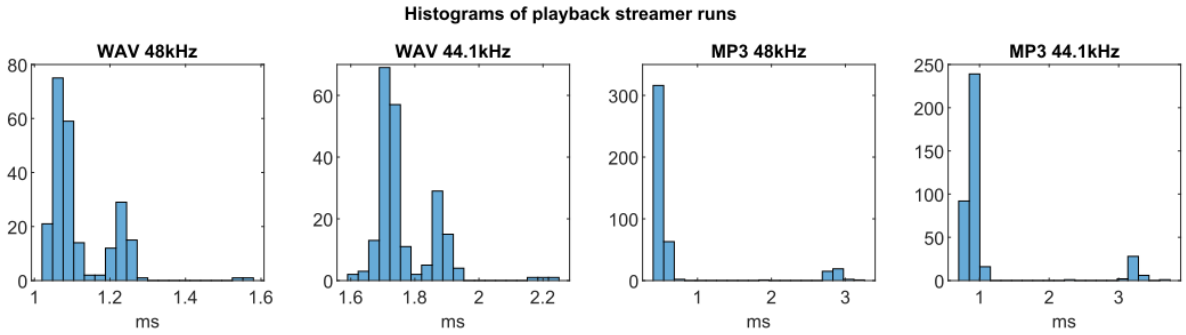
The measurement of streamer pipeline run started at the beginning of streamer_process_pipelines(): streamer.c and ended in the function streamer_pcm_write(): streamer_pcm.c just before the output buffer.

In the scenario involving the WAV codec, the audio file was accessed in every iteration of the streamer pipeline. Meaning, during each run, the file was read directly from the SD card. However, in the case of the MP3 codec, where data processing necessitates complete MP3 frames, the file wasn't read during every run. Rather, it was accessed periodically, triggered when the codec buffer lacked a complete MP3 frame of data. The total time spent on codec processing varies significantly depending on the type and implementation of the codec. For certain types of codecs, like FLAC, there may be multiple file accesses during a single pipeline run. The provided values are specific to the reference implementation. For details about the codecs please see see audio-voice-components documentation middleware\audio_voice\components\.

The duration of the streamer pipeline illustrates that with a sampling frequency of 48 kHz, there is no resampling occurring at the SSRC element. Consequently, the overall pipeline time is lower than in the case of 44.1 kHz audio, where resampling takes place.

To enhance comprehension of the system's behavior, histograms of the pipeline run times and its elements are included. The greater time variance with the MP3 codec is precisely due to the absence of file reads in every run. In clusters with shorter times, there are no file accesses, while in clusters with longer times, file reads occur. This indicates that the majority of runs do not involve file access.

	WAV 48 kHz	WAV 44 kHz	MP3 48 kHz file read	MP3 48 kHz w/o file read	MP3 44 kHz file read	MP3 44 kHz w/o file read
mean	1.11 ms	1.76 ms	2.87 ms	0.51 ms	3.22 ms	0.89 ms
min	1.03 ms	1.60 ms	2.74 ms	0.41 ms	2.33 ms	0.74 ms
max	1.29 ms	2.23 ms	3.24 ms	1.83 ms	3.73 ms	1.12 ms



Time on each element In the tables and histograms below, the timings for individual elements and their connections are provided. Given that the file reading function was invoked during the codec's operation, the tables for individual elements display the total time on the codec element, the time on the codec element before the file read, and the time on the codec element after the file read. The individual blocks in the tables are as follows:

- **streamer** - total time of one pipeline run without time on output buffers
- **codec start** - time on decoder before file read
- **codec end** - time on decoder after file read
- **codec total** - codec_start+codec_end
- **file_src** - file reading time
- **SSRC_proc** - time on SSRC element
- **audio_sink** - time on audio sink without ouput buffers

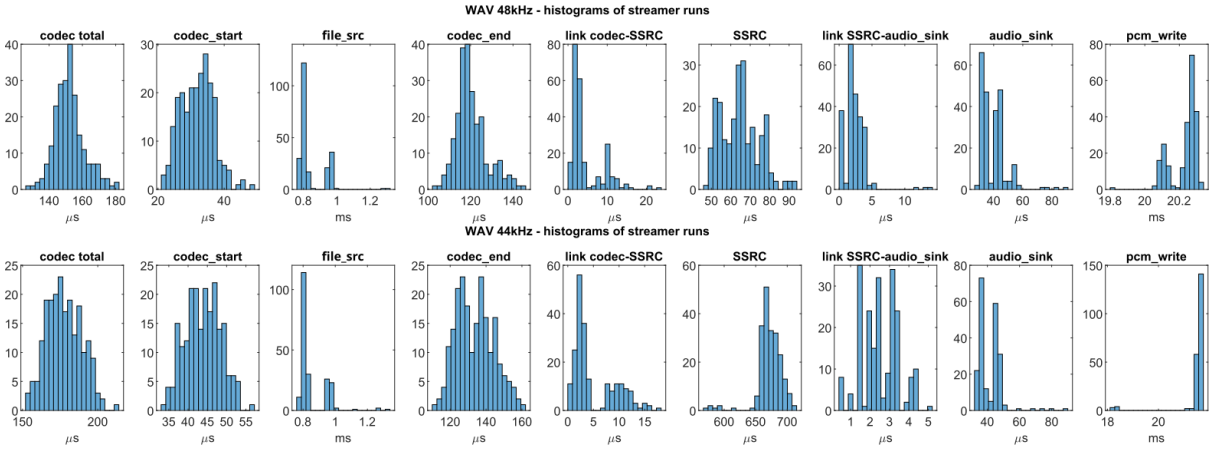
- **pcm_write** - time on output buffers
- **link** - time on element links

The start times of the time intervals for individual blocks and their respective links were measured by altering the GPIO pin level in the following functions:

- **streamer** - streamer_process_pipelines():streamer.c
- **codec** - decoder_sink_pad_process_handler():decoder_pads.c
- **file_src** - filesrc_read():file_src_rtos.c
- **SSRC_proc** - SSRC_Proc_Execute():ssrc_proc.c
- **audio_sink** - audiosink_sink_pad_chain_handler():audio_sink.c
- **pcm_write** - streamer_pcm_write():streamer_pcm.c
- **link** - pad_push():pad.c

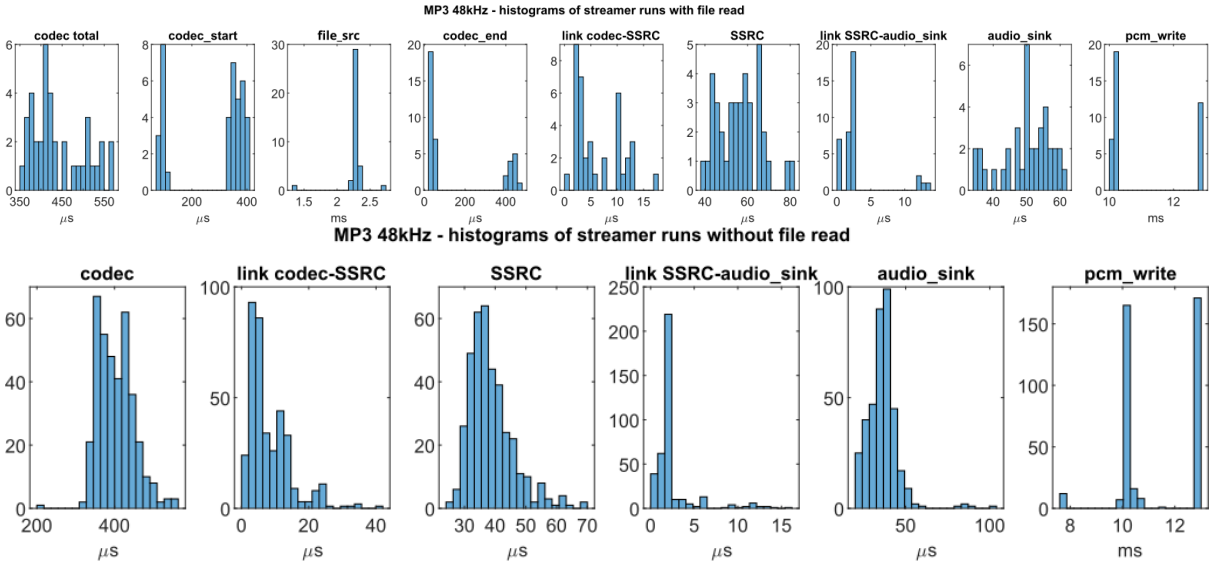
WAV 48kHz	strean	codec total	codec start	file_sr	codec end	link codec-SSRC	SSRC_p	link SSRC-audio_sink	au-dio_sin	pcm_write
mean	1.119 ms	152 µs	31 µs	0.843 ms	120 µs	5 µs	64 µs	2 µs	40 µs	20.228 ms
min	1.026 ms	125 µs	21 µs	0.773 ms	104 µs	<1 µs	47 µs	<1 µs	30 µs	19.805 ms
max	1.290 ms	193 µs	49 µs	1.311 ms	144 µs	23 µs	93 µs	14 µs	91 µs	20.324 ms

WAV 44kHz	strean	codec total	codec start	file_sr	codec end	link codec-SSRC	SSRC_p	link SSRC-audio_sink	au-dio_sin	pcm_write
mean	1.765 ms	178 µs	44 µs	0.853 ms	134 µs	5 µs	671 µs	3 µs	42 µs	21.472 ms
min	1.604 ms	145 µs	33 µs	0.770 ms	112 µs	<1 µs	574 µs	<1 µs	33 µs	18.163 ms
max	2.233 ms	218 µs	57 µs	1.335 ms	161 µs	18 µs	715 µs	5 µs	89 µs	21.746 ms



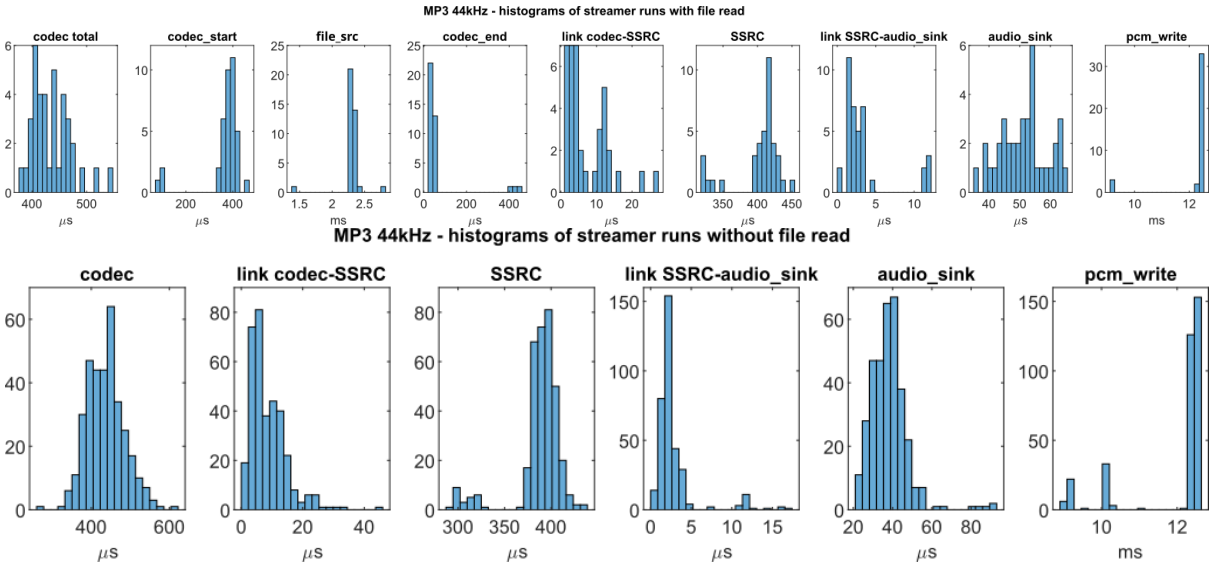
MP3 48 kHz w/ file read	strear	codec total	codec start	file_sr	codec end	link codec-SSRC	SSRC_l	link SSRC-audio_sink	au-dio_sir	pcm_write
mean	2.871 ms	441 µs	279 µs	2.271 ms	162 µs	6 µs	56 µs	3 µs	50 µs	11.019 ms
min	2.739 ms	353 µs	74 µs	1.353 ms	26 µs	<1 µs	40 µs	<1 µs	34 µs	10.091 ms
max	3.244 ms	570 µs	409 µs	2.728 ms	467 µs	18 µs	80 µs	14 µs	62 µs	12.910 ms

MP3 48 kHz w/o file read	strear	codec total	codec start	file_s	codec end	link codec-SSRC	SSRC_l	link SSRC-audio_sink	au-dio_sir	pcm_write
mean	0.508 ms	403 µs	x	x	x	8 µs	39 µs	3 µs	36 µs	11.326 ms
min	0.407 ms	208 µs	x	x	x	<1 µs	25 µs	<1 µs	21 µs	7.715 ms
max	1.834 ms	563 µs	x	x	x	41 µs	69 µs	16 µs	104 µs	12.941 ms

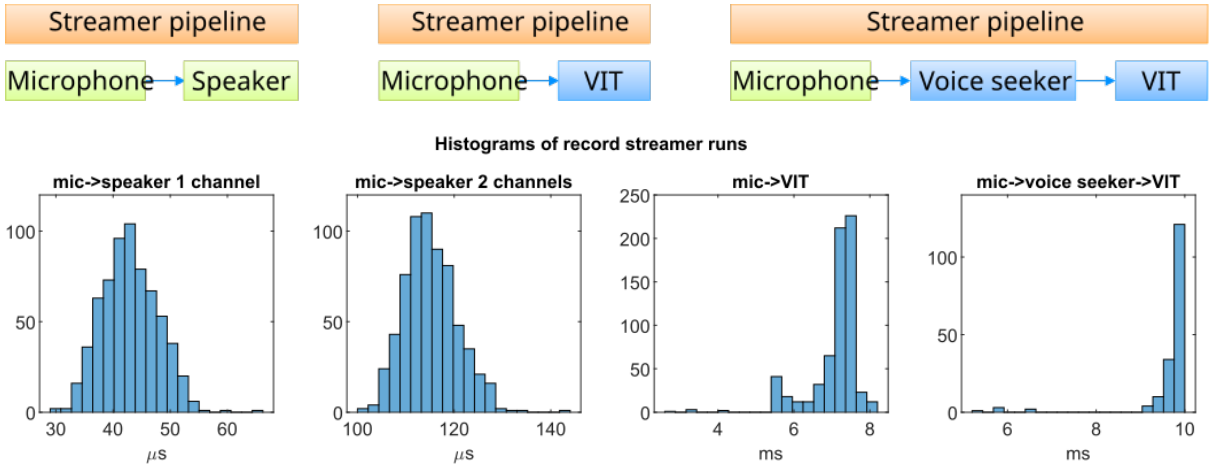


MP3 44 kHz w/ file read	strear	codec total	codec start	file_sr	codec end	link codec-SSRC	SSRC_l	link SSRC-audio_sink	au-dio_sir	pcm_write
mean	3.217 ms	436 µs	367 µs	2.300 ms	66 µs	7 µs	403 µs	3 µs	51 µs	12.188 ms
min	2.329 ms	383 µs	73 µs	1.411 ms	26 µs	2 µs	318 µs	<1 µs	35 µs	9.119 ms
max	3.726 ms	547 µs	464 µs	2.801 ms	441 µs	27 µs	454 µs	12 µs	65 µs	12.529 ms

MP3 44 kHz w/o file read	strear	codec total	codec start	file_s	codec end	link codec-SSRC	SSRC_l	link SSRC-audio_sink	au-dio_sir	pcm_write
mean	0.891 ms	437 µs	x	x	x	9 µs	388 µs	3 µs	38 µs	11.934 ms
min	0.738 ms	268 µs	x	x	x	<1 µs	290 µs	<1 µs	22 µs	8.964 ms
max	1.115 ms	620 µs	x	x	x	45 µs	438 µs	17 µs	92 µs	12.624 ms



Maestro record example Typical execution times of the streamer pipeline and its individual elements for the EVKC-MIMXRT1060 development board are detailed in the following tables. The duration spent on output buffers and reading from the microphone is excluded from traversal measurements. Three measured pipelines are depicted in the figure below. The first involves a loopback from microphone to speaker, supporting both mono and stereo configurations. The second pipeline is a mono voice control setup, comprising microphone and VIT blocks. The final pipeline is a stereo voice control setup, integrating microphone, voice seeker, and VIT blocks. The measurement of streamer pipeline run started at the beginning of streamer_process_pipelines():streamer.c and ended in the function streamer_pcm_write(): streamer_pcm.c just before the output buffer.



The individual blocks in the tables are as follows:

- **streamer** - total time of one pipeline run without time on output buffers and without time reading from the microphone
- **audio_src_start** - time on audio src before reading from the microphone
- **audio_src_end** - time on audio src after reading from the microphone
- **pcm_read** - reading from the microphone
- **voiceseeker** - time on voice seeker element
- **vit** - time on VIT element
- **audio_sink** - time on audio sink without ouput buffers
- **pcm_write** - time on output buffers
- **link** - time on element links

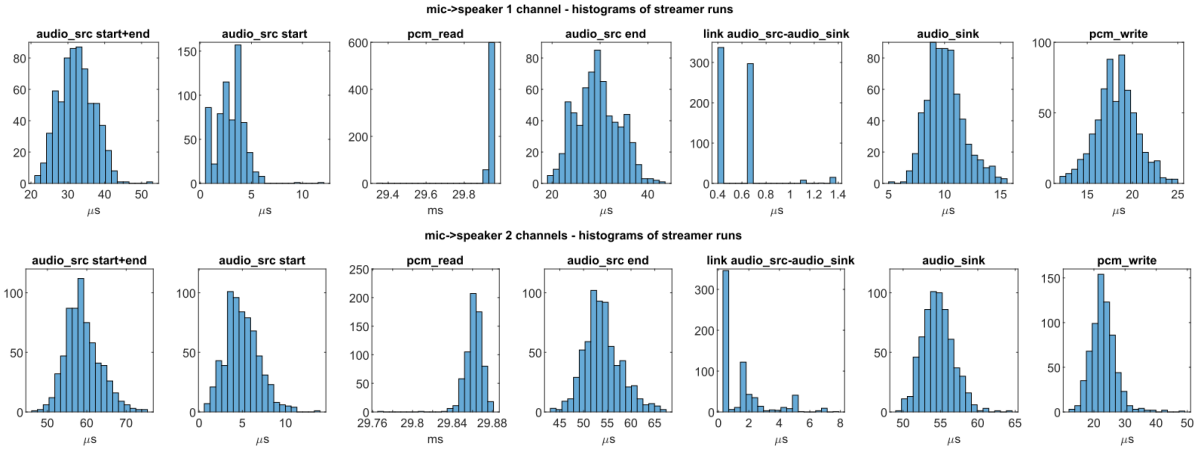
The start times of the time intervals for individual blocks and their respective links were measured by altering the GPIO pin level in the following functions:

- **streamer** - streamer_process_pipelines():streamer.c
- **audio_src** - audiosrc_src_process():audio_src.c
- **pcm_read** - streamer_pcm_read():streamer_pcm.c
- **voiceseeker** - audio_proc_sink_pad_chain_handler():audio_proc.c
- **vit** - vitsink_sink_pad_chain_handler():vit_sink.c
- **audio_sink** - audiosink_sink_pad_chain_handler():audio_sink.c
- **pcm_write** - streamer_pcm_write():streamer_pcm.c
- **link** - pad_push():pad.c

Pipeline Microphone -> Speaker

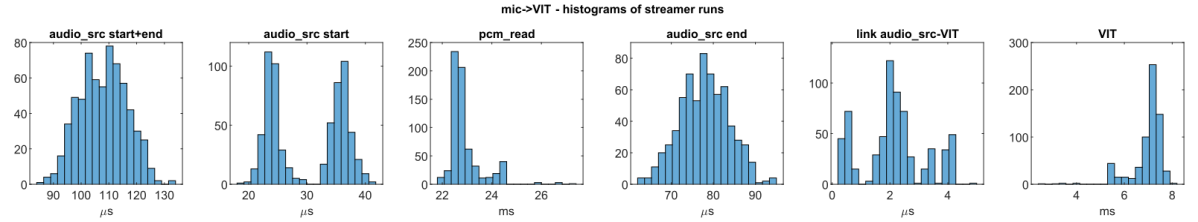
microphone -> speaker mono	stream	audio_src_sta	pcm_re	audio_src_er	link audio_src-audio_sink	audio_sink	pcm_write
mean	43 µs	3 µs	29.938 ms	29 µs	<1 µs	10 µs	18 µs
min	26 µs	<1 µs	29.350 ms	19 µs	<1 µs	5 µs	12 µs
max	72 µs	12 µs	29.957 ms	44 µs	1 µs	15 µs	25 µs

microphone -> speaker stereo	stream	audio_src_sta	pcm_re	audio_src_er	link audio_src-audio_sink	audio_sink	pcm_write
mean	115 µs	5 µs	29.861 ms	54 µs	2 µs	55 µs	23 µs
min	94 µs	<1 µs	29.768 ms	43 µs	<1 µs	50 µs	12 µs
max	154 µs	14 µs	29.880 ms	67 µs	8 µs	65 µs	49 µs



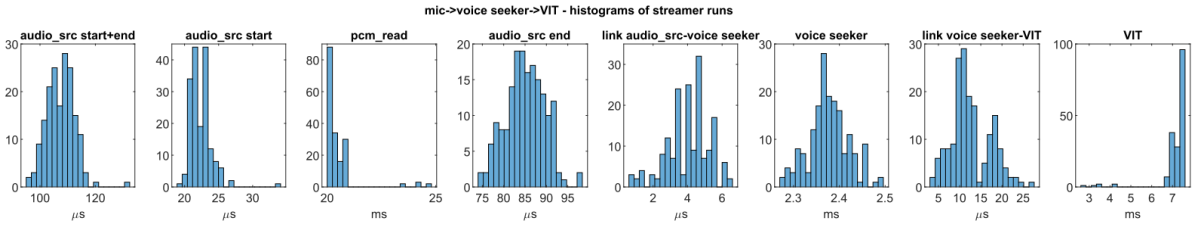
Pipeline Microphone -> VIT

microphone -> VIT	streamer	audio_src_start	pcm_read	audio_src_end	link audio_src-vit	vit
mean	7.380 ms	30 µs	22.624 ms	78 µs	2 µs	7.261 ms
min	2.641 ms	10 µs	2.2265 ms	58 µs	<1 µs	2.559 ms
max	7.780 ms	42 µs	2.7341 ms	94 µs	5 µs	7.624 ms



Pipeline Microphone -> Voice seeker -> VIT

microphone -> voice seeker -> VIT	stream	audio_src_s	pcm_r	audio_src_	link audio_src-voiceseeker	voice-seeker	link voiceseeke vit	vit
mean	9.916 ms	22 µs	20.084 ms	84 µs	4 µs	2.386 ms	13 µs	7.407 ms
min	4.983 ms	19 µs	19.738 ms	72 µs	<1 µs	2.228 ms	2 µs	2.662 ms
max	10.423 ms	34 µs	24.777 ms	100 µs	7 µs	2.522 ms	31 µs	7.729 ms



Maestro on Zephyr

- Based on and tested with Zephyr version, given by tag v4.0.0
- Tested with Zephyr SDK version 16.4
- To see the pre-built documentation, see: README.html. Also see the *documentation section*.

Maestro sample for recording data from microphone to RAM

Description This sample records data from microphone (alias dmic0 in devicetree) and stores them to a buffer in RAM.

Currently one PDM channel with fixed 16 kHz sample rate and 16 bit sample width is supported.

For configuration options, see Kconfig and prj.conf.

User Input/Output

- Input:

  None.

- Output:

  UART Output:

  - Demo result: OK if everything went OK
  - Demo result: FAIL otherwise

Supported platforms Currently tested for:

- RD_RW612_BGA.

Maestro voice detection sample using VIT

Description Records data from microphone (alias dmic0 in devicetree) and detects voice commands from selected language model. Detected commands are printed via UART.

Language model may be changed via Kconfig using CONFIG_MAESTRO_EXAMPLE_VIT_LANGUAGE selection. For other configuration options, see example's Kconfig and prj.conf.

This project requires an NXP board supported by the VIT library.

The example has to be modified if a new board needs to be added. Please create an issue in that case.

User Input/Output

- Input:

  None.

- Output:

  UART Output:

  - List of voice commands the model can detect (printed immediately after start)
  - <Specific voice command> if voice command was detected
  - Demo result: FAIL otherwise

Dependencies

- VIT library: https://www.nxp.com/design/design-center/software/embedded-software/voice-intelligent-technology-wake-word-and-voice-command-engines:VOICE-INTELLIGENT-TECHNOLOGY

Supported platforms Currently tested for:

- RD_RW612_BGA.

Maestro decoder sample

Description Tests and demonstrates decoder functionality in Maestro pipeline.

Supported decoders:

- MP3
- WAV
- AAC
- FLAC
- OPUS with OGG envelop
- (RAW OPUS - TBD)

Data Input:

- Prepared encoded audio data (part of Maestro repository, folder `zephyr/audioTracks`)
- Prepared decoded audio data (RAW PCM format, part of Maestro repository, folder `zephyr/audioTracks`)

Function:

1. Loads encoded data into source buffer stored in RAM
2. Decodes audio data using selected decoder and stores data in RAM
3. Compares prepared data with decoded data to check if its the same
4. Prints `Demo result: OK` or `Demo result: FAIL` via UART

User Input/Output

- Input:

  None

- Output:

  UART Output

  - `Demo result: OK` if everything went OK
  - `Demo result: FAIL` otherwise

Dependencies

- Audio voice component library (pulled in by Maestro's west), containing Decoder libraries

Configuration

- See prj.conf for user input sections
  - Selecting decoder may be done by enabling CONFIG_MAESTRO_EXAMPLE_DECODER_SELECTED in prj.conf file. When no decoder is selected, default one (WAV) is used instead.
  - System settings should be modified (stack size, heap size) based on selected decoder and system capabilities/requirements in prj.conf.
- For other configuration options, see example's Kconfig and prj.conf.

Supported platforms Currently tested for:

- RD_RW612_BGA - Working decoders: FLAC, WAV, OPUS OGG

Maestro encoder sample

Description Tests and demonstrates encoder functionality in Maestro pipeline.

Supported encoders:

- OPUS with OGG envelop - TBD
- RAW OPUS - TBD

Input:

- Prepared decoded audio data (RAW PCM format, part of Maestro repository)
- Prepared encoded audio data (part of Maestro repository)

Function:

1. Loads RAW data into source buffer stored in RAM
2. Encodes audio data using selected encoder and stores data in RAM
3. Compares prepared data with decoded data if same
4. Prints Demo result: OK or Demo result: FAIL via UART

Dependencies

- Audio voice component library (pulled in by Maestro's west), containing Encoder libraries

User Input/Output Input:

- None

Output:

- UART Output
  - Demo result: OK if everything went OK
  - Demo result: FAIL otherwise

Configuration

- See prj.conf for user input sections
  - Selecting encoder may be done by enabling CONFIG_MAESTRO_EXAMPLE_ENCODER_SELECTED in prj.conf file. When no encoder is selected, default one (OPUS) is used instead.
  - System settings should be modified (stack size, heap size) based on selected encoder and system capabilities/requirements in prj.conf file.
- For other configuration options, see example's Kconfig and prj.conf.

Supported platforms Currently tested for:

- RD_RW612_BGA - Working encoders: None.

Maestro mem2mem sample

Description Tests basic memory to memory pipeline.

Function:

1. Moves generated data with fixed size of 256B from memory source to memory sink.
2. Compares copied data to check if they're the same.
3. Returns Demo result: OK or Demo result: FAIL via UART.

- *Maestro environment setup*
- *Build and run Maestro example*
  - *Using command line*
  - *Using MCUXpresso for VS Code*
- *Folder structure*
- *Supported elements and libraries*
- *Examples support*
- *Creating your own example*
- *Documentation*
- *FAQ*

Maestro environment setup Follow these steps to set up a Maestro development environment on your machine.

1. If you haven't already, please follow this guide to set up a Zephyr development environment and its dependencies first:
   - Cmake
   - Python
   - Devicetree compiler
   - West
   - Zephyr SDK bundle

2. Get Maestro. You can pick either of the options listed below. If you need help deciding which option is the best fit for your needs, please see the *FAQ*.

   - Freestanding Maestro - This option pulls in only Maestro's necessary dependencies.

     Run:

     ```
     1. west init -m <maestro repository url> --mr <revision> --mf west-freestanding.yml
     ↪<foldername>
     2. cd <foldername>
     3. west update
     ```

   - Maestro as a Zephyr module

     To include Maestro into Zephyr, update Zephyr's west.yml file:

     ```
     projects:
     name: maestro
     url: <maestro repository url>
     revision: <revision with Zephyr support>
     path: modules/audio/maestro
     import: west.yml
     ```

     Then run west update maestro command.

Build and run Maestro example These steps will guide you through building and running Maestro samples. You can use either the command line utilizing Zephyr's powerful west tool or you can use VS Code's GUI. Detailed steps for both options are listed below.

Using command line See Zephyr's Building, Flashing and Debugging guide if you aren't familiar with it yet.

1. To **build** a project, run:

   ```
   west build -b <board> -d <output build directory> <path to example> -p
   ```

   For example, this compiles VIT example for rd_rw612_bga board:

   ```
   1. cd maestro/zephyr
   2. west build -b rd_rw612_bga -d build samples/vit -p
   ```

2. To **run** a project, run:

   ```
   west flash -d <directory>
   ```

   e.g.:

   ```
   west flash -d build
   ```

3. To **debug** a project, run:

   ```
   west debug -d <directory>
   ```

   e.g.:

   ```
   west debug -d build
   ```

Using MCUXpresso for VS Code For this you have to have NXP's MCUXpresso for VS Code extension installed.

1. Import your topdir as a repository to MCUXPresso for VS Code:

- Open the MCUXpresso Extension. In the *Quickstart Panel* click *Import Repository*.
- In the displayed menu click *LOCAL* tab and select the folder location of your *topdir*.
- Click *Import*.
- The repository is successfully added to the *Installed Repositories* view once the import is successful.

2. To import any project from the imported repository:
   - In the *Quickstart Panel* click *Import Example from Repository*.
   - For **Repository** select *your imported* repository.
   - For **Zephyr SDK** the installed Zephyr SDK is selected automatically. If not, select one.
   - For **Board** select your board (*make sure* you've selected the *correct* revision).
   - For **Template** select the folder path to your project.
   - Click the *Create* button.
3. Build the project by clicking the *Build Selected* icon (displayed on hover) in the extension's *Projects* view. After the build, the debug console window displays the memory usage (or compiler errors if any).
4. Debug the project by clicking the *Debug* (play) icon (displayed on hover) in the extension's *Projects* view.
5. The execution will pause. To continue execution click *Continue* on the debug options.
6. In the *SERIAL MONITOR* tab of your console panel, the application prints the Zephyr boot banner during startup and then prints the test results.

Folder structure

```
maestro/
    ...
    zephyr/              All Zephyr related files
      samples/           Sample examples
      tests/             Tests
      audioTracks/       Audio tracks for testing
      doc/               Documentation configuration for Sphinx
      wrappers/          NXP SDK Wrappers
      scripts/           Helper scripts, mostly for testing
      module.yml         Defines module name, Cmake and Kconfig locations
      CMakeList.txt      Defines module's build process
      Kconfig            Defines module's configuration
      osa/               Deprecated. OSA port for Zephyr
      ...
```

Supported elements and libraries Here is the list of all features currently supported in Maestro on Zephyr. Our goal is to support all features in Maestro on Zephyr that are already supported in Maestro on NXP's SDK and to extend them further.

Supported elements:

- Memory source
- Memory sink
- Audio source
- Audio sink
- Process sink

- Decoder
- Encoder

Supported decoders:

- WAV
- MP3
- FLAC
- OPUS OGG
- AAC

Supported encoders:

- OPUS RAW

Supported libraries:

- VIT

Examples support All included examples use UART as output. Examples are located in zephyr/tests and zephyr/samples directories.

List of included examples:

- *Maestro sample for recording data from microphone to RAM*
- *Maestro voice detection sample using VIT*
- *Maestro encoder sample*
- *Maestro decoder sample*
- *Maestro mem2mem sample*

Examples support for specific boards:

Example	RDRW612BGA	LPCx-presso55s69	MIMXRT1060EVKE	MIMXRT1170EVKB
Record	YES	TO BE TESTED	TO BE TESTED	TO BE TESTED
VIT	YES	TO BE TESTED	TO BE TESTED	TO BE TESTED
Encoder	In progress: OPUS RAW	TO BE TESTED	TO BE TESTED	TO BE TESTED
Decoder	YES - WAV, FLAC, OPUS OGG	TO BE TESTED	TO BE TESTED	TO BE TESTED
Mem2mem	YES	TO BE TESTED	TO BE TESTED	TO BE TESTED

Creating your own example There are two ways to create your own example - you can either one of the included examples as a reference or you can create your own example from scratch by hand.

When creating your own example from scratch, set CONFIG_MAESTRO_AUDIO_FRAMEWORK=y in your prj.conf file. Then you can start enabling specific elements by setting CONFIG_MAESTRO_ELEMENT_<NAME>_ENABLE=y.

However, the recommended way to edit config options is to open gui-config (or menuconfig) by calling west build -t guiconfig. Then you can use the graphical interface to interactively turn on/off the features you need.

Documentation Please note, Maestro documentation is under reconstruction. It is currently mixing several tools and formats.

To see the pre-generated Maestro Zephyr documentation, see zephyr/doc/doc/README.html

To generate the Zephyr documentation, go under zephyr/doc folder and execute make html. Sphinx version sphinx-build 8.1.3 must be installed. Open doc/doc/html/README.hml afterwards.

To see Maestro core documentation, go to the Maestro top directory and see README.md.

FAQ

1. Should I choose the freestanding version of Maestro or should integrate it into my west instead?
    - Freestanding version of Maestro pulls in all the dependencies it needs including Zephyr itself.
    - Integrating it as a module is easier if you already have your Zephyr environment set up.

Maestro Audio Framework changelog

2.0.0 (newest)

- Added Zephyr port, see *Zephyr README*.
    - Possible to use standalone version, pulling its own Zephyr and dependencies
    - Possible to import it as a module in your Zephyr project
- Changed build system - newly uses Kconfig and Cmake
- Supports NXP MCUXSDK (previously 2.x)
- Changed folder structure and names to improve readability (description may be found in *README*)
- Removed audio libraries and placed into audio-voice-components repository
- Added libraries are pulled into the build via Kconfig and Cmake
- Changed Maestro library core - minor changes

1.8.0

- New platforms support: MCX-N5XX-EVK, FRDMMCXN236 and RD-RW612-BGA
- Fixed compilation warnings
- Documentation improvements and updates
    - Added section with processing time information
    - Added application state diagrams
- Various updates and fixes

1.7.0

- Removed EAP support for future SDK releases
- Created new API for audio_sink and audio_src to support USB source, sink
- ASRC library integrated
- License changed to BSD 3-Clause
- Improved pipeline creation API
- Fixed compilation warnings in Opus
- Various other improvements and bug fixes

1.6.0

- Up to 2 parallel pipelines supported
- Synchronous Sample Rate Converter support Added
- Various improvements and bug fixes

1.5.0

- Enabled switching from 2 to 4 channel output during processing
- PadReturn type has been replaced by FlowReturn
- Support of AAC, WAV, FLAC decoders
- Renamed eap element to audio_proc element
- Added audio_proc to VIT pipeline to support VoiceSeeker
- Minor bug fixes

1.4.0

- Use Opusfile lib for Ogg Opus decoder
- Refactor code, fix issues found in unit tests
- Various bug fixes

1.3.0

- Make Maestro framework open source (except mp3 and wav decoder)
- Refactor code, remove unused parts, add comments

1.2.0

- Unified buffering in audio source, audio sink
- Various improvements and bug fixes

1.0_rev0

- Initial version of framework with support for Cortex-M7 platforms

3.7.2 VGLite Graphics Driver

IMXRTVGLITEAPIRM

Introduction The VGLite Graphics API (Application Programming Interface) is designed to support 2D vector and 2D raster-based operations for rendering the interactive user interface that may include menus, fonts, curves, and images. The goal is to provide the maximum 2D vector/raster rendering performance, while keeping the memory footprint to the minimum.

Note: This document contains proprietary information of VeriSilicon Holdings Co., Ltd, and Vivante Corporation.

VGLite Graphics API The Vivante VGLite Graphics API is used to control the Vivante vector graphics hardware units that provide accelerated vector and raster operations.

The Vivante VGLite API is developed for use with Vivante GCNanoLiteV, GCNanoUltraV, GCNanoV, GC355, and GC555 hardware. GC355 and GC555 support the Khronos OpenVG 1.1 feature set, while GCNanoLiteV, GCNanoUltraV and GCNanoV have a feature set smaller than that required to pass Khronos OpenVG CTS.

The VGLite API driver V4 is a new design and implementation of the driver (from 2023Q1) to support the new generation 2.5D GPU (GC555), and the previous 2.5D GPU releases (GC255, GC265, GC355). The new V4 driver supports the new and improved VGLite API (version 3.0) and can generate the most CPU-efficient, customized driver build for a specific 2.5D GPU release based on the hardware feature set.

VGLite API supported features include: Porter-Duff Blending, Gradient Controls, Fast Clear, Arbitrary Rotations, Path Filling rules, Path painting, and Pattern Path Filling.

By default, VGLite API driver V4 supports one implicit global application context in a single thread. VGLite V4 driver does not support multithreaded applications, which is not suitable for embedded IoT devices.

Parent topic:*Introduction*

API function group The VGLite Graphics API has been designed to have independent function groups. It is permissible for a user to use only one of the function groups in the VGLite application:

- **Initialization** is used for initializing hardware and software structures
- **Blit API** is used for the raster part of rendering
- **Draw API** is used for 2D vector-based draw operations

Parent topic:*Introduction*

API files The VGLite source code is available as part of the NXP MCUXpresso SDK:

The VGLite graphics API functions are defined in the header file VGLite/inc/vg_lite.h.

All VGLite enumerations and data types are defined in VGLite/inc/vg_lite.h.

Parent topic:*Introduction*

Hardware versions The Vivante VGLite API is compatible with a range of Vivante Vector Graphics IPs including: GCNanoLiteV, GCNanoUltraV, GCNanoV, GC355, and GC555.

Note: A specific hardware version has customized feature set that may limit hardware support for some VGLite API options. The VGLite application can use the vg_lite_query_feature API to query specific VGLite feature availability.

Users can also check the VGLite/VGLite/vg_lite_options.h file which includes CHIPID, REVISION, CID to identify specific HW releases, and the gcFEATURE_VG_* macros to define the feature set for the HW release.

The gcFEATURE_VG_* macro values (except a few SW features) should NOT be changed. Otherwise, the VGLite driver does not function correctly on the specific HW release. Users can change the "SW Features" macro values to disable some software features, unnecessary error checks, or enable VGLite API trace for debug purposes.

.

Parent topic:*Introduction*

Common parameters and error values This chapter provides an overview of the common parameter types and the enumeration used for error reporting.

Common parameter types The VGLite graphics API uses a naming convention scheme wherein definitions are preceded by vg_lite.

Below is the list of types and structures in the driver implementation.

Nam	Type-def	Value
vg_li	int	A signed 32-bit integer 0: FALSE; 1: TRUE.
vg_li	char	A signed 8-bit integer
vg_li	un-signe char	An unsigned 8-bit integer
vg_li	short	A signed 16-bit integer
vg_li	un-signe short	An unsigned 16-bit integer
vg_li	int	A signed 32-bit integer
vg_li	un-signe int	An unsigned 32-bit integer
vg_li	un-signe long long	An unsigned 64-bit integer
vg_li	float	A 32-bit single precision floating point number
vg_li	dou-ble	A 64-bit double precision floating point number
vg_li	char	A signed 8-bit integer
vg_li	char*	A pointer to a character string
vg_li	void*	A generic address pointer (void *). On 32-bit OS, it is a 32-bit address pointer. On 64-bit OS, it is a 64-bit address pointer.
vg_li	void	The void type
vg_li	vg_lit	A 32-bit color value The color value specifies the color used in various functions. The color is formed using 8-bit RGBA channels. The red channel is in the lower 8-bit of the color value, followed by the green and blue channels. The alpha channel is in the upper 8-bit of the color value. vg_lite_color_t: 31:24 A, 23:16 B, 15:8 G, 7:0 R. For L8 target formats, the RGB color is converted to L8 by using the default ITU-R BT.709 conversion rules.
VG_l	enum vg_lit	A signed 8-bit integer coordinate
VG_l	enum vg_lit	A signed 16 bit integer coordinate
VG_l	enum vg_lit	A signed 32-bit integer coordinate
VG_l	enum vg_lit	A 32-bit floating point coordinate

Parent topic:*Common parameters and error values*

Enumerations for error reporting This section describes enumerations used for error reporting.

vg_lite_error_t **enumeration** Most functions in the API include an error status via the vg_lite_error_tenumeration. API functions return the status of the command and will report VG_LITE_SUCCESS if successful with no errors. Possible error values include the values in the table below. vg_lite_error_tenumeration is used in many functions, including initialization, flush, blit, draw, gradient, and pattern functions.

vg_lite_error_t string values	Description
VG_LITE_GENERIC_IO	Cannot communicate with the kernel driver
VG_LITE_INVALID_ARGUMEN	An invalid argument was specified
VG_LITE_MULTI_THREAD_FA	Multi-thread/tasks fail *(available from June 2020)*
VG_LITE_NO_CONTEXT	No context specified
VG_LITE_NOT_SUPPORT	Function call is not supported. Hardware support is not available.
VG_LITE_OUT_OF_MEMORY	Out of memory (driver heap)
VG_LITE_OUT_OF_RESOURC	Out of resources (OS heap)
VG_LITE_SUCCESS	Successful with no errors
VG_LITE_TIMEOUT	Timeout
VG_LITE_ALREADY_EXISTS	Object exists *(available from August 2021)*
VG_LITE_NOT_ALIGNED	Data alignment error *(available from August 2021)*

Parent topic: Enumerations for error reporting

Parent topic:*Common parameters and error values*

Hardware product and feature information These query functions can be used to identify the product and its key features and to get VGLite driver information.

Enumerations for product and feature queries This section describes enumerations used for product and feature queries.

vg_lite_feature_t **enumeration** The following feature values may be queried for availability in compatible hardware. *(expanded March 2023 to support additional hardware for driver V4)*

Used in information function: vg_lite_query_feature.

vg_lite_feature_t string values	Description
gcFEATURE_BIT_VG_16PIXELS_ALIGN	Require 16 pixels aligned for the input pixel buffer
gcFEATURE_BIT_VG_24BIT	RGB888 or RGBA5658 formats support
gcFEATURE_BIT_VG_24BIT_PLANAR	24-bit planar format support
gcFEATURE_BIT_VG_AYUV_INPUT	AYUV input format support
gcFEATURE_BIT_VG_BORDER_CULLING	Border culling support
gcFEATURE_BIT_VG_COLOR_KEY	Color key support.
gcFEATURE_BIT_VG_COLOR_TRANSFORMATION	Color transform support.
gcFEATURE_BIT_VG_DEC_COMPRESS	DEC compression format output support
gcFEATURE_BIT_VG_DITHER	Dither support
gcFEATURE_BIT_VG_DOUBLE_IMAGE	Support two image source inputs
gcFEATURE_BIT_VG_FLEXA	FLEXA interface support
gcFEATURE_BIT_VG_GAMMA	Gamma support
gcFEATURE_BIT_VG_GAUSSIAN_BLUR	Gaussian blur sampling support
gcFEATURE_BIT_VG_GLOBAL_ALPHA	Global alpha support
gcFEATURE_BIT_VG_HW_PREMULTIPLY	HW supports alpha premultiply for image
gcFEATURE_BIT_VG_IM_DEC_INPUT	DEC compressed format input support
gcFEATURE_BIT_VG_IM_FASTCLEAR	Fast Clear support
gcFEATURE_BIT_VG_IM_INDEX_FORMAT	Index format support for image
gcFEATURE_BIT_VG_IM_INPUT	Blit and draw API support
gcFEATURE_BIT_VG_IM_REPEAT_REFLECT	Image repeat reflect mode support
gcFEATURE_BIT_VG_INDEX_ENDIAN	Index format endian support
gcFEATURE_BIT_VG_LINEAR_GRADIENT_EXT	Support for extended linear gradient capabilities

continues on next page

Table 1 – continued from previous page

vg_lite_feature_t string values	Description
gcFEATURE_BIT_VG_LVGL_SUPPORT	LVGL blend mode support
gcFEATURE_BIT_VG_MASK	Mask support
gcFEATURE_BIT_VG_MIRROR	Mirror support
gcFEATURE_BIT_VG_NEW_BLEND_MODE	New blend mode DARKEN/LIGHTEN support
gcFEATURE_BIT_VG_NEW_IMAGE_INDEX	New CLUT image index support
gcFEATURE_BIT_VG_PARALLEL_PATHS	New parallel path HW support
gcFEATURE_BIT_VG_PE_CLEAR	Pixel engine clear support
gcFEATURE_BIT_VG_PIXEL_MATRIX	Pixel matrix support
gcFEATURE_BIT_VG_QUALITY_8X	8x anti-aliasing path support
gcFEATURE_BIT_VG_RADIAL_GRADIENT	Radial gradient support
gcFEATURE_BIT_VG_RECTANGLE_TILED_OUT	Rectangle tiled output support
gcFEATURE_BIT_VG_RGBA2_FORMAT	RGBA2222 format support
gcFEATURE_BIT_VG_RGBA8_ETC2_EAC	ETC2/EAC compressed image format support
gcFEATURE_BIT_VG_SCISSOR	Scissor support
gcFEATURE_BIT_VG_SRC_PREMULTIPLIED	Source image alpha premultiplied
gcFEATURE_BIT_VG_STENCIL	Stencil image mode support
gcFEATURE_BIT_VG_STRIPE_MODE	Stripe mode support
gcFEATURE_BIT_VG_TESSELLATION_TILED_OUT	Tessellation tiled output support
gcFEATURE_BIT_VG_USE_DST	Read destination pixel support
gcFEATURE_BIT_VG_YUV_INPUT	YUV input format support
gcFEATURE_BIT_VG_YUV_OUTPUT	YUV format output support
gcFEATURE_BIT_VG_YUV_TILED_INPUT	YUV tiled input format support
gcFEATURE_BIT_VG_YUY2_INPUT	YUY2 input format support

Parent topic: Enumerations for product and feature queries

Parent topic:*Hardware product and feature information*

Structures for product and feature queries This section describes structures used for product and feature queries.

vg_lite_info_t **structure** This structure is used to query VGLite driver information.

Used in function: vg_lite_get_info_t.

vg_lite_info_t member	Type	Description
api_version	vg_lite_uint32_t	VGLite API version
header_version	vg_lite_uint32_t	VGLite header version
release_version	vg_lite_uint32_t	VGLite driver release version
reserved	vg_lite_uint32_t	Reserved for future use

Parent topic: Structures for product and feature queries

Parent topic:*Hardware product and feature information*

Functions for product and feature queries This section describes functions used for product and feature queries.

vg_lite_get_product_info **Description:**

This function is used to identify the VGLite-compatible product.

Syntax:

```
uint32_t vg_lite_get_product_info (
      char            *name,
      uint32_t         *chip_id,
      uint32_t         *chip_rev
);
```

Parameters:

Name	Description
name	A character array to store the name of the chip.
chip_id	Stores an ID number for the chip.
chip_rev	Stores a revision number for the chip.

Parent topic: Functions for product and feature queries

vg_lite_get_info **Description:**

This function is used to query the VGLite driver information.

Syntax:

```
vg_lite_error_t vg_lite_get_info (
   vg_lite_info_t              *info
);
```

Parameters:

Name	Description
info	Points to the VGLite driver information structure, which includes the API version, header version, and release version

Parent topic: Functions for product and feature queries

vg_lite_get_register **Description:**

This function can be used to read a GPU AHB register value given the AHB byte address of a register. Refer to the appropriate Vivante GPU AHB register specification documents for register descriptions. The value range of AHB accessible addresses for VGLite cores is usually 0x0 to 0x1FF and 0xA00 to 0xA7F.

Syntax:

```
vg_lite_error_t vg_lite_get_register (
      vg_lite_uint32_t      address,
      vg_lite_uint32_t      *result
);
```

Parameters:

Name	Description
address	Byte Address of the register which value you want.
*result	The registers value.

Parent topic: Functions for product and feature queries

vg_lite_query_feature **Description:**

This function is used to query if a specific feature is available.

Syntax:

```
vg_lite_uint32_t vg_lite_query_feature (
    vg_lite_feature_t           feature
);
```

Parameters:

Name	Description
feature	Feature to be queried, as detailed in enum vg_lite_feature_t

Returns:

The feature is either not supported (0) or supported (1).

Parent topic: Functions for product and feature queries

vg_lite_get_mem_size **Description:**

This function queries whether there is any remaining allocated contiguous video memory. *(available from June 2020)*

Syntax:

```
vg_lite_error_t vg_lite_get_mem_size(
    vg_lite_uint32_t            *size
);
```

Parameters:

Name	Description
size	Pointer to the remaining allocated contiguous video memory.

Returns:

Returns VG_LITE_SUCCESS if the query is successful and memory is available. Returns VG_LITE_NO_CONTEXT if the driver is not initialized or there is no available memory.

Parent topic: Functions for product and feature queries

Parent topic:*Hardware product and feature information*

API control Before calling any VGLite API function, the application must initialize the VGLite implicit (global) context by calling *vg_lite_init()*, which will fill in a features table, reset the fast-clear buffer, reset the compositing target buffer and allocate the command and tessellation buffers.

The VGLite driver only supports one current context and one thread to issue commands to the Vivante Vector Graphics hardware. The VGLite driver does not support multiple concurrent contexts running simultaneously in multiple threads/processes, as the VGLite kernel driver does not support context switching. A VGLite application can only use a single context at any time to issue commands to the Vivante Vector Graphics hardware. If a VGLite application must switch contexts, vg_lite_close() must be called to close the current context in the current thread, then

vg_lite_init() can be called to initialize a new context either in the current thread or from another thread/process.

Context initialization and control functions This section provides an overview of the context initialization and control functions.

vg_lite_init **Description:**

This function initializes the memory and data structures needed for VGLite draw/blit functions, by allocating memory for the command buffer and a tessellation buffer of the specified size.

GC555 has a newly designed hardware tessellation module that requires less memory for the tessellation buffer than GC355 and GNanoLite-V. Specifically, the GC555 required tessellation buffer size is “buffer_height * 128 byte”. vg_lite_init API can simply be called with the render buffer “width” and “height” as the input parameters for GC555. This results in the best path to tessellation performance.

GC355 and GCNanoLiteV hardware tessellation module requires a tessellation buffer with size “buffer_height * buffer_width * 8 byte”. If system memory is limited, the application can define a smaller tessellation window based on the amount of memory available. GPU hardware can process the entire render buffer path tessellation in multiple passes with the tessellation window sliding across the render buffer. The multi-pass path tessellation with the smaller tessellation window has a certain performance overhead.

The minimum tessellation window that can be used is 16x16. If tess_height or tess_width is less than 0 in vg_lite_init API, then no path tessellation buffer is created and path drawing APIs do not work, only blit APIs can be used after vg_lite_init.

If this would be the first context that accesses the hardware, the hardware is turned on and initialized. If a new context must be initialized, vg_lite_close must be called to close the current context. Otherwise, vg_lite_init will return an error.

Syntax:

```
vg_lite_error_t vg_lite_init (
    vg_lite_int32_t             tess_width,
    vg_lite_int32_t             tess_height

);
```

Parameters:

Name	Description
tess_v	Width of tessellation window. Maximum cannot be greater than render buffer width. If less than or equal to 0, then no tessellation buffer is created, in which case only blit APIs can be used afterward.
tess_h	Height of tessellation window. Maximum cannot be greater than render buffer height. If less than or equal to 0, then no tessellation buffer is created, in which case blit APIs can be used afterward.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_close **Description:**

This function deallocates all the resources and free up all the memory that was initialized earlier by the vg_lite_init function. It will also turn OFF the hardware automatically if this was the only active context.

Syntax:

```
vg_lite_error_t vg_lite_close (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_flush **Description:**

This function explicitly submits the command buffer to the GPU without waiting for it to complete. *(From Dec 2019, return type is vg_lite_error_t, previously was void.)*

Syntax:

```
vg_lite_error_t vg_lite_flush (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the flush is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_finish **Description:**

This function explicitly submits the command buffer to the GPU and waits for it to complete.

Syntax:

```
vg_lite_error_t vg_lite_finish (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_frame_delimiter **Description:**

This function sets a flag for GPU to signal the completion of current frame. A vg_lite_finish is called by default within this API. The enum VG_LITE_FRAME_END_FLAG is the only value that can be set by flag parameter.

Syntax:

```
vg_lite_error_t vg_lite_frame_delimiter (
    vg_lite_frame_flag_t flag
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Context initialization and control functions

vg_lite_set_command_buffer_size **Description:**

This function is optional. If used, call it before vg_lite_init if you want to change the command buffer size. *(available from March 2020)*

Syntax:

```
vg_lite_error_t vg_lite_set_command_buffer_size (
    vg_lite_uint32_t            size
);
```

Parameters:

Name	Description
size	Size of the VGLite Command buffer. Default is 64K.

Returns:

Returns VG_LITE_SUCCESS if the flush is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_set_command_buffer **Description:**

This function sets a user-defined external memory buffer (physical, 64-byte aligned) as the VGLite command buffer. By default, the VGLite driver allocates a static command buffer internally. Thus, it is not necessary for an application to allocate and set the command buffer. This function is only used for devices where an application needs to allocate the command buffer dynamically. *(from December 2021)*

Syntax:

```
vg_lite_error_t vg_lite_set_command_buffer (
    vg_lite_uint32_t            physical,
    vg_lite_uint32_t            size
);
```

Parameters:

Name	Description
physical	The physical address of a memory buffer. The address must be 64-byte aligned.
size	The size of memory buffer. The size must be 128-byte aligned.

Returns:

Returns VG_LITE_SUCCESS if the command buffer set is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_set_tess_buffer **Description:**

This function specifies a memory buffer from an application as the VGLite driver's tessellation buffer. By default, the VGLite driver allocates a static tessellation buffer internally. Thus, it is not necessary for an application to allocate and set the tessellation buffer. This function is only used for devices where the application needs to allocate the tessellation buffer dynamically. *(from December 2021)*

Syntax:

```
vg_lite_error_t vg_lite_set_tess_buffer (
    vg_lite_uint32_t            physical,
    vg_lite_uint32_t            size
);
```

Parameters:

Name	Description
physical	The physical address of a tessellation buffer. The address must be 64-byte aligned.
size	The size of tessellation buffer. tessellation buffer size = target buffer's height * 128B.

Returns:

Returns VG_LITE_SUCCESS if the tessellation buffer set is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

vg_lite_set_memory_pool **Description:**

This function sets the specific memory pool from which certain type of buffers, VG_LITE_COMMAND_BUFFER, VG_LITE_TESSELLATION_BUFFER, or VG_LITE_RENDER_BUFFER, should be allocated. By default, all types of buffers are allocated from VG_LITE_MEMORY_POOL_1. This API must be called before vg_lite_init() for setting VG_LITE_COMMAND_BUFFER or VG_LITE_TESSELLATION_BUFFER memory pools. This API can be called anytime for VG_LITE_RENDER_BUFFER to affect the following vg_lite_allocate() calls.*(from December 2023)*

Syntax:

```
vg_lite_error_t vg_lite_set_memory_pool (
    vg_lite_buffer_type_t       type,
    vg_lite_memory_pool_t       pool
);
```

Parameters:

Nam	Description
type	The buffer type (VG_LITE_COMMAND_BUFFER, VG_LITE_TESSELLATION_BUFFER, or VG_LITE_RENDER_BUFFER) to be allocated from memory pool.
pool	The memory pool (VG_LITE_MEMORY_POOL_1, VG_LITE_MEMORY_POOL_2) from which the buffer type should be allocated.

Returns:

Returns VG_LITE_SUCCESS if the memory pool set is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic: Context initialization and control functions

Parent topic:*API control*

Pixel buffers This chapter provides an overview of the pixel buffer alignment, cache, internal representation, enumerations, structures, and functions.

Pixel buffer alignment The VGLite hardware requires the pixel buffer start address and stride to be properly byte-aligned to work correctly. The start address and stride alignment requirement for a pixel buffer depends on the specific pixel format, and gcFEATURE_VG_16PIXELS_ALIGNED value (0/1) in vg_lite_options.h file.

Parent topic:*Pixel buffers*

Pixel cache The Vivante Imaging Engine (IM) includes two fully associative caches. Each cache has 8 lines. Each line has 64 bytes. In this case, one cache line can hold either a 4x4-pixel tile or a 16x1-pixel row.

Parent topic:*Pixel buffers*

Internal representation For non-32-bit color formats, each pixel is extended to 32 bits as follows:

If the source and destination formats have the same color format, but differ in the number of bits per color channel, the source channel is multiplied by (2d- 1)/(2s– 1) and is rounded to the nearest integer, where:

- **d** is the number of bits in the destination channel
- **s** is the number of bits in the source channel

Example: a b11111 5-bit source channel gets converted to an 8-bit destination b11111000.

The YUV formats are internally converted to RGB. The pixel selection is unified for all formats by using the LSB of the coordinate.

Parent topic:*Pixel buffers*

Pixel buffer enumerations This section provides an overview of the pixel buffer enumerations.

vg_lite_buffer_format_t enumeration This enumeration specifies the color format to use for a buffer. This applies to both image and Render Target. Formats include supported swizzles for RGB. For YUV swizzles, use the related values and parameters in vg_lite_swizzle_t.

The application shall use the vg_lite_query_feature API to determine support for some hardware-specific formats. For example, related vg_lite_feature_t enum values include gcFEATURE_BIT_VG_RGBA2_FORMAT and gcFEATURE_BIT_VG_IM_INDEX_FORMAT.

(Alignment columns refined March and Sept 2023)

Used in structure: vg_lite_buffer_t.

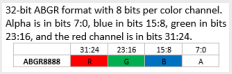
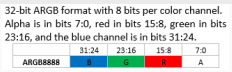
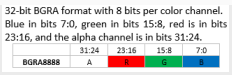
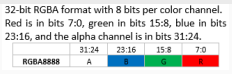
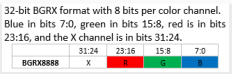
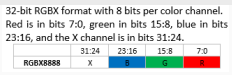
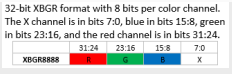
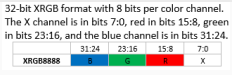
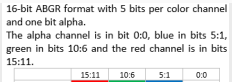
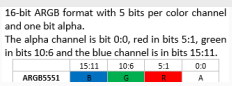
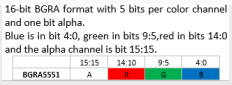
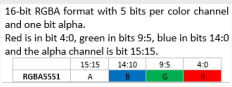
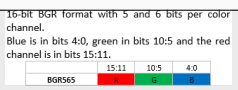
See also vg_lite_blit, vg_lite_clear, vg_lite_draw.

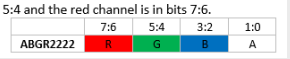
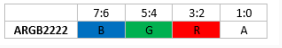
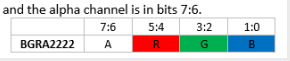
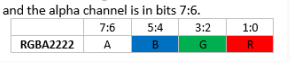
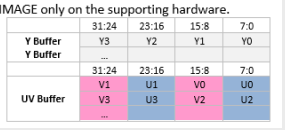
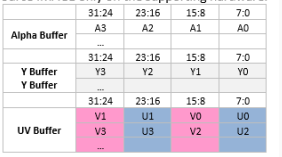
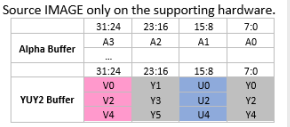
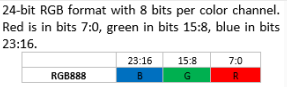
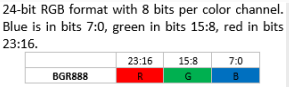
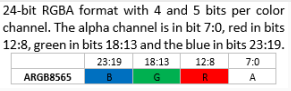
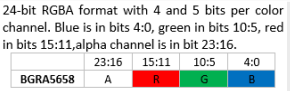
Attention: OpenVG VGImageFormat Note: The bits for each color channel are stored within a machine word from MSB to LSB in the order indicated by the pixel format name. This is the opposite of the original VG_LITE_* formats that are ordered from LSB to MSB. The formats with the same organization are listed in the same row as their VG_Lite counterparts.

Attention: Original VGLite API Image Format Note: The bits for each color channel are stored within a machine word from LSB to MSB in the order indicated by the pixel format name. This is the opposite of the OPENVG VG_* formats that are ordered from MSB to LSB.

The following codes, as also used in OpenVG 1.1 Specification Table 11, are used for format description:

- A - Alpha channel
- B - Blue color channel
- G - Green color channel
- R - Red color channel
- X - Uninterpreted padding byte or bit
- L - Grayscale
- BW - 1-bit black and white
- l - Linear color space
- s - Non-linear (sRGB) color space
- PRE - Alpha values are premultiplied

vg_lite_buffer_format_t String Value	Description	Supported as source	Supported as destination	Start address/ Stride alignment: bytes
VG_LITE_ABGR8888 VG_sRGBA_8888 VG_sRGBA_8888_PRE VG_lRGBA_8888 VG_lRGBA_8888_PRE		Yes	Yes	Start 4B / Stride 64B
VG_LITE_ARGB8888 VG_sBGRA_8888 VG_sBGRA_8888_PRE VG_lBGRA_8888 VG_lBGRA_8888_PRE		Yes	Yes	Start 4B / Stride 64B
VG_LITE_BGRA8888 VG_sARGB_8888 VG_sARGB_8888_PRE VG_lARGB_8888 VG_lARGB_8888_PRE		Yes	Yes	Start 4B / Stride 64B
VG_LITE_RGBA8888 VG_sABGR_8888 VG_sABGR_8888_PRE VG_lABGR_8888 VG_lABGR_8888_PRE		Yes	Yes	Start 4B / Stride 64B
VG_LITE_BGRX8888 VG_sXRGB_8888 VG_lXRGB_8888		Yes	Yes	Start 4B / Stride 64B
VG_LITE_RGBX8888 VG_sXBGR_8888 VG_lXBGR_8888		Yes	Yes	Start 4B / Stride 64B
VG_LITE_XBGR8888 RGBX VG_sRGBX_8888 VG_lRGBX_8888		Yes	Yes	Start 4B / Stride 64B
VG_LITE_XRGB8888 VG_sBGRX_8888 VG_lBGRX_8888		Yes	Yes	Start 4B / Stride 64B
VG_LITE_ABGR1555 VG_sRGBA_5551		Yes	Yes	Start 4B / Stride 32B
VG_LITE_ARGB1555 VG_sBGRA_5551		Yes	Yes	Start 4B / Stride 32B
VG_LITE_BGRA5551 VG_sARGB_1555		Yes	Yes	Start 4B / Stride 32B
VG_LITE_RGBA5551 VG_sABGR_1555		Yes	Yes	Start 4B / Stride 32B
3.7. Multimedia				**1565**
VG_LITE_BGR565 VG_sRGB_565		Yes	Yes	Start 4B / Stride 32B

Hardware-dependent formats for vg_lite_buffer_format_t	Description	Sup-ported as source	Supported as destina-tion	Alignment (bytes)
VG_LITE_ABGR2222	8-bit BGRA format with 2 bits per color channel. Alpha is in bits 1:0, blue in bits 3:2, green in bits 5:4 and the red channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_ARGB2222	8-bit BGRA format with 2 bits per color channel. Alpha is in bits 1:0, red in bits 3:2,green in bits 5:4 and the blue channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_BGRA2222	8-bit BGRA format with 2 bits per color channel. Blue is in bits 1:0, green in bits 3:2, red in bits 5:4 and the alpha channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_RGBA2222	8-bit RGBA format with 2 bits per color channel. Red is in bits 1:0, green in bits 3:2, blue in bits 5:4 and the alpha channel is in bits 7:6. 	Yes	No	8B
VG_LITE_INDEX_1	1-bit index format	Yes	No	8B
VG_LITE_INDEX_2	2-bit index format	Yes	No	both 8B
VG_LITE_INDEX_4	4-bit index format	Yes	No	both 8B
VG_LITE_INDEX_8	8-bit index format	Yes	No	both 16B
VG_LITE_NV12_TILED	Supertiled (8x8 pixels), planar YUV format, 96-bit for 4 pixels. Y plane is 32 bits for 4 pixels and is organized in 64 pixel super tiles (8x8 Y); UV plane is 64 bits for 4 pixels. Pixels are organized in super tiles are (4x4 UV pairs), available for Source IMAGE only on the supporting hardware. 	Yes	No	Y: both 16 Bytes UV: both 8 Bytes
VG_LITE_ANV12_TILED	Pixel organization as NV12_TILED but with an Alpha Buffer is also supertiled, available for Source IMAGE only on the supporting hardware. 	Yes	No	A, Y: both 16 Bytes UV: both 8 Bytes
VG_LITE_AYUY2_TILED	Supertiled (8x8) and packed YUV format a with separate tiled Alpha Buffer. Y0 is in bits 7:0 and V is in bits 31:23, available for Source IMAGE only on the supporting hardware. 	Yes	No	both 32B
VG_LITE_RGB888	24-bit RGB format with 8 bits per color channel. Red is in bits 7:0, green in bits 15:8, blue in bits 23:16. 	Yes	Yes	Start 4B / Stride 32B
VG_LITE_BGR888	24-bit RGB format with 8 bits per color channel. Blue is in bits 7:0, green in bits 15:8, red in bits 23:16. 		Yes	Yes
VG_LITE_ARGB8565	24-bit RGBA format with 4 and 5 bits per color channel. The alpha channel is in bit 7:0, red in bits 12:8, green in bits 18:13 and the blue in bits 23:19. 		Yes	Yes
VG_LITE_BGRA5658	24-bit RGBA format with 4 and 5 bits per color channel. Blue is in bits 4:0, green in bits 10:5, red in bits 15:11,alpha channel is in bit 23:16. 	Yes	Yes	Start 4B / Stride 32B

Parent topic: Pixel buffer enumerations

Image buffer alignment requirement The image (or source) buffer alignment requirement depends on the specific pixel format, and some gcFEATURE_*_ALIGNED defines in the vg_lite_options.h file.

Image format	Bits per pixel	Source tile mode	Start address alignment requirement in bytes	Stric
VG_LITE_INDEX1	1	linear	8B	2B
VG_LITE_INDEX1	1	tile	8B	1B
VG_LITE_INDEX2	2	linear	8B	4B
VG_LITE_INDEX2	2	tile	8B	1B
VG_LITE_INDEX4	4	linear	8B	8B
VG_LITE_INDEX4	4	tile	8B	2B
VG_LITE_INDEX8	8	linear	16B	16B
VG_LITE_INDEX8	8	tile	16B	4B
VG_LITE_A4	4	linear	8B	8B
VG_LITE_A4	4	tile	8B	2B
VG_LITE_A8	8	linear	16B	16B
VG_LITE_A8	8	tile	16B	4B
VG_LITE_L8	8	linear	16B	16B
VG_LITE_L8	8	tile	16B	4B
VG_LITE_ARGB2222	8	linear	16B	16B
VG_LITE_ARGB2222	8	tile	16B	4B
VG_LITE_RGB565	16	linear	32B	32B
VG_LITE_RGB565	16	tile	32B	8B
VG_LITE_ARGB1555	16	linear	32B	32B
VG_LITE_ARGB1555	16	tile	32B	8B
VG_LITE_ARGB4444	16	linear	32B	32B
VG_LITE_ARGB4444	16	tile	32B	8B
VG_LITE_ARGB8888	32	linear	64B	64B
VG_LITE_ARGB8888	32	tile	64B	16B
VG_LITE_XRGB8888	32	linear	64B	64B
VG_LITE_XRGB8888	32	tile	64B	16B
VG_LITE_ARGB8565	24	linear	64B	48B*
VG_LITE_ARGB8565	24	tile	64B	12B*
VG_LITE_RGB888	24	linear	64B	48B*
VG_LITE_RGB888	24	tile	64B	12B*
VG_LITE_YUY2/UYVY	16	linear	32B	32B
VG_LITE_YUY2/UYVY	16	tile	32B	8B
VG_LITE_NV12	12	linear	Y: 32B UV: 32B	Y: 32
VG_LITE_YV12	12	linear	Y: 32B U: 16B V: 16B	Y: 32
VG_LITE_NV16	16	linear	Y: 32B UV: 32B	Y: 32
VG_LITE_YV16	16	linear	Y: 32B U: 16B V: 16B	Y: 32
VG_LITE_YV24	24	linear	Y: 32B U: 32B V: 32B	Y: 32
VG_LITE_ETC2	8	tile	16B	4B

Note:

1. The values in the table reflect the alignment requirements of the data in memory. The stride of ARGB8888 / ARGB8565 is seen as 4Byte per pixel when configuring the hardware.
2. For tile mode, the stride is still the byte size of a row of pixels in the buffer instead of 4 rows.
3. When DECNano function is enabled for the buffer, the total buffer size need align to 64Byte*compression rate for ARGB8888 or XRGB8888 format, align to 48Byte*compress rate for RGB888 format.

Additional Alignment Requirement

1. Buffer starting address must be 16 pixel-byte-size aligned, that is 8 bit-per-pixel format buffer must be 16 bytes aligned; 16 bit-per-pixel format buffer must be 32 bytes aligned; 24 and 32 bit-per-pixel format buffer must be 64 bytes aligned.
2. For linear mode buffer, the buffer stride must be 16 pixel-byte-size aligned.
3. For tile mode buffer, buffer width and height must be 4 pixel aligned so buffer width and height end at tile boundary.

Parent topic: Pixel buffer enumerations

Destination buffer alignment requirement The destination (or render target) buffer alignment requirement depends on the specific pixel format, and some gcFEATURE_*_ALIGNED defines in the vg_lite_options.h file.

Target format	Bits per pixel	Target tile mode	VG tile mode	Start address alignment requirement i
VG_LITE_A8	8	linear	linear	4B
VG_LITE_A8	8	linear	tile	64B
VG_LITE_A8	8	tile	linear	64B
VG_LITE_A8	8	tile	tile	64B
VG_LITE_L8	8	linear	linear	4B
VG_LITE_L8	8	linear	tile	64B
VG_LITE_L8	8	tile	linear	64B
VG_LITE_L8	8	tile	tile	64B
VG_LITE_ARGB2222	8	linear	linear	4B
VG_LITE_ARGB2222	8	linear	tile	64B
VG_LITE_ARGB2222	8	tile	linear	64B
VG_LITE_ARGB2222	8	tile	tile	64B
VG_LITE_RGB565	16	linear	linear	4B
VG_LITE_RGB565	16	linear	tile	64B
VG_LITE_RGB565	16	tile	linear	64B
VG_LITE_RGB565	16	tile	tile	64B
VG_LITE_ARGB1555	16	linear	linear	4B
VG_LITE_ARGB1555	16	linear	tile	64B
VG_LITE_ARGB1555	16	tile	linear	64B
VG_LITE_ARGB1555	16	tile	tile	64B
VG_LITE_ARGB4444	16	linear	linear	4B
VG_LITE_ARGB4444	16	linear	tile	64B
VG_LITE_ARGB4444	16	tile	linear	64B
VG_LITE_ARGB4444	16	tile	tile	64B
VG_LITE_ARGB8888	32	linear	linear	4B
VG_LITE_ARGB8888	32	linear	tile	64B
VG_LITE_ARGB8888	32	tile	linear	64B
VG_LITE_ARGB8888	32	tile	tile	64B
VG_LITE_XRGB8888	32	linear	linear	4B
VG_LITE_XRGB8888	32	linear	tile	64B
VG_LITE_XRGB8888	32	tile	linear	64B
VG_LITE_XRGB8888	32	tile	tile	64B
VG_LITE_ARGB8565	24	linear	linear	64B
VG_LITE_ARGB8565	24	linear	tile	64B
VG_LITE_ARGB8565	24	tile	linear	64B
VG_LITE_ARGB8565	24	tile	tile	64B
VG_LITE_RGB888	24	linear	linear	64B
VG_LITE_RGB888	24	linear	tile	64B
VG_LITE_RGB888	24	tile	linear	64B
VG_LITE_RGB888	24	tile	tile	64B

Note:

1. The values in the table reflect the alignment requirements of pixel data in memory. The stride of ARGB8888/ARGB8565 is seen as 4 Bytes per pixel when configuring the hardware.
2. For tile mode, the buffer stride is still the byte size of a row of pixels instead of 4 rows of pixels.
3. For PE clear function, the clear size must align to 48 Bytes for the RGB888 or ARGB8565 format.
4. For PE clear function with DECNano enabled, the clear size must align to 48 Bytes for RGB888, align to 64 Bytes for ARGB8888 or XRGB8888.
5. If the DECNano function is enabled for the buffer, the target buffer start address needs to align to 64 Bytes.
6. If the DECNano function is enabled for the buffer, the total buffer size needs to align to a 64-byte compression rate for ARGB8888 or XRGB8888 format and align to a 48 Byte*compression rate for RGB888 format.

Additional Alignment Requirement

1. Buffer starting address must be at least 4-byte aligned. Buffer stride must be at least one pixel size aligned.
2. Buffer starting address must be 64-byte aligned for 24 bit-per-pixel format, or tile mode, or DECNano enabled.
3. Buffer height must be 4-pixel aligned for tile mode buffer.
4. For tile mode buffer, the buffer stride must be 16-byte aligned for non-24bit-per-pixel formats. So, 8 bits-per-pixel format buffer width must be 16-pixel aligned; 16 bits-per-pixel format buffer width must be 8-pixel aligned; 32 bit-per-pixel format buffer width must be 4 pixel aligned.
5. For tile mode buffer, the buffer stride must be 12-byte aligned for 24 bits-per-pixel formats, that is, the buffer width must be 4-pixel aligned.
6. For PE clear function, the clear size must align to 48 Bytes for 24-bits-per-pixel formats.
7. For PE clear function with DECNano enabled, the clear size must align to 48 Bytes for 24 bits-per-pixel formats and align to 64 Bytes for 32 bits-per-pixel formats.
8. If source buffer tile mode is different from destination buffer tile mode, buffer starting address must be 64 Byte aligned, buffer stride must be 64 Byte aligned for non-24 bits-per-pixel formats, buffer stride must be 48-Byte aligned for 24 bits-per-pixel formats.

VGLite hardware requires the raster image width to be a multiple of 16 pixels for linear gradient and radial gradient operations. This requirement applies to all image formats. Therefore, the user must pad an arbitrary image width to a multiple of 16 pixels for VGLite linear gradient and radial gradient APIs.

Parent topic: Pixel buffer enumerations

vg_lite_buffer_layout_t **enumeration** Specifies the buffer data layout in memory.

Used in structure: vg_lite_buffer.

vg_lite_buffer_layout_t String Value	Description
VG_LITE_LINEAR	Linear (scanline) layout.
VG_LITE_TILED	Data is organized in 4x4 pixel tiles. **Note:** for this layout, the buffer start address and stride must be 64-byte aligned

Parent topic: Pixel buffer enumerations

vg_lite_compress_mode_t **enumeration** Specifies the DECNano comprssion mode. *(from March 2023)*

Used in structure: vg_lite_buffer_t.

vg_lite_compress_mode_t string value	Description
VG_LITE_DEC_DISABLE	Disable compression.
VG_LITE_DEC_NON_SAMPLE	compression ratio is 1.6 for ARGB8888, 2.0 for XRGB8888
VG_LITE_DEC_HSAMPLE	compression ratio is 2.0 for ARGB8888, 2.6 for XRGB8888
VG_LITE_DEC_HV_SAMPLE	compression ratio is 2.6 for ARGB8888, 4.0 for XRGB8888

Parent topic: Pixel buffer enumerations

vg_lite_gamma_conversion_t **enumeration** Specifies the gamma conversion mode *(from Sept 2022)*

Used in function: vg_lite_set_gamma.

vg_lite_gamma_conversion_t string value	Description
VG_LITE_GAMMA_NO_CONVERSION	Leave the color as it is.
VG_LITE_GAMMA_LINEAR	Convert from sRGB to linear.
VG_LITE_GAMMA_NON_LINEAR	Convert from linear to sRGB space.

Parent topic: Pixel buffer enumerations

vg_lite_index_endian_t **enumeration** Specifies the endian order parsing mode for index formats *(from March 2023)*.

Used in structure: vg_lite_buffer_t.

vg_lite_index_endi string value	Description
VG_LITE_INDEX	Parse the index pixel from low to high, when using index1, the parsing order is bit0~bit7. when using index2, the parsing order is bit0:1,bit2:3,bit4:5.bit6:7. when using index4, the parsing order is bit0:3,bit4:7.
VG_LITE_INDEX	Parse the index pixel from low to high, when using index1, the parsing order is bit7~bit0. when using index2, the parsing order is bit7:6,bit5:4,bit3:2.bit1:0. when using index4, the parsing order is bit4:7,bit0:3.

Parent topic: Pixel buffer enumerations

vg_lite_image_mode_t **enumeration** Specifies how an image is rendered onto a buffer *(prior to Sept 2022 name was* vg_lite_buffer_image_mode_t*)*.

Used in structure: vg_lite_buffer_t.

vg_lite_image_mode_t string value	Description
VG_LITE_ZERO	
VG_LITE_NORMAL_IMAGE_MODE	Image drawn with blending mode
VG_LITE_MULTIPLY_IMAGE_MODE	Image is multiplied with paint color
VG_LITE_STENCIL_MODE	
VG_LITE_NONE_IMAGE_MODE	Image input is ignored.
VG_LITE_RECOLOR_MODE	

Parent topic: Pixel buffer enumerations

vg_lite_map_flag_t **enumeration** Specifies whether mapping is for user memory or the DMA buffer *(from March 2023)*.

Used in function: vg_lite_map.

vg_lite_map_flag_t string value	Description
VG_LITE_MAP_USER_MEMORY	Mapping is for user memory.
VG_LITE_MAP_DMABUF	Mapping is for the DMA buffer.

Parent topic: Pixel buffer enumerations

vg_lite_paint_type_t **enumeration** Specifies paint type *(from May 2023)*.

Used in structure: vg_lite_buffer_t.

vg_lite_paint_type_t string value	Description
VG_LITE_PAINT_ZERO	
VG_LITE_PAINT_COLOR	Color
VG_LITE_PAINT_LINEAR_GRADIENT	Linear Gradient
VG_LITE_PAINT_RADIAL_GRADIENT	Radial Gradient
VG_LITE_PAINT_PATTERN	Pattern

Parent topic: Pixel buffer enumerations

vg_lite_transparency_t **enumeration** Specifies the transparency mode for a buffer *(prior to Sept 2022 name was vg_lite_buffer_transparency_mode_t)*.

Used in structure:vg_lite_buffer.

vg_lite_transp string value	Description
VG_LITE_IN	Opaque image: all image pixels are copied to the VG PE for rasterization
VG_LITE_IN	Transparent image: only the non-transparent image pixels are copied to the VG PE. **Note:** This mode is only valid when IMAGE_MODE (vg_lite_image_mode_t) is either VG_LITE_NORMAL_IMAGE_MODE or VG_LITE_MULTIPLY_IMAGE_MODE.

Parent topic: Pixel buffer enumerations

vg_lite_swizzle_t **enumeration** This enumeration specifies the swizzle for the UV components of YUV data.

Used in structure: vg_lite_yuvinfo.

vg_lite_swizzle_t string value	Description
VG_LITE_SWIZZLE_UV	U in lower bits, V in upper bits
VG_LITE_SWIZZLE_VU	V in lower bits, U in upper bits

Parent topic: Pixel buffer enumerations

vg_lite_yuv2rgb_t **enumeration** This enumeration specifies the standard for conversion of YUV data to RGB data.

Used in structure: vg_lite_yuvinfo.

vg_lite_yuv2rgb_t string value	Description
VG_LITE_YUV601	YUV Converting with ITC.BT-601 standard
VG_LITE_YUV709	YUV Converting with ITC.BT-709 standard

Parent topic: Pixel buffer enumerations

Parent topic:*Pixel buffers*

Pixel buffer structures This section provides an overview on the pixel buffer structures.

vg_lite_buffer_t **structure** This structure defines the buffer layout for a VGLite image or memory data.

Used in structures: vg_lite_linear_gradient_t, vg_lite_radial_gradient_t.

Used in init functions: vg_lite_allocate, vg_lite_free, vg_lite_upload_buffer, vg_lite_map, vg_lite_unmap.

Used in blit functions:vg_lite_blit, vg_lite_blit_rect, vg_lite_clear, vg_lite_create_masklayer, vg_lite_fill_masklayer, vg_lite_blend_masklayer, vg_lite_set_masklayer, vg_lite_render_masklayer, vg_lite_destroy_masklayer

Used in draw functions: vg_lite_draw, vg_lite_draw_pattern, vg_lite_draw_grad, vg_lite_draw_radial_grad

vg_lite_buffer_t member	Type	Description
width	vg_lite_int32_t	Width of buffer in pixels
height	vg_lite_int32_t	Height of buffer in pixels
stride	vg_lite_int32_t	Stride in bytes
tiled	vg_lite_buffer_layo	Linear or tiled format for buffer enum
format	vg_lite_buffer_form	color format enum
handle	vg_lite_pointer	memory handle
memory	vg_lite_pointer	pointer to the start address of the memory
address	vg_lite_uint32_t	GPU address
yuv	vg_lite_yuvinfo_t	YUV format info struct
image_mode	vg_lite_image_mod	Blit image mode enum
transparency_mode	*vg_lite_transparenc*	Image transparency mode enum
fc_buffer[3]	vg_lite_fc_buffer_t	Three (3) fast clear buffers, reserved YUV format *(from March 2023)*
compress_mode	vg_lite_compress_m	Compression mode *(from March 2023)*
index_endian	vg_lite_index_endia	Big/Little Endian setting for index formats *(from March 2023)*
paintType	*vg_lite_paint_type_t*	Paint type enum *(from May 2023)*
fc_enable	vg_lite_int8_t	Enable Image fast clear *(moved from Aug 2023)*
scissor_layer	vg_lite_int8_t	Get paintcolor from different paint types *(from Aug 2023)*
premulitplied	vg_lite_int8_t	The RGB pixel values are alpha-premultipled *(from Aug 2023)*

Parent topic: Pixel buffer structures

vg_lite_fc_buffer_t **structure** This structure defines the organization of a fast clear buffer. *(from March 2023)*

Used in structure: vg_lite_buffer_t.

vg_lite_fc_buffer_t members	Type	Description
width	vg_lite_int32_t	Width of buffer in pixels
height	vg_lite_int32_t	Height of buffer in pixels
stride	vg_lite_int32_t	Stride in bytes
handle	vg_lite_pointer	memory handle as allocated by the VGLite kernel
memory	vg_lite_pointer	logical pointer to the start address of the memory for the CPU
address	vg_lite_uint32_	address to the buffer's memory for the GPU hardware
color	vg_lite_uint32_	The fast clear color value

Parent topic: Pixel buffer structures

vg_lite_yuvinfo_t **structure** This structure defines the organization of VGLite YUV data.

Used in structure: vg_lite_buffer_t.

vg_lite_yuvinfo_t member	Type	Description
swizzle	*vg_lite_swizzle_*	UV swizzle enum
yuv2rgb	*vg_lite_yuv2rgb_*	YUV conversion standard enum
‘uv_planar	vg_lite_uint32_t	UV (U) planar address for GPU, generated by driver
v_planar	vg_lite_uint32_t	V planar address for GPU, generated by driver
‘alpha_planar	vg_lite_uint32_t	Alpha planar address for GPU, generated by driver
‘uv_stride	vg_lite_uint32_t	UV (U) stride in bytes
‘v_stride	vg_lite_uint32_t	V planar stride in bytes
alpha_stride	vg_lite_uint32_t	Alpha stride in bytes
‘uv_height	vg_lite_uint32_t	UV (U) height in pixels
‘v_height	vg_lite_uint32_t	V stride in bytes
uv_memory	vg_lite_pointer	Logical pointer to the UV (U) planar memory
‘v_memory	vg_lite_pointer	Logical pointer to the V planar memory
uv_handle	vg_lite_pointer	Memory handle of the UV (U) planar, generated by the driver
v_handle	vg_lite_pointer	Memory handle of the V planar, generated by the driver

Parent topic: Pixel buffer structures

Parent topic:*Pixel buffers*

Pixel buffer functions This section provides an overview of the pixel buffer functions.

vg_lite_allocate **function** **Description:**

This function is used to allocate a buffer before it is used in either blit or draw functions.

To allow the hardware to access some memory, such as a source image or target buffer, you must first allocate the memory. The supplied vg_lite_buffer_t structure must be initialized with the size (width and height) and format of the requested buffer. If the stride is set to zero, then this function fills it in. The only input parameter to this function is the pointer to the buffer structure. If the structure has all the information needed, then appropriate memory is allocated for the buffer.

This function calls the kernel to allocate the memory. The kernel fills in the memory handle, logical address, and hardware addresses in the vg_lite_buffer_t structure.

Alignment note:

Vivante GPUs have an alignment requirement of 64 bytes. However, to meet the alignment requirements of the Vivante display controller, the VGLite driver sets the render target buffer alignment to 128 bytes. For source image buffer alignment requirements, see the alignment notes available in Table 1.

The vg_lite_buffer_format_t value descriptions:

Syntax:

```
vg_lite_error_t vg_lite_allocate (
    vg_lite_buffer_t    *buffer
);
```

Parameters:

Nam	Description
buffe	Pointer to the buffer that holds the size and format of the buffer being allocated. Either the memory or address field must be set to a non-zero value to map either a logical or physical address into hardware accessible memory.

Returns:

- VG_LITE_SUCCESS if the contiguous buffer was allocated successfully.
- VG_LITE_OUT_OF_RESOURCES if there is insufficient memory in the host OS heap for the buffer.
- VG_LITE_OUT_OF_MEMORY if allocation of a contiguous buffer failed.

Parent topic: Pixel buffer functions

vg_lite_free **function** **Description:**

This function is used to deallocate the buffer that was previously allocated. It frees up the memory for that buffer.

Syntax:

```
vg_lite_error_t vg_lite_free (
      vg_lite_buffer_t       *buffer
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_allocate() function.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_upload_buffer **function** **Description:**

The function uploads the pixel data to a GPU memory buffer object. The format of the data (pixel) to be uploaded must match the format defined for the buffer object. The input data memory buffer should contain enough data to be uploaded to the GPU buffer pointed by the input parameter buffer.

Note: Vivante Vector Graphics IP only uses data[0] and stride[0] as it does not support planar YUV formats..

Syntax:

```
vg_lite_error_t vg_lite_upload_buffer (
    vg_lite_buffer_t           *buffer,
    vg_lite_uint8_t            *data[3],
    vg_lite_uint32_t           stride[3]
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_allocate() function
data[3]	Pointer to pixel data. For the YUV format, there may be up to 3 pointers.
stride[3]	Stride for the pixel data

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_map function Description:

This function is used to map the memory appropriately for a particular buffer. For some operating systems, it is used to get proper translation to the physical or logical address of the buffer needed by the GPU.

To use a frame buffer directly as a target buffer:

- Wrap a vg_lite_buffer_t structure around the buffer
- Call the kernel to map the supplied logical or physical address into hardware accessible memory

For example, if you know the logical address of the frame buffer, set the memory field of the vg_lite_buffer_t structure with that address and call this function. If you know the physical address, set the memory field to NULL and program the address field with the physical address.

Syntax:

```
vg_lite_error_t  vg_lite_map  (
    vg_lite_buffer_t          *buffer,
    vg_lite_map_flag_t         flag,
    int32_t                    fd
    );
```

Parameters:

Name	Description
*buffe	Pointer to a buffer structure that was filled in by calling the vg_lite_allocate() function
flag	Enumerate the vg_lite_map_flag_t value that specifies whether the mapping is for user memory or DMA buffer. *(from March 2023)*
fd	File descriptor for dma_buf if the flag is VG_LITE_MAP_DMABUF. Otherwise, this parameter is ignored. *(from March 2023)*

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_unmap function Description:

This function unmaps the buffer and frees any memory resources allocated by a previous call to the vg_lite_map() function.

Syntax:

```
vg_lite_error_t vg_lite_unmap (
      vg_lite_buffer_t        *buffer
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_map() function

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_flush_mapped_buffer **function** **Description:**

This function flushes the CPU cache for the mapped buffer to make sure the buffer contents are written to GPU memory.

Syntax:

```
vg_lite_error_t vg_lite_flush_mapped_buffer (
    vg_lite_buffer_t            *buffer
);
```

Parameters:

Name	Description
*buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_map() function

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_set_CLUT **function** **Description:**

This function sets the Color Lookup Table (CLUT) in the context state for index color image. Once the CLUT is set (Not NULL), the image pixel color for index format image rendering is obtained from the Color Lookup Table (CLUT) according to the pixel's color index value.

Note: Available only for IP with Indexed color support..

Syntax:

```
vg_lite_error_t vg_lite_set_CLUT (
  vg_lite_uint32_t                  count,
  vg_lite_uint32_t                  *colors
);
```

Parameters:

Nam	Description
coun	This is the count of the colors in the color look-up table: - For INDEX_1, there can be up to 2 colors in the table - For INDEX_2, there can be up to 4 colors in the table - For INDEX_4, there can be up to 16 colors in the table - For INDEX_8, there can be up to 256 colors in the table
*col-ors	The Color Lookup Table (CLUT) pointed by “colors” will be stored in the context and programmed to the command buffer when needed. The CLUT will not take effect until the command buffer is submitted to HW. The color is in ARGB format with A located in the upper bits. **Note:** The VGLite driver does not validate the CLUT contents from the application.

Returns:

VG_LITE_SUCCESS as no checking is done.

Parent topic: Pixel buffer functions

vg_lite_enable_dither **function** **Description:**

This function is used to enable the dither function. Dither is turned off by default. The application can use the VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_DITHER) to determine HW support for dither.

Syntax:

```
vg_lite_error_t vg_lite_enable_dither (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_disable_dither **function** **Description:**

This function is used to disable the dither function. Dither is turned off by default.

Syntax:

```
vg_lite_error_t vg_lite_disable_dither (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

vg_lite_set_gamma **function** **Description:**

This function sets a gamma value.

Application can use the VGLite API vg_lite_query_feature(gcFEATURE_BIT_VG_GAMMA) to determine HW support for gamma.

Syntax:

```
vg_lite_error_t vg_lite_set_gamma (
    vg_lite_gamma_conversion_t     gamma_value
);
```

Parameters:

Name	Description
gamma_value	Sets a gamma value. See enum vg_lite_gamma_conversion_t.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Pixel buffer functions

Parent topic:*Pixel buffers*

Matrices This part of the API provides matrix controls.

Note: All the transformations in the driver/API are actually the final plane/surface coordinate system. There is no transformation of different coordinate systems with VGLite.

Matrix control float parameter type

Name	Typedef	Value
vg_lite_float_t	float	A single-precision floating-point number
vg_lite_pixel_matrix_t [20]	vg_lite_float_t	Pixel transform matrix m[20], which transforms each pixel as follows: |a'| |m0 m1 m2 m3 m4 | |a| |r'| |m5 m6 m7 m8 m9 | |r| |g'| = |m10 m11 m12 m13 m14|.|g| |b'| |m15 m16 m17 m18 m19| |b| |1 | |0 0 0 0 1 | |1|

Parent topic:*Matrices*

Matrix control structures This section provides an overview of the graphic transformation matrix control structures.

vg_lite_matrix_t **structure** This structure defines a 3x3 floating point matrix.

Used in structures: vg_lite_linear_gradient_t, vg_lite_radial_gradient_t.

Used in blit functions: vg_lite_blit, vg_lite_blit_rect.

Used in draw functions: vg_lite_draw, vg_lite_draw_gradient, vg_lite_draw_radial_gradient, vg_lite_draw_pattern, vg_lite_identity, vg_lite_scale, vg_lite_translate.

vg_lite_matrix_t member	Type	Description
m[3][3]	vg_lite_float_t	3x3 matrix, in [row] [column] order

Parent topic: Matrix control structures

vg_lite_pixel_channel_enable_t **structure** This structure provides enable disable flags for hardware pixel channels A,R,G,B.

Used in function: vg_lite_set_pixel_matrix_t.

vg_lite_pixel_channel_enable_t members	Type	Description
enable_a	vg_lite_uint8_t	Enable A channel
enable_b	vg_lite_uint8_t	Enable B channel
enable_g	vg_lite_uint8_t	Enable G channel
enable_r	vg_lite_uint8_t	Enable R channel

Parent topic: Matrix control structures

Parent topic:*Matrices*

Matrix control functions This section provides an overview of the matrix control functions.

vg_lite_identity **function** **Description:**

This function loads an identity matrix into a matrix variable.

Syntax:

```
vg_lite_error_t vg_lite_identity (
    vg_lite_matrix_t            *matrix,
);
```

Parameters:

Name	Description
*matrix	Pointer to the vg_lite_matrix_t structure that will be loaded with an identity matrix.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Matrix control functions

vg_lite_set_pixel_matrix **function** **Description:**

This function sets up a pixel transform matrix m[20] which transforms each pixel as follows:

```
|a'|    |m0  m1  m2  m3  m4 | |a|
|r'|    |m5  m6  m7  m8  m9 | |r|
|g'| =  |m10 m11 m12 m13 m14|.|g|
|b'|    |m15 m16 m17 m18 m19| |b|
|1 |    |0   0   0   0   1  | |1|
```

The pixel transform for the A, R, G, B channels can be enabled/disabled individually with the channel parameter.

Applications can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_PIXEL_MATRIX) to determine HW support for gaussian blur.

Syntax:

```
vg_lite_error_t vg_lite_set_pixel_matrix (
    vg_lite_pixel_matrix_t          matrix,
    vg_lite_pixel_channel_enable_t  *channel
);
```

Parameters:

Name	Description
*matrix	Specifies the vg_lite_pixel_matrix_t pixel transform matrix that will be loaded.
*channel	Pointer to the vg_lite_pixel_channel_enable_t structure used to enable/disable individual channels.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Matrix control functions

vg_lite_rotate function Description:

This function rotates a matrix a specified number of degrees.

Syntax:

```
vg_lite_error_t vg_lite_rotate (
    vg_lite_float_t          degrees,
    vg_lite_matrix_t         *matrix
);
```

Parameters:

Nam	Description
degrees	Number of degrees to rotate the matrix. Positive numbers rotate clockwise.The coordinates for the transformation are given in the surface coordinate system (top-to-bottom orientation). Rotations with positive angles are in the clockwise direction.
*matrix	Pointer to the vg_lite_matrix_t structure that has to be rotated

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Matrix control functions

vg_lite_scale **function** **Description:**

This function scales a matrix in both horizontal and vertical directions.

Syntax:

```
vg_lite_error_t vg_lite_scale (
    vg_lite_float_t             scale_x,
    vg_lite_float_t             scale_y,
    vg_lite_matrix_t            *matrix
);
```

Parameters:

Name	Description
scale_x	Horizontal scale
scale_y	Vertical scale
matrix	Pointer to the vg_lite_matrix_t structure that will be scaled.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Matrix control functions

vg_lite_translate **function** **Description:**

This function translates a matrix to a new location.

Syntax:

```
vg_lite_error_t vg_lite_translate (
    vg_lite_float_t             x,
    vg_lite_float_t             y,
    vg_lite_matrix_t            *matrix
);
```

Parameters:

Name	Description
x	X location of the transformation.
y	Y location of the transformation.
matrix	Pointer to the vg_lite_matrix_t structure that will be translated.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Matrix control functions

Parent topic:*Matrices*

Blits for compositing and blending This part of the API performs the hardware accelerated blit operations.

Compositing rules describes how two areas are combined to form a single area. Blending rules describes how combining the colors of the overlapping areas are combined. VGLite supports two blending operations and a subset of the Porter-Duff operations [PD84]. The Porter-Duff operators assume that the pixels have the alpha associated (premultiplied), it means that the pixels are premultiplied prior to the blending operation. GC555, GC355, and some GCNanoUltraV hardware support alpha premultiply for RGB image, but GCNanoLiteV does not.

The source image is copied to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction.

- The blit function can be used with or without the blend mode.
- The blit function can be used with or without specifying any color value.
- The blit function can be used for color conversion with an identity matrix and appropriate formats specified for the source and the destination buffers. In this case, do not specify blend mode and color value.

Blit enumerations This section gives details on blit enumerations.

vg_lite_blend_t **enumeration** This enumeration defines the blending modes supported by some VGLite API functions. S and D represent source and destination non-premultiplied RGB color channels. Sa and Da represent the source and destination alpha channels. SP and DP represent source and destination alpha-premultiplied RGB color channels (SP = S*Sa, DP = D*Da).

Note: VG_LITE_BLEND_*_LVGL modes are supported on all VG cores. On VG cores that do not support gcFEATURE_BIT_VG_LVGL_SUPPORT, the LVGL blend modes are supported by a combination of software and hardware operations. OPENVG_BLEND_* modes can only be supported on GC355 and GC555 cores.

Used in blit functions: vg_lite_blit, vg_lite_blit2, vg_lite_blit_rect.

Used in draw functions: vg_lite_draw, vg_lite_draw_grad, vg_lite_draw_radial_grad, vg_lite_draw_pattern.

vg_lite_blend_t String Values	Description
VG_LITE_BLEND_NONE	**S, no blending** Non-premultiplied
VG_LITE_BLEND_SRC_OVER	**S** + **D * (1 - Sa)** Non-premultiplied
VG_LITE_BLEND_DST_OVER	**S * (1 – Da)** + **D** Non-premultiplied
VG_LITE_BLEND_SRC_IN	**S * Da** Non-premultiplied
VG_LITE_BLEND_DST_IN	**D * Sa** Non-premultiplied
VG_LITE_BLEND_MULTIPLY	**S * (1 - Da)** + **D * (1 - Sa)** + **S * D** Non-premultiplied
VG_LITE_BLEND_SCREEN	**S** + **D - S * D** Non-premultiplied
VG_LITE_BLEND_DARKEN	**min(SRC_OVER, DST_OVER)** Non-premultiplied
VG_LITE_BLEND_LIGHTEN	**max(SRC_OVER, DST_OVER)** Non-premultiplied
VG_LITE_BLEND_ADDITIVE	**S** + **D** Non-premultiplied
VG_LITE_BLEND_SUBTRACT	**D * (1 - Sa)** Non-premultiplied
VG_LITE_BLEND_NORMAL_LVGL	**S * Sa** + **D * (1 - Sa)** Non-premultiplied (from March 2023)
VG_LITE_BLEND_ADDITIVE_LVGL	**(S** + **D) * Sa** + **D * (1 - Sa)** Non-premultiplied (from March 2023)
VG_LITE_BLEND_SUBTRACT_LVGL	**(S - D) * Sa** + **D * (1 - Sa)** Non-premultiplied (from March 2023)
VG_LITE_BLEND_MULTIPLY_LVGL	**(S * D) * Sa** + **D * (1 - Sa)** Non-premultiplied (from March 2023)
OpenVG Porter-Duff Blend String Values	*(from Aug 2023)*
OPENVG_BLEND_NONE	**SP, no blending** Premultiplied
OPENVG_BLEND_SRC_OVER	**(SP** + **DP * (1 - Sa))** / **(Sa** + **Da * (1 - Sa))** Premultiplied
OPENVG_BLEND_DST_OVER	**(SP * (1 - Da)** + **DP)** / **(Sa * (1 - Da)** + **Da)** Premultiplied
OPENVG_BLEND_SRC_IN	**(SP * Da)** / **(Sa * Da)** Premultiplied
OPENVG_BLEND_DST_IN	**(DP * Sa)** / **(Sa * Da)** Premultiplied
OPENVG_BLEND_MULTIPLY	**(SP*DP** + **SP*(1 - Da)** + **DP*(1 - Sa))** / **(Sa** + **Da*(1 - Sa))** Premultiplied
OPENVG_BLEND_SCREEN	**(SP** + **DP - (SP*DP))** / **(Sa** + **Da*(1 - Sa))** Premultiplied
OPENVG_BLEND_DARKEN	**min(SRC_OVER, DST_OVER)** Premultiplied
OPENVG_BLEND_LIGHTEN	**max(SRC_OVER, DST_OVER)** Premultiplied
OPENVG_BLEND_ADDITIVE	**(SP** + **DP)** / **(Sa** + **Da)** Premultiplied

Parent topic: Blit enumerations

vg_lite_color_t **parameter** The common parameter vg_lite_color_t is described in Table 1.

Parent topic: Blit enumerations

vg_lite_color_transform_t **structure** Specifies the pixel color_transform values for scale and bias.

Used in functions: vg_lite_set_color_transform.

vg_lite_color_transform_t members	Type	Description
a_scale	vg_lite_float_t	Scale value for alpha.
a_bias	vg_lite_float_t	Bias value for alpha.
r_scale	vg_lite_float_t	Scale value for red.
r_bias	vg_lite_float_t	Bias value for red.
g_scale	vg_lite_float_t	Scale value for green.
g_bias	vg_lite_float_t	Bias value for green.
b_scale	vg_lite_float_t	Scale value for blue.
b_bias	vg_lite_float_t	Bias value for blue.

Parent topic: Blit enumerations

vg_lite_filter_t **enumeration** Specifies the sample-filtering mode in VGLite blit and draw APIs.

Used in blit functions: vg_lite_blit, vg_lite_blit_rect.

Used in draw functions: vg_lite_draw_radial_gradient, vg_lite_draw_pattern.

vg_lite_filter_t string values	Description
VG_LITE_FILTER_POINT	Fetch only the nearest image pixel
VG_LITE_FILTER_LINEAR	Use linear interpolation along a horizontal line
VG_LITE_FILTER_BI_LI	Use a 2x2 box around the image pixel and perform an interpolation
VG_LITE_FILTER_GAUS	Perform 3x3 gaussian blur with the convolution for image pixel. *(from March 2023)*

Parent topic: Blit enumerations

vg_lite_color_transform_t **structure** Specifies the pixel color_transform values for scale and bias.

Used in functions: vg_lite_set_color_transform.

vg_lite_color_transform_t members	Type	Description
a_scale	vg_lite_float_t	Scale value for alpha.
a_bias	vg_lite_float_t	Bias value for alpha.
r_scale	vg_lite_float_t	Scale value for red.
r_bias	vg_lite_float_t	Bias value for red.
g_scale	vg_lite_float_t	Scale value for green.
g_bias	vg_lite_float_t	Bias value for green.
b_scale	vg_lite_float_t	Scale value for blue.
b_bias	vg_lite_float_t	Bias value for blue.

Parent topic: Blit enumerations

vg_lite_mask_operation_t **enumeration** Specifies the mask operation mode in VGLite blit APIs.

Used in functions: vg_lite_blend_masklayer, vg_lite_render_masklayer.

vg_lite_mask_o string values	Description
VG_LITE_CL	This operation sets all mask values in the region of interest to 0, ignoring the new mask layer.
VG_LITE_FIL	This operation sets all mask values in the region of interest to 1, ignoring the new mask layer.
VG_LITE_SE	This operation copies values in the region of interest from the new mask layer, overwriting the previous mask values.
VG_LITE_UN	This operation replaces the previous mask in the region of interest by its union with the new mask layer. The resulting values are always greater than or equal to their previous value.
VG_LITE_INT	This operation replaces the previous mask in the region of interest by its intersection with the new mask layer. The resulting mask values are always less than or equal to their previous value.
VG_LITE_SUI	This operation subtracts the new mask from the previous mask and replaces the previous mask in the region of interest by the resulting mask. The resulting values are always less than or equal to their previous value.

Parent topic: Blit enumerations

vg_lite_orientation_t **enumeration** Specifies the mirror orientation in VGLite blit APIs.

Used in functions: vg_lite_set_mirror.

vg_lite_orientation_t string values	Description
VG_LITE_ORIENTATION_TOP_BOTT	Target output orientation is from top to bottom (default).
VG_LITE_ORIENTATION_BOTTOM_T	Target output orientation is from bottom to top.

Parent topic: Blit enumerations

vg_lite_param_type_t **enumeration** Specifies the parameter type in VGLite blit APIs.

Used in functions: vg_lite_get_parameter.

vg_lite_param_type_t string value	Description
VG_LITE_GPU_IDLE_STATE	The count must be 1 for GPU idle state TRUE or FALSE.
VG_LITE_SCISSOR_RECT	The count must be 4n for x, y, right, bottom.

Parent topic: Blit enumerations

Parent topic:*Blits for compositing and blending*

Blit structures This section provides details about blit structures.

vg_lite_buffer_t **structure** Defined under the “Pixel buffer structures” section (see vg_lite_buffer_t structure).

Parent topic: Blit structures

vg_lite_color_key_t **structure** A “color key” have two sections, where each section contains R,G,B channels, which are noted as high_rgb and low_rgb respectively. *(from April 2022)*

When the enable value is true, the color key specified is effective and the alpha value is used to replace the alpha channel of the destination pixel when its RGB channels are in range [low_rgb, high_rgb]. After the color key is used in the current frame, if the color key is not needed for the next frame, it should be disabled before the next frame.

Used in structure: vg_lite_color_key4_t

vg_lite_color_key_t members	Type	Description
enable	vg_lite_uint8	When set (true), this color key is enabled
low_r	vg_lite_uint8	The R channel of low_rgb
low_g	vg_lite_uint8	The G channel of low_rgb
low_b	vg_lite_uint8	The B channel of low_rgb
alpha	vg_lite_uint8	The alpha value to replace the destination pixel alpha channel value with
high_r	vg_lite_uint8	The R channel of high_rgb
high g	vg_lite_uint8	The G channel of high_rgb
high_b	vg_lite_uint8	The B channel of high_rgb

Parent topic: Blit structures

vg_lite_color_key4_t **structure** The priority order is: color_key_0 > color_key_1 > color_key_2 > color_key_3. *(from April 2022)*

Used in blit function: vg_lite_set_color_key

vg_lite_color_key4_t members	Type	Description
color_key_0		high_rgb_0, low_rgb_0, alpha_0, enable_0
color_key_1		high_rgb_1, low_rgb_1, alpha_1, enable_1
color_key_2		high_rgb_2, low_rgb_2, alpha_2, enable_2
color_key_3		high_rgb_3, low_rgb_3, alpha_3, enable_3

Parent topic: Blit structures

vg_lite_matrix_t **structure** Defined under the “Matrix control structures” section (see vg_lite_matrix_t structure).

Parent topic: Blit structures

vg_lite_path_t **structure** Defined under the “Vector path structures” section (see vg_lite_path_t structure).

Parent topic: Blit structures

vg_lite_rectangle_t **structure** This structure defines a rectangle by using coordinates.

Used in blit function: vg_lite_clear.

vg_lite_rectangle_t member	Type	Description
x	vg_lite_int32_t	X origin of rectangle, left coordinate in pixels
y	vg_lite_int32_t	Y origin of rectangle, top coordinate in pixels
width	vg_lite_int32_t	X Width of rectangle in pixels
height	vg_lite_int32_t	Y Height of rectangle in pixels

Parent topic: Blit structures

vg_lite_point_t **structure** This structure defines a 2D point *(from March 2021)*.

Used in structure: vg_lite_point4_t.

vg_lite_point_t member	Type	Description
X	vg_lite_int32_t	X value of coordinate
Y	vg_lite_int32_t	Y value of coordinate

Parent topic: Blit structures

vg_lite_point4_t **structure** This structure defines four 2D points that form a polygon. The points are defined by structure vg_lite_point_t. *(from March 2021)*

vg_lite_point4_t member	Type	Description
vg_lite_point_t[4]	vg_lite_int32_t each	a set of four points

Parent topic: Blit structures

vg_lite_float_point_t **structure** This structure defines a 2D float point *(from March 2024)*.

Used in structure: vg_lite_float_point4_t.

vg_lite_float_point_t members	Type	Description
x	vg_lite_float_t	X value of coordinate
y	vg_lite_float_t	Y value of coordinate

Parent topic: Blit structures

vg_lite_float_point4_t **structure** This structure defines four 2D float points that form a polygon. The points are defined by structure vg_lite_float_point_t. *(from March 2024)*

Used in blit function: vg_lite_get_transform_matrix.

vg_lite_float_point4_t members	Type	Description
vg_lite_float_point[4]	vg_lite_float_t each	a set of four points

Parent topic: Blit structures

Parent topic:*Blits for compositing and blending*

Blit functions This section provides an overview on blit functions.

vg_lite_blit **function** **Description:**

This is the blit function. The blit operation is performed using a source and a destination buffer. The source and destination buffer structures are defined using the vg_lite_buffer_t structure. Blit copies a source image to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction. Note that vg_lite_buffer_t does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Note:

- The blit function can be used with or without the blend function (*vg_lite_blend_t*)
- The blit function can be used with or without specifying a foreground color value (*vg_lite_color_t*)
- The blit function can be used for color conversion with an identity matrix and appropriate formats specified for the source and the destination buffers. In this case, do not specify blend mode and color value.

Syntax:

```
vg_lite_error_t vg_lite_blit (
    vg_lite_buffer_t      *target,
    vg_lite_buffer_t      *source,
    vg_lite_matrix_t      *matrix,
    vg_lite_blend_t       blend,
    vg_lite_color_t       color,
    vg_lite_filter_t      filter
);
```

Parameters:

Nam	Description
*target	Points to the vg_lite_buffer_t structure, which defines the destination buffer. See Image Source Alignment Requirement for valid destination color formats for the blit functions.
*sou	Points to the vg_lite_buffer_t structure for the source buffer. All color formats available in the vg_lite_buffer_format_t enum are valid source formats for the blit function.
*matrix	Points to a vg_lite_matrix_t structure that defines the transformation matrix of source pixels into the target. If the matrix is NULL, then an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blen	Specifies one of the enum vg_lite_blend_t values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0). **Note:** If the matrix parameter is specified with rotation or perspective, and the blend parameter is specified as VG_LITE_BLEND_NONE, VG_LITE_BLEND_SRC_IN, or VG_LITE_BLEND_DST_IN; then, the VGLite driver overwrites the application setting for the blit operation as follows: - If gcFEATURE_BIT_VG_BORDER_CULLING (*vg_lite_feature_t*) is supported, then Transparency mode is always set to TRANSPARENT- If gcFEATURE_BIT_VG_BORDER_CULLING (*vg_lite_feature_t*) is not supported, then Blend mode is always set to VG_LITE_BLEND_SRC_OVER. It happens due to some limitations in the VGLite hardware.
color	If non-zero, this color value is used as a mix color. The mixed color gets multiplied with each source pixel before blending happens. If you don't need a mix color, set the color parameter to 0.**Note:** this parameter has no effect if the source vg_lite_buffer_t structure member image_mode is set to VG_LITE_ZERO or VG_LITE_NORMAL_IMAGE_MODE.
filter	Specifies the filter type. All formats available in the vg_lite_filter_t enum are valid formats for this function. A value of zero (0) indicates VG_LITE_FILTER_POINT.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_blit2 function Description:

This is the blit function for use with two sources. The blit2 operation is performed using two source buffers and one destination buffer. The source and destination buffer structures are defined using the vg_lite_buffer_t structure. Source0 and Source1 are first blended according to the blend mode with a specific transformation matrix for each image. Source1 is used as the source while Source0 is used as the dest and is directly output to the render target buffer.

The specified matrices can include translation, rotation, scaling, and perspective correction. Note that vg_lite_buffer_t does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Application can use VGLite API vg_lite_query_feature(gcFEATURE_BIT_VG_DOUBLE_IMAGE) to determine HW support for double image.

Note:

- The vg_lite_blit function can be used for color conversion for Source0 or Source1 before merging sources with vg_lite_blit2.

Syntax:

```
vg_lite_error_t vg_lite_blit2 (
    vg_lite_buffer_t              *target,
```

(continues on next page)

(continued from previous page)

```
    vg_lite_buffer_t            *source0,
    vg_lite_buffer_t            *source1,
    vg_lite_matrix_t            *matrix0,
    vg_lite_matrix_t            *matrix1,
    vg_lite_blend_t             blend,
    vg_lite_filter_t            filter
);
```

Parameters:

Nam	Description
*target	Points to the vg_lite_buffer_t structure, which defines the destination buffer. See Alignment notes for valid destination color formats for the blit functions
*sou	Points to the vg_lite_buffer_t structure for the source0 and source1 buffers. All color formats available in the vg_lite_buffer_format_t‘ enum are valid source formats for the blit functions.
*sou	
*mat	Points to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix0 for the source0 pixels and matrix1 for the source1 pixels. If matrix0 and matrix1 are both NULL, the identity matrix is assumed, meaning the blending result of Source0 and Source1 is copied directly on the target at location(0,0).
*matrix1	
blend	Specifies one of the enum vg_lite_blend_t values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0). Note: If the “matrix” parameter is specified with rotation or perspective, and the “blend” parameter is specified as VG_LITE_BLEND_NONE, VG_LITE_BLEND_SRC_IN, or VG_LITE_BLEND_DST_IN, the VGLite driver overwrites the application’s setting for the BLIT operation as follows: - If gcFEATURE_BIT_VG_BORDER_CULLING (*vg_lite_feature_t*) is supported, the transparency mode will always be set to TRANSPARENT. - If gcFEATURE_BIT_VG_BORDER_CULLING (*vg_lite_feature_t*) is not supported, the blend mode will always be set to VG_LITE_BLEND_SRC_OVER. This is due to some limitations in the VGLite hardware.
filter	Specifies the filter type. All formats available in the vg_lite_filter_t enum are valid formats for this function. A value of zero (0) indicates VG_LITE_FILTER_POINT.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_blit_rect function Description:

This is the blit rectangle function. The blit operation is performed using a source and a destination buffer. The source and destination buffer structures are defined using the vg_lite_buffer_t structure. Blit copies a source image to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction. Note that vg_lite_buffer_t does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Note:

- The blit_rect function can be used with or without the blend function (vg_lite_blend_t).
- The blit_rect function can be used with or without specifying any color value (vg_lite_color_t).

- The blit_rect function can be used for color conversion with an identity matrix and appropriate formats specified for the source and destination buffers. In this case, do not specify blend mode and color value.
- The vg_lite_blit_rect rectangle start origin point is always (0,0) for hardware versions prior to GCNanoLiteV 1311p that do not support a non-zero rectangle origin.

Syntax:

```
vg_lite_error_t vg_lite_blit_rect (
    vg_lite_buffer_t          *target,
    vg_lite_buffer_t          *source,
    vg_lite_rectangle_t       *rect,
    vg_lite_matrix_t          *matrix,
    vg_lite_blend_t           blend,
    vg_lite_color_t           color,
    vg_lite_filter_t          filter
);
```

Parameters:

Nam	Description
*target	Points to the vg_lite_buffer_t structure that defines the destination buffer.
*sou	Points to the vg_lite_buffer_t structure for the source buffer. All color formats available in the vg_lite_buffer_format_t enum are valid source formats for the blit_rect function.
*rect	Specifies the rectangle area of the source image to blit. rect[0]/[1]/[2]/[3] are x, y, width, and height of the source rectangle respectively. **Note:** Non-zero source origins are supported.
*matrix	Points to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of source pixels into the target. If the matrix is NULL, then an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blend	Specifies one of the enum vg_lite_blend_t values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0). **Note:** If the matrix parameter is specified with rotation or perspective, and the blend parameter is specified as VG_LITE_BLEND_NONE, VG_LITE_BLEND_SRC_IN, or VG_LITE_BLEND_DST_IN; then, the VGLite driver overwrites the application setting for the blit operation as follows: - If gcFEATURE_BIT_VG_BORDER_CULLING (vg_lite_feature_t) is supported, then Transparency mode is always set to TRANSPARENT - If gcFEATURE_BIT_VG_BORDER_CULLING (vg_lite_feature_t) is not supported, then Blend mode is always set to VG_LITE_BLEND_SRC_OVER. It happens due to some limitations in the VGLite hardware.
color	If non-zero, this color value is used as a mix color. The mixed color gets multiplied with each source pixel before blending happens. If you do not need a mix color, then set the color parameter to 0. **Note:** This parameter has no effect if the source vg_lite_buffer_t structure member image_mode is set to VG_LITE_ZERO or VG_LITE_NORMAL_IMAGE_MODE.
filter	Specifies the filter type. All formats available in the vg_lite_filter_t enum are valid formats for this function. A value of zero (0) indicates VG_LITE_FILTER_POINT.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_copy_image **function** **Description:**

This API copied a pixel rectangle with dimension (width, height) from source buffer to destination buffer. The source image pixel (sx *+ i,*sy + *j*) is copied to the destination image pixel (dx *+ i,*dy + *j*), for *0 □ i <*width and *0 □ j <*height. Pixels whose source or destination lie outside the bounds of the respective image are ignored. Pixel format conversion is applied as needed.

No pre-multiply, transformation, blending, filtering operations are applied to the pixel copy.

Syntax:

```
vg_lite_error_t vg_lite_copy_image (
    vg_lite_buffer_t            *target,
    vg_lite_buffer_t            *source,
    vg_lite_int32_t             sx,
    vg_lite_int32_t             sy,
    vg_lite_int32_t             dx,
    vg_lite_int32_t             dy,
    vg_lite_int32_t             width,
    vg_lite_int32_t             height
);
```

Parameters:

Nam	Description
*tar-get	Points to the vg_lite_buffer_t structure that defines the destination buffer.
*sour	Points to the vg_lite_buffer_t structure for the source buffer. All color formats available in the vg_lite_buffer_format_t enum are valid source formats for the blit function.
sx, sy	Pixel coordinates of the lower-left corner of a pixel rectangle within the source buffer.
dx, dy	Pixel coordinates of the lower-left corner of a pixel rectangle within the target buffer.
widtl	Width of the copied pixel rectangle.
heigh	Height of the copied pixel rectangle.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_get_transform_matrix **function** **Description:**

This function generates a 3x3 homogenous transform matrix from 4 float point source coordinates and 4 float point target coordinates. *(from March 2021)*

Syntax:

```
vg_lite_error_t vg_lite_get_transform_matrix (
    vg_lite_float_point4_t      src,
    vg_lite_float_point4_t      dst,
    vg_lite_matrix_t            *mat
);
```

Parameters:

Name	Description
src	Pointer to the four 2D points that form a source polygon
dst	Pointer to the four 2D points that form a destination polygon
mat	Output parameter, pointer to a 3x3 homogenous matrix that transforms the source polygon to a destination polygon.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_clear **function** **Description:**

This function performs the clear operation, clearing/filling the specified buffer (entire buffer or partial rectangle in a buffer) with an explicit color.

Syntax:

```
vg_lite_error_t vg_lite_clear (
    vg_lite_buffer_t            *target,
    vg_lite_rectangle_t          *rect,
    vg_lite_color_t             color
);
```

Parameters:

Name	Description
*target	Pointer to the vg_lite_buffer_t structure for the destination buffer. All color formats available in the vg_lite_buffer_format_t enum are valid destination formats for the clear function.
*rect	Pointer to the vg_lite_rectangle_tstructure that specifies the area to be filled. If the rectangle is NULL, the entire target buffer is filled with the specified color.
color	Clear color, as specified in the vg_lite_color_t enum that is the color value to use for filling the buffer. If the buffer is in L8 format, the RGBA color is converted into a luminance value.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit functions

vg_lite_set_color_key **function** **Description:**

This function sets a color key. Color key can be used for blit or for draw pattern operations. *(from April 2022)*

A “color key” have two sections, where each section contains R,G,B channels which are noted as high_rgb and low_rgb respectively.

When the vg_lite_color_key_t structure value enable is true, the color key specified is effective and the alpha value is used to replace the alpha channel of the destination pixel when its RGB

channels are within range [low_rgb, high_rgb]. After the color key is used in the current frame, if the color key is not needed for the next frame, it should be disabled before the next frame.

Hardware support for color key is not available for GCNanoLiteV. Application can use VGLite API vg_lite_query_feature(gcFEATURE_BIT_VG_COLOR_KEY) to determine HW support for color key.

Syntax:

```
vg_lite_error_t vg_lite_set_color_key (
    vg_lite_color_key4_t          colorkey
);
```

Parameters:

Parameter	Description
colorkey	Color keying parameters as defined by vg_lite_color_key4_t.

Here are 4 groups of color key states:

- color_key_0, high_rgb_0, low_rgb_0, alpha_0, enable_0
- color_key_1, high_rgb_1, low_rgb_1, alpha_1, enable_1
- color_key_2, high_rgb_2, low_rgb_2, alpha_2, enable_2
- color_key_3, high_rgb_3, low_rgb_3, alpha_3, enable_3

The priority order of these states is:

color_key_0 > color_key_1 > color_key_2 > color_key_3.

Returns:

VG_LITE_SUCCESS if successful. VG_LITE_NOT_SUPPORT if color key is not supported in hardware.

Parent topic: Blit functions

vg_lite_gaussian_filter **function** **Description:**

This function sets 3x3 gaussian blur weighted values to filter an image pixel. *(from March 2023)*

The parameters w0, w1, w2 define a 3x3 gaussian blur weight matrix as:

```
|   w2    w1    w2  |
|   w1    w0    w1  |
|   w2    w1    w2  |
```

The sum of the 9 kernel weights must be 1.0 to avoid convolution overflow (w0 + 4*w1 + 4*w2 = 1.0).

The 3x3 weight matrix applies to a 3x3 pixel block:

```
| pixel[i-1][j-1]     pixel[i][j-1]       pixel[i+1][j-1]|
| pixel[i-1][j]       pixel[i][j]         pixel[i+1][j]  |
| pixel[i-1][j+1]     pixel[i][j+1]       pixel[i+1][j+1]|
```

With the following dot product equation:

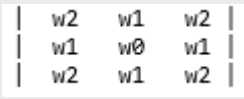
```
color[i][j] = w2*pixel[i-1][j-1] + w1*pixel[i][j-1] + w2*pixel[i+1][j-1]
            + w1*pixel[i-1][j]   + w0*pixel[i][j]   + w1*pixel[i+1][j]
            + w2*pixel[i-1][j+1] + w1*pixel[i][j+1] + w2*pixel[i+1][j+1];
```

Applications can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_GAUSSIAN_BLUR) to determine HW support for gaussian blur.

Syntax:

```
vg_lite_error_t vg_lite_gaussian_filter (
    vg_lite_float_t             w0
    vg_lite_float_t             w1
    vg_lite_float_t             w2
);
```

Parameters:

Parameter	Description
w0, w1, w2	w0, w1, w2 define a 3x3 gaussian blur weighted matrix as: 

Returns:

VG_LITE_SUCCESS if successful. Otherwise, VG_LITE_NOT_SUPPORT if gaussian blur is not supported in hardware.

Parent topic: Blit functions

Parent topic:*Blits for compositing and blending*

Blit/Draw extended functions The following BLIT or DRAW-related functions typically require GC355 or GC555 hardware and are not available for all Vivante Vector Graphics hardware configurations.

Applications can use the VGLite API vg_lite_query_feature to determine HW support for the related functionality.

vg_lite_get_parameter **function** **Description:**

This function returns the selected VGLite / GPU states to the application.

(from Aug 2023)

Syntax:

```
vg_lite_error_t vg_lite_get_parameter (
    vg_lite_param_type_t        type,
    vg_lite_int32_t             count,
    vg_lite_pointer             params
);
```

Parameters:

Parameter	Description
type	The parameter type to be queried (VG_LITE_GPU_IDLE_STATE, VG_LITE_SCISSOR_RECT)
count	The number of returned parameters
params	The pointer to the array of returned parameters

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_enable_scissor **function** **Description:**

This function enables scissor rectangle operation for the rectangle regions defined by vg_lite_scissor_rects API. *(from March 2020, modified August 2020, requires GC355 or GC555 hardware)*

Applications can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_SCISSOR) to determine HW support for scissoring. Support is available with GC355 and GC555.

Syntax:

```
vg_lite_error_t vg_lite_enable_scissor (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_disable_scissor **function** **Description:**

This function disables scissor operation for the rectangle regions defined by the vg_lite_scissor_rects API. *(from March 2020, modified August 2020, requires GC355 or GC555 hardware).*

Syntax:

```
vg_lite_error_t vg_lite_disable_scissor (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_scissor_rects **function** **Description:**

This function defines scissor rectangle regions on the hardware mask layer. But the scissor function is enable/disabled by vg_lite_enable_scissor and vg_lite_disable_scissor APIs. *(from August 2022, requires GC355 or GC555 hardware).*

Syntax:

```
vg_lite_error_t vg_lite_scissor_rects (
    vg_lite_buffer_t            *target,
    vg_lite_uint32_t             nums,
    vg_lite_rectangle_t          rect[]
);
```

Parameters:

Parameter	Description
target	Target render buffer that has the scissor mask layer.
nums	Number of scissor rectangles.
rect[]	The scissor rectangle array.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_set_scissor **function** **Description:**

This is a legacy scissor API function that can be used to set a single scissor rectangle for the render target. This scissor API is supported by a different hardware mechanism other than the mask layer and it has better performance than the mask layer scissor function.

This API is not enabled/disabled by vg_lite_enable_scissor and vg_lite_disable_scissor APIs. Instead, the vg_lite_set_scissor API calls with a valid scissor rectangle input (x, y, right, bottom) enables the scissor function by default. The vg_lite_set_scissor API call with input parameter (-1, -1, -1, -1) disables the scissor function. *(requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_scissor (
    vg_lite_int32_t             x,
    vg_lite_int32_t             y,
    vg_lite_int32_t             right,
    vg_lite_int32_t             bottom
);
```

Parameters:

Parameter	Description
x	X Origin of rectangle, left coordinate in pixels
Y	Y Origin of rectangle, top coordinate in pixels
right	X rightmost pixel of the rectangle
bottom	Y bottom pixel of the rectangle

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_disable_color_transform **function** **Description:**

This function is used to disable color transformation. By default, the color transform is turned off. *(from Sept 2022, only for GC355 and GC555 hardware)*

Applications can use the VGLite API vg_lite_query_feature(gcFEATURE_BIT_VG_COLOR_TRANSFORMATION)' to determine HW support for color transformation. Support is available with GC355 and GC555.

Syntax:

```
vg_lite_error_t vg_lite_disable_color_transform (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_enable_color_transform **function** **Description:**

This function is used to enable color transformation. By default, the color transform is turned off. *(from Sept 2022, only for GC355 and GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_enable_color_transform (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_set_color_transform **function** **Description:**

This function is used to set pixel scale and bias values for color transformation for each pixel channel. *(from August 2022, only for GC355 and GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_color_transform (
    vg_lite_color_transform_t      *values
);
```

Parameters:

Parameter	Description
*values	Pointer to the color transformation values to set. See enum vg_lite_color_transform_t.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_enable_masklayer **function** **Description:**

This function controls the availability of mask functionality. The mask is turned off by default. *(from August - Sept mber 2022, requires GC555 hardware)*

Applications can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_MASK) to determine HW support for mask. The blit and draw mask functions below require GC555 hardware support. These functions were introduced in August 2022 and the syntax or name was further refined in September 2022.

Syntax:

```
vg_lite_error_t vg_lite_enable_masklayer (
    void
  );
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_disable_masklayer **function** **Description:**

This function controls the availability of mask functionality. The mask is turned off by default. *(from August -September 2022, requires GC555 hardware, prior to Sept 2022 name was vg_lite_disable_mask_layer)*

Syntax:

```
vg_lite_error_t vg_lite_disable_masklayer (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_create_masklayer **function** **Description:**

This function creates a mask layer with the specified width and height. The mask format defaults to A8 and the default mask value is 255. *(from August 2022-September, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_create_masklayer (
    vg_lite_buffer_t            *masklayer,
    vg_lite_uint32_t             width,
    vg_lite_uint32_t             height
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be created.
width	Mask layer width (in pixels).
height	Mask layer height (in pixels).

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_blend_masklayer **function** **Description:**

This function blends the specified area of the source mask layer with the destination mask layer according to an vg_lite_mask_operation_t enumeration value, to create a blended destination mask layer. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_blend_masklayer (
    vg_lite_buffer_t            *dst_masklayer,
    vg_lite_buffer_t            *src_masklayer,
    vg_lite_mask_operation       operation,
    vg_lite_rectangle_t          *rect,
);
```

Parameters:

Parameter	Description
*dst_masklay	Points to the address of the buffer of the destination mask layer.
*src_masklay	Points to the address of the buffer of the source mask layer.
operation	Blending mode to be applied to each image pixel, as defined by the enum *vg_lite_mask_operation_t*.
*rect	The rectangle area (x, y, width, height) of the blend operation.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_set_masklayer **function** **Description:**

This function sets the given mask layer to the hardware. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_masklayer (
    vg_lite_buffer_t            *masklayer
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be set.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_render_masklayer **function** **Description:**

This function draws the mask layer according to the specified path, color, and matrix information. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_render_masklayer (
    vg_lite_buffer_t              *masklayer,
    vg_lite_mask_operation         operation,
    vg_lite_path_t                *path,
    vg_lite_fill_t                fill_rule,
    vg_lite_color_t               color,
    vg_lite_matrix_t              *matrix
);
```

Parameters:

Parameter	Description
*mas	Points to the address of the buffer of the destination mask layer.
operation	Blending mode to be applied to each image pixel, as defined by the enum vg_lite_mask_operation_t
*patl	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw. Refer to Vector path opcodes for plotting paths in this document for opcode detail.
fill_r	Specifies the vg_lite_fill_t enum value for the fill rule for the path.
color	Specifies the color vg_lite_color_t RGBA value to be applied to each pixel drawn by the path.
*matrix	Points to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed, meaning the source is copied directly on the target at 0,0 location. which is usually a bad idea since the path can be anything.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_destroy_masklayer **function** **Description:**

This function is used to free a mask layer. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_destroy_masklayer (
    vg_lite_buffer_t              masklayer
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be destroyed.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic: Blit/Draw extended functions

vg_lite_set_mirror **function** **Description:**

This function is used to control mirror functionality. By default, the mirror is turned off and the default output orientation is from top to bottom. *(from August 2022, only for GC555 hardware)*

Application can use VGLite API [vg_lite_query_feature](vg_lite_query_feature_function.md) (gcFEATURE_BIT_VG_MIRROR) to determine HW support for mirror. Mirror functions require GC555 hardware.

Syntax:

```
vg_lite_error_t vg_lite_set_mirror (
    vg_lite_orientation_t         orientation
);
```

Parameters:

Parameter	Description
orientation	The orientation mode as defined by the enum *vg_lite_orientation_t.‘*

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if not supported.

Parent topic: Blit/Draw extended functions

vg_lite_source_global_alpha **function** **Description:**

This function sets the image/source global alpha and return a status error code. *(from June 2021, requires GCNanoUltraV or GC555 hardware)*

Application can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_GLOBAL_ALPHA) to determine HW support for global alpha. The global alpha BLIT-related functions require GCNanoUltraV or GC555 hardware.

Syntax:

```
vg_lite_error_t vg_lite_source_global_alpha (
    vg_lite_global_alpha_t        alpha_mode,
    vg_lite_uint8_t               alpha_value
);
```

Parameters:

Parameter	Description
alpha_mode	Global alpha mode value. See enum vg_lite_global_alpha_t.
alpha_value	The image/source global alpha value to set.

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if global alpha is not supported.

Parent topic: Blit/Draw extended functions

vg_lite_dest_global_alpha **function** **Description:**

This function sets the destination global alpha and returns a status error code. *(from June 2021, requires GCNanoUltraV or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_dest_global_alpha (
    vg_lite_global_alpha_t        alpha_mode,
    vg_lite_uint8_t               alpha_value
);
```

Parameters:

Parameter	Description
alpha_mode	Global alpha mode value. See enum vg_lite_global_alpha_t.
alpha_value	The destination global alpha value to set.

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if global alpha is not supported.

Parent topic: Blit/Draw extended functions

Parent topic:*Blits for compositing and blending*

Vector path control This chapter provides an overview of the vector path enumerations, structures, functions, and opcodes for plotting paths.

Vector path enumerations This section provides an overview of vector path enumerations.

vg_lite_format_t **enumeration** Values for vg_lite_format_t enum are defined in Table 1.

If vg_lite_format_t	Path data alignment in the array should be:
VG_LITE_S8	8 bit
VG_LITE_S16	2 bytes
VG_LITE_S32	4 bytes

Parent topic: Vector path enumerations

vg_lite_quality_t **enumeration** Specifies the level of hardware assisted anti-aliasing.

Used in structure: vg_lite_path_t.

Used in function: vg_lite_init_path, vg_lite_init_arc_path.

vg_lite_qu string values	Description
VG_LITE_	High quality: 16x coverage sample anti-aliasing
VG_LITE_	Upper quality: 8x coverage sample anti-aliasing. Use vg_lite_query_feature to determine availability of 8x CSAA (feature enum value gcFEATURE_BIT_VG_QUALITY_8X.(deprecated from June 2020, available with supported hardware from August 2022).
VG_LITE_	Medium quality: 4x coverage sample anti-aliasing
VG_LITE_	Low quality: No anti-aliasing

Parent topic: Vector path enumerations

Parent topic:*Vector path control*

Vector path structures This section provides an overview of vector path structures.

vg_lite_hw_memory **structure** This structure gets the memory allocation information recorded by the kernel.

Used in structure: vg_lite_path_t.

vg_lite_hw_mem member	Type	Description
handle	vg_lite_p	GPU memory object handle
memory	vg_lite_p	Logical memory address
address	vg_lite_u	GPU memory address
bytes	vg_lite_u	Size of memory
property	vg_lite_u	Bit 0 is used for path upload: - 0: Disable path data uploading (always embedded into command buffer) - 1: Enable auto path data uploading

Parent topic: Vector path structures

vg_lite_path_t **structure** This structure describes VGLite path data.

Path data is made of op codes and coordinates. The format for op codes is always VG_LITE_S8. For more details on opcodes, see Vector path opcodes for plotting paths.

Used in init functions: vg_lite_init_path, vg_lite_init_arc_path, vg_lite_upload_path, vg_lite_clear_path, vg_lite_append_path.

Used in draw functions: vg_lite_draw, vg_lite_draw_grad, vg_lite_draw_radial_grad, vg_lite_draw_pattern.

vg_lite_path_t members	Type	Description
bounding_box[4]	vg_lite_float_	bounding box for path [0] left [1] top [2] right [3] bottom
quality	vg_lite_quality	enum for quality hint for the path, anti-aliasing level
format	vg_lite_format	enum for coordinate format
uploaded	vg_lite_hw_me	struct with path data that has been uploaded into GPU addressable memory
path_length	vg_lite_uint32	number of bytes in the path
path	vg_lite_pointe	pointer to path data
path_changed	vg_lite_int8_t	0: not changed; 1: changed.
pdata_internal	vg_lite_int8_t	0: path data memory is allocated by application; 1: path data memory is allocated by driver.
path_type	vg_lite_path_t	The draw path type as specified in enum vg_lite_path_type_t. *(added for stroke control, from March 2022)*
*stroke	vg_lite_stroke_	As defined by structure vg_lite_stroke_t *(added for stroke control, from March 2022)*
stroke_path	vg_lite_pointe	Pointer to the physical description of the stroke path. *(added for stroke control, from March 2022)*
stroke_size	vg_lite_uint32	Number of bytes in the stroke path data. *(added for stroke control, from March 2022)*
stroke_color	vg_lite_color_t	The stroke path fill color. *(from Sept 2022)*
add_end	vg_lite_int8_t	Flag that add end_path in driver *(from March 2023)*

Special notes for path objects:

- Endianness has no impact, as it is aligned against the boundaries
- Multiple contiguous opcodes should be packed by the size of the specified data format. For example, by 2 bytes for VG_LITE_S16 or by 4 bytes for VG_LITE_S32.

For example, because opcodes are 8-bit (1-byte), 16-bit (2-byte), or 32-bit (4-byte) data types:

```
...
<opcode1_that_needs_data>
<align_to_data_size>
<data_for_opcode1>
<opcode2_that_doesnt_need_data>
<align_to_data_size>
<opcode3_that_needs_data>
<align_to_data_size>
<data_for_opcode3>
...
```

- Path data in the array should always be 1-, 2-, or 4-byte aligned, depending on the format:

For example, for 32-bit (4-byte) data types:

```
...
<opcode1_that_needs_data>
<pad to 4 bytes>
<4 byte data_for_opcode1>
<opcode2_that_doesnt_need_data>
<pad to 4 bytes>
<opcode3_that_needs_data>
<pad to 4 bytes>
<4 byte data_for_opcode3>
...
```

Parent topic: Vector path structures

Parent topic:*Vector path control*

Vector path functions When using a small tessellation window and depending on a path's size, a path might be uploaded to the hardware multiple times because the hardware scanline convert path with the provided tessellation window size, so VGLite path rendering performance might go down. That is why it is preferable to set the tessellation buffer size to the most common path size, for example if you only render 24-pt fonts, you can set the tessellation buffer to be 24x24.

All the RGBA color formats available in the vg_lite_buffer_format_t are supported as the destination buffer for the draw function.

vg_lite_get_path_length **function** **Description:**

This function calculates the path command buffer length (in bytes).

The application is responsible for allocating a buffer according to the buffer length calculated with this function. Then, the buffer is used by the path as a command buffer. The VGLite driver does not allocate the path command buffer.

Syntax:

```
vg_lite_uint32_t vg_lite_get_path_length (
    vg_lite_uint8_t             *opcode,
    vg_lite_uint32_t             count,
    vg_lite_format_t             format
);
```

Parameters:

Parameter	Description
*opcode	Pointer to the opcode array to use to construct the path. *(*opcode from March 2023)*
count	The opcode count
format	The coordinate data format. All formats available in the vg_lite_format_t enum are valid formats for this function.

Returns:

Returns the command buffer length in bytes.

Parent topic: Vector path functions

vg_lite_append_path **function** **Description:**

This function assembles the command buffer for the path. The command buffer is allocated by the application and assigned to the path. This function makes the final GPU command buffer for the path based on the input opcodes (cmd) and coordinates (data). The application is responsible for allocating a buffer large enough for the path*. (from Jan 2022, returns a vg_lite_error_t status code)*

Syntax:

```
vg_lite_error_t vg_lite_append_path (
    vg_lite_path_t              *path
    vg_lite_uint8_t             *opcode,
    vg_lite_pointer             data,
    vg_lite_uint32_t             seg_count
```

(continues on next page)

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```
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t structure with the path definition.
*opcode	Pointer to the opcode array to use to construct the path. *(*opcode from March 2023)*
data	Pointer to the coordinate data array to use to construct the path
seg__count	The opcode count

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Vector path functions

vg_lite_init_path function

Description:

This function initializes a path definition with specified values. *(From Dec 2019 returns vg_lite_error_t, previous was void.)*

Syntax:

```
vg_lite_error_t vg_lite_init_path (
    vg_lite_path_t              *path,
    vg_lite_format_t             format,
    vg_lite_quality_t           quality,
    vg_lite_uint32_t            length,
    vg_lite_pointer             *data,
    vg_lite_float_t             min_x,
    vg_lite_float_t             min_y,
    vg_lite_float_t             max_x,
    vg_lite_float_t             max_y
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t structure for the path object to be initialized with the member values specified.
format	The coordinate data format. All formats available in the vg_lite_format_t enum are valid formats for this function.
quality	The quality for the path object. All formats available in the vg_lite_quality_t enum are valid formats for this function.
length	The length of the path data (in bytes)
*data	Pointer to path data
min_x min_y max_x max_y	Minimum and maximum x and y values specifying the bounding box of the path

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Vector path functions

vg_lite_init_arc_path **function** **Description:**

This function initializes an arc path definition with specified values. *(from February 2021)*

Syntax:

```
vg_lite_error_t vg_lite_init_arc_path (
    vg_lite_path_t              *path,
    vg_lite_format_t             format,
    vg_lite_quality_t           quality,
    vg_lite_uint32_t            length,
    vg_lite_pointer             *data,
    vg_lite_float_t             min_x,
    vg_lite_float_t             min_y,
    vg_lite_float_t             max_x,
    vg_lite_float_t             max_y
);
```

Parameters:

Parameter	Function
*path	Pointer to the vg_lite_path_t structure for the path object to be initialized with the member values specified.
format	The coordinate data format. The vg_lite_format_t enum value should be FP32.
quality	The quality for the path object. All formats available in the vg_lite_quality_t enum are valid formats for this function.
length	The length of the path data (in bytes).
*data	Pointer to path data.
min_x min_y max_x max_y	Minimum and maximum x and y values specifying the bounding box of the path.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Vector path functions

vg_lite_upload_path **function** **Description:**

This function is used to upload a path to GPU memory.

In normal cases, the VGLite driver will copy any path data into a command buffer structure during runtime. This does take some time if there are many paths to be rendered. Also, in an embedded system the path data won't change - so it makes sense to upload the path data into GPU memory in such a form that the GPU can directly access it. This function will signal the driver to allocate a buffer that will contain the path data and the required command buffer header and footer data for the GPU to access the data directly. Call vg_lite_clear_path to free this buffer after the path is used.

Syntax:

```
vg_lite_error_t vg_lite_upload_path (
    vg_lite_path_t              *path
);
```

Parameters:

Parameter	Description
*path	Pointer to a vg_lite_path_t structure that contains the path to be uploaded.

Returns:

VG_LITE_OUT_OF_MEMORY if not enough GPU memory is available for buffer allocation.

Parent topic: Vector path functions

vg_lite_clear_path **function** **Description:**

This function will clear and reset path member values. If the path has been uploaded, it frees the GPU memory allocated when uploading the path. *(From Dec 2019 returns vg_lite_error_t, previous was void.)*

.

Syntax:

```
vg_lite_error_t vg_lite_clear_path (
    vg_lite_path_t              *path
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t path definition to be cleared.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Vector path functions

Parent topic:*Vector path control*

Vector path opcodes for plotting paths The following opcodes are path drawing commands available for vector path data.

A path operation is submitted to the GPU as [Opcode | Coordinates]. The operation code is stored as a VG_LITE_S8 while the coordinates are specified via vg_lite_format_t.

Op-code	Arguments	Description
0x00	None	**VLC_OP_END**. Finish tessellation. Close any open path.
0x01	None	**VLC_OP_CLOSE**. For VGLite driver internal use only. Application should not use this OP directly.
0x02	(x, y)	**VLC_OP_MOVE**. Move to the given vertex. Close any open path. $start_x = x$ $start_y = y$
0x03	(□x, □y)	**VLC_OP_MOVE_REL**. Move to the given relative point. Close any open path. $start_x = start_x + \Delta x$ $start_y = start_y + \Delta y$
0x04	(x, y)	**VLC_OP_LINE**. Draw a line to the given point. $Line(start_x, start_y, x, y)$ $start_x = x$ $start_y = y$
0x05	(□x, □y)	**VLC_OP_LINE_REL**. Draw a line to the given relative point. $x = start_x + \Delta x$ $y = start_y + \Delta y$ $Line(start_x, start_y, x, y)$ $start_x = x$ $start_y = y$
0x06	(cx, cy) (x, y)	**VLC_OP_QUAD**. Draw a quadratic Bezier curve to the given end point using the specified control point. $Quad(start_x, start_y, cx, cy, x, y)$ $start_x = x$ $start_y = y$
0x07	(□cx, □cy) (□x, □y)	**VLC_OP_QUAD_REL**. Draw a quadratic Bezier curve to the given relative end point using the specified relative control point. $cx = start_x + \Delta cx$ $cy = start_y + \Delta cy$ $x = start_x + \Delta x$ $y = start_y + \Delta y$ $Quad(start_x, start_y, cx, cy, x, y)$ $start_x = x$ $start_y = y$
		VLC_OP_CUBIC. Draw a cubic Bezier curve to the given end point using the specified control points. $Cubic(start_x, start_y, cx_1, cy_1, cx_2, cy_2, x, y)$ $start_x = x$

Parent topic:*Vector path control*

Vector-dased draw operations This part of the API performs the hardware accelerated draw operations.

Draw and gradient enumerations This section provides an overview of draw and gradient enumerations.

vg_lite_blend_t **enumeration** This enumeration is defined under the “Blit enumerations” section (see vg_lite_blend_t enumeration).

Parent topic: Draw and gradient enumerations

vg_lite_color_t **parameter** The common parameter vg_lite_color_t is described in Common parameter types.

Parent topic: Draw and gradient enumerations

vg_lite_fill_t **enumeration** This enumeration is used to specify the fill rule to use. For drawing any path, the hardware supports both non-zero and odd-even fill rules.

To determine whether any point is contained inside an object, imagine drawing a line from that point out to infinity in any direction such that the line does not cross any vertex of the path. For each edge that is crossed by the line, add 1 to the counter if the edge is crossed from left to right, as seen by an observer walking across the line towards infinity, and subtract 1 if the edge crossed from right to left. In this way, each region of the plane will receive an integer value.

The non-zero fill rule says that a point is inside the shape if the resulting sum is not equal to zero. The even/odd rule says that a point is inside the shape if the resulting sum is odd, regardless of sign.

Used in function: vg_lite_render_masklayer.

Used in draw functions: vg_lite_draw, vg_lite_draw_grad, vg_lite_draw_radial_grad, vg_lite_draw_pattern.

vg_lite_fill_t string values	Description
VG_LITE_FILL_NON_ZEI	Non-zero fill rule. A pixel is drawn if it crosses at least one path pixel.
VG_LITE_FILL_EVEN_OI	Even-odd fill rule. A pixel is drawn if it crosses an odd number of path pixels.

Parent topic: Draw and gradient enumerations

vg_lite_filter_t **enumeration** This enum is defined under the “Blit enumerations” section (see vg_lite_filter_t enumeration).

Parent topic: Draw and gradient enumerations

vg_lite_gradient_spreadmode_t **enumeration** vg_lite_gradient_spreadmode_t enum is defined to match OpenVG enum VGColorRampSpreadMode *(from March 2023, replaces*vg_lite_radial_gradient_spreadmode*, requires GC355/GC555 hardware)*

The application may only define stops with offsets between 0 and 1. Spread modes define how the given set of stops are repeated or extended in order to define interpolated color values for arbitrary input values outside the [0,1] range.

Used in structure: vg_lite_radial_gradient_t.

vg_lite_gradient_spreadı String Values	Description
VG_LITE_GRADIENT_S	The current fill color is used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_GRADIENT_S	Colors defined at 0 and 1 are used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_GRADIENT_S	Color values defined between 0 and 1 are repeated indefinitely in both directions.
VG_LITE_GRADIENT_S	Color values defined between 0 and 1 are repeated indefinitely in both directions but with alternate copies of the range reversed.

Parent topic: Draw and gradient enumerations

vg_lite_pattern_mode_t **enumeration** Defines how the region outside the image pattern is filled for the path.

Used in function: vg_lite_draw_gradient, vg_lite_draw_pattern.

vg_lite_pattern_ string values	Description
VG_LITE_PAT	Pixels outside the bounds of the source image should be taken as the color.
VG_LITE_PAT	Pixels outside the bounds of the source image should be taken as having the same color as the closest edge pixel. The color of the pattern border is expanded to fill the region outside the pattern.
VG_LITE_PAT	Pixels outside the bounds of the source image should be repeated indefinitely in all directions. *(from March 2023)*
VG_LITE_PAT	Pixels outside the bounds of the source image should be reflected indefinitely in all directions. *(from March 2023)*

Parent topic: Draw and gradient enumerations

vg_lite_radial_gradient_spreadmode_t **enumeration** *(Deprecated March 2023)* use vg_lite_gradient_spreadmode_t. Defines the radial gradient padding mode. *(from Nov 2020, requires GC355 hardware)*

Used in structure: vg_lite_radial_gradient_t.

vg_lite_radial_gradient_sprea String Values	Description
VG_LITE_RADIAL_GRADI = 0	The current fill color is used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_RADIAL_GRADI	Colors defined at 0 and 1 are used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_RADIAL_GRADI	Color values defined between 0 and 1 are repeated indefinitely in both directions.
VG_LITE_RADIAL_GRADI	Color values defined between 0 and 1 are repeated indefinitely in both directions but with alternate copies of the range reversed.

Parent topic: Draw and gradient enumerations

Parent topic:*Vector-dased draw operations*

Draw and gradient structures This section provides an overview of the draw and gradient structures.

vg_lite_buffer_t **structure** This structure is defined under the “Pixel buffer structures” section (see vg_lite_buffer_t structure).

Parent topic: Draw and gradient structures

vg_lite_color_ramp_t **structure** This structure defines the stops for the radial gradient. The five parameters provide the offset and color for the stop. Each stop is defined by a set of floating point values which specify the offset and the sRGBA color and alpha values. Color channel values are in the form of a non-premultiplied (R, G, B, alpha) quad. All parameters are in the range of [0,1]. The red, green, blue, alpha value of [0, 1] is mapped to an 8-bit pixel value [0, 255].*(from November 2020, requires GC355 hardware)*

The define for the max number of radial gradient stops is #define MAX_COLOR_RAMP_STOPS256.

Used in radial gradient structure: vg_lite_radial_gradient_t.

vg_lite_color_ramp_t mem-bers	Type	Description
stop	vg_lite_float_t	Offset value for the color stop
red	vg_lite_float_t	Red color channel value for the color stop
green	vg_lite_float_t	Green color channel value for the color stop
blue	vg_lite_float_t	Blue color channel value for the color stop
alpha	vg_lite_float_t	Alpha color channel value for the color stop

Parent topic: Draw and gradient structures

vg_lite_linear_gradient_t **structure** This structure defines the organization of a linear gradient in VGLite data. The linear gradient is applied to filling a path. It generates a 256x1 image according to the specified settings.

Used in init and draw functions: vg_lite_init_grad, vg_lite_set_grad, vg_lite_update_grad, vg_lite_get_grad_matrix, vg_lite_clear_grad, vg_lite_draw_grad.

vg_lite_linear_gradient_t constants	Type	Description
VLC_MAX_GRADIENT_STOP	vg_lite_int32_	Constant. Maximum number of gradient colors = 16.
vg_lite_linear_gradient_t members		
colors [VLC_MAX_GRADIENT_STOF	vg_lite_uint32	Color array for the gradient
count	vg_lite_uint32	Number of colors
stops [VLC_MAX_GRADIENT_STOF	vg_lite_uint32	Number of color stops, from 0 to 255
matrix	vg_lite_matrix	Struct for the matrix to transform the gradient color ramp
image	vg_lite_buffer_	Image object struct to represent the color ramp

Parent topic: Draw and gradient structures

vg_lite_ext_linear_gradient **structure** This structure defines the organization of the extended parameters possible for a linear gradient *(from April 2022)*.

Used in functions: vg_lite_draw_linear_grad.

vg_lite_ext_linear_gradient members	Type	Description
count	vg_lite_uint32_t	Count of colors, up to 256.
matrix	vg_lite_matrix_t	The matrix to transform the gradient.
image	vg_lite_buffer_t	The image for rendering as gradient pattern.
linear_grad	vg_lite_linear_gra	Linear gradient parameters. Includes center point, focal point and radius.
ramp_length	vg_lite_uint32_t	Color ramp length for gradient paints provided to the driver.
color_ramp[VLC_MAX_C(	vg_lite_color_ram	Color ramp parameter for gradient paints provided to the driver.
converted_length	vg_lite_uint32_t	Converted internal color ramp length.
converted_ramp[VLC_MAX_(	vg_lite_color_ram	Converted internal color ramp.
pre-multiplied	vg_lite_uint8_t	If this value is set to 1, the color value of color_ramp will be multiplied by the alpha value of color_ramp.
spread_mode	vg_lite_radial_gra	The spread mode that is applied to the pixels out of the image after transformed.

|

Parent topic: Draw and gradient structures

vg_lite_linear_gradient_parameter **structure** This structure defines a radial direction for a linear gradient. *(from April 2022)*

Line0 connects point (X0, Y0) to point (X1, Y1) and represents the radial direction of the linear gradient.

Line1 is a line perpendicular to line0 which passes through point (X0, Y0).

Line2 is a line perpendicular to line0 which passes through point (X1, Y1)

The linear gradient paint is applied at the intersection of the path fill area and the plane starting from line 1 and ending at line 2.

Used in structure: vg_lite_ext_linear_gradient.

Used in functions: vg_lite_set_linear_grad.

vg_lite_linear_gradient_parameter_t members	Type	Description
X0	vg_lite_float_	X origin of linear gradient radial direction.
Y0	vg_lite_float_	Y origin of linear gradient radial direction.
X1	vg_lite_float_	X end point of linear gradient radial direction.
Y1	vg_lite_float_	Y end point of linear gradient radial direction.

Parent topic: Draw and gradient structures

vg_lite_matrix_t **structure** This structure is defined under the “Matrix control structures” section (see vg_lite_matrix_t structure).

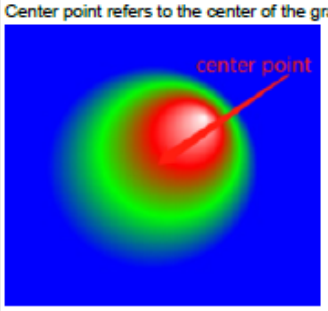
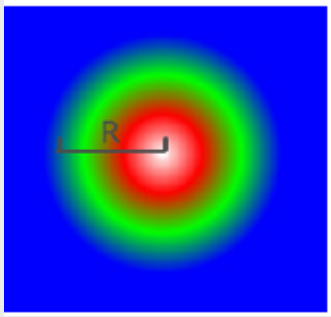
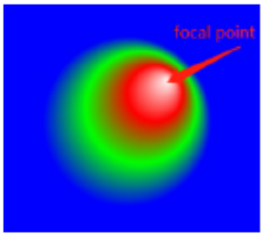
Parent topic: Draw and gradient structures

vg_lite_path_t **structure** This structure is defined under the “Vector path structures” section (see vg_lite_path_t structure).

Parent topic: Draw and gradient structures

vg_lite_radial_gradient_parameter_t **structure** This structure defines the gradient radius and the X and Y coordinates for the center and focal points of the gradient *(from November 2020, requires GC355 or GC555 hardware)*.

Used in radial gradient structure: vg_lite_radial_gradient_t.

vg_lite_radial_gradient_parameter_t member	Type	Description
cx	vg_lite_float_t	Coordinates x and y of the gradient color center point. Center point refers to the center of the gradient color. 
cy	vg_lite_float_t	
r	vg_lite_float_t	Radius of the gradient 
fx	vg_lite_float_t	Coordinates x and y of the gradient color focal point. Focal point refers to the center of the gradient color. 
fy	vg_lite_float_t	

Parent topic: Draw and gradient structures

vg_lite_radial_gradient_t **structure** This structure defines the application of the radial gradient to fill a path. *(from November 2020, requires GC355 or GC555 hardware).*

Used in radial gradient functions: vg_lite_draw_grad, vg_lite_set_radial_grad, vg_lite_update_radial_grad, vg_lite_get_radial_grad, vg_lite_clear_radial_grad.

vg_lite_radial_gradient_t member	Type	Description
count	vg_lite_uint32_t	Count of colors, up to 256
matrix	vg_lite_matrix_t	Structure that specifies the transform matrix for the gradient
image	vg_lite_buffer_t	Structure that specifies the image for rendering as a gradient pattern
radial_grad	vg_lite_radial_gra	Structure that specifies the location of the gradient's center point (cx, cy), focal point(fx, fy) and radius(r)
ramp_length	vg_lite_uint32_t	Color ramp parameters for gradient paints provided to the driver
color_ramp[VLC_MAX_C	vg_lite_color_ram	Structure that specifies the color ramp
converted_length	vg_lite_uint32_t	Converted internal color ramp.
converted_ramp[VLC_MAX_(	vg_lite_color_ram	Structure that specifies the internal color ramp
pre_multiplied	vg_lite_uint32_t	If this value is set to 1, the color value of color_ramp will be multiplied by the alpha value of color_ramp.
spread_mode	vg_lite_radial_gra	Enum that specifies the tiling mode, which is applied to the pixels out of the image after transformation

Parent topic: Draw and gradient structures

Parent topic:*Vector-dased draw operations*

Draw functions This section provides an overview of the draw functions.

vg_lite_draw **function** **Description:**

This function performs a hardware accelerated 2D vector draw operation.

The size of the tessellation buffer can be specified at initialization and it is aligned with the minimum hardware alignment requirements of the kernel. Specifying a smaller size for tessellation buffer allocates less memory but reduces performance. Because the hardware walks the target with the provided tessellation window size, a path may be sent to the hardware multiple times. It is a good practice to set the tessellation buffer size to the most common path size. For example, if all you do is render up to 24-point fonts, you can set the tessellation buffer to 24x24.

Note:

- All the color formats available in the vg_lite_buffer_format_t enum are supported as the destination buffer for the draw function
- The hardware does not support strokes; they must be converted to paths before you use them in the draw API

Syntax:

```
vg_lite_error_t vg_lite_draw (
    vg_lite_buffer_t      *target,
    vg_lite_path_t        *path,
    vg_lite_fill_t        fill_rule,
    vg_lite_matrix_t      *matrix,
    vg_lite_blend_t       blend,
    vg_lite_color_t       color
);
```

Parameters:

Parameter	Description
*target	Pointer to the vg_lite_buffer_t structure for the destination buffer. All color formats available in the vg_lite_buffer_format_t enum are valid destination formats for the draw function.
*path	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw. See opcode details in Vector path opcodes for plotting paths.
fill_r	Specifies the vg_lite_fill_t enum value for the fill rule for the path
*matrix	Pointer to a vg_lite_matrix_t structure that defines the *affine* transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed. **Note:** Non-affine transformations are not supported by vg_lite_draw; therefore, a perspective transformation matrix might have unexpected effects on path rendering.
blend	Select one of the hardware-supported blend modes in the vg_lite_blend_t enum to be applied to each drawn pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0).
color	The color applied to each pixel drawn by the path.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Draw functions

vg_lite_draw_grad function **Description:**

This function is used to fill a path with a linear gradient according to the specified fill rules. The specified path is transformed according to the selected matrix and is filled with the specified color gradient.

Syntax:

```
vg_lite_error_t vg_lite_draw_grad (
    vg_lite_buffer_t            *target,
    vg_lite_path_t              *path,
    vg_lite_fill_t              fill_rule,
    vg_lite_matrix_t            *matrix,
    vg_lite_linear_gradient_t   *grad,
    vg_lite_blend_t             blend
);
```

Parameters:

Parameter	Description
*target	Pointer to the vg_lite_buffer_t structure containing data describing the target path.
*path	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw and fill with the linear gradient. See opcode details in Vector path opcodes for plotting paths.
fill_ru	Specifies the vg_lite_fill_t enum value for the fill rule for the path
*matrix	Pointer to the vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, this option is not preferable.
*grad	Pointer to the vg_lite_linear_gradient_t structure that contains the values to be used to fill the path.
blend	Specifies the blend mode in the vg_lite_blend_t enum to be applied to each drawn pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0).

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Draw functions

vg_lite_draw_radial_grad function **Description:**

This function is used to fill a path with a radial gradient according to the specified fill rules. The specified path is transformed according to the selected matrix and is filled with the radial color gradient. The application can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_RADIAL_GRADIENT) to determine HW support for radial gradient.

Syntax:

```
vg_lite_error_t vg_lite_draw_radial_grad (
    vg_lite_buffer_t            *target,
    vg_lite_path_t              *path,
    vg_lite_fill_t              fill_rule,
    vg_lite_matrix_t            *path_matrix,
    vg_lite_radial_gradient_t   *grad,
    vg_lite_color_t             paint_color,
    vg_lite_blend_t             blend,
    vg_lite_filter_t            filter
);
```

Parameters:

Parameter	Description
*target	Pointer to the vg_lite_buffer_t structure containing data describing the target path.
*path	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw for and fill with the radial gradient. See opcode details in Vector path opcodes for plotting paths.
fill_r	Specifies the vg_lite_fill_t enum value for the fill rule for the path
*path	Pointer to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, his option is not preferable.
*grad	Pointer to the vg_lite_radial_gradient_t structure that contains the values to be used to fill the path. **Note:** grad->image.image_mode does not support VG_LITE_MULTIPLY_IMAGE_MODE .
paint_	Specifies the paint color vg_lite_color_t RGBA value to be applied by VG_LITE_RADIAL_GRADIENT_SPREAD_FILL set by the function vg_lite_set_radial_grad. When pixels are out of the image after transformation, paint_color is applied to them. For details, see vg_lite_radial_gradient_spreadmode_t.
blend	Specifies the blend mode in the vg_lite_blend_t enum to be applied to each drawn pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0).
filter	Specified the filter mode vg_lite_filter_t enum value to be applied to each drawn pixel. If no filtering is required, set this value to VG_LITE_BLEND_POINT (0).

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Draw functions

vg_lite_draw_pattern **function** **Description:**

This function fills a path with an image pattern. The path is transformed according to the specified matrix and is filled with the transformed image pattern.

Syntax:

```
vg_lite_error_t vg_lite_draw_pattern (
    vg_lite_buffer_t            *target,
    vg_lite_path_t              *path,
    vg_lite_fill_t              fill_rule,
    vg_lite_matrix_t            *path_matrix,
    vg_lite_buffer_t            *pattern_image,
    vg_lite_matrix_t            *pattern_matrix,
    vg_lite_blend_t             blend,
    vg_lite_pattern_mode_t      pattern_mode,
    vg_lite_color_t             pattern_color,
    vg_lite_color_t             color,
    vg_lite_filter_t            filter
);
```

Parameters:

Parameter	Description
*target	Pointer to the vg_lite_buffer_t structure for the destination buffer. All color formats available in the vg_lite_buffer_format_t enum are valid destination formats for this draw function.
*path	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw. See opcode details in Vector path opcodes for plotting paths
fill_r	Specifies the vg_lite_fill_t enum value for the fill rule for the path.
*path	Pointer to the vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the source pixels into the target. If the matrix is NULL, an identity matrix is assumed, meaning the source is copied directly onto the target at 0,0 location.
*pattern_	Pointer to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed.
*pattern_	Pointer to the vg_lite_buffer_t structure that describes the source of the image pattern
	Pointer to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the source pixels into the target. If the matrix is NULL, an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blend	Specifies one of the vg_lite_blend_t enum values for hardware-supported blend modes to be applied to each drawn pixel in the image. If no blending is required, set this value to VG_LITE_BLEND_NONE (0).
pattern_	Specifies the vg_lite_pattern_mode_t value that defines how the region outside the image pattern is to be filled.
pattern_	Specifies a 32bpp ARGB color (vg_lite_color_t) to be applied to the fill outside the image pattern area when the pattern_mode value is VG_LITE_PATTERN_COLOR. *(from Dec 2019, type now vg_lite_color_t, previously was uint32_t)*
color	Specifies a 32bpp ARGB color (vg_lite_color_t) to be applied as a mix color. If non-zero, the mix color value gets multiplied with each source pixel before blending happens. If a mix color is not needed, set the color parameter to 0 *(from May 2023)*. **Note:** This parameter has no effect if the pattern image vg_lite_buffer_t structure member image_mode is set to VG_LITE_ZERO or VG_LITE_NORMAL_IMAGE_MODE.
filter	Specifies the filter type. All formats available in the vg_lite_filter_t enum are valid formats for this function. A value of zero (0) indicates VG_LITE_FILTER_POINT.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Draw functions

Parent topic:*Vector-dased draw operations*

Linear gradient initialization and control functions This part of the API performs linear gradient operations.

A color gradient (color progression, color ramp) is a smooth transition between a set of colors (color stops) that is done along a line (linear, or axial color gradient) or radially, along concentric circles (radial color gradient). The color transition is done by linear interpolation between two consecutive color stops.

Note: VGLite supports linear color gradients for GCNanoLiteV and GCNanoUltraV. Both linear and radial gradients are supported with GC355 and GC555.

vg_lite_init_grad **function** **Description:**

This function initializes the internal buffer for the linear gradient object with default settings for rendering.

Syntax:

```
vg_lite_error_t vg_lite_init_grad (
      vg_lite_linear_gradient_t *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_t structure, which defines the gradient to be initialized. Default values are used.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient initialization and control functions

vg_lite_clear_grad **function** **Description:**

This function is used to clear the values of a linear gradient object and free up the memory of the image buffer.

Syntax:

```
vg_lite_error_t vg_lite_clear_grad (
      vg_lite_linear_gradient_t       *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_t structure that is to be cleared

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient initialization and control functions

vg_lite_set_grad **function** **Description:**

This function is used to set values for the members of the vg_lite_linear_gradient_t structure.

Note: The vg_lite_set_grad API adopts the following rules to set the default gradient colors if the input parameters are incomplete or invalid:

- If no valid stops have been specified (for example, due to an empty input array, out-of-range or out-of-order stops), a stop at 0 with (R, G, B, A) color (0.0, 0.0, 0.0, 1.0) (opaque black) and a stop at 1 with color (1.0, 1.0, 1.0, 1.0) (opaque white) are implicitly defined
- If at least one valid stop has been specified, but none has been defined with an offset of 0, then an implicit stop is added with an offset of 0 and the same color as the first user-defined stop

- If at least one valid stop has been specified, but none has been defined with an offset of 1, then an implicit stop is added with an offset of 1 and the same color as the last user-defined stop

Syntax:

```
vg_lite_error_t vg_lite_set_grad (
      vg_lite_linear_gradient_t       *grad,
      uint32_t                        count,
      uint32_t                        *colors,
      uint32_t                        *stops
     );
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_t structure to be set
count	The number of colors in the linear gradient. The maximum color stop count is defined by VLC_MAX_GRAD which is 16.
*colors	Specifies the color array for the gradient stops. The color is in ARGB8888 format with alpha in the upper byte.
*stops	Pointer to the gradient stop offset

Returns:

Always returns VG_LITE_SUCCESS.

Parent topic: Linear gradient initialization and control functions

vg_lite_get_grad_matrix **function** **Description:**

This function is used to get a pointer to the transformation matrix of the gradient object. It allows an application to manipulate the matrix to facilitate correct rendering of the gradient path.

Syntax:

```
vg_lite_error_t vg_lite_get_grad_matrix (
      vg_lite_linear_gradient_t       *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_t structure, which contains the matrix to be retrieved

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient initialization and control functions

vg_lite_update_grad **function** **Description:**

This function is used to update or generate values for an image object that is going to be rendered. The vg_lite_linear_gradient_t object has an image buffer, which is used to render the gradient pattern. The image buffer is created or updated with the corresponding gradient parameters.

Syntax:

```
vg_lite_error_t vg_lite_update_grad (
      vg_lite_linear_gradient_t     *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_t structure, which contains the update values to be used for the object to be rendered

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient initialization and control functions

Parent topic:*Vector-dased draw operations*

Linear gradient extended functions The following functions are available only with IP that includes hardware support for extended linear gradient capabilities, such as GC355 and GC555. These functions are not available with GCNanoLiteV, GCNanoUltraV, or GCNanoV. Applications can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_LINEAR_GRADIENT_EXT) to determine HW support for linear gradient.

vg_lite_set_linear_grad **function** **Description:**

This function is used to set the values that define the linear gradient. *(from April 2022)*

Syntax:

```
vg_lite_error_t vg_lite_set_linear_grad (
    vg_lite_ext_linear_gradient_t          *grad,
    vg_lite_uint32_t                       count,
    vg_lite_color_ramp_t                   *color_ramp,
    vg_lite_linear_gradient_parameter_t    grad_param,
    vg_lite_radial_gradient_spreadmode_t   spread_mode,
    vg_lite_uint8_t                        pre_mult
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_ext_linear_gradient_t structure that is to be set.
count	Count of the colors in the gradient. The maximum color stop count is defined by MAX_COLOR_RAMP_STOPS, which is set to 256.
*color_ramp	It is the array of stops for the linear gradient. The number of parameters for each stop is 5, and gives the offset and color of the stop. Each stop is defined by a floating-point *offset* value and four floating-point values containing the sRGBA color and alpha value associated with each stop, in the form of a non-premultiplied (R, G, B, alpha) quad. The range of all parameters is [0,1].
grad_	Gradient parameters as specified in the structure vg_lite_linear_gradient_parameter_t.
spread	The fill mode is applied to the pixels out of the paint after transformation. Uses the same spread mode enumeration types as radial gradient. For details, see vg_lite_radial_gradient_spreadmode_t enum.
pre_	This parameter controls whether color and alpha values are interpolated in premultiplied or non-premultiplied form.

Returns:

Returns VG_LITE_INVALID_ARGUMENTS to indicate the parameters are wrong.

Parent topic: Linear gradient extended functions

vg_lite_get_linear_grad_matrix **function** **Description:**

This function returns a pointer to an extended linear gradient object's matrix.*(from March 2023)*.

Syntax:

```
vg_lite_matrix_t* vg_lite_get_linear_grad_matrix (
    vg_lite_ext_linear_gradient_t   *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_ext_linear_gradient_t structure.

Returns:

Returns a pointer to vg_lite_matrix_t for the specified extended linear gradient.

Parent topic: Linear gradient extended functions

vg_lite_draw_linear_grad **function** **Description:**

This function returns a pointer to an extended linear gradient object's matrix.*(from March 2023)*.

Syntax:

```
vg_lite_error_t vg_lite_draw_linear_grad (
    vg_lite_buffer_t              *target,
    vg_lite_path_t                *path,
    vg_lite_fill_t               fill_rule,
```

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```
    vg_lite_matrix_t                *path_matrix,
    vg_lite_ext_linear_gradient_t   *grad,
    vg_lite_color_t                 paint_color,
    vg_lite_blend_t                 blend,
    vg_lite_filter_t                filter
);
```

Parameters:

Parameter	Description
*target	Pointer to the vg_lite_buffer_t structure containing data describing the target path.
*path	Pointer to the vg_lite_path_t structure containing path data that describes the path to draw for the linear gradient. Refer to Vector path opcodes for plotting paths in this document for opcode detail.
fill_r	Specifies the vg_lite_fill_t enum value for the fill rule for the path.
*path	Pointer to a vg_lite_matrix_t structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, this option is not preferable.
*grad	Pointer to the vg_lite_ext_linear_gradient_t structure that contains the values to be used to fill the path. **Note:** grad->image.image_mode does not support VG_LITE_MULTIPLY_IMAGE_MODE.
paint	Specifies the paint color vg_lite_color_t RGBA value to be applied by VG_LITE_RADIAL_GRADIENT_SPREAD_FILL, set by function vg_lite_set_linear_grad. When pixels are out of the image after transformation, this paint_color is applied to them. For details, see enum vg_lite_radial_gradient_spreadmode_t.
blend	Specifies blend mode in the vg_lite_blend_t enum to be applied to each drawn pixel. If no blending is required, set this value to VG_LITE_BLEND_NONE (0).
filter	Specified the filter mode vg_lite_filter_t enum value to be applied to each drawn pixel. If no filtering is required, set this value to VG_LITE_BLEND_POINT (0).

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient extended functions

vg_lite_update_linear_grad **function** **Description:**

This function is used to update or generate the corresponding image object to render *(from April 2022)*.

The vg_lite_ext_linear_gradient_t object has an image buffer that is used to render the linear gradient paint. The image buffer is created/updated according to the specified grad parameters.

Syntax:

```
vg_lite_error_t vg_lite_update_linear_grad (
    vg_lite_ext_linear_gradient_t   *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_ext_t structure that is to be updated or created.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient extended functions

vg_lite_clear_linear_grad **function** **Description:**

This function is used to clear the linear gradient object. This resets the grad members and free the image buffer's memory *(from April 2022)*.

Syntax:

```
vg_lite_error_t vg_lite_clear_linear_grad (
    vg_lite_ext_linear_gradient_t     *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_linear_gradient_ext_t structure that is to be cleared.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Linear gradient extended functions

Parent topic:*Vector-dased draw operations*

Radial gradient functions initialization and control functions The following functions are available only with IP that supports radial gradients, such as GC355 and GC555. These functions are not available with GCNanoLiteV, or GCNanoUltraV or GCNanoV.

Note: There is no init function required for radial gradients. Buffer initialization is done through the vg_lite_update_radial_grad function. *(from Nov 2020, requires GC355 or GC555 hardware)*

vg_lite_set_radial_grad function **Description:**

This function is used to set the values for the radial linear gradient definition. *(from November 2020, requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_radial_grad (
    vg_lite_radial_gradient_t              *grad,
    vg_lite_uint32_t                       count,
    vg_lite_color_ramp_t                   *color_ramp,
    vg_lite_radial_gradient_parameter_t    grad_param,
    vg_lite_radial_gradient_spreadmode_t   spread_mode,
    vg_lite_uint8_t                        pre_mult
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure for the radial gradient that has to be set
count	The number of color stops in the gradient. The maximum color stop count is defined by MAX_COLOR_RAMP_STOPS, which is currently 256.
*colorramp	Pointer to the vg_lite_color_ramp_t structure that defines the stops for the radial gradient. The five parameters provide the offset and color for each stop. Each stop is defined by a set of floating point values that specify the offset and the sRGBA color and alpha values. Color channel values are in the form of a non-premultiplied (R, G, B, alpha) quad. All parameters are in the range of [0,1]. The red, green, blue, alpha value of [0, 1] is mapped to an 8-bit pixel value [0, 255].
gradient	The radial gradient parameters are supplied as a vector of 5 floats. Parameters (cx, cy) specify the center point, parameters (fx, fy) specify the focal point, and r specifies the radius. See structure vg_lite_radial_gradient_parameter_t.
spread	The tiling mode that is applied to pixels out of the paint after transformation. See enum vg_lite_radial_gradient_spreadmode_t.
pre_multiply	Controls whether color and alpha values are interpolated in premultiplied or non-premultiplied form. If this value is set to 1, the color value of vgColorRamp is multipled by the alpha value of vgColorRamp.

Returns:

Returns VG_LITE_INVALID_ARGUMENTS to indicate that the parameters are wrong.

Parent topic: Radial gradient functions initialization and control functions

vg_lite_update_radial_grad function Description:

This function is used to update or generate values for an image object that is going to be rendered. The vg_lite_radial_gradient_t object has an image buffer that is used to render the gradient pattern. The image buffer will be created or updated with the corresponding gradient parameters. *(from November 2020, requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_update_radial_grad (
    vg_lite_radial_gradient_t    *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure, which contains the updated values to be used for the object to be rendered

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Radial gradient functions initialization and control functions

vg_lite_get_radial_grad_matrix **function** **Description:**

This function is used to get a pointer to the radial gradient object's transformation matrix. This allows an application to manipulate the matrix to facilitate correct rendering of the gradient path*. (from Nov 2020, requires GC355 or GC555 hardware).*

Syntax:

```
vg_lite_error_t vg_lite_get_radial_grad_matrix (
    vg_lite_radial_gradient_t     *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure, which contains the matrix to be retrieved

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Radial gradient functions initialization and control functions

vg_lite_clear_rad_grad **function** **Description:**

This function is used to clear the values of a radial gradient object and free the image buffer's memory*. (from Nov 2020, requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_clear_radial_grad (
    vg_lite_radial_gradient_t    *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure which is to be cleared

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Radial gradient functions initialization and control functions

Parent topic:*Vector-dased draw operations*

Stroke operations This part of the API performs stroke operations. *(from March 2022)*

Stroke enumerations This section gives details on stroke enumerations.

vg_lite_cap_style_t **enumeration** Defines the style of cap at the end of a stroke *(from March 2022)*.

Used in structure: vg_lite_stroke_t.

Used in function: vg_lite_set_stroke.

vg_lite_cap values	Description
VG_LITE_	The *butt* end cap style terminates each segment with a line perpendicular to the tangent at each endpoint.
VG_LITE_	The *round* end cap style appends a semicircle with a diameter equal to the line width centered around each endpoint.
VG_LITE_	The *square* end cap style appends a rectangle with two sides of length equal to the line width perpendicular to the tangent, and two sides of length equal to half the line width parallel to the tangent, at each endpoint.

Parent topic: Stroke enumerations

vg_lite_path_type_t **enumeration** Defines the type of draw path *(from March 2022)*.

Used in structure: vg_lite_path_t, vg_lite_stroke_t.

Used in function: vg_lite_set_path_type.

vg_lite_path_type_t string values	Description
VG_LITE_DRAW_FILL_PATH	Draw path is fill.
VG_LITE_DRAW_STROKE_PATH	Draw path is stroke.
VG_LITE_DRAW_FILL_STROKE_PATH	Draw path is both fill and stroke.

Parent topic: Stroke enumerations

vg_lite_join_style_t **enumeration** Defines the type of styles available for line joints. *(from March 2022)*

Used in structure: vg_lite_stroke_t.

Used in function: vg_lite_set_stroke.

vg_lite_join string values	Description
VG_LITE_	The *miter* join style appends a trapezoid with one vertex at the intersection point of the two original lines, two adjacent vertices at the outer endpoints of the two "thickened" lines and a fourth vertex at the extrapolated intersection point of the outer perimeters of the two "thickened" lines.
VG_LITE_	The *round* join style appends a wedge-shaped portion of a circle, centered at the intersection point of the two original lines, having a radius equal to half the line width.
VG_LITE_	The *bevel* type join style appends a triangle with two vertices at the outer endpoints of the two "thickened" lines and a third vertex at the intersection point of the two original lines.

Parent topic: Stroke enumerations

Parent topic:*Stroke operations*

Stroke structures This section gives details on stroke structures.

vg_lite_path_t **structure** Defined under Vector Path Structures - vg_lite_path_t structure.

(additional members added for stroke from March 2022)

Parent topic: Stroke structures

vg_lite_path_list_t **structure** The structure vg_lite_path_list_ptr points to the vg_lite_path_list structure that provides divided path data according to MOVE/MOVE_REL. *(from Aug 2023)*

Used (vg_lite_path_list_ptr) in structures: vg_lite_stroke_t.

vg_lite_path_list_t members	Type	Description
path_points	vg_lite_path_point_ptr	
path_end	vg_lite_path_point_ptr	
point_count	vg_lite_uint32_t	
next	vg_lite_path_list_ptr	
closed	vg_lite_uint8_t	

Parent topic: Stroke structures

vg_lite_path_point_t **structure** The structure vg_lite_path_point_ptr points to the vg_lite_path_point structure which provides path detail *(from March 2022)*

Used (vg_lite_path_point_ptr) in structures: vg_lite_path_point_t, vg_lite_stroke_conversion. vg_lite_sub_path_t.

vg_lite_path_point_t members	Type	Description
x	vg_lite_float_t	X coordinate
y	vg_lite_float_t	Y coordinate
flatten_flag	vg_lite_uint8_t	Flatten flag for flattened path
curve_type	vg_lite_uint8_t	Curve type for the stroke path
tangentX	vg_lite_float_t	X tangent (Note: #define centerX tangent)
tangentY	vg_lite_float_t	Y tangent (Note: #define centerX tangent)
length	vg_lite_float_t	Line length
prev	vg_lite_path_point_pt	Pointer to the previous point node

Parent topic: Stroke structures

vg_lite_stroke_t **structure** The structure provides stroke parameters and pointers to temp storage for a stroke sub path. Refer to the function vg_lite_set_stroke parameter descriptions for additional description for some members. *(from March 2022)*

Used in structure: vg_lite_path_t.

vg_lite_stroke_t members	Type	Description
cap_style	vg_lite_cap_style_t	Stroke cap style
join_style	vg_lite_join_style_t	Stroke joint style
line_width	vg_lite_float_t	Stroke line width
miter_limit	vg_lite_float_t	Stroke miter limit
*dash_pattern	vg_lite_float_t	Pointer to stroke dash pattern
pattern_count	vg_lite_uint32_t	Number of dash pattern repetitions
dash_phase	vg_lite_float_t	Stroke dash phrase
dash_length	vg_lite_float_t	Stroke dash initial length
dash_index	vg_lite_uint32_t	Stroke dash initial index
half_width	vg_lite_float_t	Half line width
pattern_length	vg_lite_float_t	Total length of stroke dash patterns.
miter_square	vg_lite_float_t	For fast checking
path_points	vg_lite_path_point_ptr	Temp storage for stroke sub path
path_end	vg_lite_path_point_ptr	Temp storage for stroke sub path
point_count	unint32_t	Temp storage for stroke sub path
left_point	vg_lite_path_point_ptr	Temp storage for stroke sub path
right_pont	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_points	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_end	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_count	vg_lite_uint32_t	Temp storage for stroke sub path
path_list_divide	vg_lite_path_list_ptr	Divide stroke path according to move or move_rel for
cur_list	vg_lite_path_list_ptr	Pointer to current divided path data. *(from Aug 2023)*
add_end	vg_lite_uint8_t	Flag that adds end_path in driver *(from Aug 2023)*
dash_reset	vg_lite_uint8_t	*(from Aug 2023)*
stroke_paths	vg_lite_sub_path_ptr	
last_stroke	vg_lite_sub_path_ptr	
swing_handling	vg_lite_uint32_t	
swing_deltax	vg_lite_float_t	
swing_deltay	vg_lite_float_t	
swing_start	vg_lite_path_point_ptr	
swing_stroke	vg_lite_path_point_ptr	
swing_length	vg_lite_float_t	
swing_centlen	vg_lite_float_t	
swing_count	vg_lite_uint32_t	
need_swing	vg_lite_uint8_t	
swing_ccw	vg_lite_uint8_t	
stroke_length	vg_lite_float_t	
stroke_size	vg_lite_uint32_t	
fattened	vg_lite_uint8_t	The stroke line is a fat line.
closed	vg_lite_uint8_t	

Parent topic: Stroke structures

vg_lite_sub_path_t **structure** The structure vg_lite_sub_path_ptr points to the vg_lite_sub_path structure that provides sub path detail and a pointer to the next sub path. *(from March 2022)*

Used in structure: vg_lite_stroke_conversion.

vg_lite_path_point_t members	Type	Description
next	vg_lite_sub_path_ptr	Pointer to the next sub path
point_count	vg_lite_uint32_t	Number of points in the sub path
point_list	vg_lite_path_point_pt	Pointer to the point list.
end_point	vg_lite_path_point_pt	Pointer to the last point.
closed	vg_lite_uint8_t	Indicates whether or not the path is closed.
length	vg_lite_float_t	Length of the sub path.

Parent topic: Stroke structures

Parent topic:*Stroke operations*

Stroke functions All return vg_lite_error_t status.

vg_lite_set_path_type **function** **Description:**

This function sets the path type*. (from March 2022)*

Syntax:

```
vg_lite_error_t vg_lite_set_path_type (
    vg_lite_path_t              *path,
    vg_lite_path_type_t          path_type
);
```

Parameters:

Parameter	Description
*path	Pointer to the **vg_lite_path_t** structure that describes the vector path.
path_type	Pointer to a vg_lite_path_type_t structure that describes the path type.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Stroke functions

vg_lite_set_stroke **function** **Description:**

This function uses input parameters to set stroke attributes *(from March 2022)*.

Syntax:

```
vg_lite_error_t vg_lite_set_stroke (
    vg_lite_path_t              *path,
    vg_lite_cap_style_t          cap_style,
    vg_lite_join_style_t         join_style,
    vg_lite_float_t             line_width,
    vg_lite_float_t             miter_limit,
    vg_lite_float_t             *dash_pattern,
    vg_lite_uint32_t             pattern_count,
    vg_lite_float_t             dash_phase,
    vg_lite_color_t              color
```

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```
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t structure that describes the path.
cap_	The end cap style is defined by the vg_lite_cap_style_t enum.
join_	The line join style defined by the vg_lite_join_style_t enum.
line_	The line width of the stroke path. A line width less than or equal to 0 prevents stroking from taking place.
miter	When stroking using the Miter stroke vg_lite_join_style_t, the miter length (that is, the length between the intersection points of the inner and outer perimeters of the two "fattened" lines) is compared to the product of the user-set miter limit and the line width. If the miter length exceeds this product, the Miter join is not drawn and a Bevel join is substituted. **Note**: Miter limit values less than 1 are silently clamped to 1.
*dash	Pointer to a dash pattern that consists of a sequence of lengths of alternating "on" and "off" dash segments. The first value of the dash array defines the length, in user coordinates, of the first "on" dash segment. The second value defines the length of the following "off" segment. Each subsequent pair of values defines one "on" and one "off" segment. **Note**: If the dash pattern has an odd number of elements, the final element is ignored.
pattern_	The count of dash on/off segments.
dash_	Defines the starting point in the dash pattern that is associated with the start of the first segment of the path. For example, if the dash pattern is [10 20 30 40] and the dash phase is 35, the path is stroked with an "on" segment of length 25 (skipping the first "on" segment of length 10, the following "off" segment of length 20, and the first 5 units of the next "on" segment), followed by an "off" segment of length 40. The pattern is then repeated from the beginning, with an "on" segment of length 10, an "off" segment of length 20, an "on" segment of length 30.
color	The stroke color.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Stroke functions

vg_lite_update_stroke function Description:

This function uses the path and stroke attributes as specified with the function vg_lite_set_stroke to update the stroke path's parameters and generate stroke path data . *(from March 2022)*

Syntax:

```
vg_lite_error_t vg_lite_update_stroke (
    vg_lite_path_t              *path,
);
```

Parameters:

Parameter	Description
*path	Pointer to the **vg_lite_path_t** structure that describes the path.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic: Stroke functions

Parent topic:*Stroke operations*

Deprecated and renamed APIs The following functions are deprecated and are either obsolete or replaced by a more efficient implementation. Their use is discouraged and will produce unpredictable behaviors.

The names of some functions, enums and structures were modified during code refinements in 2022Q3. If the parameters did not change, the deprecated syntax detail is not provided below. Changes to enums and structs are not mentioned here, instead refer to the item itself.

Deprecated or renamed API	Recommended replacement API	Source file	Date deprecated
vg_lite_perspective	n/a	vg_lite.h	August 2022
vg_lite_set_dither	vg_lite_enable_dither vg_lite_disable_dither	vg_lite.h	August 2022
vg_lite_append_path	vg_lite_path_append	vg_lite.h	Sept 2022
vg_lite_path_calc_length	vg_lite_get_path_length	vg_lite.h	Sept 2022
vg_lite_set_image_global_alpha	vg_lite_set_source_global_alpha	vg_lite.h	Sept 2022
vg_lite_dest_global_alpha	vg_lite_set_dest_global_alpha	vg_lite.h	Sept 2022
vg_lite_mem_avail	vg_lite_get_mem_size	vg_lite.h	Sept 2022
vg_lite_enable_premultiply	n/a	vg_lite.h	Dec 2022
vg_lite_disable_premultiply	n/a	vg_lite.h	Dec 2022
vg_lite_set_premultiply	n/a	vg_lite.h	Aug 2023
vg_lite_radial_gradient_spreadmo enum	vg_lite_gradient_spreadmode_t enum	vg_lite.h	March 2023
API Name Refinement	***(no change to parameters)***		
vg_lite_buffer_upload	vg_lite_upload_buffer_	vg_lite.h	Sept 2022
vg_lite_*mask*	*most vg_lite_*mask_layer*	vg_lite.h	Sept 2022
vg_lite_*_grad	vg_lite_*_gradient *(parameters unchanged)*	vg_lite.h	Sept 2022
vg_lite_*_radial_grad*	vg_lite_*_rad_grad*	vg_lite.h	Sept 2022
vg_lite_buffer_image_mode_t	vg_lite_image_mode_t	vg_lite.h	Sept 2022
vg_lite_transparency_mode_t	vg_lite_transparency_t	vg_lite.h	Sept 2022
vg_lite_set_update_stroke	vg_lite_update_stroke	vg_lite.h	Sept 2022
vg_lite_set_draw_path_type	vg_lite_set_path_type	vg_lite.h	Sept 2022

Deprecated vg_lite syntax Syntax for deprecated functions is provided below for reference.

Note: This list does not include items renamed during code refinement of Sept 2022.

vg_lite_perspective ***(deprecated)*** **Syntax:**

```
void vg_lite_perspective (
    vg_lite_float_t             px,
    vg_lite_float_t             py,
    vg_lite_matrix_t            *matrix
);
```

Parent topic: Deprecated vg_lite syntax

vg_lite_set_dither ***(deprecated)*** **Syntax:**

```
vg_lite_error_t vg_lite_set_dither (
    int             enable
);
```

Parent topic: Deprecated vg_lite syntax

vg_lite_enable_premultiply ***(deprecated)*** **Syntax:**

```
vg_lite_error_t vg_lite_enable_premultiply (
    void
);
```

Parent topic: Deprecated vg_lite syntax

vg_lite_disable_premultiply ***(deprecated)*** **Syntax:**

```
vg_lite_error_t vg_lite_disable_premultiply (
    void
);
```

Parent topic: Deprecated vg_lite syntax

vg_lite_set_premultiply ***(deprecated)*** **Syntax:**

```
vg_lite_error_t vg_lite_set_premultiply (
    vg_lite_uint8_t             src_premult,
    vg_lite_uint8_t             dst_premult,
);
```

Parent topic: Deprecated vg_lite syntax

Parent topic:*Deprecated and renamed APIs*

VGLite API version 2.0 to 3.0 migration guide The VGLite API version 3.0 is not fully compatible with VGLite API version 2.0. VGLite API version 3.0 includes some new API functions for the new features in the latest VG GPU like GC555. Some VGLite API version 2.0 function interfaces are changed in API version 3.0. So, the existing VGLite API version 2.0 applications must be modified to compile and run properly with the VGLite API version 3.0 driver. This chapter provides guidance for migrating VGLite API version 2.0 applications to VGLite API version 3.0.

VGLite API name changes in API version 3.0 Some original VGLite API names are changed in API version 3.0 for API naming consistency. In the VGLite API version 3.0 header file vg_lite.h, a set of API name macros are defined for the equivalent API names between API version 3.0 and API version 2.0, so it is not necessary to modify the VGLite API function names in API version 2.0 applications for the application to compile and run with the API version 3.0 driver.

The list of equivalent VGLite API functions between API version 3.0 and API version 2.0 is shown below. These API functions' parameters are the same between API version 3.0 and API version 2.0.

```
/* API name defines for backward compatibility to VGLite 2.0 APIs */
#define vg_lite_buffer_upload                  vg_lite_upload_buffer
#define vg_lite_path_append                    vg_lite_append_path
#define vg_lite_path_calc_length               vg_lite_get_path_length
#define vg_lite_set_ts_buffer                  vg_lite_set_tess_buffer
#define vg_lite_set_draw_path_type             vg_lite_set_path_type
#define vg_lite_create_mask_layer              vg_lite_create_masklayer
#define vg_lite_fill_mask_layer                vg_lite_fill_masklayer
#define vg_lite_blend_mask_layer               vg_lite_blend_masklayer
#define vg_lite_generate_mask_layer_by_path    vg_lite_render_masklayer
#define vg_lite_set_mask_layer                 vg_lite_set_masklayer
#define vg_lite_destroy_mask_layer             vg_lite_destroy_masklayer
#define vg_lite_enable_mask                    vg_lite_enable_masklayer
#define vg_lite_enable_color_transformation    vg_lite_enable_color_transform
#define vg_lite_set_color_transformation       vg_lite_set_color_transform
#define vg_lite_set_image_global_alpha         vg_lite_source_global_alpha
#define vg_lite_set_dest_global_alpha          vg_lite_dest_global_alpha
#define vg_lite_clear_rad_grad                 vg_lite_clear_radial_grad
#define vg_lite_update_rad_grad                vg_lite_update_radial_grad
#define vg_lite_get_rad_grad_matrix            vg_lite_get_radial_grad_matrix
#define vg_lite_set_rad_grad                   vg_lite_set_radial_grad
#define vg_lite_draw_linear_gradient           vg_lite_draw_linear_grad
#define vg_lite_draw_radial_gradient           vg_lite_draw_radial_grad
#define vg_lite_draw_gradient                  vg_lite_draw_grad
#define vg_lite_mem_avail                      vg_lite_get_mem_size
#define vg_lite_set_update_stroke              vg_lite_update_stroke
```

The list of equivalent VGLite API structures and enumerations is shown below:

```
#define vg_lite_buffer_image_mode_t            vg_lite_image_mode_t
#define vg_lite_draw_path_type_t               vg_lite_path_type_t
#define vg_lite_linear_gradient_ext_t          vg_lite_ext_linear_gradient_t
#define vg_lite_buffer_transparency_mode_t     vg_lite_transparency_t
```

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

vg_lite_set_scissor API interface change The VGLite API vg_lite_set_scissor() function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the vg_lite_set_scissor() function is defined as:

```
/* Set and enable a scissor rectangle for render target. */
vg_lite_error_t vg_lite_set_scissor(vg_lite_int32_t x, vg_lite_int32_t y,
            vg_lite_int32_t right, vg_lite_int32_t bottom);
```

In VGLite API version 2.0, the vg_lite_set_scissor() function is defined as:

```
vg_lite_error_t vg_lite_set_scissor(int32_t x, int32_t y, int32_t width, int32_t height);
```

So, the vg_lite_set_scissor() API parameters "width" and "height" in the VGLite API version 2.0 application must be changed to "right" x-coordinate value and "bottom" y-coordinate value.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

vg_lite_map API interface change The VGLite API vg_lite_map() function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the vg_lite_map() function is defined as:

```
/* Map a buffer into hardware accessible address space. */
vg_lite_error_t vg_lite_map(vg_lite_buffer_t *buffer, vg_lite_map_flag_t flag, int32_t fd);
```

In VGLite API version 2.0, the vg_lite_map() function is defined as:

```
vg_lite_error_t vg_lite_map(vg_lite_buffer_t *buffer);
```

So, vg_lite_map() in VGLite API version 3.0 API requires two extra parameters “flag” and “fd”, which can simply be set as vg_lite_map (buffer, 0, 0) in applications.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

vg_lite_enable_scissor / vg_lite_disable_scissor API The VGLite API vg_lite_enable_scissor() and vg_lite_disable_scissor() functions are valid only for vg_lite_scissor_rects() API. They have no effect for vg_lite_set_scissor() in VGLite API version 3.0.

Although the behavior of vg_lite_enable_scissor() and vg_lite_disable_scissor() is changed in VGLite API version 3.0, there is no need to change these functions in VGLite API version 2.0 applications to work with the VGLite API version 3.0 driver.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

vg_lite_draw_pattern API interface change The VGLite API vg_lite_draw_pattern() function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the vg_lite_draw_pattern() function is defined as:

```
/* Draw a path that is filled by a transformed image pattern. */
vg_lite_error_t vg_lite_draw_pattern(vg_lite_buffer_t *target,
                                     vg_lite_path_t *path,
                                     vg_lite_fill_t fill_rule,
                                     vg_lite_matrix_t *path_matrix,
                                     vg_lite_buffer_t *pattern_image,
                                     vg_lite_matrix_t *pattern_matrix,
                                     vg_lite_blend_t blend,
                                     vg_lite_pattern_mode_t pattern_mode,
                                     vg_lite_color_t  pattern_color,
                                     vg_lite_color_t  color,
                                     vg_lite_filter_t filter);
```

Compared to the VGLite API version 2.0 vg_lite_draw_pattern() function, “color” is a new additional parameter. It specifies a 32bpp ARGB color (vg_lite_color_t) to be applied as a mix color. If nonzero, the mix color value gets multiplied with each source pixel before blending happens. If a mix color is not needed, set the color parameter to 0.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

[New] vg_lite_copy_image in VGLite API version 3.0 The new API vg_lite_copy_image() is added in VGLite API version 3.0 to support the OpenVG vgCopyImage API, which performs a pixel rectangle copy without pixel transformation, blending, filtering operations.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

vg_lite_set_dither API is deprecated in API version 3.0 The original API version 2.0 function vg_lite_set_dither(int enable) API is removed from API version 3.0, it is replaced with two new APIs for dither enable/disable:

```
/* Enable dither function. Dither is OFF by default. */
vg_lite_error_t vg_lite_enable_dither();
/* Disable dither function. Dither is OFF by default. */
vg_lite_error_t vg_lite_disable_dither();
```

Therefore, the vg_lite_set_dither(enable) function in the VGLite API version 2.0 application must be replaced with vg_lite_enable_dither() or vg_lite_disable_dither() to work with the VGLite API version 3.0 driver.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

Deprecated VGLite API version 2.0 functions The VGLite API vg_lite_perspective(), vg_lite_enable_premultiply(), vg_lite_disable_premultiply() functions are removed from API version 3.0. These API functions must be deleted from a VGLite API version 2.0 application to work with the VGLite API version 3.0 driver.

In VGLite API version 3.0, the color premultiply setting is defined by the vg_lite_blend_t enumeration to replace the original vg_lite_enable_premultiply() and vg_lite_disable_premultiply() APIs.

- VG_LITE_BLEND_* enumeration values in vg_lite_blend_t define non-premultiplied blending modes.
- OPEVG_BLEND_* enumeration values in vg_lite_blend_t define premultiplied Porter-Duff blending modes.

So, the VGLite API version 3.0 application can set different blending modes to get the desired premultiplied/non-premultiplied blending result.

Parent topic:*VGLite API version 2.0 to 3.0 migration guide*

Revision history

Document ID	Release date	Description
IMX Rev. 1.2	17 January 2025	The document is updated to correspond to the API version 3.0
IMX Rev. 1.1	22 September 2022	- Paragraph 4.1.1 Updated *Table 3* - *vg_lite_feature_t* enumeration. - Paragraph 6.6 Added documentation for new API *vg_lite_set_dither* - Paragraph 8.2 Blit structures- Added documentation for new data structure *vg_lite_color_key_t* -; added documentation for new data structure *vg_lite_color_key4_t* - Paragraph 8.3.1, *vg_lite_blit* function- added note related to HW limitation on RT500 platform - Paragraph 8.3.2, *vg_lite_blit_rect* function -added note related to HW limitation on RT500 platforms - Paragraph 8.3.3, *vg_lite_get_transform_matrix* function- adjusted function description, adjusted function parameters description - Paragraph 8.3, blit functions- added documentation for new API *vg_lite_set_color_key* - Paragraph 8.4.1, *vg_lite_enable_premultiply* function- added note about limited support on specific platforms - Paragraph 8.4.2, *vg_lite_disable_premultiply* function- added note about limited support on specific platforms - Paragraph 10.1.3, *vg_lite_fill_t* enumeration- added note about crossing points buffer limitation - Paragraph 10.2, draw and gradient structures- added documentation for new data structure *vg_lite_gradient_parameter_t - done*- added documentation for new data structure *vg_lite_gradient_ext_t*- Paragraph 10.3, draw functions- added documentation for new API *vg_lite_draw_linear_gradient*- Paragraph 10, vector-Based Draw Operations - added new paragraph 10.5 *Extended linear gradient initialization and control functions*; added documentation for new API *vg_lite_set_linear_gradient*; added documentation for new API *vg_lite_get_linear_grad_matrix*; added documentation for new API *vg_lite_update_linear_grad*; Added documentation for new API *vg_lite_clear_linear_grad* - Paragraph 10.5, Radial gradient functions - adjusted paragraph title - Added new Chapter *Stroke Operations* - Chapter *Platform-Specific Features* -updated *Table 41* - Platform-specific VGLite features
IMX Rev. 1	27 January 2022	*Introduction* Added i.MX RT1160 to the list of NXP devices that support VGLite graphics API vg_lite_error_t enumeration Updated Table 1 vg_lite_feature_t enumerationUpdated Table 1 *API control*
IMX Rev. 0	22 February 2021	Initial release

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3.8 Wireless

3.8.1 NXP Wireless Framework and Stacks

Wi-Fi, Bluetooth, 802.15.4

Application notes

- Link AN12918-Wi-Fi-Tx-Power-Table-and-Channel-Scan-Management-for-i.MX-RT-SDK.pdf
- Link TN00066-WFA-Derivative-Certification-Process.pdf

User manuals

- Link UM11441-Getting-Started-with-NXP-based-Wireless-Modules-and-i.MX-RT-Platforms.pdf
- UM11442-NXP-Wi-Fi-and-Bluetooth-Demo-Applications-for-i.MX-RT-Platforms.pdf
- Link UM11443-NXP-Wi-Fi-and-Bluetooth-Debug-Feature-Configuration-Guide-for-i.MX-RT-Platforms.pdf
- Link UM11567-WFA-Certification-Guide-for-NXP-based-Wireless-Modules-on-i.MX-RT-Platform-Running-RTOS.pdf

Release notes

Wireless SoC features and release notes for FreeRTOS

About this document This document provides information about the supported features, release versions, fixed and/or known issues, performance of the Wi-Fi, Bluetooth/802.15.4 radios, including the coexistence.

The SDK release version 25.06.00 has been tested for the wireless SoCs listed in Supported products.

Supported products

- 88W8987
- IW416
- IW611[1]

[1] The support of IW611 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

- IW612[2]
- AW611[3]
- RW610
- RW612

Parent topic:*About this document*

Features

Wi-Fi radio

Client mode

Features	Sub features
802.11n - High throughput	2.4 GHz band operation supported channel bandwidth: 20 M
802.11n - High throughput	2.4 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	Short/long guard interval (400 ns/800 ns)
802.11n - High throughput	Data rates up to 72 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	Data rates up to 150 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	1 spatial stream (1x1)
802.11n - High throughput	HT protection mechanisms
802.11n - High throughput	Aggregated MAC protocol data unit (AMPDU) TX and RX sup
802.11n - High throughput	Aggregated MAC service data unit (AMSDU) 4k TX and RX su
802.11n - High throughput	TX MCS rate adaptation (BGN)
802.11n - High throughput	RX low density parity check (LDPC) 1x1 20 MHz and 40 MHz
802.11n - High throughput	HT Beamformee (explicit)
802.11ac - Very high throughput	2.4 GHz band supported channel bandwidth: 20MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 80 MHz
802.11ac - Very high throughput	Data rates up to 86.7 Mbps (MCS0 to MCS 8)
802.11ac - Very high throughput	Data rates up to 433.3 Mbps (MCS 0 to MCS 9) - 1x1
802.11ac - Very high throughput	MU-MIMO Beamformee (Explicit and Implicit)
802.11ac - Very high throughput	RTS/CTS with BW signaling
802.11ac - Very high throughput	Operation mode notification
802.11ac - Very high throughput	Backward compatibility with non-VHT devices
802.11ac - Very high throughput	TX VHT MCS rate adaptation
802.11ac - Very high throughput	Low density parity check (LDPC)
802.11ax - High efficiency	2.4 GHz band supported channel bandwidth: 20MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidth: 20 MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidth: 40 MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidths: 80 MHz
802.11ax - High efficiency	OFDMA (UL/DL, 106 RU)
802.11ax - High efficiency	OFDMA (UL/DL, 484 RU)
802.11ax - High efficiency	1024 QAM
802.11ax - High efficiency	Target wake time (TWT)

[2] The support of IW612 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.
[3] AW611 module support is available only in i.MX RT1180 EVKA

Table 5 – continued from p

Features	Sub features
802.11ax - High efficiency	256 QAM modulation – MCS8 and MCS9
802.11ax - High efficiency	1024 QAM modulation – MCS10 and MCS11, 2.4 GHz
802.11ax - High efficiency	1024 QAM modulation – MCS10 and MCS11, 5 GHz
802.11ax - High efficiency	DCM
802.11ax - High efficiency	DCM
802.11ax - High efficiency	ER (extended range)
802.11ax - High efficiency	SU Beamforming
802.11ax - High efficiency	OMI (operating mode indication)
802.11a/b/g features	802.11b/g data rates up to 54 Mbit/s
802.11a/b/g features	802.11a data rates up to 54 Mbit/s
802.11a/b/g features	TX rate adaptation (BG)
802.11a/b/g features	Fragmentation/defragmentation
802.11a/b/g features	ERP protection, slot time, preamble
802.11d	802.11d - Regulatory domain/operating class/country info
802.11e QoS	EDCA [enhanced distributed channel access] / WMM (wirele
802.11i security	Opensource WPA Supplicant Support
802.11i security	WPA2-PSK AES | WPA Supplicant
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) | WPA
802.11i security	WPA2+WPA3 PSK Mixed Mode (WPA3 Transition Mode) | W
802.11i security	Wi-Fi Enhanced Open - OWE (Opportunistic Wireless Encry
802.11i security	802.1x EAP Authentication Methods | WPA Supplicant
802.11i security	WPA2-Enterprise Mixed Mode | WPA Supplicant
802.11i security	WPA3-Enterprise (Suite-B) |National Security Algorithm (CS
802.11i security	802.11w - PMF (Protected Management Frames) | WPA Supp
802.11i security	Embedded Supplicant Support
802.11i security	WPA2-PSK AES | Embedded Supplicant
802.11i security	WPA+WPA2 PSK Mixed Mode | Embedded Supplicant
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) | Embe
802.11i security	802.11w - PMF (Protected Management Frames) | Embedde
802.11i security	Wi-Fi Roaming
802.11i security	WPA3 Enterprise
Power save mode	Deep sleep
Power save mode	IEEE power save
Power save mode	Host sleep/WoWLAN (inband)
Power save mode	Host sleep/WoWLAN (outband)
Power save mode	U-APSD
802.11w - PMF (protected management frames)	PMF require and capable
802.11w - PMF (protected management frames)	Unicast management frames - Encryption/decryption - using
802.11w - PMF (protected management frames)	Broadcast management frames - Encryption/decryption - us
802.11w - PMF (protected management frames)	SA query request/response
802.11w - PMF (protected management frames)	PMF support using embedded supplicant
DPP functionality	Wi-Fi easy connect**[^3]**
General features	Embedded supplicant
General features	Host sleep packet filtering
General features	Host-based supplicant
General features	Embedded MLME
General features	EDMAC - EU adaptivity support (ETSI certification)
General features	External coexistence
General features	IPv6 NS offload
General features	FIPS
General features	TKIP**[^1]**
General features	RF test mode
General features	802.11k
General features	802.11v
General features	DFS radar detection in peripheral mode (follow AP)**[^5]**

Table 5 – continued from p

Features	Sub features
General features	Embedded roaming based on RSSI threshold beacon loss
General features	ARP offload
General features	Cloud keep alive
General features	UNII-4 channel support
General features	ClockSync using TSF
General features	Auto reconnect
General features	CSI (channel state information)
General features	Independent reset (in-band)[^3]
General features	Independent reset (out-band)[^3]
General features	Wi-Fi agile multiband
General features	Network co-processor (NCP) mode
General features	802.11mc - WLS (Wi-Fi location service)
General features	802.11az

Parent topic: Wi-Fi radio

[^1] As per Wi-Fi specification, connecting in TKIP security in non 802.11n mode is allowed.

[^2] Support available in host-base supplicant.

[^3] Feature not enabled by default in the SDK. Refer to *Feature enable and memory impact* for the macro to enable the feature and the impact on the memory when enabling the feature.

[^4] Read more about NCP feature in *References*. **[^5]** To enable the feature, CONFIG_ECSA = 1 must be defined in wifi_config.h (does not apply to RW610 and RW612).

AP mode

Features	Sub features
802.11n - High throughput	2.4 GHz band operation supported channel bandwidth: 20 M
802.11n - High throughput	2.4 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	Short/long guard interval (400 ns/800 ns)
802.11n - High throughput	Data rates up to 72 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	Data rates up to 150 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	1 spatial stream (1x1)
802.11n - High throughput	HT protection mechanisms
802.11n - High throughput	Aggregated MAC protocol data unit (AMPDU) Rx support
802.11n - High throughput	Aggregated MAC service data unit (AMSDU) -4k RX support
802.11n - High throughput	Max client support (up to 8 devices)
802.11n - High throughput	TX MCS rate adaptation (BGN)
802.11n - High throughput	RX low density parity check (LDPC)
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 80MHz
802.11ac – Very high throughput	Short/long guard interval (400ns/800ns)
802.11ac – Very high throughput	Data rates up to 86.7 Mbps (MCS0 to MCS 8)
802.11ac – Very high throughput	Data rates up to 433.3 Mbps (MCS 0 to MCS 9)
802.11ac – Very high throughput	Single user- Aggregated MAC protocol data unit (SU-AMPDU
802.11ac – Very high throughput	RTS/CTS with BW signaling
802.11ac – Very high throughput	Backward compatibility with non-VHT devices
802.11ac – Very high throughput	TX VHT MCS rate adaptation
802.11ac – Very high throughput	MU-MIMO Beamformee (explicit and implicit)

Table 6 – continued from previ

Features	Sub features
802.11ac – Very high throughput	Operation mode notification
802.11ax – High efficiency	2.4 GHz band operation (20 MHz channel bandwidth)
802.11ax – High efficiency	2.4 GHz band operation (40 MHz channel bandwidth)
802.11ax – High efficiency	5 GHz band operation (20MHz channel bandwidth)
802.11ax – High efficiency	5 GHz band operation (40MHz channel bandwidth)
802.11ax – High efficiency	5 GHz band operation (80 MHz channel bandwidth)
802.11d	802.11d - Regulatory domain/operating class/country info
802.11e -QoS	EDCA [enhanced distributed channel access] / WMM (wirele
802.11i security	Hostapd Support
802.11i security	WPA2-PSK AES | hostapd
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) | Hosta
802.11i security	WPA2+WPA3 PSK Mixed Mode (WPA3 Transition Mode) | H
802.11i security	Wi-Fi Enhanced Open - OWE (Opportunistic Wireless Encry
802.11i security	802.1x EAP Authentication Methods | Hostapd
802.11i security	WPA2-Enterprise Mixed Mode | Hostapd
802.11i security	WPA3-Enterprise (Suite-B) |National Security Algorithm (CS
802.11i security	802.11w - PMF (Protected Management Frames) | Hostapd
802.11i security	Embedded Authenticator
802.11i security	WPA2-PSK AES | Embedded Supplicant
802.11i security	WPA+WPA2 PSK Mixed Mode | Embedded Supplicant
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) | Embe
802.11i security	802.11w - PMF (Protected Management Frames) | Embedde
802.11y	Extended channel switch announcement (ECSA)
802.11w - protected management frames (PMF)	PMF require and capable
802.11w - protected management frames (PMF)	Unicast management frames -Encryption/decryption - using
802.11w - protected management frames (PMF)	Broadcast management frames -encryption/decryption - usi
802.11w - protected management frames (PMF)	SA query request/response
General features	Embedded authenticator
General features	Embedded MLME
General features	EU adaptivity support
General features	Automatic channel selection (ACS)
General features	External coexistence (software interface)
General features	Independent reset (in-band)[^1]
General features	Network co-processor (NCP) mode[^2]
General features	Vendor specific IE (custom IE)
General features	Hidden SSID (broadcast SSID disabled)
General features	MAC address filter
General features	Multiple external STA support

Parent topic: Wi-Fi radio

[^1] Feature not enabled by default in the SDK. Refer to *Feature enable and memory impact* for the macro to enable the feature and the impact on the memory. [^2] Read more about NCP feature in *References*.

AP-STA mode

Features	Sub features	88W8	IW41	IW611/IV	RW610/R	IW61	AW611
Simultaneous AP-STA operation (same channel)	AP-STA functionality	Y	Y	Y	Y	Y	Y
SAD	Software antenna diversity[^1]	Y	Y	Y	Y	Y	Y

Parent topic: Wi-Fi radio

[^1] Feature not enabled by default in the SDK. Refer to *Feature enable and memory impact* for the macro to enable the feature and the impact on the memory when enabling the feature.

Parent topic:*Features*

Wi-Fi Generic features

Features	Sub features	88W898	IW416	IW611/IW6	RW610/RW6	IW610	AW611
Generic	Firmware download (parallel)**[^1]**	Y	Y	Y	N	N	Y
Generic	Secure boot	N	N	Y	Y	Y	Y
Generic	Kconfig memory optimizer	Y	Y	Y	Y	Y	Y
Generic	Firmware Compression**[^2]**	N	Y	N	N	N	N
Generic	u-AP intra-BSS	Y	N	Y	Y	Y	Y
Generic	Net Monitor Mode	N	N	N	Y	Y	N
Generic	Net Monitor Mode with packet transmission	N	N	N	Y	Y	N
Generic	In-Channel Net Monitor mode	N	N	N	N	N	N

Parent topic: Wi-Fi radio

[^1] Feature not enabled by default in the SDK. Refer to *Feature enable and memory impact* for the macro to enable the feature and the impact on the memory when enabling the feature. **[^2]** The feature is used to compress the Wi-Fi Bluetooth firmware and optimize the flashing of the host

Wi-Fi direct/P2P

Features	Sub features	88W8987	IW416**[**	IW611/IW61	RW610/RW61	IW610**[**	AW611**[^3]**
P2P basic functionality**[^1]**	P2P Auto GO	Y	Y	Y	Y	Y	Y
P2P basic functionality**[^1]**	P2P GO	Y	Y	Y	Y	Y	Y
P2P basic functionality**[^1]**	P2P GC	Y	Y	Y	Y	Y	Y

Parent topic: Wi-Fi radio

[^1] Feature not enabled by default in the SDK. Refer to *Feature enable and memory impact* for the macro to enable the feature and the impact on the memory when enabling the feature. **[^2]** This is an experimental software release for this feature for IW416. **[^3]** Contact your support representative to use this feature for.

Bluetooth radio

Bluetooth classic

Feature	Sub feature	88W8	IW4'	IW611/	RW610/	IW6'	AW611
General features	Bluetooth Class 1.5 and Class 2 support	Y	Y	Y	N	N	Y
General features	Scatternet support	Y	Y	Y	N	N	Y
General features	Maximum of seven simultaneous ACL connections – Central links	Y	Y	Y	N	N	Y
General features	Automatic packet type selection	Y	Y	Y	N	N	Y
General features	Bluetooth - 2.1 to 5.0 specification support	Y	Y	Y	N	N	Y
General features	Low power sniff	Y	Y	Y	N	N	Y
General features	Deep sleep using out-of-band	Y	Y	N	N	N	N
General features	Wake on Bluetooth (SoC to host)	Y	Y	Y	N	N	Y
General features	Independent reset (in-band)[^1]	Y	Y	Y	Y	N	Y
General features	Independent reset (out-band)[^1]	Y	Y	N	N	N	N
General features	Firmware download (parallel)[^1]	Y	Y	N	N	N	N
General features	RF test mode	Y	Y	Y	N	N	Y
Bluetooth packet type supported	ACL (DM1, DH1, DM3, DH3, DM5, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5)	Y	Y	Y	N	N	Y
Bluetooth packet type supported	SCO (HV1, HV3)	Y	Y	Y	N	N	Y
Bluetooth packet type supported	eSCO (EV3, EV4, EV5, 2EV3, 3EV3, 2EV5, 3EV5)	Y	Y	Y	N	N	Y
Bluetooth profiles supported	A2DP source/sink	Y	Y	Y	N	N	Y
Bluetooth profiles supported	AVRCP target/controller	Y	Y	Y	N	N	Y
Bluetooth profiles supported	HFP Dev/AG	Y	Y	Y	N	N	Y
Bluetooth profiles supported	OPP server/client	Y	Y	Y	N	N	Y
Bluetooth profiles supported	SPP server/client	Y	Y	Y	N	N	Y
Bluetooth profiles supported	HID target/device	Y	Y	Y	N	N	Y
Bluetooth audio features	PCM NBS central/peripheral	Y	Y	Y	N	N	Y
Bluetooth audio features	PCM WBS central/peripheral	Y	Y	Y	N	N	Y

Parent topic: Bluetooth radio

[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

Bluetooth LE

Features	Sub features
Generic features	Maximum 16 Bluetooth LE connections (central role)
Generic features	Deep sleep using out-of-band
Generic features	Wake on Bluetooth LE (SoC to Host)
Generic features	RF Test mode
Bluetooth profile support	Bluetooth LE GATT
Bluetooth profile support	Bluetooth LE HID over GATT
Bluetooth profile support	Bluetooth LE GAP
Bluetooth LE 4.0 support	Low Energy physical layer
Bluetooth LE 4.0 support	Low Energy link layer
Bluetooth LE 4.0 support	Enhancements to HCI for Low Energy
Bluetooth LE 4.0 support	Low energy direct test mode
Bluetooth 4.1 support	Low duty cycle directed advertising
Bluetooth 4.1 support	Bluetooth LE dual mode topology
Bluetooth 4.1 support	Bluetooth LE privacy v1.1
Bluetooth 4.1 support	Bluetooth LE link layer topology
Bluetooth 4.2 support	Bluetooth LE secure connection
Bluetooth 4.2 support	Bluetooth LE link layer privacy v1.2
Bluetooth 4.2 support	Bluetooth LE data length extension
Bluetooth 4.2 support	Link layer extended scanner filter policies
Bluetooth 5.0 support	Bluetooth LE 2 Mbps support
Bluetooth 5.0 support	High duty cycle directed advertising
Bluetooth 5.0 support	Low Energy advertising extension
Bluetooth 5.0 support	Low Energy long range
Bluetooth 5.0 support	Low Energy periodic advertisement
Bluetooth 5.2 support	Low Energy power control
Bluetooth LE audio support[^1] [^2]	Isochronous channel
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS source
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS sink
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIG Validation
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio Phy: 1M/2M/ coded
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio framed mode
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio unframed mode
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio sequential packing
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio: Mono and Stereo
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS encrypted audio
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS unencrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS source
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS sink
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIG validation
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS synchronization
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio Phy: 1M/2M/ coded
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio framed mode
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio unframed mode
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio sequential packing
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio: mono and stereo
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS encrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS unencrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio TX/RX and bidirectional traffic

Table 7 – continued from prev

Features	Sub features
Bluetooth LE audio support[^1] [^2]	ISO interval for LE Audio: 7.5ms 10ms 20ms 30ms
Bluetooth LE audio support[^1] [^2]	Sampling frequency for LE Audio: 8kHz 16kHz 24kHz, 32kH
Bluetooth LE audio support[^1] [^2]	LE Audio Auracast use cases: Auracast streaming 2 BISes
Bluetooth LE audio support[^1] [^2]	LE Audio Unicast use cases: Unicast streaming 2 CISes
Bluetooth LE audio support[^1] [^2]	LE Audio Unicast Use cases: Unicast streaming 4 CISes
Bluetooth LE audio support[^1] [^2]	A2DP + Auracast/Unicast Bridge use cases – CIS/BIS
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth coexistence
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth + Bluetooth LE coexistence

Note: Details of the tested Bluetooth LE Audio use cases:

- Number of streams:
  - 1-CIG | upto 4-CIS with 1 LE ACL (for 4-CIS: execute only mono UCs, SDU Int: 10ms)
  - 1-CIG | upto 4-CIS with 4 separate LE ACL (for 4-CIS: SDU Size= Max 100 Oct, PHY=2M, RTN=1, SDU Int: 10ms only) (execute only mono UCs for 4-CIS)
  - 1-BIG | upto 4-BIS (for 4-BIS: execute only mono UCs, SDU Int: 10ms only)
- PHY: 2M and 1M
- Audio mode: mono (for 1 to 4 streams) and stereo (for 1 stream)
- Packing: sequential and interleaved
- Bit rate: maximum 96kbps
  - For 1-CIG with upto 3-CIS: maximum bit rate 96kbps
  - For 1-CIG with 4-CIS: maximum bit rate 80kbps
  - For 1-BIG with 4-BIS: maximum bit rate 80kbps
  - For 2-CIG cases: maximum bit rate 80kbps
- Mode: unframed mode
- 48_5 and 48_6 mono and stereo configurations are not supported.

Details of the tested Bluetooth coexistence (Bluetooth + Bluetooth LE Audio) use cases:

- Bluetooth + Bluetooth LE Audio
- A2DP + Bluetooth LE Audio bridging support
- A2DP sink link (central) -> LEA 2-CIS (SDU Int: 10ms only | A2DP only with SBC Codec | PHY: 2M)

Parent topic: Bluetooth radio

[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

[^2] LE audio feature is supported for standalone scenarios only and not for BR/EDR and Wi-Fi coexistence scenarios such as LE audio + BR/EDR link or LE audio + Wi-Fi link. From the

perspective of NXP Edgefast Bluetooth host stack, LE audio feature can be disabled by the CONFIG_BT_AUDIO macro without impact on any other features. LE audio feature can be tested by the user, using their own supported host stack.

Parent topic:*Features*

802.15.4 radio

Features	Sub features	IW612	IW610	RW612
General features	Spinel over SPI	Y	N	N
General features	OpenThread RCP Mode implementing Thread1.3	Y	N	N
General features	802.15.4-2015 MAC/PHY as required by Thread 1.3	Y	Y	Y
General features	OpenThread Border Router (OTBR) v1.1	Y	Y	Y
General features	Direct/indirect transmission with/without ACK	Y	Y	Y
General features	802.15.4 CSL parent feature implementation	Y	Y	Y
General features	Enhanced Frame Pending	Y	Y	Y
General features	Enhanced keep alive	Y	Y	Y
General features	Router	Y	Y	Y
General features	Leader	Y	Y	Y
General features	Router Eligible End Device (REED)	Y	Y	Y
General features	End Device (FED, MED)	Y	Y	Y
Zigbee features	Coordinator	N	N	Y
Zigbee features	Router	N	N	Y
Zigbee features	End Device (RX ON)	N	N	Y
Zigbee features	R23	N	N	Y
Zigbee features	OTA Client	N	N	Y
Zigbee features	OTA server	N	N	Y
Matter features	Matter over Wi-Fi	Y	N	N
Matter features	Matter over Thread	Y	N	Y

Parent topic:*Features*

Coexistence

Wi-Fi and Bluetooth/802.15.4 coexistence

Features	Sub features	IW6´	IW6´	RW612
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	STA + Bluetooth	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Mobile AP + Bluetooth	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth LE + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + Bluetooth LE + Wi-Fi	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth LE[^2]	Y	Y	Y
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth + Bluetooth LE	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + OpenThread + Wi-Fi	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth LE + OpenThread + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + Bluetooth LE + OpenThread + Wi-Fi	Y	N	N
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Single antenna configuration	Y	Y	Y
BCA_TDM separate antenna[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	External Coexistence PTA	N	Y	Y

Parent topic: Coexistence

[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

[^2] The narrow-band radio can be configured to support Bluetooth LE, 802.15.4, and to time-slice between Bluetooth LE and 802.15.4.

Parent topic:*Features*

Feature enable and memory impact

Features	Macros to enable the feature	Memory impact
CSI	CONFIG_CSI	Flash - 60K, RAM - 4K
DPP	CONFIG_WPA_SUPP_DPP	Flash - 240K, RAM - 12K
Independent reset	CONFIG_WIFI_IND_DNLDCONFIG_WIFI_IND_RESET	Minimal
Parallel firmware download Wi-Fi	CONFIG_WIFI_IND_DNLD	Minimal
Parallel firmware download Bluetooth	CONFIG_BT_IND_DNLD	Minimal
WPA3 enterprise	CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME	Flash - 165K, RAM - 18K
WPA2 enterprise	CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME	Flash - 165K, RAM - 18K
Host sleep	CONFIG_HOST_SLEEP	Minimal
WMM	CONFIG_WMM[^1]	Flash - 10K, RAM - 57K
802.11mc	CONFIG_11MC CONFIG_CSI CONFIG_WLS_CSI_PROC[^2] CONFIG_11AZ	Flash: 52.78KB, RAM : 121.1KB
802.11az	CONFIG_11MC CONFIG_CSI[2] CONFIG_WLS_CSI_PROC[^2] CONFIG_11AZ	Flash: 52.78KB, RAM : 121.1KB
Non-blocking firmware download mechanism	CONFIG_FW_DNLD_ASYNC	—
Antenna diversity	CONFIG_WLAN_CALDATA_2ANT_DIVERSITY	-
P2P	CONFIG_WPA_SUPP_P2P	-

Note:

- For Wi-Fi, the macros are set with the value "**0**" by default in the file wifi_config_default.h located in <SDK_PATH>/middleware/wifi_nxp/incl/ directory.

  To enable the features, set the value of the macros to "***1****" in the file wifi_config.h located in*<SDK_Wi-Fi_Example_PATH>/ *directory****.***

- Bluetooth

  To enable the features, set the value of the macros to "**1**" in the file app_bluetooth_config.h located in <SDK_Bluetooth_Example_PATH>/ directory.

Kconfig memory optimizer The MCUXpresso SDK provides options to reduce the host memory usage with build-time configuration parameters referred to as Kconfig memory optimizer. The configuration parameters are used to reduce the use of the flash memory and SRAM.

This section explains how to enable the host memory saving configurations within the Wi-Fi drivers of NXP wireless devices.

Memory impact of i.MX RT1060 EVKC + IW416 module (Murata 1XK):

- Maximum Flash usage: 889 KB
- Maximum SRAM usage: 418.77 KB

To reduce the use of the flash and SRAM, change the settings of the Kconfig macros listed in table in the file wifi_config.h located in <path-to-SDK_Wi-Fi_Example> directory.

Kconfig macros	Feature disabled
CONFIG_WIFI_SL	CONFIG_ROAMING CONFIG_11R
CONFIG_WIFI_SL	CONFIG_CLOUD_KEEP_ALIVE CONFIG_WIFI_EU_CRYPTO CONFIG_TX_AMPDU_PROT_MODE CONFIG_WNM_PS CONFIG_TURBO_MODE CONFIG_AUTO_RECONNECT CONFIG_DRIVER_OWE CONFIG_OWE CONFIG_WIFI_FORCE_RTS CONFIG_WIFI_FRAG_THRESHOLD CONFIG_COMBO_SCAN CONFIG_SCAN_CHANNEL_GAP
CONFIG_WIFI_SL	CONFIG_UAP_STA_MAC_ADDR_FILTER CONFIG_WIFI_MAX_CLIENTS_CNT
CONFIG_FREERTC	If the macro is enabled, the heap memory usage is reduced by 10 KB (from 70 KB to 60 KB).
CONFIG_LWIP_LC	Curtails LWIP stack parameters, reduces data throughput, disables data net-stats
Non-blocking firmware download mechanism	CONFIG_FW_DNLD_ASYNC

Parent topic:*Feature enable and memory impact*

[^1] The macro is not used for IW416.

[^2] Prerequisite macros for 802.11mc and 802.11az features

88W8987 release notes

Package information

- SDK version: 25.06.00

Parent topic:*88W8987 release notes*

Version information

- Wireless SoC: 88W8987
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 16.92.21.p151.7
  - 16 - Major revision
  - 91 - Feature pack
  - 21 - Release version
  - p151.7 - Patch number

Parent topic:*88W8987 release notes*

Host platform

- All i.MX RT platforms running FreeRTOS.
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*88W8987 release notes*

Wi-Fi and Bluetooth certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | 802.11ac
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | QTT

Refer to *6*.

Note: This release supports STAUT only certifications.

Parent topic: Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: refer to *4*.

Parent topic: Wi-Fi and Bluetooth certification

Parent topic:*88W8987 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- External Access Point: ASUS AX88U
- DUT: W8987 Murata (Module: **1ZM M.2**) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- External Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi_wpa_supplicant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *2*.

Parent topic: Wi-Fi throughput

STA throughput External APs: ASUS AX88U

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	46	51	60	60
WPA2-AES	45	42	60	54
WPA3-SAE	46	41	60	54

STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	62	83	121	124
WPA2-AES	61	82	120	126
WPA3-SAE	60	82	120	126

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	52	60	64
WPA2-AES	43	52	61	64
WPA3-SAE	43	52	60	65

STA mode throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	64	87	126	125
WPA2-AES	63	85	125	120
WPA3-SAE	63	80	125	123

STA mode throughput - AC Mode | 5 GHz Band | 20 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	48	60	73	78
WPA2-AES	47	60	73	77
WPA3-SAE	47	60	73	77

STA mode throughput - AC Mode | 5 GHz Band | 40 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	68	96	161	157
WPA2-AES	69	92	160	155
WPA3-SAE	70	94	160	155

STA mode throughput - AC Mode | 5 GHz Band | 80 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	78	99	125	203
WPA2-AES	78	98	126	197
WPA3-SAE	82	98	125	197

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple Macbook Air

Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	51	56	62
WPA2-AES	42	50	54	61
WPA3-SAE	40	50	65	62

Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	66	81	107	121
WPA2-AES	65	80	107	120
WPA3-SAE	65	80	108	120

Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	52	60	61
WPA2-AES	44	51	60	61
WPA3-SAE	44	51	60	61

Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	70	89	126	103
WPA2-AES	70	87	124	102
WPA3-SAE	70	88	125	103

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	49	60	73	76
WPA2-AES	48	59	73	76
WPA3-SAE	48	60	73	76

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	77	106	161	102
WPA2-AES	77	104	160	102
WPA3-SAE	77	104	160	111

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	93	114	125	206
WPA2-AES	92	111	125	191
WPA3-SAE	92	111	125	173

Parent topic: Wi-Fi throughput

Parent topic:*88W8987 release notes*

EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

Parent topic:*88W8987 release notes*

Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p64.1 to 16.91.21.p82

Component	Description
Wi-Fi	WPA3-R3 enabled APUT beacons does not have RSNXE when configured in H2E mode-Associated event is received even when connecting using wrong password WFA APUT Low iperf TCP/UDP Tx throughput with Realtek station

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p82 to 16.91.21.p91.6

Component	Description
Wi-Fi	In wrong password scenario, After updating new password the phone is not able to connect with DUTAP

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p91.6 to 16.91.21.p124

Component	Description
Wi-Fi	Cloud keep alive packets not seen after DUT enters host sleep. DUT is sending QOS null packets even in host sleep

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p124 to 16.91.21.p133

Component	Description
Wi-Fi	Samsung S24 Ultra and Google Pixel 7 mobiles having Android 14 are not able connect to the DUTAP with WPA3 SAE security.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p133 to 16.91.21.p142.5 {#firmware_version_from_16_91_21_p133_to_16_91_21_p142_5}

Component	Description
Wi-Fi	Fails to encrypt and decrypt data with ccmp 128 and 256 using CLI crypto commands.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p142.5 to 16.91.21.p149.2 {#firmware_version_from_16_91_21_p142_5_to_16_91_21_p149_2}

Component	Description
Wi-Fi	DUTSTA does not associate to hidden SSID beaconing in DFS channel.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p149.2 to 16.92.21.p151.7 {#firmware_version_from_16_91_21_p149_2_to_16_92_21_p151_7}

Component	Description
Wi-Fi	Getting low TCP/UDP TP in DUT-AP 11ac-vht80 mode after hard-reset or wlan-reset.

Parent topic: Bug fixes and/or feature enhancements

Parent topic:*88W8987 release notes*

Known issues

Component	Description
-	NA

Parent topic:*88W8987 release notes*

IW416 release notes

Package information

- SDK version: 25.06.00

Parent topic:*IW416 release notes*

Version information

- Wireless SoC: IW416
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 16.92.21.p151.7
  - 16 - Major revision

  - 92 - Feature pack
  - 21 - Release version
  - p151.7 - Patch number

Parent topic:*IW416 release notes*

Host platform

- All i.MX RT platforms running FreeRTOS.
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 Support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*IW416 release notes*

Wi-Fi and Bluetooth certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | QTT

Refer to *6*.

Note: This release supports STAUT only certifications.

Parent topic: Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: refer to *4*.

Note: QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

Parent topic: Wi-Fi and Bluetooth certification

Parent topic:*IW416 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW416 Murata (Module: 1XK M.2) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi_wpa_supplicant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *2*.

Parent topic: Wi-Fi throughput

STA throughput External AP: Asus AX88u

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	38	59	58
WPA2-AES	38	36	57	58
WPA3-SAE	41	35	57	57

STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	58	58	93	91
WPA2-AES	56	49	94	74
WPA3-SAE	54	57	94	73

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	45	61	58
WPA2-AES	40	43	61	57
WPA3-SAE	40	44	61	57

STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	60	66	94	100
WPA2-AES	58	61	94	98
WPA3-SAE	59	61	94	98

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple MacBook Air

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	43	59	57
WPA2-AES	40	42	59	57
WPA3-SAE	39	42	59	57

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	62	74	121	118
WPA2-AES	60	64	116	91
WPA3-SAE	60	65	116	91

Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	50	42	45	62
WPA2-AES	42	45	53	62
WPA3-SAE	42	62	53	45

Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	66	76	126	96
WPA2-AES	63	68	121	95
WPA3-SAE	63	67	121	95

Parent topic: Wi-Fi throughput

Parent topic:*IW416 release notes*

EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

Parent topic:*IW416 release notes*

Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p64.1 to 16.91.21.p82

Component	Description
Wi-Fi	WPA3-R3 enabled APUT beacons does not have RSNXE when configured in H2E mode

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p82 to 16.91.21.p91.6

Component	Description
Wi-Fi	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p91.6 to 16.91.21.p124

Component	Description
Wi-Fi	Cloud keep alive packets not seen after DUT enters host sleep. DUT is sending QOS null packets even in host sleep

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p124 to 16.91.21.p133

Component	Description
Wi-Fi	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p133 to 16.91.21.p133.2 {#firmware_version_from_16_91_21_p133_to_16_91_21_p133_2}

Component	Description
Wi-Fi	DUT STA getting rebooted after 15~20 iterations of 11R-Command based roaming0xa4 command timeout after several hours of stress test

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p133.2 to 16.91.21.p142.5 {#firmware_version_from_16_91_21_p133_2_to_16_91_21_p142_5}

Component	Description
Wi-Fi	DUT fails to reconnect after the configured auto-reconnect time interval.
Coex	During HFP call, TX side noise is observed with coex CLI

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p142.5 to 16.91.21.p149.4 {#firmware_version_from_16_91_21_p142_5_to_16_91_21_p149_4}

Component	Description
-	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: From 16.91.21.p149.4 to 16.92.21.p151.7 {#firmware_version_from_16_91_21_p149_4_to_16_92_21_p151_7}

Component	Description
Wi-Fi	Samsung S24 Ultra and Google Pixel 7 mobiles having Android 14 are not able connect to the DUTAP with WPA3 SAE security.

Parent topic: Bug fixes and/or feature enhancements

Parent topic:*IW416 release notes*

Known issues

Component	Description
Coex	Wi-Fi connection in 2.4GHz is not stable, observed deauthentication within 10sec.

Parent topic:*IW416 release notes*

IW611/IW612 release notes **Note:** The IW611/IW612 support is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

Package information

- SDK version: 25.06.00

Parent topic:*IW611/IW612 release notes*

Version information

- Wireless SoC: IW611/IW612
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.3.p25.11
  - 18 - Major revision
  - 99 - Feature pack
  - 3 - Release version
  - p25.11 - Patch number

Parent topic:*IW611/IW612 release notes*

Host platform

- i.MX RT1170 EVKB and i.MX RT1060 EVKC Platforms running FreeRTOS
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
  - 802.15.4 over SPI (IW612 only)
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*IW611/IW612 release notes*

Wi-Fi and Bluetooth certification

The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to *6*.

Note: This release supports STAUT only certifications.

Parent topic: Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: refer to *4*.

Note: QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

Parent topic: Wi-Fi and Bluetooth certification

Parent topic:*IW611/IW612 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW612 Murata (Module: 2EL M.2) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi_wpa_supplicant
- Compiler used to build application: armgcc
- Compiler Version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *2*

The throughput numbers are captured with default configurations using *wifi_wpa_supplicant* sample application.

Parent topic: Wi-Fi throughput

iPerf host configuration and impact on throughput {#iperf_host_configuration_and_impact_on_throughpu
To get the highest throughput, the throughput values shown in STA throughput and Mobile AP throughput are measured with the maximum values of the default host configuration macros. STA and AP throughput captured with the minimum values of the host configuration macros shows the throughput numbers obtained when using the minimum values of the host configuration macros. The macro values are defined in *lwipopts.h* file.

The table below lists the minimum and maximum values of the host configuration macros.

Values of the host configuration macros

Parameter	Maximum value	Minimum value
TCPIP_MBOX_SIZE	96	32
DEFAULT_RAW_RECVMBOX_SIZE	32	12
DEFAULT_UDP_RECVMBOX_SIZE	64	12
DEFAULT_TCP_RECVMBOX_SIZE	64	12
TCP_MSS	1460	536
TCP_SND_BUF	24 * TCP_MSS	2 * TCP_MSS
MEM_SIZE	319160	41,080
TCP_WND	15 * TCP_MSS	10 * TCP_MSS
MEMP_NUM_PBUF	20	10
MEMP_NUM_TCP_SEG	96	12
MEMP_NUM_TCPIP_MSG_INPKT	80	16
MEMP_NUM_TCPIP_MSG_API	80	8
MEMP_NUM_NETBUF	32	16

STA and AP throughput captured with the minimum values of the host configuration macros {#sta_and_ap_throughput_captured_with_the_minimum_values_of_the_host_configuration_macr

STA mode throughput - HE Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
Open Security	7	18	111	124
WPA2-AES	7	18	110	124
WPA3-SAE	6	18	110	124

Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
Open Security	2	19	93	127
WPA2-AES	2	19	105	126
WPA3-SAE	2	19	104	132

Parent topic:iPerf host configuration and impact on throughput

Parent topic: Wi-Fi throughput

STA throughput

External AP: Asus AX88u

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	47	45	60
WPA2-AES	43	46	48	59
WPA3-SAE	47	49	63	63

STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	68	82	131	131
WPA2-AES	72	82	130	129
WPA3-SAE	68	81	129	130

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	45	51	63	65
WPA2-AES	45	51	63	65
WPA3-SAE	45	51	63	65

STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	67	83	129	134
WPA2-AES	66	83	129	133
WPA3-SAE	65	83	129	133

STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	49	53	72	71
WPA2-AES	48	52	73	70
WPA3-SAE	52	56	75	75

STA mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	74	88	172	172
WPA2-AES	75	92	171	169
WPA3-SAE	77	92	172	171

STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	50	58	76	78
WPA2-AES	49	57	76	77
WPA3-SAE	49	57	76	77

STA mode throughput - VHT Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	74	93	175	177
WPA2-AES	74	93	174	174
WPA3-SAE	73	93	173	175

STA mode throughput - VHT Mode | 5 GHz Band | 80 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	88	94	221	196
WPA2-AES	87	95	219	194
WPA3-SAE	89	95	219	195

STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	60	60	98	115
WPA2-AES	62	61	94	113
WPA3-SAE	61	59	97	108

STA mode throughput - HE Mode | 2.4 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	77	71	215	190
WPA2-AES	77	72	212	187
WPA3-SAE	76	72	152	189

STA mode throughput - HE Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	63	65	127	128
WPA2-AES	63	67	125	128
WPA3-SAE	63	67	125	126

STA mode throughput - HE Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	79	64	212	199
WPA2-AES	78	68	218	199
WPA3-SAE	79	68	217	198

STA mode throughput - HE Mode | 5 GHz Band | 80 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	88	70	219	192
WPA2-AES	87	72	219	193
WPA3-SAE	91	72	220	194

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple MacBook Air

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	52	61	62
WPA2-AES	40	51	61	62
WPA3-SAE	40	51	61	62

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	63	83	116	130
WPA2-AES	67	82	115	131
WPA3-SAE	60	81	115	132

Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	49	60	62
WPA2-AES	39	49	60	62
WPA3-SAE	41	51	63	62

Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	66	89	128	133
WPA2-AES	64	87	128	133
WPA3-SAE	62	86	128	133

Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	60	74	75
WPA2-AES	43	59	74	75
WPA3-SAE	43	59	74	75

Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	64	53	112	75
WPA2-AES	65	51	111	75
WPA3-SAE	62	51	112	75

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	45	60	76	76
WPA2-AES	44	59	76	76
WPA3-SAE	44	59	76	76

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	73	100	155	178
WPA2-AES	72	99	152	176
WPA3-SAE	72	99	152	176

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	80	86	211	189
WPA2-AES	84	87	223	188
WPA3-SAE	83	94	224	192

Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	53	66	85	123
WPA2-AES	52	65	83	122
WPA3-SAE	52	65	83	120

Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	75	102	124	166
WPA2-AES	74	100	121	148
WPA3-SAE	73	101	121	154

Mobile AP mode throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	54	68	84	124
WPA2-AES	53	66	83	122
WPA3-SAE	54	66	83	123

Mobile AP mode throughput - HE Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	76	107	155	193
WPA2-AES	75	105	152	192
WPA3-SAE	76	106	151	191

Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	86	118	220	187
WPA2-AES	86	119	221	185
WPA3-SAE	86	116	220	188

Parent topic: Wi-Fi throughput

Parent topic:*IW611/IW612 release notes*

EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

Parent topic:*IW611/IW612 release notes*

Bug fixes and/or feature enhancements

Firmware version: 18.99.2.p7.19

Component	Description
-	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.2.p7.19 to 18.99.2.p49.9

Component	Description
-	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.2.p49.9 to 18.99.2.p155

Component	Description
Bluetooth	Audio lost occurs due to periodic adv sync lost, during 2 BIS 44.1kHz unencrypted streams with 1M PHY configuration.BIS sync loss may occur in long audio streaming sessions.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.2.p155 to 18.99.2.p66.30

Component	Description
Wi-Fi	802.11R Fast BSS roaming works only with hostapd and does not work with standard APs (supporting 11R)
Bluetooth	DUT is not able to sustain a connection with the remote device that does extended advertisement with coded PHY configuration. When 2 CIS streams are active, after the first device disconnects followed by the second device disconnecting, the second peripheral device hangs.Audio Play/Pause does not work in BIS case.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.2.p66.30 to 18.99.3.p10.5

Component	Description
Wi-Fi	STAUT not sending Neighbor Advertisement packet after receiving Neighbor Solicitation packet from Ex-AP.Antenna selection time exceeds configured evaluation time
Bluetooth	When DUT works as CIS source and CIS Offset is 612us, high packet drops observed which affects the audio streaming.For BIS Source Use Cases, Periodic Interval and ISO Interval should be multiple of each other value.In 1-CIS and 2-CIS, Continuous Audio Glitches are observed with 96 kbps bit rate.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.3.p10.5 to 18.99.3.p17.9 {#firmware_version_18_99_3_p10_5_to_18_99_3_p17_9}

Component	Description
Wi-Fi	After performing independent reset (out-of-band mode), the STAUT fails to connect to the external AP via `wlan-connect` command, observed command timeout `0x107` error.
Bluetooth	Audio glitches observed with Google Pixel 7 Pro streaming audio after CIS is established with DUT.During Call Gateway (CG) / Call Terminal (CT) Use Case, the firmware periodically sends NULL PDU, which results in frequent Audio Glitch on both CG and CT sides.Heavy audio glitches observed with CIS SRC Google Pixel 7 ProContinuous audio glitches observed in 1 CIS and 2 CIS for 48_3 and 48_4 config.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.3.p17.9 to 18.99.3.p21.154 {#firmware_version_18_99_3_p17_9_to_18_99_3_p21_154}

Component	Description
Wi-Fi	STAUT fail to ping AP backend machine when connected with DFS channel and DUTSTA went in bad state.
Bluetooth	CIS Sink frequently fails to acknowledge CIS Source TX PDU.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.3.p21.154 to 18.99.3.p23.16 {#firmware_version_18_99_3_p21_154_to_18_99_3_p23_16}

Component	Description
-	NA

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.3.p23.16 to 18.99.3.p25.11 {#firmware_version_18_99_3_p23_16_to_18_99_3_p25_11}

Component	Description
Bluetooth	Packet lost observed in CIS case, which causes audio noise.

Parent topic: Bug fixes and/or feature enhancements

Parent topic:*IW611/IW612 release notes*

Known issues

Component	Description
Bluetootl	Sequential Removal of CIS Handles as per current Controller implementation i.e CIS Disconnection sequence should be in sequence => CIS - 4,3,2,1While 4-CIS streaming, audio glitches observed on all CIS SINK with Samsung Galaxy budsWhile 4-CIS streaming, disconnection with connection timeout observed on first CIS SINK with Samsung Galaxy budsOnly two streams (CIS/BIS) with one channel is supported.

Parent topic:*IW611/IW612 release notes*

RW610/RW612 release notes

Package information

- SDK version: 25.06.00

Parent topic:*RW610/RW612 release notes*

Version information

- Wi-Fi firmware version: 18.99.6.p40
  - rw61x_sb_wifi_a2.bin for A2
  - 18 - Major revision
  - 99 - Feature pack
  - 6 - Release version
  - p40 - Patch number
- Bluetooth LE firmware version: 18.25.6.p40
  - rw61x_sb_ble_a2.bin for A2
  - 18 - Major revision
  - 25 - Feature pack
  - 6 - Release version
  - p40 - Patch number
- 802.15.4 and Bluetooth LE (up to core 4.1) firmware version: 18.34.6.p40
  - rw61x_sb_ble_15d4_combo_a2.bin for A2
  - 18 - Major revision
  - 34 - Feature pack
  - 6 - Release version
  - p40 - Patch number

Parent topic:*RW610/RW612 release notes*

Host platform

- RW610/RW612 platform running FreeRTOS
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*RW610/RW612 release notes*

Wireless certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to *1*.

Note: This release supports STAUT only certifications.

Parent topic: Wireless certification

Bluetooth LE controller certification QDID: Refer to *4*.

Parent topic: Wireless certification

Thread Thread group: refer to *7*.

Product Name: NXP RW612 Wireless MCU with Integrated Tri-Radio

Thread version: V1.3.0

CID #: 13A109

Parent topic: Wireless certification

Matter RW612 certification: refer to *8*.

Certificate ID: CSA23C36MAT41746-24

Device type: Root Node, Thermostat

Transport: Matter over Wi-Fi

RW610 certification: refer to *9*.

Certificate ID: CSA23C43MAT41753-50

Device type: Root Node, Thermostat

Transport: Matter over Wi-Fi and Matter over Thread

Parent topic: Wireless certification

Parent topic:*RW610/RW612 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: RW610/RW612
- External Client: Intel AX210
- Channel: 6 | 36
- Wi-Fi application: wifi_cli
- Compiler used to build application: armgcc
- Compiler version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *3*.

Parent topic: Wi-Fi throughput

STA throughput External AP: Asus AX88u

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	38	38	62	62
WPA2-AES	37	37	61	63
WPA3-SAE	37	37	60	61

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	39	64	64
WPA2-AES	37	38	62	64
WPA3-SAE	39	38	62	64

STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	41	41	75	74
WPA2-AES	41	41	73	74
WPA3-SAE	40	41	72	73

STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	42	42	76	76
WPA2-AES	42	41	75	75
WPA3-SAE	42	41	75	74

STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	45	97	99
WPA2-AES	43	44	96	98
WPA3-SAE	42	44	97	98

STA mode throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	47	47	100	103
WPA2-AES	45	46	100	101
WPA3-SAE	47	46	100	101

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple MacBook Air

Mobile AP throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	39	62	62
WPA2-AES	39	39	61	61
WPA3-SAE	38	39	61	61

Mobile AP throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	40	63	63
WPA2-AES	39	39	62	61
WPA3-SAE	39	39	62	61

Mobile AP throughput - VHT Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	43	73	73
WPA2-AES	43	42	72	72
WPA3-SAE	43	42	73	72

Mobile AP throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	44	74	74
WPA2-AES	43	43	74	74
WPA3-SAE	43	43	74	74

Mobile AP throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	48	48	95	96
WPA2-AES	47	47	98	95
WPA3-SAE	47	47	97	95

Mobile AP throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	49	49	96	97
WPA2-AES	48	48	101	97
WPA3-SAE	48	48	101	97

Parent topic: Wi-Fi throughput

Parent topic:*RW610/RW612 release notes*

Bug fixes and/or feature enhancements

Firmware version: 18.99.6.p34 to 18.99.6.p40 {#firmware_version_18_99_6_p34_to_18_99_6_p40}

Com-ponent	Description
Zigbee	Zigbee Coordinator and Router are disconnected during BLE connection pairing and bonding with a mobile app for the first time.

Parent topic: Bug fixes and/or feature enhancements

Parent topic:*RW610/RW612 release notes*

Known issues

Component	Description
Wi-Fi	—
Bluetooth LE	—
Zigbee	-

Parent topic:*RW610/RW612 release notes*

IW610 release notes

Package information

- SDK version: 25.06.00

Parent topic:*IW610 release notes*

Version information

- Wireless SoC: IW610
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.5.p66
  - 18 - Major revision
  - 99 - Feature pack
  - 5 - Release version
  - p66 - Patch number

Parent topic:*IW610 release notes*

Host platform

- IW610 platform running FreeRTOS
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*IW610 release notes*

Wi-Fi and Bluetooth certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to *6*.

Note: This release supports STAUT only certifications.

Parent topic: Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: Refer to *4*.

Note: QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

Parent topic: Wi-Fi and Bluetooth certification

Parent topic:*IW610 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW610
- External Client: Intel AX210
- Channel: 6 | 36
- Wi-Fi application: wifi_cli
- Compiler used to build application: armgcc
- Compiler version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *3*.

Parent topic: Wi-Fi throughput

STA throughput External AP: Asus AX88u

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	42	63	61
WPA2-AES	40	47	60	62
WPA3-SAE	40	39	60	62

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	42	49	64	64
WPA2-AES	41	48	62	63
WPA3-SAE	41	48	62	63

STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	45	54	75	74
WPA2-AES	45	53	73	73
WPA3-SAE	44	53	73	72

STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	46	48	77	70
WPA2-AES	45	47	74	68
WPA3-SAE	46	47	74	68

STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	51	62	98	98
WPA2-AES	50	60	96	91
WPA3-SAE	51	60	96	91

STA mode throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	53	60	101	94
WPA2-AES	53	58	99	93
WPA3-SAE	52	58	99	93

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple MacBook Air

Mobile AP throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	39	63	62
WPA2-AES	39	38	60	60
WPA3-SAE	39	38	60	60

Mobile AP throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	39	64	62
WPA2-AES	39	39	61	61
WPA3-SAE	39	38	61	61

Mobile AP throughput - VHT Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	43	74	73
WPA2-AES	42	42	73	71
WPA3-SAE	42	42	74	72

Mobile AP throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	43	75	73
WPA2-AES	43	42	74	72
WPA3-SAE	43	43	74	72

Mobile AP throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	46	46	95	94
WPA2-AES	45	45	96	91
WPA3-SAE	45	45	96	91

Mobile AP throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	47	47	96	94
WPA2-AES	46	46	98	91
WPA3-SAE	46	46	99	91

Parent topic: Wi-Fi throughput

Parent topic:*IW610 release notes*

Known issues

Component	Description
Wi-Fi	—
Bluetooth LE	—

Parent topic:*IW610 release notes*

AW611 release notes

Note: The AW611 support is enabled in i.MX RT1180 EVKA.

Package information

- SDK version: 25.06.00

Parent topic:*AW611 release notes*

Version information

- Wireless SoC: AW611
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.3.p25.11
  - 18 - Major revision
  - 99 - Feature pack
  - 3 - Release version
  - p25.11 - Patch number

Parent topic:*AW611 release notes*

Host platform

- i.MX RT1180 EVKA Platform running FreeRTOS
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 Support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

Parent topic:*AW611 release notes*

Wi-Fi and Bluetooth certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to *6*.

Note: This release supports STAUT only certifications.

Parent topic: Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: Refer to *4*.

Note: QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

Parent topic: Wi-Fi and Bluetooth certification

Parent topic:*AW611 release notes*

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: AW611 uBlox (Module: U-BLOX_Jody_W5 M.2) with EVK-MIMXRT1180 EVKA platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi_wpa_supplicant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in *2*.

The throughput numbers are captured with default configurations using *wifi_wpa_supplicant* sample application.

Parent topic: Wi-Fi throughput

STA throughput External AP: Asus AX88u

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	47	45	60
WPA2-AES	43	46	48	59
WPA3-SAE	47	49	63	63

STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	68	82	131	131
WPA2-AES	72	82	130	129
WPA3-SAE	68	81	129	130

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	45	51	63	65
WPA2-AES	45	51	63	65
WPA3-SAE	45	51	63	65

STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	67	83	129	134
WPA2-AES	66	83	129	133
WPA3-SAE	65	83	129	133

STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	49	53	72	71
WPA2-AES	48	52	73	70
WPA3-SAE	52	56	75	75

STA mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	74	88	172	172
WPA2-AES	75	92	171	169
WPA3-SAE	77	92	172	171

STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	50	58	76	78
WPA2-AES	49	57	76	77
WPA3-SAE	49	57	76	77

STA mode throughput - VHT Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	74	93	175	177
WPA2-AES	74	93	174	174
WPA3-SAE	73	93	173	175

STA mode throughput - VHT Mode | 5 GHz Band | 80 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	88	94	221	196
WPA2-AES	87	95	219	194
WPA3-SAE	89	95	219	195

STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	60	60	98	115
WPA2-AES	62	61	94	113
WPA3-SAE	61	59	97	108

STA mode throughput - HE Mode | 2.4 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	77	71	215	190
WPA2-AES	77	72	212	187
WPA3-SAE	76	72	152	189

STA mode throughput - HE Mode | 5 GHz Band | 20 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	63	65	127	128
WPA2-AES	63	67	125	128
WPA3-SAE	63	67	125	126

STA mode throughput - HE Mode | 5 GHz Band | 40 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	79	64	212	199
WPA2-AES	78	68	218	199
WPA3-SAE	79	68	217	198

STA mode throughput - HE Mode | 5 GHz Band | 80 MHz (HT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	88	70	219	192
WPA2-AES	87	72	219	193
WPA3-SAE	91	72	220	194

Parent topic: Wi-Fi throughput

Mobile AP throughput External client: Apple MacBook Air

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	40	52	61	62
WPA2-AES	40	51	61	62
WPA3-SAE	40	51	61	62

Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	63	83	116	130
WPA2-AES	67	82	115	131
WPA3-SAE	60	81	115	132

Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	39	49	60	62
WPA2-AES	39	49	60	62
WPA3-SAE	41	51	63	62

Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	66	89	128	133
WPA2-AES	64	87	128	133
WPA3-SAE	62	86	128	133

Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	60	74	75
WPA2-AES	43	59	74	75
WPA3-SAE	43	59	74	75

Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	64	53	112	75
WPA2-AES	65	51	111	75
WPA3-SAE	62	51	112	75

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	45	60	76	76
WPA2-AES	44	59	76	76
WPA3-SAE	44	59	76	76

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	73	100	155	178
WPA2-AES	72	99	152	176
WPA3-SAE	72	99	152	176

Mobile AP mode throughput - VHT Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	80	86	211	189
WPA2-AES	84	87	223	188
WPA3-SAE	83	94	224	192

Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	53	66	85	123
WPA2-AES	52	65	83	122
WPA3-SAE	52	65	83	120

Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	75	102	124	166
WPA2-AES	74	100	121	148
WPA3-SAE	73	101	121	154

Mobile AP mode throughput - HE Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	54	68	84	124
WPA2-AES	53	66	83	122
WPA3-SAE	54	66	83	123

Mobile AP mode throughput - HE Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	76	107	155	193
WPA2-AES	75	105	152	192
WPA3-SAE	76	106	151	191

Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	86	118	220	187
WPA2-AES	86	119	221	185
WPA3-SAE	86	116	220	188

Parent topic: Wi-Fi throughput

Parent topic:*AW611 release notes*

EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

Parent topic:*AW611 release notes*

Bug fixes and/or feature enhancements {#bug_fixes_and_or_feature_enhancements_04}

Firmware version: 18.99.3.p10.5 to 18.99.3.p17.9 {#firmware_version_18_99_3_p10_5_to_18_99_3_p17_9_0}

Component	Description
Wi-Fi	After performing independent reset (out-of-band mode), the STAUT fails to connect to the external AP via `wlan-connect` command, observed command timeout `0x107` error.
Bluetooth	Audio glitches observed with Google Pixel 7 Pro streaming audio after CIS is established with DUT.During Call Gateway (CG) / Call Terminal (CT) Use Case, the firmware periodically sends NULL PDU, which results in frequent Audio Glitch on both CG and CT sides.Heavy audio glitches observed with CIS SRC Google Pixel 7 ProContinuous audio glitches observed in 1 CIS and 2 CIS for 48_3 and 48_4 config.

Parent topic: Bug fixes and/or feature enhancements

Firmware version: 18.99.3.p17.9 to 18.99.3.p21.154 {#firmware_version_18_99_3_p17_9_to_18_99_3_p21_154_0}

Component	Description
Wi-Fi	STAUT fail to ping AP backend machine when connected with DFS channel and DUTSTA went in bad state.
Bluetooth	CIS Sink frequently fails to acknowledge CIS Source TX PDU.

Parent topic: Bug fixes and/or feature enhancements

Parent topic:*AW611 release notes*

Known issues

Component	Description
Bluetootl	Packet lost would be observed in CIS case which causes audio noise.Sequential Removal of CIS Handles as per current Controller implementation i.e CIS Disconnection sequence should be in sequence => CIS - 4,3,2,1While 4-CIS streaming, audio glitches observed on all CIS SINK with Samsung Galaxy budsWhile 4-CIS streaming, disconnection with connection timeout observed on first CIS SINK with Samsung Galaxy budsOnly two streams (CIS/BIS) with one channel is supported.

Parent topic:*AW611 release notes*

Abbreviations

Abbreviation	Definition
A2DP	Advanced audio distribution profile
AMPDU	Aggregated MAC protocol data unit
AMSDU	Aggregated MAC service data unit
AP	Access point
BW	Bandwidth
CCMP	Counter mode CBC-MAC protocol
CSI	Channel state information
CTS	Clear To Send
DL	Down link
EDCA	Enhanced distributed channel access
ER	Extended range
ERP	Extended rate physical
GATT	Generic attribute profile
HFP	Hands free profile
HID	Human interface device
HT	High throughput
LDPC	Low density parity check
MCS	Modulation and coding scheme
MLME	Mac layer management entity
OMI	Operating mode indication
PMF	Protected management frames
RTS	Request to send

continues on next page

Table 8 – continued from previous page

Abbreviation	Definition
SAE	Simultaneous authentication of equals
STA	Station
TWT	Target wake time
UL	Up link
VHT	Very high throughput
WEP	Wired equivalent private
WFD	Wi-Fi direct
WMM	Wireless multi-media
WPA	Wi-Fi protected access
WPS	Wi-Fi protected setup
WSC	Wi-Fi Simple Configuration

References

1. Application note - AN13681 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
2. User manual – UM11442 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for i.MX RT Platforms (available in the SDK package)
3. User manual – UM11799 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for RW61x (available in the SDK package)
4. Certification – Bluetooth controller - QDID (*link*)
5. User manual - UM12133 - NXP NCP Application Guide for RW612 with MCU Host
6. Technical note - TN00066 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
7. Web page – Thread certified products (link)
8. Web page – Connectivity standard alliance (csa) – NXP RW612 Tri-Radio Wireless MCU Development Platform (link)
9. Web page – Connectivity standard alliance (csa) – NXP RW610 Wireless MCU Development Platform (link)

3.8.2 EdgeFast Bluetooth

Currently we provide pdf version of those documentation, later release may convert the pdf documentation to markdown for better review and aligned format.

- EdgeFast BT PAL API Reference Manual pdf.

MCUXpressoSDK EdgeFast Bluetooth Protocol Abstraction

Introduction This document provides an overview of the EdgeFast Bluetooth Protocol Abstraction Layer stack software based on FreeRTOS OS on the NXP board with variant wireless module chipsets. This document covers hardware setup, build, and usage of the provided demo applications.

Stack API Reference EdgeFast Bluetooth Protocol Abstraction Layer is a wrapper layer on top of the bluetooth host stack. Zephyr Bluetooth host stack API is used as the basis of the EdgeFast Bluetooth Protocol Abstraction Layer with some enhancement on A2DP/SPP/HFP.

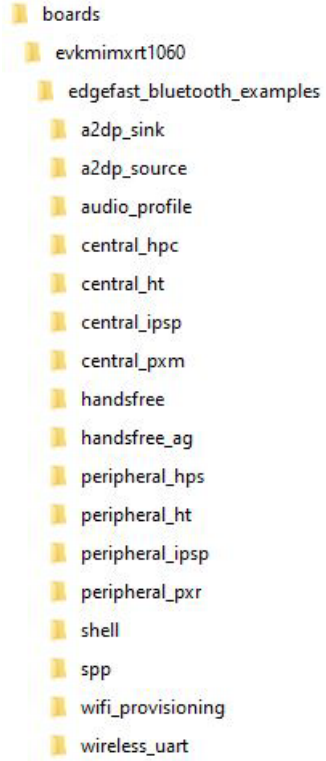
The APIs of the EdgeFast Bluetooth Protocol Abstraction Layer host stack are described in the EdgeFast Bluetooth Protocol Abstraction Layer RM document.

Note: The online document of the Zephyr Bluetooth Host stack is available here: https://docs.zephyrproject.org/latest/reference/bluetooth/index.html.

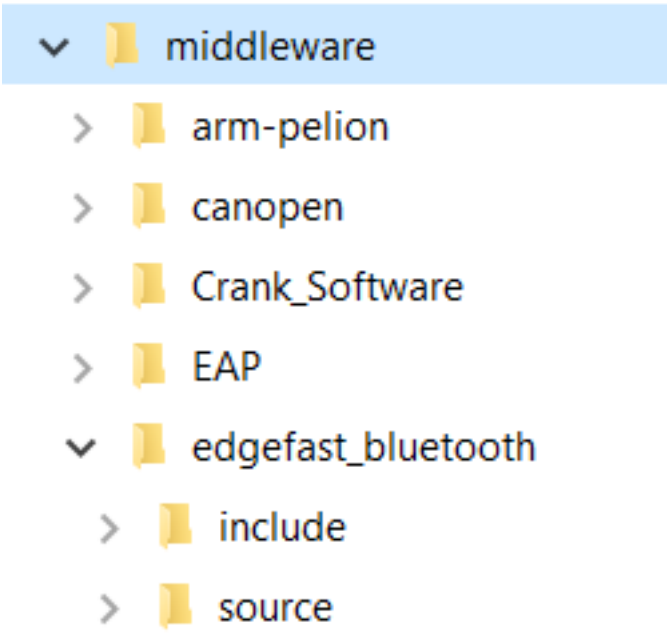
Parent topic:*Introduction*

Overview The EdgeFast Bluetooth Protocol Abstraction Layer host stack software is built based on MCUXpresso SDK. The following chapter uses RT1060 as an example, other boards have similar folder structure and corresponding document.

Folder structure The following figure shows the EdgeFast Bluetooth examples folder structure.



The following figure shows the EdgeFast Bluetooth Protocol Abstraction Layer host stack folder structure.



The following table provides information regarding the structure and description.

|**Folder**

|**Description**

| |————|————| |*boards/*

CMSIS/

devices/

docs/

middleware/

rtos/

tools/

|MCUXpresso SDK directory. Refer to Chapter 5

Release contents of MCUXpresso SDK Release Notes at *root/docs/ MCUXpresso SDK Release Notes for EVK-MIMXRT1060.pdf* to *know the details*

| |*boards/<board>/wireless/edgefast_bluetooth_examples*

|EdgeFast Bluetooth Protocol Abstraction Layer host stack example projects| |*middleware/wireless/edgefast_bluetooth*

|EdgeFast Bluetooth Protocol Abstraction Layer host stack source code

|

The EdgeFast Bluetooth folder includes two subfolders:

- **include**: This subfolder includes EdgeFast Bluetooth Protocol Abstraction Layer host stack headers.
- **source**: This subfolder includes EdgeFast Bluetooth Protocol Abstraction Layer host stack source code based on the Ethermind Bluetooth host stack APIs.

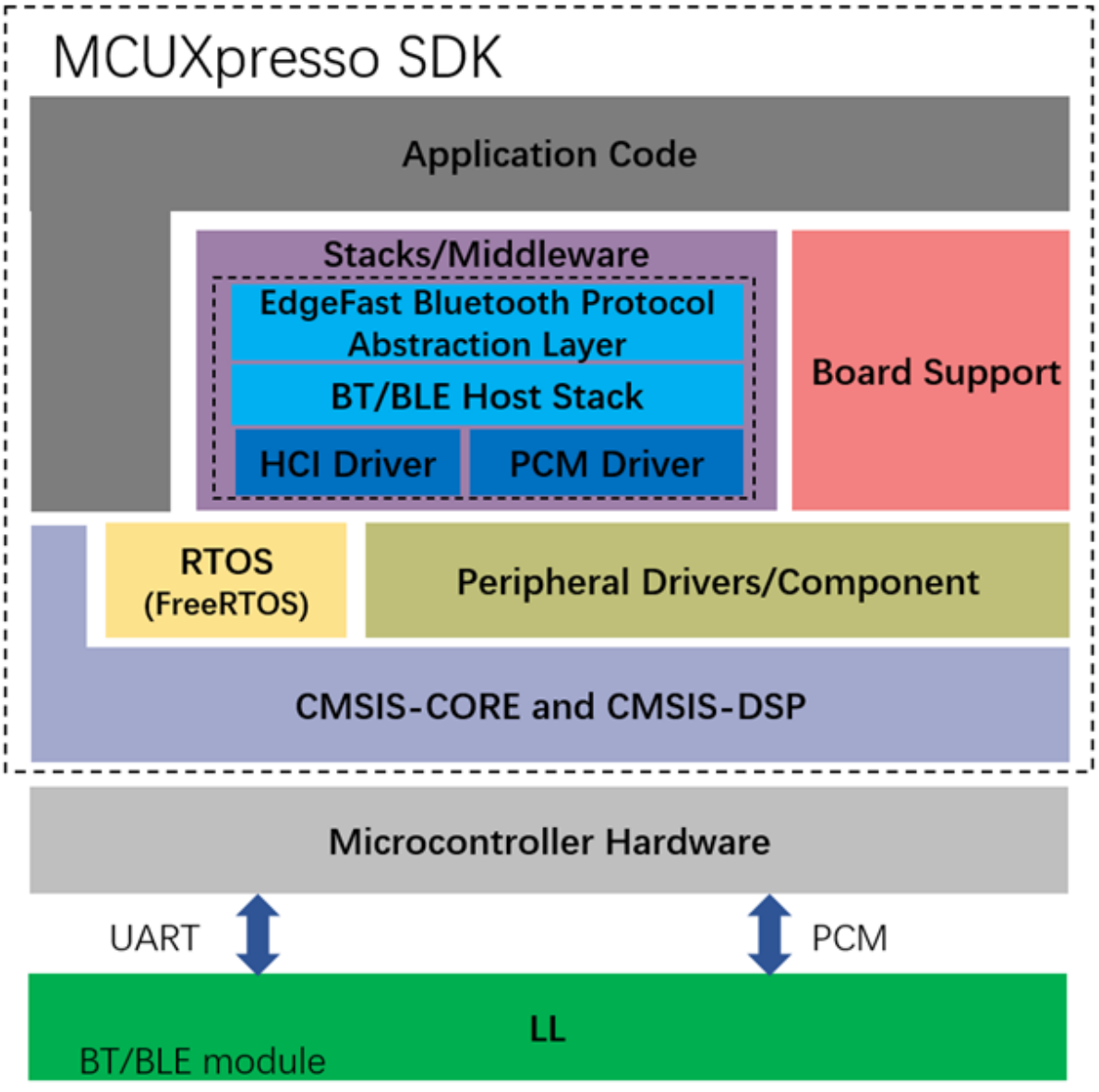
Parent topic:*Overview*

Architecture The figure Architecture of EdgeFast Bluetooth Protocol Abstraction Layer demo in MCUXpresso SDK below shows that the EdgeFast Bluetooth Protocol Abstraction Layer host stack is integrated into the MCUXpresso SDK as a middleware component. It leverages the RTOS, the board support, the peripheral driver/component, and other components in the MCUXpresso SDK. The Bluetooth application is built on top of the EdgeFast Bluetooth Protocol Abstraction Layer host stack and supports different peripheral features, Bluetooth features, and different RTOSes required by the user.

MCUXpresso SDK has the dual-chip architecture defined by EdgeFast Bluetooth Protocol Abstraction Layer project, the Bluetooth application code, and the EdgeFast Bluetooth Protocol Abstraction Layer host stack running on the reference board. For example, MIMXRT1060-EVK and the Linker Layer (LL) run on the Bluetooth modules like AW-AM457-USD, Murata Type 1XK, and Murata Type 1ZM and has single-chip architecture. Bluetooth Host stack and LL runs on the same chip, and communicate with Internal Communication Unit (IMU).

The communication between the host stack and the LL is implemented via the standard HCI UART interface and PCM interface for voice, or the IMU interface.

For details about the different components in MCUXpresso SDK, see *Getting Started with MCUXpresso SDK User's Guide* (document MCUXSDKGSUG) at *root/docs/Getting Started with MCUXpresso SDK.pdf*. For details on possible hardware rework requirements, see the hardware rework guide document of the relative board. For example, Hardware Rework Guide for EdgeFast BT PAL.



Parent topic:*Overview*

Features This section provides an overview of Bluetooth features, toolchain support, and RTOS support.

Bluetooth features

- Bluetooth 5.0 compliant
- Protocol support
  - L2CAP, GAP, GATT, RFCOMM, SDP, and SM

    Note: The Enhanced Attribute (EATT) protocol is not supported in the current version. However, the support will be available in a future version.
- Classic profile
  - SPP, A2DP, and HFP
- LE profile
  - HTP, PXP, IPSP, HPS
- Integrated the Fatfs based on USB Host MSD in SDK
- Digital Audio Interface including PCM interface for HFP

Parent topic: Features

Toolchain support

- IAR Embedded Workbench for ARM®
- MCUXpresso IDE
- Keil® MDK/µVision
- Makefiles support with GCC from Arm Embedded

Note: For details on IDE Development tools version details, see Section 3, Development tools in MCUXpresso SDK Release Notes (document MCUXSDKMIMXRT106XRN). The Release Notes document is available at *root/docs/ MCUXpresso SDK Release Notes for EVK-MIMXRT1060.pdf*.

Parent topic: Features

RTOS support

- FreeRTOSTMOS

Parent topic: Features

Parent topic:*Overview*

Examples list

- The following examples are provided. Not all the examples are implemented on all the boards. See the board package for a list of the implemented examples.
  - **central_hpc (central http proxy service client)**: Demonstrates a basic Bluetooth Low Energy Central role functionality. The application scans for other Bluetooth Low Energy devices and establishes a connection to the peripheral with the strongest signal. The application specifically looks for HPS Server and programs a set of characteristics that configures a Hyper Text Transfer Protocol (HTTP) request, initiates request, and reads the response once connected.

- **central_ht (central health thermometer)**: Demonstrates a basic Bluetooth Low Energy Central role functionality. The application scans for other Bluetooth Low Energy devices and establishes a connection to the peripheral with the strongest signal. The application specifically looks for health thermometer sensor and reports the die temperature readings once connected.
- **central_ipsp (central Internet protocol support profile)**: Demonstrates a basic Bluetooth Low Energy Central role functionality. The application scans for other Bluetooth Low Energy devices and establishes connection to the peripheral with the strongest signal. The application specifically looks for IPSP Service and communicates between the devices that support IPSP. Once connected, the communication is done using IPv6 packets over the Bluetooth Low Energy transport.
- **central_pxm (central proximity monitor)**: Demonstrates a basic Bluetooth Low Energy Central role functionality. The application scans for other Bluetooth Low Energy devices and establishes a connection to the peripheral with the strongest signal. The application specifically looks for Proximity Reporter.
- **peripheral beacon**: Demonstrates the Bluetooth Low Energy Peripheral role, This application implements types of beacon applications.
  - **beacon**: Demonstrates the Bluetooth Low Energy Broadcaster role functionality by advertising Company Identifier, Beacon Identifier, UUID, A, B, C, RSSI.
  - **Eddystone**: The Eddystone Configuration Service runs as a GATT service on the beacon while it is connectable and allows configuration of the advertised data, the broadcast power levels, and the advertising intervals.
  - **iBeacon**: Demonstrates the Bluetooth Low Energy Broadcaster role functionality by advertising an Apple iBeacon.
- **peripheral_hps (peripheral http proxy service)**: Demonstrates the Bluetooth Low Energy Peripheral role. The application specifically exposes the HTTP Proxy GATT Service.
- **peripheral_ht (peripheral health thermometer)**: Demonstrates the Bluetooth Low Energy Peripheral role. The application specifically exposes the HT (Health Thermometer) GATT Service. Once a device connects, it generates dummy temperature values.
- **peripheral_ipsp (peripheral Internet protocol support profile)**: Demonstrates the Bluetooth Low Energy Peripheral role. The application specifically exposes the Internet Protocol Support GATT Service.
- **peripheral_pxr (peripheral proximity reporter)**: Demonstrates the Bluetooth Low Energy Peripheral role. The application specifically exposes the Proximity Reporter (including LLS, IAS, and TPS) GATT Service.
- **wireless uart**: The application automatically starts advertising the wireless uart service and connects to the wireless uart service after the role switch. The wireless UART service is a custom service that implements a custom writable ASCII Char characteristic (UUID: 01ff0101-ba5e-f4ee-5ca1-eb1e5e4b1ce0) that holds the character written by the peer device.
- **spp (serial prot profile)**: Application demonstrates the use of the SPP feature.
- **handsfree**: Application demonstrating usage of the Hands-free Profile (HFP) feature.
- **handsfree_ag**: Application demonstrating usage of the Hands-free Profile Audio Gateway (HFP-AG) feature.
- **a2dp_sink**: Application demonstrating how to use the a2dp sink feature.
- **a2dp_source**: Application demonstrating how to use the a2dp source feature.
- **audio_profile**: Demonstrates the following functions.

    * There are five parts working in the demo: AWS cloud, Android app, audio demo (running on RT1060), U-disk, and Bluetooth headset.
    * With an app running on the smartphone (Android phone), the end user connects to the AWS cloud and controls the audio demo running on the RT1060 EVK board through AWS cloud. Some operations like play, play next, and pause are used to control the media play functionalities.
    * Audio demo running on the RT1060 EVK board connects to the AWS through WiFi. A connection establishes between the RT1060 EVK board and a Bluetooth headset. To get the media resource (mp3 files) from the U-disk, an HS USB host is enabled, and a U-disk with mp3 files is connected to RT1060 EVK board via the USB port. The audio demo searches the root directory of the U-disk for the music files (only mp3 files are supported) and uploads the song file list to AWS. The song list is shown in the app running on the smartphone. The music can then be played out via the Bluetooth headset once end user controls the app to play the mp3 file.

  – **wifi_provisioning**: Demonstrates the WiFi provisioning service that safely sends credential from phone to device over Bluetooth low energy. By default, AWS Wi-Fi provisioning demo starts advertising if the Wi-Fi access point (AP) is not configured and waits for the Wi-Fi AP configuration. After connecting to the Android APK, the demo executes the request from cellphone and sends the response. When the Wi-Fi AP is configured, the Shadow demo connects to the AWS via Wi-Fi and publishes the configured Wi-Fi AP information.
  – **shell**: Shell application demonstrating the shell mode of the simplified Adapter APIs.

Parent topic:*Overview*

Hardware For dual-chip implementation, the Bluetooth demo runs on a (reference board) along with the ported EdgeFast Bluetooth Protocol Abstraction Layer API host stack. The Linker Layer (LL) runs on a wireless module. A standard UART HCI and PCM is used to communicate between the two boards, the IMU is used to communicate in between. The Bluetooth host and controller stack run on different boards. The demo hardware requires two different boards; a development board for host stack and application and a wireless module adapter board for controller running. For example, the evkmimxrt1060 and uSD-15x15 Adapter Board for AW-AM457-uSD board, or any of the supported Murata modules with the Murata uSD-M.2 adapter. For details on the board hardware requirement and board setting, see the following documents. For one-chip implementation, the Bluetooth demo, EdgeFast Bluetooth Protocol Abstraction Layer API host stack, and LL run on one chip and they communicate with IMU.

- Hardware rework guide document of the relative board, Hardware Rework Guide for MIMXRT1060-EVK and AW-AM457-uSD, or Hardware Interconnection Guide for i.MX RT EVKs and Murata M.2 modules.
- Readme file of the examples.

Reference boards list

- MIMXRT1170: For details, see the quick start guide of this reference board (MIMXRT1170).
- MIMXRT685-EVK: For details, see the quick start guide of this reference board (MIMXRT685-EVK).
- MIMXRT595-EVK: For details, see the quick start guide of this reference board. (MIMXRT595-EVK).
- MIMXRT1050-EVKB: For details, see the quick start guide of this reference board (MIMXRT1050-EVKB).

Parent topic:*Hardware*

Dual-chip wireless module list

Module	HCI
uSD-15x15 Adapter Board for AW-AM457-uSD	UART
uSD-15x15 Adapter Board for AW-CM358-uSD	UART
uSD-15x15 Adapter Board for AW-AM510-uSD	UART
AW-CM358MA	UART
AW-CM510MA	UART
K32W061	UART
Murata uSD-M.2 Adapter (LBEE0ZZ1WE-uSD-M2) and Embedded Artists 1ZM M.2 Module (EAR00364)	UART
Murata uSD-M.2 Adapter (LBEE0ZZ1WE-uSD-M2) and Embedded Artists 1XK M.2 Module (EAR00385)	UART

For details on AzureWave module, see the quick start guide of this reference board AW-AM457-uSD, AW-CM358-uSD, AW-CM358MA, AW-AM510-uSD, AW-CM510MA, and K32W061.

For Murata documentation, refer to the Quick Start Guide and User Guide here.

Note: The boards and wireless module lists are not random combination. For the wireless module support list of specific board, see the readme.txt of each example.

Parent topic:*Hardware*

Demo This topic lists the steps to run a demo application using IAR, steps to run a demo application using MCUXpresso IDE, and steps to download LL firmware from the reference board. The following chapter uses RT1060 and peripheral_ht as an example.

Before you run the example, see the readme.txt in current the peripheral_ht directory and the Hardware Rework Guide for EdgeFast BT PAL document to set the jumper and connect the wireless module with development board.

The uSD type wireless module is similar to the Development board connector in the Run an IAR example section. If the module is M2 type, connect the module to the onboard M2 interface.

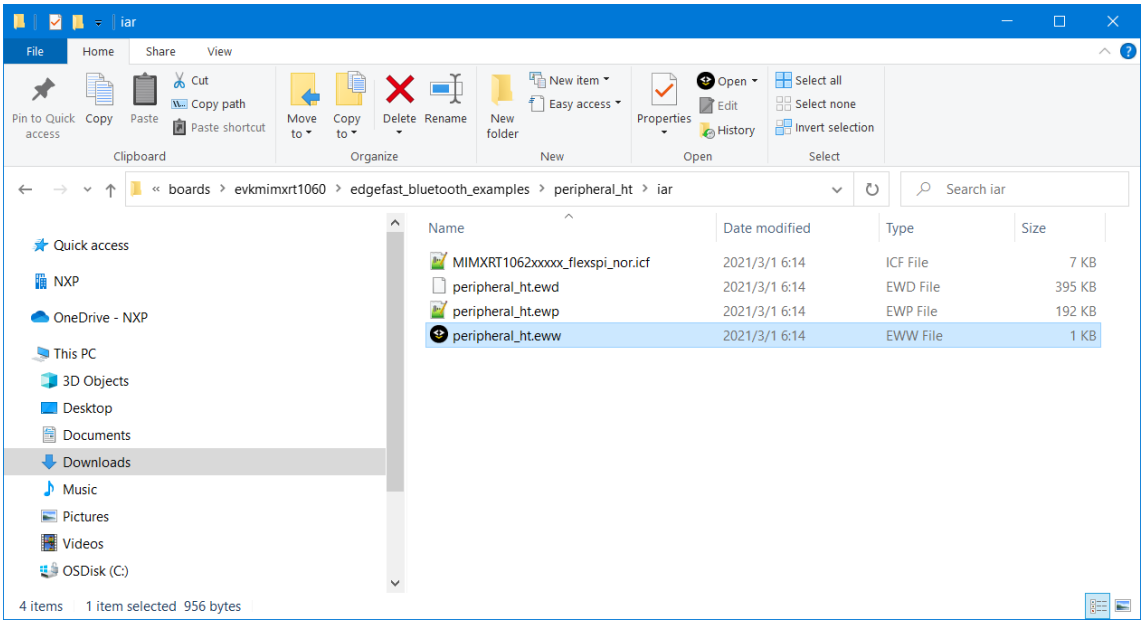
Run a demo application using IAR This document uses EVKRT1060 EdgeFast Bluetooth Protocol Abstraction Layer API example to describe the steps to open a project, build an example, and run a project. For details, see Section 3 in *Getting Started with MCUXpresso SDK User's Guide*(document MCUXSDKGSUG) at*root/docs/Getting Started with MCUXpresso SDK.pdf*.

Open an IAR example For the IAR Embedded Workbench, unpack the contents of the archive to a folder on a local drive.

1. The example projects are available at:

   <root>/boards/evkmimxrt1060/edgefast_bluetooth_examples/peripheral_ht/iar

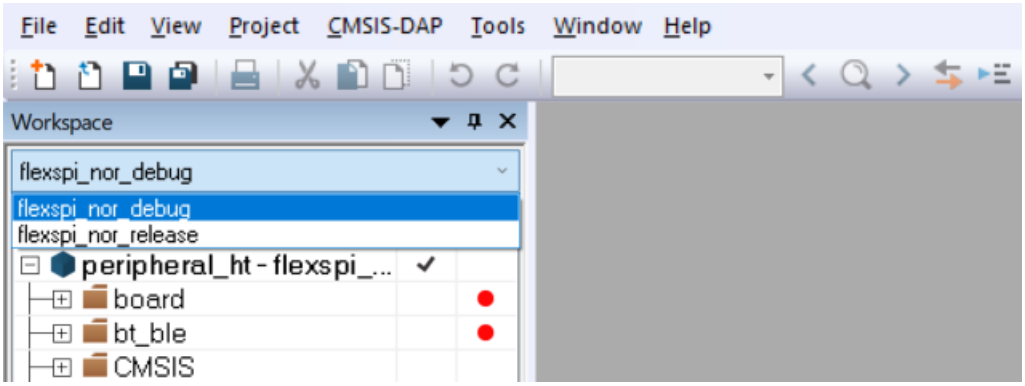
2. Open the IAR workspace file. For example, the highlighted *.eww format file



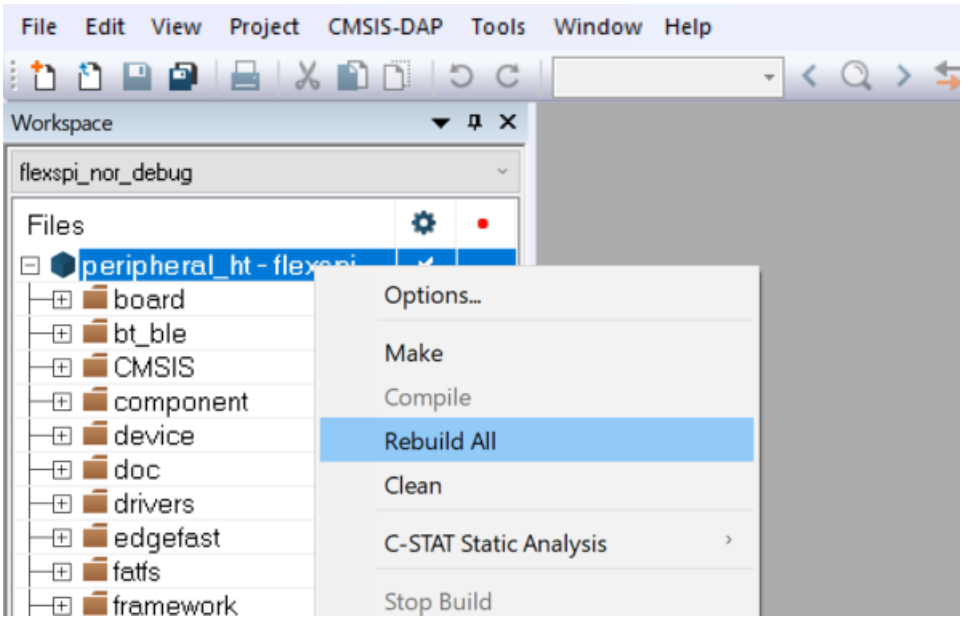
Parent topic: Run a demo application using IAR

Build an IAR example

1. Select flexspi_nor_debug or flexspi_nor_release configurations from the drop-down selector above the project tree in the workspace.



2. Build the EdgeFast Bluetooth Protocol Abstraction Layer project.

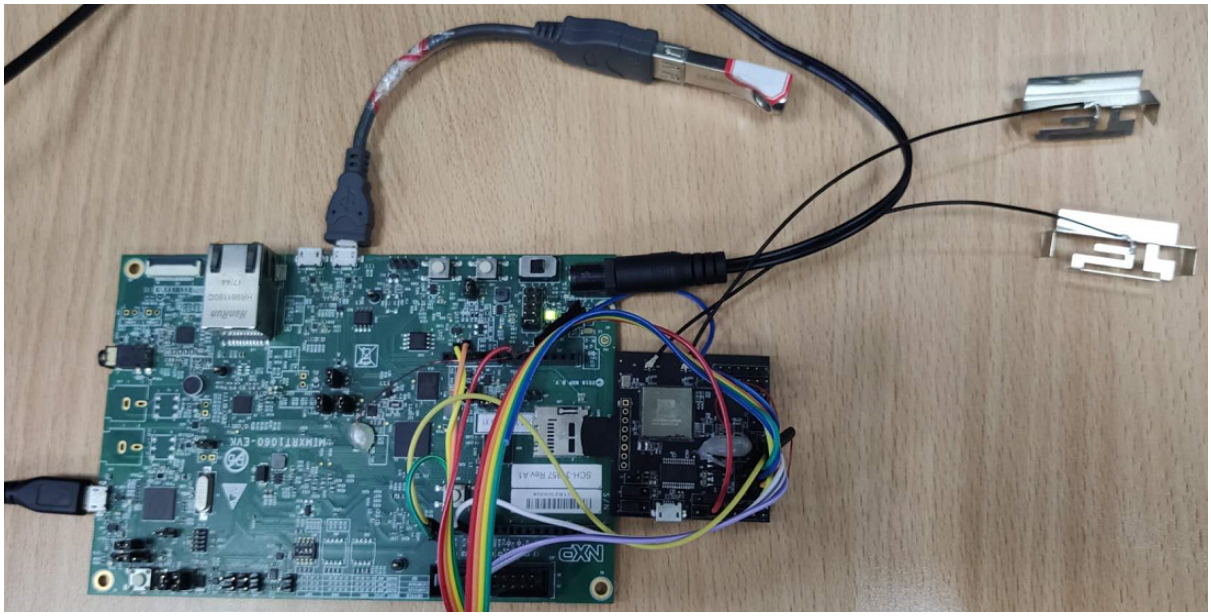


Note: Wireless module does not have flash hardware and requires 512 KB image loaded from board (such as RT1060) on system startup. The 512 KB image is kept on RT1060 side and only flexspi_nor target is supported for Bluetooth examples. Other targets are not supported because memory size limit.

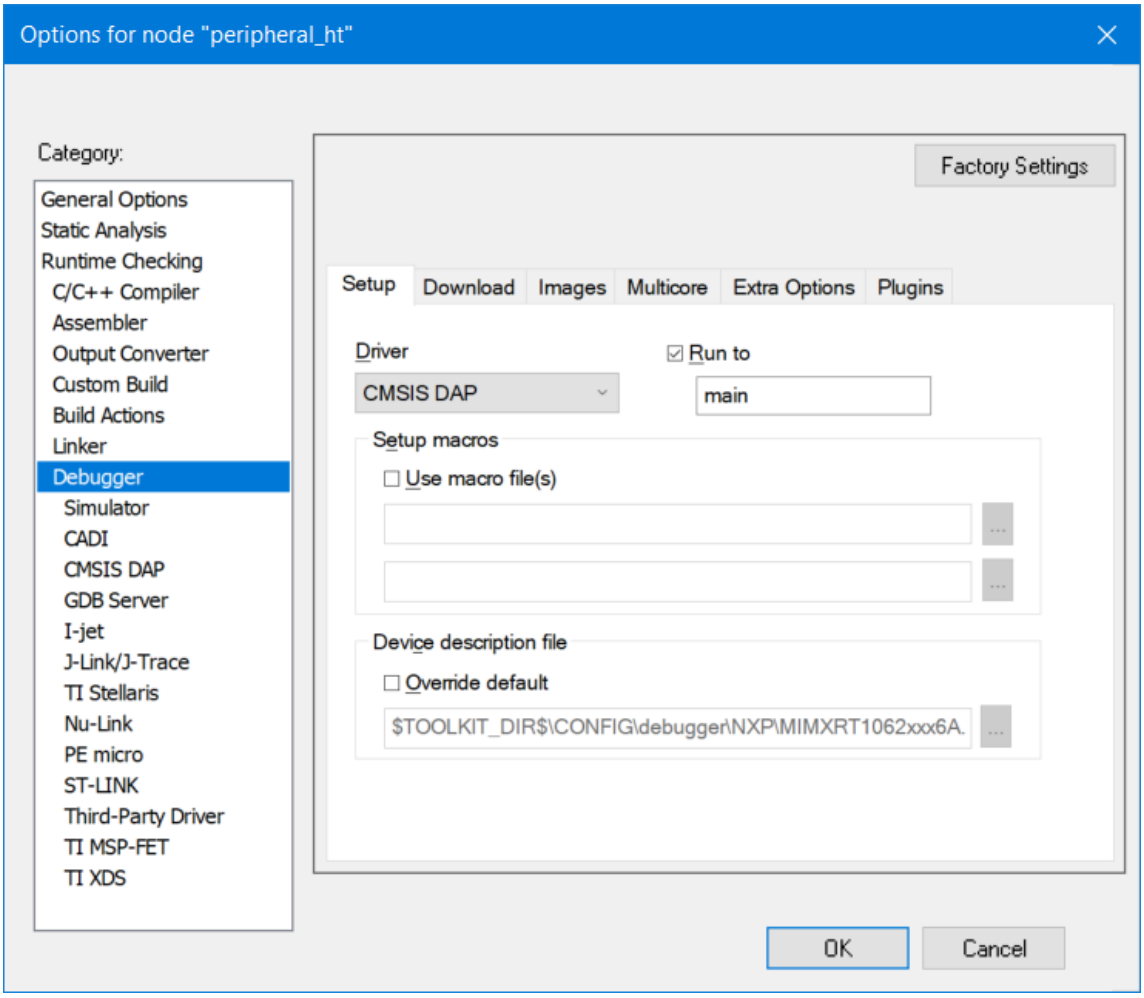
Parent topic: Run a demo application using IAR

Run an IAR example This document uses the peripheral_ht as an example to describe the steps to run an example. For details on other projects and compilers, see the readme file in the corresponding example directory.

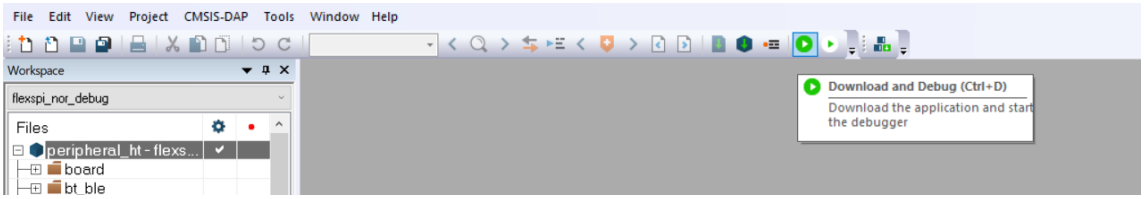
The following figure shows the connection of RT1060 and the uSD wireless module.



1. Connect the USB debug console port to PC. For example, connect J14 of EVKRT1060 to the PC.
2. Connect a 5 V power source to the J1 jack in the Wireless module board.
3. Make the appropriate debugger settings in the project options window, as shown in the figure below.



4. Click the **Download and Debug** button to flash the executable onto the board, as shown in the following figure. After the download is complete, if you must test the function of HFP, stop IAR debugging, and then connect the PCM interface. Reset the target board by manually.



5. Linker layer (LL) Firmware running in wireless module loads from EVKRT1060 by SDIO interface, so need take a bit time to download the LL firmware, “Initialize AW-AM457-uSD Driver” prints in the debug console. For example, it depends on the firmware. For details, see readme.txt.

Note: The projects are configured to use “CMSIS DAP” as the default debugger. Ensure that the OpenSDA chip of the board contains a CMSIS. DAP firmware or that the debugger selection corresponds to the physical interface used to interface to the board.

Parent topic: Run a demo application using IAR

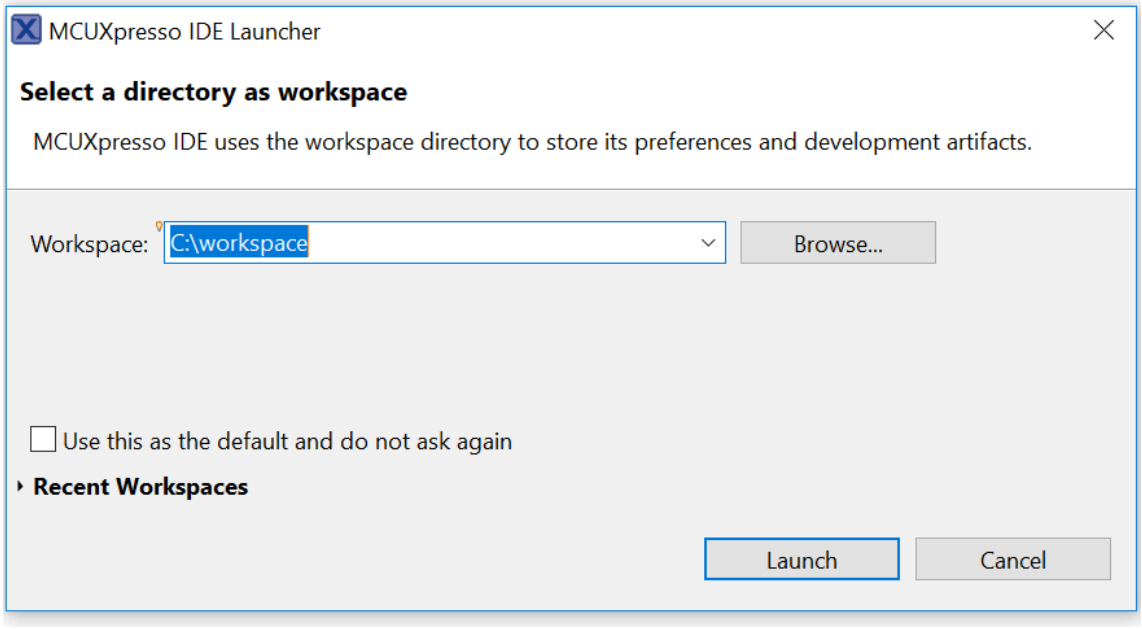
Parent topic:*Demo*

Run a demo application using MCUXpresso IDE This document uses peripheral_ht example to describe the steps to open a project, build an example, and run a project on MCUXpresso IDE.

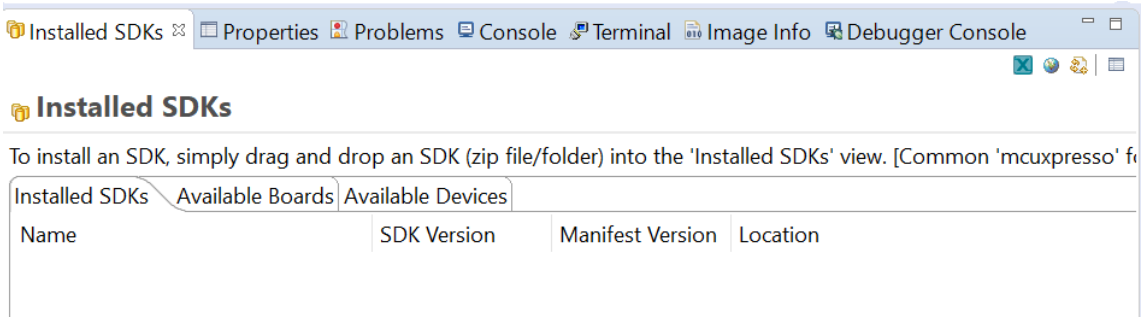
For details, see Section 3 in *Getting Started with MCUXpresso SDK User's Guide* (document MCUXSDKGSUG) at *root/docs/Getting Started with MCUXpresso SDK.pdf* and refer to the readme file in the corresponding demo's directory.

Open an MCUXpresso IDE example

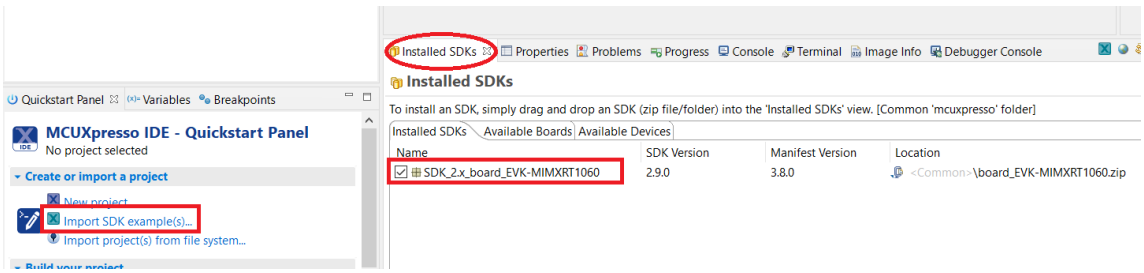
1. Open MCUXpresso IDE and open an existing or a new workspace location.



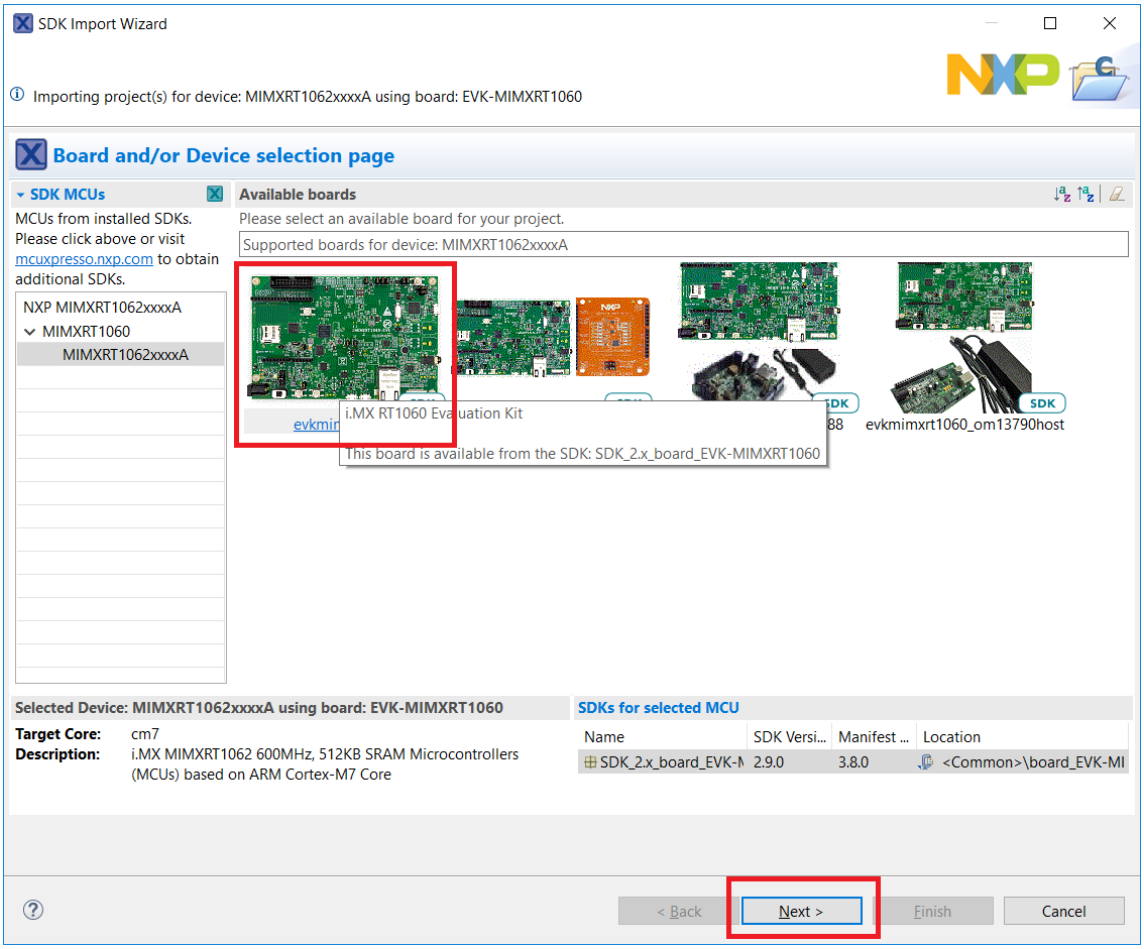
2. Drag and drop the package archive into the MCUXpresso Installed SDKs area in the lower right of the main window.



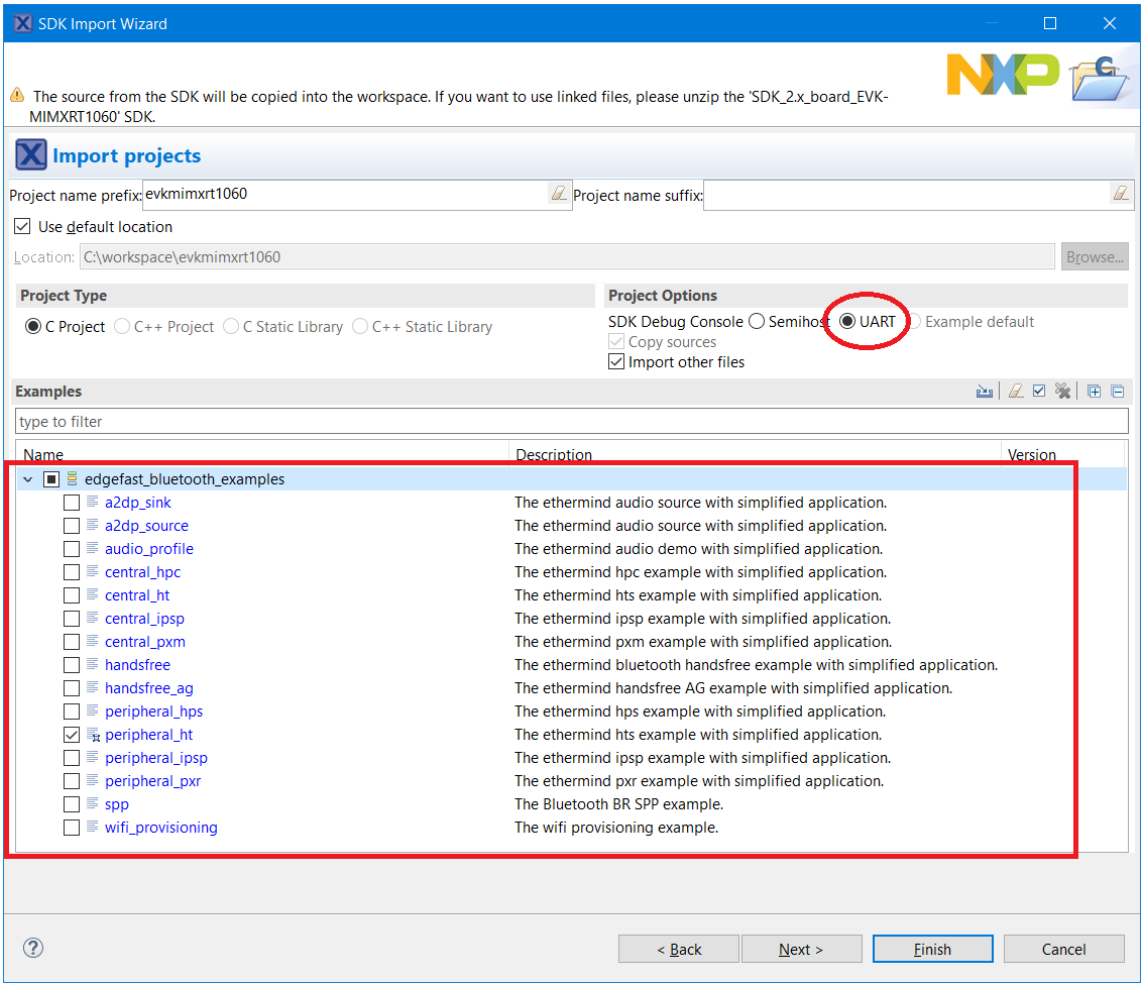
3. After the SDK is loaded successfully, select the **Import the SDK examples(s)...** to add examples to your workspace.



4. Select the evkmimxrt1060 board and click the **Next** button to select the desired example(s).



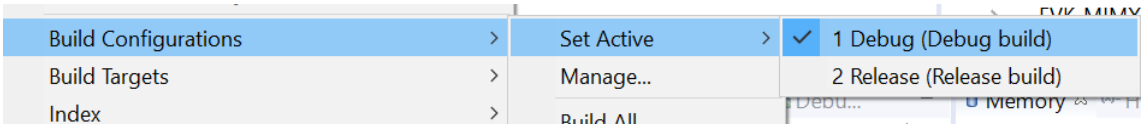
5. Select the evkmimxrt1060 board EdgeFast Bluetooth example. For example, peripheral_ht.
6. Ensure to change SDK debug console from **Semihost** to **UART**.
7. Click **Finish**.



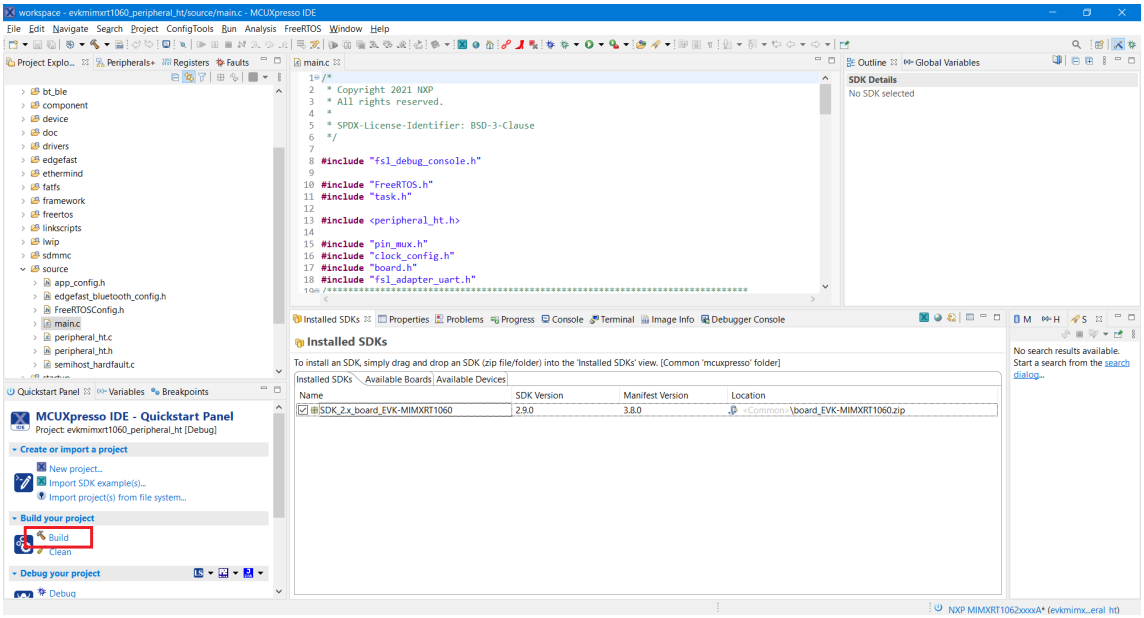
Parent topic: Run a demo application using MCUXpresso IDE

Build an MCUXpresso IDE example

1. Select desired target for your project.



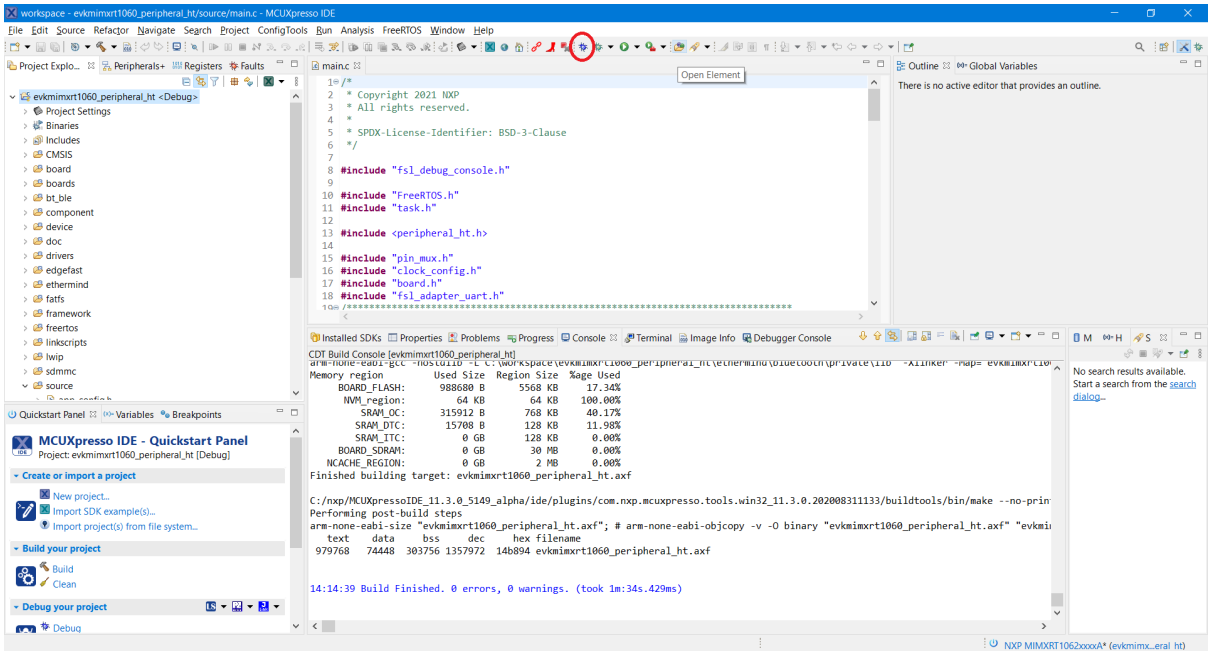
2. Build MCUXpresso IDE EdgeFast Bluetooth Protocol Abstraction Layer project.



Parent topic: Run a demo application using MCUXpresso IDE

Run an MCUXpresso IDE example For MCUXpresso IDE project running, all steps are similar to Run an IAR example except the steps of downloading image from compiler.

To download MCUXpresso IDE image to board, click the **Debug** button to download the executable file onto the board.



Parent topic: Run a demo application using MCUXpresso IDE

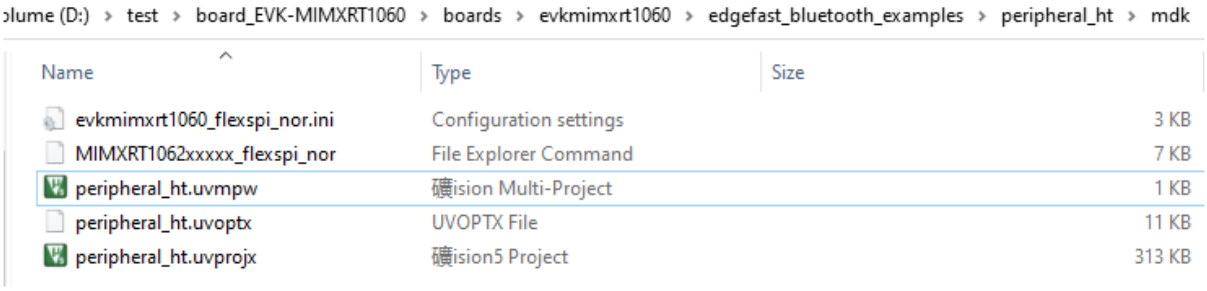
Parent topic:*Demo*

Run a demo application using MDK This document uses peripheral_ht example to describe the steps to open a project, build an example, and run a project on MDK.

For details, see the related section in the Getting Started with MCUXpresso SDK User's Guide (document: MCUXSDKGSUG) in the directory *root/docs/* and the readme file in the corresponding demo's directory.

Open an MDK project For the IAR Embedded Workbench, unpack the contents of the archive to a folder on a local drive.

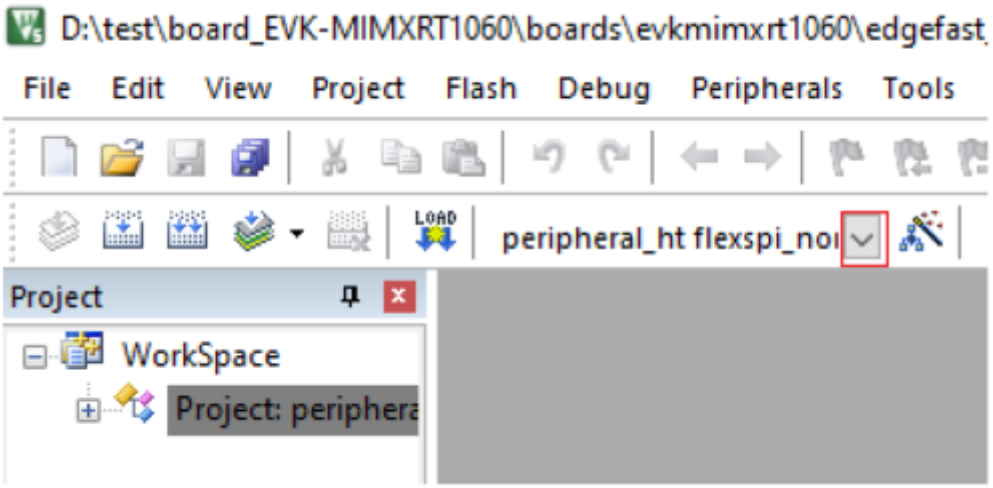
1. The example projects are available at: <root>/boards/evkmimxrt1060/edgefast_bluetooth_examples/peripheral_ht/mdk.
2. Open the mdk workspace file. For example, the highlighted *.uvmpw format file.



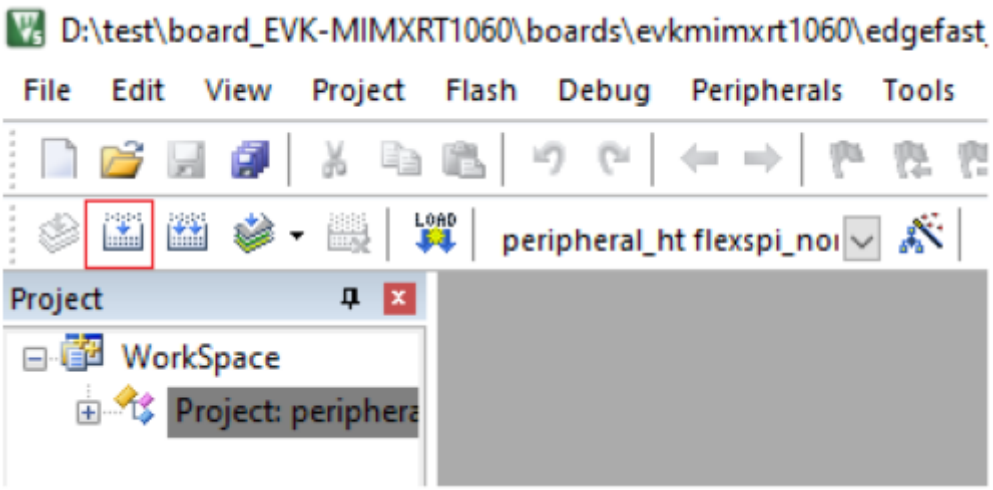
Parent topic: Run a demo application using MDK

Build an MDK example To build an MDK example:

1. Select *flexspi_nor_debug* or *flexspi_nor_release* configurations from the drop-down selector above the project tree in the workspace.



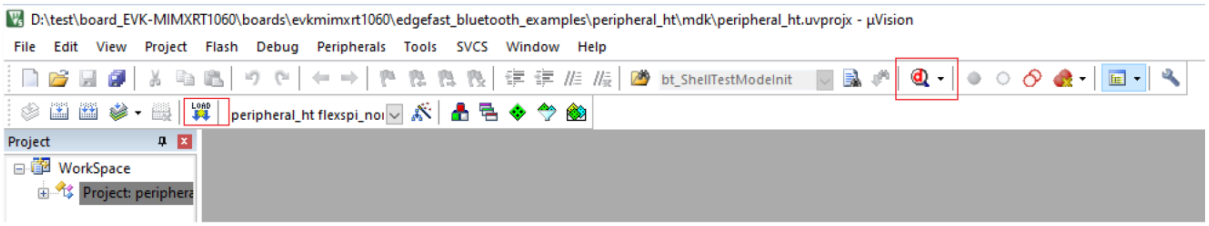
2. Click the highlighted icon to build the EdgeFast Bluetooth Protocol Abstraction Layer project.



Parent topic: Run a demo application using MDK

Run an MDK example For MDK project running, all steps are similar to Run an IAR example except the steps of downloading image from compiler.

To download the MDK image to the board, click the **Debug** button. The executable file downloads to the board.



Parent topic: Run a demo application using MDK

Parent topic:*Demo*

Run a demo application using Arm GCC This document uses peripheral_ht example to describe the steps to open a project, build an example, and run a project on MDK.

For details, see the related section in *Getting Started with MCUXpresso SDK User's Guide* (document: MCUXSDKGSUG) at *root/docs/* and the readme file in the corresponding demo's directory.

Setup tool chains See the section "Run a demo using Arm GCC" of getting start document. For example, *Getting Started with MCUXpresso SDK for MIMXRT1160-EVK*.

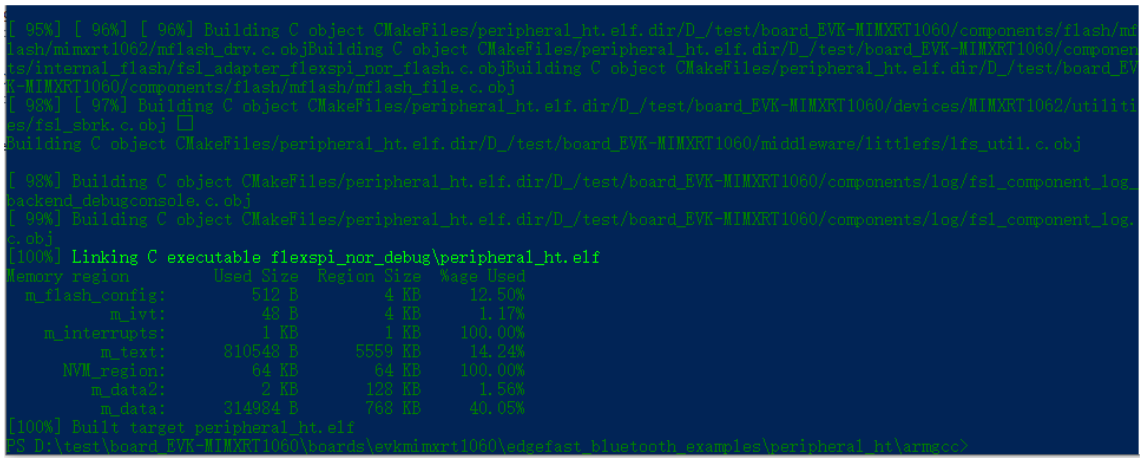
Parent topic: Run a demo application using Arm GCC

Build a GCC example To build a GCC example:

1. Change the directory to the project directory: <install_dir>\boards\evkmimxrt1060\edgefast_bluetooth_examples\peripheral_ht\armgcc.
2. Run the build script.

   For windows, the script is build_flexspi_nor_debug.bat/ build_flexspi_nor_release.bat.

   The build output is shown in the following figure.



Parent topic: Run a demo application using Arm GCC

Run a GCC example Refer to the section "Run a demo using Arm GCC" of the getting start document. For example, see Getting Started with MCUXpresso SDK for MIMXRT1060-EVK. The peripheral_ht.elf is the target to download.

Parent topic: Run a demo application using Arm GCC

Parent topic:*Demo*

Download Linker Layer firmware from the reference board Download the Linker Layer (LL) Firmware from Reference board EVKRT1060 by SDIO interface before running the Bluetooth Controller stack. The LL download is necessary because wireless module does not support flash.

Parent topic:*Demo*

Change board-specific parameters There are some board-specific parameters that can be changed in the application layer for EdgeFast BT PAL.

Change HCI UART parameters Since the controller can support different baud rates, the demo provides an interface with configurable baud rates. The function*controller_hci_uart_get_configuration* is used to get HCI UART parameters, including the instance, default baud rate, which depends on the controller, running baud rate which defined by macro BOARD_BT_UART_BAUDRATE and so on. If this function returns '0' and the running baud rate is inconsistent with the default baud rate, EdgeFast BT PAL switches the baud rate of the controller to the running baud rate.

Parent topic: Change board-specific parameters

Change USB Host stack parameters Since the board supports multiple USB ports, the demo provides a configurable interface for USB Host stack. The function*USB_HostGetConfiguration* received the instance of USB for EdgeFast BT PAL. For the case where there is a USBPHY, the demo configures the properties of the PHY through*USB_HostPhyGetConfiguration*.

Note: There are series of hex bytes printed on the console after the wireless module resets. However, it does not impact the EdgeFast BT PAL application running.

Parent topic: Change board-specific parameters

Parent topic:*Demo*

Known issues This section provides a list of known issues in the release package.

Notes This section provides a list of notes to use EdgeFast Bluetooth stack

- the follow configuration items related to resource needs more attention
  - CONFIG_BT_MAX_CONN The max connections that can be created.
  - CONFIG_BT_MAX_PAIRED The max supported paired devices.
  - CONFIG_BT_BUF_EVT_RX_COUNT The max received hci events and acl data packets at one time if the sys work queue task is blocked. One example is: when LE connection is created and HCI_LE_Enhanced_Connection_Complete is received, the sys work queue task is busy with processing the HCI_LE_Enhanced_Connection_Complete. If the received hci events exceed CONFIG_BT_BUF_EVT_RX_COUNT, it may leads potential issue, please increase value of the macro.
- All the EdgeFast Bluetooth API should be called only after EdgeFast Bluetooth is initialized.
- Don't send HCI cmd from the sys work queue task or any stack's callbacks.

CONFIG_BT_BUF_RESERVE

Buffer reserved length, suggested value is 8.

CONFIG_BT_SNOOP

Whether enable bt snoop feature, 0 - disable, 1 - enable.

CONFIG_BT_HCI_CMD_COUNT

Number of HCI command buffers, ranging from 2 to 64. Number of buffers available for HCI commands Range 2 to 64 is valid.

CONFIG_BT_RX_BUF_COUNT

Number of HCI RX buffers, ranging from 2 to 255. Number of buffers available for incoming ACL packets or HCI events from the controller Range 2 to 255 is valid.

CONFIG_BT_RX_BUF_LEN

Maximum supported HCI RX buffer length, ranging from 73 to 2000. Maximum data size for each HCI RX buffer. This size includes everything starting with the ACL or HCI event headers. Note that buffer sizes are always rounded up to the nearest multiple of 4, so if this Kconfig value is something else then there is some wasted space. The minimum of 73 has been taken for LE SC which has an L2CAP MTU of 65 bytes. On top of this, The L2CAP header (4 bytes) and the ACL header (also 4 bytes) which yields 73 bytes. Range is 73 to 2000.

CONFIG_BT_HCI_RESERVE

Reserve buffer size for user. Headroom that the driver needs for sending and receiving buffers. Add a new 'default' entry for each new driver.

CONFIG_BT_DISCARDABLE_BUF_COUNT

Number of discardable event buffers, if the macro is set to 0, disable this feature, if greater than 0, this feature is enabled. Number of buffers in a separate buffer pool for events which the HCI driver considers discardable. Examples of such events could be , for example, Advertising Reports. The benefit of having such a pool means that if there is a heavy inflow of such events it does not cause the allocation for other critical events to block and may even eliminate deadlocks in some cases.

CONFIG_BT_DISCARDABLE_BUF_SIZE

Size of discardable event buffers, ranging from 45 to 257. Size of buffers in the separate discardable event buffer pool. The minimum size is set based on the Advertising Report. Setting the buffer can save memory if with size set differently from that of the CONFIG_BT_RX_BUF_LEN. range is 45 to 257.

CONFIG_BT_HCI_TX_STACK_SIZE

HCI TX task stack size needed for executing bt_send with specified driver, should be no less than 512.

CONFIG_BT_HCI_TX_PRIO

HCI TX task priority.

CONFIG_BT_RX_STACK_SIZE

Size of the receiving thread stack. This is the context from which all event callbacks to the application occur. The default value is sufficient for basic operation, but if the application needs to do advanced things in its callbacks that require extra stack space, this value can be increased to accommodate for that.

CONFIG_BT_RX_PRIO

RX task priority.

CONFIG_BT_PERIPHERAL

Peripheral Role support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. Select this for LE Peripheral role support.

CONFIG_BT_BROADCASTER

Broadcaster Role support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. Select this for LE Broadcaster role support.

CONFIG_BT_EXT_ADV

Extended Advertising and Scanning support [EXPERIMENTAL], if the macro is set to 0, feature is disabled, if 1, feature is enabled. Select this to enable Extended Advertising API support. This enables support for advertising with multiple advertising sets, extended advertising data, and advertising on LE Coded PHY. It enables support for receiving extended advertising data as a scanner, including support for advertising data over the LE coded PHY. It enables establishing connections over LE Coded PHY.

CONFIG_BT_CENTRAL

Central Role support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. Select this for LE Central role support.

CONFIG_BT_WHITELIST

Enable whitelist support. This option enables the whitelist API. This takes advantage of the whitelisting feature of a Bluetooth LE controller. The whitelist is a global list and the same whitelist is used by both scanner and advertiser. The whitelist cannot be modified while it is in use. An Advertiser can whitelist which peers can connect or request scan response data. A scanner can whitelist advertiser for which it generates advertising reports. Connections can be established automatically for whitelisted peers.

This option deprecates the bt_le_set_auto_conn API in favor of the bt_conn_create_aute_le API.

CONFIG_BT_DEVICE_NAME

Bluetooth device name. Name can be up to 248 bytes long (excluding NULL termination). Can be empty string.

CONFIG_BT_DEVICE_APPEARANCE

Bluetooth device appearance. For the list of possible values, see the link: www.bluetooth.com/specifications/assigned-numbers.

CONFIG_BT_DEVICE_NAME_DYNAMIC

Allow to set Bluetooth device name on runtime. Enabling this option allows for runtime configuration of Bluetooth device name.

CONFIG_BT_ID_MAX

Maximum number of local identities, range 1 to 10 is valid. Maximum number of supported local identity addresses. For most products, this is safe to leave as the default value (1). Range 1 to 10 is valid.

CONFIG_BT_CONN

Connection enablement, if the macro is set to 0, feature is disabled, if 1, feature is enabled.

CONFIG_BT_MAX_CONN

it is the max connection supported by host stack. Maximum number of simultaneous Bluetooth connections supported.

CONFIG_BT_HCI_ACL_FLOW_CONTROL

Controller to host ACL flow control support. Enable support for throttling ACL buffers from the controller to the host. This is useful when the host and controller are on separate cores, since it ensures that we do not run out of incoming ACL buffers.

CONFIG_BT_PHY_UPDATE

PHY Update, if the macro is set to 0, feature is disabled, if 1, feature is enabled. Enable support for Bluetooth 5.0 PHY Update Procedure.

CONFIG_BT_DATA_LEN_UPDATE

Data Length Update. If the macro is set to 0, feature is disabled, if 1, feature is enabled. Enable support for Bluetooth v4.2 LE Data Length Update procedure.

CONFIG_BT_CREATE_CONN_TIMEOUT

Timeout for pending LE Create Connection command in seconds.

CONFIG_BT_CONN_PARAM_UPDATE_TIMEOUT

Peripheral connection parameter update timeout in milliseconds, range 1 to 65535 is valid. The value is a timeout used by peripheral device to wait until it starts the connection parameters update procedure to change default connection parameters. The default value is set to 5s, to comply with BT protocol specification: Core 4.2 Vol 3, Part C, 9.3.12.2 Range 1 to 65535 is valid.

CONFIG_BT_CONN_TX_MAX

Maximum number of pending TX buffers. Maximum number of pending TX buffers that have not yet been acknowledged by the controller.

CONFIG_BT_REMOTE_INFO

Enable application access to remote information. Enable application access to the remote information available in the stack. The remote information is retrieved once a connection has been established and the application is notified when this information is available through the remote_version_available connection callback.

CONFIG_BT_REMOTE_VERSION

Enable fetching of remote version. Enable this to get access to the remote version in the Controller and in the host through bt_conn_get_info(). The fields in question can be then found in the bt_conn_info struct.

CONFIG_BT_SMP_SC_ONLY

Secure Connections Only Mode. This option enables support for Secure Connection Only Mode. In this mode device shall only use Security Mode 1 Level 4 with exception for services that only require Security Mode 1 Level 1 (no security). Security Mode 1 Level 4 stands for authenticated LE Secure Connections pairing with encryption. Enabling this option disables legacy pairing.

CONFIG_BT_SMP_OOB_LEGACY_PAIR_ONLY

Force Out of Band Legacy pairing. This option disables Legacy and LE SC pairing and forces legacy OOB.

CONFIG_BT_SMP_DISABLE_LEGACY_JW_PASSKEY

Forbid usage of insecure legacy pairing methods. This option disables Just Works and Passkey legacy pairing methods to increase security.

CONFIG_BT_PRIVACY

Privacy Feature, if the macro is set to 0, feature is disabled, if 1, feature is enabled. Enable local Privacy Feature support. This makes it possible to use Resolvable Private Addresses (RPAs).

CONFIG_BT_ECC

Enable ECDH key generation support. This option adds support for ECDH HCI commands.

CONFIG_BT_TINYCRYPT_ECC

Use TinyCrypt library for ECDH. If this option is used to set TinyCrypt library which is used for emulating the ECDH HCI commands and events needed by e.g. LE Secure Connections. In builds including the Bluetooth LE host, if don't set the controller crypto which is used for ECDH and if the controller doesn't support the required HCI commands the LE Secure Connections support will be disabled. In builds including the HCI Raw interface and the Bluetooth LE controller, this

option injects support for the 2 HCI commands required for LE Secure Connections so that hosts can make use of those. The option defaults to enabled for a combined build with Zephyr's own controller, since it does not have any special ECC support itself (at least not currently).

CONFIG_BT_TINYCRYPT_ECC_PRIORITY

Thread priority of ECC Task.

CONFIG_BT_HCI_ECC_STACK_SIZE

Thread stack size of ECC Task.

CONFIG_BT_RPA

Bluetooth Resolvable Private Address (RPA)

CONFIG_BT_RPA_TIMEOUT

Resolvable Private Address timeout, defaults to 900 seconds. This option defines how often resolvable private address is rotated. Value is provided in seconds and defaults to 900 seconds (15 minutes).

CONFIG_BT_SIGNING

Data signing support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables data signing which is used for transferring authenticated data in an unencrypted connection.

CONFIG_BT_SMP_APP_PAIRING_ACCEPT

Accept or reject pairing initiative. When receiving pairing request or pairing response queries, the application shall either accept proceeding with pairing or not. This is for pairing over SMP and does not affect SSP, which will continue pairing without querying the application. The application can return an error code, which is translated into an SMP return value if the pairing is not allowed.

CONFIG_BT_SMP_ALLOW_UNAUTH_OVERWRITE

Allow unauthenticated pairing for paired device. This option allows all unauthenticated pairing attempts made by the peer where an unauthenticated bond already exists. This would enable cases where an attacker could copy the peer device address to connect and start an unauthenticated pairing procedure to replace the existing bond. When this option is disabled in order to create a new bond the old bond must be explicitly deleted with bt_unpair.

CONFIG_BT_FIXED_PASSKEY

Use a fixed passkey for pairing, set passkey to fixed or not. With this option enabled, the application will be able to call the bt_passkey_set() API to set a fixed passkey. If set, the pairing_confim() callback will be called for all incoming pairings.

CONFIG_BT_BONDABLE

Bondable Mode, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables support for Bondable Mode. In this mode, Bonding flag in AuthReq of SMP Pairing Request/Response is set indicating the support for this mode.

CONFIG_BT_BONDING_REQUIRED

Always require bonding. When this option is enabled remote devices are required to always set the bondable flag in their pairing request. Any other kind of requests will be rejected.

CONFIG_BT_SMP_ENFORCE_MITM

Enforce MITM protection, if the macro is set to 0, feature is disabled, if 1, feature is enabled. With this option enabled, the Security Manager is set MITM option in the Authentication Requirements Flags whenever local IO Capabilities allow the generated key to be authenticated.

CONFIG_BT_OOB_DATA_FIXED

Use a fixed random number for LESC OOB pairing. With this option enabled, the application will be able to perform LESC pairing with OOB data that consists of fixed random number and confirm value. This option should only be enabled for debugging and should never be used in production.

CONFIG_BT_KEYS_OVERWRITE_OLDEST

Overwrite oldest keys with new ones if key storage is full. With this option enabled, if a pairing attempt occurs and the key storage is full, then the oldest keys in storage will be removed to free space for the new pairing keys.

CONFIG_BT_HOST_CCM

Enable host side AES-CCM module. Enables the software-based AES-CCM engine in the host. Will use the controller's AES encryption functions if available, or BT_HOST_CRYPTO otherwise.

CONFIG_BT_L2CAP_RX_MTU

Maximum supported L2CAP MTU for incoming data, if CONFIG_BT_SMP is set, range is 65 to 1300, otherwise range is 23 to 1300. Maximum size of each incoming L2CAP PDU. Range is 23 to 1300 range is 65 to 1300 for CONFIG_BT_SMP.

CONFIG_BT_L2CAP_TX_BUF_COUNT

Number of buffers available for outgoing L2CAP packets, ranging from 2 to 255. Range is 2 to 255.

CONFIG_BT_L2CAP_TX_FRAG_COUNT

Number of L2CAP TX fragment buffers, ranging from 0 to 255. Number of buffers available for fragments of TX buffers.

Warning: Setting this to 0 means that the application must ensure that queued TX buffers never need to be fragmented, that is the controller's buffer size is large enough. If this is not ensured, and there are no dedicated fragment buffers, a deadlock may occur. In most cases the default value of 2 is a safe bet. Range is 0 to 255.

CONFIG_BT_L2CAP_TX_MTU

Maximum supported L2CAP MTU for L2CAP TX buffers, if CONFIG_BT_SMP is set, the range is 65 to 2000. Otherwise, range is 23 to 2000. Range is 23 to 2000. Range is 65 to 2000 for CONFIG_BT_SMP.

CONFIG_BT_L2CAP_DYNAMIC_CHANNEL

L2CAP Dynamic Channel support. This option enables support for LE Connection oriented Channels, allowing the creation of dynamic L2CAP Channels.

CONFIG_BT_L2CAP_DYNAMIC_CHANNEL

L2CAP Dynamic Channel support. This option enables support for LE Connection oriented Channels, allowing the creation of dynamic L2CAP Channels.

Bluetooth BR/EDR support [EXPERIMENTAL] This option enables Bluetooth BR/EDR support.

CONFIG_BT_ATT_PREPARE_COUNT

Number of ATT prepares write buffers, if the macro is set to 0, feature is disabled, if greater than 1, feature is enabled. Number of buffers available for ATT prepares write, setting this to 0 disables GATT long/reliable writes.

CONFIG_BT_ATT_TX_MAX

Maximum number of queued outgoing ATT PDUs. Number of ATT PDUs that can be at a single moment queued for transmission. If the application tries to send more than this amount the calls blocks until an existing queued PDU gets sent. Range is 1 to CONFIG_BT_L2CAP_TX_BUF_COUNT.

CONFIG_BT_GATT_SERVICE_CHANGED

GATT Service Changed support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables support for the service changed characteristic.

CONFIG_BT_GATT_DYNAMIC_DB

GATT dynamic database support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables registering/unregistering services at runtime.

CONFIG_BT_GATT_CACHING

GATT Caching support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables support for GATT Caching. When enabled the stack registers Client Supported Features and Database Hash characteristics which is used by clients to detect if anything has changed on the GATT database.

CONFIG_BT_GATT_CLIENT

GATT client support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables support for the GATT Client role.

CONFIG_BT_GATT_READ_MULTIPLE

GATT Read Multiple Characteristic. Values support, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables support for the GATT Read Multiple Characteristic Values procedure.

CONFIG_BT_GAP_AUTO_UPDATE_CONN_PARAMS

Automatic Update of Connection Parameters, if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option, if enabled, allows automatically sending request for connection parameters update after GAP recommended 5 seconds of connection as peripheral.

CONFIG_BT_GAP_PERIPHERAL_PREF_PARAMS

Configure peripheral preferred connection parameters. This configures peripheral preferred connection parameters. Enabling this option results in adding PPCP characteristic in GAP. If disabled it is up to application to set expected connection parameters.

CONFIG_BT_MAX_PAIRED

Maximum number of paired devices. Maximum number of paired Bluetooth devices. The minimum (and default) number is 1.

CONFIG_BT_MAX_SCO_CONN

Maximum number of simultaneous SCO connections. Maximum number of simultaneous Bluetooth synchronous connections supported. The minimum (and default) number is 1. Range 1 to 3 is valid.

CONFIG_BT_RFCOMM

Bluetooth RFCOMM protocol support [EXPERIMENTAL], if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables Bluetooth RFCOMM support.

CONFIG_BT_RFCOMM_L2CAP_MTU

L2CAP MTU for RFCOMM frames. Maximum size of L2CAP PDU for RFCOMM frames.

CONFIG_BT_HFP_HF

Bluetooth Handsfree profile HF Role support [EXPERIMENTAL], if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables Bluetooth HF support.

CONFIG_BT_AVDTP

Bluetooth AVDTP protocol support [EXPERIMENTAL], if the macro is set to 0, feature is disabled, if 1, feature is enabled. This option enables Bluetooth AVDTP support.

CONFIG_BT_A2DP

Bluetooth A2DP Profile [EXPERIMENTAL]. This option enables the A2DP profile.

CONFIG_BT_A2DP_SOURCE

Bluetooth A2DP profile source function. This option enables the A2DP profile Source function.

CONFIG_BT_A2DP_SINK

Bluetooth A2DP profile sink function. This option enables the A2DP profile Sink function.

CONFIG_BT_A2DP_TASK_PRIORITY

Bluetooth A2DP profile task priority. This option sets the task priority. The task is used to process the streamer data and retry command.

CONFIG_BT_A2DP_TASK_STACK_SIZE

Bluetooth A2DP profile task stack size. This option sets the task stack size.

CONFIG_BT_PAGE_TIMEOUT

Bluetooth Page Timeout. This option sets the page timeout value. Value is selected as (N * 0.625) ms.

CONFIG_BT_DIS_MODEL

Model name. The device model inside Device Information Service.

CONFIG_BT_DIS_MANUF

Manufacturer name. The device manufacturer inside Device Information Service.

CONFIG_BT_DIS_PNP

Enable PnP_ID characteristic. Enable PnP_ID characteristic in Device Information Service.

CONFIG_BT_DIS_PNP_VID_SRC

Vendor ID source, range 1 - 2. The Vendor ID Source field designates which organization assigned the value used in the Vendor ID field value. The possible values are:

- 1 Bluetooth SIG, the Vendor ID was assigned by the Bluetooth SIG
- 2 USB IF, the Vendor ID was assigned by the USB IF

CONFIG_BT_DIS_PNP_VID

Vendor ID, range 0 - 0xFFFF. The Vendor ID field is intended to uniquely identify the vendor of the device. This field is used in conjunction with Vendor ID Source field, which determines which organization assigned the Vendor ID field value. Note: The Bluetooth Special Interest Group assigns Device ID Vendor ID, and the USB Implementers Forum assigns Vendor IDs, either of which can be used for the Vendor ID field value. Device providers should procure the Vendor ID from the USB Implementers Forum or the Company Identifier from the Bluetooth SIG.

CONFIG_BT_DIS_PNP_PID

Product ID, range 0 - 0xFFFF. The Product ID field is intended to distinguish between different products made by the vendor identified with the Vendor ID field. The vendors themselves manage Product ID field values.

CONFIG_BT_DIS_PNP_VER

Product Version, range 0 - 0xFFFF. The Product Version field is a numeric expression identifying the device release number in Binary-Coded Decimal. This is a vendor-assigned value, which defines the version of the product identified by the Vendor ID and Product ID fields. This field is intended to differentiate between versions of products with identical Vendor IDs and Product IDs. The value of the field value is 0xJJMN for version JJ.M.N (JJ - major version number, M - minor version number, N - subminor version number); For example, version 2.1.3 is represented with value 0x0213 and version 2.0.0 is represented with a value of 0x0200. When upward-compatible changes are made to the device, it is recommended that the minor version number be incremented. If incompatible changes are made to the device. It is recommended that the major version number is incremented. The subminor version is incremented for bug fixes.

CONFIG_BT_DIS_SERIAL_NUMBER

Enable DIS Serial number characteristic, 1 - enable, 0 - disable. Enable Serial Number characteristic in Device Information Service.

CONFIG_BT_DIS_SERIAL_NUMBER_STR

Serial Number. Serial Number characteristic string in Device Information Service.

CONFIG_BT_DIS_FW_REV

Enable DIS Firmware Revision characteristic, 1 - enable, 0 - disable. Enable Firmware Revision characteristic in Device Information Service.

CONFIG_BT_DIS_FW_REV_STR

Firmware revision. Firmware Revision characteristic String in Device Information Service.

CONFIG_BT_DIS_HW_REV

Enable DIS Hardware Revision characteristic, 1 - enable, 0 - disable. Enable Hardware Revision characteristic in Device Information Service.

CONFIG_BT_DIS_HW_REV_STR

Hardware revision. Hardware Revision characteristic String in Device Information Service.

CONFIG_BT_DIS_SW_REV

Enable DIS Software Revision characteristic, 1 - enable, 0 - disable. Enable Software Revision characteristic in Device Information Service.

CONFIG_BT_DIS_SW_REV_STR

Software revision Software revision characteristic String in Device Information Service.

CONFIG_SYSTEM_WORKQUEUE_STACK_SIZE

System work queue stack size.

CONFIG_SYSTEM_WORKQUEUE_PRIORITY

System work queue priority.

CONFIG_BT_HCI_TRANSPORT_INTERFACE_TYPE

HCI transport interface type.

CONFIG_BT_HCI_TRANSPORT_INTERFACE_INSTANCE

HCI transport interface instance number.

CONFIG_BT_HCI_TRANSPORT_INTERFACE_SPEED

HCI transport interface rate. Configures the interface speed, for example, the default interface is h4, the speed to 115200

CONFIG_BT_HCI_TRANSPORT_TX_THREAD

Whether enable HCI transport TX thread.

CONFIG_BT_HCI_TRANSPORT_RX_THREAD

Whether enable HCI transport RX thread.

CONFIG_BT_HCI_TRANSPORT_RX_STACK_SIZE

HCI transport RX thread stack size.

CONFIG_BT_HCI_TRANSPORT_TX_STACK_SIZE

HCI transport TX thread stack size.

CONFIG_BT_HCI_TRANSPORT_TX_PRIO

HCI transport TX thread priority.

CONFIG_BT_HCI_TRANSPORT_RX_PRIO

HCI transport RX thread priority.

CONFIG_BT_MSG_QUEUE_COUNT

Message number in message queue.

Rework Guide for EdgeFast Bluetooth Protocol Abstraction Layer

Hardware Rework Guide for MIMXRT1170-EVKB and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT1170-EVKB and the Murata's 1XK, 1ZM, 2EL or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM), Rev-A1 (2EL) or EAR00500 (2LL) M.2 modules.

The hardware rework has two parts:

- HCI UART rework
- PCM interface rework

Hardware rework

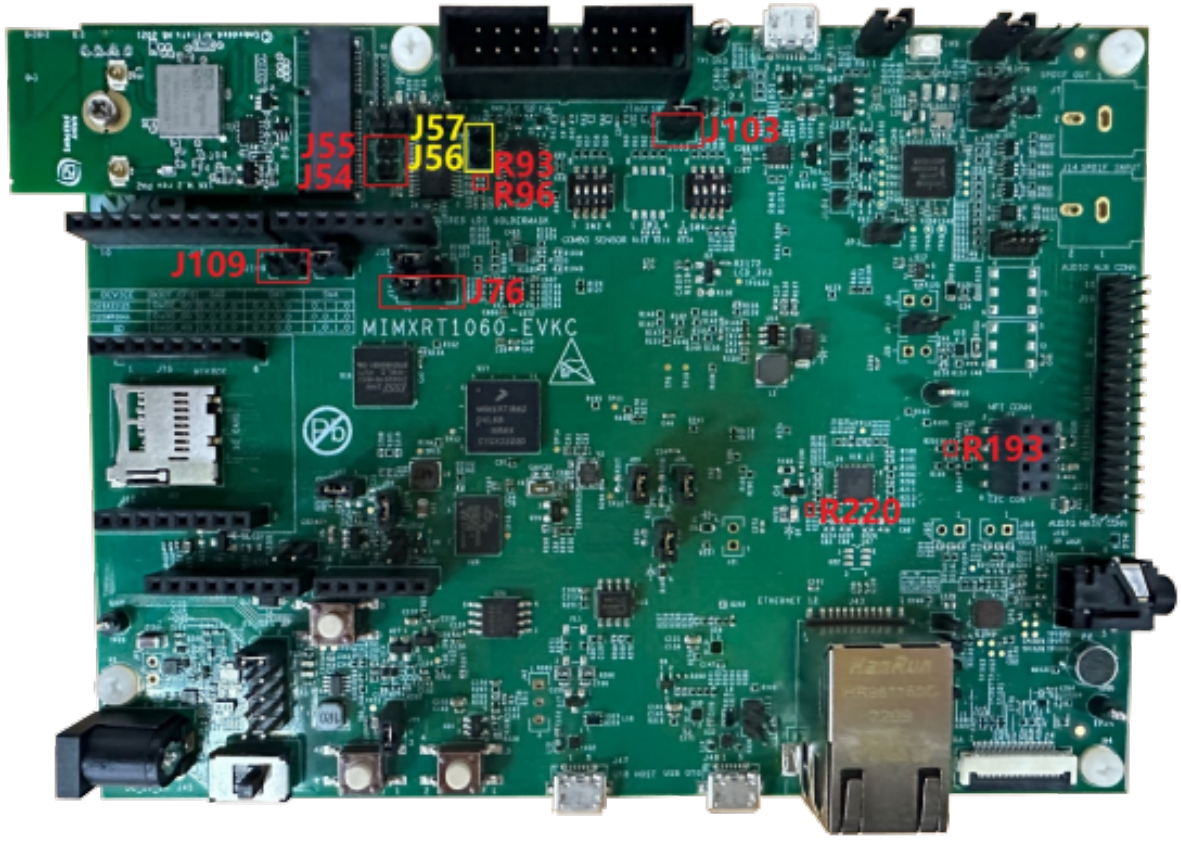
- **HCI UART rework**

1. Mount R93, R96.
2. Remove R193.
3. Connect J109, connect J76 2-3.

- **PCM interface rework**

1. Remove J54 and J55, connect J56 and J57.
2. Remove R220.
3. Connect J103.

Note: When J103 is connected, flash cannot be downloaded. So, remove the connection when downloading flash and reconnect it after downloading.



Parent topic:*Hardware Rework Guide for MIMXRT1060-EVKC and Murata M.2 Module*

Hardware Rework Guide for MIMXRT1170-EVKB and Murata 2EL M.2 Module Hardware Rework Guide for MIMXRT1170-EVKB and Murata

2EL M.2 Module

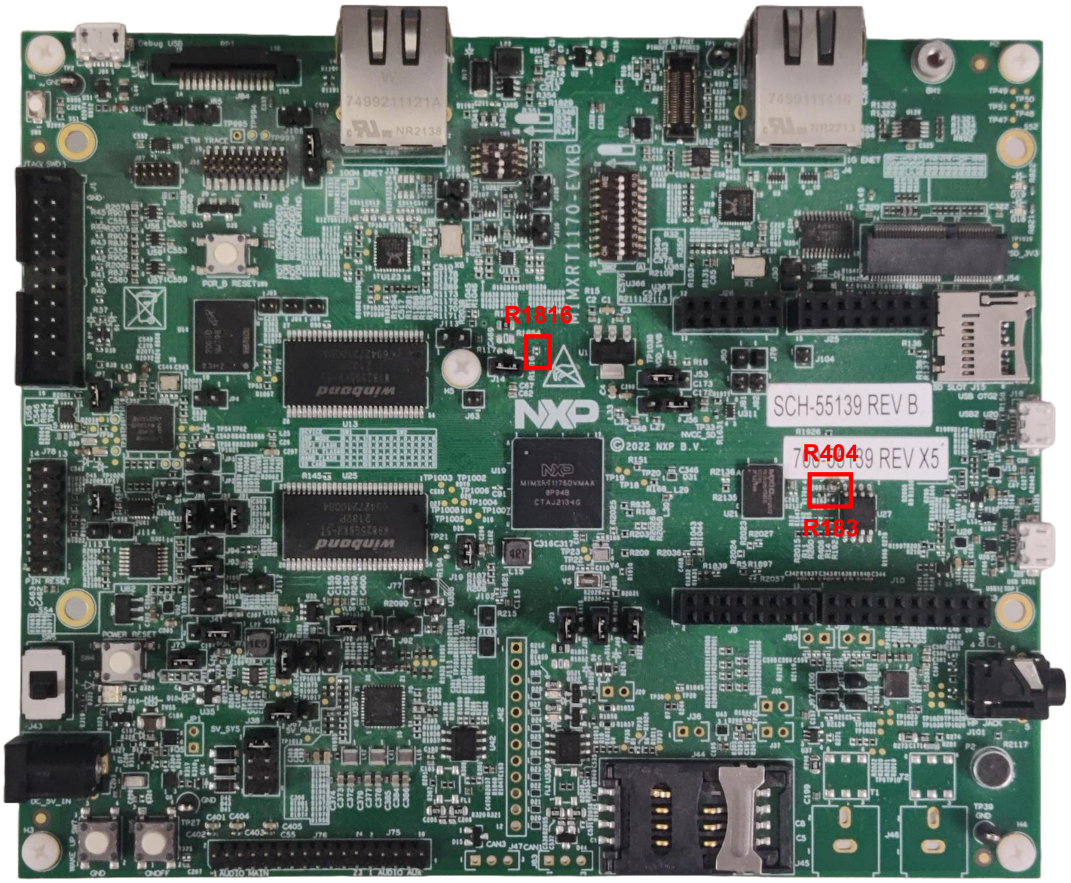
This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT1170-EVKB and the Murata 2EL M.2 solution - direct M.2 connection to Embedded Artists' Rev-A1 (2EL) M.2 modules.

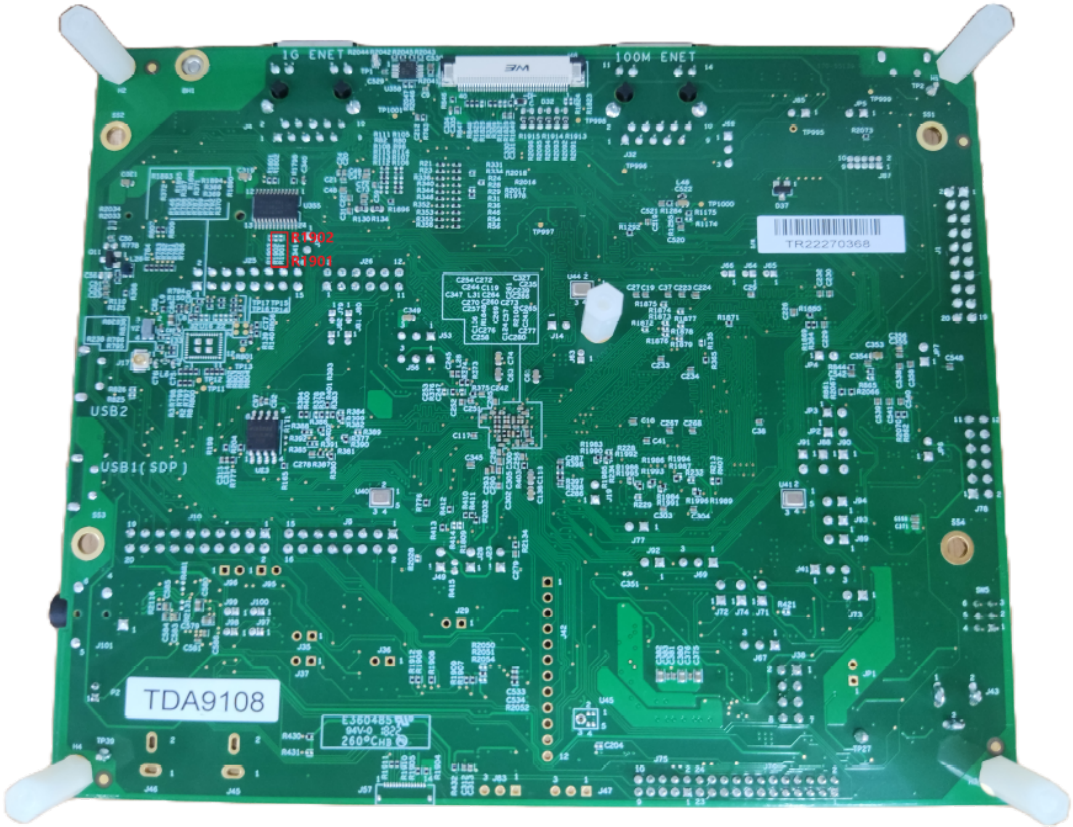
The hardware rework has three parts:

- HCI UART rework
- PCM interface rework
- LE Audio Synchronization interface rework (only used on sink side)

Hardware rework

- **HCI UART rework**
  1. Remove resistors R183 and R1816.
  2. Solder 0 ohm resistor to R404, R1901, and R1902.

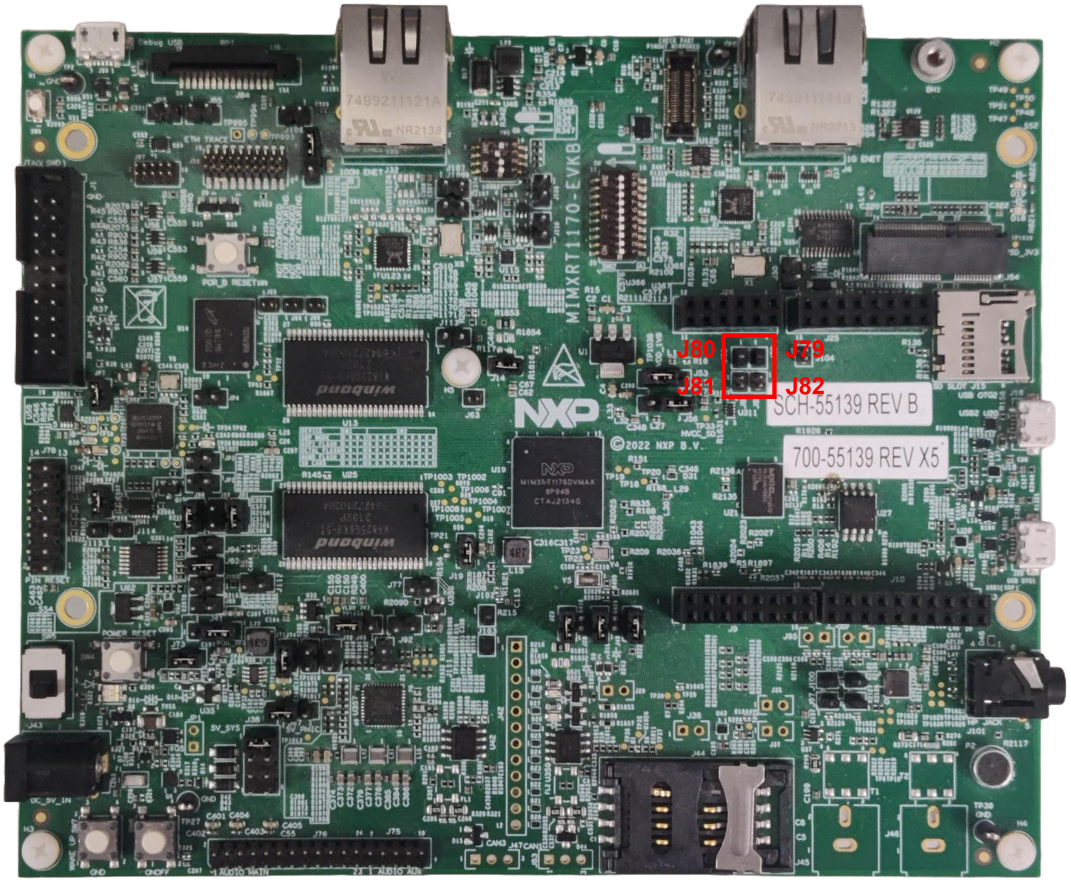


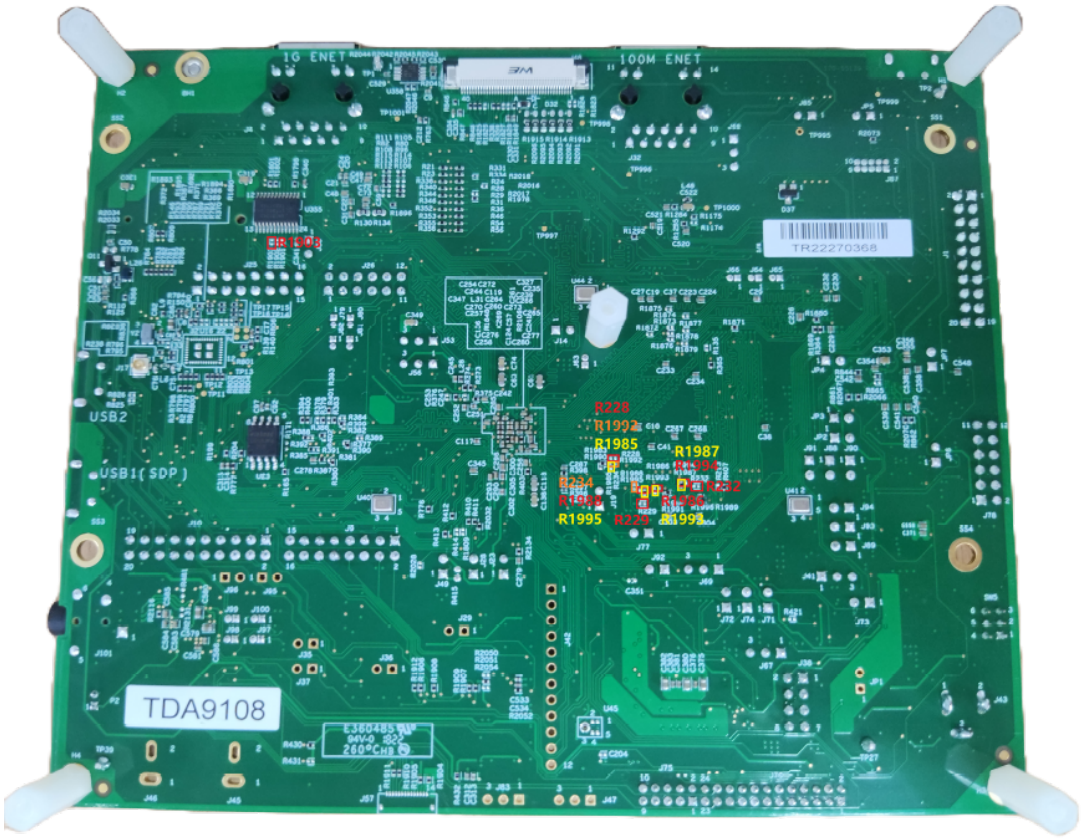


- **PCM interface rework**

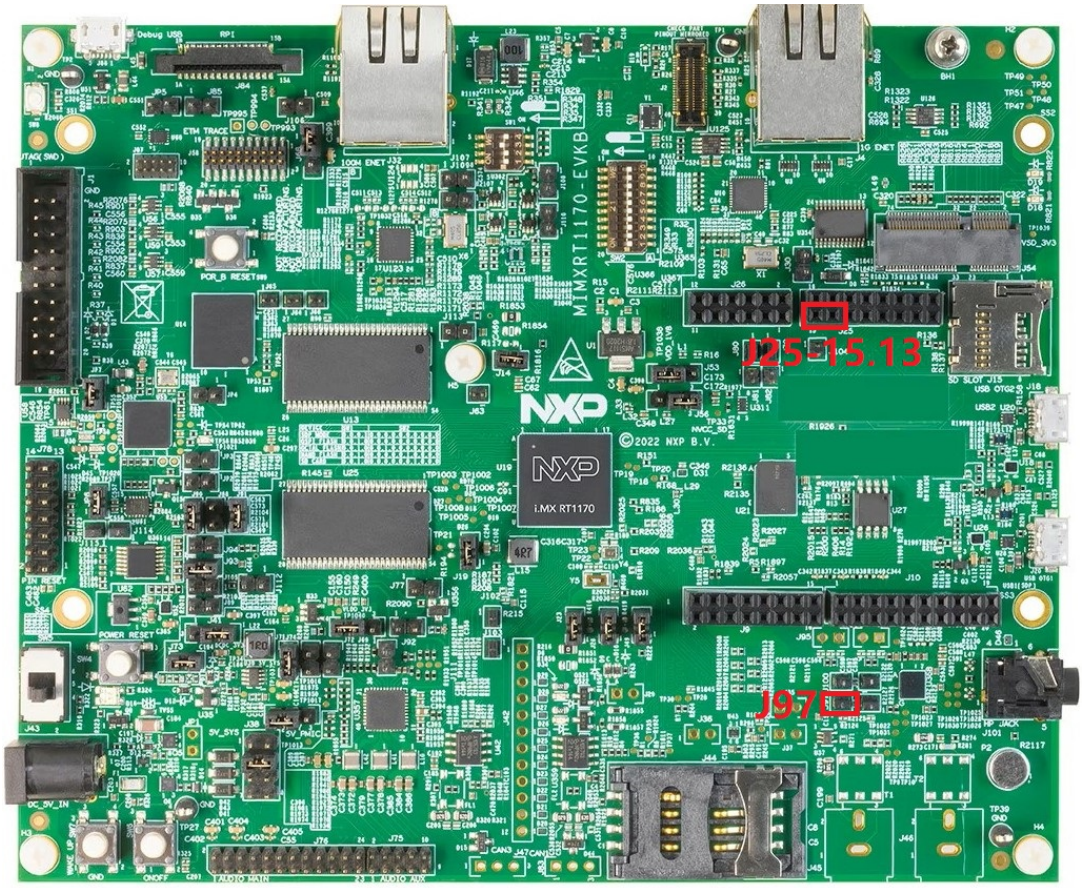
  1. Disconnect header J79 and J80.

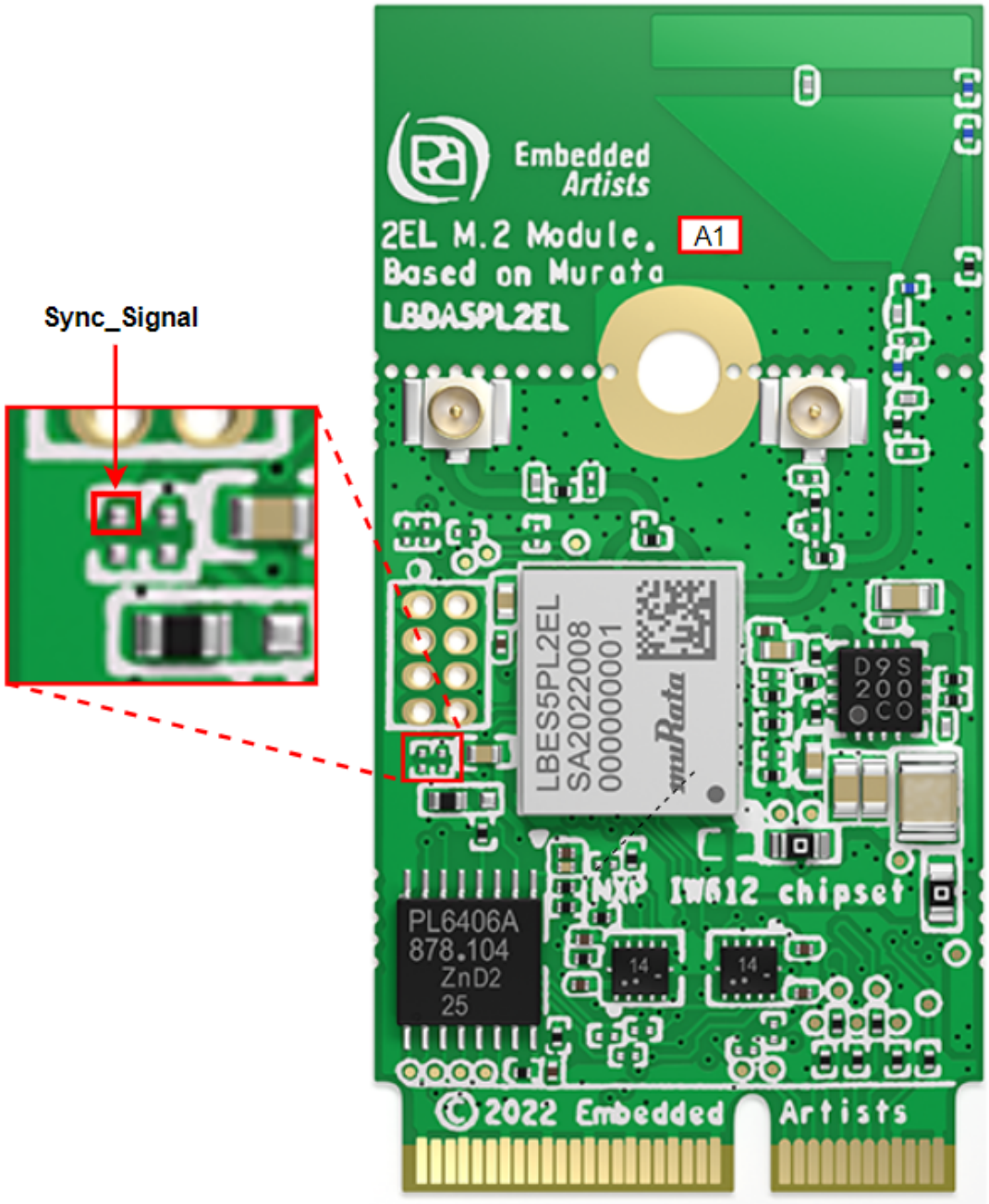
2. Connect header J81 and J82.
3. Remove resistors R1985, R1986, R1987, R1988, R1992, R1993, R1994, and R1995.
4. Solder 0 ohm resistor to R228, R229, R232, R234, and R1903.





- LE Audio Synchronization interface rework (only used on sink side)
  1. Connect J25-15 with J97.
  2. Connect J25-13 with 2EL's GPIO_27


J25 15.13
J97



Parent topic:*Hardware Rework Guide for MIMXRT1170-EVKB and Murata 2EL M.2 Adapter*

Hardware Rework Guide for MIMXRT685-EVK and AW-AM457-uSD This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT685-EVK board and AW-AM457-uSD. The AW-AM457-uSD user guide is available here.The hardware rework has one part:

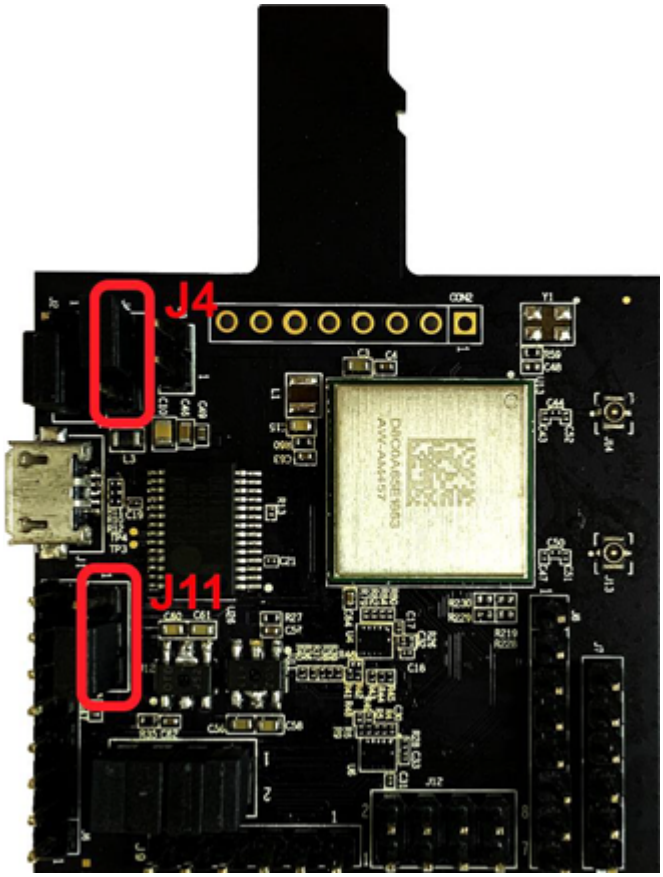
- HCI UART rework

Hardware rework **HCI UART rework**

- R398 move from 1-2 to 2-3
- JP12 2-3
- Connect the pins of two boards as the following table.

Pin Name	AW-AM457-uSD	i.MX RT685	PIN NAME	GPIONAME of i.MX RT685
UART_TXD	J10 (pin 4)	J27 (pin 1)	US-ART4_RXD	FC4_RXD_SDA_MOSI_DATA
UART_RXD	J10 (pin 2)	J27 (pin 2)	USART4_TXD	FC4_TXD_SCL_MISO_WS
UART_RTS	J10 (pin 6)	J47 (pin 9)	USART4_CTS	FC4_CTS_SDA_SSEL0
UART_CTS	J10 (pin 8)	J27 (pin 5)	USART4_RTS	FC4_RTS_SCL_SSEL1
GND	J6 (pin 7)	J29 (pin 6)	GND	GND





Jumper Settings:

- Connect J4[2-3] for VIO 3.3 V supply
- Connect J11[2-3] for VIO_SD 3.3 V supply

PCM interface rework

Connect the pins of two boards as the following table.

Pin Name	AW-AM457-uSD	i.MX RT685	PIN NAME of I.MX RT685	GPIONAME of I.MX RT685
PCM_IN	J9 (pin 1)	J47 (pin 7)	I2S2_TXD	FC2_RXD_SDA_MOSI_DATA
PCM_OUT	J9 (pin 2)	J28 (pin 4)	I2S5_RXD	FC5_RXD_SDA_MOSI_DATA
PCM_SYNC	J9 (pin 3)	J28 (pin 5)	I2S5_WS	FC5_TXD_SCL_MISO_WS
PCM_CLK	J9 (pin 4)	J28 (pin 6)	I2S5_SCK	FC5_SCK
GND	J9 (pin 6)	J29 (pin 7)	GND	GND

Parent topic:*Hardware Rework Guide for MIMXRT685-EVK and AW-AM457-uSD*

Hardware Rework Guide for MIMXRT685-EVK and AW-CM358-uSD This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT685-EVK board and AW-CM358-uSD. The AW-CM358-uSD user guide is available here. The hardware rework has one part:

- HCI UART rework

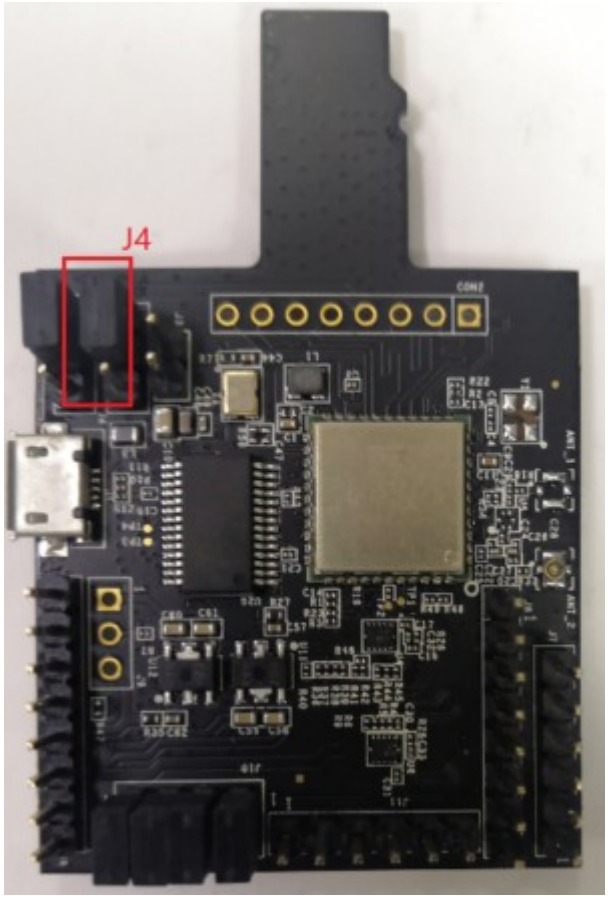
Hardware rework **HCI UART rework**

R398 move from 1-2 to 2-3.

Connect the pins of two boards as the following table.

Pin Name	AW-CM358-USD	i.MXRT685	PIN NAME	GPIONAME of RT685
UART_TXD	J10 (pin 4)	J27 (pin 1)	USART4_RXD	FC4_RXD_SDA_MOSI_DATA
UART_RXD	J10 (pin 2)	J27 (pin 2)	USART4_TXD	FC4_TXD_SCL_MISO_WS
UART_RTS	J10 (pin 6)	J47 (pin 9)	USART4_CTS	FC4_CTS_SDA_SSEL0
UART_CTS	J10 (pin 8)	J27 (pin 5)	USART4_RTS	FC4_RTS_SCL_SSEL1
GND	J6 (pin 7)	J29 (pin 6)	GND	GND





Jumper Setting:

Connect J4[1-2] for VIO 1.8 V supply.

PCM interface rework

Connect the pins of two boards as the following table.

Pin Name	AW-CM358-USD	i.MX RT685	PIN NAME of RT685	GPIONAME of RT685
PCM_IN	J11 (pin 1)	J47 (pin 7)	I2S2_TXD	FC2_RXD_SDA_MOSI_DATA
PCM_OUT	J11 (pin 2)	J28 (pin 4)	I2S5_RXD	FC5_RXD_SDA_MOSI_DATA
PCM_SYNC	J11 (pin 3)	J28 (pin 5)	I2S5_WS	FC5_TXD_SCL_MISO_WS
PCM_CLK	J11 (pin 4)	J28 (pin 6)	I2S5_SCK	FC5_SCK
GND	J11 (pin 5)	J29 (pin 7)	GND	GND

Parent topic:*Hardware Rework Guide for MIMXRT685-EVK and AW-CM358-uSD*

Hardware Rework Guide for MIMXRT685-EVK and AW-AM510-uSD This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT685-EVK board and AW-AM510-uSD. The AW-AM510-uSD user guide is available here. The hardware rework has one part:

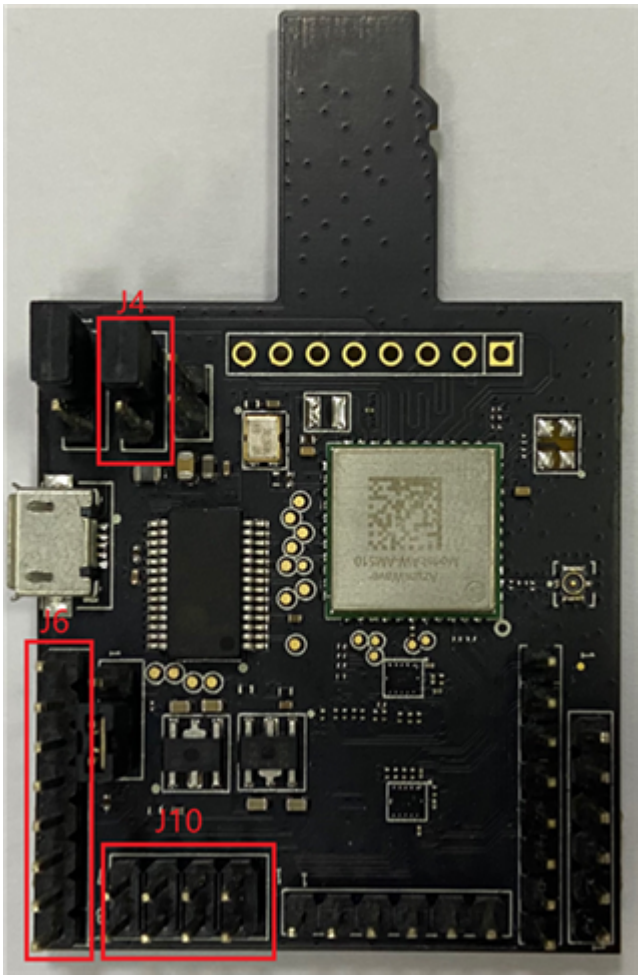
- HCI UART rework

Hardware rework

- **HCI UART rework**

Connect the pins of two boards as the following table.

Pin Name	AW-AM510-uSD	i.MXRT685	PIN NAME	GPIO NAME of RT685
UART_TXD	J10 (pin 4)	J27 (pin 1)	USART4_RXD	FC4_RXD_SDA_MOSI_DATA
UART_RXD	J10 (pin 2)	J27 (pin 2)	USART4_TXD	FC4_TXD_SCL_MISO_WS
UART_RTS	J10 (pin 6)	J47 (pin 9)	USART4_CTS	FC4_CTS_SDA_SSEL0
UART_CTS	J10 (pin 8)	J27 (pin 5)	USART4_RTS	FC4_RTS_SCL_SSEL1
GND	J6 (pin 7)	J29 (pin 6)	GND	GND



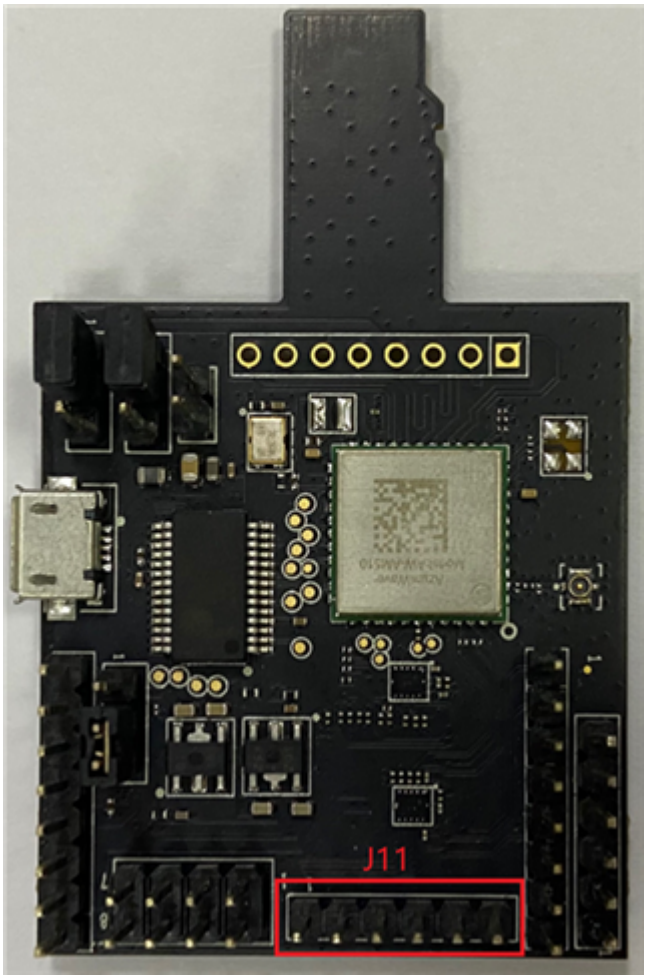
Jumper Setting:

– Connect J4[2-3] for VIO 3.3 V supply

- **PCM interface rework**

Connect the pins of two boards as the following table.

PIN NAME	AW-AM510-USD	i.MX RT685	PIN NAME of RT685	GPIONAME of RT685
PCM_IN	J11 (pin 1)	J47 (pin 7)	I2S2_TXD	FC2_RXD_SDA_MOSI_DATA
PCM_OUT	J11 (pin 2)	J28 (pin 4)	I2S5_RXD	FC5_RXD_SDA_MOSI_DATA
PCM_SYNC	J11 (pin 3)	J28 (pin 5)	I2S5_WS	FC5_TXD_SCL_MISO_WS
PCM_CLK	J11 (pin 4)	J28 (pin 6)	I2S5_SCK	FC5_SCK
GND	J11 (pin 6)	J29 (pin 7)	GND	GND



Parent topic:*Hardware Rework Guide for MIMXRT685-EVK and AW-AM510-uSD*

Hardware Rework Guide for MIMXRT685-EVK and Murata uSD-M.2 Adapter This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT685-EVK board and the Murata uSD-M.2 adapter. For details on the Murata uSD-M.2 Adapter, see Murata's uSD-M.2 webpage.

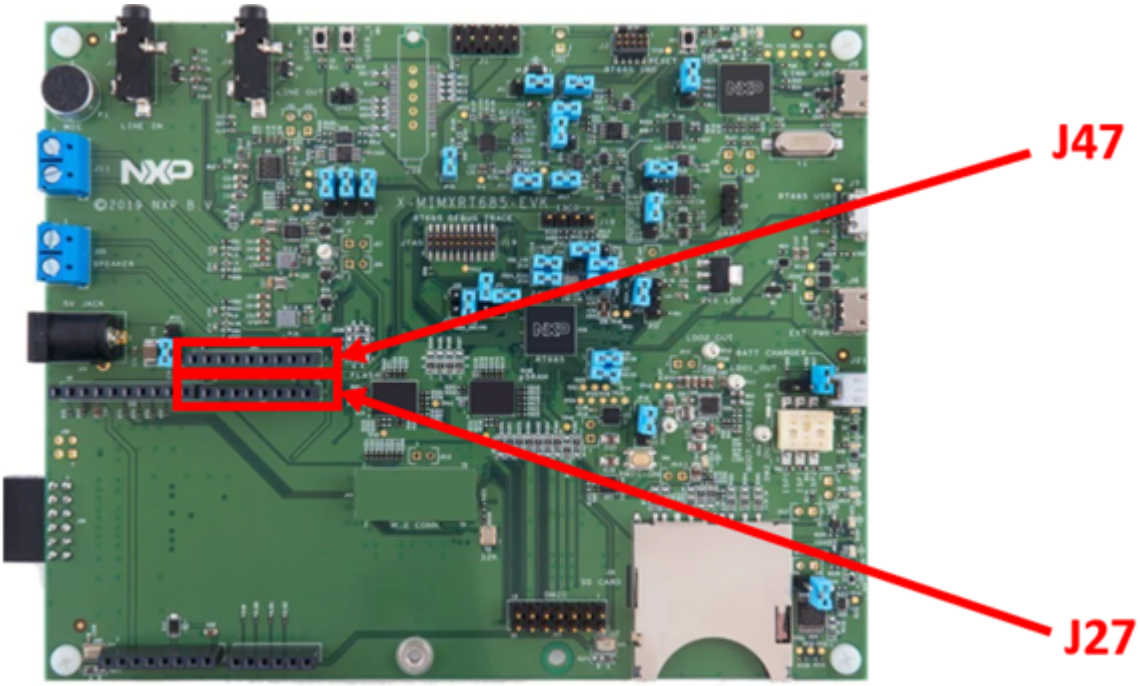
The hardware rework has one part:

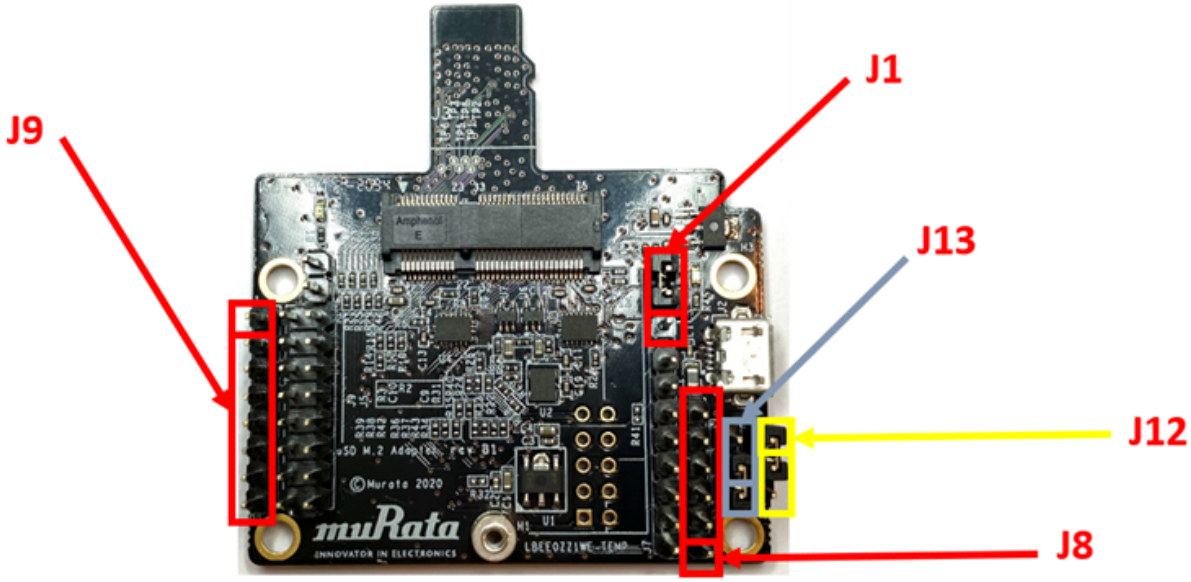
- HCI UART rework

Hardware rework **HCI UART rework :**

- JP12 2-3
- Connect the pins of two boards as the following table using jumper cables included in Murata's uSD-M.2 Adapter kit.

Pin name	uSD-M.2 adapter pin	i.MX RT685 pin	Pin name of RT685	GPIO name of RT685
BT_UART_TXD_HO	J9 (pin 1)	J27 (pin 1)	USART4_RXD	FC4_RXD_SDA_MOSI_DATA
BT_UART_RXD_HO	J9 (pin 2)	J27 (pin 2)	USART4_TXD	FC4_TXD_SCL_MISO_WS
BT_UART_RTS_HO	J8 (pin 3)	J47 (pin 9)	USART4_CTS	FC4_CTS_SDA_SSEL0
BT_UART_CTS_HO	J8 (pin 4)	J27 (pin 5)	USART4_RTS	FC4_RTS_SCL_SSEL1





Murata uSD-M.2 jumper settings:

- Both J12 and J13 = 1-2 (WLAN-SDIO = 1.8 V; and BT-UART and WLAN/BT-CTRL = 3.3 V)
- J1 = 2-3 (3.3 V from uSD connector)

Parent topic:*Hardware Rework Guide for MIMXRT685-EVK and Murata uSD-M.2 Adapter*

Hardware Rework Guide for MIMXRT685-AUD-EVK and Murata M.2 Module This section is a brief hardware rework guidance of the Edgefast Bluetooth PAL on the NXP i.MX MIMXRT685-AUD-EVK board and the Murata's 1XK, 1ZM, 2EL or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM), Rev-A1 (2EL) or EAR00500 (2LL) M.2 modules.

The hardware rework has one part:

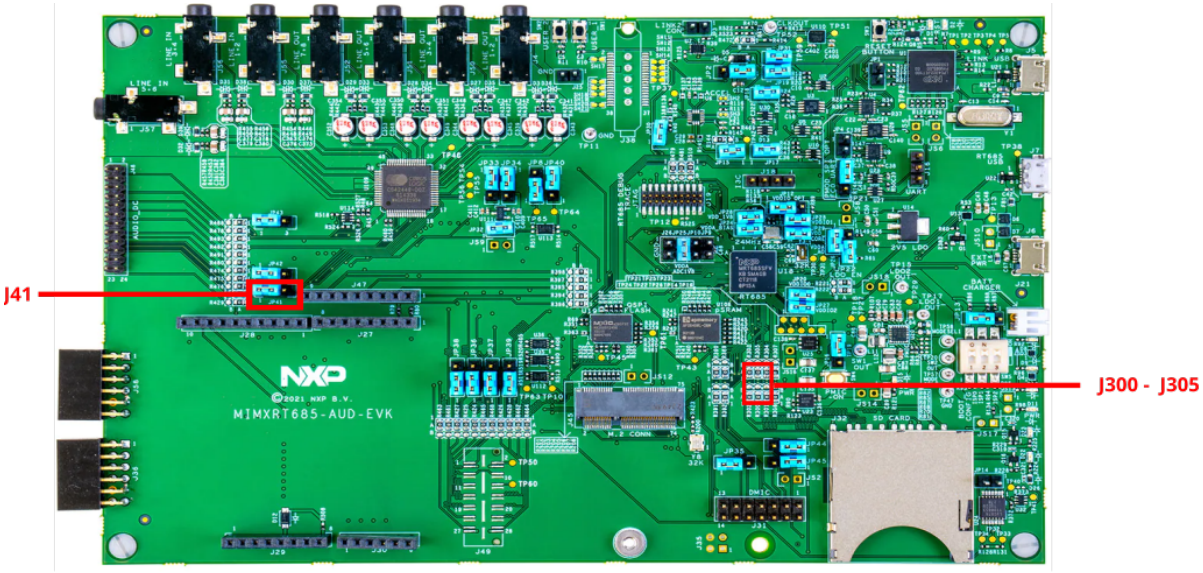
- HCI UART rework

Hardware rework HCI UART rework:

Mount R300~R305 A-B

Jumper Setting:

- Connect JP41[2-3]



Parent topic:*Hardware Rework Guide for MIMXRT685-AUD-EVK and Murata M.2 Module*

Hardware Rework Guide for Low Power Feature on MIMXRT595-EVK and Murata 2EL M.2 Module

This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL for low power feature on the NXP i.MX MIMXRT595-EVK board and the Murata's 2EL - direct M.2 connection to Embedded Artists' Rev-A1 (2EL) M.2 modules.

The hardware rework has three parts:

- Debug console serial rework
- Host wake-up controller pin rework (H2C)
- Controller wake-up host pin rework (C2H)

Hardware rework

- **Debug console serial rework**

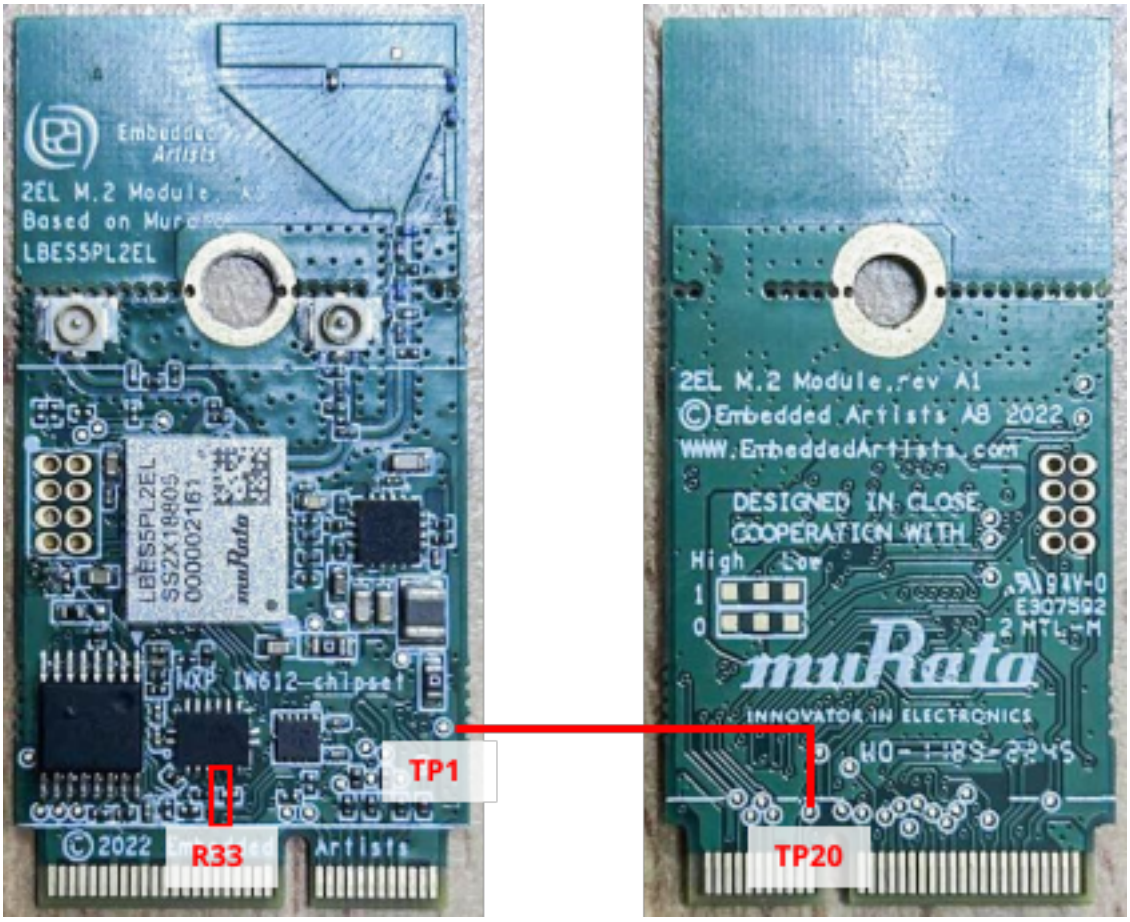
  For details, refer *Hardware Rework Guide for MIMXRT595-EVK and Murata M.2 Module*.

- **Host wake-up controller pin rework**:

  For details, refer Hardware Rework Guide for Low Power Feature on MIMXRT595-EVK and Murata 1XK M.2 Module.

- **Controller wake-up host pin rework:**

1. Remove resistors R709 on MIMXRT595-EVK,
2. Solder 0K ohm resistor on R33 of Murata 2EL M.2 Module
3. Solder 10K ohm resistor on the Murata 2EL M.2 Module between TP1 and TP20.



Parent topic:*Hardware Rework Guide for Low Power Feature on MIMXRT595-EVK and Murata 2EL M.2 Module*

Hardware Rework Guide for MIMXRT595-EVK and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT595-EVK board and the Murata's 1XK, 1ZM, 2EL or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM), Rev-A1 (2EL) or EAR00500 (2LL) M.2 modules.

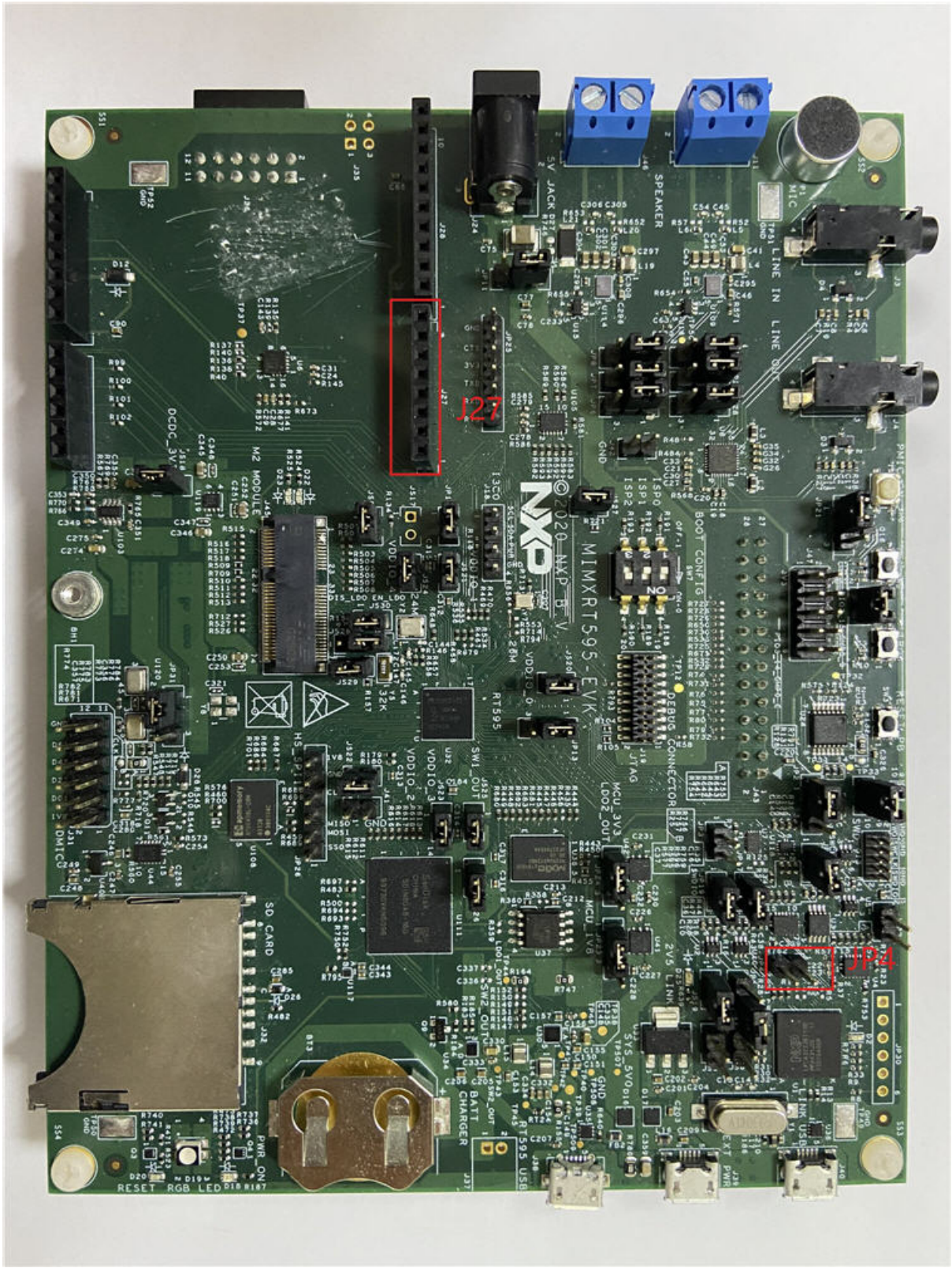
The hardware rework has one part:

- Debug console serial rework

Hardware rework **Debug console serial rework:**

No special rework is required, except the following to enable the debug port.

- JP4 1-2.
- J27 1 - TX of USB to serial converter
- J27 2 - RX of USB to serial converter



Parent topic:*Hardware Rework Guide for MIMXRT595-EVK and Murata M.2 Module*

Hardware Rework Guide for Low Power Feature on MIMXRT595-EVK and Murata 1XK M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL for low power feature on the NXP i.MX MIMXRT595-EVK board and the Murata's 1XK - direct M.2 connection to Embedded Artists EAR00385 (1XK) M.2 modules.

The hardware rework has three parts:

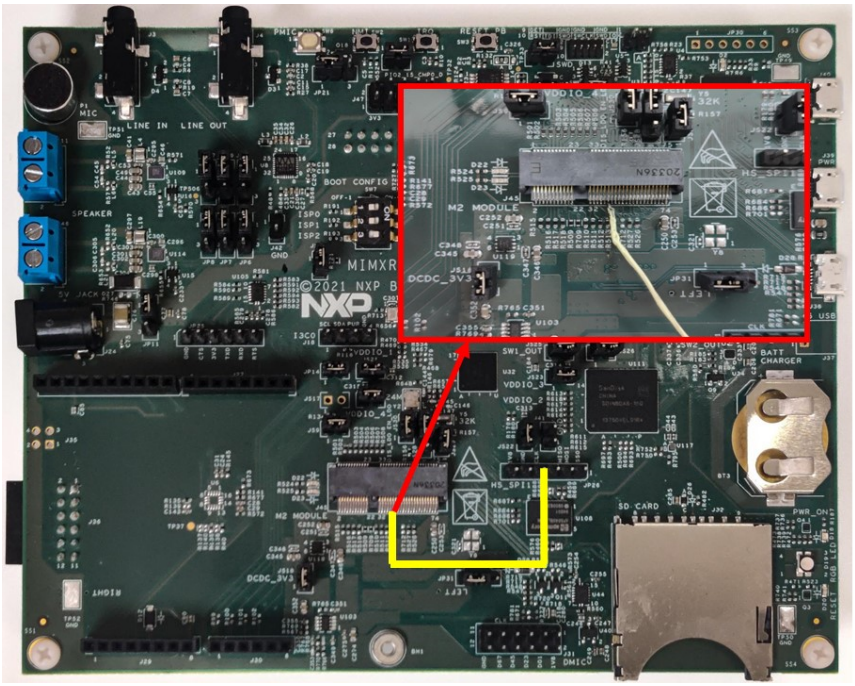
- Debug console serial rework
- Host wake-up controller pin rework (H2C)
- Controller wake-up host pin rework (C2H)

Hardware rework **Debug console serial rework:**

For details, refer *Hardware Rework Guide for MIMXRT595-EVK and Murata M.2 Module*.

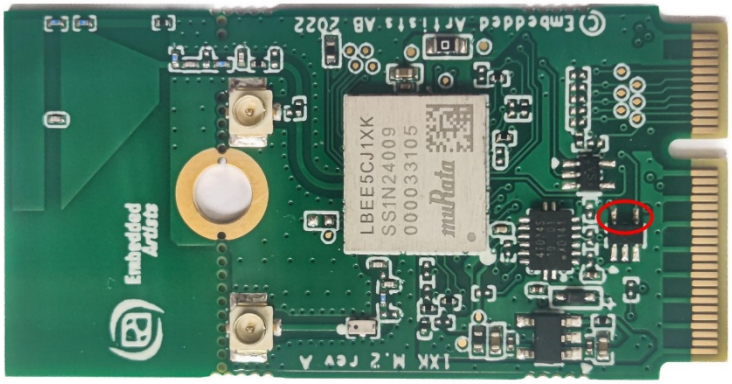
Host wake-up controller pin rework:

Connect M.2 (pin 42) to JP26 (pin 4) with a wire.



Controller wake-up host pin rework:

1. Remove resistors R709 on MIMXRT595-EVK.
2. Solder 10K ohm resistor on the Murata 1XK M.2 Module at the location shown in the following figure.



Parent topic:*Hardware Rework Guide for Low Power Feature on MIMXRT595-EVK and Murata 1XK M.2 Module*

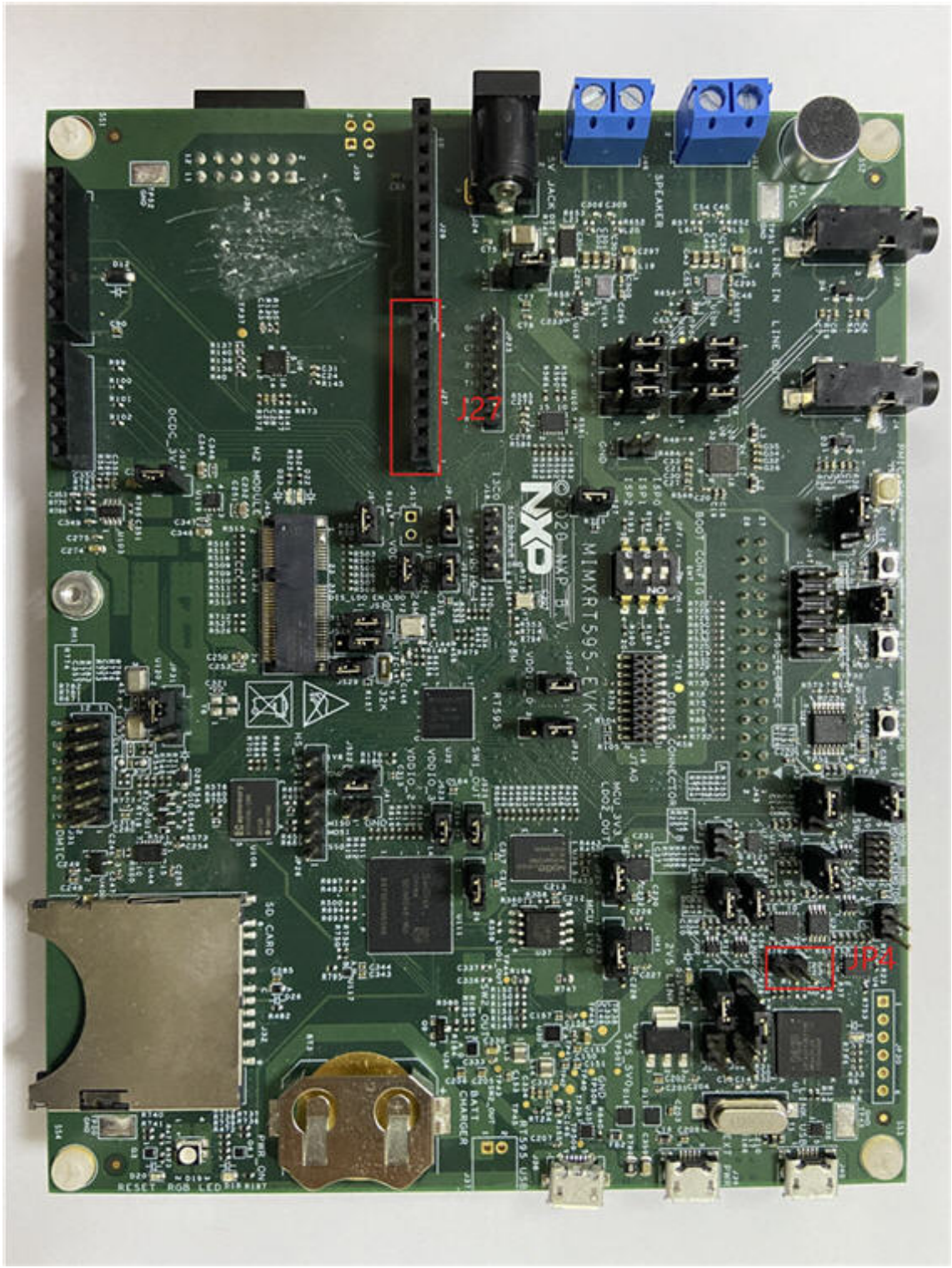
Hardware Rework Guide for MIMXRT595-EVK and AW-AM510MA This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT595-EVK board and AW-AM510MA. The AW-AM510MA user guide is available here. The hardware rework has one part:

- Debug console serial rework

Hardware rework **Debug console serial rework:**

No special rework is required, except the following to enable the debug port.

- Connect J39 with external power.
- Connect JP4 1-2.
- J27 1 — TX of USB to serial converter.
- J27 2 — RX of USB to serial converter.



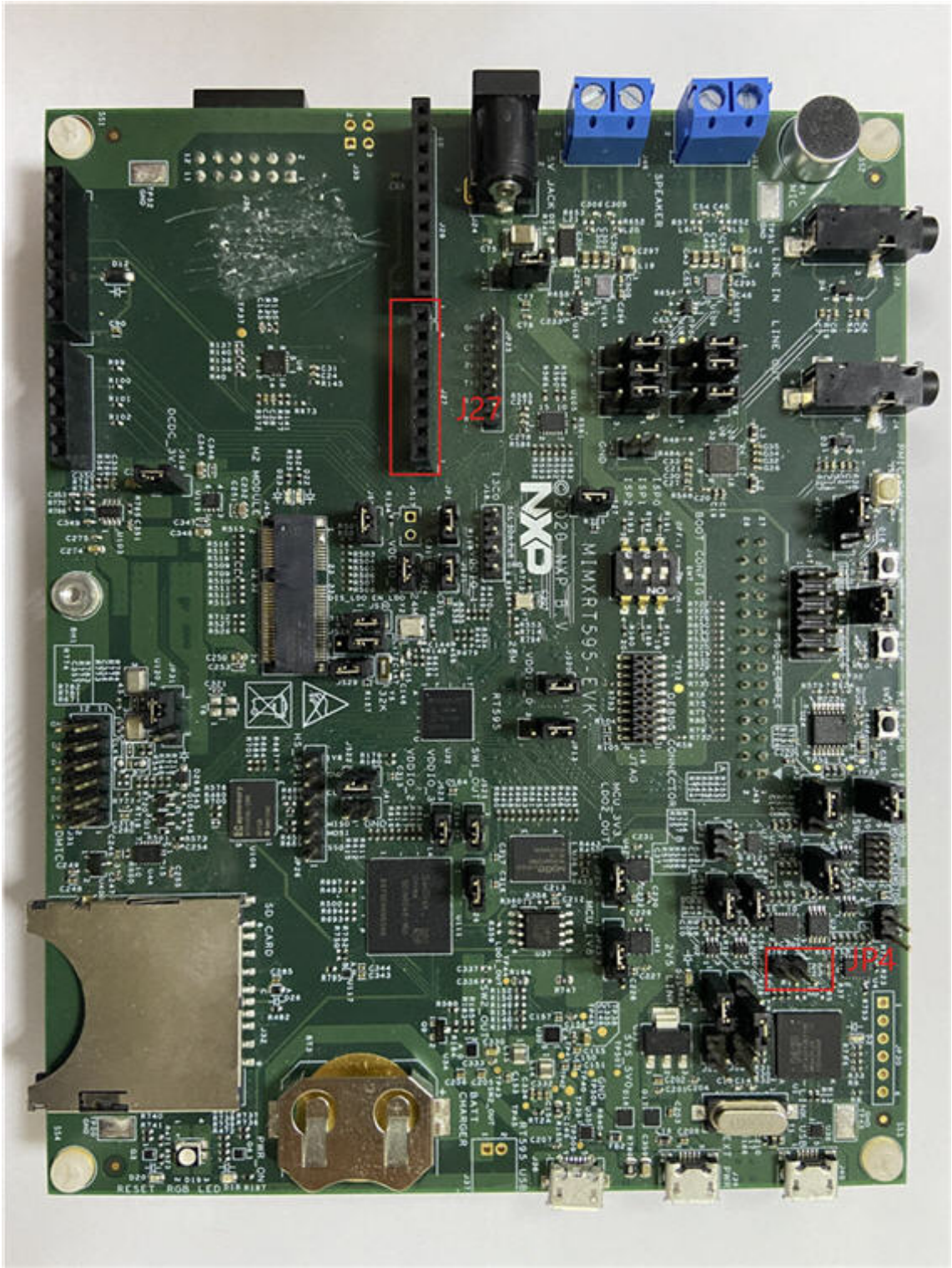
Parent topic:*Hardware Rework Guide for MIMXRT595-EVK and AW-AM510MA*

Hardware Rework Guide for MIMXRT595-EVK and AW-CM358MA This section is a brief hardware rework guidance of the Ethermind Bluetooth stack on the NXP i.MX MIMXRT595-EVK board and AW-CM358MA. The AW-CM358MA user guide is available here. The hardware rework has one part:

- Debug console serial rework

Hardware rework **Debug console serial rework:**

- Connect J39 with external power.
- JP4 1-2
- J27 1 - TX of USB to serial converter
- J27 2 - RX of USB to serial converter



Parent topic:*Hardware Rework Guide for MIMXRT595-EVK and AW-CM358MA*

Hardware Rework Guide for MIMXRT1040-EVK and Murata M.2 Module This section is a brief hardware rework guidance of the Edgefast Bluetooth PAL on the NXP i.MX MIMXRT1040-EVK board and the Murata's 1XK, 1ZM or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM) or EAR00500 (2LL) M.2 modules.

The hardware rework has two parts:

- HCI UART rework
- PCM interface rework
- Wake pin rework

Hardware rework

1. HCI UART rework
   - Solder R93 and R96
2. PCM interface rework
   - Solder R70 and R79; remove R76 and R86; Connect J80.
3. Wake pin rework
   - When using 2LL M.2 module, remove R456 and R457 to avoid the module has an impact on boot configuration.

Note: Make sure to disconnect J80 when debugging. Otherwise, the debugger downloading fails.

Parent topic:*Hardware Rework Guide for MIMXRT1040-EVK and Murata M.2 Module*

Hardware Rework Guide for MIMXRT1060-EVKC and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT1060-EVKC and the Murata's 1XK, 1ZM, 2EL or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM), Rev-A1 (2EL) or EAR00500 (2LL) M.2 modules.

The hardware rework has two parts:

- HCI UART rework
- PCM interface rework

Hardware rework

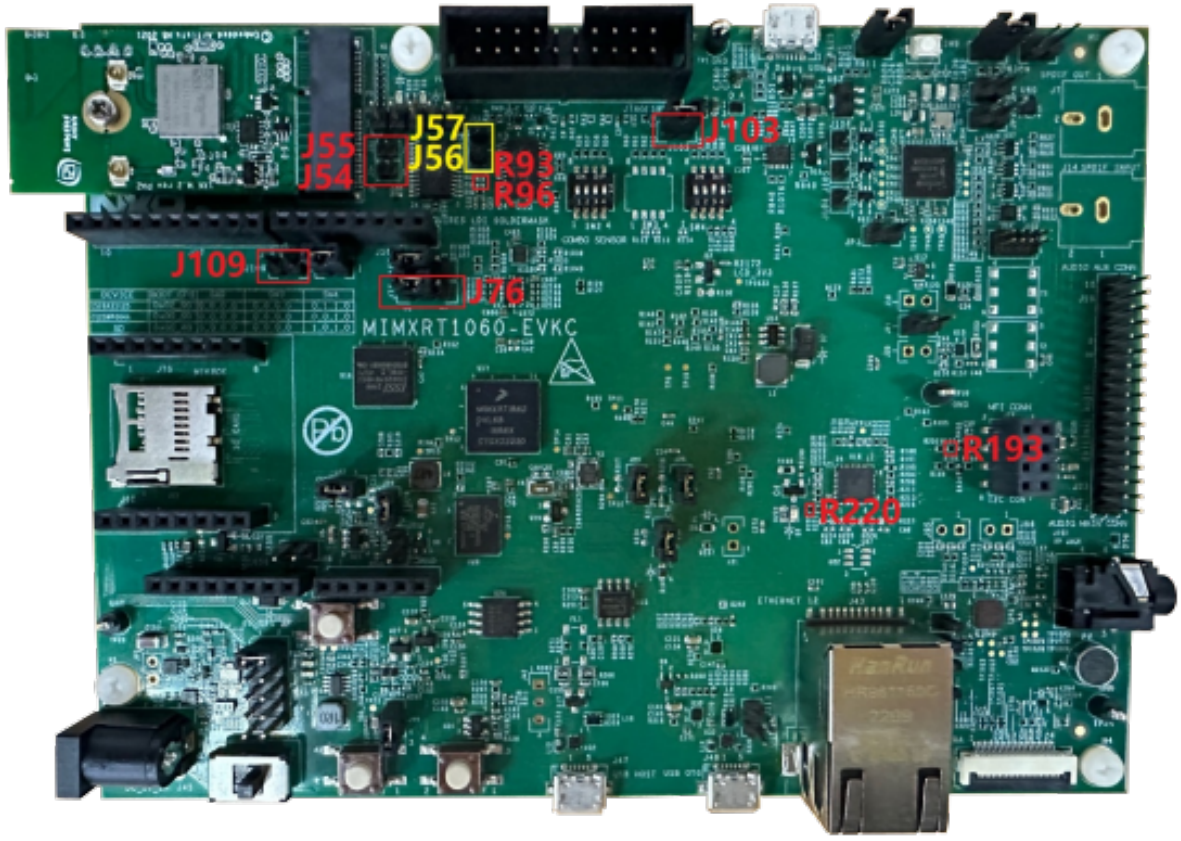
- **HCI UART rework**

1. Mount R93, R96.
2. Remove R193.
3. Connect J109, connect J76 2-3.

- **PCM interface rework**

1. Remove J54 and J55, connect J56 and J57.
2. Remove R220.
3. Connect J103.

Note: When J103 is connected, flash cannot be downloaded. So, remove the connection when downloading flash and reconnect it after downloading.



Parent topic:*Hardware Rework Guide for MIMXRT1060-EVKC and Murata M.2 Module*

Hardware Rework Guide for MIMXRT1060-EVKC and Murata 2EL M.2 Adapter This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP i.MX MIMXRT1060-EVKC and the Murata 2EL M.2 solution - direct M.2 connection to Embedded Artists' Rev-A1 (2EL) M.2 modules.

The hardware rework has three parts:

- HCI UART rework
- PCM interface rework
- LE Audio Synchronization interface rework (only used on sink side)

Hardware rework

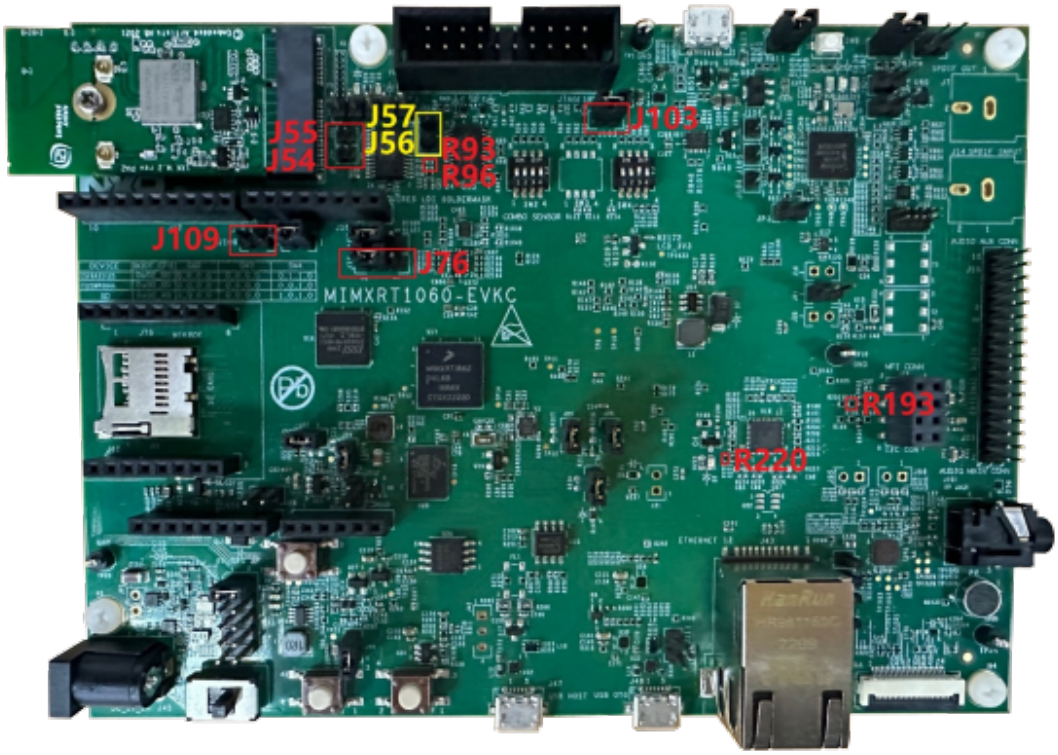
- HCI UART rework

1. Mount R93, R96.
2. Remove R193.
3. Connect J109, connect J76 2-3.

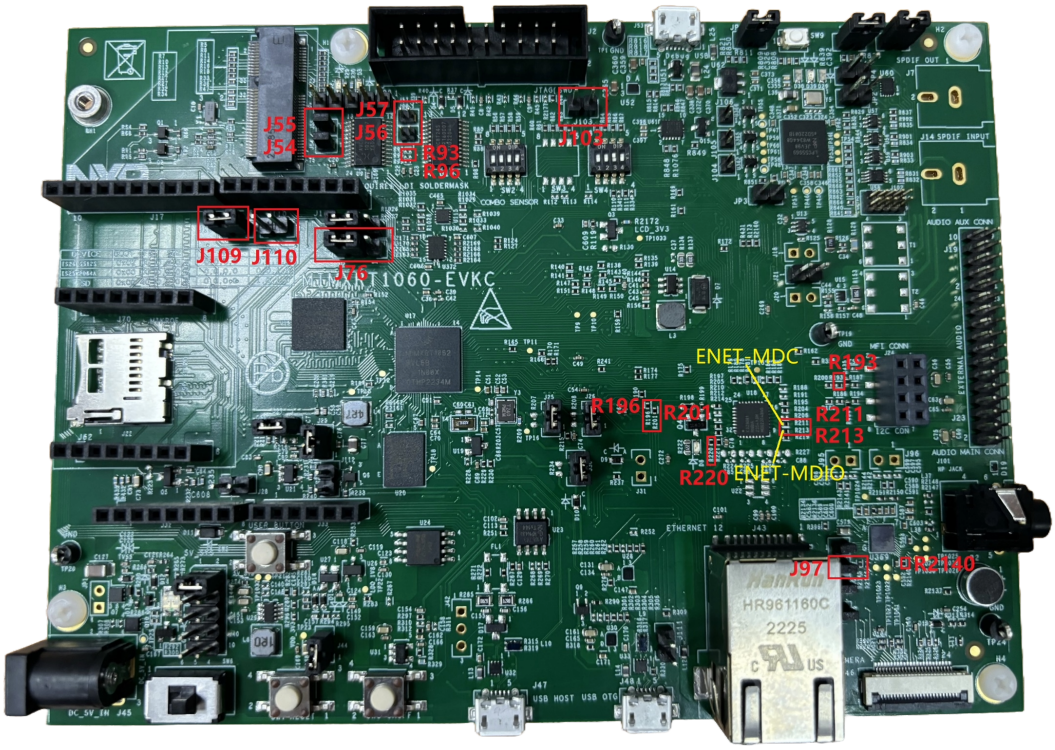
- PCM interface rework

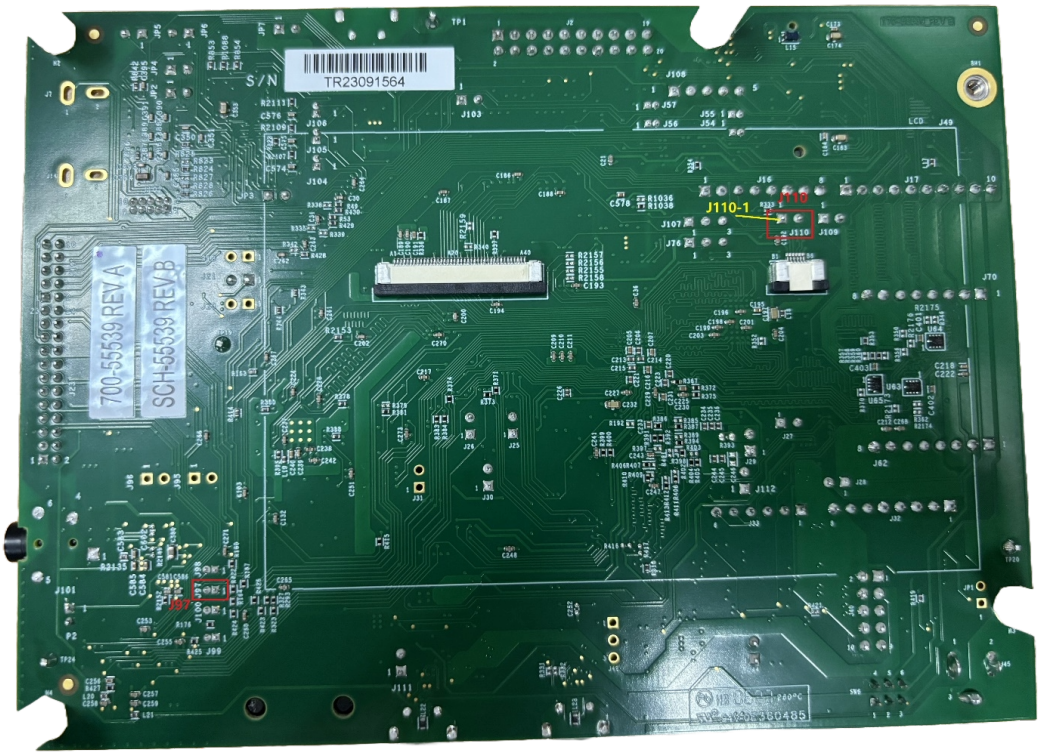
1. Remove J54 and J55, connect J56, and J57.
2. Remove R220.
3. Connect J103.

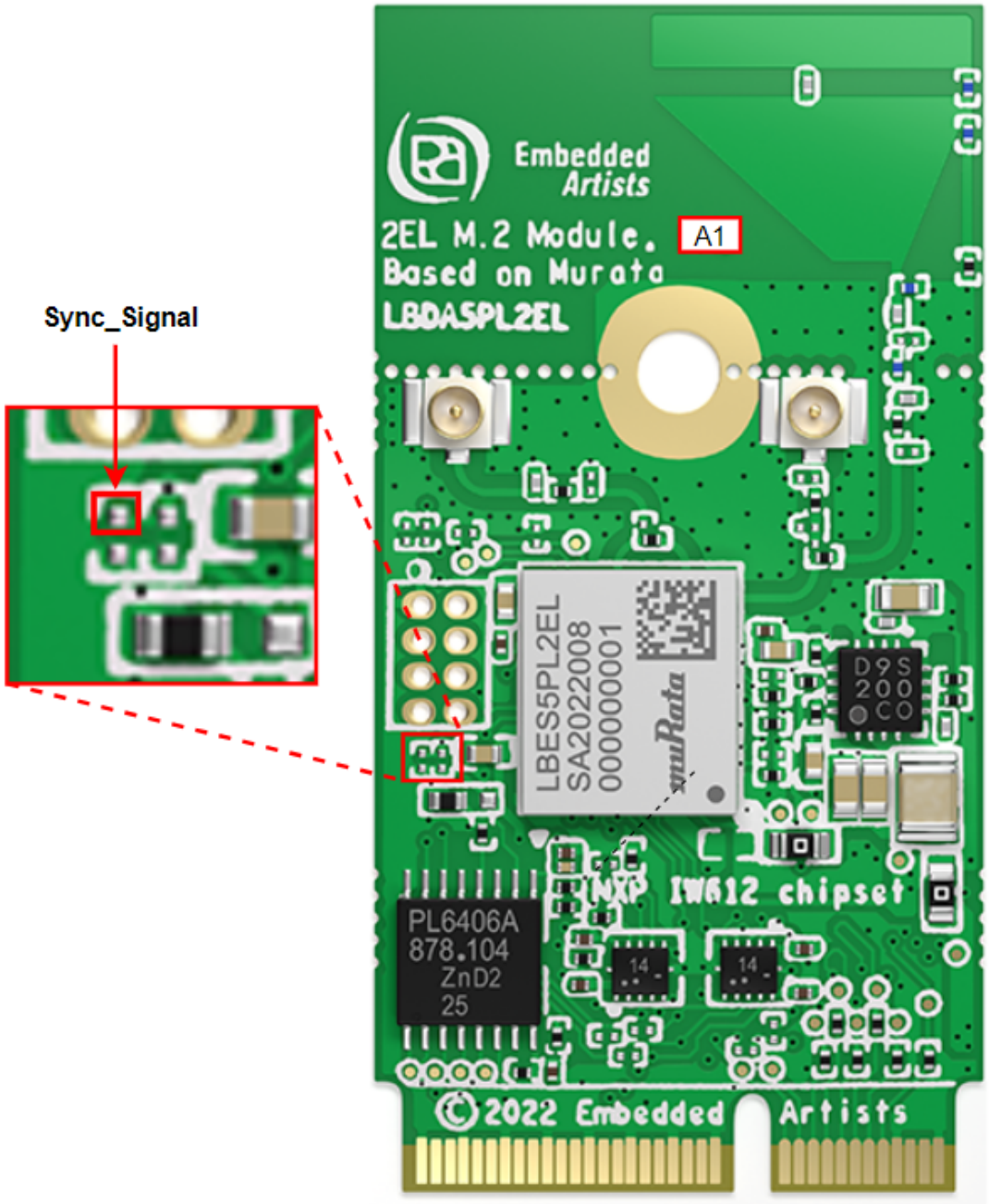
   Note: When J103 is connected, flash cannot be downloaded. So, remove the connection when downloading flash and reconnect it after downloading.



- LE Audio Synchronization interface rework (only used on sink side)
  1. Remove J110 jumper cap.
  2. Remove R196, R201, R213, and R211.
  3. Connect J110-1 (GPT2_CLK) to R2140 (SAI_MCLK).
  4. Connect ENET_MDIO (GPT2_CAP1) with J97 (SAI_SW).
  5. Connect ENET_MDC (GPT2_CAP2) with 2EL's GPIO_27 (Sync Signal).




S/N
TR23091564
700-55539 REV.A
SCH-55539 REV.B
J110-1
J110
J107



Parent topic:*Hardware Rework Guide for MIMXRT1060-EVKC and Murata 2EL M.2 Adapter*

Hardware Rework Guide for MCXN547-EVK and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP MCXN547-EVK board and the Murata's 1XK, 1ZM or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM) or EAR00500 (2LL) M.2 modules.

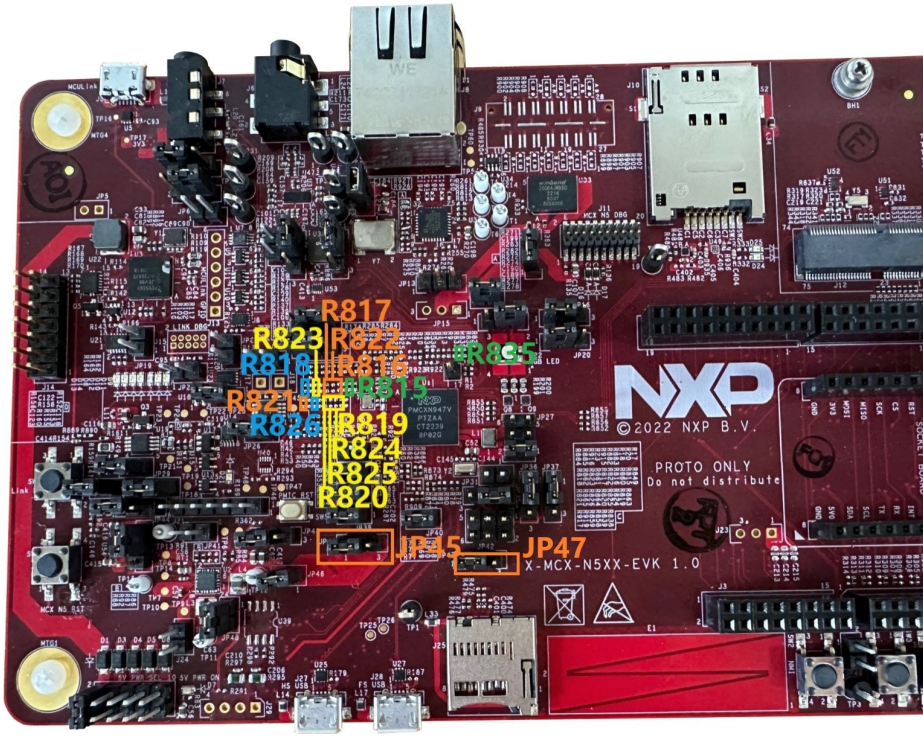
The hardware rework consists of two parts:

- M.2 UART interface
- M.2 SDIO interface

Hardware rework

- M.2 UART interface rework

  - Mount R835
  - Connect JP45 2-3 to supply 1.8V for GPIO4
- M.2 SDIO interface rework
  - Connect JP47 2-3 to supply 1.8V for GPIO2
  - Remove R818, connect R823
  - Remove R819, connect R824
  - Remove R817, connect R822
  - Remove R815, connect R816
  - Remove R820, connect R825
  - Remove R821, connect R826



Hardware Rework Guide for MCXN947-EVK and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP MCXN947-EVK board and the Murata's 1XK, 1ZM or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM) or EAR00500 (2LL) M.2 modules.

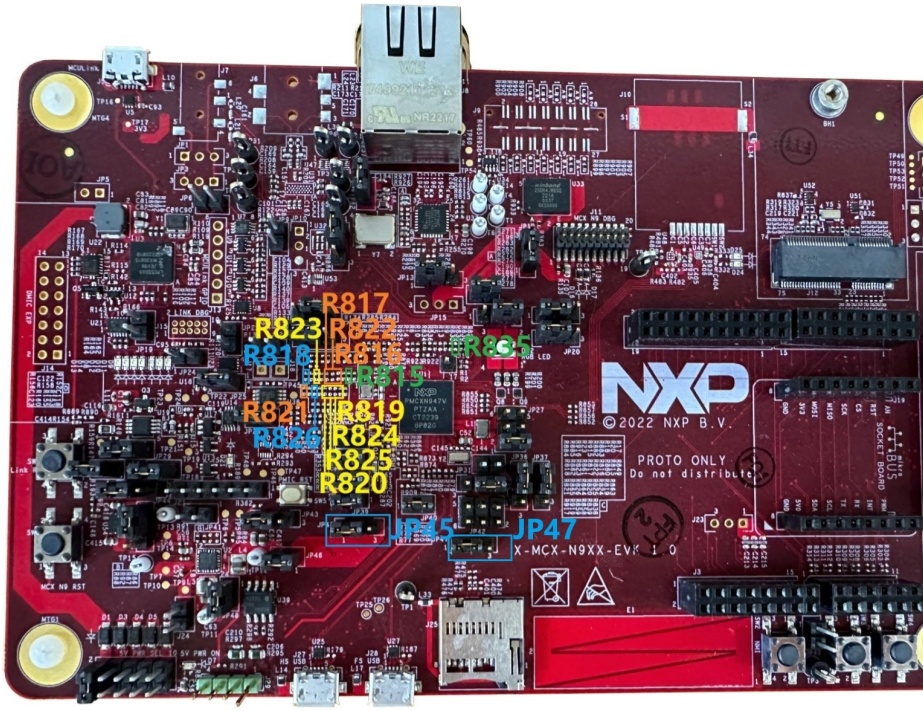
The hardware rework consists of two parts:

- M.2 UART interface
- M.2 SDIO interface

Hardware rework

- M.2 UART interface rework
  - Mount R835
  - Connect JP45 2-3 to supply 1.8V for GPIO4
- M.2 SDIO interface rework
  - Connect JP47 2-3 to supply 1.8V for GPIO2

  - Remove R818, connect R823
  - Remove R819, connect R824
  - Remove R817, connect R822
  - Remove R815, connect R816
  - Remove R820, connect R825



  - Remove R821, connect R826

Hardware Rework Guide for IMXRT1050-EVKB and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP IMXRT1050-EVKB board and the Murata 1XK,1ZM and 2EL solution - direct M.2 connection to Embedded Artists' EAR00385 (1XK) , EAR00364 (1ZM) or EAR00409 (2EL)M.2 modules. The hardware rework consists of three parts:

- Murata uSDM
- HCI UART rework

Hardware rework

- Murata uSD-M.2 jumper settings
  - J12 = 1-2: WLAN-SDIO & BT-PCM = 1.8 V
  - J13 = 1-2: BT-UART & WLAN/BT-CTRL = 3.3 V
  - J1 = 2-3: 3.3 V from uSD connector
- HCI UART interface rework

  Connect the TX/RX/RTS/CTS pins of the two boards as show in Table 1 using the jumper cables included in the Murata's uSD-M.2 Adapter kit as shown in the following table.

Pin name	uSD-M.2 adapter pin	i.MX RT1050-EVKB pin	Pin name of RT1050-EVKB	GPIO name of RT1050-EVKB
BT_UART_TXD_	J9 (pin 1)	J22 (pin 1)	LPUART3_RXD	GPIO_AD_B1_07
BT_UART_RXD_	J9 (pin 2)	J22 (pin 2)	LPUART3_TXD	GPIO_AD_B1_06
BT_UART_RTS_]	J8 (pin 3)	J23 (pin 3)	LPUART3_CTS	GPIO_AD_B1_04
BT_UART_CTS_]	J8 (pin 4)	J23 (pin 4)	LPUART3_RTS	GPIO_AD_B1_05
GND	J7 (pin 7)	J25 (pin 7)	GND	GND

Parent topic:*Hardware Rework Guide for IMXRT1050-EVKB and Murata M.2 Module*

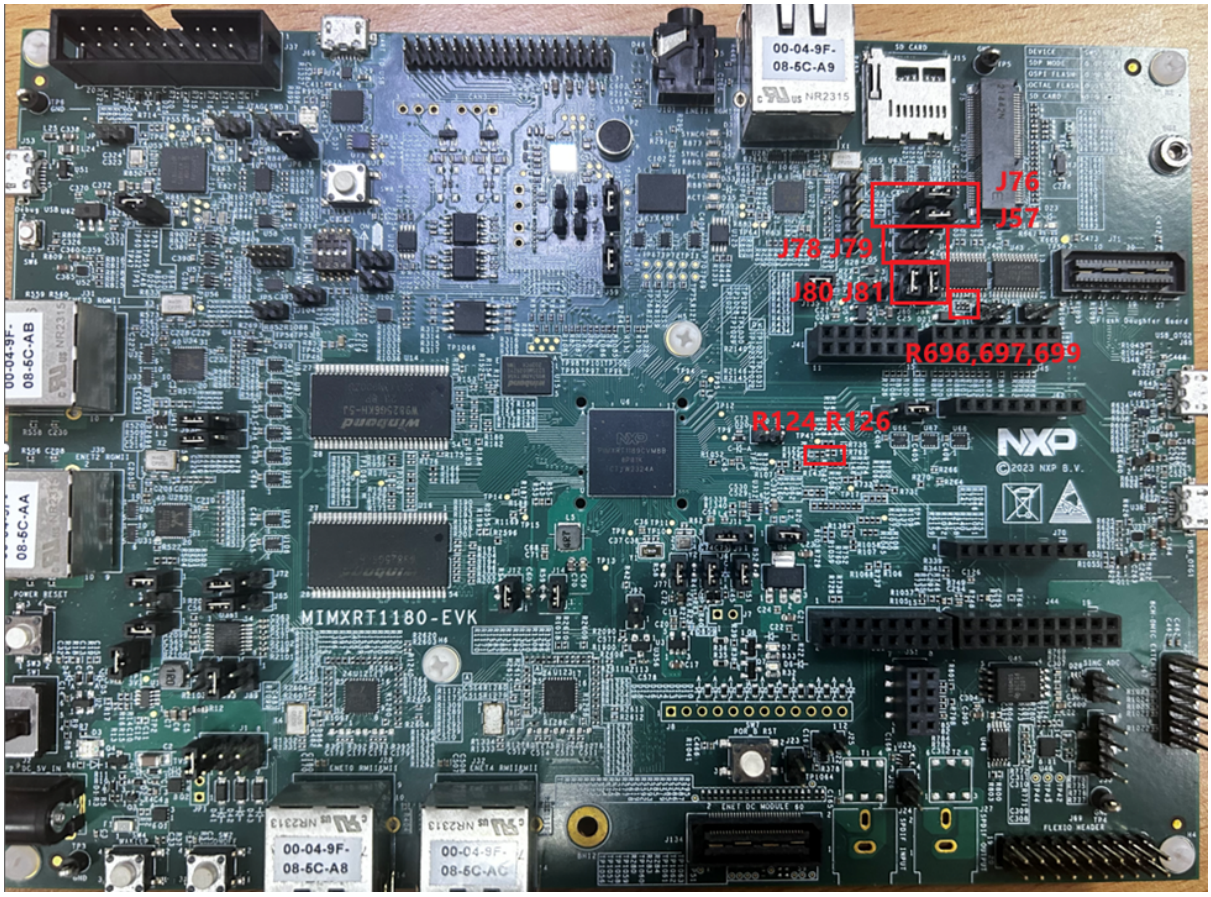
Hardware Rework Guide for MIMXRT1180 and Murata M.2 Module This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP MIMXRT1180 board and the Murata's 1XK, 1ZM, 2EL or 2LL solution - direct M.2 connection to Embedded Artists EAR00385 (1XK), EAR00364 (1ZM), Rev-A1 (2EL) or EAR00500 (2LL) M.2 modules.

The hardware rework consists of two parts:

- HCI UART rework
- PCM interface rework

Hardware rework

- HCI UART rework:
  - Remove: R124,R126
  - Mount R696, R697
  - Connect J57 [2-3], J76 [2-3]
- PCM interface rework
  - Mount R699
  - Disconnect J78 J79
  - Connect J80 J81



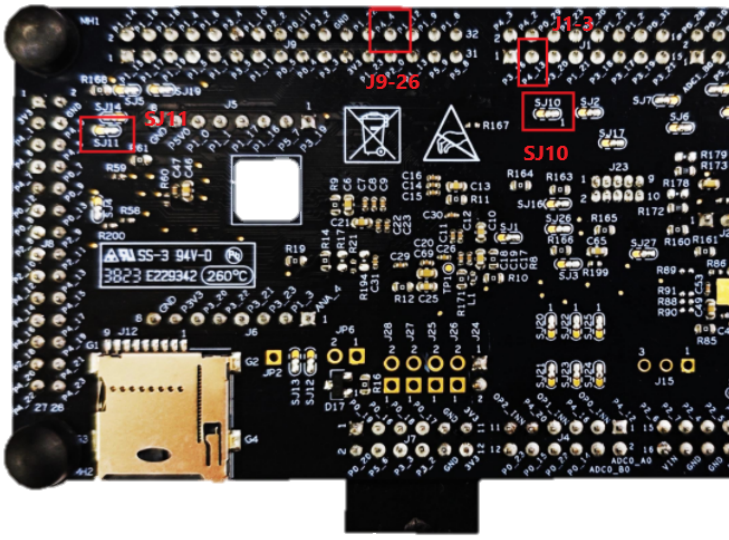
Hardware Rework Guide for FRDM-MCXN947 and X-FRDM-WIFI-M.2 Adapter This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP FRDM-MCXN947 board and X-FRDM-WIFI-M.2 or the Murata's 2LL EAR00500 (2LL) M.2 modules solution.

The hardware rework consists of one part:

- UART interface rework

Hardware rework

- UART interface rework
  - Remove SJ11 1-2, connect SJ11 2-3
  - Remove SJ10 1-2, connect J1-3 to J9-26
- X-FRDM-WIFI-M.2 jumper setting
  - Connect J8(On X-FRDM-WIFI-M.2) for 1.8V
  - Connect J24(On X-FRDM-WIFI-M.2) for 3.3V
  - Connect J19(On X-FRDM-WIFI-M.2) for 1.8V
  - Connect J25(On X-FRDM-WIFI-M.2) for 3.3V
  - Connect J15(On X-FRDM-WIFI-M.2) for 1.8V
  - Connect J16(On X-FRDM-WIFI-M.2) for 3.3V
  - Connect J17(On X-FRDM-WIFI-M.2) for 1.8V



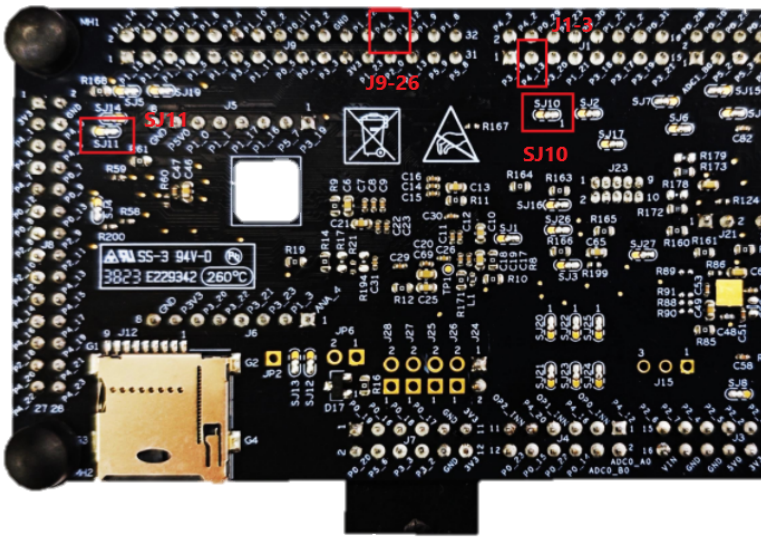
- Connect J18(On X-FRDM-WIFI-M.2) for 3.3V

Hardware Rework Guide for FRDM-MCXN947 and FRDM-IW416-AW-AM510 This section is a brief hardware rework guidance of the EdgeFast Bluetooth PAL on the NXP FRDM-MCXN947 board and FRDM-IW416-AW-AM510 board. The hardware rework consists of two parts:

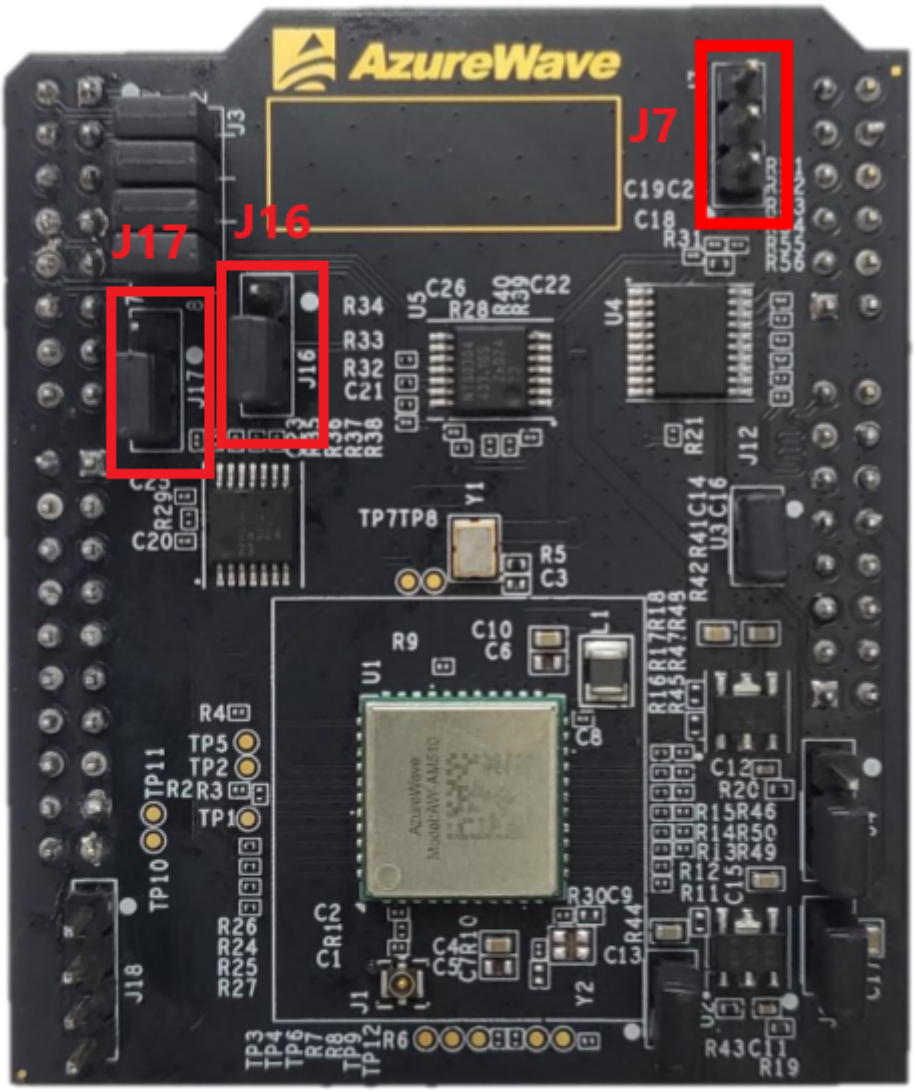
- UART interface rework
- FRDM-IW416-AW-AM510

Hardware rework

- UART interface rework
  - Remove SJ11 1-2, connect SJ11 2-3
  - Remove SJ10 1-2, connect J1-3 to J9-26
- FRDM-IW416-AW-AM510 jumper setting
  - Connect J16 2-3 for 3.3V supply
  - Connect J17 2-3 for 3.3V UART voltage level



- Connect J7 2-3 for 3.3V SDIO voltage level



Enabling Additional EdgeFast Bluetooth Protocol Abstraction Layer Examples on RT1064

Introduction NXP supports Bluetooth/Bluetooth Low Energy on RT1060EVK and RT1060EVKC. RT1064 has the same MCU die with RT1060EVK and RT1060EVKC and therefore it is possible to migrate the examples.

This document takes *peripheral_ht* as an example and describes the steps to migrate EdgeFast examples from RT1060EVK to RT1064 (based on SDK 2.13.0) and from RT1060EVKC to RT1064 (based on SDK 2.14.0) with different toolchains including IAR, Arm GCC, and MDK.

Migrate examples from RT1060EVK to RT1064 This topic describes the Common steps and the steps to migrate with the IAR, Arm GCC, and MDKtoolchains.

Common steps

1. Download *SDK_2.13.0_EVK-MIMXRT1060* and *SDK_2.13.0_EVK-MIMXRT1064*.
2. Copy the following folders from RT1060EVK package to RT1064 package: <install_dir>/components/internal_flash/ <install_dir>/middleware/edgefast_bluetooth/ <install_dir>/middleware/wireless/.

3. Create a folder named edgefast_bluetooth_examples/ under <rt1064_install_dir>/boards/evkmimxrt1064/.
4. Copy the entire folder from <rt1060evk_install_dir>/boards/evkmimxrt1060/edgefast_bluetooth_examples/peripheral_ht/ to < rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/.
5. Copy *clock_config.[c/h]* and *board.c* from <rt1064_install_dir>/boards/evkmimxrt1064/demo_apps/hello_world/ to <rt1064_installed>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/ to replace the previous files.
6. Add #define EDGEFAST_BT_LITTLEFS_MFLASH 1 in <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht /app_config.c.
7. Make the following changes in <rt1064_installed>/boards/evkmimxrt1064/edgefast_bluetooth/peripheral_ht/board.h.

```
73 #define BOARD_FLASH_SIZE (0x800000U)
```

```
73 #define BOARD_FLASH_SIZE (0x400000U)
```

Parent topic:*Migrate examples from RT1060EVK to RT1064*

IAR

1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/iar/.
2. Make the following changes.

File name	Previous item	New item
peripheral_ht.ewp	1060 1062	1064 1064

3. Rename MIMXRT1062xxxxx_flexspi_nor.icf as MIMXRT1064xxxxx_flexspi_nor.icf and make the following changes.

```
47 define symbol m_interrupts_start       = 0x60002000;
48 define symbol m_interrupts_end         = 0x600023FF;
49
50 define symbol m_text_start             = 0x60002400;
51 define symbol _ROM_END_                = 0x6057FFFF;
66 define exported symbol m_boot_hdr_conf_start = 0x60000000;
67 define symbol m_boot_hdr_ivt_start           = 0x60001000;
68 define symbol m_boot_hdr_boot_data_start     = 0x60001020;
69 define symbol m_boot_hdr_dcd_data_start      = 0x60001030;
95 BT_LITTLEFS_STORAGE_SECTOR_SIZE = 0x1000;  /* 4k flash secto
96 BT_LITTLEFS_STORAGE_MAX_SECTORS = (0x60800000 - EDGEFAST_BT_
97 ***/
```

```
47 define symbol m_interrupts_start       = 0x70002000;
48 define symbol m_interrupts_end         = 0x700023FF;
49
50 define symbol m_text_start             = 0x70002400;
51 define symbol _ROM_END_                = 0x7017FFFF;
66 define exported symbol m_boot_hdr_conf_start = 0x70000000;
67 define symbol m_boot_hdr_ivt_start           = 0x70001000;
68 define symbol m_boot_hdr_boot_data_start     = 0x70001020;
69 define symbol m_boot_hdr_dcd_data_start      = 0x70001030;
95 BT_LITTLEFS_STORAGE_SECTOR_SIZE = 0x1000;  /* 4k flash sect
96 BT_LITTLEFS_STORAGE_MAX_SECTORS = (0x70400000 - EDGEFAST_BT
97 ***/
```

Parent topic:*Migrate examples from RT1060EVK to RT1064*

Arm GCC

1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/armgcc/.
2. Rename the following files.

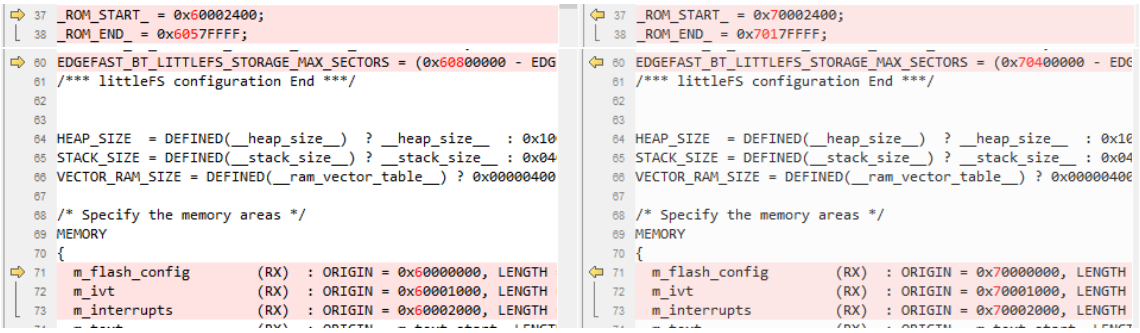
Path	Previous name	**New name**
<rt1064_install_dir>/middleware/wireless/ethermind/	middleware_edgefast_bluetooth_cmake	middleware_edgefast_bluetooth_k32w061_contro cmake

3. Make following changes.

File name	Previous item	New item
config.cmake	1060	1064
	1062	1064
flags.cmake	1062	1064
CMakeLists.txt	1060	1064
	1062	1064

4. *mflash* is used in RT1064 instead of flash_adapter,therefore, comment include(component_flexspi_nor_flash_adapter_rt1064_MIMXRT1064) in *CMakeLists.txt*.

5. Rename MIMXRT1062xxxxx_flexspi_nor.ld as MIMXRT1064xxxxx_flexspi_nor.ld and make the following changes.



```
_ROM_START_ = 0x60002400;
_ROM_END_ = 0x6057FFFF;
EDGEFAST_BT_LITTLEFS_STORAGE_MAX_SECTORS = (0x60800000 - EDG
/*** littleFS configuration End ***/
HEAP_SIZE  = DEFINED(__heap_size__)  ? __heap_size__  : 0x10
STACK_SIZE = DEFINED(__stack_size__) ? __stack_size__ : 0x04
VECTOR_RAM_SIZE = DEFINED(__ram_vector_table__) ? 0x00000400
/* Specify the memory areas */
MEMORY
{
  m_flash_config        (RX)  : ORIGIN = 0x60000000, LENGTH
  m_ivt                 (RX)  : ORIGIN = 0x60001000, LENGTH
  m_interrupts          (RX)  : ORIGIN = 0x60002000, LENGTH
```

```
_ROM_START_ = 0x70002400;
_ROM_END_ = 0x7017FFFF;
EDGEFAST_BT_LITTLEFS_STORAGE_MAX_SECTORS = (0x70400000 - EDG
/*** littleFS configuration End ***/
HEAP_SIZE  = DEFINED(__heap_size__)  ? __heap_size__  : 0x10
STACK_SIZE = DEFINED(__stack_size__) ? __stack_size__ : 0x04
VECTOR_RAM_SIZE = DEFINED(__ram_vector_table__) ? 0x00000400
/* Specify the memory areas */
MEMORY
{
  m_flash_config        (RX)  : ORIGIN = 0x70000000, LENGTH
  m_ivt                 (RX)  : ORIGIN = 0x70001000, LENGTH
  m_interrupts          (RX)  : ORIGIN = 0x70002000, LENGTH
```

Parent topic:*Migrate examples from RT1060EVK to RT1064*

MDK

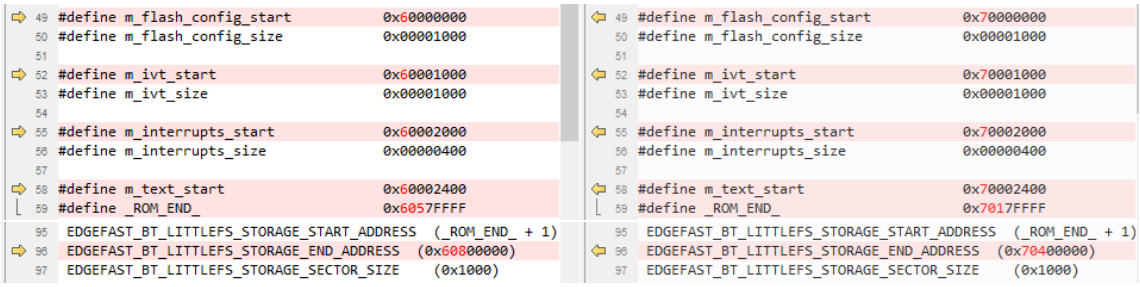
1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/mdk/.

2. Make following changes.

File name	Previous item	New item
peripheral_ht.uvprojx	1060	1064
	1062	1064

3. Copy evkmimxrt1064_flexspi_nor.ini from <rt1064_install_dir>/boards/evkmimxrt1064/demo_apps/hello_world/mdk/ to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/mdk/.

4. Rename MIMXRT1062xxxxx_flexspi_nor as MIMXRT1064xxxxx_flexspi_nor and make the following changes.



```
#define m_flash_config_start            0x60000000
#define m_flash_config_size             0x00001000
#define m_ivt_start                     0x60001000
#define m_ivt_size                      0x00001000
#define m_interrupts_start              0x60002000
#define m_interrupts_size               0x00000400
#define m_text_start                    0x60002400
#define _ROM_END_                       0x6057FFFF
 EDGEFAST_BT_LITTLEFS_STORAGE_START_ADDRESS  (_ROM_END_ + 1)
 EDGEFAST_BT_LITTLEFS_STORAGE_END_ADDRESS  (0x60800000)
 EDGEFAST_BT_LITTLEFS_STORAGE_SECTOR_SIZE    (0x1000)
```

```
#define m_flash_config_start            0x70000000
#define m_flash_config_size             0x00001000
#define m_ivt_start                     0x70001000
#define m_ivt_size                      0x00001000
#define m_interrupts_start              0x70002000
#define m_interrupts_size               0x00000400
#define m_text_start                    0x70002400
#define _ROM_END_                       0x7017FFFF
 EDGEFAST_BT_LITTLEFS_STORAGE_START_ADDRESS  (_ROM_END_ + 1)
 EDGEFAST_BT_LITTLEFS_STORAGE_END_ADDRESS  (0x70400000)
 EDGEFAST_BT_LITTLEFS_STORAGE_SECTOR_SIZE    (0x1000)
```

Parent topic:*Migrate examples from RT1060EVK to RT1064*

Migrate examples from RT1060EVKC to RT1064 This topic describes the Common steps and the steps to migrate with the IAR, Arm GCC, and MDK toolchains.

Common steps

1. Download SDK_2.14.0_EVKC-MIMXRT1060 and SDK_2.14.0_EVK-MIMXRT1064.
2. Copy the following folders from the RT1060EVKC package to the RT1064 package: <install_dir>/middleware/edgefast_bluetooth/ <install_dir>/middleware/wireless/ethermind.
3. Create a new folder named edgefast_bluetooth_examples/ under <rt1064_install_dir>/boards/evkmimxrt1064/.
4. Copy the entire folder from <rt1060evkc_install_dir>/boards/evkcmimxrt1060/edgefast_bluetooth_examples/peripheral_ht/ to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/.
5. Copy clock_config.[c/h] and board.c from <rt1064_install_dir>/boards/evkmimxrt1064/demo_apps/hello_world/ to <rt1064_installed>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/ to replace the previous files.

Parent topic:*Migrate examples from RT1060EVKC to RT1064*

IAR

1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/iar/.
2. Make the following changes in the listed order.

File name	Previous item	New item
peripheral_ht.ewp	1062	1064
mflash/evkcmimxrt1060	mflash/mimxrt1064	
evkcmimxrt1060	evkmimxrt1064	
6B	6A	

3. Rename MIMXRT1062xxxxx_flexspi_nor.icf as MIMXRT1064xxxxx_flexspi_nor.icf and make the following changes.

```
define symbol m_interrupts_start       = 0x60002000;
define symbol m_interrupts_end         = 0x600023FF;

define symbol m_text_start             = 0x60002400;
define symbol m_text_end               = 0x607FFFFF -

define exported symbol m_boot_hdr_conf_start = 0x60000000;
define symbol m_boot_hdr_ivt_start           = 0x60001000;
define symbol m_boot_hdr_boot_data_start     = 0x60001020;
define symbol m_boot_hdr_dcd_data_start      = 0x60001030;
```

```
define symbol m_interrupts_start       = 0x70002000;
define symbol m_interrupts_end         = 0x700023FF;

define symbol m_text_start             = 0x70002400;
define symbol m_text_end               = 0x703FFFFF -

define exported symbol m_boot_hdr_conf_start = 0x70000000;
define symbol m_boot_hdr_ivt_start           = 0x70001000;
define symbol m_boot_hdr_boot_data_start     = 0x70001020;
define symbol m_boot_hdr_dcd_data_start      = 0x70001030;
```

Parent topic:*Migrate examples from RT1060EVKC to RT1064*

Arm GCC

1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/armgcc/.

2. Copy folder from <rt1060evkc_install_dir>/boards/evkcmimxrt1060/edgefast_bluetooth_examples/template/ to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/ and rename the files.

Path	Previous name	New name
<rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/	middleware_edgefast_bluetooth_mcux_linker_template_evkcmimxrt1060.cmake	middleware_edgefast_bluetooth_mcux_linker_template_evkmimxrt1064.cmake
	middleware_edgefast_bluetooth_sdio_template_evkcmimxrt1060.cmake	middleware_edgefast_bluetooth_sdio_template_evkmimxrt1064.cmake

3. Add the following content to<rt1064_install_dir>/devices/MIMXRT1064/all_lib_device.cmake at appropriate location.

```
...
  ${CMAKE_CURRENT_LIST_DIR}/../../boards
  ${CMAKE_CURRENT_LIST_DIR}/../../boards/evkmimxrt1064/edgefast_bluetooth_examples/
↪template
  ${CMAKE_CURRENT_LIST_DIR}/../../middleware/edgefast_bluetooth
  ${CMAKE_CURRENT_LIST_DIR}/../../middleware/wireless/ethermind
...
include_if_use(middleware_edgefast_bluetooth_ble_ethermind_cm7f)
include_if_use(middleware_edgefast_bluetooth_ble_ethermind_lib_cm7f)
include_if_use(middleware_edgefast_bluetooth_br_ethermind_cm7f)
include_if_use(middleware_edgefast_bluetooth_br_ethermind_lib_cm7f)
include_if_use(middleware_edgefast_bluetooth_btble_ethermind_cm7f)
include_if_use(middleware_edgefast_bluetooth_btble_ethermind_lib_cm7f)
include_if_use(middleware_edgefast_bluetooth_common_ethermind)
include_if_use(middleware_edgefast_bluetooth_common_ethermind_hci)
include_if_use(middleware_edgefast_bluetooth_common_ethermind_hci_uart)
include_if_use(middleware_edgefast_bluetooth_config_ethermind)
include_if_use(middleware_edgefast_bluetooth_config_template)
include_if_use(middleware_edgefast_bluetooth_extension_common_ethermind)
include_if_use(middleware_edgefast_bluetooth_k32w061_controller)
include_if_use(middleware_edgefast_bluetooth_mcux_linker_template_ evkmimxrt1064)
include_if_use(middleware_edgefast_bluetooth_pal)
include_if_use(middleware_edgefast_bluetooth_pal_db_gen_ethermind)
include_if_use(middleware_edgefast_bluetooth_pal_host_msd_fatfs_ethermind)
include_if_use(middleware_edgefast_bluetooth_pal_platform_ethermind)
include_if_use(middleware_edgefast_bluetooth_porting)
include_if_use(middleware_edgefast_bluetooth_porting_atomic)
include_if_use(middleware_edgefast_bluetooth_porting_list)
include_if_use(middleware_edgefast_bluetooth_porting_net)
include_if_use(middleware_edgefast_bluetooth_porting_toolchain)
include_if_use(middleware_edgefast_bluetooth_porting_work_queue)
include_if_use(middleware_edgefast_bluetooth_profile_bas)
include_if_use(middleware_edgefast_bluetooth_profile_dis)
include_if_use(middleware_edgefast_bluetooth_profile_fmp)
include_if_use(middleware_edgefast_bluetooth_profile_hps)
include_if_use(middleware_edgefast_bluetooth_profile_hrs)
include_if_use(middleware_edgefast_bluetooth_profile_hts)
include_if_use(middleware_edgefast_bluetooth_profile_ipsp)
include_if_use(middleware_edgefast_bluetooth_profile_pxr)
include_if_use(middleware_edgefast_bluetooth_profile_tip)
include_if_use(middleware_edgefast_bluetooth_profile_wu)
include_if_use(middleware_edgefast_bluetooth_sdio_template_evkmimxrt1064)
include_if_use(middleware_edgefast_bluetooth_shell)
include_if_use(middleware_edgefast_bluetooth_shell_ble)
include_if_use(middleware_edgefast_bluetooth_template)
include_if_use(middleware_edgefast_bluetooth_wifi_nxp_controller_base)...
```

4. Make the following changes in the listed order.

File name	Previous item	New item
config.cmake	MIMXRT1	MIMXRT1064xxxxA
mflash_evkcmimxrt1060	mflash_rt	
1062	1064	
evkcmimxrt1060	evk-mimxrt10	
flags.cmake	1062	1064
6B	6A	
CMakeLists.txt	1062	1064
<rt1064_install_dir>/middleware/edgefast_bluetooth/middleware_edgefast_bluetooth_template.cmake	evkcmimx	evk-mimxrt1064
<rt1064_install_dir>/middleware/wireless/ethermind/middleware_edgefast_bluetooth_common_ethermind_hci_uart.cmake	1062	1064
<rt1064_install_dir>/middleware/wireless/ethermind/middleware_edgefast_bluetooth_k32w061_controller.cmake	1062	1064
<rt1064_install_dir>/middleware/wireless/ethermind/middleware_edgefast_bluetooth_wifi_nxp_controller_base.cmake	evkcmimx	evk-mimxrt1064
<rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/middleware_edgefast_bluetooth_mcux_cmake	1062	1064 mxrt1064.
<rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/middleware_edgefast_bluetooth_sdio_t cmake	1062	1064 1.

5. Rename MIMXRT1062xxxxx_flexspi_nor.ld as MIMXRT1064xxxxx_flexspi_nor.ld and make the following changes.

```
m_text_start         = 0x60002400;
m_text_size          = 0x007FDC00 - LITTLEFS_REGION_SIZE;

HEAP_SIZE  = DEFINED(__heap_size__)  ? __heap_size__  : 0x1000;
STACK_SIZE = DEFINED(__stack_size__) ? __stack_size__ : 0x0400;
VECTOR_RAM_SIZE = DEFINED(__ram_vector_table__) ? 0x00000400 : 0;

/* Specify the memory areas */
MEMORY
{
  m_flash_config       (RX)  : ORIGIN = 0x60000000, LENGTH = 0x00001000
  m_ivt                (RX)  : ORIGIN = 0x60001000, LENGTH = 0x00001000
  m_interrupts         (RX)  : ORIGIN = 0x60002000, LENGTH = 0x00000400
```

```
m_text_start         = 0x70002400;
m_text_size          = 0x003FDC00 - LITTLEFS_REGION_SIZE;

HEAP_SIZE  = DEFINED(__heap_size__)  ? __heap_size__  : 0x1000;
STACK_SIZE = DEFINED(__stack_size__) ? __stack_size__ : 0x0400;
VECTOR_RAM_SIZE = DEFINED(__ram_vector_table__) ? 0x00000400 : 0;

/* Specify the memory areas */
MEMORY
{
  m_flash_config       (RX)  : ORIGIN = 0x70000000, LENGTH = 0x00001000
  m_ivt                (RX)  : ORIGIN = 0x70001000, LENGTH = 0x00001000
  m_interrupts         (RX)  : ORIGIN = 0x70002000, LENGTH = 0x00000400
```

Parent topic:*Migrate examples from RT1060EVKC to RT1064*

MDK

1. Navigate to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/mdk/.
2. Make the following changes in the listed order.

File name	Previous item	New item
peripheral_ht.uvprojx	1062	1064
	mflash/evkcmimxrt1060	mflash/mimxrt1064
	evkcmimxrt1060	evkcmimxrt1064
	6B	6A

3. Copy evkmimxrt1064_flexspi_nor.ini from <rt1064_install_dir>/boards/evkmimxrt1064/demo_apps/hello_world/mdk/ to <rt1064_install_dir>/boards/evkmimxrt1064/edgefast_bluetooth_examples/peripheral_ht/mdk/.
4. Rename MIMXRT1062xxxxx_flexspi_nor as MIMXRT1064xxxxx_flexspi_nor and make the following changes.

```
43 #define m_flash_config_start          0x60000000
44 #define m_flash_config_size           0x00001000
45
46 #define m_ivt_start                   0x60001000
47 #define m_ivt_size                    0x00001000
48
49 #define m_interrupts_start            0x60002000
50 #define m_interrupts_size             0x00000400
51
52 #define m_text_start                  0x60002400
53 #define m_text_size                   0x007FDC00 - LITTLEFS
```

```
43 #define m_flash_config_start          0x70000000
44 #define m_flash_config_size           0x00001000
45
46 #define m_ivt_start                   0x70001000
47 #define m_ivt_size                    0x00001000
48
49 #define m_interrupts_start            0x70002000
50 #define m_interrupts_size             0x00000400
51
52 #define m_text_start                  0x70002400
53 #define m_text_size                   0x003FDC00 - LITTLEFS
```

Parent topic:*Migrate examples from RT1060EVKC to RT1064*

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Enabling Additional Edgefast BT PAL Examples on M4 core for RT1170

Introduction RT1170 works with two cores: M7 and M4, on which both all EdgeFast examples can run. However, all the EdgeFast examples in the release package are enabled on M7. Only the A2DP source example is enabled on M4.

EdgeFast projects for both the cores share the demo source files but with different project settings. Therefore, the examples can be migrated.

This document describes the steps to migrate EdgeFast examples from M7 to M4 with different toolchains. There are four main steps required. Additionally, you can also delete the function.

1. Create an M4 project
2. Rearrange source files
3. Rearrange project files

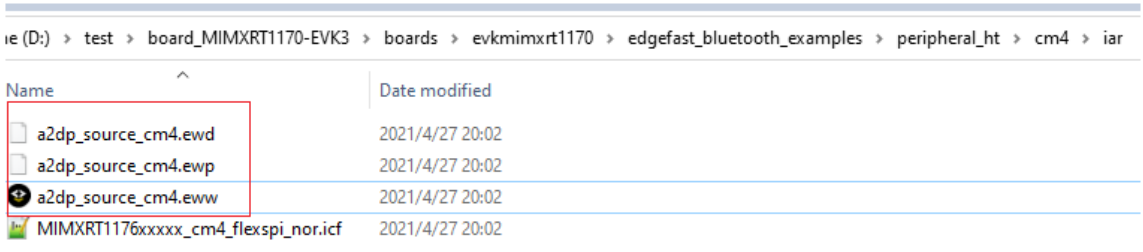
4. Adjust project settings
5. Delete function

In this document, the peripheral_ht example is used to demonstrate how to enable EdgeFast examples on M4 core with IAR and ARMGCC.

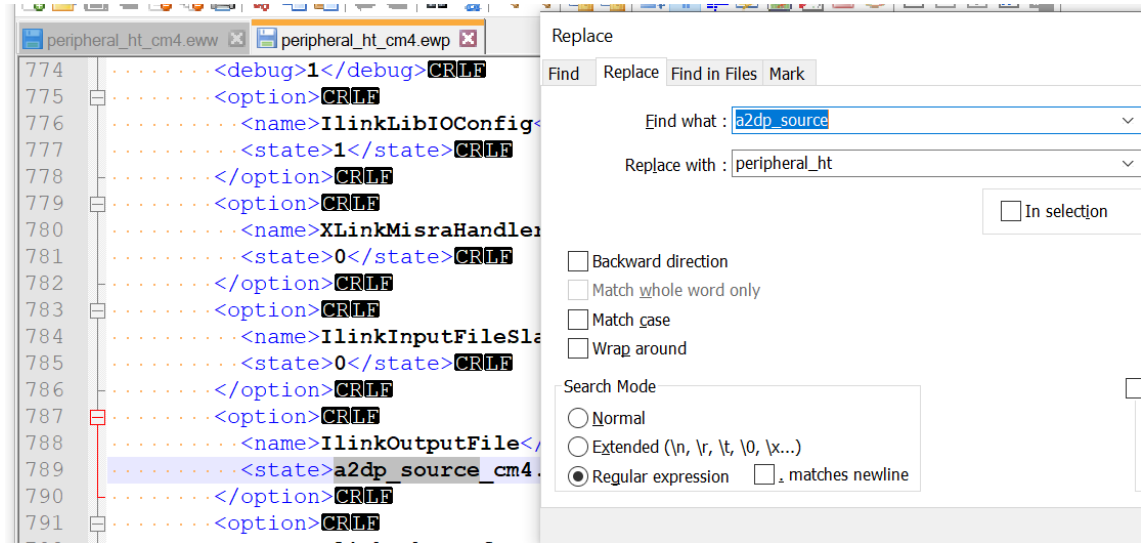
IAR This section describes the steps to create an M4 project with IAR, rearrange source and project files, adjust project settings, and delete function.

Create an M4 project To create an M4 project, perform the following steps:

1. Copy the folder *cm4* in the directory <*install_dir*>*boards*\|*evkmimxrt1170*\|*edgefast_bluetooth_examples*\|*a2dp_* into the folder in which the example should be enabled. In this case, copy the folder *cm4* into the directory <*install_dir*>\|*boards*\|*evkmimxrt1170*\|*edgefast_bluetooth_examples*\|*peripheral_ht*.
2. Open the folder *iar* in the directory <*install_dir*>*boards*\|*evkmimxrt1170*\|*edgefast_bluetooth_examples*\|*periph*
3. Rename the files. Change the file name name *a2dp_source_cm4* to *peripheral_ht_cm4* in all the respective files.



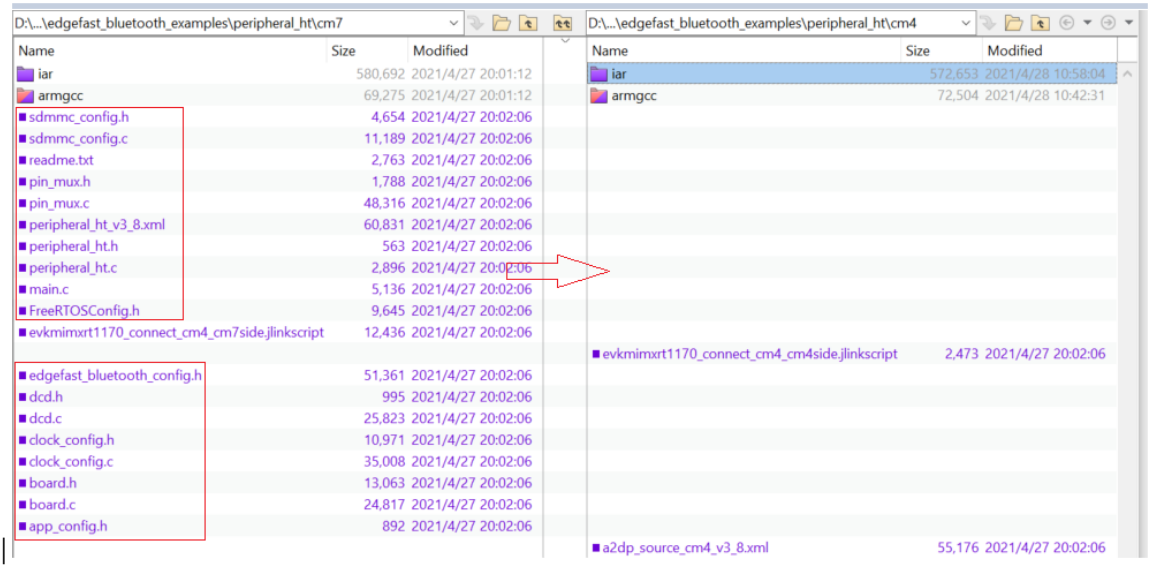
4. Open the files *peripheral_ht_cm4.eww* and *peripheral_ht_cm4.ewp* with a text editor, such as Notepad, Notepad++, Sublime, or Visual Studio Code.
5. Search and replace all *a2dp_source_cm4* with *peripheral_ht _cm4*, and then save the files.



Parent topic:*IAR*

Rearrange source files To rearrange source files, perform the following steps:

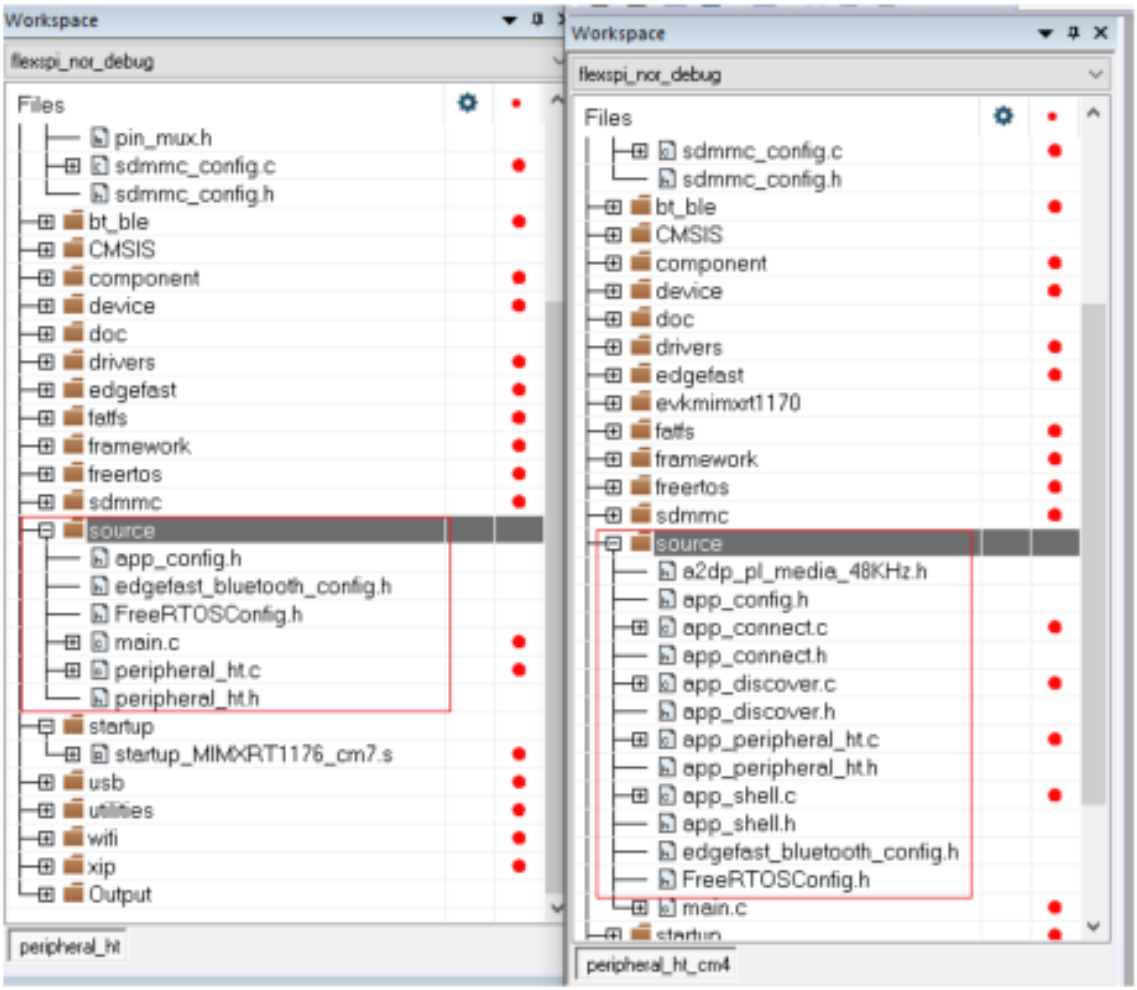
1. Open the folder *cm4* in the directory <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peri* and delete all files with the extensions *.c and *.h.
2. Copy the files with the extensions *.c and *.h from the folder *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm7*| to the folder <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4*.



Parent topic:*IAR*

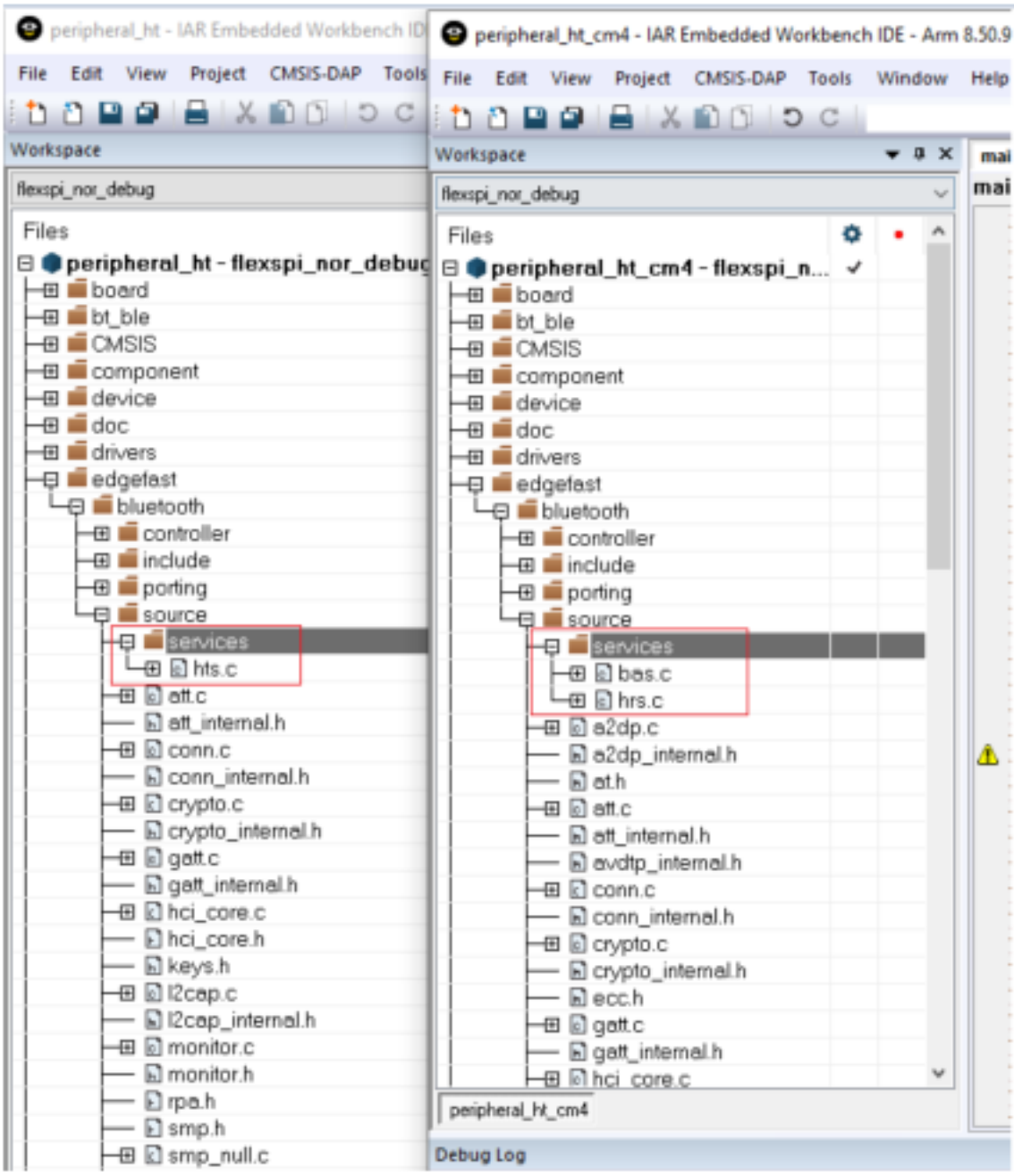
Rearrange project files To rearrange project files, perform the following steps:

1. Open the *peripheral_ht _cm7*and *peripheral_ht _cm4* IAR projects in the directories <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht* |*cm7*|*iar* and <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht* |*cm4*|*iar*.
    1. Compare the whole project directory, find file groups that the cm7 project has but are missing in the cm4 project. Add the missing file groups from the cm7 project into the cm4 project.
    2. Compare the difference between the two groups with the same name. Remove files that do not exist in the cm7 project but exist in the cm4 project. Find files that are available in the cm7 project but are missing in the cm4 project. Add the missing files from the cm7 project into the cm4 project.
2. For example, in the following figure, the files in the source group in the cm4 project must be removed, and the files in the path: <*install_dir*>|*boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht* with the same name as the files in the cm7 project must be added into the *source* group.



3. Compare the *services* group.

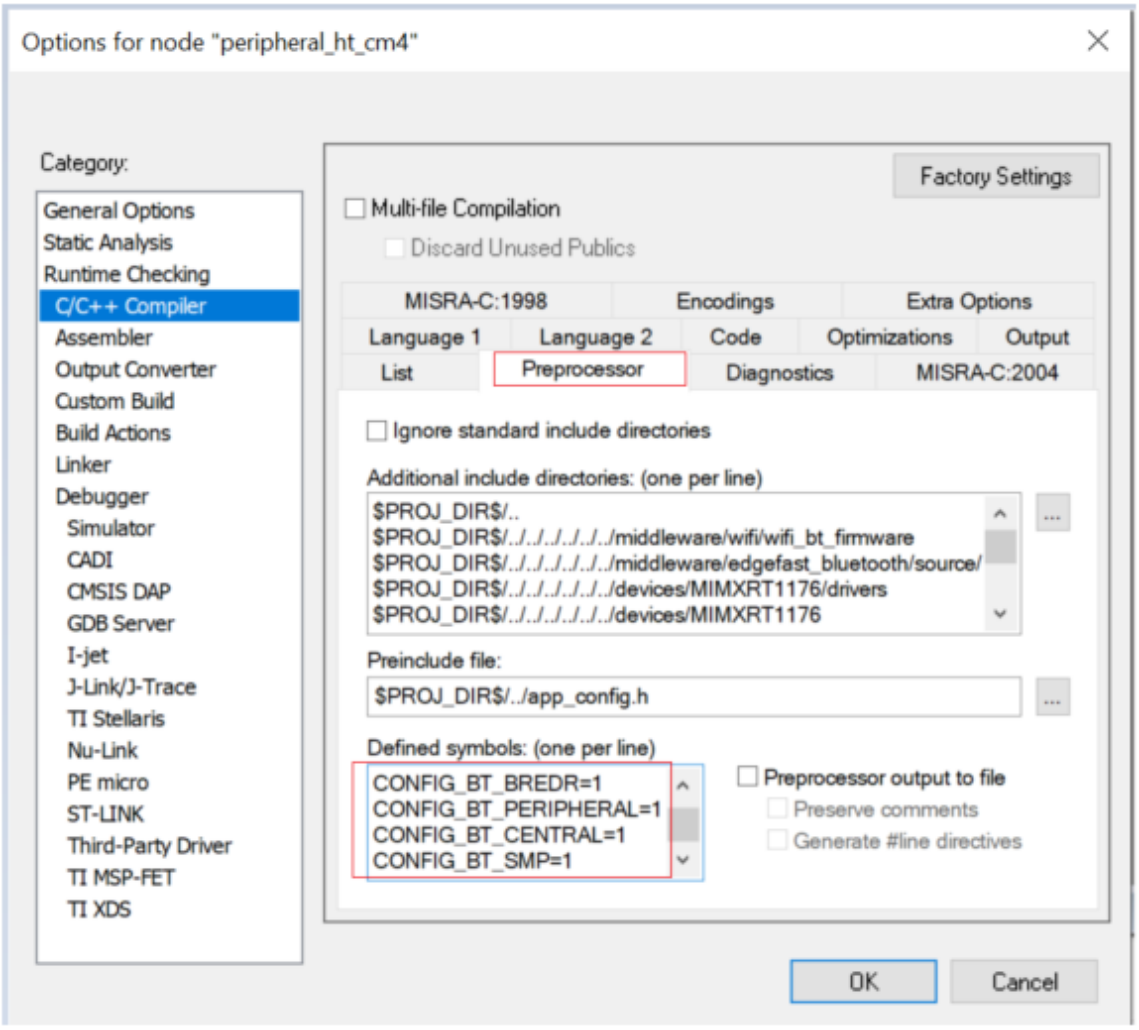
   The peripheral hts profile is in the *services* folder. Add the hts.c file to the *services* group of the *cm4* folder.



Parent topic:*IAR*

Adjust project settings To adjust the project settings, perform the following steps:

1. Compare the macro in the project settings: **Option** > **C/C++ compiler** > **Preprocessor**.
2. Find the macros that do not exist in the **cm4** project but are available in the **cm7** project. Delete these macro. The rule is that **m7** macro setting should be same with **m4**.



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The macros are in the**peripheral_ht_cm4.ewp** file.

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Parent topic:*IAR*

Delete function As a final step, remove the function *"SCB_DisableDCache()*; in main.c.

On the completion of the above steps, the M7 project successfully migrates to an M4 project. You can now download and debug the M4 example project.

Parent topic:*IAR*

Arm GCC This section describes the steps to create an M4 project with Arm GCC, rearrange source and project files, adjust project settings, and delete function.

Create an M4 project To create an M4 project, perform the following steps:

1. Copy the folder <*install_dir*> *boards\evkmimxrt1170\edgefast_bluetooth_examples\a2dp_source\cm4* into another folder in which the example should be enabled. In this case, copy the folder <*install_dir*>

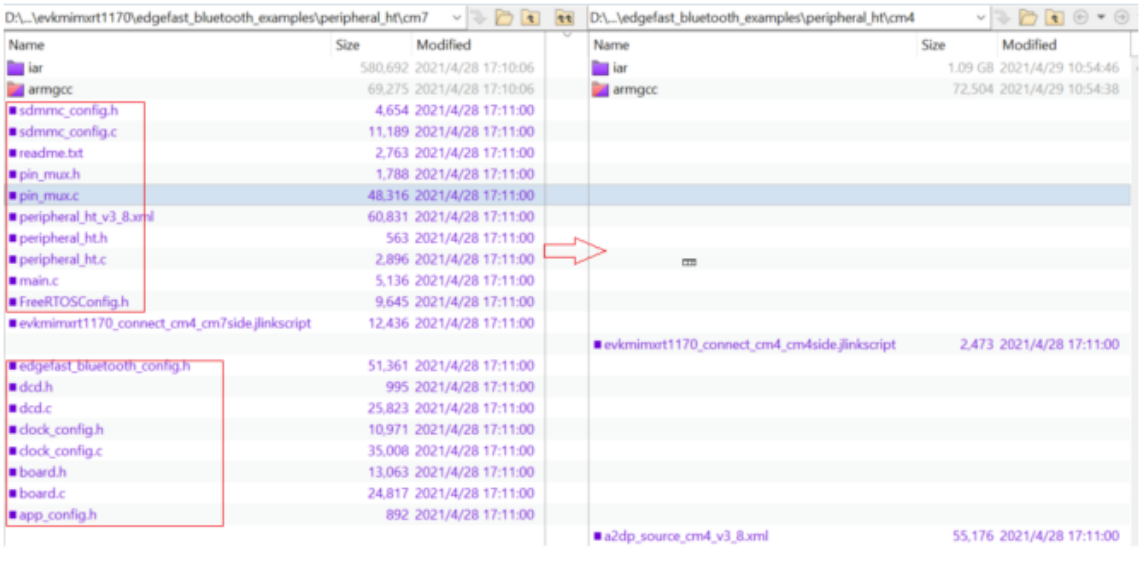
boards\evkmimxrt1170\edgefast_bluetooth_examples\a2dp_source \cm4 into*<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm4*.

2. Open the file *CMakeLists.txt* located in the path: *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm4\ armgcc*.
3. Search and replace all *a2dp_source_cm4* with *peripheral_ht_cm4*, and then save the files.

Parent topic:*Arm GCC*

Rearrange source files To rearrange source files, perform the following steps:

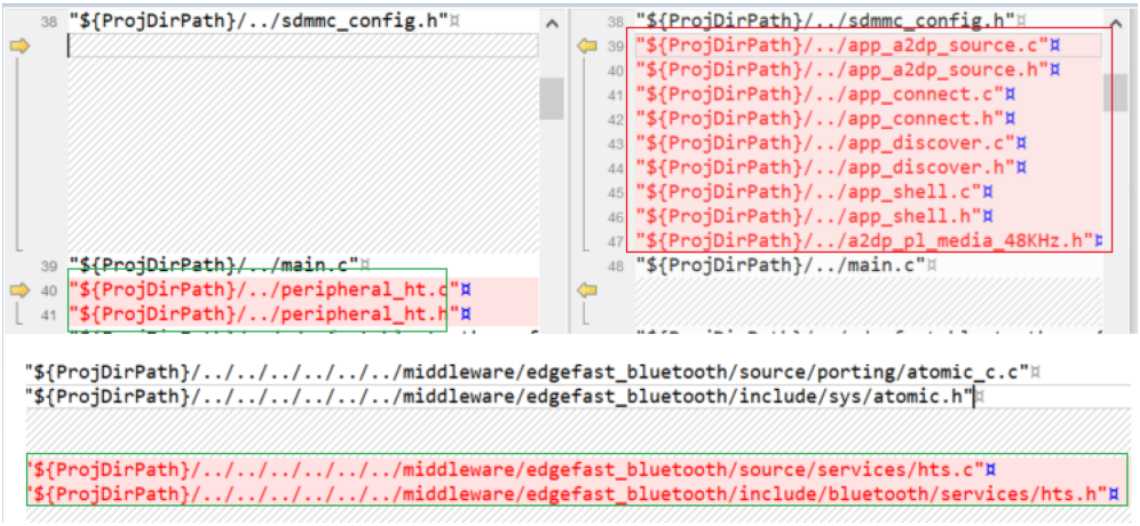
1. Open the folder *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm4* and delete all files with the extensions *.c and *.h.
2. Copy the files with the extensions *.c and *.h in the folder *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm7* to the folder *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm4*.



Parent topic:*Arm GCC*

Rearrange project files To rearrange project files, perform the following steps:

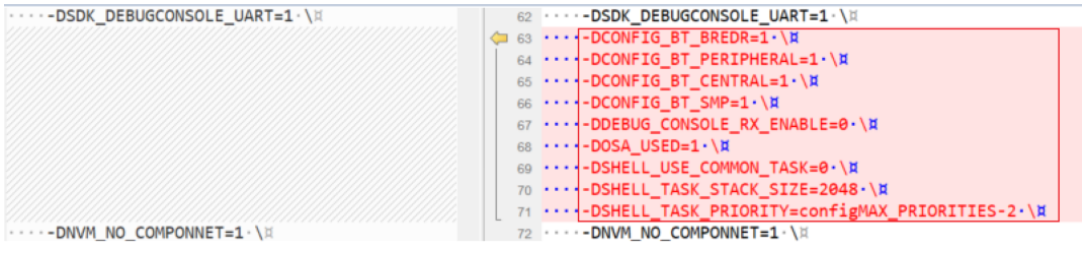
1. Open the *CMakeLists.txt* of the two examples respectively. The two files are in the *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm7\armgcc* and *<install_dir>boards\evkmimxrt1170\edgefast_bluetooth_examples\peripheral_ht\cm4\armgcc* folders respectively.
2. Search the section *add_executable*. Compare the difference between the two sections. Remove files that do not exist in the *cm7* project but are available in the *cm4* project. Add the files that exist in the *cm7* project but are not available in the *cm4* project into the *cm4* project. For example, in the following figure, the files in the red box should be removed and the files in the green box must be added into the *cm4* project.



Parent topic:*Arm GCC*

Adjust project setting To adjust the project settings, perform the following steps:

1. Open the *flags.cmake* of the two examples respectively. The two files are in the <*install_dir*>*boards**evkmimxrt1170**edgefast_bluetooth_examples**peripheral_ht**cm7**armgcc* and <*install_dir*>*boards**evkmimxrt1170**edgefast_bluetooth_examples**peripheral_ht**cm4**armgcc* folders respectively.
2. Search the ***CMAKE_C_FLAGS_DEBUG*** section.
    1. Compare the macro between the two sections.
    2. Add the macros that do not exist in the **cm4** project but are available in the **cm7** project into the cm4 project. The rule is that macro setting should be same.
    3. Delete the macros highlighted in the red rectangle.



Parent topic:*Arm GCC*

Delete function As a final step, remove the function *"SCB_DisableDCache()* in main.c.

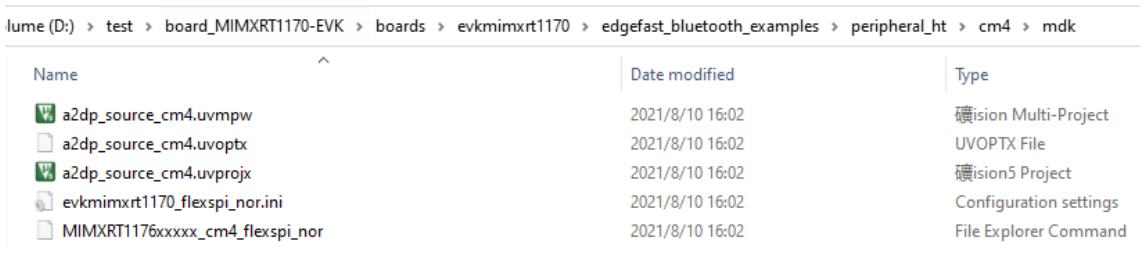
On the completion of the above steps, the M7 project successfully migrates to an M4 project. You can now download and debug the M4 example project.

Parent topic:*Arm GCC*

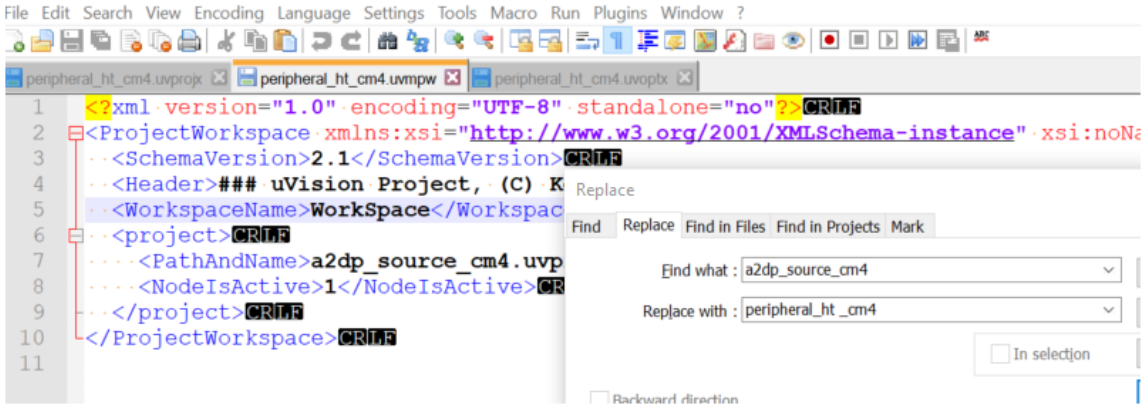
MDK This section describes the steps to create an M4 project with MDK, rearrange source and project files, adjust project settings, and delete function.

Create an M4 project

1. Copy folder *cm4* from <*install_dir*>*boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*a2dp_source*|*cm4* into the folder in where the example must be enabled. In this case, copy folder *cm4* into directory <*install_dir*>|*boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*.
2. Open folder mdk from <*install_dir*>*boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4*



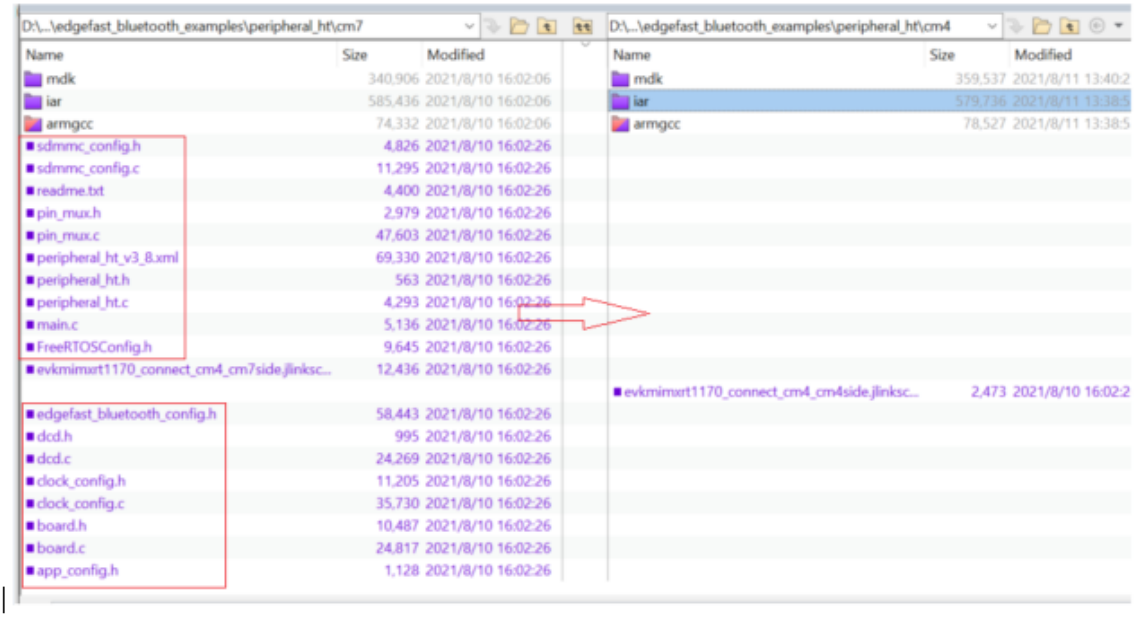
3. Change the filename *a2dp_source_cm4* to *peripheral_ht_cm4* respectively.
4. Open the files *peripheral_ht_cm4.**uvmpw* and *peripheral_ht_cm4.* *uvoptx, peripheral_ht_cm4.uvprojx*with a text editor, such as Notepad, Notepad++, Sublime, or Visual Studio code.
5. Search and replace *a2dp_source_cm4* with *peripheral_ht _cm4*, and then save the files.



Parent topic:*MDK*

Rearrange source files

1. Open folder *cm4* in *<install_dir>**boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4*, and delete all files with the .c and .h file name extension.
2. Copy files with the .c and .h filename extension in folder *cm7* with directory <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm7*to folder *cm4* with directory <*install_dir*> *boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4*.

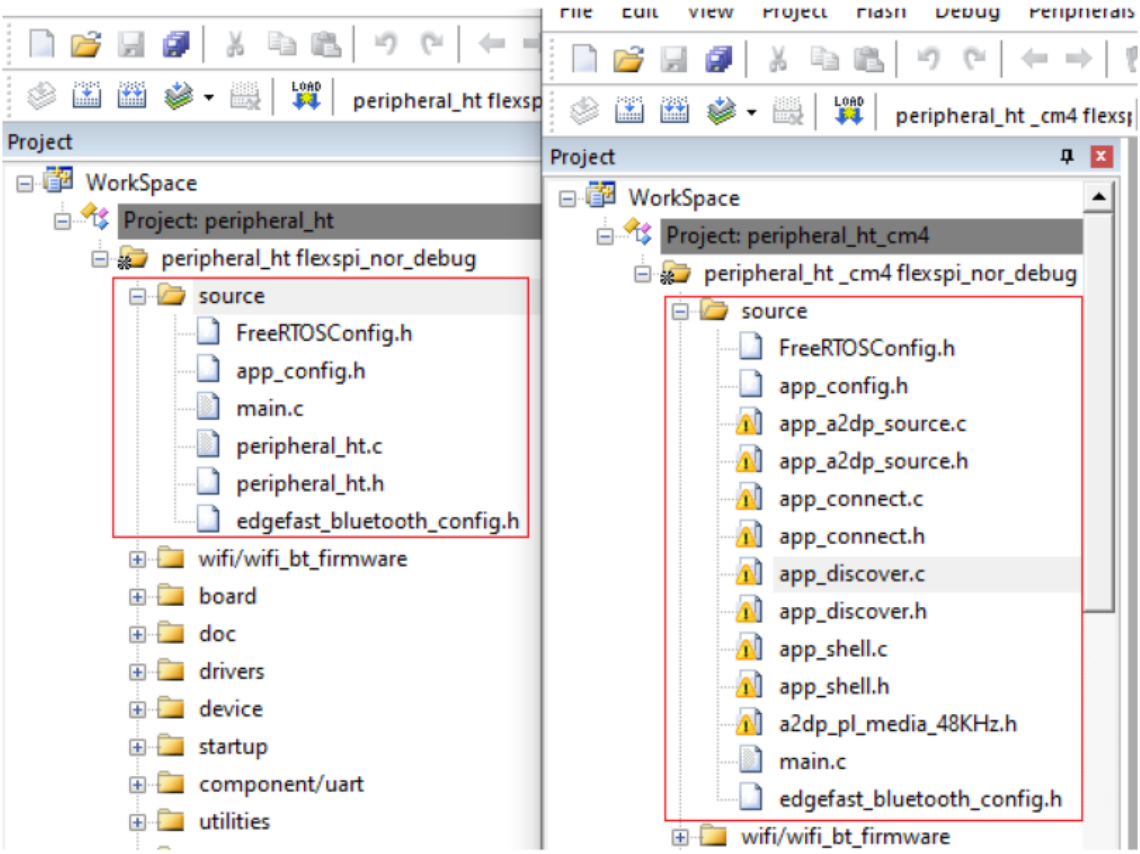


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Parent topic:*MDK*

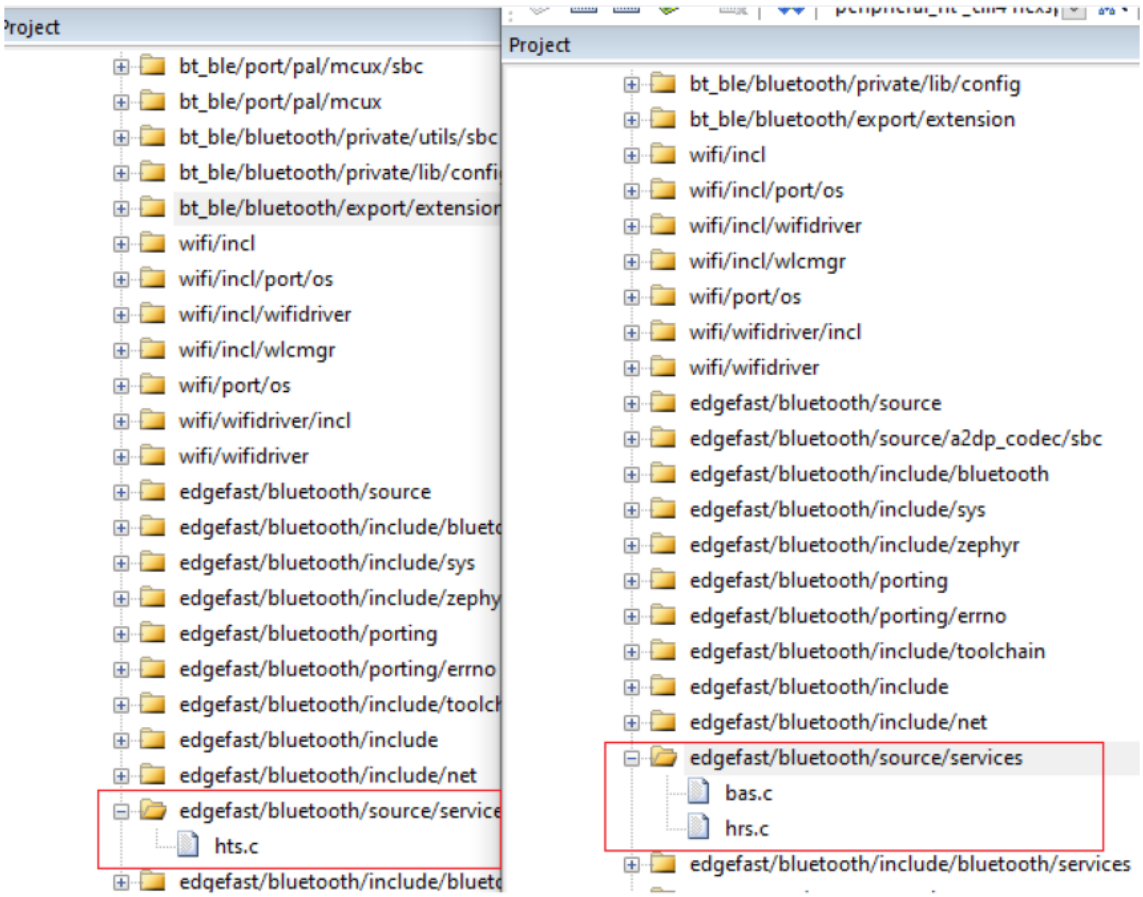
Rearrange project files

1. Open the *peripheral_ht _cm7* and *peripheral_ht _cm4* IAR projects. The two workspaces are located in *<install_dir>**boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm7*|*mdk* and *<install_dir>**boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4*|*mdk* respectively.
   - Compare the whole project directory, find file groups that the cm7 project has but the cm4 project not and then add these groups into the cm4 project.
   - Compare the difference between the two groups with the same name, remove files that do not exist in the cm7 project but exist in the cm4 project; find files that the cm7 project has but the cm4 project not and then add these files into the cm4 project.
2. For the *source* group, in this case, the files in the source group in the cm4 project must be removed, and the files in the path *<install_dir>*|*boards*|*evkmimxrt1170*|*boards*|*evkmimxrt1170*|*edgefast_bluetooth_examples*|*peripheral_ht*|*cm4* with the same name as the files in the cm7 project must be added into the *source* group.



3. Compare the **service: group**.

   Peripheral hts profile is located in "**service**" folder. Add the hts.c file to the services group of the cm4 folder.

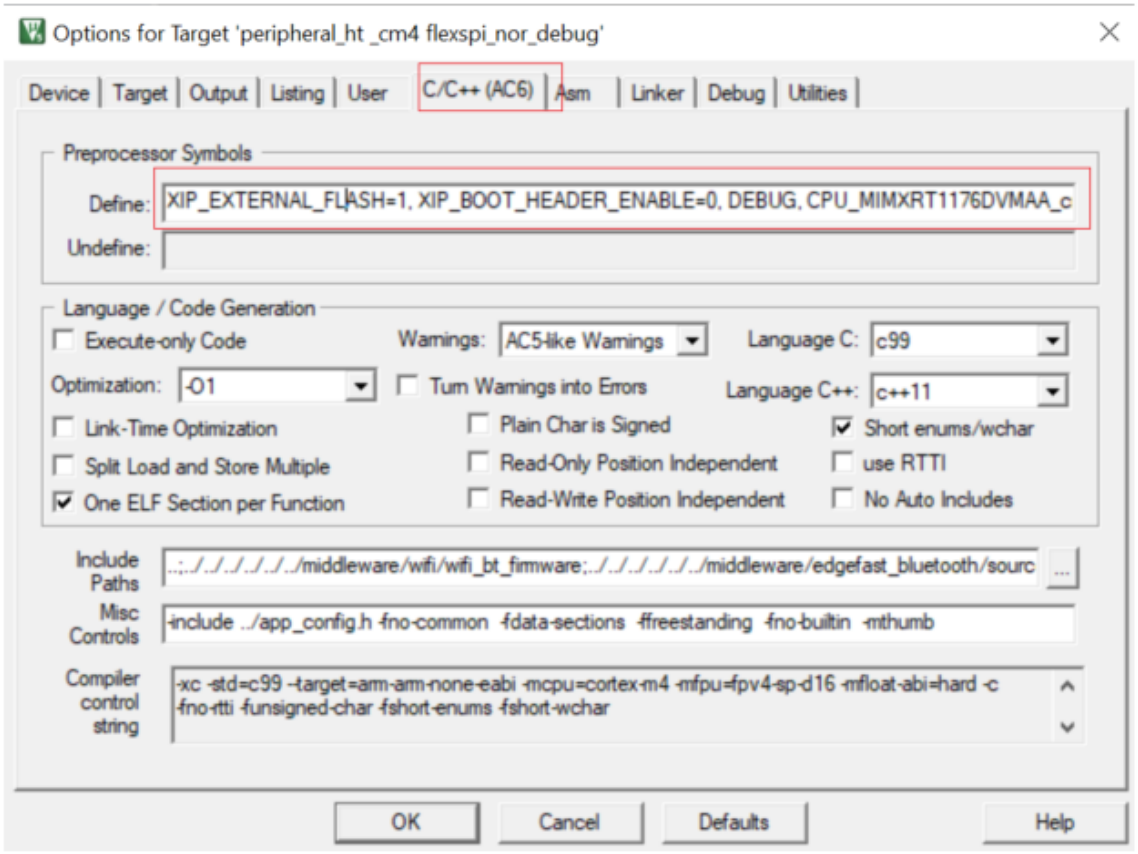


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Parent topic:*MDK*

Adjust project settings

1. Compare the macro in the project settings: *preprocessor symbols*.
2. Compare the macro that does exist in the cm4 project but exists in the cm7 project.
3. Delete the following macro. The rule is that m7 macro setting should be same as m4 .
   The macro could also be found in be eripheral_ht_cm4.uvprojx.



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Parent topic:*MDK*

Delete function Remove function *SCB_DisableDCache();* in *main.c*.

On successful completion of the above steps, the M7 project is changed to the M4 project. You can now download and debug the M4 example project.

Parent topic:*MDK*

Note The above steps are based on the **a2dp_source** example and help enable the **peripheral_ht** example on the **m4** core. You can use the same steps for other examples and migrate them from an **m7** project to an **m4** project.

Chapter 4

RTOS

4.1 FreeRTOS

4.1.1 FreeRTOS kernel

Open source RTOS kernel for small devices.

FreeRTOS kernel for MCUXpresso SDK Readme

FreeRTOS kernel for MCUXpresso SDK ChangeLog

FreeRTOS kernel Readme

4.1.2 FreeRTOS drivers

This is set of NXP provided FreeRTOS reentrant bus drivers.

4.1.3 backoffalgorithm

Algorithm for calculating exponential backoff with jitter for network retry attempts.

Readme

4.1.4 corehttp

C language HTTP client library designed for embedded platforms.

4.1.5 corejson

JSON parser.

Readme

4.1.6 coremqtt

MQTT publish/subscribe messaging library.

4.1.7 coremqtt-agent

The coreMQTT Agent library is a high level API that adds thread safety to the coreMQTT library.

Readme

4.1.8 corepkcs11

PKCS #11 key management library.

Readme

4.1.9 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

Readme