



# MCUXpresso SDK Documentation

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NXP  
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This documentation contains information specific to the lpcxpresso860max board.



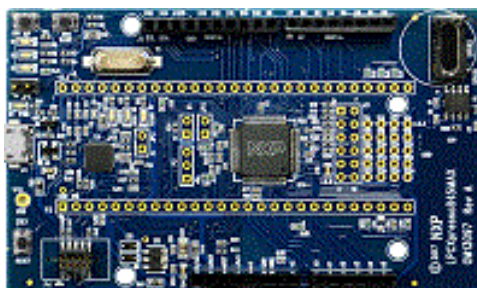
# Chapter 1

## LPCXpresso860MAX

### 1.1 Overview

The LPC86x are an Arm Cortex-M0+ based, low-cost 32-bit MCU family operating at CPU frequencies of up to 48 MHz. The LPC86x support up to 64 KB of flash memory and 8 KB of SRAM.

The peripheral complement of the LPC86x includes a CRC engine, one I2C-bus interface, one I3C-MIPI bus interface, up to three USARTs, up to two SPI interfaces, one multi-rate timer, self-wake-up timer, two FlexTimers, a DMA, one 12-bit ADC, one analog comparator, function-configurable I/O ports through a switch matrix, an input pattern match engine, and up to 54 general-purpose I/O pins.



MCU device and part on board is shown below:

- Device: LPC865
- PartNumber: LPC865M201JBD64

### 1.2 Getting Started with MCUXpresso SDK Package

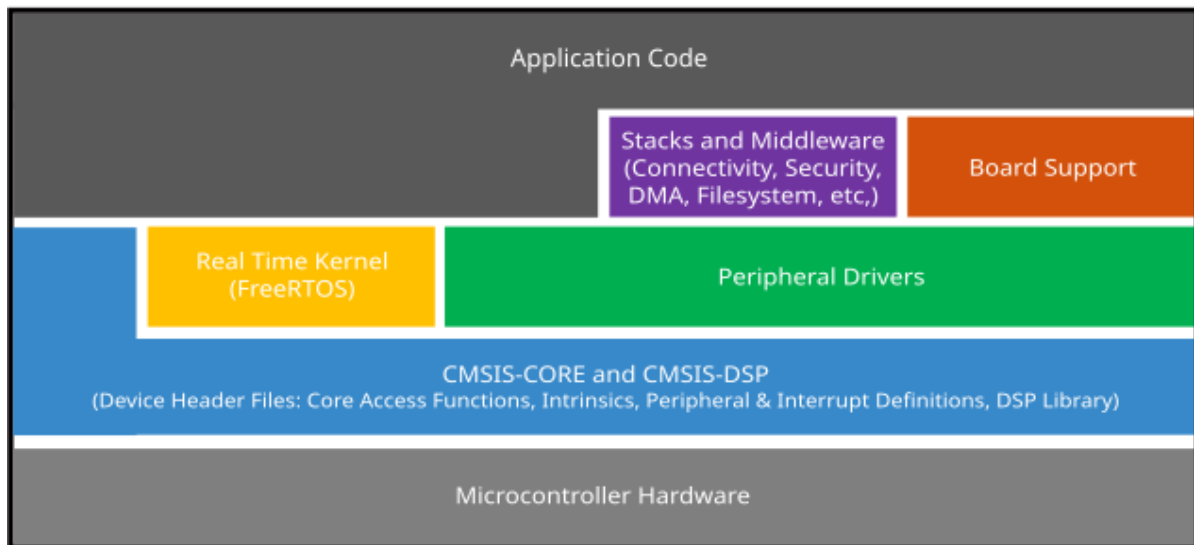
#### 1.2.1 Getting Started with MCUXpresso SDK Package

##### Overview

The NXP MCUXpresso software and tools offer comprehensive development solutions designed to optimize, ease, and help accelerate embedded system development of applications based on general purpose, crossover, and Bluetooth-enabled MCUs from NXP. 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 optional RTOS integrations such as FreeRTOS and Azure RTOS, and various other middleware to support rapid development.

For supported toolchain versions, see *MCUXpresso SDK Release Notes* (document MCUXSDKRN).

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 subfolders to classify the type of examples it contains. These include (but are not limited to):

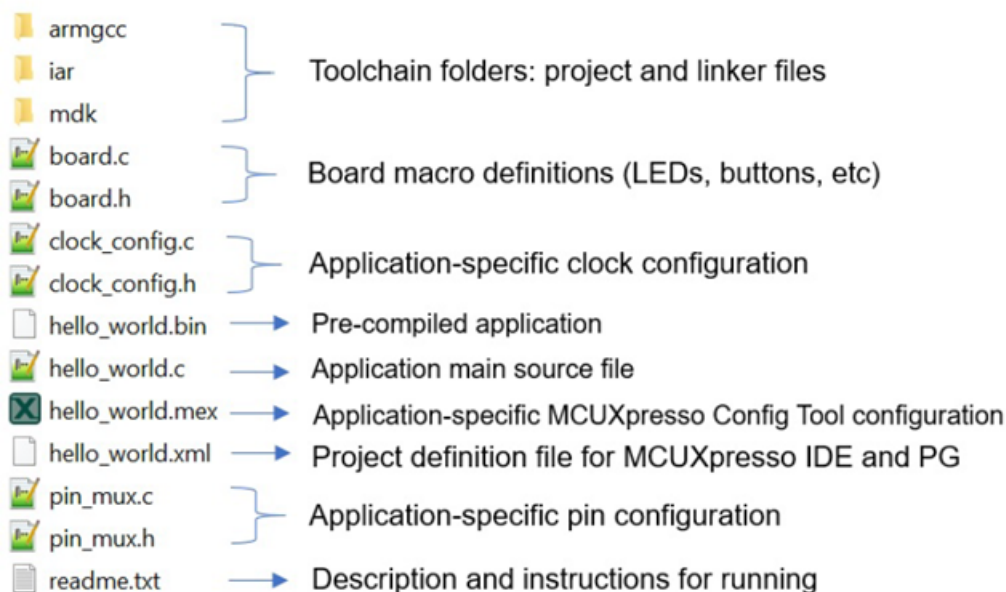
- `cmsis_driver_examples`: Simple applications intended to show how to use CMSIS drivers.
- `demo_apps`: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- `driver_examples`: 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).
- `emwin_examples`: Applications that use the emWin GUI widgets.
- `rtos_examples`: Basic FreeRTOS 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.

**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.

**Locating example application source files** When opening an example application in any of the supported IDEs, various source files are referenced. The MCUXpresso SDK devices folder is the central component to all example applications. It means that 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>/cmsis_drivers`: All the CMSIS drivers for your specific MCU
- `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/<device_name>/project`: Project template used in CMSIS PACK new project creation

For examples containing middleware/stacks or an RTOS, there are references to the appropriate source code. Middleware source files are located in the `middleware` folder and 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.

## Run a demo using MCUXpresso IDE

**Note:** Ensure that the MCUXpresso IDE toolchain is included when generating the MCUXpresso SDK package.

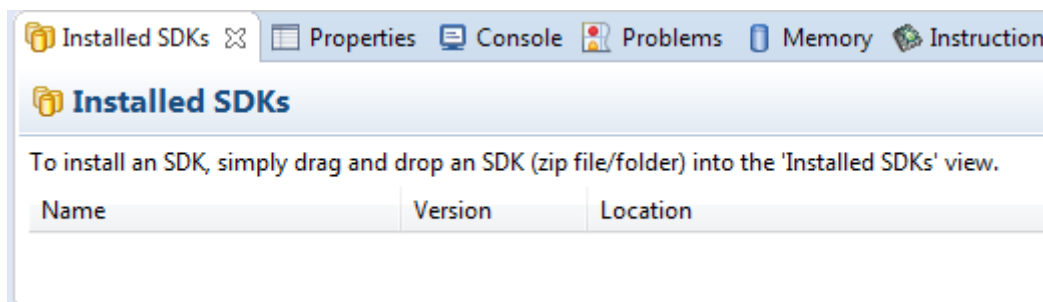
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The `hello_world` demo application targeted for the hardware platform is

used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

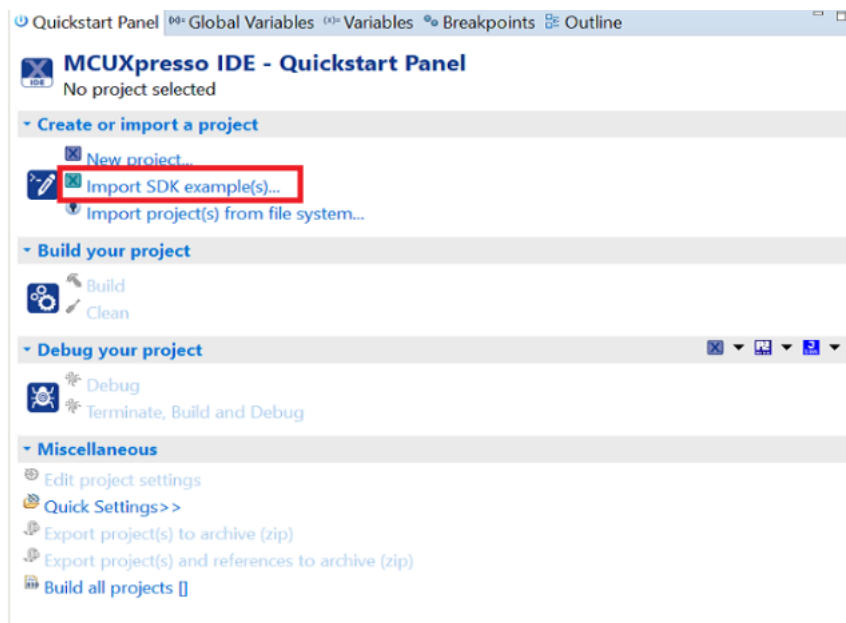
**Select the workspace location** Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse which uses workspace to store information about its current configuration, and in some use cases, source files for the projects are in the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

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

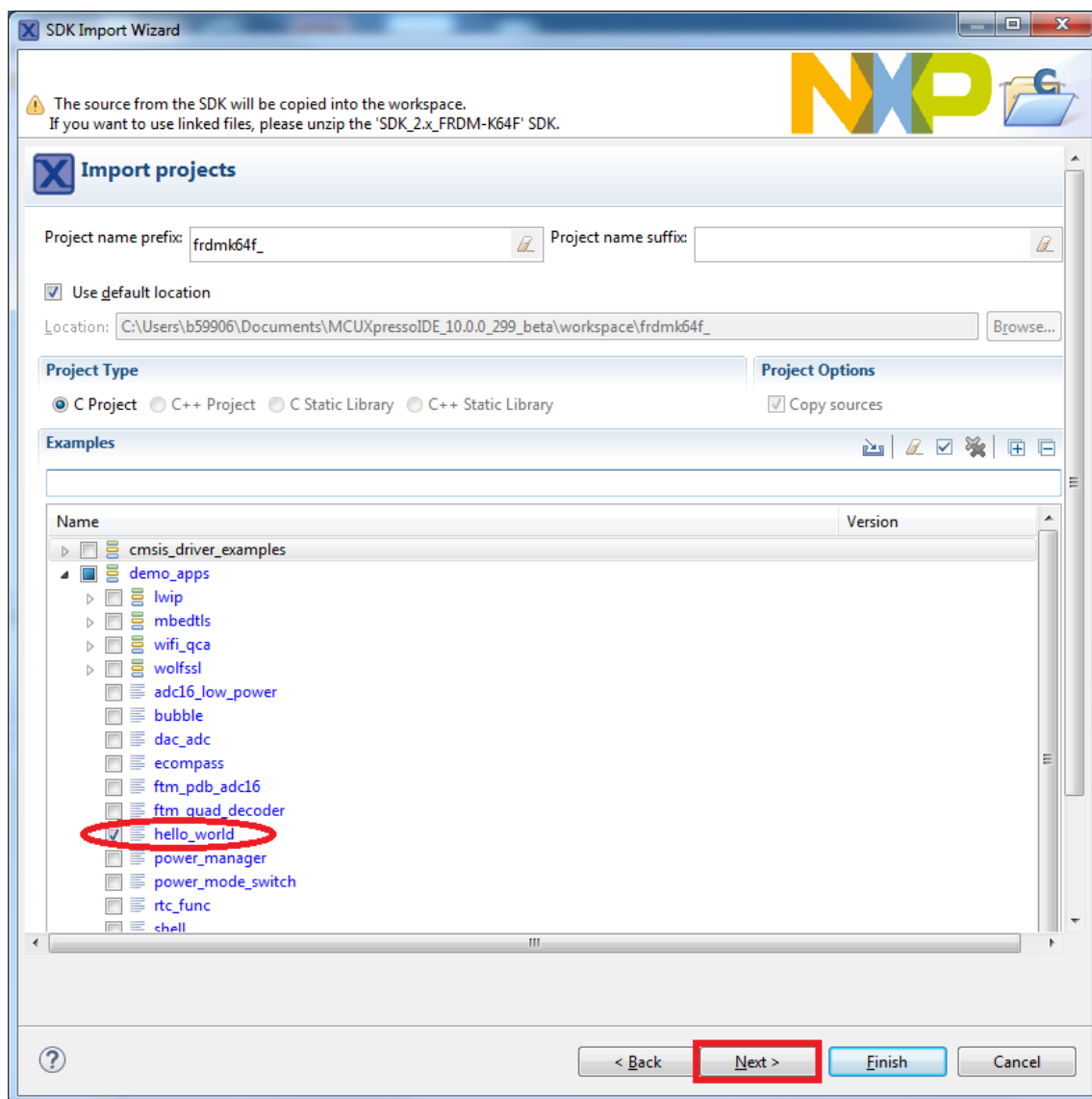
1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.



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



3. Expand the `demo_apps` folder and select `hello_world`.
4. Click **Next**.



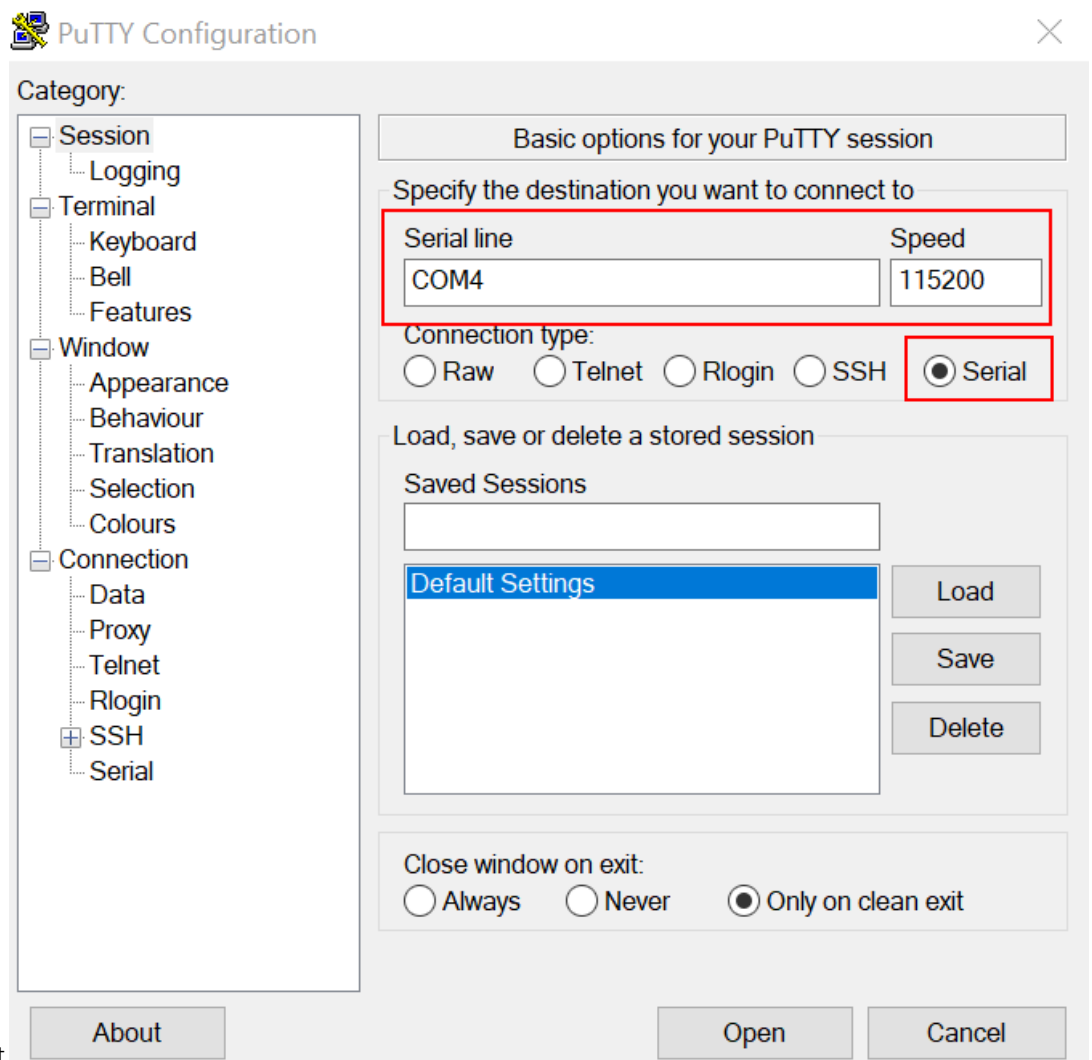
5. Ensure **Redlib: Use floating-point version of printf** is selected if the example prints floating-point numbers on the terminal for demo applications such as `adc_basic`, `adc_burst`, `adc_dma`, and `adc_interrupt`. Otherwise, it is not necessary to select this option. Then, click **Finish**.

**Run an example application** For more information on debug probe support in the MCUXpresso IDE, see [community.nxp.com](http://community.nxp.com).

To download and run the application, perform the following steps:

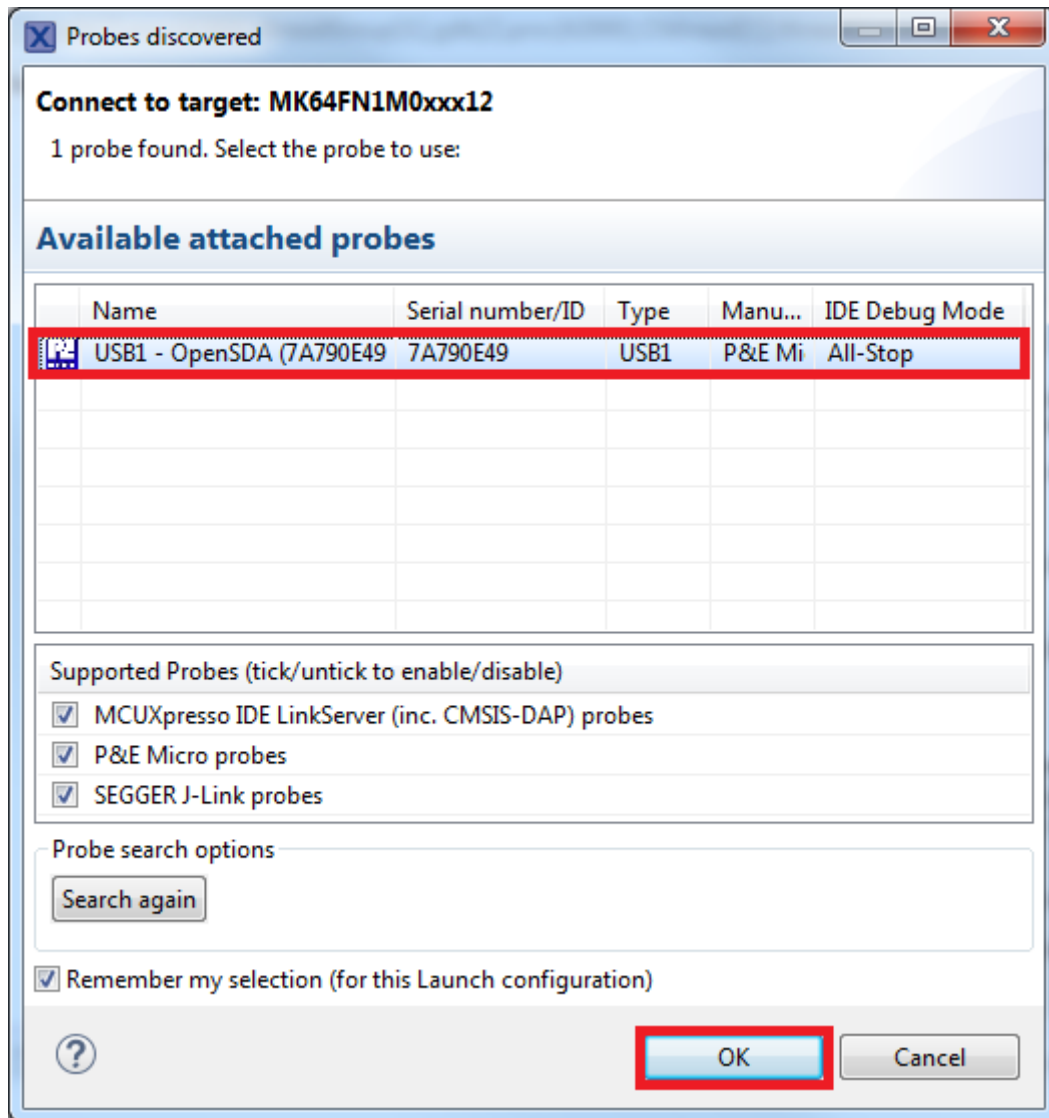
1. Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
2. Connect the development platform to your PC via a USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM 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_BAUDRATE` variable in `board.h` file)
  2. No parity

## 3. 8 data bits



## 4. 1 stop bit

4. On the **Quickstart Panel**, click **Debug** to launch the debug session.
5. 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.)



- The application is downloaded to the target and automatically runs to `main()`.
- Start the application by clicking **Resume**.

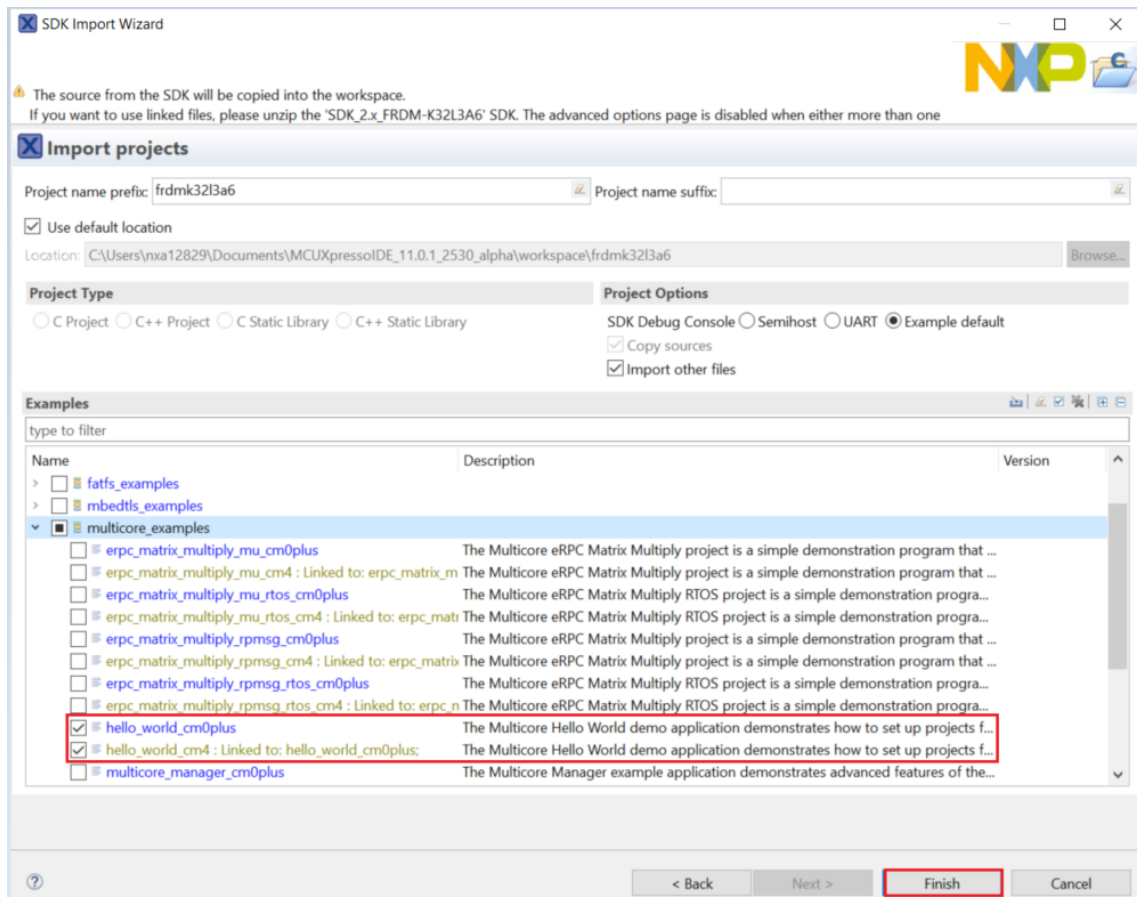


The `hello_world` application is now running and a banner is displayed on the terminal. If not, check your terminal settings and connections.

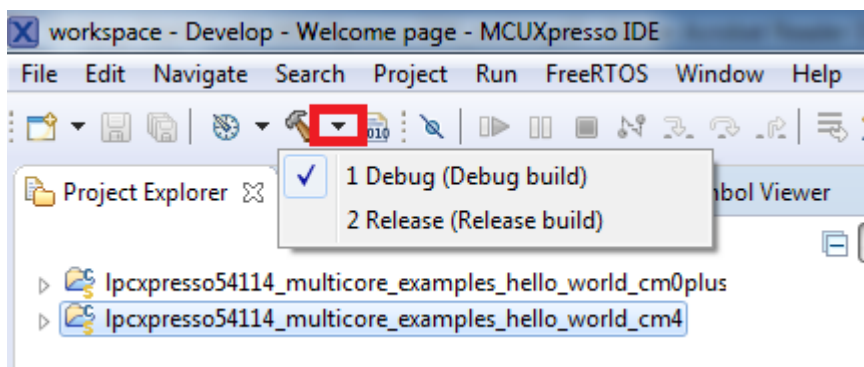


**Build a multicore example application** This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of hello\_world example application targeted for the LPCXpresso54114 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 LPCXpresso54114 is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, expand the **LPCxx** folder and select **LPC54114J256**. Then, select **lpcxpresso54114** and click **Next**.
2. Expand the multicore\_examples/hello\_world folder and select **cm4**. The cm0plus counterpart project is automatically imported with the cm4 project, because the multicore examples are linked together and there is no need to select it explicitly. Click **Finish**.



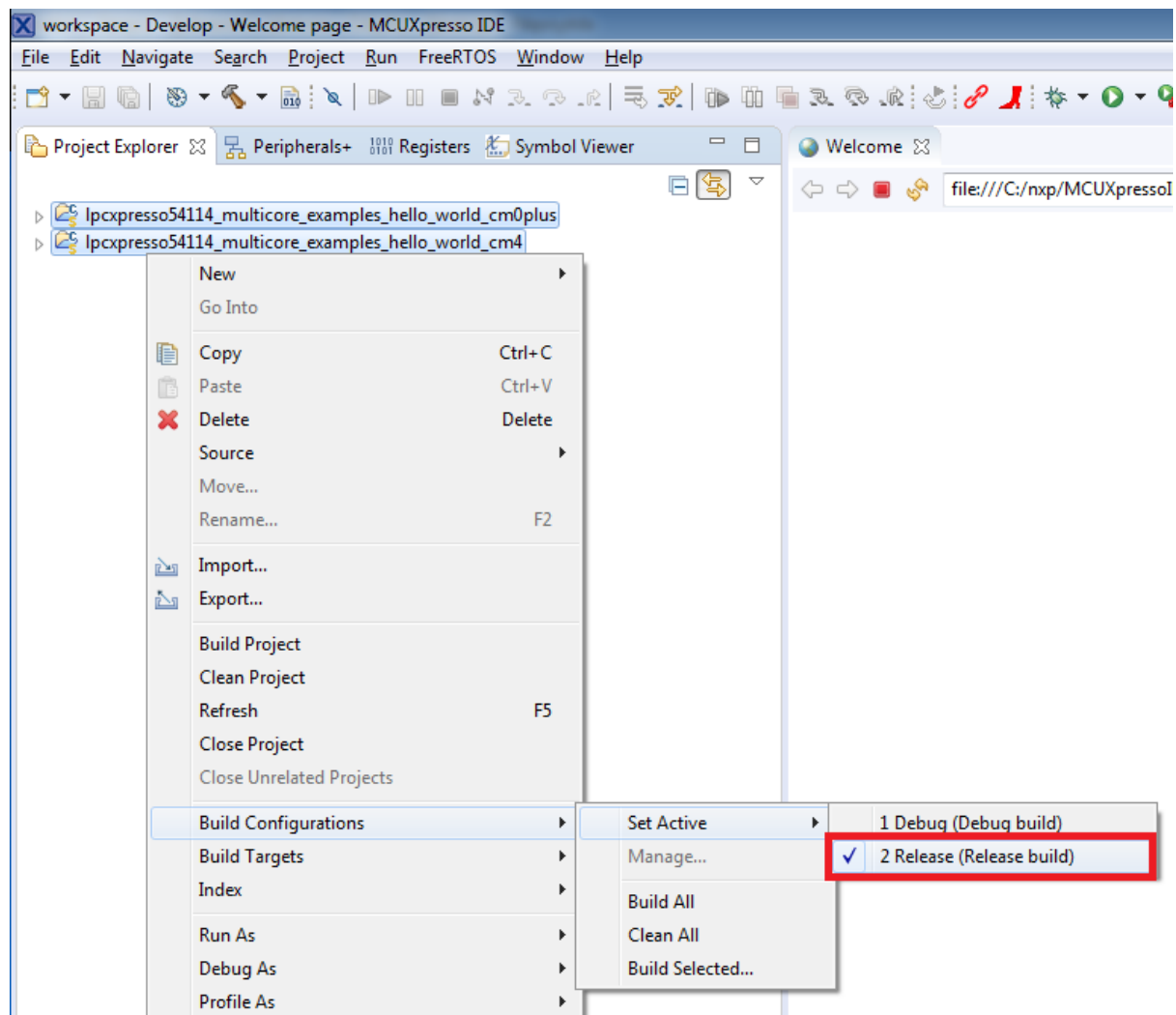
3. Now, two projects should be imported into the workspace. To start building the multicore application, highlight the `lpcxpresso54114_multicore_examples_hello_world_cm4` project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing arrow next to the hammer icon, as shown in the figure. For this example, select **Debug**.



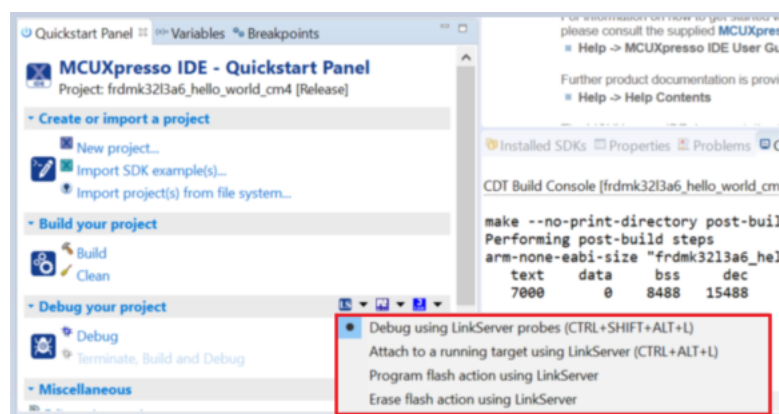
The project starts building after the build target is selected. Because of the project reference settings in multicore projects, triggering the build of the primary core application (cm4) also causes the referenced auxiliary core application (cm0plus) to build.

**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 (cm4) build.

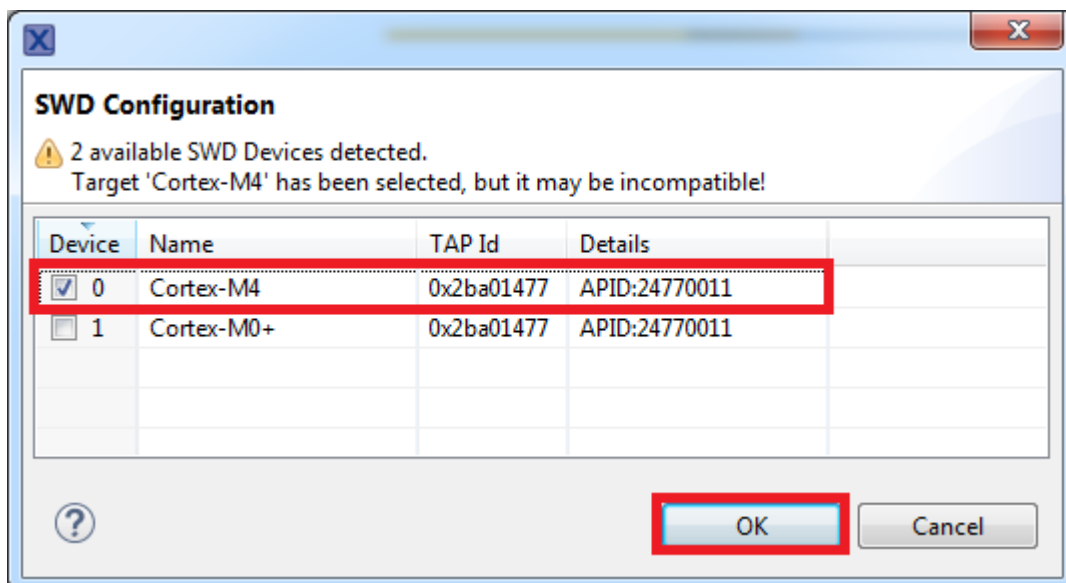
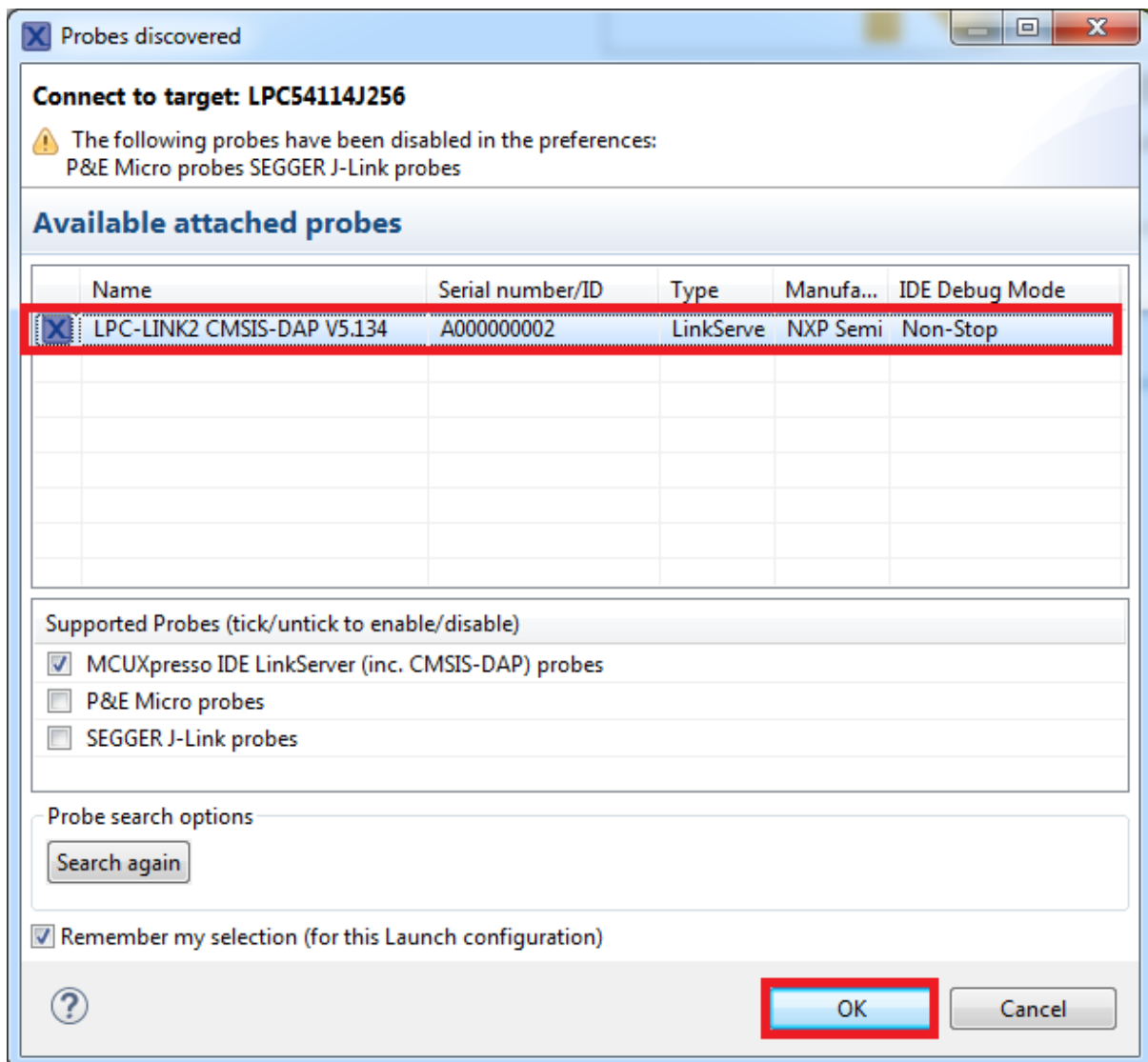


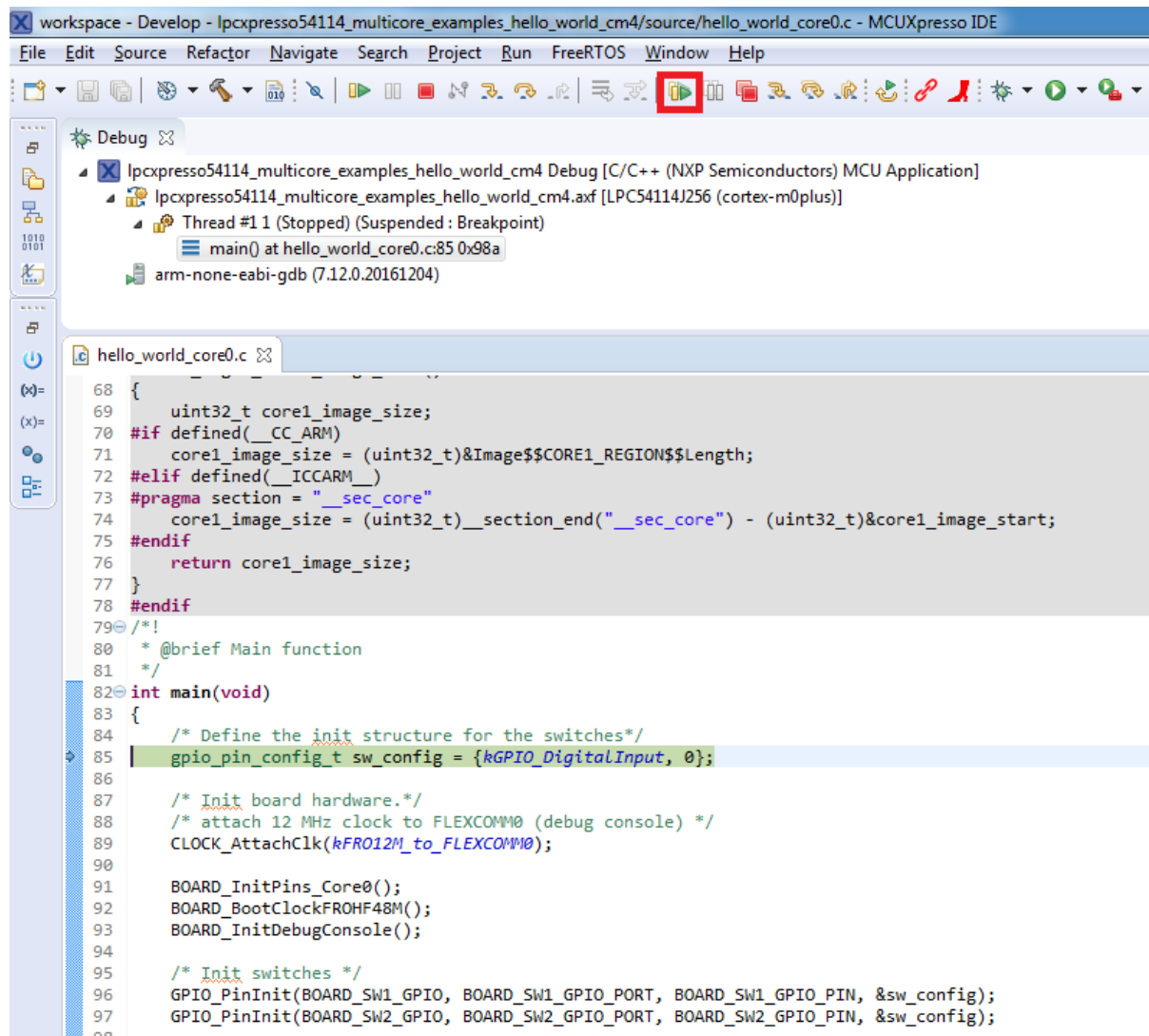


**Run a multicore example application** The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in **Run 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 the following figures as reference.

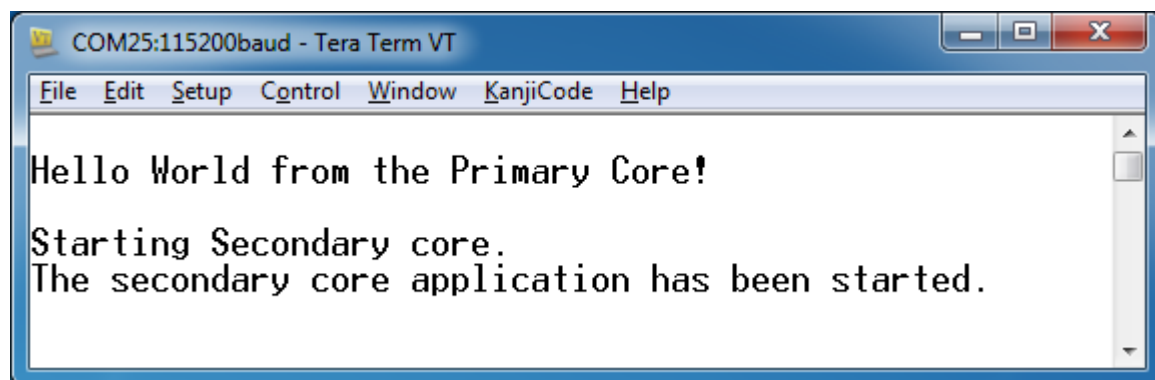






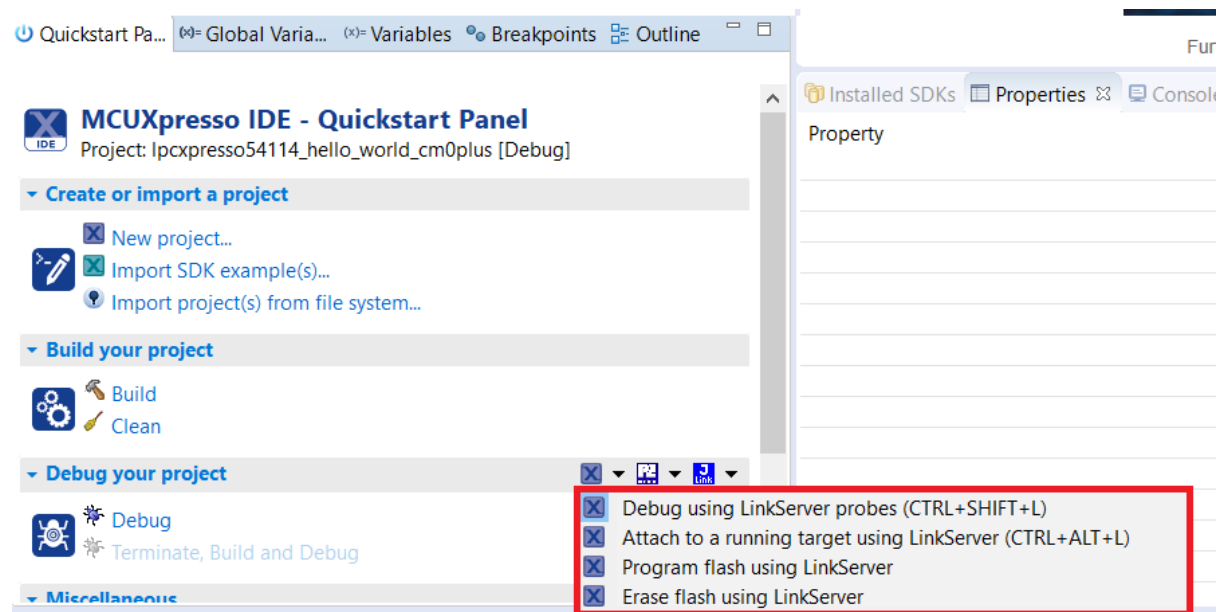


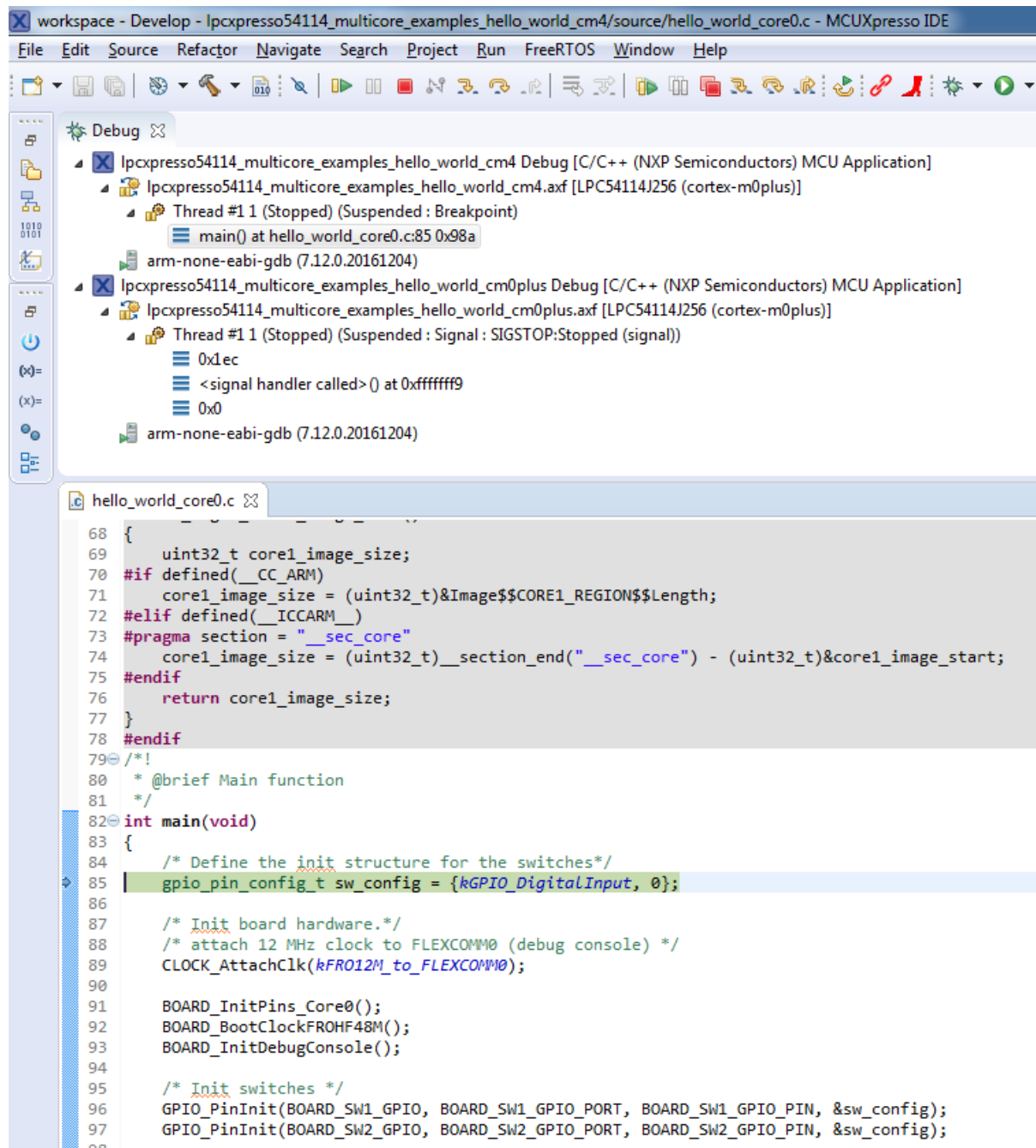
After clicking the “Resume All Debug sessions” button, the hello\_world multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.



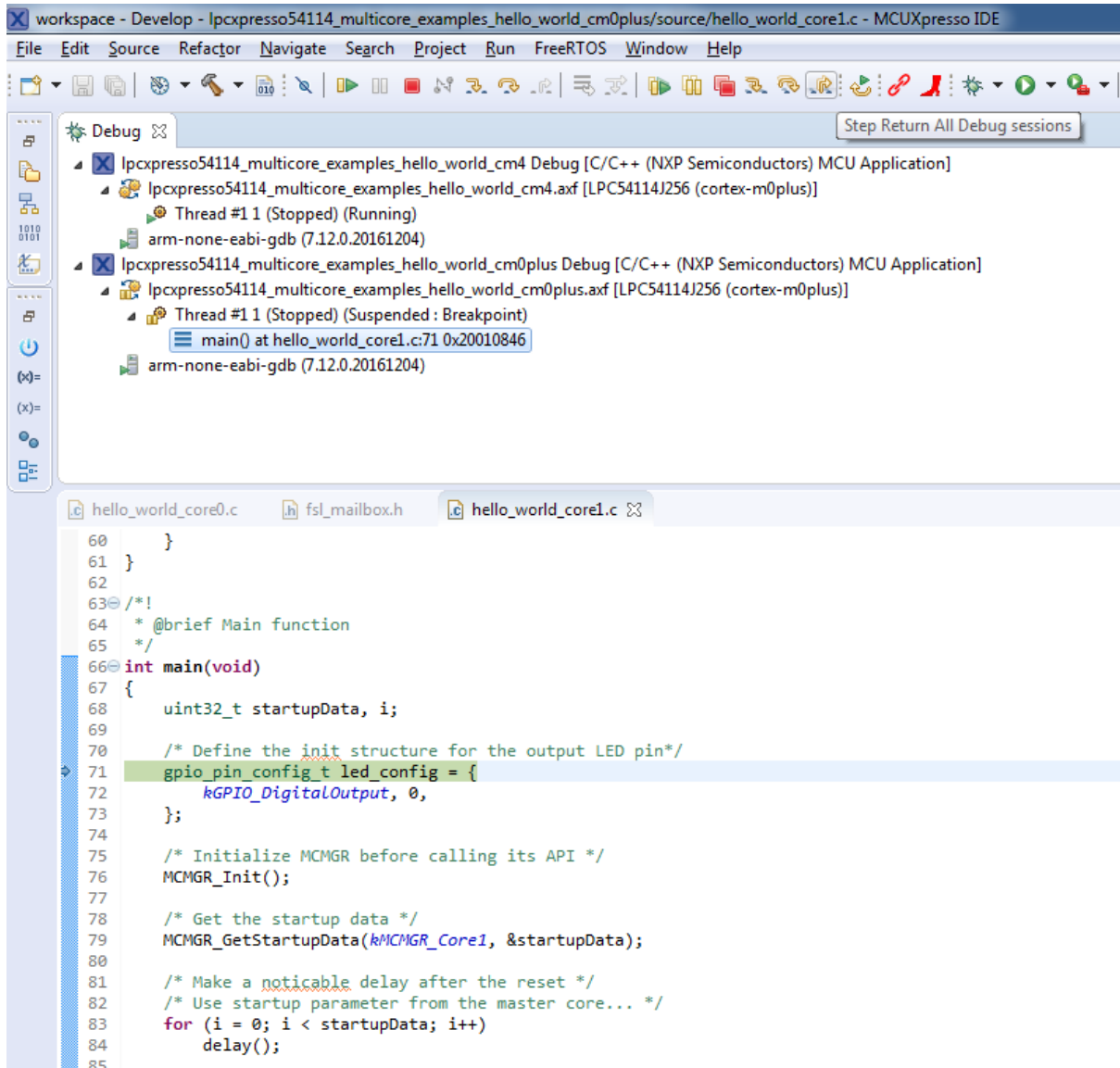
An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and running correctly. It is also possible to debug both sides of the multicore application in parallel. After creating the debug session for the primary core, perform same steps also for the auxiliary core application. Highlight the lpcxpresso54114\_multicore\_examples\_hello\_world\_cm0plus project (multicore slave project) in the Project Explorer. On the Quickstart Panel, click “Debug ‘lpcxpresso54114\_multicore\_examples\_hello\_world\_cm0plus’ [Debug]” to launch the second debug

session.

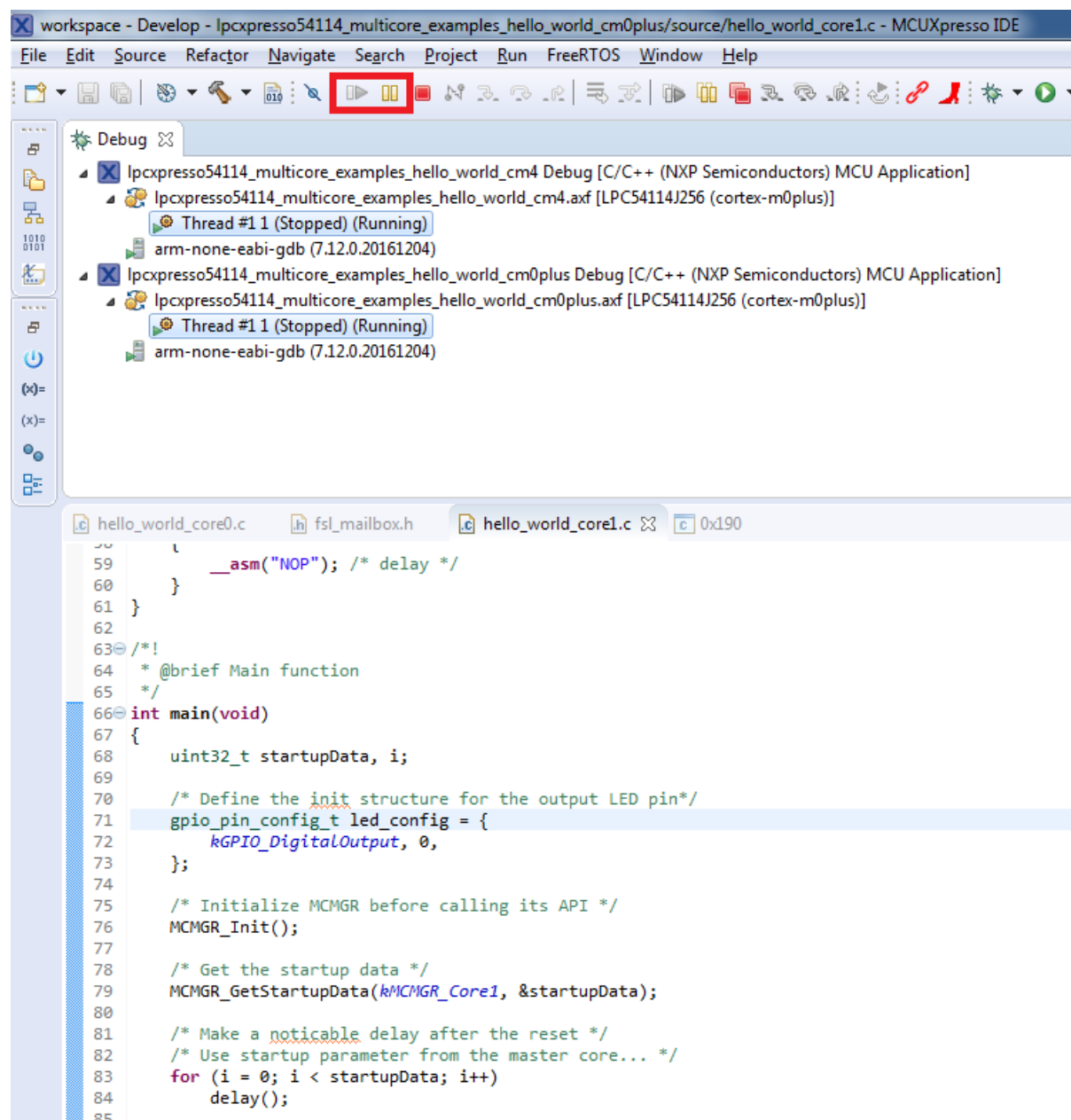


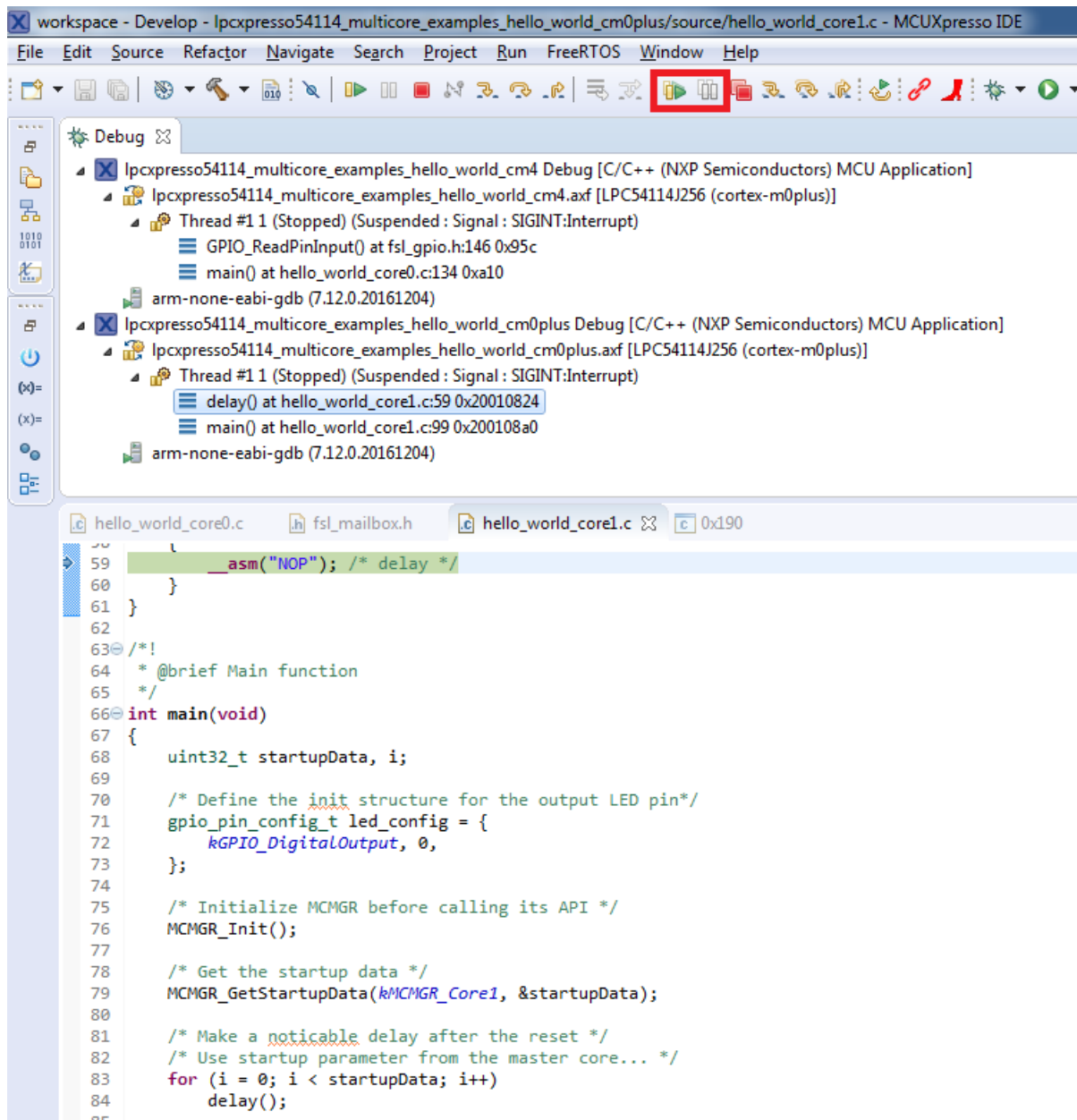


Now, the two debug sessions should be opened, and the debug controls can be used for both debug sessions depending on the debug session selection. Keep the primary core debug session selected by clicking the “Resume” button. The hello\_world multicore application then starts running. The primary core application starts the auxiliary core application during runtime, and the auxiliary core application stops at the beginning of the main() function. The debug session of the auxiliary core application is highlighted. After clicking the “Resume” button, it is applied to the auxiliary core debug session. Therefore, the auxiliary core application continues its execution.



At this point, it is possible to suspend and resume individual cores independently. It is also possible to make synchronous suspension and resumption of both the cores. This is done either by selecting both opened debug sessions (multiple selections) and clicking the “Suspend” / “Resume” control button, or just using the “Suspend All Debug sessions” and the “Resume All Debug sessions” buttons.

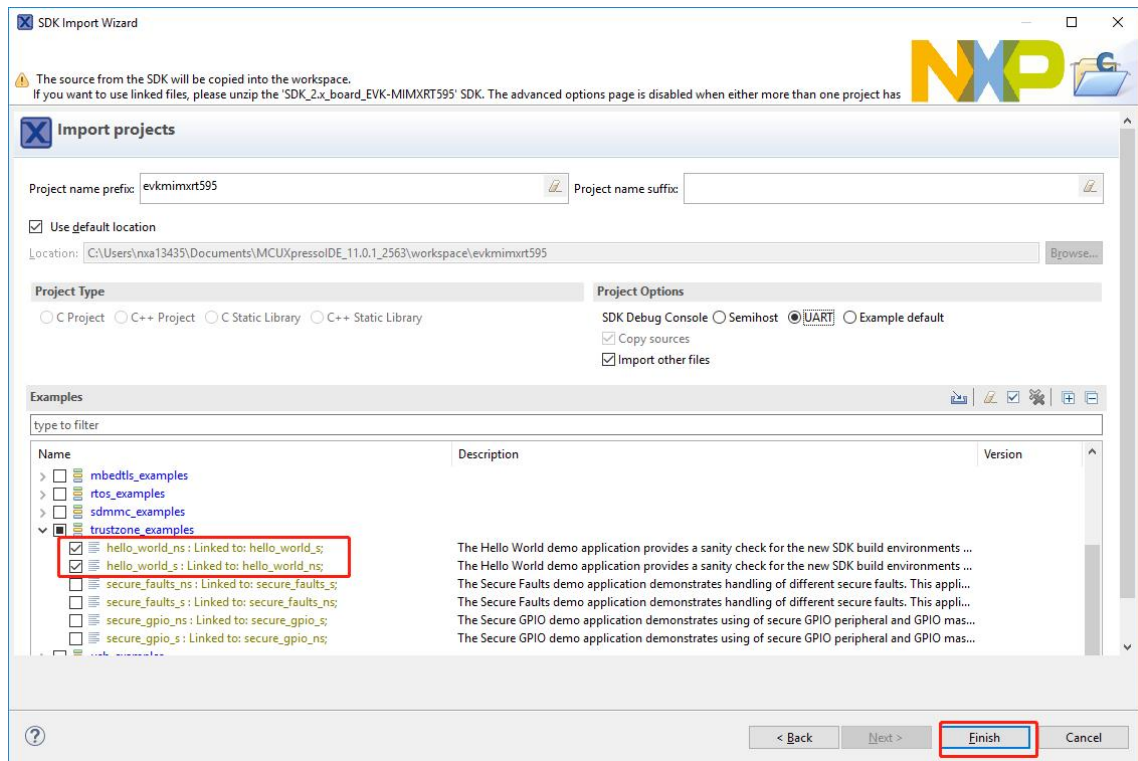




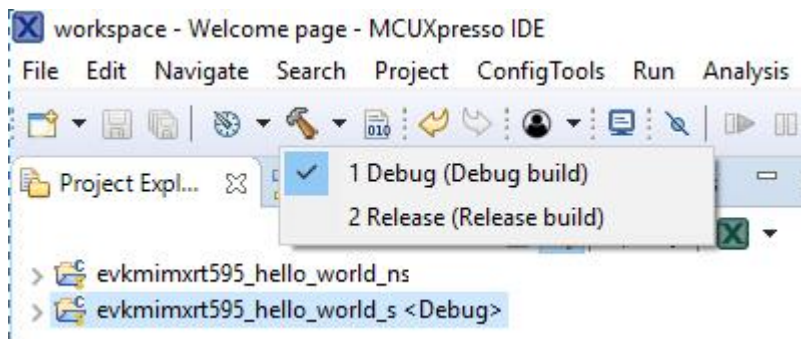
**Build a TrustZone example application** This section describes the steps required to configure MCUXpresso IDE to build, run, and debug TrustZone example applications. The TrustZone version of the hello\_world example application targeted for the MIMXRT595-EVK hardware platform is used as an example, though these steps can be applied to any TrustZone example application in the MCUXpresso SDK.

1. TrustZone examples are imported into the workspace in a similar way as single core applications. When the SDK zip package for MIMXRT595-EVK is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, expand the **MIMXRT500** folder and select **MIMXRT595S**. Then, select **evkmimxrt595** and click **Next**.
2. Expand the **trustzone\_examples/** folder and select **hello\_world\_s**. Because TrustZone examples are linked together, the non-secure project is automatically imported with the secure project, and there is no need to select it explicitly. Then, click **Finish**.





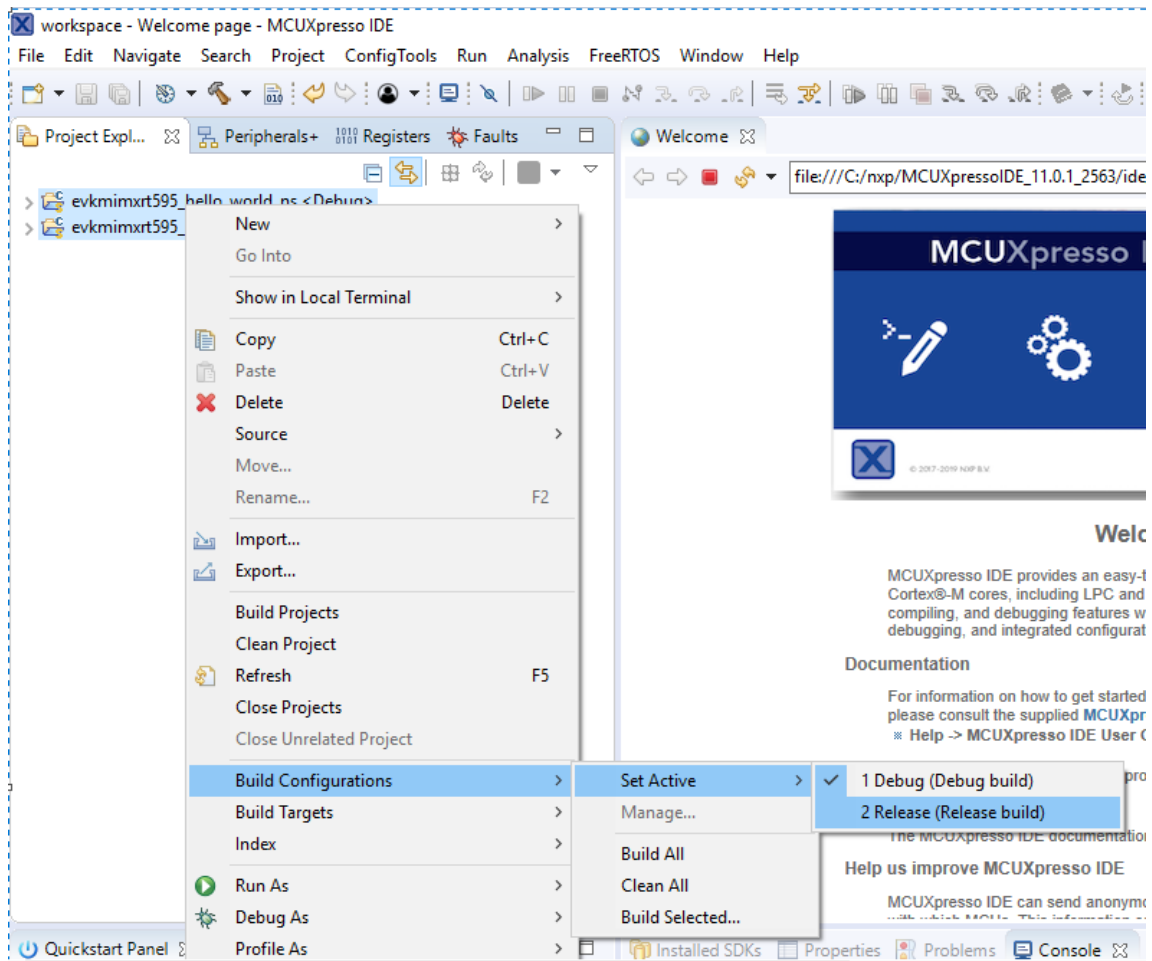
- Now, two projects should be imported into the workspace. To start building the TrustZone application, highlight the `evkmimxrt595_hello_world_s` project (TrustZone master project) in the Project Explorer. Then, choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing arrow next to the hammer icon, as shown in following figure. For this example, select the **Debug** target.



The project starts building after the build target is selected. It is requested to build the application for the secure project first, because the non-secure project must know the secure project since CMSE library when running the linker. It is not possible to finish the non-secure project linker when the secure project since CMSE library is not ready.

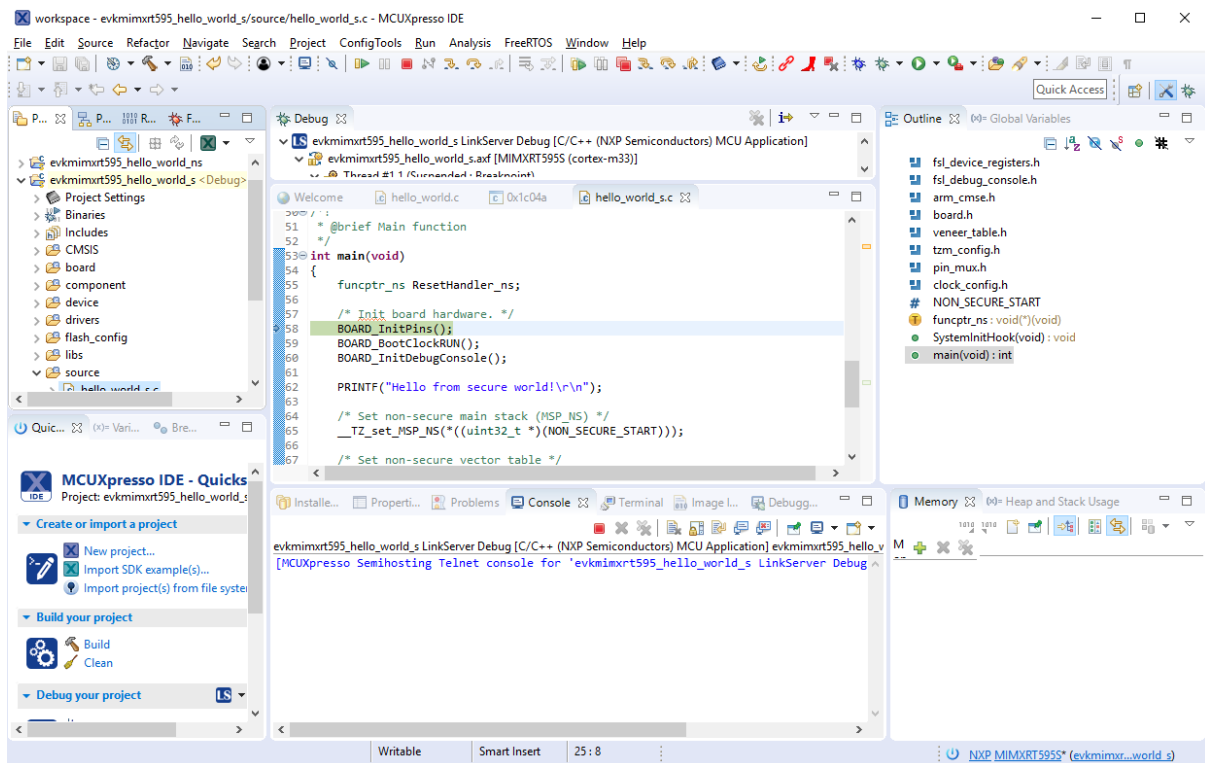
**Note:** When the **Release** build is requested, it is necessary to change the build configuration of both the secure and non-secure application projects first. To do this, select both projects in the Project Explorer view by clicking to select the first project, then using shift-click or control-click to select the second project. Right click in the Project Explorer view to display the context-sensitive menu and select **Build Configurations > Set Active > Release**. This is also possible by using the menu item of **Project > Build Configuration > Set Active > Release**. After switching to the **Release** build configuration. Build the application for the secure project first.





**Run a TrustZone example application** To download and run the application, perform all steps as described in **Run an example application**. These steps are common for single core, and TrustZone applications, ensuring <board\_name>\_hello\_world\_s is selected for debugging.

In the Quickstart Panel, click **Debug** to launch the second debug session.



Now, the TrustZone sessions should be opened. Click **Resume**. The `hello_world` TrustZone application then starts running, and the secure application starts the non-secure application during runtime.

## Run a demo application using IAR

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

**Note:** IAR Embedded Workbench for Arm version 8.32.3 is used in the following example, and the IAR toolchain should correspond to the latest supported version, as described in the *MCUXpresso SDK Release Notes*.

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

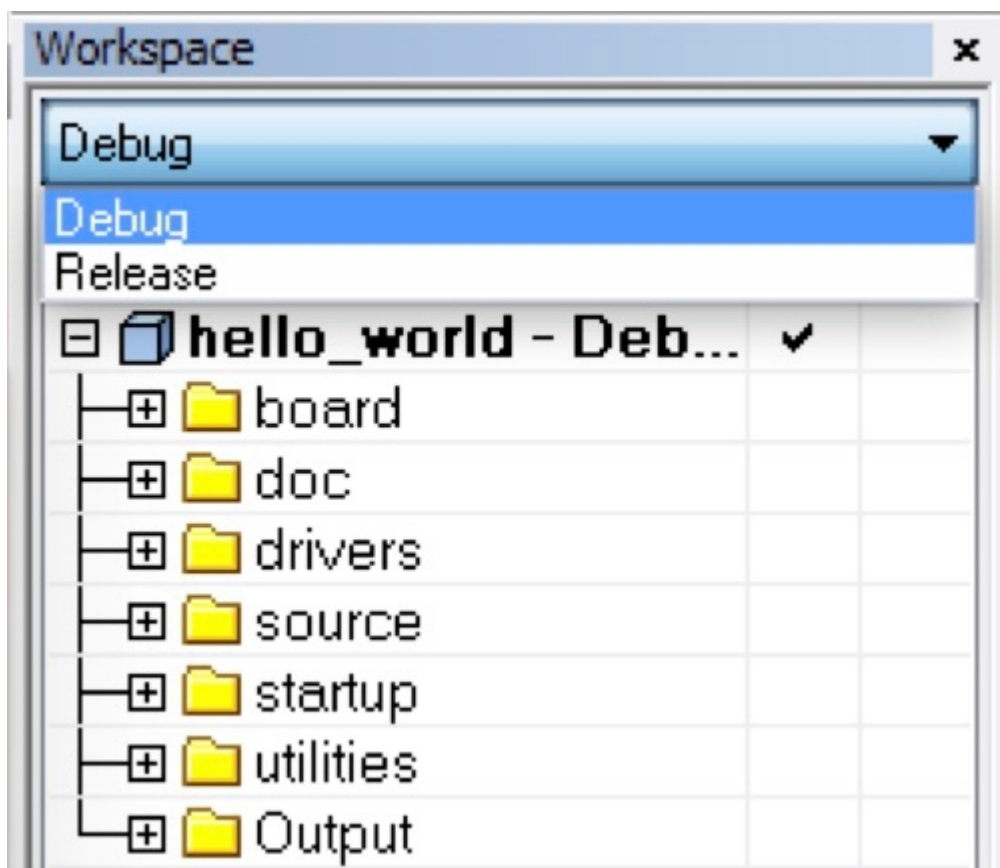
1. Open the desired demo application workspace. Most example application workspace files can be located using the following path:

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

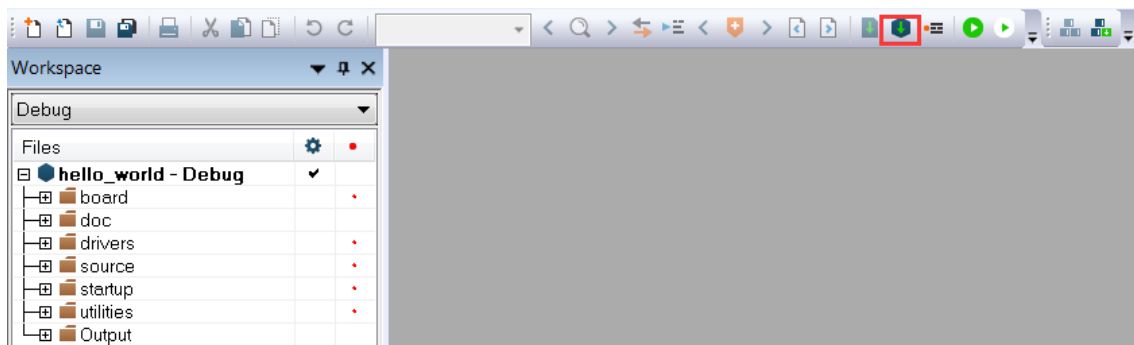
Other example applications may have additional folders in their path.

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

For this example, select **hello\_world – debug**.



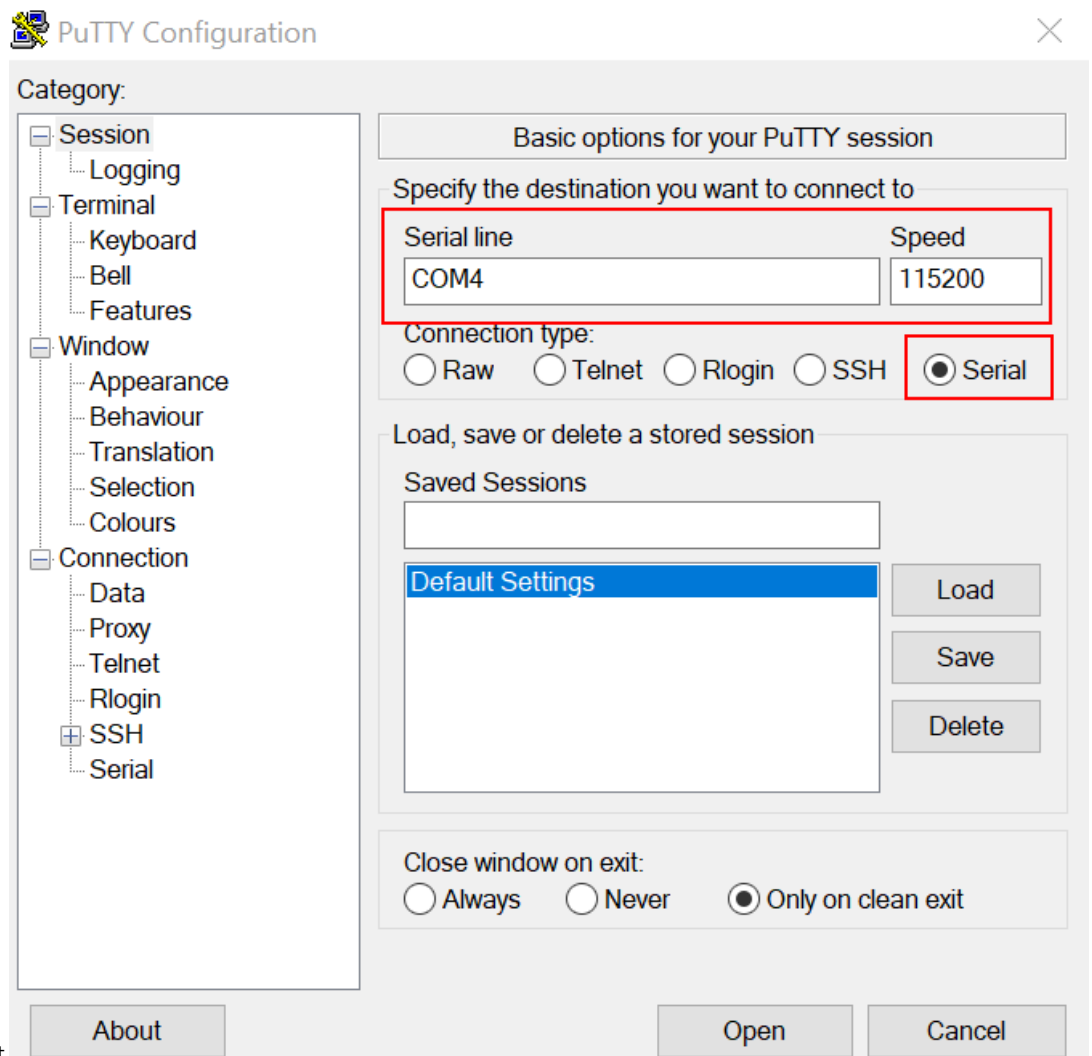
3. To build the demo application, click **Make**, highlighted in red in following figure.



4. The build completes without errors.

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

1. Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
2. Connect the development platform to your PC via USB cable.
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\_BAUDRATE variable in the board.h file)
  2. No parity
  3. 8 data bits

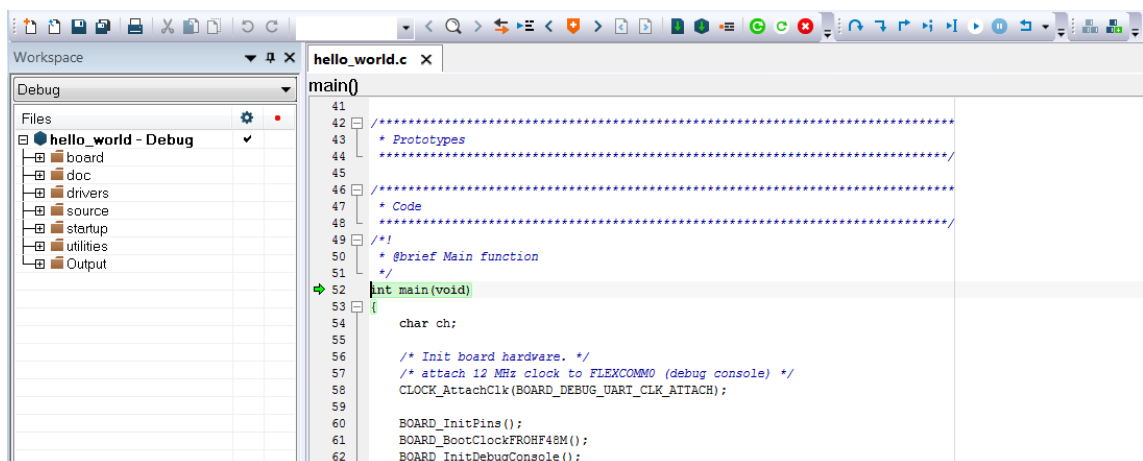


4. 1 stop bit

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



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.

7. The `hello_world` application is now running and a banner is displayed on the terminal. If it does not appear, check your terminal settings and connections.



**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/lpcxpresso54114/multicore_examples/hello_world/cm0plus/iar/hello_world_cm0plus.  
→ eww
```

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/iar/hello_world_cm4.eww
```

Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm0plus) first, because the primary core application project (cm4) must 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.

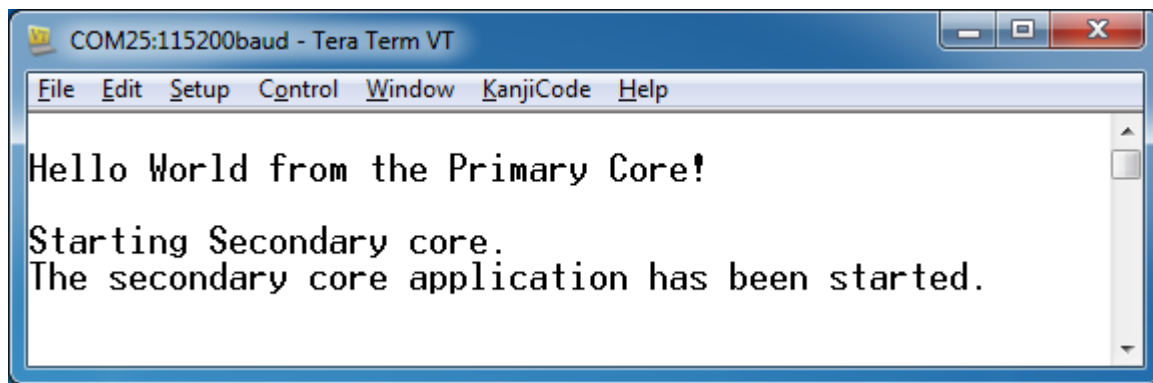
**Run a multicore example application** The primary core debugger handles flashing both primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 4 as described in **Run an example application**. 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 images 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” control buttons to stop or run both cores simultaneously.



**Build a TrustZone example application** This section describes the particular steps that must be done in order to build and run a TrustZone application. The demo applications workspace files are located in this folder:

```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/[<core_type>]/iar/  
↪<application_name>_ns/iar
```

```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/[<core_type>]/iar/  
↪<application_name>_s/iar
```

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

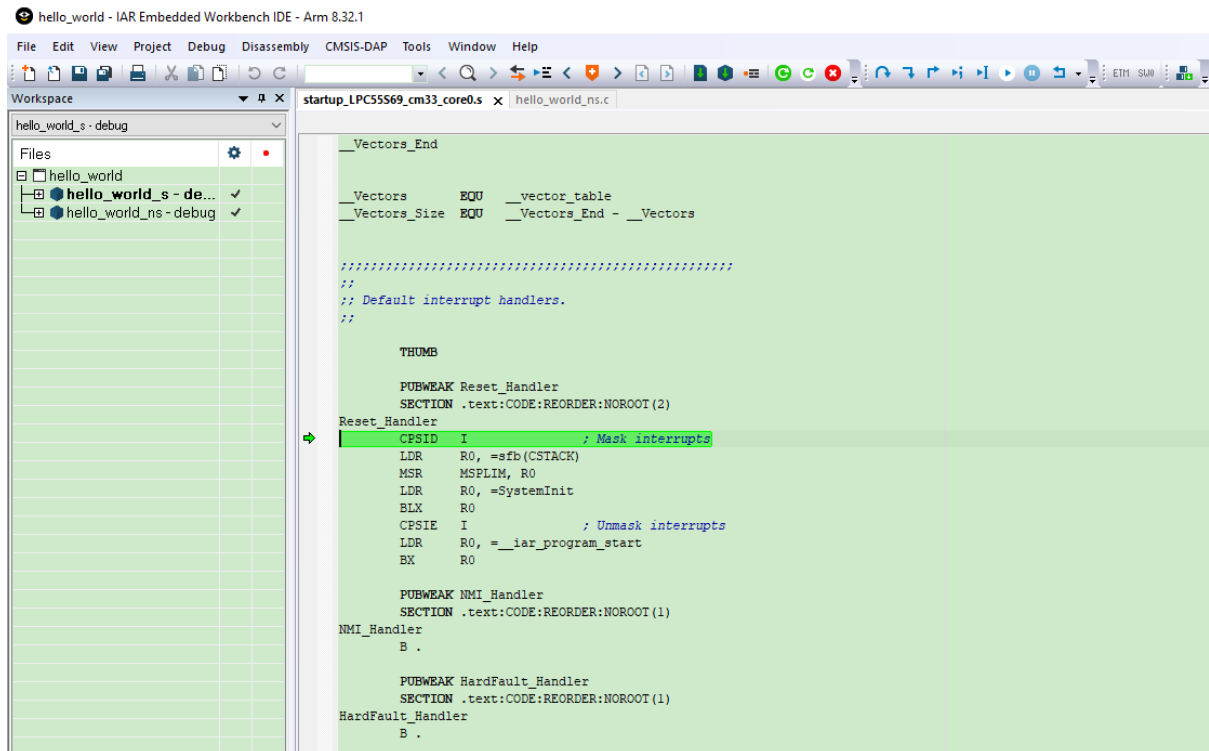
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_ns/iar/hello_world_  
↪ns.eww
```

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/iar/hello_world_s.  
↪eww
```

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/iar/hello_world.eww
```

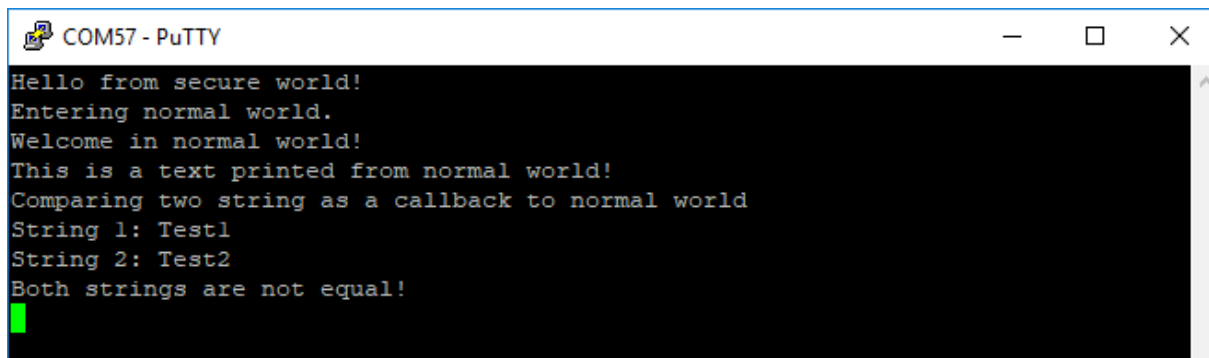
This project `hello_world.eww` contains both secure and non-secure projects in one workspace and it allows the user to easily transition from one project to another. Build both applications separately by clicking **Make**. It is requested to build the application for the secure project first, because the non-secure project must know the secure project, since the CMSE library is running the linker. It is not possible to finish the non-secure project linker with the secure project since CMSE library is not ready.

**Run a TrustZone example application** The secure project is configured to download both secure and non-secure output files, so debugging can be fully managed from the secure project. To download and run the TrustZone application, switch to the secure application project and perform steps 1 – 4 as described in **Run an example application**. These steps are common for both single core, and TrustZone applications in IAR. After clicking **Download and Debug**, both the secure and non-secure images are loaded into the device memory, and the secure application is executed. It stops at the `Reset_Handler` function.



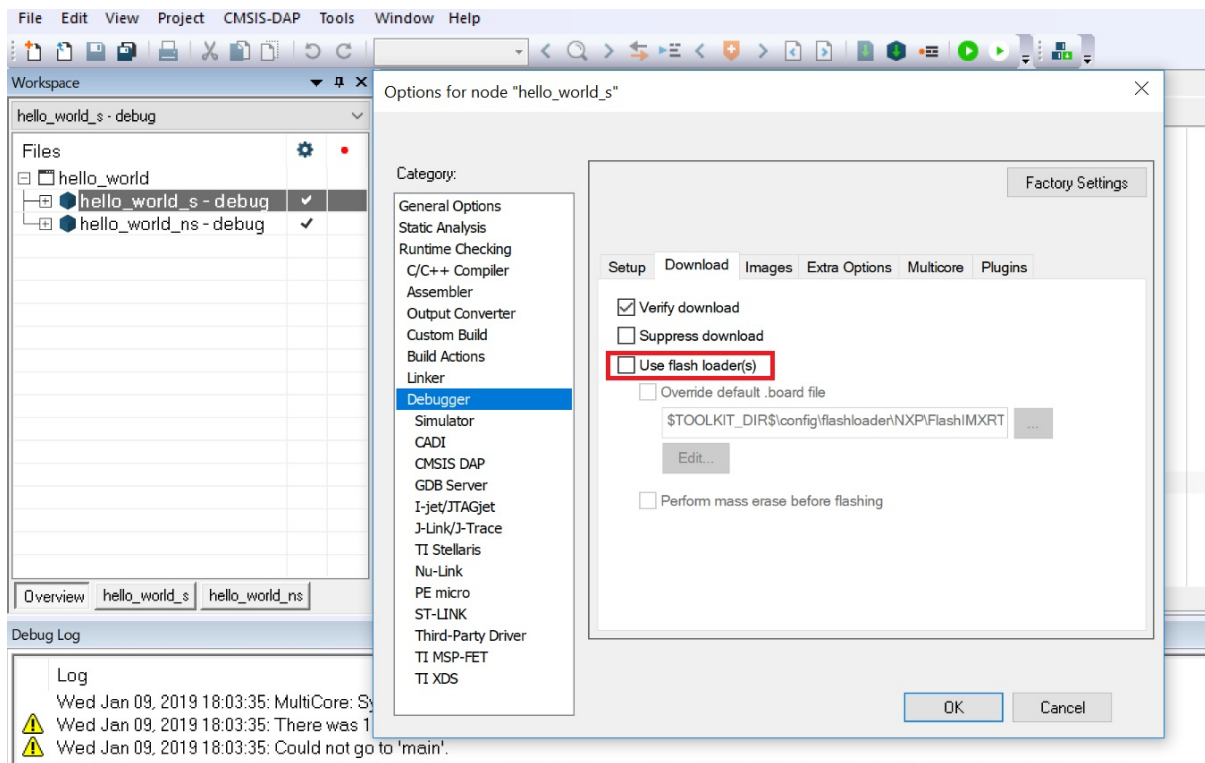
Run the code by clicking **Go** to start the application.

The TrustZone 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:** If the application is running in RAM (debug/release build target), in **Options\*\*>\*\*Debugger > Download** tab, disable **Use flash loader(s)**. This can avoid the \_\_ns download issue on i.MXRT500.



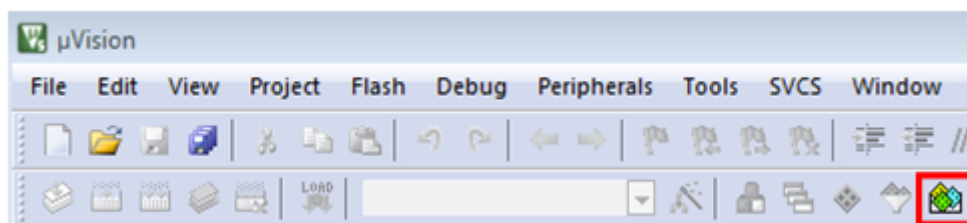


## Run a demo using Keil MDK/μVision

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 appropriate CMSIS pack.

1. Open the MDK IDE, which is called μVision. In the IDE, select the **Pack Installer** icon.



2. After the installation finishes, close the Pack Installer window and return to the μVision IDE.

## 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:



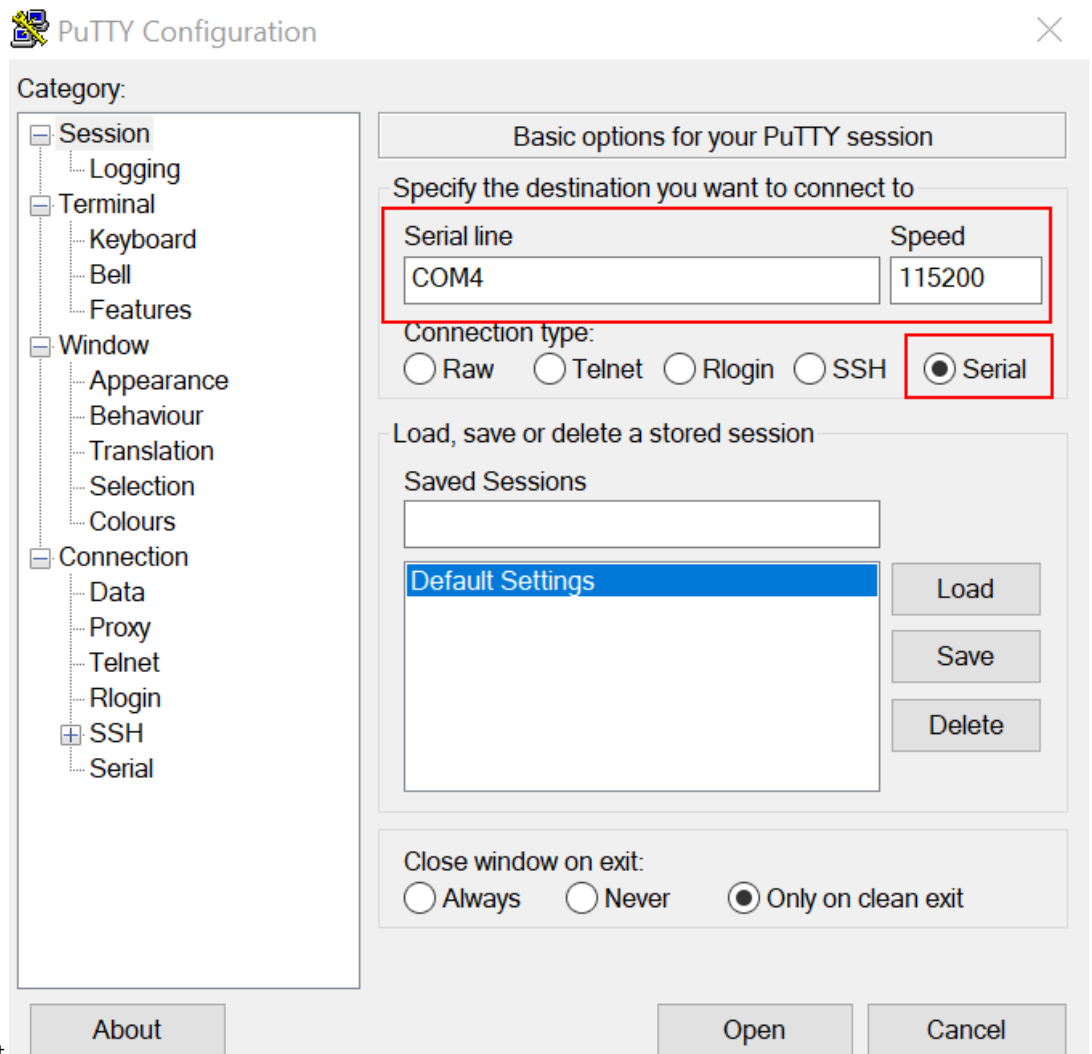
- To build the demo project, select **Rebuild**, highlighted in red.



- The build completes without errors.

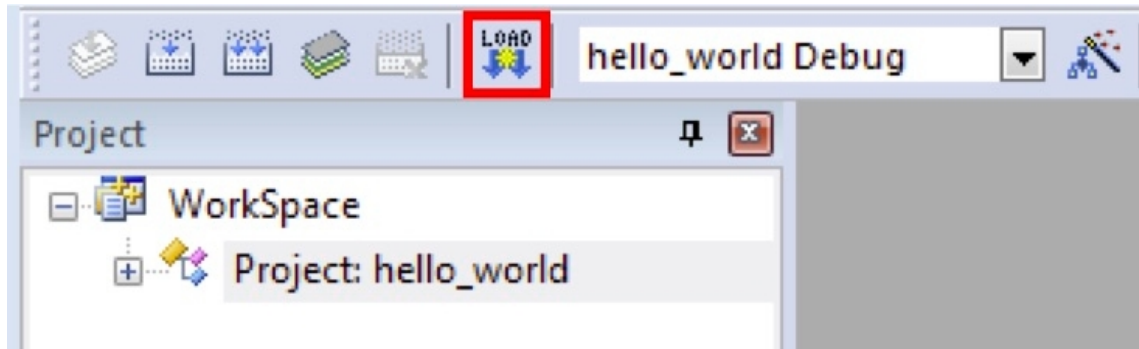
**Run an example application** To download and run the application, perform these steps:

- Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
- Connect the development platform to your PC via USB cable using USB connector.
- 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:
  - 115200 or 9600 baud rate, depending on your board (reference BOARD\_DEBUG\_UART\_BAUDRATE variable in the board.h file)
  - No parity
  - 8 data bits

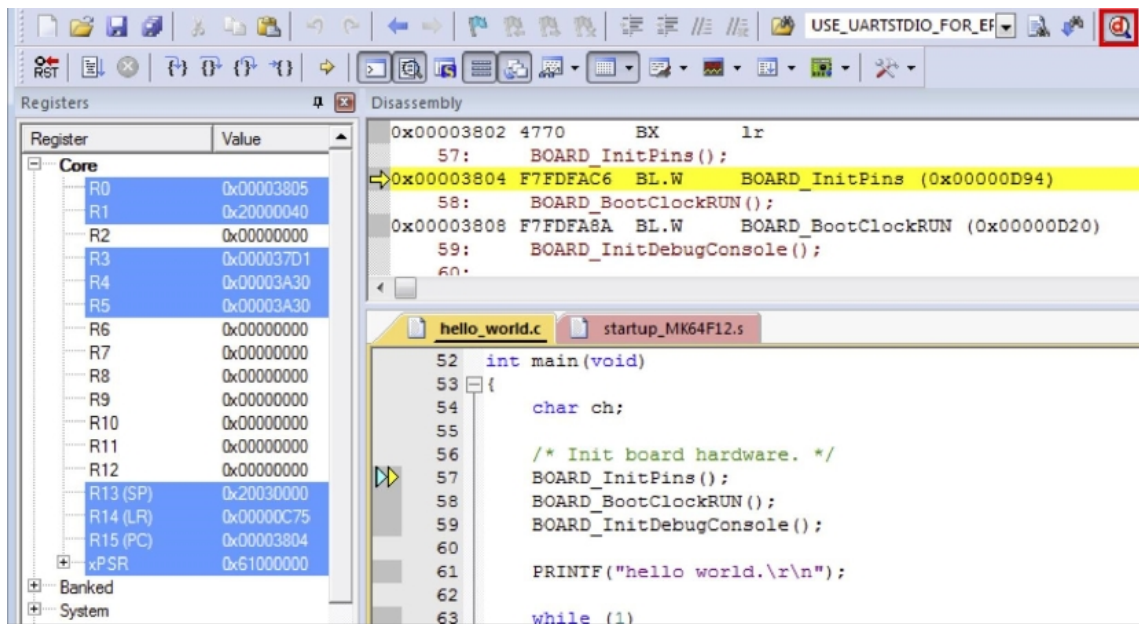


- 1 stop bit

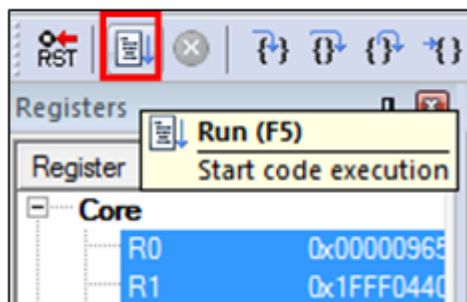
- In  $\mu$ Vision, after the application is built, click the **Download** button to download the application to the target.



5. After clicking the **Download** button, the application downloads to the target and is running. To debug the application, click the **Start/Stop Debug Session** button, highlighted in red.



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



The hello\_world application is now running and a banner is displayed on the terminal. If this does not appear, check your terminal settings and connections.



**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>/mdk
```

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

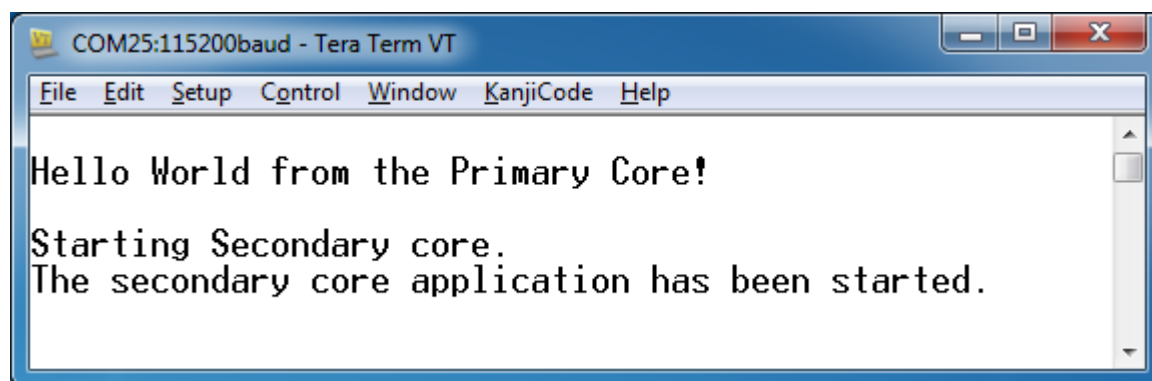
```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/mdk/hello_world_
→cm0plus.uvmpw
```

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/mdk/hello_world_cm4.uvmpw
```

Build both applications separately by clicking the **Rebuild** button. Build the application for the auxiliary core (cm0plus) first because the primary core application project (cm4) must 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.

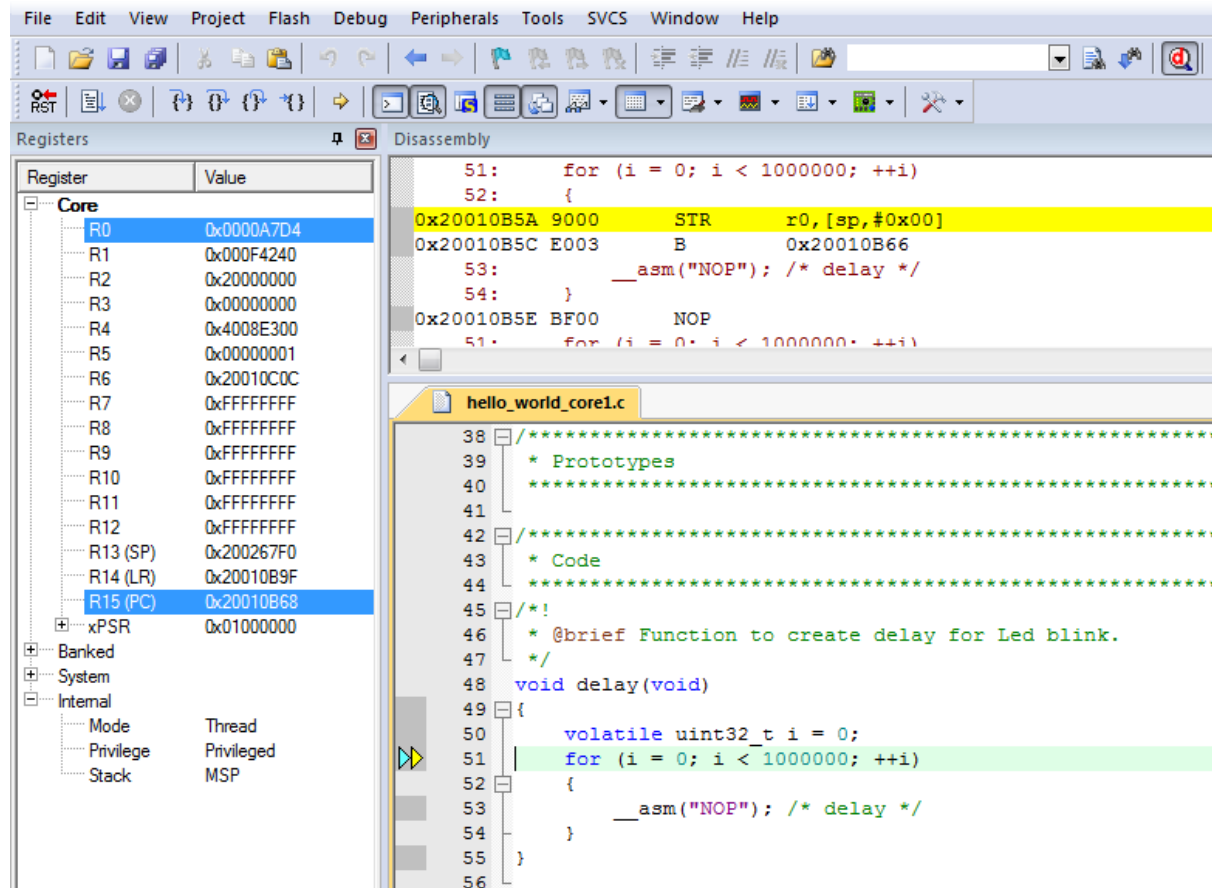
**Run a multicore example application** The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 5 as described in **Run an example 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 device flash memory. After clicking the “Run” button, the primary core application is executed. 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 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  $\mu$ Vision 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.



Arm describes multicore debugging using the NXP LPC54114 Cortex-M4/M0+ dual-core processor and Keil uVision IDE in Application Note 318 at [www.keil.com/appnotes/docs/apnt\\_318.asp](http://www.keil.com/appnotes/docs/apnt_318.asp). The associated video can be found [here](#).

**Build a TrustZone example application** This section describes the particular steps that must be done in order to build and run a TrustZone application. The demo applications workspace files are located in this folder:

```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/<application_name>_ns/
↪ mdk
```

```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/<application_name>_s/
↪ mdk
```

Begin with a simple TrustZone version of the Hello World application. The TrustZone Hello World Keil MSDK/ $\mu$ Vision workspaces are located in this folder:

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_ns/mdk/hello_world_
↪ ns.uvmpw
```

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/mdk/hello_world_s.
↪ uvmpw
```

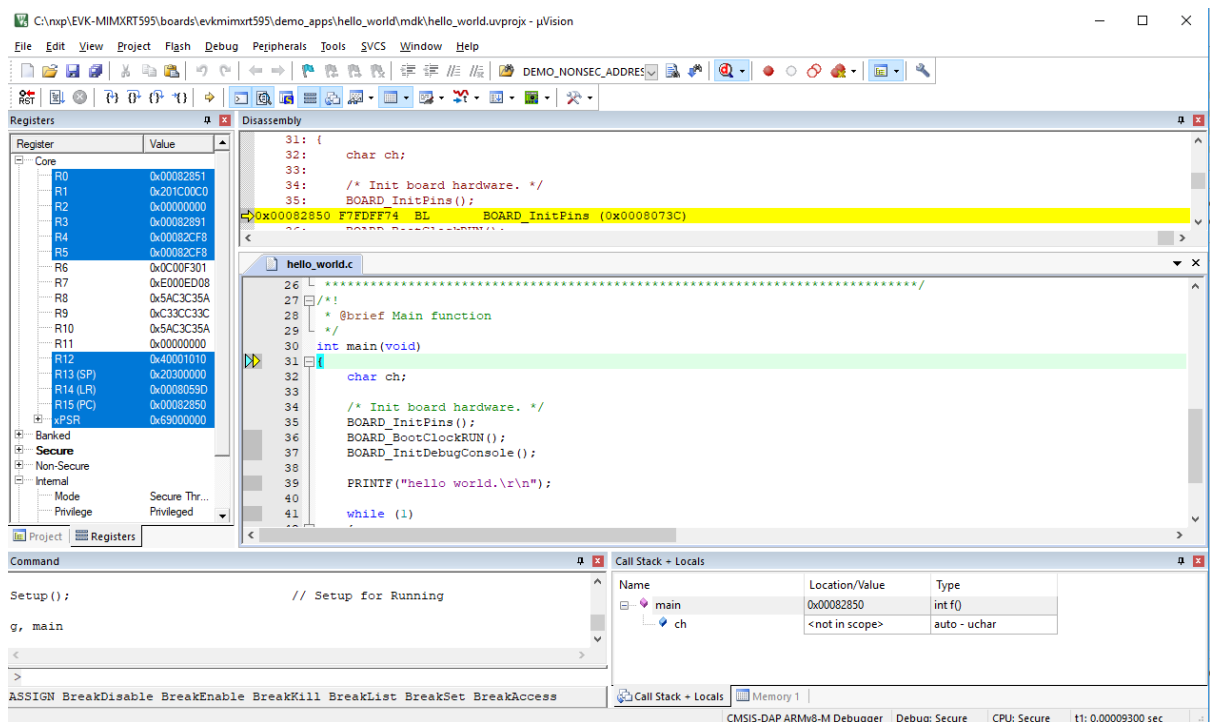
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/mdk/hello_world.  
→ uvmpw
```

This project `hello_world.uvmpw` contains both secure and non-secure projects in one workspace and it allows the user to easily transition from one project to another.

Build both applications separately by clicking **Rebuild**. It is requested to build the application for the secure project first, because the non-secure project must know the secure project since CMSE library is running the linker. It is not possible to finish the non-secure project linker with the secure project because CMSE library is not ready.

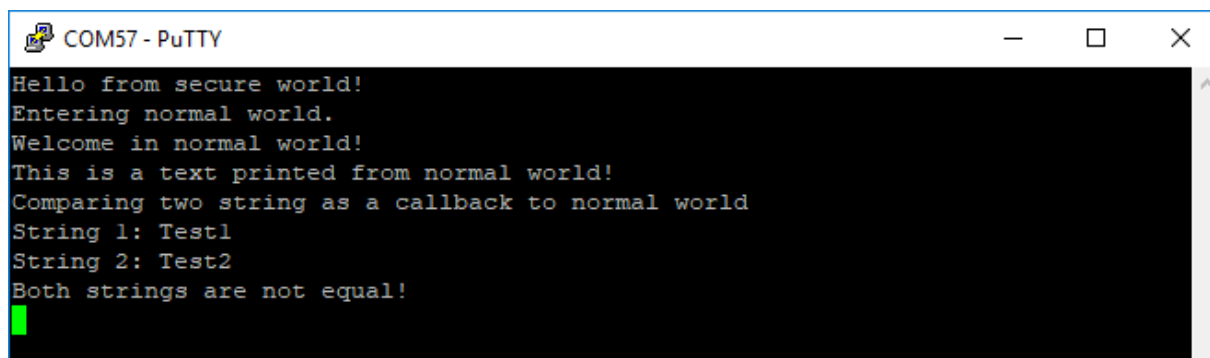
**Run a TrustZone example application** The secure project is configured to download both secure and non-secure output files so debugging can be fully managed from the secure project.

To download and run the TrustZone application, switch to the secure application project and perform steps as described in **Run an example application**. These steps are common for single core, dual-core, and TrustZone applications in  $\mu$ Vision. After clicking **Download and Debug**, both the secure and non-secure images are loaded into the device flash memory, and the secure application is executed. It stops at the `main()` function.



Run the code by clicking **Run** to start the application.

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



## 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_world` demo 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.

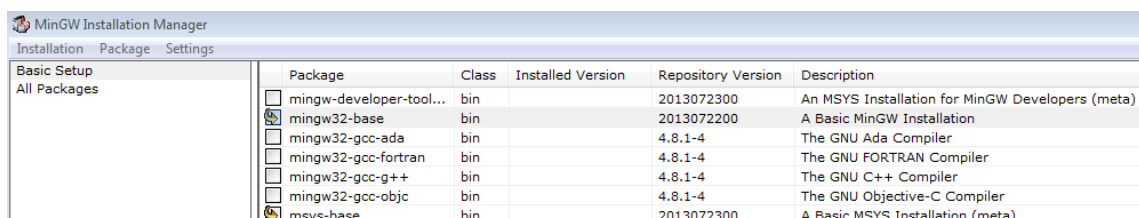
**Install GCC Arm Embedded tool chain** Download and run the installer from GNU Arm Embedded Toolchain. This is the actual toolset (in other words, compiler, linker, and so on). The GCC toolchain should correspond to the latest supported version, as described in **MCUXpresso SDK Release Notes**.

**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.

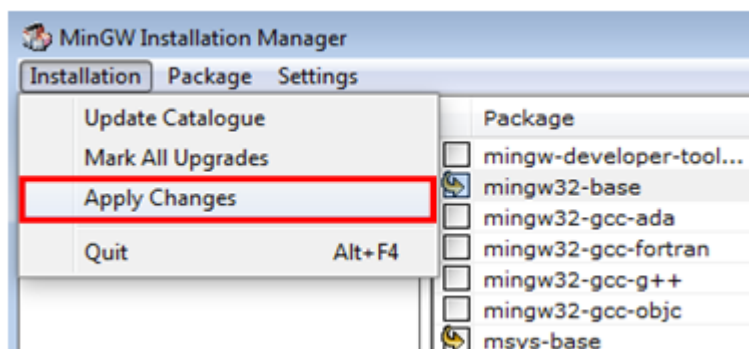
1. Download the latest MinGW mingw-get-setup installer from [MinGW](#).
2. Run the installer. The recommended installation path is `C:\MinGW`, however, you may install to any location.

**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.



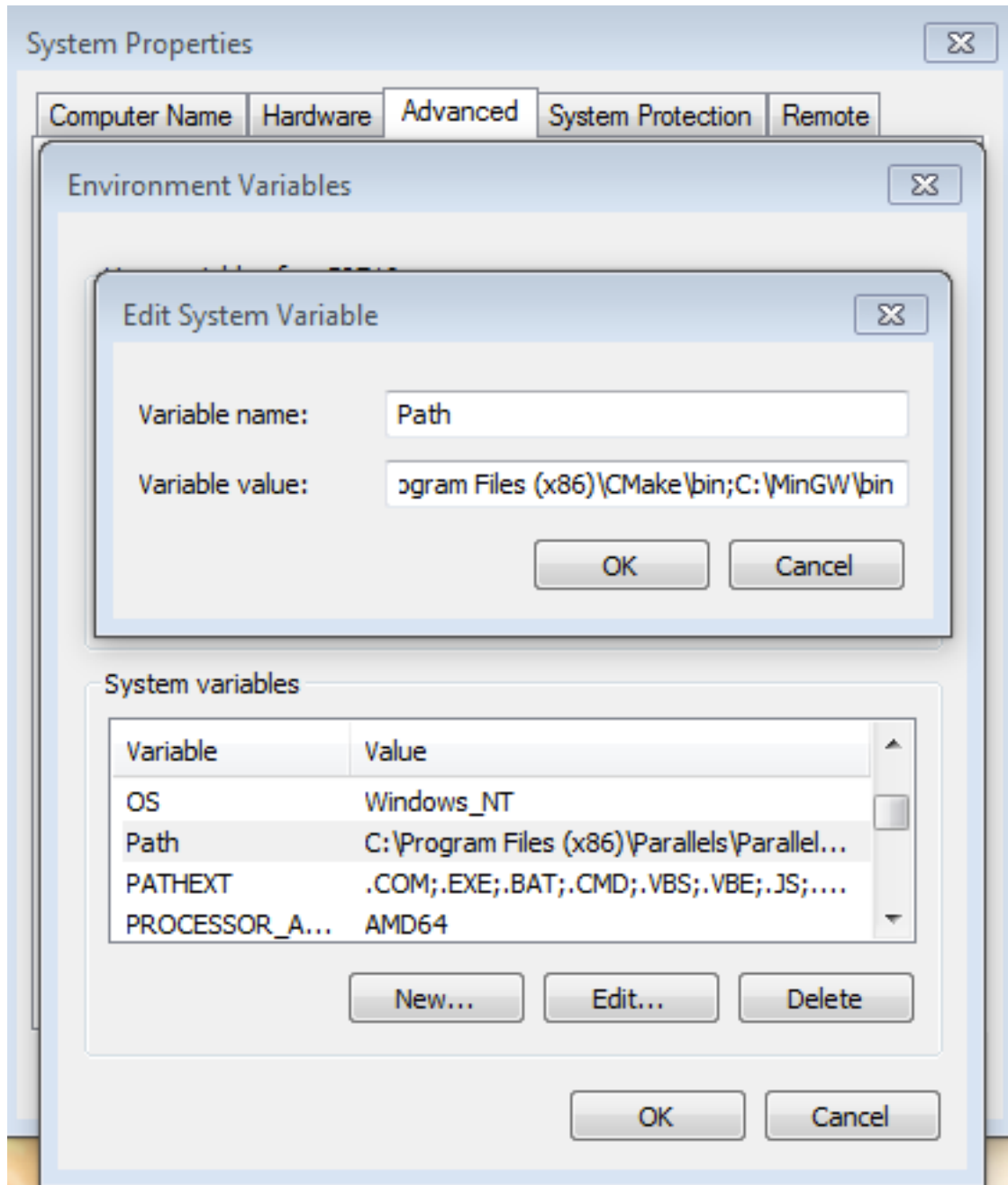
5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel->System and Security->System->Advanced System Settings** in the **Environment Variables...** section. The path is:



```
<mingw_install_dir>\bin
```

Assuming the default installation path, C:\MinGW, an example is shown below. 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.



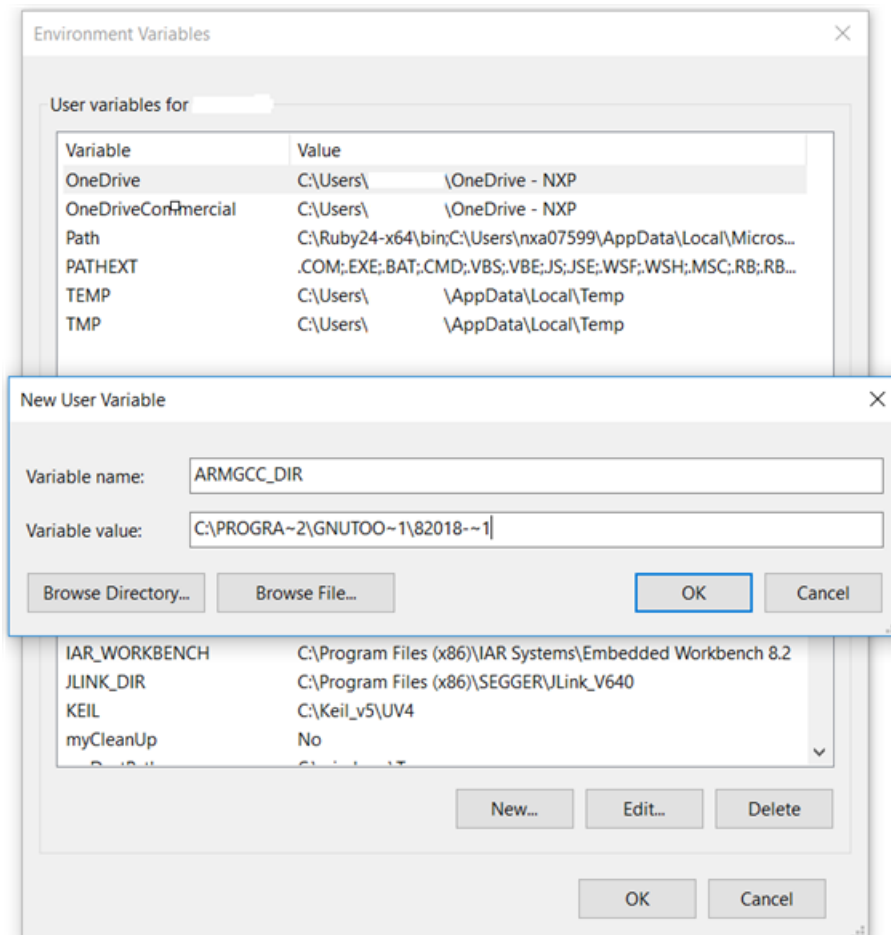
**Add a new system environment variable for ARMGCC\_DIR** Create a new *system* environment variable and name it as ARMGCC\_DIR. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

```
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 pathname of your installation.

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

```
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
```

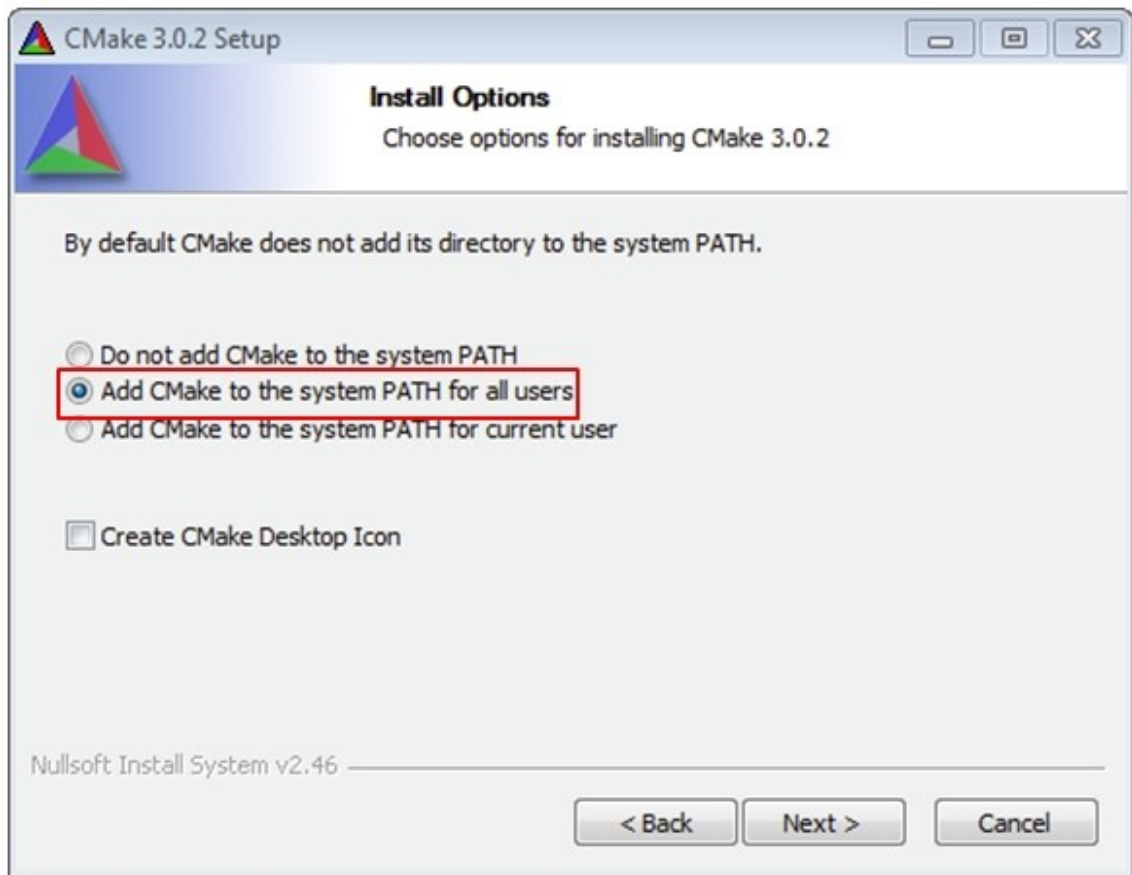


## Install CMake

### Windows OS

1. Download CMake 3.0.x from [www.cmake.org/cmake/resources/software.html](http://www.cmake.org/cmake/resources/software.html).
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.

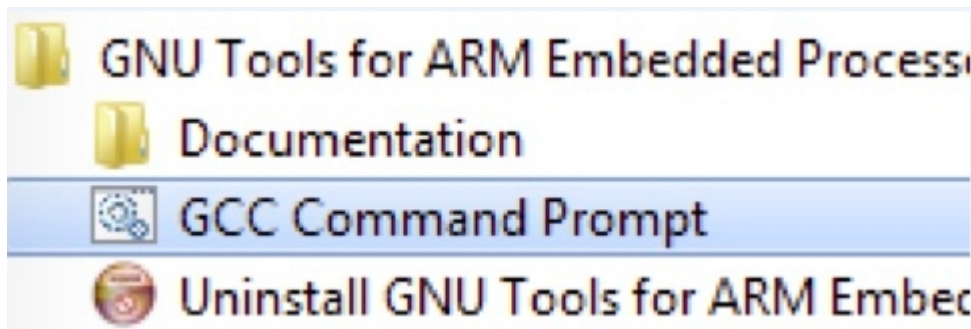
**Linux OS** It depends on the distributions of Linux Operation System. Here we use Ubuntu as an example.

Open shell and use following commands to install cmake and its version. Ensure the cmake version is above 3.0.x.

```
$ sudo apt-get install cmake
$ cmake --version
```

**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>/<application_name>/armgcc
```

For this example, the exact path is:

**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 following figure.

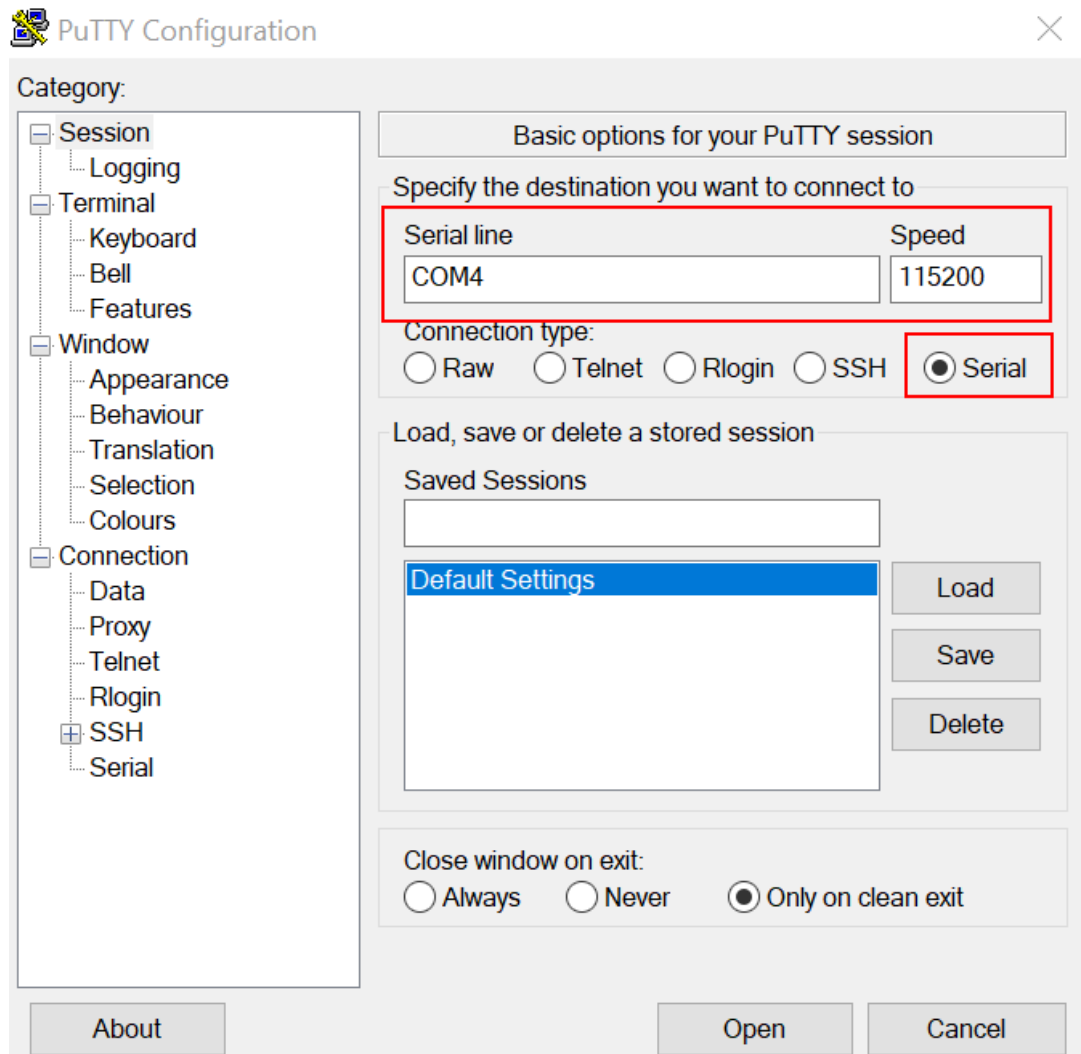
```
[ 84%] Building C object CMakeFiles/hello_world.elf.dir/C:/nxp/SDK_2.0_FRDM-K64F
/devices/MK64F12/drivers/fsl_smc.c.obj
[ 92%] Building C object CMakeFiles/hello_world.elf.dir/C:/nxp/SDK_2.0_FRDM-K64F
/devices/MK64F12/drivers/fsl_clock.c.obj
[100%] Linking C executable debug\hello_world.elf
[100%] Built target hello_world.elf

C:\nxp\SDK_2.0_FRDM-K64F\boards\frdmk64f\demo_apps\hello_world\armgcc>IF "" == "
" <pause >
Press any key to continue . . .
```

**Run an example application** This section describes steps to run a demo application using J-Link GDB Server application. To install J-Link host driver and update the on-board debugger firmware to Jlink firmware, see [On-board debugger](#).

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

1. Connect the development platform to your PC via USB cable between the on-board debugger USB connector and the PC USB connector. If using a standalone J-Link debug pod, connect it to the SWD/JTAG connector of the board.
2. 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\_BAUDRATE variable in board.h file)
  2. No parity
  3. 8 data bits
  4. 1 stop bit



3. To launch the application, open the Windows **Start** menu and select **Programs > SEGGER > J-Link <version> J-Link GDB Server**.

**Note:** It is assumed that the J-Link software is already installed.

The **SEGGER J-Link GDB Server Config** settings dialog appears.

4. Make sure to check the following options.
  1. **Target interface:** The debug connection on board uses internal SWD signaling. In case of a wrong setting J-Link is unable to communicate with device under test.
  2. **Script file:** If required, a J-Link init script file can be used for board initialization. The file with the ".jlinkscript" file extension is located in the <install\_dir>/boards/<board\_name>/ directory.
  3. Under the **Server settings**, check the GDB port for connection with the gdb target remote command. For more information, see step 9.
  4. There is a command line version of J-Link GDB server "JLinkGDBServerCL.exe". Typical path is C:\Program Files\SEGGER\JLink\. To start the J-Link GDB server with the same settings as are selected in the UI, you can use these command line options.

SEGGER J-Link GDB Server V7.94b Config

Connection to J-Link

☒ USB ☒ SN / Nickname 0

☐ TCP/IP

Target device

MIMXRT1021xxx4A

Little Endian

Flash banks

BaseAddr	Name	Loader
0x60000000	External QSPI flash	Default

Target interface a)

SWD

Speed

☐ Auto Selection

☐ Adaptive clocking

☒ Fixed 4000 kHz

Script file (optional) b)

Server settings

☐ Init registers

☒ Localhost only

☐ Generate logfile c)

GDB port 2331

SWO port 2332

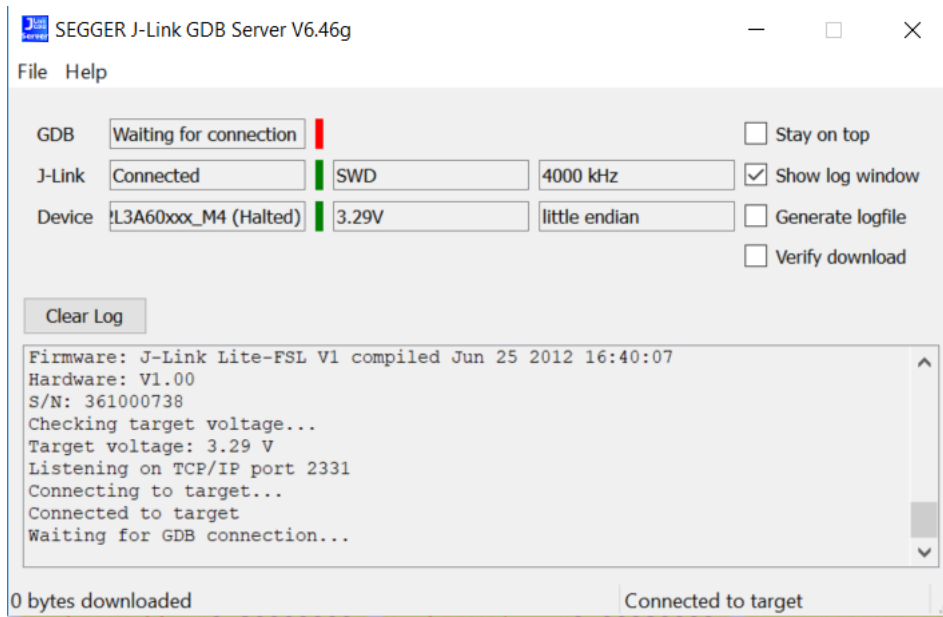
Telnet port 2333

Command line option d)

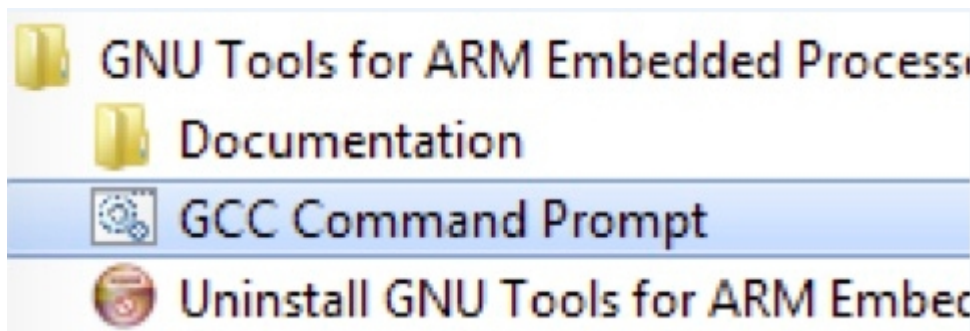
```
-select USB=0 -device MIMXRT1021xxx4A -endian little -if SWD -speed 4000 -noir -LocalhostOnly -nologtofile -port 2331 -SWOPort 2332 -TelnetPort 2333
```

OK Cancel

5. After it is connected, the screen should look like this figure:



6. 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**.

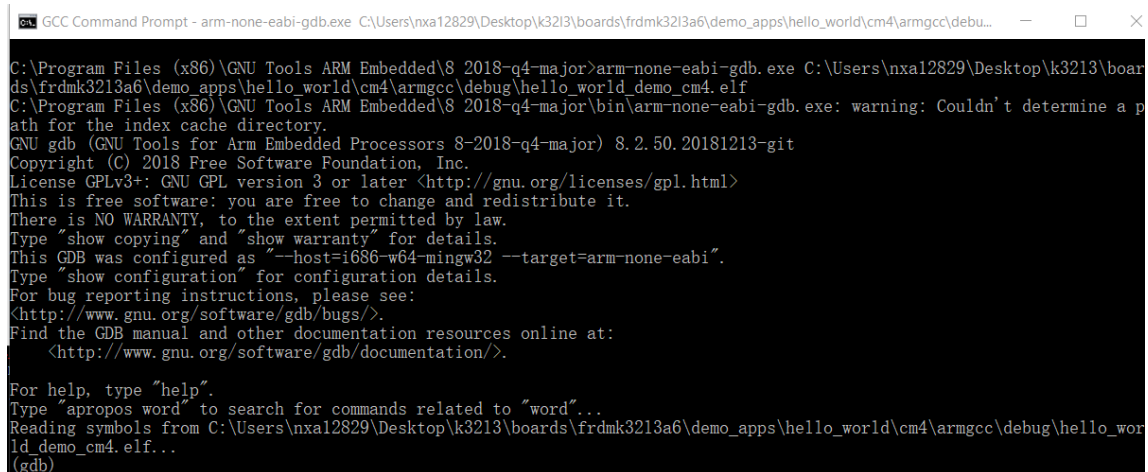


7. Change to the directory that contains the example application output. The output can be found in using one of these paths, depending on the build target selected:

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

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

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



```

GCC Command Prompt - arm-none-eabi-gdb.exe C:\Users\nxa12829\Desktop\k3213\boards\frdmk3213a6\demo_apps\hello_world\cm4\armgcc\debug\hello_world_demo_cm4.elf
C:\Program Files (x86)\GNU Tools ARM Embedded\8 2018-q4-major>arm-none-eabi-gdb.exe C:\Users\nxa12829\Desktop\k3213\boards\frdmk3213a6\demo_apps\hello_world\cm4\armgcc\debug\hello_world_demo_cm4.elf
C:\Program Files (x86)\GNU Tools ARM Embedded\8 2018-q4-major\bin>arm-none-eabi-gdb.exe: warning: Couldn't determine a path for the index cache directory.
GNU gdb (GNU Tools for Arm Embedded Processors 8-2018-q4-major) 8.2.50.20181213-git
Copyright (C) 2018 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "--host=i686-w64-mingw32 --target=arm-none-eabi".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from C:\Users\nxa12829\Desktop\k3213\boards\frdmk3213a6\demo_apps\hello_world\cm4\armgcc\debug\hello_world_demo_cm4.elf...
(gdb)

```

9. Run these commands:

1. target remote localhost:2331
2. monitor reset
3. monitor halt
4. load
5. monitor reset

10. The application is now downloaded and halted. Execute the `monitor go` command to start the demo application.

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



```

COM4 - PuTTY
hello world.

```

**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/<board_name>/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/lpcxpresso54114/multicore_examples/hello_world/cm0plus/armgcc/build_debug.bat
```

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm4/armgcc/build_debug.bat
```

Build both applications separately following steps for single core examples as described in **Build an example application**.

```

GCC Command Prompt - build_debug.bat

[ 47%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/drivers/fsl_common.c.obj
[ 52%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/drivers/fsl_msmc.c.obj
[ 56%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/debug_console/fsl_debug_console.c.obj
[ 60%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/fsl_assert.c.obj
[ 65%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/str/fsl_str.c.obj
[ 69%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/uart/lpuart_adapter.c.obj
[ 73%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/serial_manager/serial_manager.c.obj
[ 78%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/serial_manager/serial_port_uart.c.obj
[ 82%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/lists/generic_list.c.obj
[ 86%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/system_K32L3A60_cm0plus.c.obj
[ 91%] Building ASM object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/gcc/startup_K32L3A60_cm0plus.S.obj
[ 95%] Building C object CMakeFiles/hello_world_cm0plus.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/middleware/multicore/mcmgr/src/mcmgr.c.obj
[100%] Linking C executable debug\hello_world_cm0plus.elf
[100%] Built target hello_world_cm0plus.elf

c:\packages\SDK_2.6.0_FRDM-K32L3A6_RC1\boards\frdmk32l3a6\multicore_examples\hello_world\cm0plus\armgcc>IF "" == "" (pause)
Press any key to continue . . .

GCC Command Prompt - build_debug.bat

[ 50%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/drivers/fsl_lpuart.c.obj
[ 54%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/drivers/fsl_common.c.obj
[ 58%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/drivers/fsl_msmc.c.obj
[ 62%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/str/fsl_str.c.obj
[ 66%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/fsl_assert.c.obj
[ 70%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/utilities/debug_console/fsl_debug_console.c.obj
[ 75%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/uart/lpuart_adapter.c.obj
[ 79%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/serial_manager/serial_port_uart.c.obj
[ 83%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/serial_manager/serial_manager.c.obj
[ 87%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/components/lists/generic_list.c.obj
[ 91%] Building C object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/system_K32L3A60_cm4.c.obj
[ 95%] Building ASM object CMakeFiles/hello_world_cm4.elf.dir/C:/packages/SDK_2.6.0_FRDM-K32L3A6_RC1/devices/K32L3A60/gcc/startup_K32L3A60_cm4.S.obj
[100%] Linking C executable debug\hello_world_cm4.elf
[100%] Built target hello_world_cm4.elf

c:\packages\SDK_2.6.0_FRDM-K32L3A6_RC1\boards\frdmk32l3a6\multicore_examples\hello_world\cm4\armgcc>IF "" == "" (pause)
Press any key to continue . . .

```

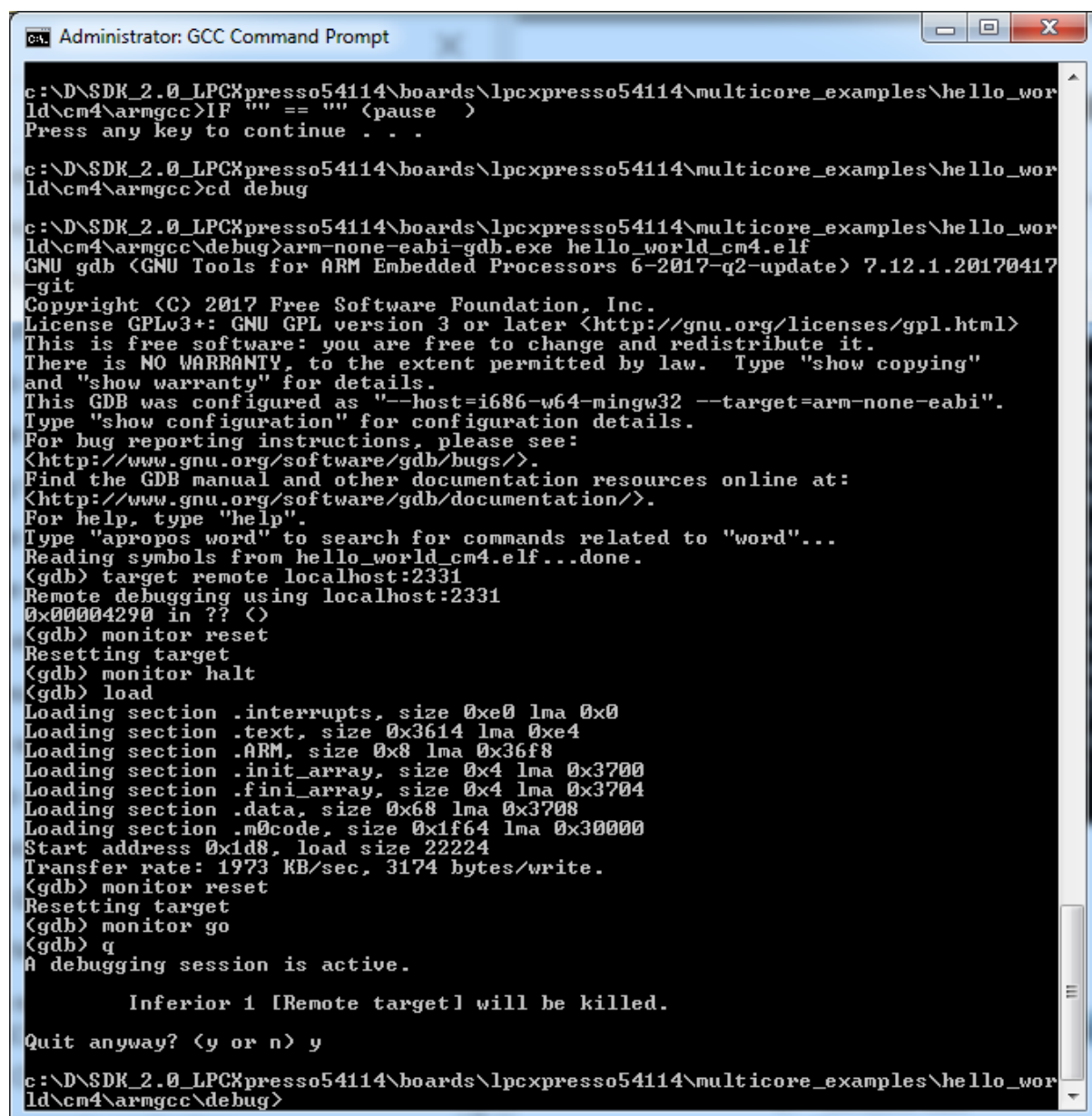
**Run a multicore example application** When running a multicore application, the same pre-requisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single-core application, applies, as described in **Run an example application**.

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 reallocated from the 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.



```

Administrator: GCC Command Prompt

c:\D\SDK_2.0_LPCXpresso54114\boards\lpcxpresso54114\multicore_examples\hello_world_cm4\armgcc>IF "" == "" <pause >
Press any key to continue . . .

c:\D\SDK_2.0_LPCXpresso54114\boards\lpcxpresso54114\multicore_examples\hello_world_cm4\armgcc>cd debug

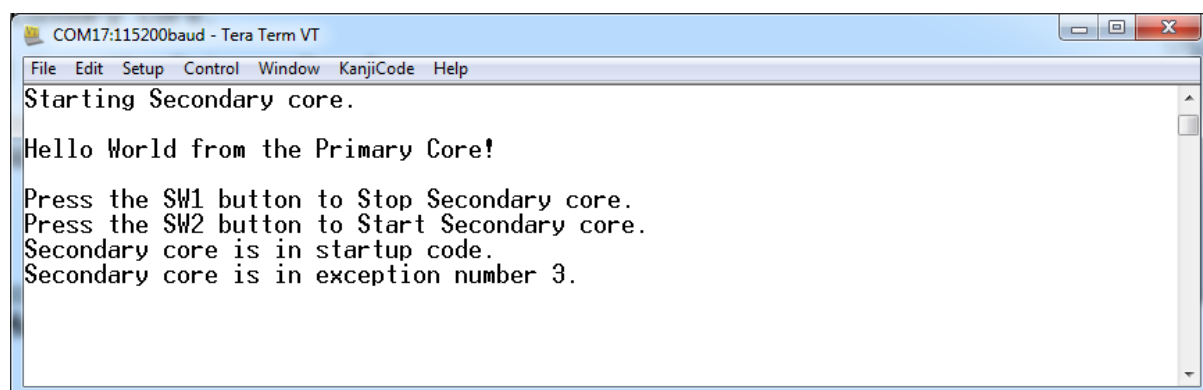
c:\D\SDK_2.0_LPCXpresso54114\boards\lpcxpresso54114\multicore_examples\hello_world_cm4\armgcc\debug>arm-none-eabi-gdb.exe hello_world_cm4.elf
GNU gdb (GNU Tools for ARM Embedded Processors 6-2017-q2-update) 7.12.1.20170417-git
Copyright (C) 2017 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law. Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=i686-w64-mingw32 --target=arm-none-eabi".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from hello_world_cm4.elf...done.
(gdb) target remote localhost:2331
Remote debugging using localhost:2331
0x00004290 in ?? ()
(gdb) monitor reset
Resetting target
(gdb) monitor halt
(gdb) load
Loading section .interrupts, size 0xe0 lma 0x0
Loading section .text, size 0x3614 lma 0xe4
Loading section .ARM, size 0x8 lma 0x36f8
Loading section .init_array, size 0x4 lma 0x3700
Loading section .fini_array, size 0x4 lma 0x3704
Loading section .data, size 0x68 lma 0x3708
Loading section .m0code, size 0x1f64 lma 0x30000
Start address 0x1d8, load size 22224
Transfer rate: 1973 KB/sec, 3174 bytes/write.
(gdb) monitor reset
Resetting target
(gdb) monitor go
(gdb) q
A debugging session is active.

    Inferior 1 [Remote target] will be killed.

Quit anyway? (y or n) y

c:\D\SDK_2.0_LPCXpresso54114\boards\lpcxpresso54114\multicore_examples\hello_world_cm4\armgcc\debug>

```



```

COM17:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help
Starting Secondary core.

Hello World from the Primary Core!

Press the SW1 button to Stop Secondary core.
Press the SW2 button to Start Secondary core.
Secondary core is in startup code.
Secondary core is in exception number 3.

```

**Build a TrustZone example application** This section describes the steps to build and run a TrustZone application. The demo application build scripts are located in this folder:



```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/[<core_type>]/
↪<application_name>_ns/armgcc
```

```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/[<core_type>]/
↪<application_name>_s/armgcc
```

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

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_ns/armgcc/build_
↪debug.bat
```

```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/armgcc/build_
↪debug.bat
```

Build both applications separately, following steps for single core examples as described in **Build an example application**. It is requested to build the application for the secure project first, because the non-secure project must know the secure project, since CMSE library is running the linker. It is not possible to finish the non-secure project linker with the secure project because the CMSE library is not ready.

```
C:\WINDOWS\system32\cmd.exe
[ 55%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/utilities/fsl_
l_assert.c.obj
[ 59%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/uart/usart_adapter.c
.obj
[ 62%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
flexspi.c.obj
[ 66%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
cache.c.obj
[ 70%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/serial_manager/seria
l_manager.c.obj
[ 74%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/serial_manager/seria
l_port_uart.c.obj
[ 77%] Building ASM object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/gcc/startu
p_MIMXRT595S_cm33.S.obj
[ 81%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/lists/generic_list.c
.obj
[ 85%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
usart.c.obj
[ 88%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
flexcomm.c.obj
[ 92%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
gpio.c.obj
[ 96%] Building C object CMakeFiles/hello_world_s.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/fsl_
iap.c.obj
[100%] Linking C executable debug\hello_world_s.elf
[100%] Built target hello_world_s.elf

C:\npx\SDK_2.6.0_EVK-MIMXRT595\boards\evkmimxrt595\trustzone_examples\hello_world\hello_world_s\armgcc>IF "" == "" (paus
e)
Press any key to continue . . .
```

```

C:\WINDOWS\system32\cmd.exe
[ 52%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/uart/usart_adapter.c.obj
[ 56%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/utilities/flexspi_assert.c.obj
[ 60%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexspi/flexspi.c.obj
[ 64%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexspi/cache.c.obj
[ 68%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/serial_manager/serial_manager.c.obj
[ 72%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/serial_manager/serial_port_uart.c.obj
[ 76%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexspi/usart.c.obj
[ 80%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/components/lists/generic_list.c.obj
[ 84%] Building ASM object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/gcc/startup_MIMXRT595S_cm33.S.obj
[ 88%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexcomm/flexcomm.c.obj
[ 92%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexcomm/gpio.c.obj
[ 96%] Building C object CMakeFiles/hello_world_ns.elf.dir/C:/npx/SDK_2.6.0_EVK-MIMXRT595/devices/MIMXRT595S/drivers/flexcomm/iap.c.obj
[100%] Linking C executable debug\hello_world_ns.elf
[100%] Built target hello_world_ns.elf

C:\npx\SDK_2.6.0_EVK-MIMXRT595\boards\evkmimxrt595\trustzone_examples\hello_world\hello_world_ns\armgcc>IF "" == "" (pause)
Press any key to continue . . .

```

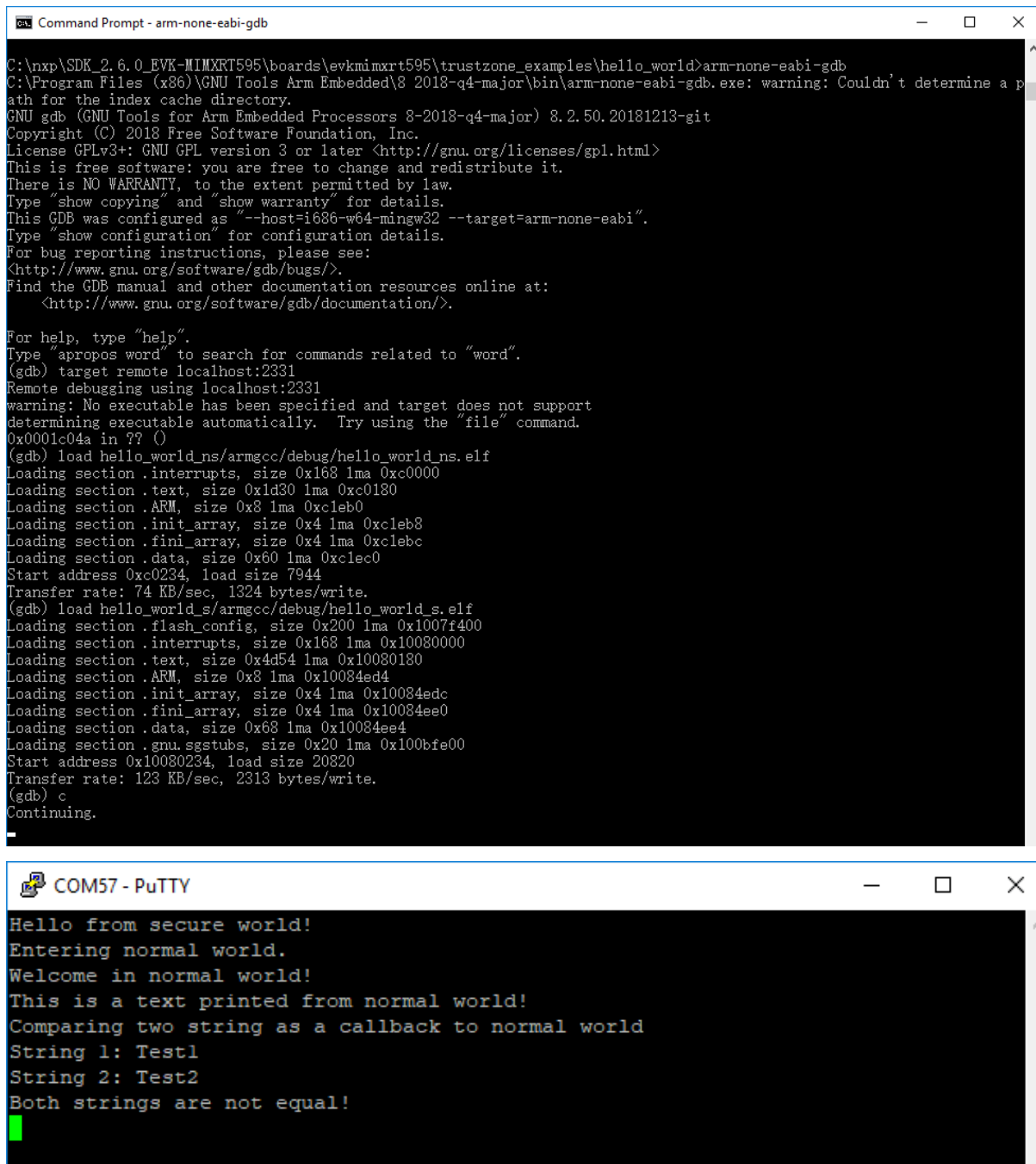
**Run a TrustZone example application** When running a TrustZone application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single core application, apply, as described in **Run an example application**.

To download and run the TrustZone application, perform steps 1 to 10, as described in **Run an example application**. These steps are common for both single core and TrustZone applications in Arm GCC.

Then, run these commands:

1. arm-none-eabi-gdb.exe
2. target remote localhost:2331
3. monitor reset
4. monitor halt
5. monitor exec SetFlashDLNoRMWThreshold = 0x20000
6. load <install\_dir>/boards/evkmimxrt595/trustzone\_examples/hello\_world/hello\_world\_ns/armgcc/debug/hello\_world\_ns.elf
7. load <install\_dir>/boards/evkmimxrt595/trustzone\_examples/hello\_world/hello\_world\_s/armgcc/debug/hello\_world\_s.elf
8. monitor reset

The application is now downloaded and halted. Execute the `c` command to start the demo application.



```

C:\nxp\SDK_2.6.0_EVK-MIMXRT595\boards\evkmimxrt595\trustzone_examples\hello_world>arm-none-eabi-gdb
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major\bin\arm-none-eabi-gdb.exe: warning: Couldn't determine a path for the index cache directory.
GNU gdb (GNU Tools for Arm Embedded Processors 8-2018-q4-major) 8.2.50.20181213-git
Copyright (C) 2018 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software; you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "--host=i686-w64-mingw32 --target=arm-none-eabi".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word".
(gdb) target remote localhost:2331
Remote debugging using localhost:2331
warning: No executable has been specified and target does not support
determining executable automatically. Try using the "file" command.
0x0001c04a in ?? ()
(gdb) load hello_world_ns/armgcc/debug/hello_world_ns.elf
Loading section .interrupts, size 0x168 lma 0xc0000
Loading section .text, size 0x1d30 lma 0xc0180
Loading section .ARM, size 0x8 lma 0xc1eb0
Loading section .init_array, size 0x4 lma 0xc1eb8
Loading section .fini_array, size 0x4 lma 0xc1ebc
Loading section .data, size 0x60 lma 0xc1ec0
Start address 0xc0234, load size 7944
Transfer rate: 74 KB/sec, 1324 bytes/write.
(gdb) load hello_world_s/armgcc/debug/hello_world_s.elf
Loading section .flash_config, size 0x200 lma 0x1007f400
Loading section .interrupts, size 0x168 lma 0x10080000
Loading section .text, size 0x4d54 lma 0x10080180
Loading section .ARM, size 0x8 lma 0x10084ed4
Loading section .init_array, size 0x4 lma 0x10084edc
Loading section .fini_array, size 0x4 lma 0x10084ee0
Loading section .data, size 0x68 lma 0x10084ee4
Loading section .gnu.sgstubs, size 0x20 lma 0x100bfe00
Start address 0x10080234, load size 20820
Transfer rate: 123 KB/sec, 2313 bytes/write.
(gdb) c
Continuing.

```

```






COM57 - PuTTY
Hello from secure world!
Entering normal world.
Welcome in normal world!
This is a text printed from normal world!
Comparing two string as a callback to normal world
String 1: Test1
String 2: Test2
Both strings are not equal!

```

## 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 24.12.00 or later.

Following table describes the tools included in the MCUXpresso Config Tools.

Config Tool	Description	Image
<b>Pins tool</b>	For configuration of pin routing and pin electrical properties.	
<b>Clock tool</b>	For system clock configuration	
<b>Peripherals tools</b>	For configuration of other peripherals	
<b>TEE tool</b>	Configures access policies for memory area and peripherals helping to protect and isolate sensitive parts of the application.	
<b>Device Configuration tool</b>	Configures Device Configuration Data (DCD) contained in the program image that the Boot ROM code interprets to set up various on-chip peripherals prior to 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 [www.nxp.com/mcuxpresso](http://www.nxp.com/mcuxpresso). Recommended for customers using IAR Embedded Workbench, Keil MDK  $\mu$ Vision, or Arm GCC.
- **Online version** available on [mcuxpresso.nxp.com](http://mcuxpresso.nxp.com). Recommended doing 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. All NXP boards ship with a factory programmed, onboard debug interface, whether it is based on MCU-Link or the legacy OpenSDA, LPC-Link2, P&E Micro OSJTAG interface. To determine what your specific board ships with, see [Default debug interfaces](#).

1. **Linux:** The serial port can be determined by running the following command after the USB Serial is connected to the host:

```
$ dmesg | grep "ttyUSB"
[503175.307873] usb 3-12: cp210x converter now attached to ttyUSB0
[503175.309372] usb 3-12: cp210x converter now attached to ttyUSB1
```

There are two ports, one is for core0 debug console and the other is for core1.

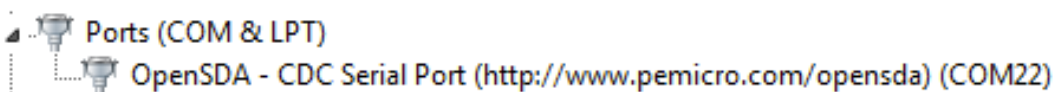
2. **Windows:** To determine the COM port open Device Manager in the Windows operating system. Click the **Start** menu and type **Device Manager** in the search bar.

In the Device Manager, expand the **Ports (COM & LPT)** section to view the available ports. The COM port names are different for all the NXP boards.

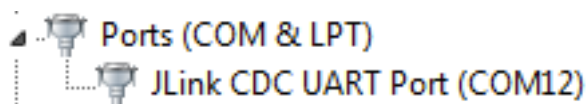
1. **CMSIS-DAP/mbd/DAPLink** interface:



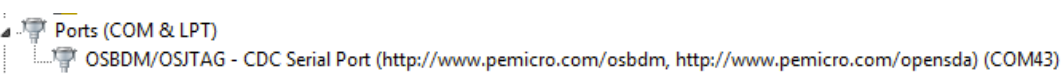
## 2. P&E Micro:



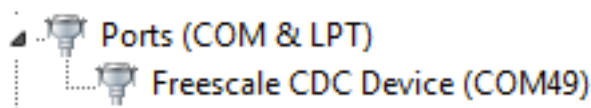
## 3. J-Link:



## 4. P&E Micro OSJTAG:



## 5. MRB-KW01:



## On-board Debugger

This section describes the on-board debuggers used on NXP development boards.

**On-board debugger MCU-Link** MCU-Link is a powerful and cost effective debug probe that can be used seamlessly with MCUXpresso IDE, and is also compatible with 3rd party IDEs that support CMSIS-DAP protocol. MCU-Link also includes a USB to UART bridge feature (VCOM) that can be used to provide a serial connection between the target MCU and a host computer. MCU-Link features a high-speed USB interface for high performance debug. MCU-Link is compatible with Windows, MacOS and Linux. A free utility from NXP provides an easy way to install firmware updates.

On-board MCU-Link debugger supports CMSIS-DAP and J-Link firmware. See the table in [Default debug interfaces](#) to determine the default debug interface that comes loaded on your specific hardware platform.

**The corresponding host driver must be installed before debugging.**

- For boards with CMSIS-DAP firmware, visit [developer.mbed.org/handbook/Windows-serial-configuration](http://developer.mbed.org/handbook/Windows-serial-configuration) and follow the instructions to install the Windows operating system serial driver. If running on Linux OS, this step is not required.
- If using J-Link with either a standalone debug pod or MCU-Link, install the J-Link software (drivers and utilities) from [www.segger.com/jlink-software.html](http://www.segger.com/jlink-software.html).

**Updating MCU-Link firmware** This firmware in this debug interface may be updated using the host computer utility called MCU-Link. This typically used when switching between the default debugger protocol (CMSIS-DAP) to SEGGER J-Link, or for updating this firmware with new releases of these. This section contains the steps to reprogram the debug probe firmware.

**Note:** If MCUXpresso IDE is used and the jumper making DFUlink is installed on the board (JP5 on some boards, but consult the board user manual or schematic for specific jumper number), MCU-Link debug probe boots to DFU mode, and MCUXpresso IDE automatically downloads the

CMSIS-DAP firmware to the probe before flash memory programming (after clicking **Debug**). Using DFU mode ensures that most up-to-date/compatible firmware is used with MCUXpresso IDE.

NXP provides the MCU-Link utility, which is the recommended tool for programming the latest versions of CMSIS-DAP and J-Link firmware onto MCU-Link or NXP boards. The utility can be downloaded from [MCU-Link](#).

These steps show how to update the debugger firmware on your board for Windows operating system.

1. Install the MCU-Link utility.
2. Unplug the board's USB cable.
3. Make the DFU link (install the jumper labeled DFUlink).
4. Connect the probe to the host via USB (use Link USB connector).
5. Open a command shell and call the appropriate script located in the MCU-Link installation directory (<MCU-Link install dir>).
  1. To program CMSIS-DAP debug firmware: <MCU-Link install dir>/scripts/program\_CMSIS
  2. To program J-Link debug firmware: <MCU-Link install dir>/scripts/program\_JLINK
6. Remove DFU link (remove the jumper installed in Step 3).
7. Repower the board by removing the USB cable and plugging it in again.

**On-board debugger LPC-Link** LPC-Link 2 is an extensible debug probe that can be used seamlessly with MCUXpresso IDE, and is also compatible with 3rd party IDEs that support CMSIS-DAP protocol. MCU-Link also includes a USB to UART bridge feature (VCOM) that can be used to provide a serial connection between the target MCU and a host computer. LPC-Link 2 is compatible with Windows, MacOS and Linux. A free utility from NXP provides an easy way to install firmware updates.

On-board LPC-Link 2 debugger supports CMSIS-DAP and J-Link firmware. See the table in [Default debug interfaces](#) to determine the default debug interface that comes loaded on your specific hardware platform.

**The corresponding host driver must be installed before debugging.**

- For boards with CMSIS-DAP firmware, visit [developer.mbed.org/handbook/Windows-serial-configuration](https://developer.mbed.org/handbook/Windows-serial-configuration) and follow the instructions to install the Windows operating system serial driver. If running on Linux OS, this step is not required.
- If using J-Link with either a standalone debug pod or MCU-Link, install the J-Link software (drivers and utilities) from [www.segger.com/jlink-software.html](http://www.segger.com/jlink-software.html).

**Updating LPC-Link firmware** The LPCXpresso hardware platform comes with a CMSIS-DAP-compatible debug interface (known as LPC-Link2). This firmware in this debug interface may be updated using the host computer utility called LPCScript. This typically used when switching between the default debugger protocol (CMSIS-DAP) to SEGGER J-Link, or for updating this firmware with new releases of these. This section contains the steps to reprogram the debug probe firmware.

**Note:** If MCUXpresso IDE is used and the jumper making DFUlink is installed on the board (JP5 on some boards, but consult the board user manual or schematic for specific jumper number), LPC-Link2 debug probe boots to DFU mode, and MCUXpresso IDE automatically downloads the CMSIS-DAP firmware to the probe before flash memory programming (after clicking **Debug**). Using DFU mode ensures that most up-to-date/compatible firmware is used with MCUXpresso IDE.



NXP provides the LPCScript utility, which is the recommended tool for programming the latest versions of CMSIS-DAP and J-Link firmware onto LPC-Link2 or LPCXpresso boards. The utility can be downloaded from [LPCScript](#).

These steps show how to update the debugger firmware on your board for Windows operating system. For Linux OS, follow the instructions described in LPCScript user guide ([LPCScript](#), select **LPCScript**, and then the documentation tab).

1. Install the LPCScript utility.
2. Unplug the board's USB cable.
3. Make the DFU link (install the jumper labeled DFUlink).
4. Connect the probe to the host via USB (use Link USB connector).
5. Open a command shell and call the appropriate script located in the LPCScript installation directory (<LPCScript install dir>).
  1. To program CMSIS-DAP debug firmware: <LPCScript install dir>/scripts/program\_CMSIS
  2. To program J-Link debug firmware: <LPCScript install dir>/scripts/program\_JLINK
6. Remove DFU link (remove the jumper installed in Step 3).
7. Repower the board by removing the USB cable and plugging it in again.

**On-board debugger OpenSDA** OpenSDA/OpenSDAv2 is a serial and debug adapter that is built into several NXP evaluation boards. It provides a bridge between your computer (or other USB host) and the embedded target processor, which can be used for debugging, flash programming, and serial communication, all over a simple USB cable.

The difference is the firmware implementation: OpenSDA: Programmed with the proprietary P&E Micro developed bootloader. P&E Micro is the default debug interface app. OpenSDAv2: Programmed with the open-sourced CMSIS-DAP/mbd bootloader. CMSIS-DAP is the default debug interface app.

See the table in [Default debug interfaces](#) to determine the default debug interface that comes loaded on your specific hardware platform.

**The corresponding host driver must be installed before debugging.**

- For boards with CMSIS-DAP firmware, visit [developer.mbed.org/handbook/Windows-serial-configuration](https://developer.mbed.org/handbook/Windows-serial-configuration) and follow the instructions to install the Windows operating system serial driver. If running on Linux OS, this step is not required.
- For boards with a P&E Micro interface, see [PE micro](#) to download and install the P&E Micro Hardware Interface Drivers package.

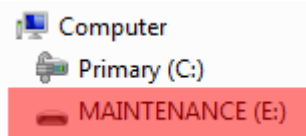
**Updating OpenSDA firmware** Any NXP hardware platform that comes with an OpenSDA-compatible debug interface has the ability to update the OpenSDA firmware. This typically means to switch from the default application (either CMSIS-DAP or P&E Micro) to a SEGGER J-Link. This section contains the steps to switch the OpenSDA firmware to a J-Link interface. However, the steps can be applied to restoring the original image also. For reference, OpenSDA firmware files can be found at the links below:

- J-Link: Download appropriate image from [www.segger.com/opensda.html](http://www.segger.com/opensda.html). Choose the appropriate J-Link binary based on the table in [Default debug interfaces](#). Any OpenSDA v1.0 interface should use the standard OpenSDA download (in other words, the one with no version). For OpenSDA 2.0 or 2.1, select the corresponding binary.
- CMSIS-DAP: CMSIS-DAP OpenSDA firmware is available at [www.nxp.com/opensda](http://www.nxp.com/opensda).

- P&E Micro: Downloading P&E Micro OpenSDA firmware images requires registration with P&E Micro ([www.pemicro.com](http://www.pemicro.com)).

Perform the following steps to update the OpenSDA firmware on your board for Windows and Linux OS users:

1. Unplug the board's USB cable.
2. Press the **Reset** button on the board. While still holding the button, plug the USB cable back into the board.
3. When the board re-enumerates, it shows up as a disk drive called **MAINTENANCE**.



4. Drag and drop the new firmware image onto the MAINTENANCE drive.

**Note:** If for any reason the firmware update fails, the board can always reenter maintenance mode by holding down **Reset** button and power cycling.

These steps show how to update the OpenSDA firmware on your board for Mac OS users.

1. Unplug the board's USB cable.
2. Press the **Reset** button of the board. While still holding the button, plug the USB cable back into the board.
3. For boards with OpenSDA v2.0 or v2.1, it shows up as a disk drive called **BOOTLOADER** in **Finder**. Boards with OpenSDA v1.0 may or may not show up depending on the bootloader version. If you see the drive in **Finder**, proceed to the next step. If you do not see the drive in **Finder**, use a PC with Windows OS 7 or an earlier version to either update the OpenSDA firmware, or update the OpenSDA bootloader to version 1.11 or later. The bootloader update instructions and image can be obtained from P&E Microcomputer website.
4. For OpenSDA v2.1 and OpenSDA v1.0 (with bootloader 1.11 or later) users, drag the new firmware image onto the BOOTLOADER drive in **Finder**.
5. For OpenSDA v2.0 users, type these commands in a Terminal window:

```
> sudo mount -u -w -o sync /Volumes/BOOTLOADER  
> cp -X <path to update file> /Volumes/BOOTLOADER
```

**Note:** If for any reason the firmware update fails, the board can always reenter bootloader mode by holding down the **Reset** button and power cycling.

**On-board debugger Multilink** An on-board Multilink debug circuit provides a JTAG interface and a power supply input through a single micro-USB connector. It is a hardware interface that allows PC software to debug and program a target processor through its debug port.

**The host driver must be installed before debugging.**

- See [PE micro](#) to download and install the P&E Micro Hardware Interface Drivers package.

**On-board debugger OSJTAG** An on-board OSJTAG debug circuit provides a JTAG interface and a power supply input through a single micro-USB connector. It is a hardware interface that allows PC software to debug and program a target processor through its debug port.

**The host driver must be installed before debugging.**

- See [PE micro](#) to download and install the P&E Micro Hardware Interface Drivers package.



## Default debug interfaces

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

Hardware platform	Default debugger firmware	On-board debugger probe
EVK-MCIMX7ULP	N/A	N/A
EVK-MIMX8MM	N/A	N/A
EVK-MIMX8MN	N/A	N/A
EVK-MIMX8MNDDR3L	N/A	N/A
EVK-MIMX8MP	N/A	N/A
EVK-MIMX8MQ	N/A	N/A
EVK-MIMX8ULP	N/A	N/A
EVK-MIMXRT1010	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1015	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1020	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1064	CMSIS-DAP	LPC-Link2
EVK-MIMXRT595	CMSIS-DAP	LPC-Link2
EVK-MIMXRT685	CMSIS-DAP	LPC-Link2
EVK9-MIMX8ULP	N/A	N/A
EVKB-IMXRT1050	CMSIS-DAP	LPC-Link2
FRDM-K22F	CMSIS-DAP	OpenSDA v2
FRDM-K32L2A4S	CMSIS-DAP	OpenSDA v2
FRDM-K32L2B	CMSIS-DAP	OpenSDA v2
FRDM-K32L3A6	CMSIS-DAP	OpenSDA v2
FRDM-KE02Z40M	P&E Micro	OpenSDA v1
FRDM-KE15Z	CMSIS-DAP	OpenSDA v2
FRDM-KE16Z	CMSIS-DAP	OpenSDA v2
FRDM-KE17Z	CMSIS-DAP	OpenSDA v2
FRDM-KE17Z512	CMSIS-DAP	MCU-Link
FRDM-MCXA153	CMSIS-DAP	MCU-Link
FRDM-MCXA156	CMSIS-DAP	MCU-Link
FRDM-MCXA266	CMSIS-DAP	MCU-Link
FRDM-MCXA344	CMSIS-DAP	MCU-Link
FRDM-MCXA346	CMSIS-DAP	MCU-Link
FRDM-MCXA366	CMSIS-DAP	MCU-Link
FRDM-MCXC041	CMSIS-DAP	MCU-Link
FRDM-MCXC242	CMSIS-DAP	MCU-Link
FRDM-MCXC444	CMSIS-DAP	MCU-Link
FRDM-MCXE247	CMSIS-DAP	MCU-Link
FRDM-MCXE31B	CMSIS-DAP	MCU-Link
FRDM-MCXN236	CMSIS-DAP	MCU-Link
FRDM-MCXN947	CMSIS-DAP	MCU-Link
FRDM-MCXW23	CMSIS-DAP	MCU-Link
FRDM-MCXW71	CMSIS-DAP	MCU-Link
FRDM-MCXW72	CMSIS-DAP	MCU-Link
FRDM-RW612	CMSIS-DAP	MCU-Link
IMX943-EVK	N/A	N/A
IMX95LP4XEVK-15	N/A	N/A
IMX95LPD5EVK-19	N/A	N/A
IMX95VERDINEVK	N/A	N/A
KW45B41Z-EVK	CMSIS-DAP	MCU-Link
KW45B41Z-LOC	CMSIS-DAP	MCU-Link
KW47-EVK	CMSIS-DAP	MCU-Link

continues on next page

Table 1 – continued from previous page

Hardware platform	Default debugger firmware	On-board debugger probe
KW47-LOC	CMSIS-DAP	MCU-Link
LPC845BREAKOUT	CMSIS-DAP	LPC-Link2
LPCXpresso51U68	CMSIS-DAP	LPC-Link2
LPCXpresso54628	CMSIS-DAP	LPC-Link2
LPCXpresso54S018	CMSIS-DAP	LPC-Link2
LPCXpresso54S018M	CMSIS-DAP	LPC-Link2
LPCXpresso55S06	CMSIS-DAP	LPC-Link2
LPCXpresso55S16	CMSIS-DAP	LPC-Link2
LPCXpresso55S28	CMSIS-DAP	LPC-Link2
LPCXpresso55S36	CMSIS-DAP	MCU-Link
LPCXpresso55S69	CMSIS-DAP	LPC-Link2
LPCXpresso802	CMSIS-DAP	LPC-Link2
LPCXpresso804	CMSIS-DAP	LPC-Link2
LPCXpresso824MAX	CMSIS-DAP	LPC-Link2
LPCXpresso845MAX	CMSIS-DAP	LPC-Link2
LPCXpresso860MAX	CMSIS-DAP	LPC-Link2
MC56F80000-EVK	P&E Micro	Multilink
MC56F81000-EVK	P&E Micro	Multilink
MC56F83000-EVK	P&E Micro	OSJTAG
MCIMX93-EVK	N/A	N/A
MCIMX93-QSB	N/A	N/A
MCIMX93AUTO-EVK	N/A	N/A
MCX-N5XX-EVK	CMSIS-DAP	MCU-Link
MCX-N9XX-EVK	CMSIS-DAP	MCU-Link
MCX-W71-EVK	CMSIS-DAP	MCU-Link
MCX-W72-EVK	CMSIS-DAP	MCU-Link
MIMXRT1024-EVK	CMSIS-DAP	LPC-Link2
MIMXRT1040-EVK	CMSIS-DAP	LPC-Link2
MIMXRT1060-EVKB	CMSIS-DAP	LPC-Link2
MIMXRT1060-EVKC	CMSIS-DAP	MCU-Link
MIMXRT1160-EVK	CMSIS-DAP	LPC-Link2
MIMXRT1170-EVKB	CMSIS-DAP	MCU-Link
MIMXRT1180-EVK	CMSIS-DAP	MCU-Link
MIMXRT685-AUD-EVK	CMSIS-DAP	LPC-Link2
MIMXRT700-EVK	CMSIS-DAP	MCU-Link
RD-RW612-BGA	CMSIS-DAP	MCU-Link
TWR-KM34Z50MV3	P&E Micro	OpenSDA v1
TWR-KM34Z75M	P&E Micro	OpenSDA v1
TWR-KM35Z75M	CMSIS-DAP	OpenSDA v2
TWR-MC56F8200	P&E Micro	OSJTAG
TWR-MC56F8400	P&E Micro	OSJTAG

## How to define IRQ handler in CPP files

With MCUXpresso SDK, users could define their own IRQ handler in application level to override the default IRQ handler. For example, to override the default PIT\_IRQHandler define in startup\_DEVICE.s, application code like app.c can be implement like:

```
// c
void PIT_IRQHandler(void)
{
    // Your code
}
```

When application file is CPP file, like app.cpp, then `extern "C"` should be used to ensure the function prototype alignment.

```
// cpp
extern "C" {
    void PIT_IRQHandler(void);
}
void PIT_IRQHandler(void)
{
    // Your code
}
```

## 1.3 Getting Started with MCUXpresso SDK GitHub

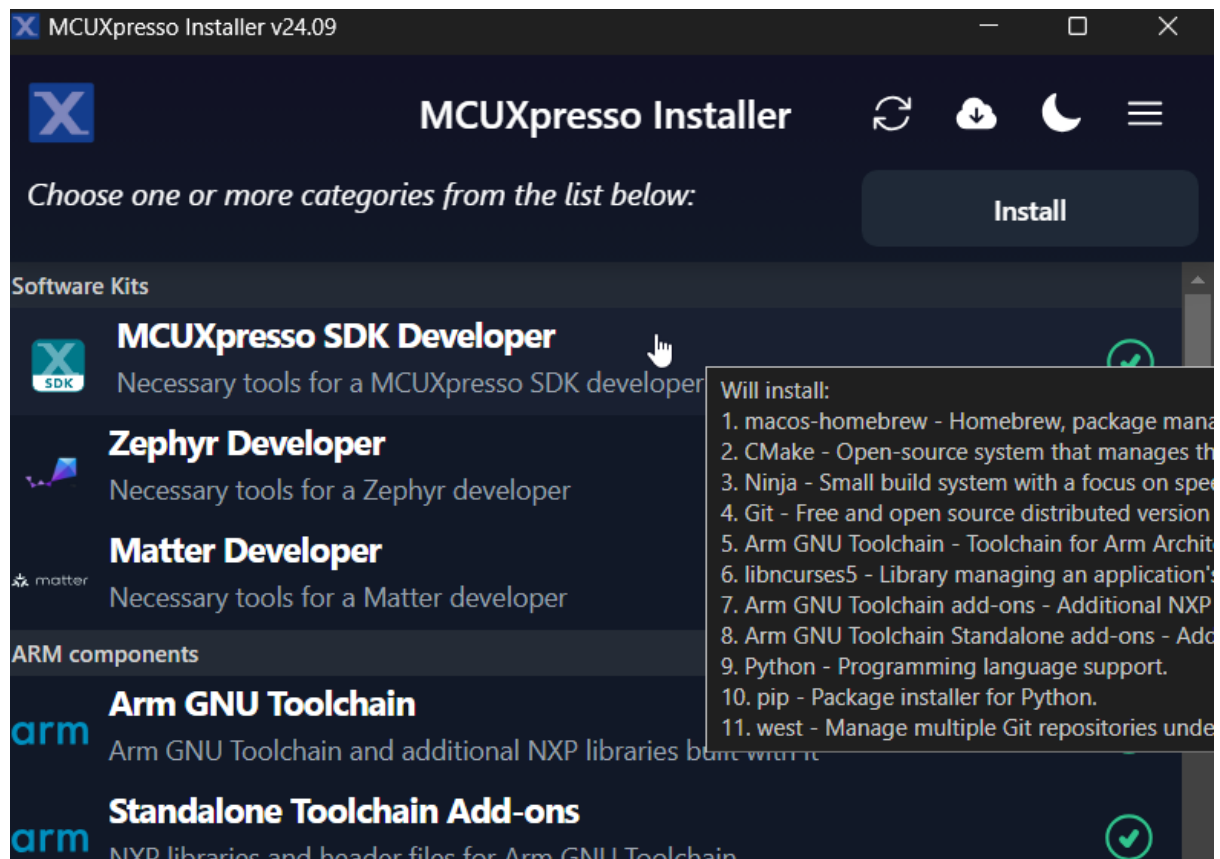
### 1.3.1 Getting Started with MCUXpresso SDK Repository

#### 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 OOB 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.

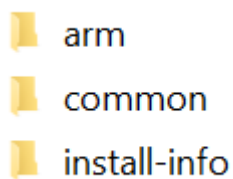
**Toolchain** MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

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

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	AR-MGCC_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	ARM-CLANG_DIR	C:\ArmCompilerforEmbedded6.22 for Windows/opt/ArmCompilerforEmbedded6.21 for Linux	– toolchain mdk
Zephyr	ZEPHYR_DIR	c:\NXP\zephyr-sdk-<version> for windows/opt/zephyr-sdk-<version> for Linux	– toolchain zephyr
CodeWarrior	CW_DIR	C:\Freescall\CW MCU v11.2 for windowsCodeWarrior is not supported with Linux	– toolchain code-warrior
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	RISCV-LVM_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 riscv-llvm

- 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 <code>west manifest config group.filter +optional</code> and <code>west update mcux-soc-svd</code> 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

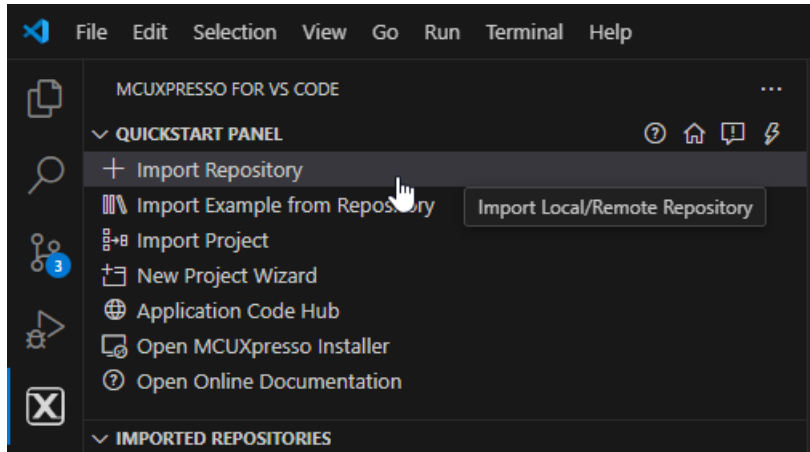
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the `hello_world` demo application as an example. However, these

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](#).

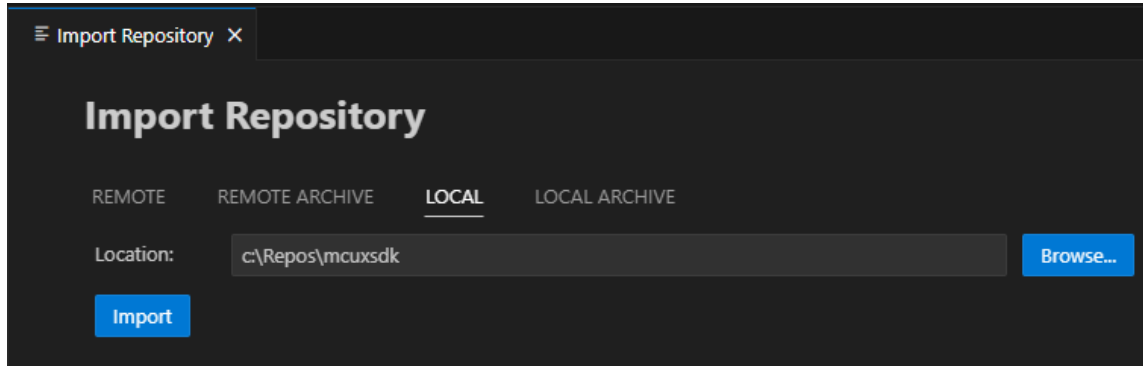
To build an example application:

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

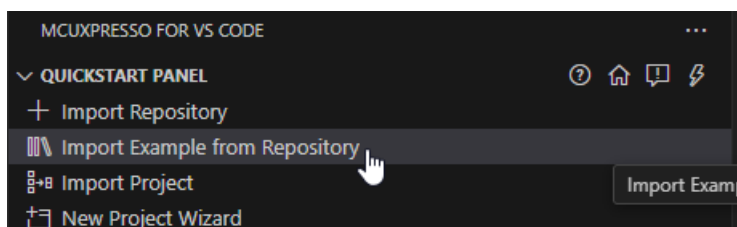


**Note:** You can import the SDK in several ways. Refer to [MCUXpresso for VS Code Wiki](#) for details.

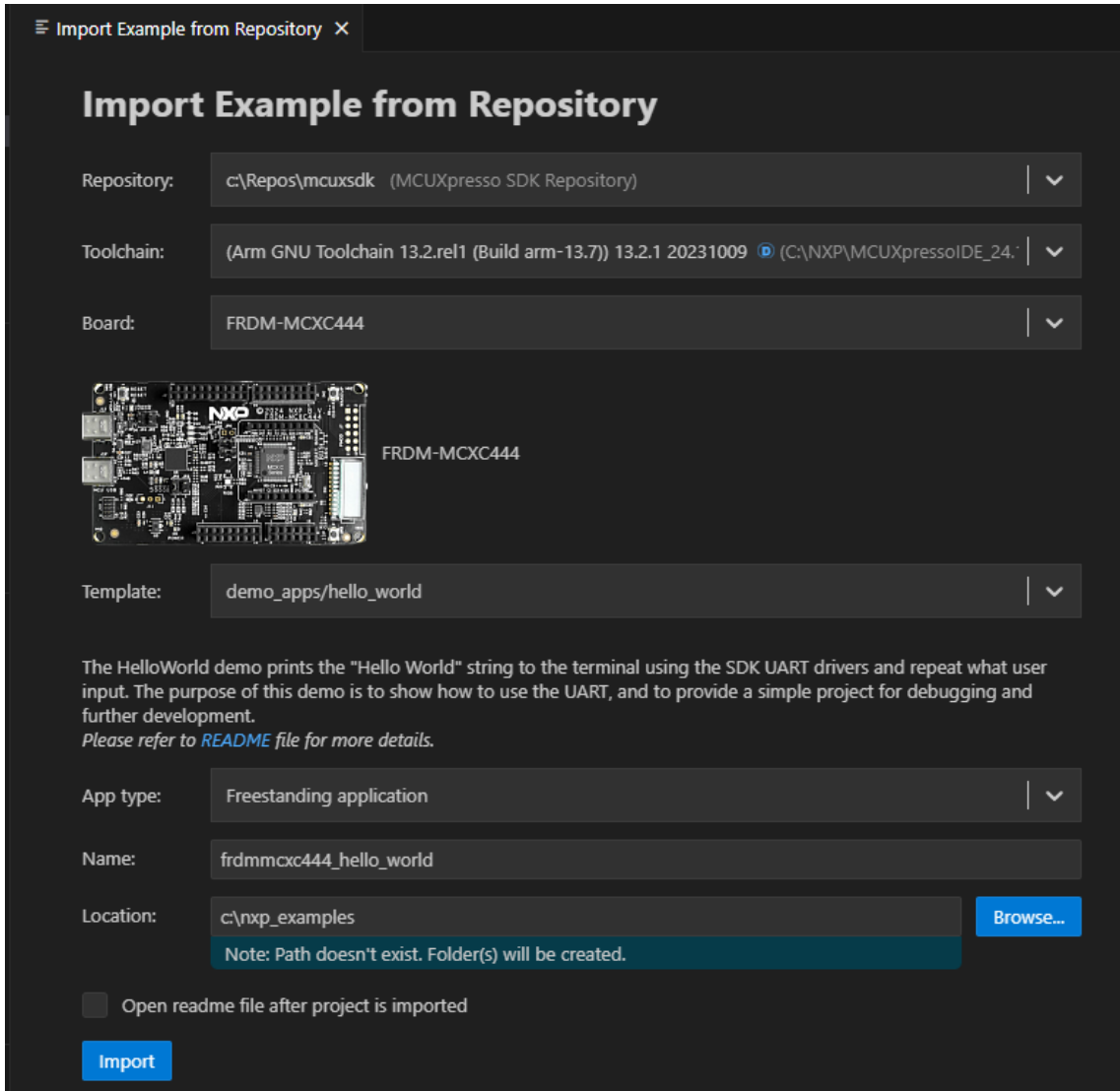
Select **Local** if you've already obtained the SDK as seen in [Get MCUXpresso SDK Repo](#). Select your location and click **Import**.



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**.




**Import Example from Repository**

Repository: c:\Repos\mcuxsdk (MCUXpresso SDK Repository) | v

Toolchain: (Arm GNU Toolchain 13.2.rel1 (Build arm-13.7)) 13.2.1 20231009 | v

Board: FRDM-MCXC444 | v

 FRDM-MCXC444

Template: demo\_apps/hello\_world | v

The HelloWorld demo prints the "Hello World" string to the terminal using the SDK UART drivers and repeat what user input. The purpose of this demo is to show how to use the UART, and to provide a simple project for debugging and further development.  
Please refer to [README](#) file for more details.

App type: Freestanding application | v

Name: frdmmcxc444\_hello\_world

Location: c:\nxp\_examples [Browse...](#)

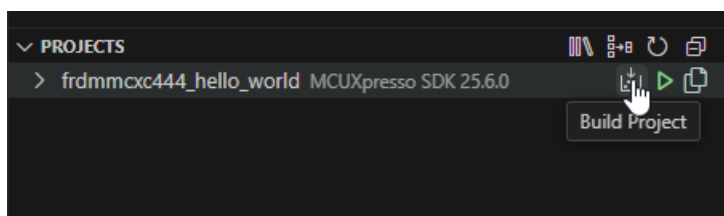
Note: Path doesn't exist. Folder(s) will be created.

☐ Open readme file after project is imported

[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.

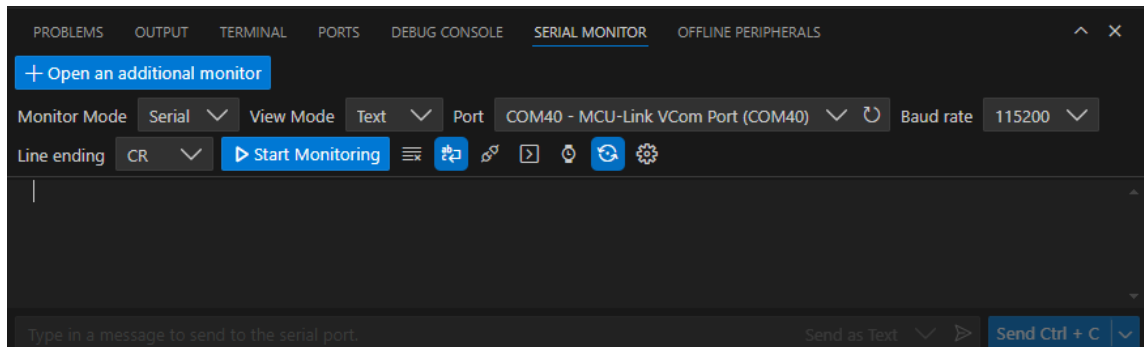
```

[17/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/components/debug_console_lite/fsl_debug_console.c.obj
[18/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/devices/MCX/MCX444/drivers/fsl_clock.c.obj
[19/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/drivers/lpuart/fsl_lpuart.c.obj
[20/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/drivers/uart/fsl_uart.c.obj
[21/21] Linking C executable hello_world.elf
Memory region      Used Size  Region Size  %age Used
  m_interrupts:     192 B      512 B      37.50%
  m_flash_config:    16 B       16 B     100.00%
  m_text:          7892 B    261104 B      3.02%
  m_data:          2128 B      32 KB      6.49%
build finished successfully.
Terminal will be reused by tasks, press any key to close it.

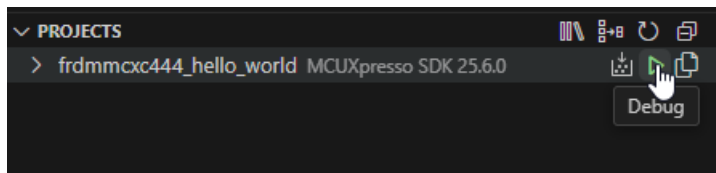
```

**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.

```

18  /*****
21
22  /*****
23  * Variables
24  *****/
25
26  /*****
27  * Code
28  *****/
29  /*!
30  * @brief Main function
31  */
32  int main(void)
33  {
34      char ch;
35
36      /* Init board hardware. */
37      BOARD_InitHardware();
38
39      PRINTF("hello world.\r\n");
40
41      while (1)
42      {
43          ch = GETCHAR();
44          PUTCHAR(ch);
45      }
46  }
47

```

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

```

PROBLEMS  OUTPUT  TERMINAL  PERIPHERALS  RTOS DETAILS  PORTS  DEBUG CONSOLE  SERIAL MONITOR
+ Open an additional monitor
Monitor Mode Serial View Mode Text Port COM40 - MCU-Link VCom Port (COM40)
[ ] Stop Monitoring
---- Opened the serial port COM40 ----
hello world.
|

```

## 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_
```

(continues on next page)

(continued from previous page)

```

↪ evkbnimxrt1060]
INFO: [ 4]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1170 -Dcore_id=cm4]
INFO: [ 5]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1170 -Dcore_id=cm7]
INFO: [ 6]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1060]
INFO: [ 7]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt7ulp]
...

```

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 evkbnimxrt1170 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 evkbnimxrt1170 --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

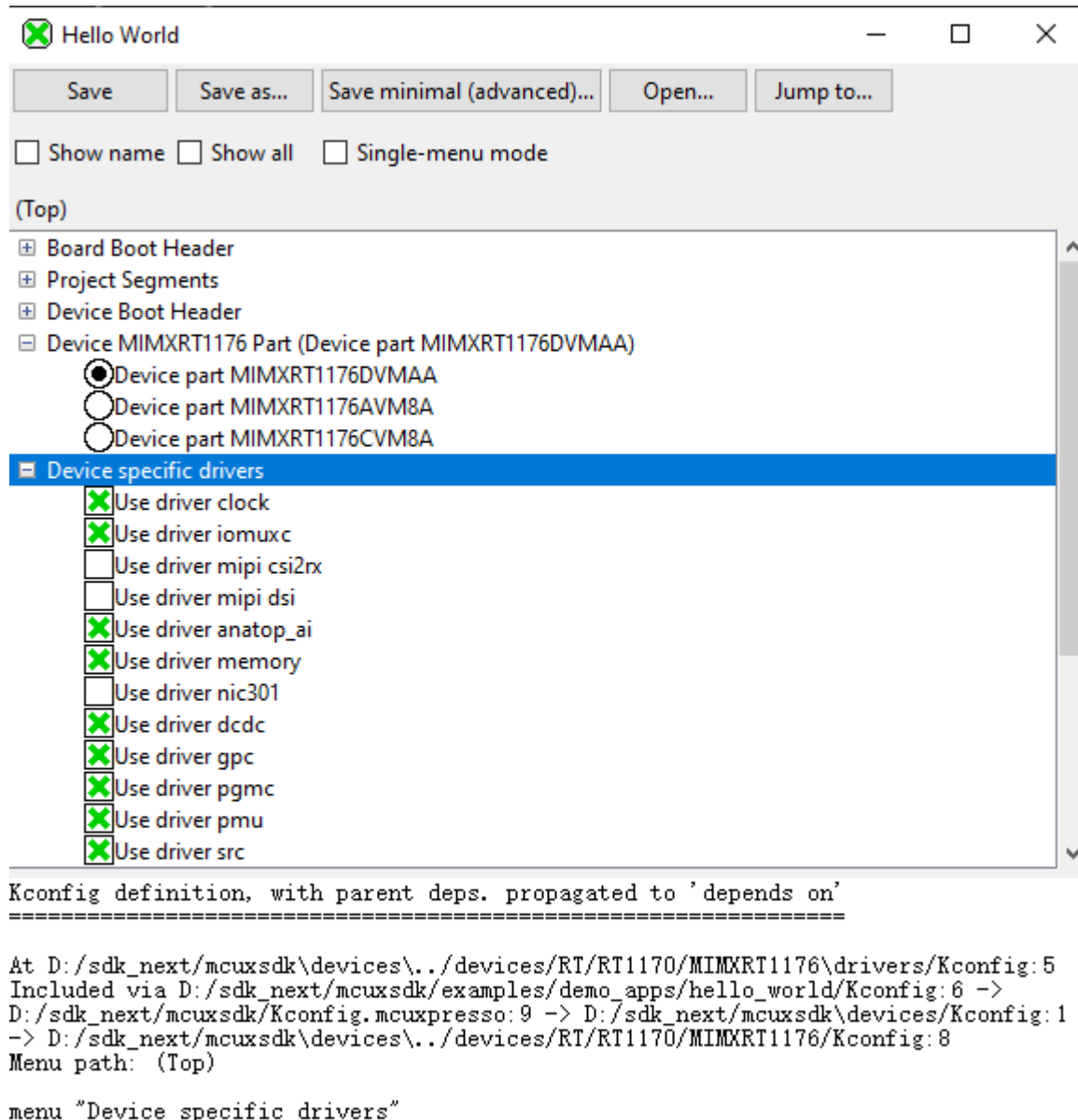
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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



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:

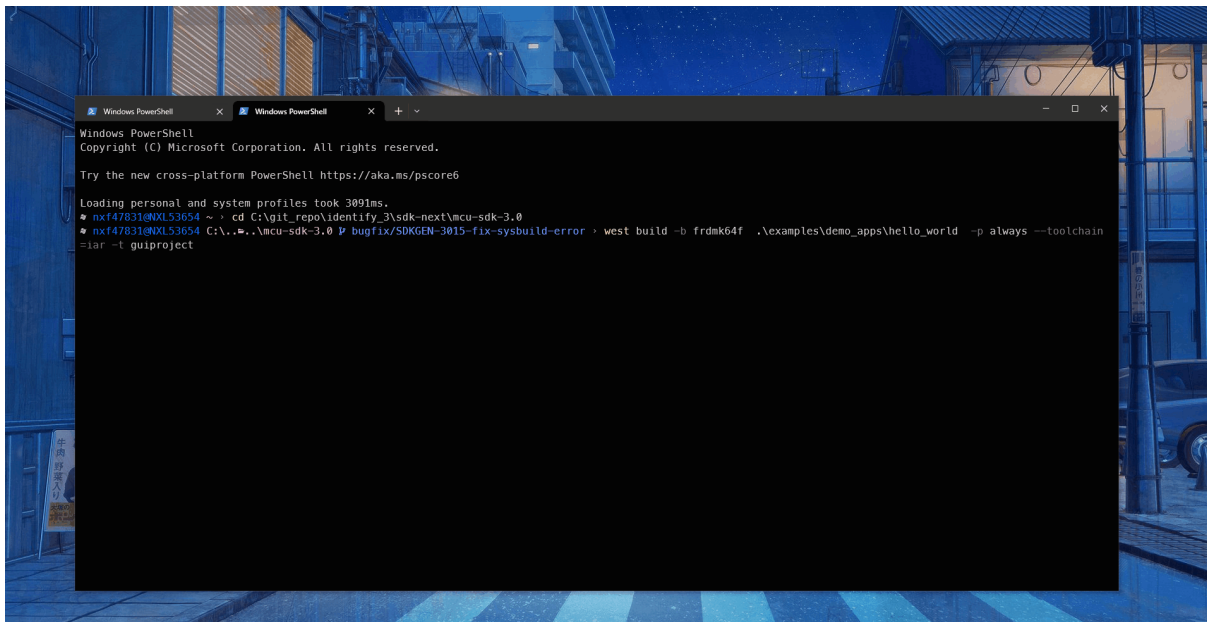
```
west debug -r linkserver
```

**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 5.42
- MCUXpresso for VS Code v25.09
- 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 boards	MCU devices		
<b>LPCXpresso860MAX</b>	LPC864M201JBD64, <b>LPC865M201JBD64</b>	LPC864M201JHI33, LPC865M201JHI33	LPC864M201JHI48, LPC865M201JHI48

## 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.

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

**FreeMASTER** FreeMASTER communication driver for 32-bit platforms.

## 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_name>
Utilities such as debug console	INSTALL_DIR/devices/<device_name>/utilities
Device Project Template for MCUXpresso IDE NPW	INSTALL_DIR/devices/<device_name>/project_template
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.

### Cannot add SDK components into FreeRTOS projects

It is not possible to add any SDK components into FreeRTOS project using the MCUXpresso IDE New Project wizard.

### The spi\_transfer\_interrupt examples don't work

Boards cannot transfer data successfully.

**Affected toolchains:** mcux **Affected platforms:** lpc845breakout, lpcxpresso860max

## 1.5 ChangeLog

### 1.5.1 MCUXpresso SDK Changelog

#### Board Support Files

##### board

##### [25.06.00]

- Initial version

##### clock\_config

#### [25.06.00]

- Initial version

### pin\_mux

#### [25.06.00]

- Initial version
- 

## LPC\_ACOMP

### [2.1.0]

- Bug Fixes
  - Fixed one wrong enum value for the hysteresis.
  - Fixed the violations of MISRA C-2012 rules:
    - \* Rule 10.1, 17.7.

### [2.0.2]

- Bug Fixes
  - Fixed the out-of-bounds error of Coverity caused by missing an assert sentence to avoid the return value of ACOMP\_GetInstance() exceeding the array bounds.

### [2.0.1]

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

### [2.0.0]

- Initial version.
- 

## LPC\_ADC

### [2.6.0]

- New Features
  - Added new feature macro to distinguish whether the GPADC\_CTRL0\_GPADC\_TSAMP control bit is on the device.
  - Added new variable extendSampleTimeNumber to indicate the ADC extend sample time.
- Bugfix
  - Fixed the bug that incorrectly sets the PASS\_ENABLE bit based on the sample time setting.

**[2.5.3]**

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

**[2.5.2]**

- Improvements
  - Integrated different sequence's sample time numbers into one variable.
- Bug Fixes
  - Fixed violation of MISRA C-2012 rule 20.9 .

**[2.5.1]**

- Bug Fixes
  - Fixed ADC conversion sequence priority misconfiguration issue in the ADC\_SetConvSeqAHighPriority() and ADC\_SetConvSeqBHighPriority() APIs.
- Improvements
  - Supported configuration ADC conversion sequence sampling time.

**[2.5.0]**

- Improvements
  - Add missing parameter tag of ADC\_DoOffsetCalibration().
- Bug Fixes
  - Removed a duplicated API with typo in name: ADC\_EnableShresholdCompareInterrupt().

**[2.4.1]**

- Bug Fixes
  - Enabled self-calibration after clock divider be changed to make sure the frequency update be taken.

**[2.4.0]**

- New Features
  - Added new API ADC\_DoOffsetCalibration() which supports a specific operation frequency.
- Other Changes
  - Marked the ADC\_DoSelfCalibration(ADC\_Type \*base) as deprecated.
- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules:
    - \* Rule 10.1 10.3 10.4 10.7 10.8 17.7.

### [2.3.2]

- Improvements
  - Added delay after enabling using the ADC GPADC\_CTRL0 LDO\_POWER\_EN bit for JN5189/QN9090.
- New Features
  - Added support for platforms which have only one ADC sequence control/result register.

### [2.3.1]

- Bug Fixes
  - Avoided writing ADC STARTUP register in ADC\_Init().
  - Fixed Coverity zero divider error in ADC\_DoSelfCalibration().

### [2.3.0]

- Improvements
  - Updated “ADC\_Init()”/“ADC\_GetChannelConversionResult()” API and “adc\_resolution\_t” structure to match QN9090.
  - Added “ADC\_EnableTemperatureSensor” API.

### [2.2.1]

- Improvements
  - Added a brief delay in uSec after ADC calibration start.

### [2.2.0]

- Improvements
  - Updated “ADC\_DoSelfCalibration” API and “adc\_config\_t” structure to match LPC845.

### [2.1.0]

- Improvements
  - Renamed “ADC\_EnableShresholdCompareInterrupt” to “ADC\_EnableThresholdCompareInterrupt”.

### [2.0.0]

- Initial version.
- 

## CLOCK

### [2.3.4]

- Improvements
  - Added CLOCK\_SetFLASHAccessCyclesForFreq.

**[2.3.3]**

- Improvements
    - Added lost comments for some enumerations.
- 

**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.
- 

### CRC

#### [2.1.1]

- Fix MISRA issue.

#### [2.1.0]

- Add CRC\_WriteSeed function.

#### [2.0.2]

- Fix MISRA issue.

#### [2.0.1]

- Fixed KPSDK-13362. MDK compiler issue when writing to WR\_DATA with -O3 optimize for time.

#### [2.0.0]

- Initial version.
-

## LPC\_DMA

### [2.5.3]

- Improvements
  - Add assert in DMA\_SetChannelXferConfig to prevent XFERCOUNT value overflow.

### [2.5.2]

- Bug Fixes
  - Use separate “SET” and “CLR” registers to modify shared registers for all channels, in case of thread-safe issue.

### [2.5.1]

- Bug Fixes
  - Fixed violation of the MISRA C-2012 rule 11.6.

### [2.5.0]

- Improvements
  - Added a new api DMA\_SetChannelXferConfig to set DMA xfer config.

### [2.4.4]

- Bug Fixes
  - Fixed the issue that DMA\_IRQHandle might generate redundant callbacks.
  - Fixed the issue that DMA driver cannot support channel bigger then 32.
  - Fixed violation of the MISRA C-2012 rule 13.5.

### [2.4.3]

- Improvements
  - Added features FSL\_FEATURE\_DMA\_DESCRIPTOR\_ALIGN\_SIZEn/FSL\_FEATURE\_DMA0\_DESCRIPTOR\_ALIGN\_SIZEn to support the descriptor align size not constant in the two instances.

### [2.4.2]

- Bug Fixes
  - Fixed violation of the MISRA C-2012 rule 8.4.

### [2.4.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 5.7, 8.3.

#### [2.4.0]

- Improvements
  - Added new APIs DMA\_LoadChannelDescriptor/DMA\_ChannelIsBusy to support polling transfer case.
- Bug Fixes
  - Added address alignment check for descriptor source and destination address.
  - Added DMA\_ALLOCATE\_DATA\_TRANSFER\_BUFFER for application buffer allocation.
  - Fixed the sign-compare warning.
  - Fixed violations of the MISRA C-2012 rules 18.1, 10.4, 11.6, 10.7, 14.4, 16.3, 20.7, 10.8, 16.1, 17.7, 10.3, 3.1, 18.1.

#### [2.3.0]

- Bug Fixes
  - Removed DMA\_HandleIRQ prototype definition from header file.
  - Added DMA\_IRQHandle prototype definition in header file.

#### [2.2.5]

- Improvements
  - Added new API DMA\_SetupChannelDescriptor to support configuring wrap descriptor.
  - Added wrap support in function DMA\_SubmitChannelTransfer.

#### [2.2.4]

- Bug Fixes
  - Fixed the issue that macro DMA\_CHANNEL\_CFER used wrong parameter to calculate DSTINC.

#### [2.2.3]

- Bug Fixes
  - Improved DMA driver Deinit function for correct logic order.
- Improvements
  - Added API DMA\_SubmitChannelTransferParameter to support creating head descriptor directly.
  - Added API DMA\_SubmitChannelDescriptor to support ping pong transfer.
  - Added macro DMA\_ALLOCATE\_HEAD\_DESCRIPTOR/DMA\_ALLOCATE\_LINK\_DESCRIPTOR to simplify DMA descriptor allocation.

#### [2.2.2]

- Bug Fixes
  - Do not use software trigger when hardware trigger is enabled.

**[2.2.1]**

- Bug Fixes
  - Fixed Coverity issue.

**[2.2.0]**

- Improvements
  - Changed API DMA\_SetupDMADescriptor to non-static.
  - Marked APIs below as deprecated.
    - \* DMA\_PrepareTransfer.
    - \* DMA\_Submit transfer.
  - Added new APIs as below:
    - \* DMA\_SetChannelConfig.
    - \* DMA\_PrepareChannelTransfer.
    - \* DMA\_InstallDescriptorMemory.
    - \* DMA\_SubmitChannelTransfer.
    - \* DMA\_SetChannelConfigValid.
    - \* DMA\_DoChannelSoftwareTrigger.
    - \* DMA\_LoadChannelTransferConfig.

**[2.0.1]**

- Improvements
  - Added volatile for DMA descriptor member xfercfg to avoid optimization.

**[2.0.0]**

- Initial version.
- 

**FTM****[2.7.2]**

- Improvements
  - Add API FTM\_ERRATA\_010856 for ERR010856 workaround.

**[2.7.1]**

- Bug Fixes
  - Added function macro when accsee FLTCTRL register FSTATE bit to prevent access nonexistent register.
  - Added function macro to prevent access nonexistent FTM channel for API FTM\_ConfigSinglePWM() and FTM\_ConfigCombinePWM().

## [2.7.0]

- Improvements
  - Support period dithering and edge dithering feature with new APIs:
    - \* FTM\_SetPeriodDithering()
    - \* FTM\_SetEdgeDithering()
  - Support get channel n output and input state feature with new APIs:
    - \* FTM\_GetChannelOutputState()
    - \* FTM\_GetChannelInputState()
  - Support configure deadtime for specific combined channel pair with new API:
    - \* FTM\_SetPairDeadTime()
  - Support filter clock prescale, fault output state.
  - Support new APIs to configure PWM and Modified Combine PWM:
    - \* FTM\_ConfigSinglePWM()
    - \* FTM\_ConfigCombinePWM()
  - Support new API to configure channel software output control:
    - \* FTM\_SetSoftwareOutputCtrl()
    - \* FTM\_GetSoftwareOutputValue()
    - \* FTM\_GetSoftwareOutputEnable()
  - Support new API to update FTM counter initial value, modulo value and chanle value:
    - \* FTM\_SetInitialModuloValue()
    - \* FTM\_SetChannelValue()

## [2.6.1]

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

## [2.6.0]

- Improvements
  - Added support to half and full cycle reload feature with new APIs:
    - \* FTM\_SetLdok()
    - \* FTM\_SetHalfCycPeriod()
    - \* FTM\_LoadFreq()
- Bug Fixes
  - Set the HWRSTCNT and SWRSTCNT bits to optional at initialization.



**[2.5.0]**

- Improvements
  - Added FTM\_CalculateCounterClkDiv to help calculates the counter clock prescaler.
  - Modify FTM\_UpdatePwmDutycycle API to make it return pwm duty cycles status.
- Bug Fixes
  - Fixed TPM\_SetupPwm can't configure 100% center align combined PWM issues.

**[2.4.1]**

- Bug Fixes
  - Added function macro to determine if FTM instance has only basic features, to prevent access to protected register bits.

**[2.4.0]**

- Improvements
  - Added CNTIN register initialization in FTM\_SetTimerPeriod API.
  - Added a new API to read the captured value of a FTM channel configured in capture mode:
    - \* FTM\_GetInputCaptureValue()

**[2.3.0]**

- Improvements
  - Added support of EdgeAligned/CenterAligned/Asymmetrical combine PWM mode in FTM\_SetupPWM() and FTM\_SetupPwmMode() APIs.
  - Remove kFTM\_ComplementaryPwm from support PWM mode, and add new parameter "enableComplementary" in structure ftm\_chnl\_pwm\_signal\_param\_t.
  - Rename FTM\_SetupFault() API to FTM\_SetupFaultInput() to avoid ambiguity.

**[2.2.3]**

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 14.4 and 17.7.

**[2.2.2]**

- Bug Fixes
  - Fixed the issue that when FTM instance has only TPM features cannot be initialized by FTM\_Init() function. By added function macro to assert FTM is TPM only instance.

**[2.2.1]**

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.1, 10.3, 10.4, 10.6, 10.7 and 11.9.

### [2.2.0]

- Bug Fixes
  - Fixed the issue of comparison between signed and unsigned integer expressions.
- Improvements
  - Added support of complementary mode in FTM\_SetupPWM() and FTM\_SetupPwmMode() APIs.
  - Added new parameter “enableDeadtime” in structure `ftm_chnl_pwm_signal_param_t`.

### [2.1.1]

- Bug Fixes
  - Fixed COVERITY integer handing issue where the right operand of a left bit shift statement should not be a negative value. This appears in FTM\_SetReloadPoints().

### [2.1.0]

- Improvements
  - Added a new API FTM\_SetupPwmMode() to allow the user to set the channel match value in units of timer ticks. New configure structure called `ftm_chnl_pwm_config_param_t` was added to configure the channel’s PWM parameters. This API is similar with FTM\_SetupPwm() API, but the new API will not set the timer period(MOD value), it will be useful for users to set the PWM parameters without changing the timer period.
- Bug Fixes
  - Added feature macro to enable/disable the external trigger source configuration.

### [2.0.4]

- Improvements
  - Added a new API to enable DMA transfer:
    - \* FTM\_EnableDmaTransfer()

### [2.0.3]

- Bug Fixes
  - Updated the FTM driver to enable fault input after configuring polarity.

### [2.0.2]

- Improvements
  - Added support to Quad Decoder feature with new APIs:
    - \* FTM\_GetQuadDecoderFlags()
    - \* FTM\_SetQuadDecoderModuloValue()
    - \* FTM\_GetQuadDecoderCounterValue()
    - \* FTM\_ClearQuadDecoderCounterValue()

**[2.0.1]**

- Bug Fixes
  - Updated the FTM driver to fix write to ELSA and ELSB bits.
  - FTM combine mode: set the COMBINE bit before writing to CnV register.

**[2.0.0]**

- Initial version.
- 

**GPIO****[2.1.7]**

- Improvements
  - Enhanced GPIO\_PinInit to enable clock internally.

**[2.1.6]**

- Bug Fixes
  - Clear bit before set it within GPIO\_SetPinInterruptConfig() API.

**[2.1.5]**

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 10.6, 10.7, 17.7.

**[2.1.4]**

- Improvements
  - Added API GPIO\_PortGetInterruptStatus to retrieve interrupt status for whole port.
  - Corrected typos in header file.

**[2.1.3]**

- Improvements
  - Updated “GPIO\_PinInit” API. If it has DIRCLR and DIRSET registers, use them at set 1 or clean 0.

**[2.1.2]**

- Improvements
  - Removed deprecated APIs.

### [2.1.1]

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

### [2.1.0]

- New Features
  - Added GPIO initialize API.

### [2.0.0]

- Initial version.
- 

## I2C

### [2.2.1]

- Bug Fixes
  - Fixed coverity issues.

### [2.2.0]

- Removed `lpc_i2c_dma` driver.

### [2.1.0]

- Bug Fixes
  - Fixed MISRA 8.6 violations.

### [2.0.4]

- Bug Fixes
  - Fixed wrong assignment for `datasize` in `I2C_InitTransferStateMachineDMA`.
  - Fixed wrong working flow in `I2C_RunTransferStateMachineDMA` to ensure master can work in no start flag and no stop flag mode.
  - Fixed wrong working flow in `I2C_RunTransferStateMachine` and added `kReceiveDataBeginState` in `_i2c_transfer_states` to ensure master can work in no start flag and no stop flag mode.
  - Fixed wrong handle state in `I2C_MasterTransferDMAHandleIRQ`. After all the data has been transferred or nak is returned, handle state should be changed to idle.
  - Eliminated IAR Pa082 warning in `I2C_SlaveTransferHandleIRQ` by assigning volatile variable to local variable and using local variable instead.
  - Fixed MISRA issues.
    - \* Fixed rules 4.7, 10.1, 10.3, 10.4, 11.1, 11.8, 14.4, 17.7.

- Improvements
  - Rounded up the calculated divider value in I2C\_MasterSetBaudRate.
  - Updated the I2C\_WAIT\_TIMEOUT macro to unified name I2C\_RETRY\_TIMES.

#### [2.0.3]

- Bug Fixes
  - Fixed Coverity issue of unchecked return value in I2C\_RTOS\_Transfer.

#### [2.0.2]

- New Features
  - Added macro gate “FSL\_SDK\_ENABLE\_I2C\_DRIVER\_TRANSACTIONAL\_APIS” to enable/disable the transactional APIs which will help reduce the code size when no non-blocking transfer is used. Default configuration is enabled.
  - Added a control macro to enable/disable the RESET and CLOCK code in current driver.

#### [2.0.1]

- Improvements
  - Added I2C\_WAIT\_TIMEOUT macro to allow the user to specify the timeout times for waiting flags in functional API and blocking transfer API.

#### [2.0.0]

- Initial version.
- 

## I3C

#### [2.14.2]

- Improvements
  - Added timeout for ENTDA process API.
  - Added build system macro to control the timeout setting.

#### [2.14.1]

- Improvements
  - Split the function I3C\_MasterTransferBlocking to meet the HIS-CCM requirement.

#### [2.14.0]

- Improvements
  - Added the choice to set fast start header with push-pull speed when all targets addresses have MSB 0 instead of forcing to set it.
  - Deleted duplicated busy check in I3C\_MasterStart function.

### [2.13.1]

- Bug Fixes
  - Disabled Rx auto-termination in repeated start interrupt event while transfer API doesn't enable it.
  - Waited the completion event after loading all Tx data in Tx FIFO.
- 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]

- New features
  - Added the hot-join support for I3C bus initialization API.
- Bug Fixes
  - Set read termination with START at the same time in case unknown issue.
  - Set MCTRL[TYPE] as 0 for DDR force exit.
- Improvements
  - Added the API to reset device count assigned by ENTDAAs.
  - Provided the method to set global macro I3C\_MAX\_DEVCNT to determine how many device addresses ENTDAAs can allocate at one time.
  - Initialized target management static array based on instance number for the case that multiple instances are used at the same time.

### [2.12.0]

- Improvements
  - Added the slow clock parameter for Controller initialization function to calculate accurate timeout.
- Bug Fixes
  - Fixed the issue that BAMATCH field can't be 0. BAMATCH should be 1 for 1MHz slow clock.

### [2.11.1]

- Bug Fixes
  - Fixed the issue that interrupt API transmits extra byte when subaddress and data size are null.
  - Fixed the slow clock calculation issue.

### [2.11.0]

- New features
  - Added the START/ReSTART SCL delay setting for the Soc which supports this feature.
- Bug Fixes
  - Fixed the issue that ENTDAAs process waits Rx pending flag which causes problem when Rx watermark isn't 0. Just check the Rx FIFO count.

**[2.10.8]**

- Improvements
  - Support more instances.

**[2.10.7]**

- Improvements
  - Fixed the potential compile warning.

**[2.10.6]**

- New features
  - Added the I3C private read/write with 0x7E address as start.

**[2.10.5]**

- New features
  - Added I3C HDR-DDR transfer support.

**[2.10.4]**

- Improvements
  - Added one more option for master to not set RDTERM when doing I3C Common Command Code transfer.

**[2.10.3]**

- Improvements
  - Masked the slave IBI/MR/HJ request functions with feature macro.

**[2.10.2]**

- Bug Fixes
  - Added workaround for errata ERR051617: I3C working with I2C mode creates the unintended Repeated START before actual STOP on some platforms.

**[2.10.1]**

- Bug Fixes
  - Fixed the issue that DAA function doesn't wait until all Rx data is read out from FIFO after master control done flag is set.
  - Fixed the issue that DAA function could return directly although the disabled interrupts are not enabled back.

**[2.10.0]**

- New features
  - Added I3C extended IBI data support.



#### [2.9.0]

- Improvements
  - Added adaptive termination for master blocking transfer. Set termination with start signal when receiving bytes less than 256.

#### [2.8.2]

- Improvements
  - Fixed the build warning due to armgcc strict check.

#### [2.8.1]

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

#### [2.8.0]

- Improvements
  - Added API I3C\_MasterProcessDAASpecifiedBaudrate for temporary baud rate adjustment when I3C master assigns dynamic address.

#### [2.7.1]

- Bug Fixes
  - Fixed the issue that I3C slave handle STOP event before finishing data transmission.

#### [2.7.0]

- Fixed the CCM problem in file fsl\_i3c.c.
- Fixed the FSL\_FEATURE\_I3C\_HAS\_NO\_SCONFIG\_IDRAND usage issue in I3C\_GetDefaultConfig and I3C\_Init.

#### [2.6.0]

- Fixed the FSL\_FEATURE\_I3C\_HAS\_NO\_SCONFIG\_IDRAND usage issue in fsl\_i3c.h.
- Changed some static functions in fsl\_i3c.c as non-static and define the functions in fsl\_i3c.h to make I3C DMA driver reuse:
  - I3C\_GetIBIType
  - I3C\_GetIBIAddress
  - I3C\_SlaveCheckAndClearError
- Changed the handle pointer parameter in IRQ related functions to void \* type to make it reuse in I3C DMA driver.
- Added new API I3C\_SlaveRequestIBIWithSingleData for slave to request single data byte, this API could be used regardless slave is working in non-blocking interrupt or non-blocking dma.
- Added new API I3C\_MasterGetDeviceListAfterDAA for master application to get the device information list built up in DAA process.

**[2.5.4]**

- Improved I3C driver to avoid setting state twice in the SendCommandState of I3C\_RunTransferStateMachine.
- Fixed MISRA violation of rule 20.9.
- Fixed the issue that I3C\_MasterEmitRequest did not use Type I3C SDR.

**[2.5.3]**

- Updated driver for new feature FSL\_FEATURE\_I3C\_HAS\_NO\_SCONFIG\_BAMATCH and FSL\_FEATURE\_I3C\_HAS\_NO\_SCONFIG\_IDRAND.

**[2.5.2]**

- Updated driver for new feature FSL\_FEATURE\_I3C\_HAS\_NO\_MERRWARN\_TERM.
- Fixed the issue that call to I3C\_MasterTransferBlocking API did not generate STOP signal when NAK status was returned.

**[2.5.1]**

- Improved the receive terminate size setting for interrupt transfer read, now it's set at beginning of transfer if the receive size is less than 256 bytes.

**[2.5.0]**

- Added new API I3C\_MasterRepeatedStartWithRxSize to send repeated start signal with receive terminate size specified.
- Fixed the status used in I3C\_RunTransferStateMachine, changed to use pending interrupts as status to be handled in the state machine.
- Fixed MISRA 2012 violation of rule 10.3, 10.7.

**[2.4.0]**

- Bug Fixes
  - Fixed kI3C\_SlaveMatchedFlag interrupt is not properly handled in I3C\_SlaveTransferHandleIRQ when it comes together with interrupt kI3C\_SlaveBusStartFlag.
  - Fixed the inaccurate I2C baudrate calculation in I3C\_MasterSetBaudRate.
  - Added new API I3C\_MasterGetIBIRules to get registered IBI rules.
  - Added new variable isReadTerm in struct\_i3c\_master\_handle for transfer state routine to check if MCTRL.RDTERM is configured for read transfer.
  - Changed to emit Auto IBI in transfer state routine for slave start flag assertion.
  - Fixed the slave maxWriteLength and maxReadLength does not be configured into SMAXLIMITS register issue.
  - Fixed incorrect state for IBI in I3C master interrupt transfer IRQ handle routine.
  - Added isHotJoin in i3c\_slave\_config\_t to request hot-join event during slave init.

### [2.3.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 8.4, 17.7.
  - Fixed incorrect HotJoin event index in I3C\_GetIBIType.

### [2.3.1]

- Bug Fixes
  - Fixed the issue that call of I3C\_MasterTransferBlocking/I3C\_MasterTransferNonBlocking fails for the case which receive length 1 byte of data.
  - Fixed the issue that STOP signal is not sent when NAK status is detected during execution of I3C\_MasterTransferBlocking function.

### [2.3.0]

- Improvements
  - Added I3C common driver APIs to initialize I3C with both master and slave configuration.
  - Updated I3C master transfer callback to function set structure to include callback invoke for IBI event and slave2master event.
  - Updated I3C master non-blocking transfer model and always enable the interrupts to be able to re-act to the slave start event and handle slave IBI.

### [2.2.0]

- Bug Fixes
  - Fixed the issue that I3C transfer size limit to 255 bytes.

### [2.1.2]

- Bug Fixes
  - Reset default hkeep value to kI3C\_MasterHighKeeperNone in I3C\_MasterGetDefaultConfig

### [2.1.1]

- Bug Fixes
  - Fixed incorrect FIFO reset operation in I3C Master Transfer APIs.
  - Fixed i3c slave IRQ handler issue, slave transmit could be underrun because tx FIFO is not filled in time right after start flag detected.

### [2.1.0]

- Added definitions and APIs for I3C slave functionality, updated previous I3C APIs to support I3C functionality.

**[2.0.0]**

- Initial version.
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**I3C\_DMA****[2.1.8]**

- Bug Fixes
  - Updated the logic to handle Rx termination and complete event to adapt different situation.
- Improvements
  - Added the MCTRLDONE flag check after STOP request to ensure the completion of whole transfer operation.

**[2.1.7]**

- Bug Fixes
  - Fixed the issue to use subaddress to read/write data with RT500/600 DMA.

**[2.1.6]**

- Improvements
  - Added the FSL\_FEATURE\_I3C\_HAS\_NO\_MASTER\_DMA\_WDATA\_REG to select the correct register to write data based on specific Soc.

**[2.1.5]**

- New features
  - Supported I3C HDR-DDR transfer with DMA.
- Improvements
  - Added workaround for RT500/600 I3C DMA transfer.
  - Removed I3C IRQ handler calling in the Tx EDMA callback. Previously driver doesn't use the END byte which can trigger the complete interrupt for controller sending and receiving, now let I3C event handler deal with I3C events.
  - Used linked DMA to transfer all I3C subaddress and data without handling of intermediate states, simplifying code logic.
  - Prepare the Tx DMA before I3C START to ensure there's no time delay between START and transmitting data.

**[2.1.4]**

- Improvements
  - Used linked DMA transfer to reduce the latency between DMA transfers previous data and the END byte.

#### [2.1.3]

- Bug Fixes
  - Fixed the MISRA issue rule 10.4, 11.3.

#### [2.1.2]

- Bug Fixes
  - Fixed the issue that I3C slave send the last byte data without using the END type register.

#### [2.1.1]

- Bug Fixes
  - Fixed MISRA issue rule 9.1.

#### [2.1.0]

- Improvements
  - Deleted legacy IBI data request code.

#### [2.0.1]

- Bug Fixes
  - Fixed issue that bus STOP occurs when Tx FIFO still takes data.
- Improvements
  - Fixed the build warning due to armgcc strict check.

#### [2.0.0]

- Initial version.
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## IAP

#### [2.0.7]

- Bug Fixes
  - Fixed IAP\_ReinvokeISP bug that can't support UART ISP auto baud detection.

#### [2.0.6]

- Bug Fixes
  - Fixed IAP\_ReinvokeISP wrong parameter setting.

#### [2.0.5]

- New Feature
  - Added support config flash memory access time.

**[2.0.4]**

- Bug Fixes
  - Fixed the violations of MISRA 2012 rules 9.1

**[2.0.3]**

- New Features
  - Added support for LPC 845's FAIM operation.
  - Added support for LPC 80x's fixed reference clock for flash controller.
  - Added support for LPC 5411x's Read UID command useless situation.
- Improvements
  - Improved the document and code structure.
- Bug Fixes
  - Fixed the violations of MISRA 2012 rules:
    - \* Rule 10.1 10.3 10.4 17.7

**[2.0.2]**

- New Features
  - Added an API to read generated signature.
- Bug Fixes
  - Fixed the incorrect board support of IAP\_ExtendedFlashSignatureRead().

**[2.0.1]**

- New Features
  - Added an API to read factory settings for some calibration registers.
- Improvements
  - Updated the size of result array in part APIs.

**[2.0.0]**

- Initial version.
- 

**INPUTMUX****[2.0.9]**

- Improvements
  - Use INPUTMUX\_CLOCKS to initialize the inputmux module clock to adapt to multiple inputmux instances.
  - Modify the API base type from INPUTMUX\_Type to void.

#### [2.0.8]

- Improvements
  - Updated a feature macro usage for function INPUTMUX\_EnableSignal.

#### [2.0.7]

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

#### [2.0.6]

- Bug Fixes
  - Fixed the documentation wrong in API INPUTMUX\_AttachSignal.

#### [2.0.5]

- Bug Fixes
  - Fixed build error because some devices has no sct.

#### [2.0.4]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rule 10.4, 12.2 in INPUTMUX\_EnableSignal() function.

#### [2.0.3]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.4, 10.7, 12.2.

#### [2.0.2]

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

#### [2.0.1]

- Support channel mux setting in INPUTMUX\_EnableSignal().

#### [2.0.0]

- Initial version.
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## IOCON

#### [2.0.2]

- Bug Fixes
  - Fixed MISRA-C 2012 violations.



**[2.0.1]**

- Bug Fixes
  - Fixed out-of-range issue of the IOCON mode function when enabling DAC.

**[2.0.0]**

- Initial version.
- 

**MRT****[2.0.5]**

- Bug Fixes
  - Fixed CERT INT31-C violations.

**[2.0.4]**

- Improvements
  - Don't reset MRT when there is not system level MRT reset functions.

**[2.0.3]**

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1 and 10.4.
  - Fixed the wrong count value assertion in MRT\_StartTimer API.

**[2.0.2]**

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

**[2.0.1]**

- Added control macro to enable/disable the RESET and CLOCK code in current driver.

**[2.0.0]**

- Initial version.
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## PINT

### [2.2.0]

- Fixed
  - Fixed the issue that clear interrupt flag when it's not handled. This causes events to be lost.
- Changed
  - Used one callback for one PINT instance. It's unnecessary to provide different callbacks for all PINT events.

### [2.1.13]

- Improvements
  - Added instance array for PINT to adapt more devices.
  - Used release reset instead of reset PINT which may clear other related registers out of PINT.

### [2.1.12]

- Bug Fixes
  - Fixed coverity issue.

### [2.1.11]

- Bug Fixes
  - Fixed MISRA C-2012 rule 10.7 violation.

### [2.1.10]

- New Features
  - Added the driver support for MCXN10 platform with combined interrupt handler.

### [2.1.9]

- Bug Fixes
  - Fixed MISRA-2012 rule 8.4.

### [2.1.8]

- Bug Fixes
  - Fixed MISRA-2012 rule 10.1 rule 10.4 rule 10.8 rule 18.1 rule 20.9.

### [2.1.7]

- Improvements
  - Added fully support for the SECPINT, making it can be used just like PINT.

**[2.1.6]**

- Bug Fixes
  - Fixed the bug of not enabling common pint clock when enabling security pint clock.

**[2.1.5]**

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - \* Fixed rule 10.1 rule 10.3 rule 10.4 rule 10.8 rule 14.4.
  - Changed interrupt init order to make pin interrupt configuration more reasonable.

**[2.1.4]**

- Improvements
  - Added feature to control distinguish PINT/SECPINT relevant interrupt/clock configurations for PINT\_Init and PINT\_Deinit API.
  - Swapped the order of clearing PIN interrupt status flag and clearing pending NVIC interrupt in PINT\_EnableCallback and PINT\_EnableCallbackByIndex function.
- Bug Fixes
  - \* Fixed build issue caused by incorrect macro definitions.

**[2.1.3]**

- Bug fix:
  - Updated PINT\_PinInterruptClrStatus to clear PINT interrupt status when the bit is asserted and check whether was triggered by edge-sensitive mode.
  - Write 1 to IST corresponding bit will clear interrupt status only in edge-sensitive mode and will switch the active level for this pin in level-sensitive mode.
  - Fixed MISRA c-2012 rule 10.1, rule 10.6, rule 10.7.
  - Added FSL\_FEATURE\_SECPINT\_NUMBER\_OF\_CONNECTED\_OUTPUTS to distinguish IRQ relevant array definitions for SECPINT/PINT on lpc55s69 board.
  - Fixed PINT driver c++ build error and remove index offset operation.

**[2.1.2]**

- Improvement:
  - Improved way of initialization for SECPINT/PINT in PINT\_Init API.

**[2.1.1]**

- Improvement:
  - Enabled secure pint interrupt and add secure interrupt handle.

**[2.1.0]**

- Added PINT\_EnableCallbackByIndex/PINT\_DisableCallbackByIndex APIs to enable/disable callback by index.

#### [2.0.2]

- Added control macro to enable/disable the RESET and CLOCK code in current driver.

#### [2.0.1]

- Bug fix:
  - Updated PINT driver to clear interrupt only in Edge sensitive.

#### [2.0.0]

- Initial version.
- 

### POWER

#### [2.1.0]

- initial version.
- 

### RESET

#### [2.4.0]

- Improvements
  - Add RESET\_ReleasePeripheralReset API.

#### [2.0.0]

- initial version.
- 

### SPI

#### [2.0.8]

- Bug Fixes
  - Fixed coverity issue.

#### [2.0.7]

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

#### [2.0.6]

- Improvements
  - Changed SPI\_DUMMYDATA to 0x00.

**[2.0.5]**

- Bug Fixes
  - Fixed bug that the transfer configuration does not take effect after the first transfer.

**[2.0.4]**

- Bug Fixes
  - Fixed the issue that when transfer finish callback is invoked TX data is not sent to bus yet.

**[2.0.3]**

- Improvements
  - Added timeout mechanism when waiting certain states in transfer driver.
  - Fixed MISRA 10.4 issue.

**[2.0.2]**

- Bug Fixes
  - Fixed Coverity issue of incrementing null pointer in SPI\_MasterTransferNonBlocking.
  - Fixed MISRA issues.
    - \* Fixed rules 10.1, 10.3, 10.4, 10.6, 14.4.
- New Features
  - Added enumeration for dataWidth.

**[2.0.1]**

- Bug Fixes
  - Added wait mechanism in SPI\_MasterTransferBlocking() API, which checks if master SPI becomes IDLE when the EOT bit is set before returning. This confirms that all data will be sent out by SPI master.
  - Fixed the bug that the EOT bit couldn't be set when only one frame was sent in polling mode and interrupt transfer mode.
- New Features
  - Added macro gate "FSL\_SDK\_ENABLE\_SPI\_DRIVER\_TRANSACTIONAL\_APIS" to enable/disable the transactional APIs, which helps reduce the code size when no non-blocking transfer is used. Enabled default configuration.
  - Added a control macro to enable/disable the RESET and CLOCK code in current driver.

**[2.0.0]**

- Initial version.
-

## SWM

### [2.1.2]

- Improvements
  - Reduce RAM footprint.

### [2.1.1]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.1 and 10.3.

### [2.1.0]

- New Features
  - Supported Flextimer function pin assign.

### [2.0.2]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 14.3.

### [2.0.1]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.1, 10.3, and 10.4.

### [2.0.0]

- Initial version.
  - The API `SWM_SetFixedMovablePinSelect()` is targeted at the device that has `PINASSIGN-FIXED0` register, such as LPC804.
- 

## SYSCON

### [2.0.1]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - \* Fixed rule 10.4.

### [2.0.0]

- Initial version.
-

## USART

### [2.5.2]

- Improvements
  - Fixed coverity issues.

### [2.5.1]

- Improvements
  - Fixed doxygen warning in USART\_SetRxIdleTimeout.

### [2.5.0]

- New Features
  - Supported new feature of rx idle timeout.

### [2.4.0]

- Improvements
  - Used separate data for TX and RX in usart\_transfer\_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling USART\_TransferReceiveNonBlocking, the received data count returned by USART\_TransferGetReceiveCount is wrong.

### [2.3.0]

- New Features
  - Modified usart\_config\_t, USART\_Init and USART\_GetDefaultConfig APIs so that the hardware flow control can be enabled during module initialization.

### [2.2.0]

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

### [2.1.1]

- Bug Fixes
  - Fixed the bug that in USART\_SetBaudRate best\_diff rather than diff should be used to compare with calculated baudrate.
  - Eliminated IAR pa082 warnings from USART\_TransferGetRxRingBufferLength and USART\_TransferHandleIRQ.
  - Fixed MISRA issues.
- Improvements
  - Rounded up the calculated sbr value in USART\_SetBaudRate to achieve more accurate baudrate setting.

- Modified USART\_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.

#### [2.1.0]

- New Features
  - Added new APIs to allow users to configure the USART continuous SCLK feature in synchronous mode transfer.

#### [2.0.1]

- Bug Fixes
  - Fixed the repeated reading issue of the STAT register while dealing with the IRQ routine.
- New Features
  - Added macro gate “FSL\_SDK\_ENABLE\_USART\_DRIVER\_TRANSACTIONAL\_APIS” to enable/disable the transactional APIs, which helps reduce the code size when no non-blocking transfer is used. Enabled default configuration.
  - Added a control macro to enable/disable the RESET and CLOCK code in current driver.
  - Added macro switch gate “FSL\_SDK\_USART\_DRIVER\_ENABLE\_BAUDRATE\_AUTO\_GENERATE” to enable/disable the baud rate to generate automatically. Disabling this feature will help reduce the code size to a certain degree. Default configuration enables auto generating of baud rate.
  - Added the check of baud rate while initializing the USART. If the baud rate calculated is not precise, the software assertion will be triggered.
  - Added a new API to allow users to enable the CTS, which determines whether CTS is used for flow control.

#### [2.0.0]

- Initial version.
- 

### WKT

#### [2.0.2]

- Bug Fixes
  - Fixed violation of MISRA C-2012 rule 10.3.

#### [2.0.1]

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

#### [2.0.0]

- Initial version.
-



## WWDT

### [2.1.10]

- Bug Fixes
  - Check WWDT\_RSTS instead of FSL\_FEATURE\_WWDT\_HAS\_NO\_RESET to determine whether the peripheral can be reset.

### [2.1.9]

- Bug Fixes
  - Fixed violation of the MISRA C-2012 rule 10.4.

### [2.1.8]

- Improvements
  - Updated the “WWDT\_Init” API to add wait operation. Which can avoid the TV value read by CPU still be 0xFF (reset value) after WWDT\_Init function returns.

### [2.1.7]

- Bug Fixes
  - Fixed the issue that the watchdog reset event affected the system from PMC.
  - Fixed the issue of setting watchdog WDPROTECT field without considering the backwards compatibility.
  - Fixed the issue of clearing bit fields by mistake in the function of WWDT\_ClearStatusFlags.

### [2.1.5]

- Bug Fixes
  - deprecated a unusable API in WWWDWT driver.
    - \* WWDT\_Disable

### [2.1.4]

- Bug Fixes
  - Fixed violation of the MISRA C-2012 rules Rule 10.1, 10.3, 10.4 and 11.9.
  - Fixed the issue of the inseparable process interrupted by other interrupt source.
    - \* WWDT\_Init

### [2.1.3]

- Bug Fixes
  - Fixed legacy issue when initializing the MOD register.

### [2.1.2]

- Improvements
  - Updated the “WWDT\_ClearStatusFlags” API and “WWDT\_GetStatusFlags” API to match QN9090. WDTOF is not set in case of WD reset. Get info from PMC instead.

### [2.1.1]

- New Features
  - Added new feature definition macro for devices which have no LCOK control bit in MOD register.
  - Implemented delay/retry in WWDT driver.

### [2.1.0]

- Improvements
  - Added new parameter in configuration when initializing WWDT module. This parameter, which must be set, allows the user to deliver the WWDT clock frequency.

### [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.

[LPC865](#)

## 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 FreeMASTER

[freemaster](#)

### 1.7.2 FreeRTOS

[FreeRTOS](#)

# Chapter 2

## LPC865

### 2.1 Clock Driver

enum \_clock\_ip\_name

Clock gate name used for CLOCK\_EnableClock/CLOCK\_DisableClock.

*Values:*

enumerator kCLOCK\_IpInvalid

Invalid Ip Name.

enumerator kCLOCK\_Rom

Clock gate name: Rom.

enumerator kCLOCK\_Ram0\_1

Clock gate name: Ram0\_1.

enumerator kCLOCK\_I2c0

Clock gate name: I2c0.

enumerator kCLOCK\_Gpio0

Clock gate name: Gpio0.

enumerator kCLOCK\_Swm

Clock gate name: Swm.

enumerator kCLOCK\_Wkt

Clock gate name: Wkt.

enumerator kCLOCK\_Mrt

Clock gate name: Mrt.

enumerator kCLOCK\_Spi0

Clock gate name: Spi0.

enumerator kCLOCK\_Spi1

Clock gate name: Spi1.

enumerator kCLOCK\_Crc

Clock gate name: Crc.

enumerator kCLOCK\_Uart0

Clock gate name: Uart0.

enumerator kCLOCK\_Uart1  
Clock gate name: Uart1.

enumerator kCLOCK\_Uart2  
Clock gate name: Uart2.

enumerator kCLOCK\_Wwdt  
Clock gate name: Wwdt.

enumerator kCLOCK\_Iocon  
Clock gate name: Iocon.

enumerator kCLOCK\_Acmp  
Clock gate name: Acmp.

enumerator kCLOCK\_Gpio1  
Clock gate name: Gpio1.

enumerator kCLOCK\_Ftm0  
Clock gate name: Ftm0.

enumerator kCLOCK\_Ftm1  
Clock gate name: Ftm1.

enumerator kCLOCK\_I3c0  
Clock gate name: I3c0.

enumerator kCLOCK\_Adc  
Clock gate name: Adc.

enumerator kCLOCK\_GpioInt  
Clock gate name: GpioInt.

enumerator kCLOCK\_Dma  
Clock gate name: Dma.

enum \_clock\_name

Clock name used to get clock frequency.

*Values:*

enumerator kCLOCK\_CoreSysClk  
Cpu/AHB/AHB matrix/Memories,etc

enumerator kCLOCK\_MainClk  
Main clock

enumerator kCLOCK\_Fro  
FRO18/24/30

enumerator kCLOCK\_FroDiv  
FRO div clock

enumerator kCLOCK\_ExtClk  
External Clock

enumerator kCLOCK\_PllOut  
PLL Output

enumerator kCLOCK\_LpOsc  
Low power Oscillator

enumerator kCLOCK\_Frg0  
fractional rate0

enumerator kCLOCK\_Frg1  
fractional rate1

enum \_\_clock\_select

Clock Mux Switches CLK\_MUX\_DEFINE(reg, mux) reg is used to define the mux register mux is used to define the mux value.

*Values:*

enumerator kADC\_Clk\_From\_Fro  
Mux ADC\_Clk from Fro.

enumerator kADC\_Clk\_From\_SysPll\_DIV  
Mux ADC\_Clk from SysPllDiv.

enumerator kEXT\_Clk\_From\_SysOsc  
Mux EXT\_Clk from SysOsc.

enumerator kEXT\_Clk\_From\_ClkIn  
Mux EXT\_Clk from ClkIn.

enumerator kUART0\_Clk\_From\_Fro  
Mux UART0\_Clk from Fro.

enumerator kUART0\_Clk\_From\_MainClk  
Mux UART0\_Clk from MainClk.

enumerator kUART0\_Clk\_From\_Frg0Clk  
Mux UART0\_Clk from Frg0Clk.

enumerator kUART0\_Clk\_From\_Frg1Clk  
Mux UART0\_Clk from Frg1Clk.

enumerator kUART0\_Clk\_From\_Fro\_Div  
Mux UART0\_Clk from Fro\_Div.

enumerator kUART1\_Clk\_From\_Fro  
Mux UART1\_Clk from Fro.

enumerator kUART1\_Clk\_From\_MainClk  
Mux UART1\_Clk from MainClk.

enumerator kUART1\_Clk\_From\_Frg0Clk  
Mux UART1\_Clk from Frg0Clk.

enumerator kUART1\_Clk\_From\_Frg1Clk  
Mux UART1\_Clk from Frg1Clk.

enumerator kUART1\_Clk\_From\_Fro\_Div  
Mux UART1\_Clk from Fro\_Div.

enumerator kUART2\_Clk\_From\_Fro  
Mux UART2\_Clk from Fro.

enumerator kUART2\_Clk\_From\_MainClk  
Mux UART2\_Clk from MainClk.

enumerator kUART2\_Clk\_From\_Frg0Clk  
Mux UART2\_Clk from Frg0Clk.

enumerator kUART2\_Clk\_From\_Frg1Clk  
Mux UART2\_Clk from Frg1Clk.

enumerator kUART2\_Clk\_From\_Fro\_Div  
Mux UART2\_Clk from Fro\_Div.

enumerator kI2C0\_Clk\_From\_Fro  
Mux I2C0\_Clk from Fro.

enumerator kI2C0\_Clk\_From\_MainClk  
Mux I2C0\_Clk from MainClk.

enumerator kI2C0\_Clk\_From\_Frg0Clk  
Mux I2C0\_Clk from Frg0Clk.

enumerator kI2C0\_Clk\_From\_Frg1Clk  
Mux I2C0\_Clk from Frg1Clk.

enumerator kI2C0\_Clk\_From\_Fro\_Div  
Mux I2C0\_Clk from Fro\_Div.

enumerator kI3C\_Clk\_From\_Fro  
Mux I3C\_Clk from Fro.

enumerator kI3C\_Clk\_From\_ExtClk  
Mux I3C\_Clk from ExtClk.

enumerator kI3C\_TC\_Clk\_From\_I3C\_Clk  
Mux I3C\_TC\_Clk from I3C\_Clk.

enumerator kI3C\_TC\_Clk\_From\_LpOsc  
Mux I3C\_TC\_Clk from LpOsc.

enumerator kSPI0\_Clk\_From\_Fro  
Mux SPI0\_Clk from Fro.

enumerator kSPI0\_Clk\_From\_MainClk  
Mux SPI0\_Clk from MainClk.

enumerator kSPI0\_Clk\_From\_Frg0Clk  
Mux SPI0\_Clk from Frg0Clk.

enumerator kSPI0\_Clk\_From\_Frg1Clk  
Mux SPI0\_Clk from Frg1Clk.

enumerator kSPI0\_Clk\_From\_Fro\_Div  
Mux SPI0\_Clk from Fro\_Div.

enumerator kSPI1\_Clk\_From\_Fro  
Mux SPI1\_Clk from Fro.

enumerator kSPI1\_Clk\_From\_MainClk  
Mux SPI1\_Clk from MainClk.

enumerator kSPI1\_Clk\_From\_Frg0Clk  
Mux SPI1\_Clk from Frg0Clk.

enumerator kSPI1\_Clk\_From\_Frg1Clk  
Mux SPI1\_Clk from Frg1Clk.

enumerator kSPI1\_Clk\_From\_Fro\_Div  
Mux SPI1\_Clk from Fro\_Div.

enumerator kFRG0\_Clk\_From\_Fro  
Mux FRG0\_Clk from Fro.

enumerator kFRG0\_Clk\_From\_MainClk  
Mux FRG0\_Clk from MainClk.

enumerator kFRG0\_Clk\_From\_SysPll\_DIV  
Mux FRG0\_Clk from SysPllDiv.

enumerator kFRG1\_Clk\_From\_Fro  
Mux FRG1\_Clk from Fro.

enumerator kFRG1\_Clk\_From\_MainClk  
Mux FRG1\_Clk from MainClk.

enumerator kFRG1\_Clk\_From\_SysPll\_DIV  
Mux FRG1\_Clk from SysPllDiv.

enumerator kCLKOUT\_From\_Fro  
Mux CLKOUT from Fro.

enumerator kCLKOUT\_From\_MainClk  
Mux CLKOUT from MainClk.

enumerator kCLKOUT\_From\_SysPll\_DIV  
Mux CLKOUT from SysPllDiv.

enumerator kCLKOUT\_From\_ExtClk  
Mux CLKOUT from ExtClk.

enumerator kCLKOUT\_From\_LpOsc  
Mux CLKOUT from LpOsc.

enumerator kWKT\_Clk\_From\_Fro  
Mux Wkt\_Clk from FroOsc.

enumerator kWKT\_Clk\_From\_LpOsc  
Mux Wkt\_Clk from LpOsc.

enum \_clock\_divider

Clock divider.

*Values:*

enumerator kCLOCK\_DivPllClk  
Pll Clock Divider.

enumerator kCLOCK\_DivAdcClk  
Adc Clock Divider.

enumerator kCLOCK\_DivClkOut  
Clk Out Divider.

enumerator kCLOCK\_IOCONCLKDiv6  
IOCON Clock Div6 Divider.

enumerator kCLOCK\_IOCONCLKDiv5  
IOCON Clock Div5 Divider.

enumerator kCLOCK\_IOCONCLKDiv4  
IOCON Clock Div4 Divider.

enumerator kCLOCK\_IOCONCLKDiv3  
IOCON Clock Div3 Divider.

enumerator kCLOCK\_IOCONCLKDiv2  
IOCON Clock Div2 Divider.

enumerator kCLOCK\_IOCONCLKDiv1  
IOCON Clock Div1 Divider.

enumerator kCLOCK\_IOCONCLKDiv0  
IOCON Clock Div0 Divider.

enum \_clock\_fro\_src  
fro output frequency source definition

*Values:*

enumerator kCLOCK\_FroSrcFroOscDiv  
fro source from the fro oscillator divided by 2

enumerator kCLOCK\_FroSrcFroOsc  
fre source from the fro oscillator directly

enum \_clock\_fro\_osc\_freq  
fro oscillator output frequency value definition

*Values:*

enumerator kCLOCK\_FroOscOut36M  
FRO oscillator output 36M

enumerator kCLOCK\_FroOscOut48M  
FRO oscillator output 48M

enumerator kCLOCK\_FroOscOut60M  
FRO oscillator output 60M

enum \_clock\_sys\_pll\_src  
PLL clock definition.

*Values:*

enumerator kCLOCK\_SysPllSrcFRO  
system pll source from FRO

enumerator kCLOCK\_SysPllSrcExtClk  
system pll source from external clock

enumerator kCLOCK\_SysPllSrcLpOsc  
system pll source from Low power oscillator

enumerator kCLOCK\_SysPllSrcFroDiv  
system pll source from FRO divided clock

enum \_clock\_main\_clk\_src  
Main clock source definition.

*Values:*

enumerator kCLOCK\_MainClkSrcFro  
main clock source from FRO

enumerator kCLOCK\_MainClkSrcExtClk  
main clock source from Ext clock



enumerator kCLOCK\_MainClkSrcLpOsc  
main clock source from Low power oscillator

enumerator kCLOCK\_MainClkSrcFroDiv  
main clock source from FRO Div

enumerator kCLOCK\_MainClkSrcSysPll  
main clock source from system pll

typedef enum *\_clock\_ip\_name* clock\_ip\_name\_t  
Clock gate name used for CLOCK\_EnableClock/CLOCK\_DisableClock.

typedef enum *\_clock\_name* clock\_name\_t  
Clock name used to get clock frequency.

typedef enum *\_clock\_select* clock\_select\_t  
Clock Mux Switches CLK\_MUX\_DEFINE(reg, mux) reg is used to define the mux register mux is used to define the mux value.

typedef enum *\_clock\_divider* clock\_divider\_t  
Clock divider.

typedef enum *\_clock\_fro\_src* clock\_fro\_src\_t  
fro output frequency source definition

typedef enum *\_clock\_fro\_osc\_freq* clock\_fro\_osc\_freq\_t  
fro oscillator output frequency value definition

typedef enum *\_clock\_sys\_pll\_src* clock\_sys\_pll\_src  
PLL clock definition.

typedef enum *\_clock\_main\_clk\_src* clock\_main\_clk\_src\_t  
Main clock source definition.

typedef struct *\_clock\_sys\_pll* clock\_sys\_pll\_t  
PLL configuration structure.

volatile uint32\_t g\_Ext\_Clk\_Freq  
external clock frequency.

This variable is used to store the external clock frequency which is include external oscillator clock and external clk in clock frequency value, it is set by CLOCK\_InitExtClkin when CLK IN is used as external clock or by CLOCK\_InitSysOsc when external oscillator is used as external clock ,and it is returned by CLOCK\_GetExtClkFreq.

FSL\_CLOCK\_DRIVER\_VERSION  
CLOCK driver version 2.3.3.

SDK\_DEVICE\_MAXIMUM\_CPU\_CLOCK\_FREQUENCY

g\_Lp\_Osc\_Freq  
Low power oscilltor clock frequency.

Definition for the low power oscillator frequency which is 1 Mhz at default, and it is returned by CLOCK\_GetLpOscFreq.

CLOCK\_FRO\_SETTING\_API\_ROM\_ADDRESS  
FRO clock setting API address in ROM.

CLOCK\_FAIM\_BASE  
FAIM base address.

ADC\_CLOCKS

Clock ip name array for ADC.

ACMP\_CLOCKS

Clock ip name array for ACMP.

SWM\_CLOCKS

Clock ip name array for SWM.

ROM\_CLOCKS

Clock ip name array for ROM.

SRAM\_CLOCKS

Clock ip name array for SRAM.

IOCON\_CLOCKS

Clock ip name array for IOCON.

GPIO\_CLOCKS

Clock ip name array for GPIO.

GPIO\_INT\_CLOCKS

Clock ip name array for GPIO\_INT.

DMA\_CLOCKS

Clock ip name array for DMA.

CRC\_CLOCKS

Clock ip name array for CRC.

WWDT\_CLOCKS

Clock ip name array for WWDT.

I2C\_CLOCKS

Clock ip name array for I2C.

USART\_CLOCKS

Clock ip name array for I2C.

SPI\_CLOCKS

Clock ip name array for SPI.

MRT\_CLOCKS

Clock ip name array for MRT.

WKT\_CLOCKS

Clock ip name array for WKT.

FTM\_CLOCKS

Clock ip name array for FLEXTMR.

I3C\_CLOCKS

Clock ip name array for I3C.

CLK\_GATE\_DEFINE(reg, bit)

Internal used Clock definition only.

CLK\_GATE\_GET\_REG(x)

CLK\_GATE\_GET\_BITS\_SHIFT(x)

CLK\_MUX\_DEFINE(reg, mux)

```
CLK_MUX_GET_REG(x)
CLK_MUX_GET_MUX(x)
CLK_MAIN_CLK_MUX_DEFINE(preMux, mux)
CLK_MAIN_CLK_MUX_GET_PRE_MUX(x)
CLK_MAIN_CLK_MUX_GET_MUX(x)
CLK_DIV_DEFINE(reg)
CLK_DIV_GET_REG(x)
CLK_WDT_OSC_DEFINE(freq, regValue)
CLK_WDT_OSC_GET_FREQ(x)
CLK_WDT_OSC_GET_REG(x)
CLK_FRG_DIV_REG_MAP(base)
CLK_FRG_MUL_REG_MAP(base)
CLK_FRG_SEL_REG_MAP(base)
SYS_AHB_CLK_CTRL0
SYS_AHB_CLK_CTRL1
static inline void CLOCK_EnableClock(clock_ip_name_t clk)
static inline void CLOCK_DisableClock(clock_ip_name_t clk)
static inline void CLOCK_Select(clock_select_t sel)
static inline void CLOCK_SetClkDivider(clock_divider_t name, uint32_t value)
static inline uint32_t CLOCK_GetClkDivider(clock_divider_t name)
static inline void CLOCK_SetCoreSysClkDiv(uint32_t value)
static inline void CLOCK_SetI3CFClkDiv(uint32_t value)
static inline void CLOCK_SetI3CTCClkDiv(uint32_t value)
static inline void CLOCK_SetI3CSClkDiv(uint32_t value)
void CLOCK_SetMainClkSrc(clock_main_clk_src_t src)
    Set main clock reference source.
```

#### Parameters

- `src` – Refer to `clock_main_clk_src_t` to set the main clock source.

```
void CLOCK_SetFroOutClkSrc(clock_fro_src_t src)
    Set FRO clock source.
```

#### Parameters

- `src` – Please refer to `_clock_fro_src` definition.

```
static inline void CLOCK_SetFRGClkMul(uint32_t *base, uint32_t mul)
```

`void CLOCK_SetFLASHAccessCyclesForFreq(uint32_t iFreq)`

Set the flash wait states for the input frequency.

**Parameters**

- `iFreq` – : Input frequency

`uint32_t CLOCK_GetFRG0ClkFreq(void)`

Return Frequency of FRG0 Clock.

**Returns**

Frequency of FRG0 Clock.

`uint32_t CLOCK_GetFRG1ClkFreq(void)`

Return Frequency of FRG1 Clock.

**Returns**

Frequency of FRG1 Clock.

`uint32_t CLOCK_GetMainClkFreq(void)`

Return Frequency of Main Clock.

**Returns**

Frequency of Main Clock.

`uint32_t CLOCK_GetFroFreq(void)`

Return Frequency of FRO.

**Returns**

Frequency of FRO.

`static inline uint32_t CLOCK_GetCoreSysClkFreq(void)`

Return Frequency of core.

**Returns**

Frequency of core.

`uint32_t CLOCK_GetClockOutClkFreq(void)`

Return Frequency of ClockOut.

**Returns**

Frequency of ClockOut

`uint32_t CLOCK_GetUart0ClkFreq(void)`

Get UART0 frequency.

**Return values**

UART0 – frequency value.

`uint32_t CLOCK_GetUart1ClkFreq(void)`

Get UART1 frequency.

**Return values**

UART1 – frequency value.

`uint32_t CLOCK_GetUart2ClkFreq(void)`

Get UART2 frequency.

**Return values**

UART2 – frequency value.

`uint32_t CLOCK_GetUart3ClkFreq(void)`

Get UART3 frequency.

**Return values**

UART3 – frequency value.

uint32\_t CLOCK\_GetUart4ClkFreq(void)

Get UART4 frequency.

**Return values**

UART4 – frequency value.

uint32\_t CLOCK\_GetI3cClkFreq(void)

Get I3C frequency.

**Return values**

I3C – frequency value.

uint32\_t CLOCK\_GetLpOscClkFreq(void)

Get LP\_OSC frequency.

**Return values**

LP\_OSC – frequency value.

uint32\_t CLOCK\_GetFreq(*clock\_name\_t* clockName)

Return Frequency of selected clock.

**Returns**

Frequency of selected clock

uint32\_t CLOCK\_GetSystemPLLInClockRate(void)

Return System PLL input clock rate.

**Returns**

System PLL input clock rate

static inline uint32\_t CLOCK\_GetSystemPLLFreq(void)

Return Frequency of System PLL.

**Returns**

Frequency of PLL

static inline uint32\_t CLOCK\_GetLpOscFreq(void)

Get low power OSC frequency.

**Return values**

low – power OSC frequency value.

static inline uint32\_t CLOCK\_GetExtClkFreq(void)

Get external clock frequency.

**Return values**

external – clock frequency value.

void CLOCK\_InitSystemPll(const *clock\_sys\_pll\_t* \*config)

System PLL initialize.

**Parameters**

- config – System PLL configurations.

static inline void CLOCK\_DenitSystemPll(void)

System PLL Deinitialize.

bool CLOCK\_SetFRG0ClkFreq(uint32\_t freq)

Set FRG0 output frequency.

**Parameters**

- freq – Target output frequency,  $\text{freq} < \text{input}$  and  $(\text{input} / \text{freq}) < 2$  should be satisfy.

**Return values**

true -- successfully, false - input argument is invalid.

bool CLOCK\_SetFRG1ClkFreq(uint32\_t freq)

Set FRG1 output frequency.

**Parameters**

- freq – Target output frequency,  $\text{freq} < \text{input}$  and  $(\text{input} / \text{freq}) < 2$  should be satisfy.

**Return values**

true -- successfully, false - input argument is invalid.

void CLOCK\_InitExtClkin(uint32\_t clkInFreq)

Init external CLK IN, select the CLKIN as the external clock source.

**Parameters**

- clkInFreq – external clock in frequency.

void CLOCK\_InitSysOsc(uint32\_t oscFreq)

Init SYS OSC.

**Parameters**

- oscFreq – oscillator frequency value.

void CLOCK\_InitXtalin(uint32\_t xtalinFreq)

XTALIN init function system oscillator is bypassed, sys\_osc\_clk is fed directly from the XTALIN.

**Parameters**

- xtalinFreq – XTALIN frequency value

**Returns**

Frequency of PLL

static inline void CLOCK\_DeinitSysOsc(void)

Deinit SYS OSC.

static inline void CLOCK\_SetFroOscFreq(*clock\_fro\_osc\_freq\_t* freq)

Set FRO oscillator output frequency. Initialize the FRO clock to given frequency (36, 48 or 60 MHz).

**Parameters**

- freq – Please refer to *clock\_fro\_osc\_freq\_t* definition, frequency must be one of 36000, 48000 or 60000 KHz.

uint32\_t targetFreq

System pll fclk output frequency, the output frequency should be lower than 100MHz

*clock\_sys\_pll\_src* src

System pll clock source

struct \_\_clock\_sys\_pll

#include <fsl\_clock.h> PLL configuration structure.

## 2.2 CRC: Cyclic Redundancy Check Driver

FSL\_CRC\_DRIVER\_VERSION

CRC driver version. Version 2.1.1.

Current version: 2.1.1

Change log:

- Version 2.0.0
  - initial version
- Version 2.0.1
  - add explicit type cast when writing to WR\_DATA
- Version 2.0.2
  - Fix MISRA issue
- Version 2.1.0
  - Add CRC\_WriteSeed function
- Version 2.1.1
  - Fix MISRA issue

enum \_crc\_polynomial

CRC polynomials to use.

*Values:*

enumerator kCRC\_Polynomial\_CRC\_CCITT

$x^{16}+x^{12}+x^5+1$

enumerator kCRC\_Polynomial\_CRC\_16

$x^{16}+x^{15}+x^2+1$

enumerator kCRC\_Polynomial\_CRC\_32

$x^{32}+x^{26}+x^{23}+x^{22}+x^{16}+x^{12}+x^{11}+x^{10}+x^8+x^7+x^5+x^4+x^2+x+1$

typedef enum \_crc\_polynomial crc\_polynomial\_t

CRC polynomials to use.

typedef struct \_crc\_config crc\_config\_t

CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

void CRC\_Init(CRC\_Type \*base, const crc\_config\_t \*config)

Enables and configures the CRC peripheral module.

This functions enables the CRC peripheral clock in the LPC SYSCON block. It also configures the CRC engine and starts checksum computation by writing the seed.

#### Parameters

- base – CRC peripheral address.
- config – CRC module configuration structure.

static inline void CRC\_Deinit(CRC\_Type \*base)

Disables the CRC peripheral module.

This functions disables the CRC peripheral clock in the LPC SYSCON block.

#### Parameters

- base – CRC peripheral address.

`void CRC_Reset(CRC_Type *base)`  
resets CRC peripheral module.

**Parameters**

- `base` – CRC peripheral address.

`void CRC_WriteSeed(CRC_Type *base, uint32_t seed)`  
Write seed to CRC peripheral module.

**Parameters**

- `base` – CRC peripheral address.
- `seed` – CRC Seed value.

`void CRC_GetDefaultConfig(crc_config_t *config)`  
Loads default values to CRC protocol configuration structure.  
Loads default values to CRC protocol configuration structure. The default values are:

```
config->polynomial = kCRC_Polynomial_CRC_CCITT;  
config->reverseIn = false;  
config->complementIn = false;  
config->reverseOut = false;  
config->complementOut = false;  
config->seed = 0xFFFFU;
```

**Parameters**

- `config` – CRC protocol configuration structure

`void CRC_GetConfig(CRC_Type *base, crc_config_t *config)`  
Loads actual values configured in CRC peripheral to CRC protocol configuration structure.  
The values, including seed, can be used to resume CRC calculation later.

**Parameters**

- `base` – CRC peripheral address.
- `config` – CRC protocol configuration structure

`void CRC_WriteData(CRC_Type *base, const uint8_t *data, size_t dataSize)`  
Writes data to the CRC module.  
Writes input data buffer bytes to CRC data register.

**Parameters**

- `base` – CRC peripheral address.
- `data` – Input data stream, MSByte in `data[0]`.
- `dataSize` – Size of the input data buffer in bytes.

`static inline uint32_t CRC_Get32bitResult(CRC_Type *base)`  
Reads 32-bit checksum from the CRC module.  
Reads CRC data register.

**Parameters**

- `base` – CRC peripheral address.

**Returns**

final 32-bit checksum, after configured bit reverse and complement operations.



```
static inline uint16_t CRC_Get16bitResult(CRC_Type *base)
```

Reads 16-bit checksum from the CRC module.

Reads CRC data register.

#### Parameters

- `base` – CRC peripheral address.

#### Returns

final 16-bit checksum, after configured bit reverse and complement operations.

```
CRC_DRIVER_USE_CRC16_CCITT_FALSE_AS_DEFAULT
```

Default configuration structure filled by `CRC_GetDefaultConfig()`. Uses CRC-16/CCITT-FALSE as default.

```
struct __crc_config
```

*#include <fsl\_crc.h>* CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

#### Public Members

*crc\_polynomial\_t* polynomial

CRC polynomial.

bool reverseIn

Reverse bits on input.

bool complementIn

Perform 1's complement on input.

bool reverseOut

Reverse bits on output.

bool complementOut

Perform 1's complement on output.

uint32\_t seed

Starting checksum value.

## 2.3 CTIMER: Standard counter/timers

```
void CTIMER_Init(CTIMER_Type *base, const ctimer_config_t *config)
```

Ungates the clock and configures the peripheral for basic operation.

---

**Note:** This API should be called at the beginning of the application before using the driver.

---

#### Parameters

- `base` – Ctimer peripheral base address
- `config` – Pointer to the user configuration structure.

void CTIMER\_Deinit(CTIMER\_Type \*base)

Gates the timer clock.

#### Parameters

- base – Ctimer peripheral base address

void CTIMER\_GetDefaultConfig(*ctimer\_config\_t* \*config)

Fills in the timers configuration structure with the default settings.

The default values are:

```
config->mode = kCTIMER_TimerMode;
config->input = kCTIMER_Capture_0;
config->prescale = 0;
```

#### Parameters

- config – Pointer to the user configuration structure.

*status\_t* CTIMER\_SetupPwmPeriod(CTIMER\_Type \*base, const *ctimer\_match\_t* pwmPeriodChannel, *ctimer\_match\_t* matchChannel, uint32\_t pwmPeriod, uint32\_t pulsePeriod, bool enableInt)

Configures the PWM signal parameters.

Enables PWM mode on the match channel passed in and will then setup the match value and other match parameters to generate a PWM signal. This function can manually assign the specified channel to set the PWM cycle.

---

**Note:** When setting PWM output from multiple output pins, all should use the same PWM period

---

#### Parameters

- base – Ctimer peripheral base address
- pwmPeriodChannel – Specify the channel to control the PWM period
- matchChannel – Match pin to be used to output the PWM signal
- pwmPeriod – PWM period match value
- pulsePeriod – Pulse width match value
- enableInt – Enable interrupt when the timer value reaches the match value of the PWM pulse, if it is 0 then no interrupt will be generated.

#### Returns

kStatus\_Success on success kStatus\_Fail If matchChannel is equal to pwmPeriodChannel; this channel is reserved to set the PWM cycle If PWM pulse width register value is larger than 0xFFFFFFFF.

*status\_t* CTIMER\_SetupPwm(CTIMER\_Type \*base, const *ctimer\_match\_t* pwmPeriodChannel, *ctimer\_match\_t* matchChannel, uint8\_t dutyCyclePercent, uint32\_t pwmFreq\_Hz, uint32\_t srcClock\_Hz, bool enableInt)

Configures the PWM signal parameters.

Enables PWM mode on the match channel passed in and will then setup the match value and other match parameters to generate a PWM signal. This function can manually assign the specified channel to set the PWM cycle.

---

**Note:** When setting PWM output from multiple output pins, all should use the same PWM frequency. Please use CTIMER\_SetupPwmPeriod to set up the PWM with high resolution.

---

#### Parameters

- base – Ctimer peripheral base address
- pwmPeriodChannel – Specify the channel to control the PWM period
- matchChannel – Match pin to be used to output the PWM signal
- dutyCyclePercent – PWM pulse width; the value should be between 0 to 100
- pwmFreq\_Hz – PWM signal frequency in Hz
- srcClock\_Hz – Timer counter clock in Hz
- enableInt – Enable interrupt when the timer value reaches the match value of the PWM pulse, if it is 0 then no interrupt will be generated.

```
static inline void CTIMER__UpdatePwmPulsePeriod(CTIMER_Type *base, ctimer_match_t  
                                              matchChannel, uint32_t pulsePeriod)
```

Updates the pulse period of an active PWM signal.

#### Parameters

- base – Ctimer peripheral base address
- matchChannel – Match pin to be used to output the PWM signal
- pulsePeriod – New PWM pulse width match value

```
status_t CTIMER__UpdatePwmDutycycle(CTIMER_Type *base, const ctimer_match_t  
                                   pwmPeriodChannel, ctimer_match_t matchChannel,  
                                   uint8_t dutyCyclePercent)
```

Updates the duty cycle of an active PWM signal.

---

**Note:** Please use CTIMER\_SetupPwmPeriod to update the PWM with high resolution. This function can manually assign the specified channel to set the PWM cycle.

---

#### Parameters

- base – Ctimer peripheral base address
- pwmPeriodChannel – Specify the channel to control the PWM period
- matchChannel – Match pin to be used to output the PWM signal
- dutyCyclePercent – New PWM pulse width; the value should be between 0 to 100

#### Returns

kStatus\_Success on success kStatus\_Fail If PWM pulse width register value is larger than 0xFFFFFFFF.

```
static inline void CTIMER__EnableInterrupts(CTIMER_Type *base, uint32_t mask)
```

Enables the selected Timer interrupts.

#### Parameters

- base – Ctimer peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration ctimer\_interrupt\_enable\_t

static inline void CTIMER\_DisableInterrupts(CTIMER\_Type \*base, uint32\_t mask)

Disables the selected Timer interrupts.

**Parameters**

- base – Ctimer peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration `ctimer_interrupt_enable_t`

static inline uint32\_t CTIMER\_GetEnabledInterrupts(CTIMER\_Type \*base)

Gets the enabled Timer interrupts.

**Parameters**

- base – Ctimer peripheral base address

**Returns**

The enabled interrupts. This is the logical OR of members of the enumeration `ctimer_interrupt_enable_t`

static inline uint32\_t CTIMER\_GetStatusFlags(CTIMER\_Type \*base)

Gets the Timer status flags.

**Parameters**

- base – Ctimer peripheral base address

**Returns**

The status flags. This is the logical OR of members of the enumeration `ctimer_status_flags_t`

static inline void CTIMER\_ClearStatusFlags(CTIMER\_Type \*base, uint32\_t mask)

Clears the Timer status flags.

**Parameters**

- base – Ctimer peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration `ctimer_status_flags_t`

static inline void CTIMER\_StartTimer(CTIMER\_Type \*base)

Starts the Timer counter.

**Parameters**

- base – Ctimer peripheral base address

static inline void CTIMER\_StopTimer(CTIMER\_Type \*base)

Stops the Timer counter.

**Parameters**

- base – Ctimer peripheral base address

FSL\_CTIMER\_DRIVER\_VERSION

Version 2.3.3

enum \_\_ctimer\_capture\_channel

List of Timer capture channels.

*Values:*

enumerator kCTIMER\_Capture\_0

Timer capture channel 0

enumerator kCTIMER\_Capture\_1  
Timer capture channel 1

enumerator kCTIMER\_Capture\_2  
Timer capture channel 2

enum \_ctimer\_capture\_edge  
List of capture edge options.

*Values:*

enumerator kCTIMER\_Capture\_RiseEdge  
Capture on rising edge

enumerator kCTIMER\_Capture\_FallEdge  
Capture on falling edge

enumerator kCTIMER\_Capture\_BothEdge  
Capture on rising and falling edge

enum \_ctimer\_match  
List of Timer match registers.

*Values:*

enumerator kCTIMER\_Match\_0  
Timer match register 0

enumerator kCTIMER\_Match\_1  
Timer match register 1

enumerator kCTIMER\_Match\_2  
Timer match register 2

enumerator kCTIMER\_Match\_3  
Timer match register 3

enum \_ctimer\_external\_match  
List of external match.

*Values:*

enumerator kCTIMER\_External\_Match\_0  
External match 0

enumerator kCTIMER\_External\_Match\_1  
External match 1

enumerator kCTIMER\_External\_Match\_2  
External match 2

enumerator kCTIMER\_External\_Match\_3  
External match 3

enum \_ctimer\_match\_output\_control  
List of output control options.

*Values:*

enumerator kCTIMER\_Output\_NoAction  
No action is taken

enumerator kCTIMER\_Output\_Clear  
Clear the EM bit/output to 0

enumerator kCTIMER\_Output\_Set

Set the EM bit/output to 1

enumerator kCTIMER\_Output\_Toggle

Toggle the EM bit/output

enum \_\_ctimer\_timer\_mode

List of Timer modes.

*Values:*

enumerator kCTIMER\_TimerMode

enumerator kCTIMER\_IncreaseOnRiseEdge

enumerator kCTIMER\_IncreaseOnFallEdge

enumerator kCTIMER\_IncreaseOnBothEdge

enum \_\_ctimer\_interrupt\_enable

List of Timer interrupts.

*Values:*

enumerator kCTIMER\_Match0InterruptEnable

Match 0 interrupt

enumerator kCTIMER\_Match1InterruptEnable

Match 1 interrupt

enumerator kCTIMER\_Match2InterruptEnable

Match 2 interrupt

enumerator kCTIMER\_Match3InterruptEnable

Match 3 interrupt

enumerator kCTIMER\_Capture0InterruptEnable

Capture 0 interrupt

enumerator kCTIMER\_Capture1InterruptEnable

Capture 1 interrupt

enumerator kCTIMER\_Capture2InterruptEnable

Capture 2 interrupt

enum \_\_ctimer\_status\_flags

List of Timer flags.

*Values:*

enumerator kCTIMER\_Match0Flag

Match 0 interrupt flag

enumerator kCTIMER\_Match1Flag

Match 1 interrupt flag

enumerator kCTIMER\_Match2Flag

Match 2 interrupt flag

enumerator kCTIMER\_Match3Flag

Match 3 interrupt flag

enumerator kCTIMER\_Capture0Flag

Capture 0 interrupt flag

enumerator kCTIMER\_Capture1Flag

Capture 1 interrupt flag

enumerator kCTIMER\_Capture2Flag

Capture 2 interrupt flag

enum ctimer\_callback\_type\_t

Callback type when registering for a callback. When registering a callback an array of function pointers is passed the size could be 1 or 8, the callback type will tell that.

*Values:*

enumerator kCTIMER\_SingleCallback

Single Callback type where there is only one callback for the timer. based on the status flags different channels needs to be handled differently

enumerator kCTIMER\_MultipleCallback

Multiple Callback type where there can be 8 valid callbacks, one per channel. for both match/capture

typedef enum \_ctimer\_capture\_channel ctimer\_capture\_channel\_t

List of Timer capture channels.

typedef enum \_ctimer\_capture\_edge ctimer\_capture\_edge\_t

List of capture edge options.

typedef enum \_ctimer\_match ctimer\_match\_t

List of Timer match registers.

typedef enum \_ctimer\_external\_match ctimer\_external\_match\_t

List of external match.

typedef enum \_ctimer\_match\_output\_control ctimer\_match\_output\_control\_t

List of output control options.

typedef enum \_ctimer\_timer\_mode ctimer\_timer\_mode\_t

List of Timer modes.

typedef enum \_ctimer\_interrupt\_enable ctimer\_interrupt\_enable\_t

List of Timer interrupts.

typedef enum \_ctimer\_status\_flags ctimer\_status\_flags\_t

List of Timer flags.

typedef void (\*ctimer\_callback\_t)(uint32\_t flags)

typedef struct \_ctimer\_match\_config ctimer\_match\_config\_t

Match configuration.

This structure holds the configuration settings for each match register.

typedef struct \_ctimer\_config ctimer\_config\_t

Timer configuration structure.

This structure holds the configuration settings for the Timer peripheral. To initialize this structure to reasonable defaults, call the CTIMER\_GetDefaultConfig() function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

```
void CTIMER_SetupMatch(CTIMER_Type *base, ctimer_match_t matchChannel, const  
                      ctimer_match_config_t *config)
```

Setup the match register.

User configuration is used to setup the match value and action to be taken when a match occurs.

#### Parameters

- base – Ctimer peripheral base address
- matchChannel – Match register to configure
- config – Pointer to the match configuration structure

```
uint32_t CTIMER_GetOutputMatchStatus(CTIMER_Type *base, uint32_t matchChannel)
```

Get the status of output match.

This function gets the status of output MAT, whether or not this output is connected to a pin. This status is driven to the MAT pins if the match function is selected via IOCON. 0 = LOW. 1 = HIGH.

#### Parameters

- base – Ctimer peripheral base address
- matchChannel – External match channel, user can obtain the status of multiple match channels at the same time by using the logic of “|” enumeration *ctimer\_external\_match\_t*

#### Returns

The mask of external match channel status flags. Users need to use the *\_ctimer\_external\_match* type to decode the return variables.

```
void CTIMER_SetupCapture(CTIMER_Type *base, ctimer_capture_channel_t capture,  
                        ctimer_capture_edge_t edge, bool enableInt)
```

Setup the capture.

#### Parameters

- base – Ctimer peripheral base address
- capture – Capture channel to configure
- edge – Edge on the channel that will trigger a capture
- enableInt – Flag to enable channel interrupts, if enabled then the registered call back is called upon capture

```
static inline uint32_t CTIMER_GetTimerCountValue(CTIMER_Type *base)
```

Get the timer count value from TC register.

#### Parameters

- base – Ctimer peripheral base address.

#### Returns

return the timer count value.

```
void CTIMER_RegisterCallBack(CTIMER_Type *base, ctimer_callback_t *cb_func,  
                            ctimer_callback_type_t cb_type)
```

Register callback.

This function configures CTimer Callback in following modes:

- Single Callback: *cb\_func* should be pointer to callback function pointer  
For example: *ctimer\_callback\_t* *ctimer\_callback* = *pwm\_match\_callback*;  
*CTIMER\_RegisterCallBack*(*CTIMER*, &*ctimer\_callback*, *kCTIMER\_SingleCallback*);



- **Multiple Callback:** `cb_func` should be pointer to array of callback function pointers. Each element corresponds to Interrupt Flag in IR register. For example: `ctimer_callback_t ctimer_callback_table[] = { ctimer_match0_callback, NULL, NULL, ctimer_match3_callback, NULL, NULL, NULL, NULL}; CTIMER_RegisterCallBack(CTIMER, &ctimer_callback_table[0], kCTIMER_MultipleCallback);`

**Parameters**

- `base` – Ctimer peripheral base address
- `cb_func` – Pointer to callback function pointer
- `cb_type` – callback function type, singular or multiple

```
static inline void CTIMER_Reset(CTIMER_Type *base)
```

Reset the counter.

The timer counter and prescale counter are reset on the next positive edge of the APB clock.

**Parameters**

- `base` – Ctimer peripheral base address

```
static inline void CTIMER_SetPrescale(CTIMER_Type *base, uint32_t prescale)
```

Setup the timer prescale value.

Specifies the maximum value for the Prescale Counter.

**Parameters**

- `base` – Ctimer peripheral base address
- `prescale` – Prescale value

```
static inline uint32_t CTIMER_GetCaptureValue(CTIMER_Type *base, ctimer_capture_channel_t capture)
```

Get capture channel value.

Get the counter/timer value on the corresponding capture channel.

**Parameters**

- `base` – Ctimer peripheral base address
- `capture` – Select capture channel

**Returns**

The timer count capture value.

```
static inline void CTIMER_EnableResetMatchChannel(CTIMER_Type *base, ctimer_match_t match, bool enable)
```

Enable reset match channel.

Set the specified match channel reset operation.

**Parameters**

- `base` – Ctimer peripheral base address
- `match` – match channel used
- `enable` – Enable match channel reset operation.

```
static inline void CTIMER_EnableStopMatchChannel(CTIMER_Type *base, ctimer_match_t match, bool enable)
```

Enable stop match channel.

Set the specified match channel stop operation.

**Parameters**

- base – Ctimer peripheral base address.
- match – match channel used.
- enable – Enable match channel stop operation.

```
static inline void CTIMER_EnableRisingEdgeCapture(CTIMER_Type *base,  
                                                  ctimer_capture_channel_t capture, bool  
                                                  enable)
```

Enable capture channel rising edge.

Sets the specified capture channel for rising edge capture.

**Parameters**

- base – Ctimer peripheral base address.
- capture – capture channel used.
- enable – Enable rising edge capture.

```
static inline void CTIMER_EnableFallingEdgeCapture(CTIMER_Type *base,  
                                                  ctimer_capture_channel_t capture, bool  
                                                  enable)
```

Enable capture channel falling edge.

Sets the specified capture channel for falling edge capture.

**Parameters**

- base – Ctimer peripheral base address.
- capture – capture channel used.
- enable – Enable falling edge capture.

```
struct _ctimer_match_config
```

*#include <fsl\_ctimer.h>* Match configuration.

This structure holds the configuration settings for each match register.

**Public Members**

uint32\_t matchValue

This is stored in the match register

bool enableCounterReset

true: Match will reset the counter false: Match will not reset the counter

bool enableCounterStop

true: Match will stop the counter false: Match will not stop the counter

ctimer\_match\_output\_control\_t outControl

Action to be taken on a match on the EM bit/output

bool outPinInitState

Initial value of the EM bit/output

bool enableInterrupt

true: Generate interrupt upon match false: Do not generate interrupt on match

struct `_ctimer_config`

`#include <fsl_ctimer.h>` Timer configuration structure.

This structure holds the configuration settings for the Timer peripheral. To initialize this structure to reasonable defaults, call the `CTIMER_GetDefaultConfig()` function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

### Public Members

`ctimer_timer_mode_t` mode

Timer mode

`ctimer_capture_channel_t` input

Input channel to increment the timer, used only in timer modes that rely on this input signal to increment TC

`uint32_t` prescale

Prescale value

## 2.4 DMA: Direct Memory Access Controller Driver

void `DMA_Init(DMA_Type *base)`

Initializes DMA peripheral.

This function enable the DMA clock, set descriptor table and enable DMA peripheral.

### Parameters

- `base` – DMA peripheral base address.

void `DMA_Deinit(DMA_Type *base)`

Deinitializes DMA peripheral.

This function gates the DMA clock.

### Parameters

- `base` – DMA peripheral base address.

void `DMA_InstallDescriptorMemory(DMA_Type *base, void *addr)`

Install DMA descriptor memory.

This function used to register DMA descriptor memory for linked transfer, a typical case is ping pong transfer which will request more than one DMA descriptor memory space, although current DMA driver has a default DMA descriptor buffer, but it support one DMA descriptor for one channel only.

### Parameters

- `base` – DMA base address.
- `addr` – DMA descriptor address

static inline bool `DMA_ChannelIsActive(DMA_Type *base, uint32_t channel)`

Return whether DMA channel is processing transfer.

### Parameters

- `base` – DMA peripheral base address.
- `channel` – DMA channel number.

**Returns**

True for active state, false otherwise.

```
static inline bool DMA_ChannelIsBusy(DMA_Type *base, uint32_t channel)
```

Return whether DMA channel is busy.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

**Returns**

True for busy state, false otherwise.

```
static inline void DMA_EnableChannelInterrupts(DMA_Type *base, uint32_t channel)
```

Enables the interrupt source for the DMA transfer.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_DisableChannelInterrupts(DMA_Type *base, uint32_t channel)
```

Disables the interrupt source for the DMA transfer.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_EnableChannel(DMA_Type *base, uint32_t channel)
```

Enable DMA channel.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_DisableChannel(DMA_Type *base, uint32_t channel)
```

Disable DMA channel.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_EnableChannelPeriphRq(DMA_Type *base, uint32_t channel)
```

Set PERIPHREQEN of channel configuration register.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_DisableChannelPeriphRq(DMA_Type *base, uint32_t channel)
```

Get PERIPHREQEN value of channel configuration register.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

**Returns**

True for enabled PeriphRq, false for disabled.

```
void DMA_ConfigureChannelTrigger(DMA_Type *base, uint32_t channel, dma_channel_trigger_t *trigger)
```

Set trigger settings of DMA channel.

*Deprecated:*

Do not use this function. It has been superceded by DMA\_SetChannelConfig.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.
- trigger – trigger configuration.

```
void DMA_SetChannelConfig(DMA_Type *base, uint32_t channel, dma_channel_trigger_t *trigger, bool isPeriph)
```

set channel config.

This function provide a interface to configure channel configuration registers.

**Parameters**

- base – DMA base address.
- channel – DMA channel number.
- trigger – channel configurations structure.
- isPeriph – true is periph request, false is not.

```
static inline uint32_t DMA_SetChannelXferConfig(bool reload, bool clrTrig, bool intA, bool intB, uint8_t width, uint8_t srcInc, uint8_t dstInc, uint32_t bytes)
```

DMA channel xfer transfer configurations.

**Parameters**

- reload – true is reload link descriptor after current exhaust, false is not
- clrTrig – true is clear trigger status, wait software trigger, false is not
- intA – enable interruptA
- intB – enable interruptB
- width – transfer width
- srcInc – source address interleave size
- dstInc – destination address interleave size
- bytes – transfer bytes

**Returns**

The vaule of xfer config

```
uint32_t DMA_GetRemainingBytes(DMA_Type *base, uint32_t channel)
```

Gets the remaining bytes of the current DMA descriptor transfer.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

**Returns**

The number of bytes which have not been transferred yet.

```
static inline void DMA_SetChannelPriority(DMA_Type *base, uint32_t channel, dma_priority_t priority)
```

Set priority of channel configuration register.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.
- priority – Channel priority value.

```
static inline dma_priority_t DMA_GetChannelPriority(DMA_Type *base, uint32_t channel)
```

Get priority of channel configuration register.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

**Returns**

Channel priority value.

```
static inline void DMA_SetChannelConfigValid(DMA_Type *base, uint32_t channel)
```

Set channel configuration valid.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_DoChannelSoftwareTrigger(DMA_Type *base, uint32_t channel)
```

Do software trigger for the channel.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.

```
static inline void DMA_LoadChannelTransferConfig(DMA_Type *base, uint32_t channel, uint32_t xfer)
```

Load channel transfer configurations.

**Parameters**

- base – DMA peripheral base address.
- channel – DMA channel number.
- xfer – transfer configurations.

```
void DMA_CreateDescriptor(dma_descriptor_t *desc, dma_xfercfg_t *xfercfg, void *srcAddr, void *dstAddr, void *nextDesc)
```

Create application specific DMA descriptor to be used in a chain in transfer.

*Deprecated:*

Do not use this function. It has been superceded by DMA\_SetupDescriptor.

**Parameters**

- desc – DMA descriptor address.
- xfercfg – Transfer configuration for DMA descriptor.
- srcAddr – Address of last item to transmit

- dstAddr – Address of last item to receive.
- nextDesc – Address of next descriptor in chain.

```
void DMA_SetupDescriptor(dma_descriptor_t *desc, uint32_t xfercfg, void *srcStartAddr, void
                        *dstStartAddr, void *nextDesc)
```

setup dma descriptor

Note: This function do not support configure wrap descriptor.

#### Parameters

- desc – DMA descriptor address.
- xfercfg – Transfer configuration for DMA descriptor.
- srcStartAddr – Start address of source address.
- dstStartAddr – Start address of destination address.
- nextDesc – Address of next descriptor in chain.

```
void DMA_SetupChannelDescriptor(dma_descriptor_t *desc, uint32_t xfercfg, void *srcStartAddr,
                               void *dstStartAddr, void *nextDesc, dma_burst_wrap_t
                               wrapType, uint32_t burstSize)
```

setup dma channel descriptor

Note: This function support configure wrap descriptor.

#### Parameters

- desc – DMA descriptor address.
- xfercfg – Transfer configuration for DMA descriptor.
- srcStartAddr – Start address of source address.
- dstStartAddr – Start address of destination address.
- nextDesc – Address of next descriptor in chain.
- wrapType – burst wrap type.
- burstSize – burst size, reference `_dma_burst_size`.

```
void DMA_LoadChannelDescriptor(DMA_Type *base, uint32_t channel, dma_descriptor_t
                              *descriptor)
```

load channel transfer decriptor.

This function can be used to load desscriptor to driver internal channel descriptor that is used to start DMA transfer, the head descriptor table is defined in DMA driver, it is useful for the case:

- for the polling transfer, application can allocate a local descriptor memory table to prepare a descriptor firstly and then call this api to load the configured descriptor to driver descriptor table.

```
DMA_Init(DMA0);
DMA_EnableChannel(DMA0, DEMO_DMA_CHANNEL);
DMA_SetupDescriptor(desc, xferCfg, s_srcBuffer, &s_destBuffer[0], NULL);
DMA_LoadChannelDescriptor(DMA0, DEMO_DMA_CHANNEL, (dma_descriptor_t *)desc);
DMA_DoChannelSoftwareTrigger(DMA0, DEMO_DMA_CHANNEL);
while(DMA_ChannelIsBusy(DMA0, DEMO_DMA_CHANNEL))
{ }
```

#### Parameters

- base – DMA base address.

- channel – DMA channel.
- descriptor – configured DMA descriptor.

void DMA\_AbortTransfer(*dma\_handle\_t* \*handle)

Abort running transfer by handle.

This function aborts DMA transfer specified by handle.

#### Parameters

- handle – DMA handle pointer.

void DMA\_CreateHandle(*dma\_handle\_t* \*handle, DMA\_Type \*base, uint32\_t channel)

Creates the DMA handle.

This function is called if using transaction API for DMA. This function initializes the internal state of DMA handle.

#### Parameters

- handle – DMA handle pointer. The DMA handle stores callback function and parameters.
- base – DMA peripheral base address.
- channel – DMA channel number.

void DMA\_SetCallback(*dma\_handle\_t* \*handle, *dma\_callback* callback, void \*userData)

Installs a callback function for the DMA transfer.

This callback is called in DMA IRQ handler. Use the callback to do something after the current major loop transfer completes.

#### Parameters

- handle – DMA handle pointer.
- callback – DMA callback function pointer.
- userData – Parameter for callback function.

void DMA\_PrepareTransfer(*dma\_transfer\_config\_t* \*config, void \*srcAddr, void \*dstAddr, uint32\_t byteWidth, uint32\_t transferBytes, *dma\_transfer\_type\_t* type, void \*nextDesc)

Prepares the DMA transfer structure.

#### Deprecated:

Do not use this function. It has been superceded by DMA\_PrepareChannelTransfer. 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, so the source address must be 4 bytes aligned, or it shall result in source address error(SAE).

---

#### Parameters

- config – The user configuration structure of type *dma\_transfer\_t*.
- srcAddr – DMA transfer source address.
- dstAddr – DMA transfer destination address.
- byteWidth – DMA transfer destination address width(bytes).
- transferBytes – DMA transfer bytes to be transferred.



- type – DMA transfer type.
- nextDesc – Chain custom descriptor to transfer.

```
void DMA__PrepareChannelTransfer(dma_channel_config_t *config, void *srcStartAddr, void
                                *dstStartAddr, uint32_t xferCfg, dma_transfer_type_t type,
                                dma_channel_trigger_t *trigger, void *nextDesc)
```

Prepare channel transfer configurations.

This function used to prepare channel transfer configurations.

#### Parameters

- config – Pointer to DMA channel transfer configuration structure.
- srcStartAddr – source start address.
- dstStartAddr – destination start address.
- xferCfg – xfer configuration, user can reference DMA\_CHANNEL\_XFER about to how to get xferCfg value.
- type – transfer type.
- trigger – DMA channel trigger configurations.
- nextDesc – address of next descriptor.

```
status_t DMA__SubmitTransfer(dma_handle_t *handle, dma_transfer_config_t *config)
```

Submits the DMA transfer request.

#### Deprecated:

Do not use this function. It has been superceded by DMA\_SubmitChannelTransfer.

This function submits the DMA transfer request according to the transfer configuration structure. If the user submits the transfer request repeatedly, this function packs an unprocessed request as a TCD and enables scatter/gather feature to process it in the next time.

#### Parameters

- handle – DMA handle pointer.
- config – Pointer to DMA transfer configuration structure.

#### Return values

- kStatus\_DMA\_Success – It means submit transfer request succeed.
- kStatus\_DMA\_QueueFull – It means TCD queue is full. Submit transfer request is not allowed.
- kStatus\_DMA\_Busy – It means the given channel is busy, need to submit request later.

```
void DMA__SubmitChannelTransferParameter(dma_handle_t *handle, uint32_t xferCfg, void
                                         *srcStartAddr, void *dstStartAddr, void *nextDesc)
```

Submit channel transfer paramter directly.

This function used to configure channel head descriptor that is used to start DMA transfer, the head descriptor table is defined in DMA driver, it is useful for the case:

- a. for the single transfer, application doesn't need to allocate descriptor table, the head descriptor can be used for it.

```

DMA_SetChannelConfig(base, channel, trigger, isPeriph);
DMA_CreateHandle(handle, base, channel)
DMA_SubmitChannelTransferParameter(handle, DMA_CHANNEL_XFER(reload, clrTrig,
↪ intA, intB, width, srcInc, dstInc,
bytes), srcStartAddr, dstStartAddr, NULL);
DMA_StartTransfer(handle)

```

- b. for the linked transfer, application should responsible for link descriptor, for example, if 4 transfer is required, then application should prepare three descriptor table with macro , the head descriptor in driver can be used for the first transfer descriptor.

```

define link descriptor table in application with macro
DMA_ALLOCATE_LINK_DESCRIPTOR(nextDesc[3]);

DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc2);
DMA_SetupDescriptor(nextDesc2, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, NULL);
DMA_SetChannelConfig(base, channel, trigger, isPeriph);
DMA_CreateHandle(handle, base, channel)
DMA_SubmitChannelTransferParameter(handle, DMA_CHANNEL_XFER(reload, clrTrig,
↪ intA, intB, width, srcInc, dstInc,
bytes), srcStartAddr, dstStartAddr, nextDesc0);
DMA_StartTransfer(handle);

```

### Parameters

- handle – Pointer to DMA handle.
- xferCfg – xfer configuration, user can reference DMA\_CHANNEL\_XFER about to how to get xferCfg value.
- srcStartAddr – source start address.
- dstStartAddr – destination start address.
- nextDesc – address of next descriptor.

void DMA\_SubmitChannelDescriptor(*dma\_handle\_t* \*handle, *dma\_descriptor\_t* \*descriptor)

Submit channel descriptor.

This function used to configure channel head descriptor that is used to start DMA transfer, the head descriptor table is defined in DMA driver, this function is typical for the ping pong case:

- a. for the ping pong case, application should responsible for the descriptor, for example, application should prepare two descriptor table with macro.

```

define link descriptor table in application with macro
DMA_ALLOCATE_LINK_DESCRIPTOR(nextDesc[2]);

DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc0);

```

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```
DMA_SetChannelConfig(base, channel, trigger, isPeriph);
DMA_CreateHandle(handle, base, channel)
DMA_SubmitChannelDescriptor(handle, nextDesc0);
DMA_StartTransfer(handle);
```

### Parameters

- handle – Pointer to DMA handle.
- descriptor – descriptor to submit.

*status\_t* DMA\_SubmitChannelTransfer(*dma\_handle\_t* \*handle, *dma\_channel\_config\_t* \*config)

Submits the DMA channel transfer request.

This function submits the DMA transfer request according to the transfer configuration structure. If the user submits the transfer request repeatedly, this function packs an unprocessed request as a TCD and enables scatter/gather feature to process it in the next time. It is used for the case:

- for the single transfer, application doesn't need to allocate descriptor table, the head descriptor can be used for it.

```
DMA_CreateHandle(handle, base, channel)
DMA_PrepareChannelTransfer(config,srcStartAddr,dstStartAddr,xferCfg,type,trigger,NULL);
DMA_SubmitChannelTransfer(handle, config)
DMA_StartTransfer(handle)
```

- for the linked transfer, application should responsible for link descriptor, for example, if 4 transfer is required, then application should prepare three descriptor table with macro , the head descriptor in driver can be used for the first transfer descriptor.

```
define link descriptor table in application with macro
DMA_ALLOCATE_LINK_DESCRIPTOR(nextDesc);
DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc2);
DMA_SetupDescriptor(nextDesc2, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, NULL);
DMA_CreateHandle(handle, base, channel)
DMA_PrepareChannelTransfer(config,srcStartAddr,dstStartAddr,xferCfg,type,trigger,
↪ nextDesc0);
DMA_SubmitChannelTransfer(handle, config)
DMA_StartTransfer(handle)
```

- for the ping pong case, application should responsible for link descriptor, for example, application should prepare two descriptor table with macro , the head descriptor in driver can be used for the first transfer descriptor.

```
define link descriptor table in application with macro
DMA_ALLOCATE_LINK_DESCRIPTOR(nextDesc);

DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc0);
```

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```

DMA_CreateHandle(handle, base, channel)
DMA_PrepareChannelTransfer(config,srcStartAddr,dstStartAddr,xferCfg,type,trigger,
↪nextDesc0);
DMA_SubmitChannelTransfer(handle, config)
DMA_StartTransfer(handle)

```

**Parameters**

- handle – DMA handle pointer.
- config – Pointer to DMA transfer configuration structure.

**Return values**

- kStatus\_DMA\_Success – It means submit transfer request succeed.
- kStatus\_DMA\_QueueFull – It means TCD queue is full. Submit transfer request is not allowed.
- kStatus\_DMA\_Busy – It means the given channel is busy, need to submit request later.

```
void DMA_StartTransfer(dma_handle_t *handle)
```

DMA start transfer.

This function enables the channel request. User can call this function after submitting the transfer request. It will trigger transfer start with software trigger only when hardware trigger is not used.

**Parameters**

- handle – DMA handle pointer.

```
void DMA_IRQHandle(DMA_Type *base)
```

DMA IRQ handler for descriptor transfer complete.

This function clears the channel major interrupt flag and call the callback function if it is not NULL.

**Parameters**

- base – DMA base address.

```
FSL_DMA_DRIVER_VERSION
```

DMA driver version.

Version 2.5.3.

`_dma_transfer_status` DMA transfer status

*Values:*

enumerator kStatus\_DMA\_Busy

Channel is busy and can't handle the transfer request.

`_dma_addr_interleave_size` dma address interleave size

*Values:*

enumerator kDMA\_AddressInterleave0xWidth

dma source/destination address no interleave

enumerator kDMA\_AddressInterleave1xWidth

dma source/destination address interleave 1xwidth

enumerator kDMA\_\_AddressInterleave2xWidth  
dma source/destination address interleave 2xwidth

enumerator kDMA\_\_AddressInterleave4xWidth  
dma source/destination address interleave 3xwidth

\_dma\_transfer\_width dma transfer width

*Values:*

enumerator kDMA\_\_Transfer8BitWidth  
dma channel transfer bit width is 8 bit

enumerator kDMA\_\_Transfer16BitWidth  
dma channel transfer bit width is 16 bit

enumerator kDMA\_\_Transfer32BitWidth  
dma channel transfer bit width is 32 bit

enum \_\_dma\_\_priority  
DMA channel priority.

*Values:*

enumerator kDMA\_\_ChannelPriority0  
Highest channel priority - priority 0

enumerator kDMA\_\_ChannelPriority1  
Channel priority 1

enumerator kDMA\_\_ChannelPriority2  
Channel priority 2

enumerator kDMA\_\_ChannelPriority3  
Channel priority 3

enumerator kDMA\_\_ChannelPriority4  
Channel priority 4

enumerator kDMA\_\_ChannelPriority5  
Channel priority 5

enumerator kDMA\_\_ChannelPriority6  
Channel priority 6

enumerator kDMA\_\_ChannelPriority7  
Lowest channel priority - priority 7

enum \_\_dma\_\_int  
DMA interrupt flags.

*Values:*

enumerator kDMA\_\_IntA  
DMA interrupt flag A

enumerator kDMA\_\_IntB  
DMA interrupt flag B

enumerator kDMA\_\_IntError  
DMA interrupt flag error

enum \_dma\_trigger\_type

DMA trigger type.

*Values:*

enumerator kDMA\_NoTrigger

Trigger is disabled

enumerator kDMA\_LowLevelTrigger

Low level active trigger

enumerator kDMA\_HighLevelTrigger

High level active trigger

enumerator kDMA\_FallingEdgeTrigger

Falling edge active trigger

enumerator kDMA\_RisingEdgeTrigger

Rising edge active trigger

\_dma\_burst\_size DMA burst size

*Values:*

enumerator kDMA\_BurstSize1

burst size 1 transfer

enumerator kDMA\_BurstSize2

burst size 2 transfer

enumerator kDMA\_BurstSize4

burst size 4 transfer

enumerator kDMA\_BurstSize8

burst size 8 transfer

enumerator kDMA\_BurstSize16

burst size 16 transfer

enumerator kDMA\_BurstSize32

burst size 32 transfer

enumerator kDMA\_BurstSize64

burst size 64 transfer

enumerator kDMA\_BurstSize128

burst size 128 transfer

enumerator kDMA\_BurstSize256

burst size 256 transfer

enumerator kDMA\_BurstSize512

burst size 512 transfer

enumerator kDMA\_BurstSize1024

burst size 1024 transfer

enum \_dma\_trigger\_burst

DMA trigger burst.

*Values:*

enumerator kDMA\_\_SingleTransfer

Single transfer

enumerator kDMA\_\_LevelBurstTransfer

Burst transfer driven by level trigger

enumerator kDMA\_\_EdgeBurstTransfer1

Perform 1 transfer by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer2

Perform 2 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer4

Perform 4 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer8

Perform 8 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer16

Perform 16 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer32

Perform 32 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer64

Perform 64 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer128

Perform 128 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer256

Perform 256 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer512

Perform 512 transfers by edge trigger

enumerator kDMA\_\_EdgeBurstTransfer1024

Perform 1024 transfers by edge trigger

enum \_dma\_burst\_wrap

DMA burst wrapping.

*Values:*

enumerator kDMA\_NoWrap

Wrapping is disabled

enumerator kDMA\_SrcWrap

Wrapping is enabled for source

enumerator kDMA\_DstWrap

Wrapping is enabled for destination

enumerator kDMA\_SrcAndDstWrap

Wrapping is enabled for source and destination

enum \_dma\_transfer\_type

DMA transfer type.

*Values:*

enumerator kDMA\_MemoryToMemory

Transfer from memory to memory (increment source and destination)

enumerator `kDMA_PeripheralToMemory`  
Transfer from peripheral to memory (increment only destination)

enumerator `kDMA_MemoryToPeripheral`  
Transfer from memory to peripheral (increment only source)

enumerator `kDMA_StaticToStatic`  
Peripheral to static memory (do not increment source or destination)

typedef struct *`_dma_descriptor`* `dma_descriptor_t`  
DMA descriptor structure.

typedef struct *`_dma_xfercfg`* `dma_xfercfg_t`  
DMA transfer configuration.

typedef enum *`_dma_priority`* `dma_priority_t`  
DMA channel priority.

typedef enum *`_dma_int`* `dma_irq_t`  
DMA interrupt flags.

typedef enum *`_dma_trigger_type`* `dma_trigger_type_t`  
DMA trigger type.

typedef enum *`_dma_trigger_burst`* `dma_trigger_burst_t`  
DMA trigger burst.

typedef enum *`_dma_burst_wrap`* `dma_burst_wrap_t`  
DMA burst wrapping.

typedef enum *`_dma_transfer_type`* `dma_transfer_type_t`  
DMA transfer type.

typedef struct *`_dma_channel_trigger`* `dma_channel_trigger_t`  
DMA channel trigger.

typedef struct *`_dma_channel_config`* `dma_channel_config_t`  
DMA channel trigger.

typedef struct *`_dma_transfer_config`* `dma_transfer_config_t`  
DMA transfer configuration.

typedef void (\**`dma_callback`*)(struct *`_dma_handle`* \*handle, void \*userData, bool transferDone, uint32\_t intmode)  
Define Callback function for DMA.

typedef struct *`_dma_handle`* `dma_handle_t`  
DMA transfer handle structure.

`DMA_MAX_TRANSFER_COUNT`  
DMA max transfer size.

`FSL_FEATURE_DMA_NUMBER_OF_CHANNELSn(x)`  
DMA channel numbers.

`FSL_FEATURE_DMA_MAX_CHANNELS`

`FSL_FEATURE_DMA_ALL_CHANNELS`

`FSL_FEATURE_DMA_LINK_DESCRIPTOR_ALIGN_SIZE`  
DMA head link descriptor table align size.



`DMA_ALLOCATE_HEAD_DESCRIPTOR(name, number)`

DMA head descriptor table allocate macro To simplify user interface, this macro will help allocate descriptor memory, user just need to provide the name and the number for the allocate descriptor.

**Parameters**

- name – Allocate decriptor name.
- number – Number of descriptor to be allocated.

`DMA_ALLOCATE_HEAD_DESCRIPTOR_AT_NONCACHEABLE(name, number)`

DMA head descriptor table allocate macro at noncacheable section To simplify user interface, this macro will help allocate descriptor memory at noncacheable section, user just need to provide the name and the number for the allocate descriptor.

**Parameters**

- name – Allocate decriptor name.
- number – Number of descriptor to be allocated.

`DMA_ALLOCATE_LINK_DESCRIPTOR(name, number)`

DMA link descriptor table allocate macro To simplify user interface, this macro will help allocate descriptor memory, user just need to provide the name and the number for the allocate descriptor.

**Parameters**

- name – Allocate decriptor name.
- number – Number of descriptor to be allocated.

`DMA_ALLOCATE_LINK_DESCRIPTOR_AT_NONCACHEABLE(name, number)`

DMA link descriptor table allocate macro at noncacheable section To simplify user interface, this macro will help allocate descriptor memory at noncacheable section, user just need to provide the name and the number for the allocate descriptor.

**Parameters**

- name – Allocate decriptor name.
- number – Number of descriptor to be allocated.

`DMA_ALLOCATE_DATA_TRANSFER_BUFFER(name, width)`

DMA transfer buffer address need to align with the transfer width.

`DMA_CHANNEL_GROUP(channel)`

`DMA_CHANNEL_INDEX(base, channel)`

`DMA_COMMON_REG_GET(base, channel, reg)`

DMA linked descriptor address algin size.

`DMA_COMMON_CONST_REG_GET(base, channel, reg)`

`DMA_COMMON_REG_SET(base, channel, reg, value)`

`DMA_DESCRIPTOR_END_ADDRESS(start, inc, bytes, width)`

DMA descriptor end address calculate.

**Parameters**

- start – start address
- inc – address interleave size
- bytes – transfer bytes

- width – transfer width

DMA\_CHANNEL\_XFER(reload, clrTrig, intA, intB, width, srcInc, dstInc, bytes)

struct \_\_dma\_descriptor

*#include <fsl\_dma.h>* DMA descriptor structure.

### Public Members

volatile uint32\_t xfercfg

Transfer configuration

void \*srcEndAddr

Last source address of DMA transfer

void \*dstEndAddr

Last destination address of DMA transfer

void \*linkToNextDesc

Address of next DMA descriptor in chain

struct \_\_dma\_xfercfg

*#include <fsl\_dma.h>* DMA transfer configuration.

### Public Members

bool valid

Descriptor is ready to transfer

bool reload

Reload channel configuration register after current descriptor is exhausted

bool swtrig

Perform software trigger. Transfer if fired when 'valid' is set

bool clrtrig

Clear trigger

bool intA

Raises IRQ when transfer is done and set IRQA status register flag

bool intB

Raises IRQ when transfer is done and set IRQB status register flag

uint8\_t byteWidth

Byte width of data to transfer

uint8\_t srcInc

Increment source address by 'srcInc' x 'byteWidth'

uint8\_t dstInc

Increment destination address by 'dstInc' x 'byteWidth'

uint16\_t transferCount

Number of transfers

struct \_\_dma\_channel\_trigger

*#include <fsl\_dma.h>* DMA channel trigger.

### Public Members

*dma\_trigger\_type\_t* type

Select hardware trigger as edge triggered or level triggered.

*dma\_trigger\_burst\_t* burst

Select whether hardware triggers cause a single or burst transfer.

*dma\_burst\_wrap\_t* wrap

Select wrap type, source wrap or dest wrap, or both.

struct *\_dma\_channel\_config*

*#include <fsl\_dma.h>* DMA channel trigger.

### Public Members

void \*srcStartAddr

Source data address

void \*dstStartAddr

Destination data address

void \*nextDesc

Chain custom descriptor

uint32\_t xferCfg

channel transfer configurations

*dma\_channel\_trigger\_t* \*trigger

DMA trigger type

bool isPeriph

select the request type

struct *\_dma\_transfer\_config*

*#include <fsl\_dma.h>* DMA transfer configuration.

### Public Members

uint8\_t \*srcAddr

Source data address

uint8\_t \*dstAddr

Destination data address

uint8\_t \*nextDesc

Chain custom descriptor

*dma\_xfercfg\_t* xfercfg

Transfer options

bool isPeriph

DMA transfer is driven by peripheral

struct *\_dma\_handle*

*#include <fsl\_dma.h>* DMA transfer handle structure.

### Public Members

*dma\_callback* callback

Callback function. Invoked when transfer of descriptor with interrupt flag finishes

void \*userData

Callback function parameter

DMA\_Type \*base

DMA peripheral base address

uint8\_t channel

DMA channel number

## 2.5 FTM: FlexTimer Driver

*status\_t* FTM\_Init(FTM\_Type \*base, const *ftm\_config\_t* \*config)

Ungates the FTM clock and configures the peripheral for basic operation.

---

**Note:** This API should be called at the beginning of the application which is using the FTM driver. If the FTM instance has only TPM features, please use the TPM driver.

---

### Parameters

- base – FTM peripheral base address
- config – Pointer to the user configuration structure.

### Returns

kStatus\_Success indicates success; Else indicates failure.

void FTM\_Deinit(FTM\_Type \*base)

Gates the FTM clock.

### Parameters

- base – FTM peripheral base address

void FTM\_GetDefaultConfig(*ftm\_config\_t* \*config)

Fills in the FTM configuration structure with the default settings.

The default values are:

```
config->prescale = kFTM_Prescale_Divide_1;
config->bdmMode = kFTM_BdmMode_0;
config->pwmSyncMode = kFTM_SoftwareTrigger;
config->reloadPoints = 0;
config->faultMode = kFTM_Fault_Disable;
config->faultFilterValue = 0;
config->deadTimePrescale = kFTM_Deadtime_Prescale_1;
config->deadTimeValue = 0;
config->extTriggers = 0;
config->chnlInitState = 0;
config->chnlPolarity = 0;
config->useGlobalTimeBase = false;
config->hwTriggerResetCount = false;
config->swTriggerResetCount = true;
```

### Parameters

- `config` – Pointer to the user configuration structure.

```
static inline ftm_clock_prescale_t FTM_CalculateCounterClkDiv(FTM_Type *base, uint32_t
counterPeriod_Hz, uint32_t
srcClock_Hz)
```

brief Calculates the counter clock prescaler.

This function calculates the values for SC[PS] bit.

param base FTM peripheral base address param counterPeriod\_Hz The desired frequency in Hz which corresponding to the time when the counter reaches the mod value param srcClock\_Hz FTM counter clock in Hz

return Calculated clock prescaler value, see `ftm_clock_prescale_t`.

```
status_t FTM_SetupPwm(FTM_Type *base, const ftm_chnl_pwm_signal_param_t *chnlParams,
uint8_t numOfChnls, ftm_pwm_mode_t mode, uint32_t pwmFreq_Hz,
uint32_t srcClock_Hz)
```

Configures the PWM signal parameters.

Call this function to configure the PWM signal period, mode, duty cycle, and edge. Use this function to configure all FTM channels that are used to output a PWM signal.

#### Parameters

- base – FTM peripheral base address
- 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
- mode – PWM operation mode, options available in enumeration `ftm_pwm_mode_t`
- pwmFreq\_Hz – PWM signal frequency in Hz
- srcClock\_Hz – FTM counter clock in Hz

#### Returns

`kStatus_Success` if the PWM setup was successful `kStatus_Error` on failure

```
status_t FTM_UpdatePwmDutycycle(FTM_Type *base, ftm_chnl_t chnlNumber, ftm_pwm_mode_t
currentPwmMode, uint8_t dutyCyclePercent)
```

Updates the duty cycle of an active PWM signal.

#### Parameters

- base – FTM peripheral base address
- chnlNumber – The channel/channel pair number. In combined mode, this represents the channel pair number
- currentPwmMode – The current PWM mode set during PWM setup
- dutyCyclePercent – New PWM pulse width; The value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

#### Returns

`kStatus_Success` if the PWM update was successful `kStatus_Error` on failure

```
void FTM_UpdateChnlEdgeLevelSelect(FTM_Type *base, ftm_chnl_t chnlNumber, uint8_t level)
```

Updates the edge level selection for a channel.

#### Parameters

- base – FTM peripheral base address

- `chnlNumber` – The channel number
- `level` – The level to be set to the `ELSnB:ELSnA` field; Valid values are 00, 01, 10, 11. See the Kinetis SoC reference manual for details about this field.

`status_t` FTM\_SetupPwmMode(FTM\_Type \*base, const *ftm\_chnl\_pwm\_config\_param\_t* \*chnlParams, uint8\_t numOfChnls, *ftm\_pwm\_mode\_t* mode)

Configures the PWM mode parameters.

Call this function to configure the PWM signal mode, duty cycle in ticks, and edge. Use this function to configure all FTM channels that are used to output a PWM signal. Please note that: This API is similar with `FTM_SetupPwm()` API, but will not set the timer period, and this API will set channel match value in timer ticks, not period percent.

#### Parameters

- `base` – FTM peripheral base address
- `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
- `mode` – PWM operation mode, options available in enumeration *ftm\_pwm\_mode\_t*

#### Returns

`kStatus_Success` if the PWM setup was successful `kStatus_Error` on failure

`void` FTM\_ConfigSinglePWM(FTM\_Type \*base, const *ftm\_chnl\_param\_t* \*chnlParams, *ftm\_chnl\_t* chnlNumber)

Configure FTM edge aligned PWM or center aligned PWM by each channel.

This function configure PWM signal by setting channel n value register. Need to invoke `FTM_SetInitialModuloValue` to configure FTM period.

#### Parameters

- `base` – FTM peripheral base address
- `chnlParams` – PWM configuration structure pointer.
- `chnlPairNumber` – Channel number.

`void` FTM\_ConfigCombinePWM(FTM\_Type \*base, const *ftm\_chnl\_param\_t* \*chnlParams, *ftm\_chnl\_t* chnlPairNumber)

Configure FTM Combine PWM, Modified Combine PWM or Asymmetrical PWM by each channel pair.

This function configure PWM signal by setting channel n value register. Need to invoke `FTM_SetInitialModuloValue` to configure FTM period.

#### Parameters

- `base` – FTM peripheral base address
- `chnlParams` – PWM configuration structure pointer.
- `chnlPairNumber` – Channel pair number, options are 0, 1, 2, 3.

`void` FTM\_SetupInputCapture(FTM\_Type \*base, *ftm\_chnl\_t* chnlNumber, *ftm\_input\_capture\_edge\_t* captureMode, uint32\_t filterValue)

Enables capturing an input signal on the channel using the function parameters.

When the edge specified in the `captureMode` argument occurs on the channel, the FTM counter is captured into the `CnV` register. The user has to read the `CnV` register separately

to get this value. The filter function is disabled if the filterVal argument passed in is 0. The filter function is available only for channels 0, 1, 2, 3.

#### Parameters

- base – FTM peripheral base address
- chnlNumber – The channel number
- captureMode – Specifies which edge to capture
- filterValue – Filter value, specify 0 to disable filter. Available only for channels 0-3.

```
void FTM_SetupOutputCompare(FTM_Type *base, ftm_chnl_t chnlNumber,  
                             ftm_output_compare_mode_t compareMode, uint32_t  
                             compareValue)
```

Configures the FTM to generate timed pulses.

When the FTM counter matches the value of compareVal argument (this is written into CnV reg), the channel output is changed based on what is specified in the compareMode argument.

#### Parameters

- base – FTM peripheral base address
- chnlNumber – The channel number
- compareMode – Action to take on the channel output when the compare condition is met
- compareValue – Value to be programmed in the CnV register.

```
void FTM_SetupDualEdgeCapture(FTM_Type *base, ftm_chnl_t chnlPairNumber, const  
                               ftm_dual_edge_capture_param_t *edgeParam, uint32_t  
                               filterValue)
```

Configures the dual edge capture mode of the FTM.

This function sets up the dual edge capture mode on a channel pair. The capture edge for the channel pair and the capture mode (one-shot or continuous) is specified in the parameter argument. The filter function is disabled if the filterVal argument passed is zero. The filter function is available only on channels 0 and 2. The user has to read the channel CnV registers separately to get the capture values.

#### Parameters

- base – FTM peripheral base address
- chnlPairNumber – The FTM channel pair number; options are 0, 1, 2, 3
- edgeParam – Sets up the dual edge capture function
- filterValue – Filter value, specify 0 to disable filter. Available only for channel pair 0 and 1.

```
void FTM_EnableInterrupts(FTM_Type *base, uint32_t mask)
```

Enables the selected FTM interrupts.

#### Parameters

- base – FTM peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration *ftm\_interrupt\_enable\_t*

```
void FTM_DisableInterrupts(FTM_Type *base, uint32_t mask)
```

Disables the selected FTM interrupts.

**Parameters**

- base – FTM peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration `ftm_interrupt_enable_t`

`uint32_t FTM_GetEnabledInterrupts(FTM_Type *base)`

Gets the enabled FTM interrupts.

**Parameters**

- base – FTM peripheral base address

**Returns**

The enabled interrupts. This is the logical OR of members of the enumeration `ftm_interrupt_enable_t`

`uint32_t FTM_GetInstance(FTM_Type *base)`

Gets the instance from the base address.

**Parameters**

- base – FTM peripheral base address

**Returns**

The FTM instance

`uint32_t FTM_GetStatusFlags(FTM_Type *base)`

Gets the FTM status flags.

**Parameters**

- base – FTM peripheral base address

**Returns**

The status flags. This is the logical OR of members of the enumeration `ftm_status_flags_t`

`void FTM_ClearStatusFlags(FTM_Type *base, uint32_t mask)`

Clears the FTM status flags.

**Parameters**

- base – FTM peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration `ftm_status_flags_t`

`static inline void FTM_SetTimerPeriod(FTM_Type *base, uint32_t ticks)`

Sets the timer period in units of ticks.

Timers counts from 0 until it equals the count value set here. The count value is written to the MOD register.

---

**Note:**

- This API allows the user to use the FTM module as a timer. Do not mix usage of this API with FTM's PWM setup API's.
  - Call the utility macros provided in the `fsl_common.h` to convert `usec` or `msec` to ticks.
- 

**Parameters**

- base – FTM peripheral base address



- ticks – A timer period in units of ticks, which should be equal or greater than 1.

```
static inline void FTM_SetInitialModuloValue(FTM_Type *base, uint16_t initialValue, uint16_t moduloValue)
```

Set initial value and modulo value for FTM.

#### Parameters

- base – FTM peripheral base address
- initialValue – FTM counter initial value.
- moduloValue – FTM counter modulo value.

```
static inline uint32_t FTM_GetCurrentTimerCount(FTM_Type *base)
```

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:** Call the utility macros provided in the `fsl_common.h` to convert ticks to usec or msec.

---

#### Parameters

- base – FTM peripheral base address

#### Returns

The current counter value in ticks

```
static inline void FTM_SetChannelMatchValue(FTM_Type *base, ftm_chnl_t chnlNumber, uint16_t value)
```

Set channel match value for output.

#### Parameters

- base – FTM peripheral base address
- chnlNumber – Channel to set.
- value – Channel match value for output.

```
static inline uint32_t FTM_GetInputCaptureValue(FTM_Type *base, ftm_chnl_t chnlNumber)
```

Reads the captured value.

This function returns the captured value of a FTM channel configured in input capture or dual edge capture mode.

---

**Note:** Call the utility macros provided in the `fsl_common.h` to convert ticks to usec or msec.

---

#### Parameters

- base – FTM peripheral base address
- chnlNumber – Channel to be read

#### Returns

The captured FTM counter value of the input modes.

```
static inline void FTM_StartTimer(FTM_Type *base, ftm_clock_source_t clockSource)
```

Starts the FTM counter.

#### Parameters

- base – FTM peripheral base address

- clockSource – FTM clock source; After the clock source is set, the counter starts running.

static inline void FTM\_StopTimer(FTM\_Type \*base)

Stops the FTM counter.

#### Parameters

- base – FTM peripheral base address

static inline uint32\_t FTM\_GetSoftwareOutputValue(FTM\_Type \*base)

Get channel software output status.

#### Parameters

- base – FTM peripheral base address

#### Returns

Status of channel software output, logical OR value of `ftm_channel_index_t`.

static inline uint32\_t FTM\_GetSoftwareOutputEnable(FTM\_Type \*base)

Get channel software enable status.

#### Parameters

- base – FTM peripheral base address

#### Returns

Status of channel software enable, logical OR value of `ftm_channel_index_t`.

static inline void FTM\_SetSoftwareOutputCtrl(FTM\_Type \*base, uint32\_t chnlEnable, uint32\_t chnlValue)

Enables or disables the channel software output control and set channel software output value.

#### Parameters

- base – FTM peripheral base address
- chnlEnable – Channels to enable or disable software output control, logical OR of enumeration `ftm_channel_index_t` members.
- chnlValue – Channels output value, logical OR of enumeration `ftm_channel_index_t` members

static inline void FTM\_SetSoftwareCtrlEnable(FTM\_Type \*base, *ftm\_chnl\_t* chnlNumber, bool value)

Enables or disables the channel software output control.

#### Parameters

- base – FTM peripheral base address
- chnlNumber – Channel to be enabled or disabled
- value – true: channel output is affected by software output control false: channel output is unaffected by software output control

static inline void FTM\_SetSoftwareCtrlVal(FTM\_Type \*base, *ftm\_chnl\_t* chnlNumber, bool value)

Sets the channel software output control value.

#### Parameters

- base – FTM peripheral base address.
- chnlNumber – Channel to be configured
- value – true to set 1, false to set 0

```
static inline void FTM_SetFaultControlEnable(FTM_Type *base, ftm_chnl_t chnlPairNumber,
                                             bool value)
```

This function enables/disables the fault control in a channel pair.

#### Parameters

- base – FTM peripheral base address
- chnlPairNumber – The FTM channel pair number; options are 0, 1, 2, 3
- value – true: Enable fault control for this channel pair; false: No fault control

```
static inline void FTM_SetDeadTimeEnable(FTM_Type *base, ftm_chnl_t chnlPairNumber, bool
                                         value)
```

This function enables/disables the dead time insertion in a channel pair.

#### Parameters

- base – FTM peripheral base address
- chnlPairNumber – The FTM channel pair number; options are 0, 1, 2, 3
- value – true: Insert dead time in this channel pair; false: No dead time inserted

```
static inline void FTM_SetComplementaryEnable(FTM_Type *base, ftm_chnl_t chnlPairNumber,
                                              bool value)
```

This function enables/disables complementary mode in a channel pair.

#### Parameters

- base – FTM peripheral base address
- chnlPairNumber – The FTM channel pair number; options are 0, 1, 2, 3
- value – true: enable complementary mode; false: disable complementary mode

```
static inline void FTM_SetInvertEnable(FTM_Type *base, ftm_chnl_t chnlPairNumber, bool
                                       value)
```

This function enables/disables inverting control in a channel pair.

#### Parameters

- base – FTM peripheral base address
- chnlPairNumber – The FTM channel pair number; options are 0, 1, 2, 3
- value – true: enable inverting; false: disable inverting

```
void FTM_SetupQuadDecode(FTM_Type *base, const ftm_phase_params_t *phaseAParams,
                        const ftm_phase_params_t *phaseBParams,
                        ftm_quad_decode_mode_t quadMode)
```

Configures the parameters and activates the quadrature decoder mode.

#### Parameters

- base – FTM peripheral base address
- phaseAParams – Phase A configuration parameters
- phaseBParams – Phase B configuration parameters
- quadMode – Selects encoding mode used in quadrature decoder mode

```
static inline uint32_t FTM_GetQuadDecoderFlags(FTM_Type *base)
```

Gets the FTM Quad Decoder flags.

**Parameters**

- base – FTM peripheral base address.

**Returns**

Flag mask of FTM Quad Decoder, see `_ftm_quad_decoder_flags`.

```
static inline void FTM_SetQuadDecoderModuloValue(FTM_Type *base, uint32_t startValue,  
                                                uint32_t overValue)
```

Sets the modulo values for Quad Decoder.

The modulo values configure the minimum and maximum values that the Quad decoder counter can reach. After the counter goes over, the counter value goes to the other side and decrease/increase again.

**Parameters**

- base – FTM peripheral base address.
- startValue – The low limit value for Quad Decoder counter.
- overValue – The high limit value for Quad Decoder counter.

```
static inline uint32_t FTM_GetQuadDecoderCounterValue(FTM_Type *base)
```

Gets the current Quad Decoder counter value.

**Parameters**

- base – FTM peripheral base address.

**Returns**

Current quad Decoder counter value.

```
static inline void FTM_ClearQuadDecoderCounterValue(FTM_Type *base)
```

Clears the current Quad Decoder counter value.

The counter is set as the initial value.

**Parameters**

- base – FTM peripheral base address.

```
FSL_FTM_DRIVER_VERSION
```

FTM driver version 2.7.1.

```
enum _ftm_chnl
```

List of FTM channels.

---

**Note:** Actual number of available channels is SoC dependent

---

*Values:*

enumerator kFTM\_Chnl\_0  
FTM channel number 0

enumerator kFTM\_Chnl\_1  
FTM channel number 1

enumerator kFTM\_Chnl\_2  
FTM channel number 2

enumerator kFTM\_Chnl\_3  
FTM channel number 3

enumerator kFTM\_Chnl\_4  
FTM channel number 4

enumerator kFTM\_Chnl\_5  
FTM channel number 5

enumerator kFTM\_Chnl\_6  
FTM channel number 6

enumerator kFTM\_Chnl\_7  
FTM channel number 7

enum \_ftm\_fault\_input  
List of FTM faults.

*Values:*

enumerator kFTM\_Fault\_0  
FTM fault 0 input pin

enumerator kFTM\_Fault\_1  
FTM fault 1 input pin

enumerator kFTM\_Fault\_2  
FTM fault 2 input pin

enumerator kFTM\_Fault\_3  
FTM fault 3 input pin

enum \_ftm\_pwm\_mode  
FTM PWM operation modes.

*Values:*

enumerator kFTM\_EdgeAlignedPwm  
Edge-aligned PWM

enumerator kFTM\_CenterAlignedPwm  
Center-aligned PWM

enumerator kFTM\_EdgeAlignedCombinedPwm  
Edge-aligned combined PWM

enumerator kFTM\_CenterAlignedCombinedPwm  
Center-aligned combined PWM

enumerator kFTM\_AsymmetricalCombinedPwm  
Asymmetrical combined PWM

enum \_ftm\_pwm\_level\_select  
FTM PWM output pulse mode: high-true, low-true or no output.

---

**Note:** kFTM\_NoPwmSignal: ELSnB:ELSnA = 0:0 kFTM\_LowTrue: ELSnB:ELSnA = 0:1  
EPWM: Channel n output is forced low at counter overflow, forced high at channel n match.  
CPWM: Channel n output is forced low at channel n match when counting down, and forced high at channel n match when counting up. Combined PWM: Channel n output is forced high at beginning of period and at channel n+1 match. It is forced low at the channel n match. kFTM\_HighTrue: ELSnB:ELSnA = 1:0 EPWM: Channel n output is forced high at counter overflow, forced low at channel n match. CPWM: Channel n output is forced high at channel n match when counting down, and forced low at channel n match when counting up. Combined PWM: Channel n output is forced low at beginning of period and at channel n+1 match. It is forced high at the channel n match.

---

*Values:*

enumerator kFTM\_NoPwmSignal

No PWM output on pin

enumerator kFTM\_LowTrue

Low true pulses

enumerator kFTM\_HighTrue

High true pulses

enum \_ftm\_output\_compare\_mode

FlexTimer output compare mode.

*Values:*

enumerator kFTM\_NoOutputSignal

No channel output when counter reaches CnV

enumerator kFTM\_ToggleOnMatch

Toggle output

enumerator kFTM\_ClearOnMatch

Clear output

enumerator kFTM\_SetOnMatch

Set output

enum \_ftm\_input\_capture\_edge

FlexTimer input capture edge.

*Values:*

enumerator kFTM\_RisingEdge

Capture on rising edge only

enumerator kFTM\_FallingEdge

Capture on falling edge only

enumerator kFTM\_RiseAndFallEdge

Capture on rising or falling edge

enum \_ftm\_dual\_edge\_capture\_mode

FlexTimer dual edge capture modes.

*Values:*

enumerator kFTM\_OneShot

One-shot capture mode

enumerator kFTM\_Continuous

Continuous capture mode

enum \_ftm\_quad\_decode\_mode

FlexTimer quadrature decode modes.

*Values:*

enumerator kFTM\_QuadPhaseEncode

Phase A and Phase B encoding mode

enumerator kFTM\_QuadCountAndDir

Count and direction encoding mode

enum \_ftm\_phase\_polarity

FlexTimer quadrature phase polarities.

*Values:*

enumerator kFTM\_QuadPhaseNormal

Phase input signal is not inverted

enumerator kFTM\_QuadPhaseInvert

Phase input signal is inverted

enum \_ftm\_deadtime\_prescale

FlexTimer pre-scaler factor for the dead time insertion.

*Values:*

enumerator kFTM\_Deadtime\_Prescale\_1

Divide by 1

enumerator kFTM\_Deadtime\_Prescale\_4

Divide by 4

enumerator kFTM\_Deadtime\_Prescale\_16

Divide by 16

enum \_ftm\_clock\_source

FlexTimer clock source selection.

*Values:*

enumerator kFTM\_SystemClock

System clock selected

enumerator kFTM\_FixedClock

Fixed frequency clock

enumerator kFTM\_ExternalClock

External clock

enum \_ftm\_clock\_prescale

FlexTimer pre-scaler factor selection for the clock source.

*Values:*

enumerator kFTM\_Prescale\_Divide\_1

Divide by 1

enumerator kFTM\_Prescale\_Divide\_2

Divide by 2

enumerator kFTM\_Prescale\_Divide\_4

Divide by 4

enumerator kFTM\_Prescale\_Divide\_8

Divide by 8

enumerator kFTM\_Prescale\_Divide\_16

Divide by 16

enumerator kFTM\_Prescale\_Divide\_32

Divide by 32

enumerator kFTM\_Prescale\_Divide\_64

Divide by 64

enumerator kFTM\_Prescale\_Divide\_128

Divide by 128

enum \_ftm\_bdm\_mode

Options for the FlexTimer behaviour in BDM Mode.

*Values:*

enumerator kFTM\_BdmMode\_0

FTM counter stopped, CH(n)F bit can be set, FTM channels in functional mode, writes to MOD,CNTIN and C(n)V registers bypass the register buffers

enumerator kFTM\_BdmMode\_1

FTM counter stopped, CH(n)F bit is not set, FTM channels outputs are forced to their safe value , writes to MOD,CNTIN and C(n)V registers bypass the register buffers

enumerator kFTM\_BdmMode\_2

FTM counter stopped, CH(n)F bit is not set, FTM channels outputs are frozen when chip enters in BDM mode, writes to MOD,CNTIN and C(n)V registers bypass the register buffers

enumerator kFTM\_BdmMode\_3

FTM counter in functional mode, CH(n)F bit can be set, FTM channels in functional mode, writes to MOD,CNTIN and C(n)V registers is in fully functional mode

enum \_ftm\_fault\_mode

Options for the FTM fault control mode.

*Values:*

enumerator kFTM\_Fault\_Disable

Fault control is disabled for all channels

enumerator kFTM\_Fault\_EvenChnls

Enabled for even channels only(0,2,4,6) with manual fault clearing

enumerator kFTM\_Fault\_AllChnlsMan

Enabled for all channels with manual fault clearing

enumerator kFTM\_Fault\_AllChnlsAuto

Enabled for all channels with automatic fault clearing

enum \_ftm\_external\_trigger

FTM external trigger options.

---

**Note:** Actual available external trigger sources are SoC-specific

---

*Values:*

enumerator kFTM\_Chnl0Trigger

Generate trigger when counter equals chnl 0 CnV reg

enumerator kFTM\_Chnl1Trigger

Generate trigger when counter equals chnl 1 CnV reg

enumerator kFTM\_Chnl2Trigger

Generate trigger when counter equals chnl 2 CnV reg

enumerator kFTM\_Chnl3Trigger

Generate trigger when counter equals chnl 3 CnV reg



enumerator kFTM\_Chnl4Trigger

Generate trigger when counter equals chnl 4 CnV reg

enumerator kFTM\_Chnl5Trigger

Generate trigger when counter equals chnl 5 CnV reg

enumerator kFTM\_Chnl6Trigger

Available on certain SoC's, generate trigger when counter equals chnl 6 CnV reg

enumerator kFTM\_Chnl7Trigger

Available on certain SoC's, generate trigger when counter equals chnl 7 CnV reg

enumerator kFTM\_InitTrigger

Generate Trigger when counter is updated with CNTIN

enumerator kFTM\_ReloadInitTrigger

Available on certain SoC's, trigger on reload point

enum \_ftm\_pwm\_sync\_method

FlexTimer PWM sync options to update registers with buffer.

*Values:*

enumerator kFTM\_SoftwareTrigger

Software triggers PWM sync

enumerator kFTM\_HardwareTrigger\_0

Hardware trigger 0 causes PWM sync

enumerator kFTM\_HardwareTrigger\_1

Hardware trigger 1 causes PWM sync

enumerator kFTM\_HardwareTrigger\_2

Hardware trigger 2 causes PWM sync

enum \_ftm\_reload\_point

FTM options available as loading point for register reload.

---

**Note:** Actual available reload points are SoC-specific

---

*Values:*

enumerator kFTM\_Chnl0Match

Channel 0 match included as a reload point

enumerator kFTM\_Chnl1Match

Channel 1 match included as a reload point

enumerator kFTM\_Chnl2Match

Channel 2 match included as a reload point

enumerator kFTM\_Chnl3Match

Channel 3 match included as a reload point

enumerator kFTM\_Chnl4Match

Channel 4 match included as a reload point

enumerator kFTM\_Chnl5Match

Channel 5 match included as a reload point

enumerator kFTM\_Chnl6Match

Channel 6 match included as a reload point

enumerator kFTM\_Chnl7Match

Channel 7 match included as a reload point

enumerator kFTM\_CntMax

Use in up-down count mode only, reload when counter reaches the maximum value

enumerator kFTM\_CntMin

Use in up-down count mode only, reload when counter reaches the minimum value

enumerator kFTM\_HalfCycMatch

Available on certain SoC's, half cycle match reload point

enum \_ftm\_interrupt\_enable

List of FTM interrupts.

---

**Note:** Actual available interrupts are SoC-specific

---

*Values:*

enumerator kFTM\_Chnl0InterruptEnable

Channel 0 interrupt

enumerator kFTM\_Chnl1InterruptEnable

Channel 1 interrupt

enumerator kFTM\_Chnl2InterruptEnable

Channel 2 interrupt

enumerator kFTM\_Chnl3InterruptEnable

Channel 3 interrupt

enumerator kFTM\_Chnl4InterruptEnable

Channel 4 interrupt

enumerator kFTM\_Chnl5InterruptEnable

Channel 5 interrupt

enumerator kFTM\_Chnl6InterruptEnable

Channel 6 interrupt

enumerator kFTM\_Chnl7InterruptEnable

Channel 7 interrupt

enumerator kFTM\_FaultInterruptEnable

Fault interrupt

enumerator kFTM\_TimeOverflowInterruptEnable

Time overflow interrupt

enumerator kFTM\_ReloadInterruptEnable

Reload interrupt; Available only on certain SoC's

enum \_ftm\_status\_flags

List of FTM flags.

---

**Note:** Actual available flags are SoC-specific

---

*Values:*

enumerator kFTM\_Chnl0Flag  
Channel 0 Flag

enumerator kFTM\_Chnl1Flag  
Channel 1 Flag

enumerator kFTM\_Chnl2Flag  
Channel 2 Flag

enumerator kFTM\_Chnl3Flag  
Channel 3 Flag

enumerator kFTM\_Chnl4Flag  
Channel 4 Flag

enumerator kFTM\_Chnl5Flag  
Channel 5 Flag

enumerator kFTM\_Chnl6Flag  
Channel 6 Flag

enumerator kFTM\_Chnl7Flag  
Channel 7 Flag

enumerator kFTM\_FaultFlag  
Fault Flag

enumerator kFTM\_TimeOverflowFlag  
Time overflow Flag

enumerator kFTM\_ChnlTriggerFlag  
Channel trigger Flag

enumerator kFTM\_ReloadFlag  
Reload Flag; Available only on certain SoC's

enum \_ftm\_channel\_index

List of FTM channel index used in logic OR.

*Values:*

enumerator kFTM\_Chnl0\_Mask  
Channel 0 Mask

enumerator kFTM\_Chnl1\_Mask  
Channel 1 Mask

enumerator kFTM\_Chnl2\_Mask  
Channel 2 Mask

enumerator kFTM\_Chnl3\_Mask  
Channel 3 Mask

enumerator kFTM\_Chnl4\_Mask  
Channel 4 Mask

enumerator kFTM\_Chnl5\_Mask  
Channel 5 Mask

enumerator kFTM\_Chnl6\_Mask  
Channel 6 Mask

enumerator kFTM\_Chnl7\_Mask  
Channel 7 Mask

List of FTM Quad Decoder flags.

*Values:*

enumerator kFTM\_QuadDecoderCountingIncreaseFlag  
Counting direction is increasing (FTM counter increment), or the direction is decreasing.

enumerator kFTM\_QuadDecoderCountingOverflowOnTopFlag  
Indicates if the TOF bit was set on the top or the bottom of counting.

typedef enum \_ftm\_chnl ftm\_chnl\_t  
List of FTM channels.

---

**Note:** Actual number of available channels is SoC dependent

---

typedef enum \_ftm\_fault\_input ftm\_fault\_input\_t  
List of FTM faults.

typedef enum \_ftm\_pwm\_mode ftm\_pwm\_mode\_t  
FTM PWM operation modes.

typedef enum \_ftm\_pwm\_level\_select ftm\_pwm\_level\_select\_t  
FTM PWM output pulse mode: high-true, low-true or no output.

---

**Note:** kFTM\_NoPwmSignal: ELSnB:ELSnA = 0:0 kFTM\_LowTrue: ELSnB:ELSnA = 0:1 EPWM: Channel n output is forced low at counter overflow, forced high at channel n match. CPWM: Channel n output is forced low at channel n match when counting down, and forced high at channel n match when counting up. Combined PWM: Channel n output is forced high at beginning of period and at channel n+1 match. It is forced low at the channel n match. kFTM\_HighTrue: ELSnB:ELSnA = 1:0 EPWM: Channel n output is forced high at counter overflow, forced low at channel n match. CPWM: Channel n output is forced high at channel n match when counting down, and forced low at channel n match when counting up. Combined PWM: Channel n output is forced low at beginning of period and at channel n+1 match. It is forced high at the channel n match.

---

typedef struct \_ftm\_chnl\_pwm\_signal\_param ftm\_chnl\_pwm\_signal\_param\_t  
Options to configure a FTM channel's PWM signal.

typedef struct \_ftm\_chnl\_pwm\_config\_param ftm\_chnl\_pwm\_config\_param\_t  
Options to configure a FTM channel using precise setting.

typedef struct \_ftm\_chnl\_param ftm\_chnl\_param\_t  
General options to configure a FTM channel using precise setting.

typedef enum \_ftm\_output\_compare\_mode ftm\_output\_compare\_mode\_t  
FlexTimer output compare mode.

typedef enum \_ftm\_input\_capture\_edge ftm\_input\_capture\_edge\_t  
FlexTimer input capture edge.

typedef enum \_ftm\_dual\_edge\_capture\_mode ftm\_dual\_edge\_capture\_mode\_t  
FlexTimer dual edge capture modes.

typedef struct *\_ftm\_dual\_edge\_capture\_param* ftm\_dual\_edge\_capture\_param\_t  
FlexTimer dual edge capture parameters.

typedef enum *\_ftm\_quad\_decode\_mode* ftm\_quad\_decode\_mode\_t  
FlexTimer quadrature decode modes.

typedef enum *\_ftm\_phase\_polarity* ftm\_phase\_polarity\_t  
FlexTimer quadrature phase polarities.

typedef struct *\_ftm\_phase\_param* ftm\_phase\_params\_t  
FlexTimer quadrature decode phase parameters.

typedef struct *\_ftm\_fault\_param* ftm\_fault\_param\_t  
Structure is used to hold the parameters to configure a FTM fault.

typedef enum *\_ftm\_deadtime\_prescale* ftm\_deadtime\_prescale\_t  
FlexTimer pre-scaler factor for the dead time insertion.

typedef enum *\_ftm\_clock\_source* ftm\_clock\_source\_t  
FlexTimer clock source selection.

typedef enum *\_ftm\_clock\_prescale* ftm\_clock\_prescale\_t  
FlexTimer pre-scaler factor selection for the clock source.

typedef enum *\_ftm\_bdm\_mode* ftm\_bdm\_mode\_t  
Options for the FlexTimer behaviour in BDM Mode.

typedef enum *\_ftm\_fault\_mode* ftm\_fault\_mode\_t  
Options for the FTM fault control mode.

typedef enum *\_ftm\_external\_trigger* ftm\_external\_trigger\_t  
FTM external trigger options.

---

**Note:** Actual available external trigger sources are SoC-specific

---

typedef enum *\_ftm\_pwm\_sync\_method* ftm\_pwm\_sync\_method\_t  
FlexTimer PWM sync options to update registers with buffer.

typedef enum *\_ftm\_reload\_point* ftm\_reload\_point\_t  
FTM options available as loading point for register reload.

---

**Note:** Actual available reload points are SoC-specific

---

typedef enum *\_ftm\_interrupt\_enable* ftm\_interrupt\_enable\_t  
List of FTM interrupts.

---

**Note:** Actual available interrupts are SoC-specific

---

typedef enum *\_ftm\_status\_flags* ftm\_status\_flags\_t  
List of FTM flags.

---

**Note:** Actual available flags are SoC-specific

---

typedef enum *\_ftm\_channel\_index* ftm\_channel\_index\_t  
List of FTM channel index used in logic OR.

```
typedef struct _ftm_config ftm_config_t
```

FTM configuration structure.

This structure holds the configuration settings for the FTM peripheral. To initialize this structure to reasonable defaults, call the `FTM_GetDefaultConfig()` function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

```
void FTM_SetupFaultInput(FTM_Type *base, ftm_fault_input_t faultNumber, const  
                        ftm_fault_param_t *faultParams)
```

Sets up the working of the FTM fault inputs protection.

FTM can have up to 4 fault inputs. This function sets up fault parameters, fault level, and input filter.

#### Parameters

- `base` – FTM peripheral base address
- `faultNumber` – FTM fault to configure.
- `faultParams` – Parameters passed in to set up the fault

```
static inline void FTM_SetGlobalTimeBaseOutputEnable(FTM_Type *base, bool enable)
```

Enables or disables the FTM global time base signal generation to other FTMs.

#### Parameters

- `base` – FTM peripheral base address
- `enable` – true to enable, false to disable

```
static inline void FTM_SetOutputMask(FTM_Type *base, ftm_chnl_t chnlNumber, bool mask)
```

Sets the FTM peripheral timer channel output mask.

#### Parameters

- `base` – FTM peripheral base address
- `chnlNumber` – Channel to be configured
- `mask` – true: masked, channel is forced to its inactive state; false: un-masked

```
static inline void FTM_SetPwmOutputEnable(FTM_Type *base, ftm_chnl_t chnlNumber, bool  
                                         value)
```

Allows users to enable an output on an FTM channel.

To enable the PWM channel output call this function with `val=true`. For input mode, call this function with `val=false`.

#### Parameters

- `base` – FTM peripheral base address
- `chnlNumber` – Channel to be configured
- `value` – true: enable output; false: output is disabled, used in input mode

```
static inline void FTM_SetSoftwareTrigger(FTM_Type *base, bool enable)
```

Enables or disables the FTM software trigger for PWM synchronization.

#### Parameters

- `base` – FTM peripheral base address
- `enable` – true: software trigger is selected, false: software trigger is not selected

```
static inline void FTM_SetWriteProtection(FTM_Type *base, bool enable)
```

Enables or disables the FTM write protection.

#### Parameters

- base – FTM peripheral base address
- enable – true: Write-protection is enabled, false: Write-protection is disabled

```
static inline void FTM_EnableDmaTransfer(FTM_Type *base, ftm_chnl_t chnlNumber, bool enable)
```

Enable DMA transfer or not.

Note: CHnIE bit needs to be set when calling this API. The channel DMA transfer request is generated and the channel interrupt is not generated if (CHnF = 1) when DMA and CHnIE bits are set.

#### Parameters

- base – FTM peripheral base address.
- chnlNumber – Channel to be configured
- enable – true to enable, false to disable

```
static inline void FTM_SetLdok(FTM_Type *base, bool value)
```

Enable the LDOK bit.

This function enables loading updated values.

#### Parameters

- base – FTM peripheral base address
- value – true: loading updated values is enabled; false: loading updated values is disabled.

```
static inline void FTM_SetHalfCycReloadMatchValue(FTM_Type *base, uint32_t ticks)
```

Sets the half cycle relade period in units of ticks.

This function can be called to set the half-cycle reload value when half-cycle matching is enabled as a reload point. Note: Need enable kFTM\_HalfCycMatch as reload point, and when this API call after FTM\_StartTimer(), the new HCR value will not be active until next reload point (need call FTM\_SetLdok to set LDOK) or register synchronization.

#### Parameters

- base – FTM peripheral base address
- ticks – A timer period in units of ticks, which should be equal or greater than 1.

```
static inline void FTM_SetLoadFreq(FTM_Type *base, uint32_t loadfreq)
```

Set load frequency value.

#### Parameters

- base – FTM peripheral base address.
- loadfreq – PWM reload frequency, range: 0 ~ 31.

```
struct _ftm_chnl_pwm_signal_param
```

*#include <fsl\_ftm.h>* Options to configure a FTM channel's PWM signal.

### Public Members

*ftm\_chnl\_t* chnlNumber

The channel/channel pair number. In combined mode, this represents the channel pair number.

*ftm\_pwm\_level\_select\_t* level

PWM output active level select.

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).

uint8\_t firstEdgeDelayPercent

Used only in kFTM\_AsymmetricalCombinedPwm mode to generate an asymmetrical PWM. Specifies the delay to the first edge in a PWM period. If unsure leave as 0; Should be specified as a percentage of the PWM period

bool enableComplementary

Used only in combined PWM mode. true: The combined channels output complementary signals; false: The combined channels output same signals;

bool enableDeadtime

Used only in combined PWM mode with enable complementary. true: The deadtime insertion in this pair of channels is enabled; false: The deadtime insertion in this pair of channels is disabled.

struct *\_ftm\_chnl\_pwm\_config\_param*

*#include <fsl\_ftm.h>* Options to configure a FTM channel using precise setting.

### Public Members

*ftm\_chnl\_t* chnlNumber

The channel/channel pair number. In combined mode, this represents the channel pair number.

*ftm\_pwm\_level\_select\_t* level

PWM output active level select.

uint16\_t dutyValue

PWM pulse width, the uint of this value is timer ticks.

uint16\_t firstEdgeValue

Used only in kFTM\_AsymmetricalCombinedPwm mode to generate an asymmetrical PWM. Specifies the delay to the first edge in a PWM period. If unsure leave as 0, uint of this value is timer ticks.

bool enableComplementary

Used only in combined PWM mode. true: The combined channels output complementary signals; false: The combined channels output same signals;

bool enableDeadtime

Used only in combined PWM mode with enable complementary. true: The deadtime insertion in this pair of channels is enabled; false: The deadtime insertion in this pair of channels is disabled.

struct *\_ftm\_chnl\_param*

*#include <fsl\_ftm.h>* General options to configure a FTM channel using precise setting.



### Public Members

*ftm\_pwm\_mode\_t* mode

PWM output mode.

*ftm\_pwm\_level\_select\_t* level

PWM output active level select.

uint16\_t initialValue

FTM counter initial value.

uint16\_t moduloValue

FTM counter modulo value.

uint16\_t chnlValue

FTM channel n match value.

uint16\_t combinedChnlValue

FTM combined channel n+1 match value, used only in (modified) combined PWM mode.

bool enableComplementary

Used only in combined PWM mode. true: The combined channels output complementary signals; false: The combined channels output same signals;

bool enableDeadtime

Used only in combined PWM mode with enable complementary. true: The deadtime insertion in this pair of channels is enabled; false: The deadtime insertion in this pair of channels is disabled.

struct *\_ftm\_dual\_edge\_capture\_param*

*#include <fsl\_ftm.h>* FlexTimer dual edge capture parameters.

### Public Members

*ftm\_dual\_edge\_capture\_mode\_t* mode

Dual Edge Capture mode

*ftm\_input\_capture\_edge\_t* currChanEdgeMode

Input capture edge select for channel n

*ftm\_input\_capture\_edge\_t* nextChanEdgeMode

Input capture edge select for channel n+1

struct *\_ftm\_phase\_param*

*#include <fsl\_ftm.h>* FlexTimer quadrature decode phase parameters.

### Public Members

bool enablePhaseFilter

True: enable phase filter; false: disable filter

uint32\_t phaseFilterVal

Filter value, used only if phase filter is enabled

*ftm\_phase\_polarity\_t* phasePolarity

Phase polarity

struct *\_ftm\_fault\_param*

*#include <fsl\_ftm.h>* Structure is used to hold the parameters to configure a FTM fault.

### Public Members

`bool enableFaultInput`

True: Fault input is enabled; false: Fault input is disabled

`bool faultLevel`

True: Fault polarity is active low; in other words, '0' indicates a fault; False: Fault polarity is active high

`bool useFaultFilter`

True: Use the filtered fault signal; False: Use the direct path from fault input

`struct _ftm_config`

*#include <fsl\_ftm.h>* FTM configuration structure.

This structure holds the configuration settings for the FTM peripheral. To initialize this structure to reasonable defaults, call the `FTM_GetDefaultConfig()` function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

### Public Members

*ftm\_clock\_prescale\_t* prescale

FTM clock prescale value

*ftm\_bdm\_mode\_t* bdmMode

FTM behavior in BDM mode

`uint32_t` pwmSyncMode

Synchronization methods to use to update buffered registers; Multiple update modes can be used by providing an OR'ed list of options available in enumeration `ftm_pwm_sync_method_t`.

`uint32_t` reloadPoints

FTM reload points; When using this, the PWM synchronization is not required. Multiple reload points can be used by providing an OR'ed list of options available in enumeration `ftm_reload_point_t`.

*ftm\_fault\_mode\_t* faultMode

FTM fault control mode

`uint8_t` faultFilterValue

Fault input filter value

*ftm\_deadtime\_prescale\_t* deadTimePrescale

The dead time prescalar value

`uint32_t` deadTimeValue

The dead time value `deadTimeValue`'s available range is 0-1023 when register has DT-VALEX, otherwise its available range is 0-63.

`uint32_t` extTriggers

External triggers to enable. Multiple trigger sources can be enabled by providing an OR'ed list of options available in enumeration `ftm_external_trigger_t`.

`uint8_t` chnlInitState

Defines the initialization value of the channels in OUTINT register

`uint8_t` chnlPolarity

Defines the output polarity of the channels in POL register

bool useGlobalTimeBase

True: Use of an external global time base is enabled; False: disabled

bool swTriggerResetCount

FTM counter synchronization activated by software trigger, active when (syncMethod & FTM\_SYNC\_SWSYNC\_MASK) != 0U

bool hwTriggerResetCount

FTM counter synchronization activated by hardware trigger, active when (syncMethod & (FTM\_SYNC\_TRIG0\_MASK | FTM\_SYNC\_TRIG1\_MASK | FTM\_SYNC\_TRIG2\_MASK)) != 0U

## 2.6 I2C: Inter-Integrated Circuit Driver

### 2.7 I2C Driver

FSL\_I2C\_DRIVER\_VERSION

I2C driver version.

I2C status return codes.

*Values:*

enumerator kStatus\_I2C\_Busy

The master is already performing a transfer.

enumerator kStatus\_I2C\_Idle

The slave driver is idle.

enumerator kStatus\_I2C\_Nak

The slave device sent a NAK in response to a byte.

enumerator kStatus\_I2C\_InvalidParameter

Unable to proceed due to invalid parameter.

enumerator kStatus\_I2C\_BitError

Transferred bit was not seen on the bus.

enumerator kStatus\_I2C\_ArbitrationLost

Arbitration lost error.

enumerator kStatus\_I2C\_NoTransferInProgress

Attempt to abort a transfer when one is not in progress.

enumerator kStatus\_I2C\_DmaRequestFail

DMA request failed.

enumerator kStatus\_I2C\_StartStopError

Start and stop error.

enumerator kStatus\_I2C\_UnexpectedState

Unexpected state.

enumerator kStatus\_I2C\_Addr\_Nak

NAK received during the address probe.

enumerator kStatus\_I2C\_Timeout

Timeout polling status flags.

I2C\_RETRY\_TIMES

Retry times for waiting flag.

I2C\_STAT\_MSTCODE\_IDLE

Master Idle State Code

I2C\_STAT\_MSTCODE\_RXREADY

Master Receive Ready State Code

I2C\_STAT\_MSTCODE\_TXREADY

Master Transmit Ready State Code

I2C\_STAT\_MSTCODE\_NACKADR

Master NACK by slave on address State Code

I2C\_STAT\_MSTCODE\_NACKDAT

Master NACK by slave on data State Code

I2C\_STAT\_SLVST\_ADDR

I2C\_STAT\_SLVST\_RX

I2C\_STAT\_SLVST\_TX

## 2.8 I2C Master Driver

void I2C\_MasterGetDefaultConfig(*i2c\_master\_config\_t* \*masterConfig)

Provides a default configuration for the I2C master peripheral.

This function provides the following default configuration for the I2C master peripheral:

```
masterConfig->enableMaster      = true;
masterConfig->baudRate_Bps      = 100000U;
masterConfig->enableTimeout     = false;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with I2C\_MasterInit().

### Parameters

- masterConfig – **[out]** User provided configuration structure for default values. Refer to *i2c\_master\_config\_t*.

void I2C\_MasterInit(I2C\_Type \*base, const *i2c\_master\_config\_t* \*masterConfig, uint32\_t srcClock\_Hz)

Initializes the I2C master peripheral.

This function enables the peripheral clock and initializes the I2C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

### Parameters

- base – The I2C peripheral base address.
- masterConfig – User provided peripheral configuration. Use I2C\_MasterGetDefaultConfig() to get a set of defaults that you can override.
- srcClock\_Hz – Frequency in Hertz of the I2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

`void I2C_MasterDeinit(I2C_Type *base)`

Deinitializes the I2C master peripheral.

This function disables the I2C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

**Parameters**

- `base` – The I2C peripheral base address.

`uint32_t I2C_GetInstance(I2C_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 I2C peripheral base address.

**Returns**

I2C instance number starting from 0.

`static inline void I2C_MasterReset(I2C_Type *base)`

Performs a software reset.

Restores the I2C master peripheral to reset conditions.

**Parameters**

- `base` – The I2C peripheral base address.

`static inline void I2C_MasterEnable(I2C_Type *base, bool enable)`

Enables or disables the I2C module as master.

**Parameters**

- `base` – The I2C peripheral base address.
- `enable` – Pass true to enable or false to disable the specified I2C as master.

`static inline uint32_t I2C_GetStatusFlags(I2C_Type *base)`

Gets the I2C status flags.

A bit mask with the state of all I2C status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i2c_master_flags`

**Parameters**

- `base` – The I2C 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 I2C_MasterClearStatusFlags(I2C_Type *base, uint32_t statusMask)`

Clears the I2C master status flag state.

The following status register flags can be cleared:

- `kI2C_MasterArbitrationLostFlag`

- `kI2C_MasterStartStopErrorFlag`

Attempts to clear other flags has no effect.

**See also:**

`_i2c_master_flags`.

**Parameters**

- `base` – The I2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i2c_master_flags` enumerators OR'd together. You may pass the result of a previous call to `I2C_GetStatusFlags()`.

```
static inline void I2C__EnableInterrupts(I2C_Type *base, uint32_t interruptMask)
```

Enables the I2C master interrupt requests.

**Parameters**

- `base` – The I2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_i2c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline void I2C__DisableInterrupts(I2C_Type *base, uint32_t interruptMask)
```

Disables the I2C master interrupt requests.

**Parameters**

- `base` – The I2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to disable. See `_i2c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline uint32_t I2C__GetEnabledInterrupts(I2C_Type *base)
```

Returns the set of currently enabled I2C master interrupt requests.

**Parameters**

- `base` – The I2C peripheral base address.

**Returns**

A bitmask composed of `_i2c_master_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
void I2C_MasterSetBaudRate(I2C_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)
```

Sets the I2C bus frequency for master transactions.

The I2C 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.

**Parameters**

- `base` – The I2C peripheral base address.
- `srcClock_Hz` – I2C functional clock frequency in Hertz.
- `baudRate_Bps` – Requested bus frequency in bits per second.

```
static inline bool I2C_MasterGetBusIdleState(I2C_Type *base)
```

Returns whether the bus is idle.

Requires the master mode to be enabled.

**Parameters**

- `base` – The I2C peripheral base address.

**Return values**

- true – Bus is busy.
- false – Bus is idle.

*status\_t* I2C\_MasterStart(I2C\_Type \*base, uint8\_t address, i2c\_direction\_t direction)

Sends a START on the I2C bus.

This function is used to initiate a new master mode transfer by sending the START signal. The slave address is sent following the I2C START signal.

**Parameters**

- base – I2C peripheral base pointer
- address – 7-bit slave device address.
- direction – Master transfer directions(transmit/receive).

**Return values**

- kStatus\_Success – Successfully send the start signal.
- kStatus\_I2C\_Busy – Current bus is busy.

*status\_t* I2C\_MasterStop(I2C\_Type \*base)

Sends a STOP signal on the I2C bus.

**Return values**

- kStatus\_Success – Successfully send the stop signal.
- kStatus\_I2C\_Timeout – Send stop signal failed, timeout.

static inline *status\_t* I2C\_MasterRepeatedStart(I2C\_Type \*base, uint8\_t address, i2c\_direction\_t direction)

Sends a REPEATED START on the I2C bus.

**Parameters**

- base – I2C peripheral base pointer
- address – 7-bit slave device address.
- direction – Master transfer directions(transmit/receive).

**Return values**

- kStatus\_Success – Successfully send the start signal.
- kStatus\_I2C\_Busy – Current bus is busy but not occupied by current I2C master.

*status\_t* I2C\_MasterWriteBlocking(I2C\_Type \*base, const void \*txBuff, size\_t txSize, uint32\_t flags)

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\_I2C\_Nak.

**Parameters**

- base – The I2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- flags – Transfer control flag to control special behavior like suppressing start or stop, for normal transfers use kI2C\_TransferDefaultFlag

**Return values**

- `kStatus_Success` – Data was sent successfully.
- `kStatus_I2C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I2C_Nak` – The slave device sent a NAK in response to a byte.
- `kStatus_I2C_ArbitrationLost` – Arbitration lost error.

`status_t I2C_MasterReadBlocking(I2C_Type *base, void *rxBuff, size_t rxSize, uint32_t flags)`

Performs a polling receive transfer on the I2C bus.

**Parameters**

- `base` – The I2C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.
- `flags` – Transfer control flag to control special behavior like suppressing start or stop, for normal transfers use `kI2C_TransferDefaultFlag`

**Return values**

- `kStatus_Success` – Data was received successfully.
- `kStatus_I2C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I2C_Nak` – The slave device sent a NAK in response to a byte.
- `kStatus_I2C_ArbitrationLost` – Arbitration lost error.

`status_t I2C_MasterTransferBlocking(I2C_Type *base, 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 arbitration lost or receiving a NAK.

---

**Parameters**

- `base` – I2C peripheral base address.
- `xfer` – Pointer to the transfer structure.

**Return values**

- `kStatus_Success` – Successfully complete the data transmission.
- `kStatus_I2C_Busy` – Previous transmission still not finished.
- `kStatus_I2C_Timeout` – Transfer error, wait signal timeout.
- `kStatus_I2C_ArbitrationLost` – Transfer error, arbitration lost.
- `kStatus_I2C_Nak` – Transfer error, receive NAK during transfer.

`void I2C_MasterTransferCreateHandle(I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_callback_t callback, void *userData)`

Creates a new handle for the I2C 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 `I2C_MasterTransferAbort()` API shall be called.

**Parameters**

- `base` – The I2C peripheral base address.



- `handle` – **[out]** Pointer to the I2C master driver handle.
- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

`status_t I2C_MasterTransferNonBlocking(I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_t *xfer)`

Performs a non-blocking transaction on the I2C bus.

#### Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.
- `xfer` – The pointer to the transfer descriptor.

#### Return values

- `kStatus_Success` – The transaction was started successfully.
- `kStatus_I2C_Busy` – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

`status_t I2C_MasterTransferGetCount(I2C_Type *base, i2c_master_handle_t *handle, size_t *count)`

Returns number of bytes transferred so far.

#### Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.
- `count` – **[out]** Number of bytes transferred so far by the non-blocking transaction.

#### Return values

- `kStatus_Success` –
- `kStatus_I2C_Busy` –

`status_t I2C_MasterTransferAbort(I2C_Type *base, i2c_master_handle_t *handle)`

Terminates a non-blocking I2C master transmission early.

---

**Note:** It is not safe to call this function from an IRQ handler that has a higher priority than the I2C peripheral's IRQ priority.

---

#### Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.

#### Return values

- `kStatus_Success` – A transaction was successfully aborted.
- `kStatus_I2C_Timeout` – Abort failure due to flags polling timeout.

`void I2C_MasterTransferHandleIRQ(I2C_Type *base, void *i2cHandle)`

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 I2C peripheral base address.
- i2cHandle – Pointer to the I2C master driver handle i2c\_master\_handle\_t.

enum \_i2c\_master\_flags

I2C master peripheral flags.

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

*Values:*

enumerator kI2C\_MasterPendingFlag

The I2C module is waiting for software interaction.

enumerator kI2C\_MasterArbitrationLostFlag

The arbitration of the bus was lost. There was collision on the bus

enumerator kI2C\_MasterStartStopErrorFlag

There was an error during start or stop phase of the transaction.

enum \_i2c\_direction

Direction of master and slave transfers.

*Values:*

enumerator kI2C\_Write

Master transmit.

enumerator kI2C\_Read

Master receive.

enum \_i2c\_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 \_i2c\_master\_transfer::flags field.

---

*Values:*

enumerator kI2C\_TransferDefaultFlag

Transfer starts with a start signal, stops with a stop signal.

enumerator kI2C\_TransferNoStartFlag

Don't send a start condition, address, and sub address

enumerator kI2C\_TransferRepeatedStartFlag

Send a repeated start condition

enumerator kI2C\_TransferNoStopFlag

Don't send a stop condition.

enum \_i2c\_transfer\_states

States for the state machine used by transactional APIs.

*Values:*

enumerator kIdleState

enumerator kTransmitSubaddrState

enumerator kTransmitDataState

enumerator kReceiveDataBeginState

enumerator kReceiveDataState

enumerator kReceiveLastDataState

enumerator kStartState

enumerator kStopState

enumerator kWaitForCompletionState

typedef enum *\_i2c\_direction* i2c\_direction\_t

Direction of master and slave transfers.

typedef struct *\_i2c\_master\_config* i2c\_master\_config\_t

Structure with settings to initialize the I2C master module.

This structure holds configuration settings for the I2C peripheral. To initialize this structure to reasonable defaults, call the I2C\_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef struct *\_i2c\_master\_transfer* i2c\_master\_transfer\_t

I2C master transfer typedef.

typedef struct *\_i2c\_master\_handle* i2c\_master\_handle\_t

I2C master handle typedef.

typedef void (\*i2c\_master\_transfer\_callback\_t)(I2C\_Type \*base, i2c\_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 I2C\_MasterTransferCreateHandle().

**Param base**

The I2C peripheral base address.

**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 *\_i2c\_master\_config*

*#include <fsl\_i2c.h>* Structure with settings to initialize the I2C master module.

This structure holds configuration settings for the I2C peripheral. To initialize this structure to reasonable defaults, call the I2C\_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.

uint32\_t baudRate\_Bps

Desired baud rate in bits per second.

bool enableTimeout

Enable internal timeout function.

struct \_i2c\_master\_transfer

*#include <fsl\_i2c.h>* Non-blocking transfer descriptor structure.

This structure is used to pass transaction parameters to the I2C\_MasterTransferNonBlocking() API.

### Public Members

uint32\_t flags

Bit mask of options for the transfer. See enumeration `_i2c_master_transfer_flags` for available options. Set to 0 or `kI2C_TransferDefaultFlag` for normal transfers.

uint16\_t slaveAddress

The 7-bit slave address.

*i2c\_direction\_t* direction

Either `kI2C_Read` or `kI2C_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 \_i2c\_master\_handle

*#include <fsl\_i2c.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.

uint32\_t transferCount

Indicates progress of the transfer

uint32\_t remainingBytes

Remaining byte count in current state.

uint8\_t \*buf

Buffer pointer for current state.

*i2c\_master\_transfer\_t* transfer

Copy of the current transfer info.

*i2c\_master\_transfer\_callback\_t* completionCallback

Callback function pointer.

void \*userData

Application data passed to callback.

## 2.9 I2C Slave Driver

void I2C\_SlaveGetDefaultConfig(*i2c\_slave\_config\_t* \*slaveConfig)

Provides a default configuration for the I2C slave peripheral.

This function provides the following default configuration for the I2C slave peripheral:

```
slaveConfig->enableSlave = true;
slaveConfig->address0.disable = false;
slaveConfig->address0.address = 0u;
slaveConfig->address1.disable = true;
slaveConfig->address2.disable = true;
slaveConfig->address3.disable = true;
slaveConfig->busSpeed = kI2C_SlaveStandardMode;
```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with `I2C_SlaveInit()`. Be sure to override at least the *address0.address* 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 *i2c\_slave\_config\_t*.

*status\_t* I2C\_SlaveInit(I2C\_Type \*base, const *i2c\_slave\_config\_t* \*slaveConfig, uint32\_t srcClock\_Hz)

Initializes the I2C slave peripheral.

This function enables the peripheral clock and initializes the I2C slave peripheral as described by the user provided configuration.

### Parameters

- base – The I2C peripheral base address.
- slaveConfig – User provided peripheral configuration. Use `I2C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- srcClock\_Hz – Frequency in Hertz of the I2C functional clock. Used to calculate CLKDIV value to provide enough data setup time for master when slave stretches the clock.

void I2C\_SlaveSetAddress(I2C\_Type \*base, *i2c\_slave\_address\_register\_t* addressRegister, uint8\_t address, bool addressDisable)

Configures Slave Address n register.

This function writes new value to Slave Address register.

### Parameters

- base – The I2C peripheral base address.
- addressRegister – The module supports multiple address registers. The parameter determines which one shall be changed.
- address – The slave address to be stored to the address register for matching.

- addressDisable – Disable matching of the specified address register.

`void I2C_SlaveDeinit(I2C_Type *base)`

Deinitializes the I2C slave peripheral.

This function disables the I2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

#### Parameters

- base – The I2C peripheral base address.

`static inline void I2C_SlaveEnable(I2C_Type *base, bool enable)`

Enables or disables the I2C module as slave.

#### Parameters

- base – The I2C peripheral base address.
- enable – True to enable or false to disable.

`static inline void I2C_SlaveClearStatusFlags(I2C_Type *base, uint32_t statusMask)`

Clears the I2C status flag state.

The following status register flags can be cleared:

- slave deselected flag

Attempts to clear other flags has no effect.

#### See also:

`_i2c_slave_flags`.

#### Parameters

- base – The I2C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of `_i2c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I2C_SlaveGetStatusFlags()`.

`status_t I2C_SlaveWriteBlocking(I2C_Type *base, const uint8_t *txBuff, size_t txSize)`

Performs a polling send transfer on the I2C bus.

The function executes blocking address phase and blocking data phase.

#### Parameters

- base – The I2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.

#### Returns

`kStatus_Success` Data has been sent.

#### Returns

`kStatus_Fail` Unexpected slave state (master data write while master read from slave is expected).

`status_t I2C_SlaveReadBlocking(I2C_Type *base, uint8_t *rxBuff, size_t rxSize)`

Performs a polling receive transfer on the I2C bus.

The function executes blocking address phase and blocking data phase.

#### Parameters

- `base` – The I2C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.

**Returns**

`kStatus_Success` Data has been received.

**Returns**

`kStatus_Fail` Unexpected slave state (master data read while master write to slave is expected).

```
void I2C_SlaveTransferCreateHandle(I2C_Type *base, i2c_slave_handle_t *handle,  
                                i2c_slave_transfer_callback_t callback, void *userData)
```

Creates a new handle for the I2C 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 `I2C_SlaveTransferAbort()` API shall be called.

**Parameters**

- `base` – The I2C peripheral base address.
- `handle` – **[out]** Pointer to the I2C slave driver handle.
- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

```
status_t I2C_SlaveTransferNonBlocking(I2C_Type *base, i2c_slave_handle_t *handle, uint32_t  
                                    eventMask)
```

Starts accepting slave transfers.

Call this API after calling `I2C_SlaveInit()` and `I2C_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 `I2C_SlaveTransferCreateHandle()`. The callback is always invoked from the interrupt context.

If no slave Tx transfer is busy, a master read from slave request invokes `kI2C_SlaveTransmitEvent` callback. If no slave Rx transfer is busy, a master write to slave request invokes `kI2C_SlaveReceiveEvent` callback.

The set of events received by the callback is customizable. To do so, set the `eventMask` parameter to the OR'd combination of `i2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `kI2C_SlaveTransmitEvent` and `kI2C_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 `kI2C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

**Parameters**

- `base` – The I2C peripheral base address.
- `handle` – Pointer to `i2c_slave_handle_t` structure which stores the transfer state.
- `eventMask` – Bit mask formed by OR'ing together `i2c_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 `kI2C_SlaveAllEvents` to enable all events.

**Return values**

- `kStatus_Success` – Slave transfers were successfully started.

- `kStatus_I2C_Busy` – Slave transfers have already been started on this handle.

`status_t I2C_SlaveSetSendBuffer(I2C_Type *base, volatile i2c_slave_transfer_t *transfer, const void *txData, size_t txSize, uint32_t eventMask)`

Starts accepting master read from slave requests.

The function can be called in response to `ki2c_slave_transmit_event` callback to start a new slave Tx transfer from within the transfer callback.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of `i2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `ki2c_slave_transmit_event` and `ki2c_slave_receive_event` 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 `ki2c_slave_all_events` constant is provided as a convenient way to enable all events.

#### Parameters

- *base* – The I2C peripheral base address.
- *transfer* – Pointer to `i2c_slave_transfer_t` structure.
- *txData* – Pointer to data to send to master.
- *txSize* – Size of *txData* in bytes.
- *eventMask* – Bit mask formed by OR'ing together `i2c_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 `ki2c_slave_all_events` to enable all events.

#### Return values

- `kStatus_Success` – Slave transfers were successfully started.
- `kStatus_I2C_Busy` – Slave transfers have already been started on this handle.

`status_t I2C_SlaveSetReceiveBuffer(I2C_Type *base, volatile i2c_slave_transfer_t *transfer, void *rxData, size_t rxSize, uint32_t eventMask)`

Starts accepting master write to slave requests.

The function can be called in response to `ki2c_slave_receive_event` callback to start a new slave Rx transfer from within the transfer callback.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of `i2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `ki2c_slave_transmit_event` and `ki2c_slave_receive_event` 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 `ki2c_slave_all_events` constant is provided as a convenient way to enable all events.

#### Parameters

- *base* – The I2C peripheral base address.
- *transfer* – Pointer to `i2c_slave_transfer_t` structure.
- *rxData* – Pointer to data to store data from master.
- *rxSize* – Size of *rxData* in bytes.



- `eventMask` – Bit mask formed by OR'ing together `i2c_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 `kI2C_SlaveAllEvents` to enable all events.

**Return values**

- `kStatus__Success` – Slave transfers were successfully started.
- `kStatus__I2C_Busy` – Slave transfers have already been started on this handle.

```
static inline uint32_t I2C_SlaveGetReceivedAddress(I2C_Type *base, volatile i2c_slave_transfer_t *transfer)
```

Returns the slave address sent by the I2C master.

This function should only be called from the address match event callback `kI2C_SlaveAddressMatchEvent`.

**Parameters**

- `base` – The I2C peripheral base address.
- `transfer` – The I2C slave transfer.

**Returns**

The 8-bit address matched by the I2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

```
void I2C_SlaveTransferAbort(I2C_Type *base, i2c_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 I2C peripheral base address.
- `handle` – Pointer to `i2c_slave_handle_t` structure which stores the transfer state.

**Return values**

- `kStatus__Success` –
- `kStatus__I2C_Idle` –

```
status_t I2C_SlaveTransferGetCount(I2C_Type *base, i2c_slave_handle_t *handle, size_t *count)
```

Gets the slave transfer remaining bytes during a interrupt non-blocking transfer.

**Parameters**

- `base` – I2C base pointer.
- `handle` – pointer to `i2c_slave_handle_t` structure.
- `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 I2C_SlaveTransferHandleIRQ(I2C_Type *base, void *i2cHandle)`

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 I2C peripheral base address.
- `i2cHandle` – Pointer to `i2c_slave_handle_t` structure which stores the transfer state.

`enum _i2c_slave_flags`

I2C slave peripheral flags.

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

### Values:

enumerator `kI2C_SlavePendingFlag`

The I2C module is waiting for software interaction.

enumerator `kI2C_SlaveNotStretching`

Indicates whether the slave is currently stretching clock (0 = yes, 1 = no).

enumerator `kI2C_SlaveSelected`

Indicates whether the slave is selected by an address match.

enumerator `kI2C_SaveDeselected`

Indicates that slave was previously deselected (deselect event took place, w1c).

`enum _i2c_slave_address_register`

I2C slave address register.

### Values:

enumerator `kI2C_SlaveAddressRegister0`

Slave Address 0 register.

enumerator `kI2C_SlaveAddressRegister1`

Slave Address 1 register.

enumerator `kI2C_SlaveAddressRegister2`

Slave Address 2 register.

enumerator `kI2C_SlaveAddressRegister3`

Slave Address 3 register.

`enum _i2c_slave_address_qual_mode`

I2C slave address match options.

### Values:

enumerator `kI2C_QualModeMask`

The `SLVQUAL0` field (`qualAddress`) is used as a logical mask for matching address0.

enumerator `kI2C_QualModeExtend`

The `SLVQUAL0` (`qualAddress`) field is used to extend address 0 matching in a range of addresses.

enum `_i2c_slave_bus_speed`

I2C slave bus speed options.

*Values:*

enumerator `kI2C_SlaveStandardMode`

enumerator `kI2C_SlaveFastMode`

enumerator `kI2C_SlaveFastModePlus`

enumerator `kI2C_SlaveHsMode`

enum `_i2c_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 `I2C_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 `kI2C_SlaveAddressMatchEvent`

Received the slave address after a start or repeated start.

enumerator `kI2C_SlaveTransmitEvent`

Callback is requested to provide data to transmit (slave-transmitter role).

enumerator `kI2C_SlaveReceiveEvent`

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator `kI2C_SlaveCompletionEvent`

All data in the active transfer have been consumed.

enumerator `kI2C_SlaveDeselectedEvent`

The slave function has become deselected (SLVSEL flag changing from 1 to 0).

enumerator `kI2C_SlaveAllEvents`

Bit mask of all available events.

enum `_i2c_slave_fsm`

I2C slave software finite state machine states.

*Values:*

enumerator `kI2C_SlaveFsmAddressMatch`

enumerator `kI2C_SlaveFsmReceive`

enumerator `kI2C_SlaveFsmTransmit`

typedef enum `_i2c_slave_address_register` `i2c_slave_address_register_t`

I2C slave address register.

typedef struct `_i2c_slave_address` `i2c_slave_address_t`

Data structure with 7-bit Slave address and Slave address disable.

typedef enum `_i2c_slave_address_qual_mode` `i2c_slave_address_qual_mode_t`

I2C slave address match options.

```
typedef enum _i2c_slave_bus_speed i2c_slave_bus_speed_t
```

I2C slave bus speed options.

```
typedef struct _i2c_slave_config i2c_slave_config_t
```

Structure with settings to initialize the I2C slave module.

This structure holds configuration settings for the I2C slave peripheral. To initialize this structure to reasonable defaults, call the `I2C_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 _i2c_slave_transfer_event i2c_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 `I2C_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 _i2c_slave_handle i2c_slave_handle_t
```

I2C slave handle typedef.

```
typedef struct _i2c_slave_transfer i2c_slave_transfer_t
```

I2C slave transfer structure.

```
typedef void (*i2c_slave_transfer_callback_t)(I2C_Type *base, volatile i2c_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 `I2C_SlaveSetCallback()` function after you have created a handle.

**Param base**

Base address for the I2C 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.

```
typedef enum _i2c_slave_fsm i2c_slave_fsm_t
```

I2C slave software finite state machine states.

```
typedef void (*i2c_isr_t)(I2C_Type *base, void *i2cHandle)
```

Typedef for interrupt handler.

```
struct _i2c_slave_address
```

`#include <fsl_i2c.h>` Data structure with 7-bit Slave address and Slave address disable.

**Public Members**

uint8\_t address

7-bit Slave address SLVADR.

bool addressDisable

Slave address disable SADISABLE.

struct `_i2c_slave_config`

*#include <fsl\_i2c.h>* Structure with settings to initialize the I2C slave module.

This structure holds configuration settings for the I2C slave peripheral. To initialize this structure to reasonable defaults, call the `I2C_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

`i2c_slave_address_t` `address0`

Slave's 7-bit address and disable.

`i2c_slave_address_t` `address1`

Alternate slave 7-bit address and disable.

`i2c_slave_address_t` `address2`

Alternate slave 7-bit address and disable.

`i2c_slave_address_t` `address3`

Alternate slave 7-bit address and disable.

`i2c_slave_address_qual_mode_t` `qualMode`

Qualify mode for slave address 0.

`uint8_t` `qualAddress`

Slave address qualifier for address 0.

`i2c_slave_bus_speed_t` `busSpeed`

Slave bus speed mode. If the slave function stretches SCL to allow for software response, it must provide sufficient data setup time to the master before releasing the stretched clock. This is accomplished by inserting one clock time of `CLKDIV` at that point. The `busSpeed` value is used to configure `CLKDIV` such that one clock time is greater than the `tSU;DAT` value noted in the I2C bus specification for the I2C mode that is being used. If the `busSpeed` mode is unknown at compile time, use the longest data setup time `kI2C_SlaveStandardMode` (250 ns)

`bool` `enableSlave`

Enable slave mode.

struct `_i2c_slave_transfer`

*#include <fsl\_i2c.h>* I2C slave transfer structure.

### Public Members

`i2c_slave_handle_t` `*handle`

Pointer to handle that contains this transfer.

`i2c_slave_transfer_event_t` `event`

Reason the callback is being invoked.

`uint8_t` `receivedAddress`

Matching address send by master. 7-bits plus R/nW bit0

`uint32_t` `eventMask`

Mask of enabled events.

`uint8_t` `*rxData`

Transfer buffer for receive data

const uint8\_t \*txData

Transfer buffer for transmit data

size\_t txSize

Transfer size

size\_t rxSize

Transfer size

size\_t transferredCount

Number of bytes transferred during this transfer.

status\_t completionStatus

Success or error code describing how the transfer completed. Only applies for kI2C\_SlaveCompletionEvent.

struct \_i2c\_slave\_handle

#include <fsl\_i2c.h> I2C slave handle structure.

---

**Note:** The contents of this structure are private and subject to change.

---

### Public Members

volatile *i2c\_slave\_transfer\_t* transfer

I2C slave transfer.

volatile bool isBusy

Whether transfer is busy.

volatile *i2c\_slave\_fsm\_t* slaveFsm

slave transfer state machine.

*i2c\_slave\_transfer\_callback\_t* callback

Callback function called at transfer event.

void \*userData

Callback parameter passed to callback.

## 2.10 I3C: I3C Driver

FSL\_I3C\_DRIVER\_VERSION

I3C driver version.

I3C status return codes.

*Values:*

enumerator kStatus\_I3C\_Busy

The master is already performing a transfer.

enumerator kStatus\_I3C\_Idle

The slave driver is idle.

enumerator kStatus\_I3C\_Nak

The slave device sent a NAK in response to an address.

enumerator kStatus\_I3C\_WriteAbort

The slave device sent a NAK in response to a write.

enumerator kStatus\_I3C\_Term

The master terminates slave read.

enumerator kStatus\_I3C\_HdrParityError

Parity error from DDR read.

enumerator kStatus\_I3C\_CrcError

CRC error from DDR read.

enumerator kStatus\_I3C\_ReadFifoError

Read from M/SRDATA register when FIFO empty.

enumerator kStatus\_I3C\_WriteFifoError

Write to M/SWDATA register when FIFO full.

enumerator kStatus\_I3C\_MsgError

Message SDR/DDR mismatch or read/write message in wrong state

enumerator kStatus\_I3C\_InvalidReq

Invalid use of request.

enumerator kStatus\_I3C\_Timeout

The module has stalled too long in a frame.

enumerator kStatus\_I3C\_SlaveCountExceed

The I3C slave count has exceed the definition in I3C\_MAX\_DEVCNT.

enumerator kStatus\_I3C\_IBIWon

The I3C slave event IBI or MR or HJ won the arbitration on a header address.

enumerator kStatus\_I3C\_OverrunError

Slave internal from-bus buffer/FIFO overrun.

enumerator kStatus\_I3C\_UnderrunError

Slave internal to-bus buffer/FIFO underrun

enumerator kStatus\_I3C\_UnderrunNak

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kStatus\_I3C\_InvalidStart

Slave invalid start flag

enumerator kStatus\_I3C\_SdrParityError

SDR parity error

enumerator kStatus\_I3C\_S0S1Error

S0 or S1 error

enum \_i3c\_hdr\_mode

I3C HDR modes.

*Values:*

enumerator kI3C\_HDRModeNone

enumerator kI3C\_HDRModeDDR

enumerator kI3C\_HDRModeTSP

enumerator kI3C\_HDRModeTSL

```
typedef enum _i3c_hdr_mode i3c_hdr_mode_t
```

I3C HDR modes.

```
typedef struct _i3c_device_info i3c_device_info_t
```

I3C device information.

```
I3C_RETRY_TIMES
```

Max loops to wait for I3C operation status complete.

This is the maximum number of loops to wait for I3C operation status complete. If set to 0, it will wait indefinitely.

```
I3C_MAX_DEVCNT
```

```
I3C_IBI_BUFF_SIZE
```

```
struct _i3c_device_info
```

*#include <fsl\_i3c.h>* I3C device information.

### Public Members

```
uint8_t dynamicAddr
```

Device dynamic address.

```
uint8_t staticAddr
```

Static address.

```
uint8_t dcr
```

Device characteristics register information.

```
uint8_t bcr
```

Bus characteristics register information.

```
uint16_t vendorID
```

Device vendor ID(manufacture ID).

```
uint32_t partNumber
```

Device part number info

```
uint16_t maxReadLength
```

Maximum read length.

```
uint16_t maxWriteLength
```

Maximum write length.

```
uint8_t hdrMode
```

Support hdr mode, could be OR logic in *i3c\_hdr\_mode*.

## 2.11 I3C Common Driver

```
typedef struct _i3c_config i3c_config_t
```

Structure with settings to initialize the I3C module, could both initialize master and slave functionality.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the *I3C\_GetDefaultConfig()* function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.



```
uint32_t I3C_GetInstance(I3C_Type *base)
```

Get which instance current I3C is used.

### Parameters

- `base` – The I3C peripheral base address.

```
void I3C_GetDefaultConfig(i3c_config_t *config)
```

Provides a default configuration for the I3C peripheral, the configuration covers both master functionality and slave functionality.

This function provides the following default configuration for I3C:

```
config->enableMaster          = kI3C_MasterCapable;
config->disableTimeout        = false;
config->hKeep                  = kI3C_MasterHighKeeperNone;
config->enableOpenDrainStop    = true;
config->enableOpenDrainHigh    = true;
config->baudRate_Hz.i2cBaud    = 400000U;
config->baudRate_Hz.i3cPushPullBaud = 12500000U;
config->baudRate_Hz.i3cOpenDrainBaud = 2500000U;
config->masterDynamicAddress    = 0x0AU;
config->slowClock_Hz           = 1000000U;
config->enableSlave            = true;
config->vendorID                = 0x11BU;
config->enableRandomPart        = false;
config->partNumber              = 0;
config->dcr                     = 0;
config->bcr = 0;
config->hdrMode                 = (uint8_t)kI3C_HDRModeDDR;
config->nakAllRequest           = false;
config->ignoreS0S1Error         = false;
config->offline                 = false;
config->matchSlaveStartStop     = false;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the common I3C driver with `I3C_Init()`.

### Parameters

- `config` – **[out]** User provided configuration structure for default values. Refer to `i3c_config_t`.

```
void I3C_Init(I3C_Type *base, const i3c_config_t *config, uint32_t sourceClock_Hz)
```

Initializes the I3C peripheral. This function enables the peripheral clock and initializes the I3C peripheral as described by the user provided configuration. This will initialize both the master peripheral and slave peripheral so that I3C module could work as pure master, pure slave or secondary master, etc. A software reset is performed prior to configuration.

### Parameters

- `base` – The I3C peripheral base address.
- `config` – User provided peripheral configuration. Use `I3C_GetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the I3C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

```
struct _i3c_config
```

`#include <fsl_i3c.h>` Structure with settings to initialize the I3C module, could both initialize master and slave functionality.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_GetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

### Public Members

*i3c\_master\_enable\_t* enableMaster

Enable master mode.

bool disableTimeout

Whether to disable timeout to prevent the ERRWARN.

*i3c\_master\_hkeep\_t* hKeep

High keeper mode setting.

bool enableOpenDrainStop

Whether to emit open-drain speed STOP.

bool enableOpenDrainHigh

Enable Open-Drain High to be 1 PPBAUD count for i3c messages, or 1 ODBAUD.

*i3c\_baudrate\_hz\_t* baudRate\_Hz

Desired baud rate settings.

uint8\_t masterDynamicAddress

Main master dynamic address configuration.

uint32\_t maxWriteLength

Maximum write length.

uint32\_t maxReadLength

Maximum read length.

bool enableSlave

Whether to enable slave.

bool isHotJoin

Whether to enable slave hotjoin before enable slave.

uint8\_t staticAddr

Static address.

uint16\_t vendorID

Device vendor ID(manufacture ID).

uint32\_t partNumber

Device part number info

uint8\_t dcr

Device characteristics register information.

uint8\_t bcr

Bus characteristics register information.

uint8\_t hdrMode

Support hdr mode, could be OR logic in enumeration:i3c\_hdr\_mode\_t.

bool nakAllRequest

Whether to reply NAK to all requests except broadcast CCC.

bool ignoreS0S1Error

Whether to ignore S0/S1 error in SDR mode.

bool offline

Whether to wait 60 us of bus quiet or HDR request to ensure slave track SDR mode safely.

bool matchSlaveStartStop

Whether to assert start/stop status only the time slave is addressed.

## 2.12 I3C Master DMA Driver

```
typedef struct _i3c_master_dma_handle i3c_master_dma_handle_t
```

```
typedef struct _i3c_master_dma_callback i3c_master_dma_callback_t
```

i3c master callback functions.

```
void I3C_MasterTransferCreateHandleDMA(I3C_Type *base, i3c_master_dma_handle_t *handle,
                                       const i3c_master_dma_callback_t *callback, void
                                       *userData, dma_handle_t *rxDmaHandle,
                                       dma_handle_t *txDmaHandle)
```

Create a new handle for the I3C 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 I3C\_MasterTransferAbortDMA() API shall be called.

For devices where the I3C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

### Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.
- rxDmaHandle – Handle for the DMA receive channel. Created by the user prior to calling this function.
- txDmaHandle – Handle for the DMA transmit channel. Created by the user prior to calling this function.

```
status_t I3C_MasterTransferDMA(I3C_Type *base, i3c_master_dma_handle_t *handle,
                              i3c_master_transfer_t *transfer)
```

Performs a non-blocking DMA-based transaction on the I3C bus.

The callback specified when the *handle* was created is invoked when the transaction has completed.

### Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.
- transfer – The pointer to the transfer descriptor.

### Return values

- kStatus\_Success – The transaction was started successfully.
- kStatus\_I3C\_Busy – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

*status\_t* I3C\_MasterTransferGetCountDMA(I3C\_Type \*base, *i3c\_master\_dma\_handle\_t* \*handle, *size\_t* \*count)

Returns number of bytes transferred so far.

#### Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C 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.

void I3C\_MasterTransferAbortDMA(I3C\_Type \*base, *i3c\_master\_dma\_handle\_t* \*handle)

Terminates a non-blocking I3C master transmission early.

---

**Note:** It is not safe to call this function from an IRQ handler that has a higher priority than the DMA peripheral's IRQ priority.

---

#### Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.

void I3C\_MasterTransferDMAHandleIRQ(I3C\_Type \*base, void \*i3CHandle)

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 I3C peripheral base address.
- handle – Pointer to the I3C master DMA driver handle.

void (\*slave2Master)(I3C\_Type \*base, void \*userData)

Transfer complete callback

void (\*ibiCallback)(I3C\_Type \*base, *i3c\_master\_dma\_handle\_t* \*handle, *i3c\_ibi\_type\_t* ibiType, *i3c\_ibi\_state\_t* ibiState)

IBI event callback

void (\*transferComplete)(I3C\_Type \*base, *i3c\_master\_dma\_handle\_t* \*handle, *status\_t* status, void \*userData)

Transfer complete callback

I3C\_Type \*base

I3C base pointer.

uint8\_t state

Transfer state machine current state.

uint32\_t transferCount

Indicates progress of the transfer

uint8\_t subaddressBuffer[4]

Saving subaddress command.

uint8\_t subaddressCount

Saving command count.

*i3c\_master\_transfer\_t* transfer

Copy of the current transfer info.

*i3c\_master\_dma\_callback\_t* callback

Callback function pointer.

void \*userData

Application data passed to callback.

*dma\_handle\_t* \*rxDmaHandle

Handle for receive DMA channel.

*dma\_handle\_t* \*txDmaHandle

Handle for transmit DMA channel.

uint8\_t ibiAddress

Slave address which request IBI.

uint8\_t \*ibiBuff

Pointer to IBI buffer to keep ibi bytes.

size\_t ibiPayloadSize

IBI payload size.

*i3c\_ibi\_type\_t* ibiType

IBI type.

uint32\_t event

Reason the callback is being invoked.

uint8\_t \*txData

Transfer buffer

size\_t txDataSize

Transfer size

uint8\_t \*rxData

Transfer buffer

size\_t rxDataSize

Transfer size

*status\_t* completionStatus

Success or error code describing how the transfer completed. Only applies for kI3C\_SlaveCompletionEvent.

I3C\_Type \*base

I3C base pointer.

*i3c\_slave\_dma\_transfer\_t* transfer

I3C 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.

*i3c\_slave\_dma\_callback\_t* callback

Callback function called at transfer event.

*dma\_handle\_t* \*rxDmaHandle

Handle for receive DMA channel.

*dma\_handle\_t* \*txDmaHandle

Handle for transmit DMA channel.

void \*userData

Callback parameter passed to callback.

struct *\_i3c\_master\_dma\_callback*

*#include <fsl\_i3c\_dma.h>* i3c master callback functions.

struct *\_i3c\_master\_dma\_handle*

*#include <fsl\_i3c\_dma.h>* Driver handle for master DMA APIs.

---

**Note:** The contents of this structure are private and subject to change.

---

## 2.13 I3C Master Driver

void I3C\_MasterGetDefaultConfig(*i3c\_master\_config\_t* \*masterConfig)

Provides a default configuration for the I3C master peripheral.

This function provides the following default configuration for the I3C master peripheral:

```
masterConfig->enableMaster      = kI3C_MasterOn;
masterConfig->disableTimeout     = false;
masterConfig->hKeep              = kI3C_MasterHighKeeperNone;
masterConfig->enableOpenDrainStop = true;
masterConfig->enableOpenDrainHigh = true;
masterConfig->baudRate_Hz        = 100000U;
masterConfig->busType            = kI3C_TypeI2C;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with I3C\_MasterInit().

### Parameters

- masterConfig – **[out]** User provided configuration structure for default values. Refer to *i3c\_master\_config\_t*.

void I3C\_MasterInit(I3C\_Type \*base, const *i3c\_master\_config\_t* \*masterConfig, uint32\_t sourceClock\_Hz)

Initializes the I3C master peripheral.

This function enables the peripheral clock and initializes the I3C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

### Parameters

- base – The I3C peripheral base address.

- `masterConfig` – User provided peripheral configuration. Use `I3C_MasterGetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the I3C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

`void I3C_MasterDeinit(I3C_Type *base)`

Deinitializes the I3C master peripheral.

This function disables the I3C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

#### Parameters

- `base` – The I3C peripheral base address.

`status_t I3C_MasterCheckAndClearError(I3C_Type *base, uint32_t status)`

`status_t I3C_MasterWaitForCtrlDone(I3C_Type *base, bool waitIdle)`

`status_t I3C_CheckForBusyBus(I3C_Type *base)`

`static inline void I3C_MasterEnable(I3C_Type *base, i3c_master_enable_t enable)`

Set I3C module master mode.

#### Parameters

- `base` – The I3C peripheral base address.
- `enable` – Enable master mode.

`void I3C_SlaveGetDefaultConfig(i3c_slave_config_t *slaveConfig)`

Provides a default configuration for the I3C slave peripheral.

This function provides the following default configuration for the I3C slave peripheral:

```
slaveConfig->enableSlave = true;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the slave driver with `I3C_SlaveInit()`.

#### Parameters

- `slaveConfig` – **[out]** User provided configuration structure for default values. Refer to `i3c_slave_config_t`.

`void I3C_SlaveInit(I3C_Type *base, const i3c_slave_config_t *slaveConfig, uint32_t slowClock_Hz)`

Initializes the I3C slave peripheral.

This function enables the peripheral clock and initializes the I3C slave peripheral as described by the user provided configuration.

#### Parameters

- `base` – The I3C peripheral base address.
- `slaveConfig` – User provided peripheral configuration. Use `I3C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- `slowClock_Hz` – Frequency in Hertz of the I3C slow clock. Used to calculate the bus match condition values. If `FSL_FEATURE_I3C_HAS_NO_SCONFIG_BAMATCH` defines as 1, this parameter is useless.

`void I3C_SlaveDeinit(I3C_Type *base)`

Deinitializes the I3C slave peripheral.

This function disables the I3C slave peripheral and gates the clock.

**Parameters**

- `base` – The I3C peripheral base address.

`static inline void I3C_SlaveEnable(I3C_Type *base, bool isEnabled)`

Enable/Disable Slave.

**Parameters**

- `base` – The I3C peripheral base address.
- `isEnabled` – Enable or disable.

`static inline uint32_t I3C_MasterGetStatusFlags(I3C_Type *base)`

Gets the I3C master status flags.

A bit mask with the state of all I3C master status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_master_flags`

**Parameters**

- `base` – The I3C 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 I3C_MasterClearStatusFlags(I3C_Type *base, uint32_t statusMask)`

Clears the I3C master status flag state.

The following status register flags can be cleared:

- `kI3C_MasterSlaveStartFlag`
- `kI3C_MasterControlDoneFlag`
- `kI3C_MasterCompleteFlag`
- `kI3C_MasterArbitrationWonFlag`
- `kI3C_MasterSlave2MasterFlag`

Attempts to clear other flags has no effect.

**See also:**

`_i3c_master_flags`.

**Parameters**

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_master_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_MasterGetStatusFlags()`.



```
static inline uint32_t I3C_MasterGetErrorStatusFlags(I3C_Type *base)
```

Gets the I3C master error status flags.

A bit mask with the state of all I3C master error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_master_error_flags`

**Parameters**

- `base` – The I3C peripheral base address.

**Returns**

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I3C_MasterClearErrorStatusFlags(I3C_Type *base, uint32_t statusMask)
```

Clears the I3C master error status flag state.

**See also:**

`_i3c_master_error_flags`.

**Parameters**

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_master_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_MasterGetStatusFlags()`.

```
i3c_master_state_t I3C_MasterGetState(I3C_Type *base)
```

Gets the I3C master state.

**Parameters**

- `base` – The I3C peripheral base address.

**Returns**

I3C master state.

```
static inline uint32_t I3C_SlaveGetStatusFlags(I3C_Type *base)
```

Gets the I3C slave status flags.

A bit mask with the state of all I3C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_slave_flags`

**Parameters**

- `base` – The I3C 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 I3C\_SlaveClearStatusFlags(I3C\_Type \*base, uint32\_t statusMask)

Clears the I3C slave status flag state.

The following status register flags can be cleared:

- kI3C\_SlaveBusStartFlag
- kI3C\_SlaveMatchedFlag
- kI3C\_SlaveBusStopFlag

Attempts to clear other flags has no effect.

**See also:**

`_i3c_slave_flags`.

**Parameters**

- base – The I3C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetStatusFlags()`.

static inline uint32\_t I3C\_SlaveGetErrorStatusFlags(I3C\_Type \*base)

Gets the I3C slave error status flags.

A bit mask with the state of all I3C slave error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_slave_error_flags`

**Parameters**

- base – The I3C peripheral base address.

**Returns**

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

static inline void I3C\_SlaveClearErrorStatusFlags(I3C\_Type \*base, uint32\_t statusMask)

Clears the I3C slave error status flag state.

**See also:**

`_i3c_slave_error_flags`.

**Parameters**

- base – The I3C peripheral base address.
- statusMask – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_slave_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetErrorStatusFlags()`.

*i3c\_slave\_activity\_state\_t* I3C\_SlaveGetActivityState(I3C\_Type \*base)

Gets the I3C slave state.

**Parameters**

- base – The I3C peripheral base address.

**Returns**

I3C slave activity state, refer *i3c\_slave\_activity\_state\_t*.

*status\_t* I3C\_SlaveCheckAndClearError(I3C\_Type \*base, uint32\_t status)

static inline void I3C\_MasterEnableInterrupts(I3C\_Type \*base, uint32\_t interruptMask)

Enables the I3C master interrupt requests.

All flags except *kI3C\_MasterBetweenFlag* and *kI3C\_MasterNackDetectFlag* can be enabled as interrupts.

**Parameters**

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See *\_i3c\_master\_flags* for the set of constants that should be OR'd together to form the bit mask.

static inline void I3C\_MasterDisableInterrupts(I3C\_Type \*base, uint32\_t interruptMask)

Disables the I3C master interrupt requests.

All flags except *kI3C\_MasterBetweenFlag* and *kI3C\_MasterNackDetectFlag* can be enabled as interrupts.

**Parameters**

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See *\_i3c\_master\_flags* for the set of constants that should be OR'd together to form the bit mask.

static inline uint32\_t I3C\_MasterGetEnabledInterrupts(I3C\_Type \*base)

Returns the set of currently enabled I3C master interrupt requests.

**Parameters**

- base – The I3C peripheral base address.

**Returns**

A bitmask composed of *\_i3c\_master\_flags* enumerators OR'd together to indicate the set of enabled interrupts.

static inline uint32\_t I3C\_MasterGetPendingInterrupts(I3C\_Type \*base)

Returns the set of pending I3C master interrupt requests.

**Parameters**

- base – The I3C peripheral base address.

**Returns**

A bitmask composed of *\_i3c\_master\_flags* enumerators OR'd together to indicate the set of pending interrupts.

static inline void I3C\_SlaveEnableInterrupts(I3C\_Type \*base, uint32\_t interruptMask)

Enables the I3C slave interrupt requests.

Only below flags can be enabled as interrupts.

- *kI3C\_SlaveBusStartFlag*
- *kI3C\_SlaveMatchedFlag*
- *kI3C\_SlaveBusStopFlag*

- kI3C\_SlaveRxReadyFlag
- kI3C\_SlaveTxReadyFlag
- kI3C\_SlaveDynamicAddrChangedFlag
- kI3C\_SlaveReceivedCCCFlag
- kI3C\_SlaveErrorFlag
- kI3C\_SlaveHDRCommandMatchFlag
- kI3C\_SlaveCCCHandledFlag
- kI3C\_SlaveEventSentFlag

**Parameters**

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline void I3C\_\_SlaveDisableInterrupts(I3C\_Type \*base, uint32\_t interruptMask)

Disables the I3C slave interrupt requests.

Only below flags can be disabled as interrupts.

- kI3C\_SlaveBusStartFlag
- kI3C\_SlaveMatchedFlag
- kI3C\_SlaveBusStopFlag
- kI3C\_SlaveRxReadyFlag
- kI3C\_SlaveTxReadyFlag
- kI3C\_SlaveDynamicAddrChangedFlag
- kI3C\_SlaveReceivedCCCFlag
- kI3C\_SlaveErrorFlag
- kI3C\_SlaveHDRCommandMatchFlag
- kI3C\_SlaveCCCHandledFlag
- kI3C\_SlaveEventSentFlag

**Parameters**

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32\_t I3C\_\_SlaveGetEnabledInterrupts(I3C\_Type \*base)

Returns the set of currently enabled I3C slave interrupt requests.

**Parameters**

- base – The I3C peripheral base address.

**Returns**

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
static inline uint32_t I3C_SlaveGetPendingInterrupts(I3C_Type *base)
```

Returns the set of pending I3C slave interrupt requests.

**Parameters**

- base – The I3C peripheral base address.

**Returns**

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of pending interrupts.

```
static inline void I3C_MasterEnableDMA(I3C_Type *base, bool enableTx, bool enableRx,  
                                       uint32_t width)
```

Enables or disables I3C master DMA requests.

**Parameters**

- base – The I3C 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.
- width – DMA read/write unit in bytes.

```
static inline uint32_t I3C_MasterGetTxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C master transmit data register address for DMA transfer.

**Parameters**

- base – The I3C peripheral base address.
- width – DMA read/write unit in bytes.

**Returns**

The I3C Master Transmit Data Register address.

```
static inline uint32_t I3C_MasterGetRxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C master receive data register address for DMA transfer.

**Parameters**

- base – The I3C peripheral base address.
- width – DMA read/write unit in bytes.

**Returns**

The I3C Master Receive Data Register address.

```
static inline void I3C_SlaveEnableDMA(I3C_Type *base, bool enableTx, bool enableRx, uint32_t  
                                       width)
```

Enables or disables I3C slave DMA requests.

**Parameters**

- base – The I3C 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.
- width – DMA read/write unit in bytes.

```
static inline uint32_t I3C_SlaveGetTxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave transmit data register address for DMA transfer.

#### Parameters

- *base* – The I3C peripheral base address.
- *width* – DMA read/write unit in bytes.

#### Returns

The I3C Slave Transmit Data Register address.

```
static inline uint32_t I3C_SlaveGetRxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave receive data register address for DMA transfer.

#### Parameters

- *base* – The I3C peripheral base address.
- *width* – DMA read/write unit in bytes.

#### Returns

The I3C Slave Receive Data Register address.

```
static inline void I3C_MasterSetWatermarks(I3C_Type *base, i3c_tx_trigger_level_t txLvl,  
                                           i3c_rx_trigger_level_t rxLvl, bool flushTx, bool  
                                           flushRx)
```

Sets the watermarks for I3C master FIFOs.

#### Parameters

- *base* – The I3C peripheral base address.
- *txLvl* – Transmit FIFO watermark level. The `kI3C_MasterTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches *txLvl*.
- *rxLvl* – Receive FIFO watermark level. The `kI3C_MasterRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches *rxLvl*.
- *flushTx* – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- *flushRx* – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

```
static inline void I3C_MasterGetFifoCounts(I3C_Type *base, size_t *rxCount, size_t *txCount)
```

Gets the current number of bytes in the I3C master FIFOs.

#### Parameters

- *base* – The I3C 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 void I3C_SlaveSetWatermarks(I3C_Type *base, i3c_tx_trigger_level_t txLvl,  
                                           i3c_rx_trigger_level_t rxLvl, bool flushTx, bool  
                                           flushRx)
```

Sets the watermarks for I3C slave FIFOs.

#### Parameters

- *base* – The I3C peripheral base address.
- *txLvl* – Transmit FIFO watermark level. The `kI3C_SlaveTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches *txLvl*.

- `rxLvl` – Receive FIFO watermark level. The `kI3C_SlaveRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches `rxLvl`.
- `flushTx` – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- `flushRx` – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

static inline void I3C\_SlaveGetFifoCounts(I3C\_Type \*base, size\_t \*rxCount, size\_t \*txCount)

Gets the current number of bytes in the I3C slave FIFOs.

#### Parameters

- `base` – The I3C 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.

void I3C\_MasterSetBaudRate(I3C\_Type \*base, const *i3c\_baudrate\_hz\_t* \*baudRate\_Hz, uint32\_t sourceClock\_Hz)

Sets the I3C bus frequency for master transactions.

The I3C 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.

#### Parameters

- `base` – The I3C peripheral base address.
- `baudRate_Hz` – Pointer to structure of requested bus frequency in Hertz.
- `sourceClock_Hz` – I3C functional clock frequency in Hertz.

static inline bool I3C\_MasterGetBusIdleState(I3C\_Type \*base)

Returns whether the bus is idle.

Requires the master mode to be enabled.

#### Parameters

- `base` – The I3C peripheral base address.

#### Return values

- `true` – Bus is busy.
- `false` – Bus is idle.

*status\_t* I3C\_MasterStartWithRxSize(I3C\_Type \*base, *i3c\_bus\_type\_t* type, uint8\_t address, *i3c\_direction\_t* dir, uint8\_t rxSize)

Sends a START signal and slave address on the I2C/I3C bus, receive size is also specified in the call.

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 I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].

- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.
- `rxSize` – Read terminate size for the followed read transfer, limit to 255 bytes.

#### Return values

- `kStatus_Success` – START signal and address were successfully enqueued in the transmit FIFO.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.

`status_t I3C_MasterStart(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir)`

Sends a START signal and slave address on the I2C/I3C 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 I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_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_I3C_Busy` – Another master is currently utilizing the bus.

`status_t I3C_MasterRepeatedStartWithRxSize(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir, uint8_t rxSize)`

Sends a repeated START signal and slave address on the I2C/I3C bus, receive size is also specified in the call.

This function is used to send a Repeated START signal when a transfer is already in progress. Like `I3C_MasterStart()`, it also sends the specified 7-bit address. Call this API also configures the read terminate size for the following read transfer. For example, set the `rxSize = 2`, the following read transfer will be terminated after two bytes of data received. Write transfer will not be affected by the `rxSize` configuration.

---

**Note:** This function exists primarily to maintain compatible APIs between I3C and I2C drivers, as well as to better document the intent of code that uses these APIs.

---

#### Parameters

- `base` – The I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.



- rxSize – Read terminate size for the followed read transfer, limit to 255 bytes.

**Return values**

kStatus\_Success – Repeated START signal and address were successfully enqueued in the transmit FIFO.

```
static inline status_t I3C_MasterRepeatedStart(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir)
```

Sends a repeated START signal and slave address on the I2C/I3C bus.

This function is used to send a Repeated START signal when a transfer is already in progress. Like I3C\_MasterStart(), it also sends the specified 7-bit address.

---

**Note:** This function exists primarily to maintain compatible APIs between I3C and I2C drivers, as well as to better document the intent of code that uses these APIs.

---

**Parameters**

- base – The I3C peripheral base address.
- type – The bus type to use in this transaction.
- address – 7-bit slave device address, in bits [6:0].
- dir – Master transfer direction, either kI3C\_Read or kI3C\_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.

```
status_t I3C_MasterSend(I3C_Type *base, const void *txBuff, size_t txSize, uint32_t flags)
```

Performs a polling send transfer on the I2C/I3C 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\_I3C\_Nak.

**Parameters**

- base – The I3C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- flags – Bit mask of options for the transfer. See enumeration i3c\_master\_transfer\_flags for available options.

**Return values**

- kStatus\_Success – Data was sent successfully.
- kStatus\_I3C\_Busy – Another master is currently utilizing the bus.
- kStatus\_I3C\_Timeout – The module has stalled too long in a frame.
- kStatus\_I3C\_Nak – The slave device sent a NAK in response to an address.
- kStatus\_I3C\_WriteAbort – The slave device sent a NAK in response to a write.
- kStatus\_I3C\_MsgError – Message SDR/DDR mismatch or read/write message in wrong state.
- kStatus\_I3C\_WriteFifoError – Write to M/SWDATAB register when FIFO full.

- `kStatus_I3C_InvalidReq` – Invalid use of request.

*status\_t* I3C\_MasterReceive(I3C\_Type \*base, void \*rxBuff, size\_t rxSize, uint32\_t flags)

Performs a polling receive transfer on the I2C/I3C bus.

#### Parameters

- `base` – The I3C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.
- `flags` – Bit mask of options for the transfer. See enumeration `_i3c_master_transfer_flags` for available options.

#### Return values

- `kStatus_Success` – Data was received successfully.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I3C_Timeout` – The module has stalled too long in a frame.
- `kStatus_I3C_Term` – The master terminates slave read.
- `kStatus_I3C_HdrParityError` – Parity error from DDR read.
- `kStatus_I3C_CrcError` – CRC error from DDR read.
- `kStatus_I3C_MsgError` – Message SDR/DDR mismatch or read/write message in wrong state.
- `kStatus_I3C_ReadFifoError` – Read from M/SRDATAB register when FIFO empty.
- `kStatus_I3C_InvalidReq` – Invalid use of request.

*status\_t* I3C\_MasterStop(I3C\_Type \*base)

Sends a STOP signal on the I2C/I3C bus.

This function does not return until the STOP signal is seen on the bus, or an error occurs.

#### Parameters

- `base` – The I3C peripheral base address.

#### Return values

- `kStatus_Success` – The STOP signal was successfully sent on the bus and the transaction terminated.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I3C_Timeout` – The module has stalled too long in a frame.
- `kStatus_I3C_InvalidReq` – Invalid use of request.

*void* I3C\_MasterEmitRequest(I3C\_Type \*base, *i3c\_bus\_request\_t* masterReq)

I3C master emit request.

#### Parameters

- `base` – The I3C peripheral base address.
- `masterReq` – I3C master request of type `i3c_bus_request_t`

*static inline void* I3C\_MasterEmitIBIResponse(I3C\_Type \*base, *i3c\_ibi\_response\_t* ibiResponse)

I3C master emit request.

#### Parameters

- `base` – The I3C peripheral base address.

- `ibiResponse` – I3C master emit IBI response of type `i3c_ibi_response_t`

`void I3C_MasterRegisterIBI(I3C_Type *base, i3c_register_ibi_addr_t *ibiRule)`

I3C master register IBI rule.

#### Parameters

- `base` – The I3C peripheral base address.
- `ibiRule` – Pointer to ibi rule description of type `i3c_register_ibi_addr_t`

`void I3C_MasterGetIBIRules(I3C_Type *base, i3c_register_ibi_addr_t *ibiRule)`

I3C master get IBI rule.

#### Parameters

- `base` – The I3C peripheral base address.
- `ibiRule` – Pointer to store the read out ibi rule description.

`i3c_ibi_type_t I3C_GetIBIType(I3C_Type *base)`

I3C master get IBI Type.

#### Parameters

- `base` – The I3C peripheral base address.

#### Return values

`i3c_ibi_type_t` – Type of `i3c_ibi_type_t`.

`static inline uint8_t I3C_GetIBIAddress(I3C_Type *base)`

I3C master get IBI Address.

#### Parameters

- `base` – The I3C peripheral base address.

#### Return values

The – 8-bit IBI address.

`status_t I3C_MasterProcessDAASpecifiedBaudrate(I3C_Type *base, uint8_t *addressList, uint32_t count, i3c_master_daa_baudrate_t *daaBaudRate)`

Performs a DAA in the i3c bus with specified temporary baud rate.

#### Parameters

- `base` – The I3C peripheral base address.
- `addressList` – The pointer for address list which is used to do DAA.
- `count` – The address count in the address list.
- `daaBaudRate` – The temporary baud rate in DAA process, NULL for using initial setting. The initial setting is set back between the completion of the DAA and the return of this function.

#### Return values

- `kStatus_Success` – The transaction was started successfully.
- `kStatus_I3C_Busy` – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.
- `kStatus_I3C_SlaveCountExceed` – The I3C slave count has exceed the definition in `I3C_MAX_DEVCNT`.

```
static inline status_t I3C_MasterProcessDAA(I3C_Type *base, uint8_t *addressList, uint32_t count)
```

Performs a DAA in the i3c bus.

#### Parameters

- *base* – The I3C peripheral base address.
- *addressList* – The pointer for address list which is used to do DAA.
- *count* – The address count in the address list. The initial setting is set back between the completion of the DAA and the return of this function.

#### Return values

- *kStatus\_Success* – The transaction was started successfully.
- *kStatus\_I3C\_Busy* – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.
- *kStatus\_I3C\_SlaveCountExceed* – The I3C slave count has exceed the definition in *I3C\_MAX\_DEVCNT*.

```
i3c_device_info_t *I3C_MasterGetDeviceListAfterDAA(I3C_Type *base, uint8_t *count)
```

Get device information list after DAA process is done.

#### Parameters

- *base* – The I3C peripheral base address.
- *count* – **[out]** The pointer to store the available device count.

#### Returns

Pointer to the *i3c\_device\_info\_t* array.

```
void I3C_MasterClearDeviceCount(I3C_Type *base)
```

Clear the global device count which represents current devices number on the bus. When user resets all dynamic addresses on the bus, should call this API.

#### Parameters

- *base* – The I3C peripheral base address.

```
status_t I3C_MasterTransferBlocking(I3C_Type *base, i3c_master_transfer_t *transfer)
```

Performs a master polling transfer on the I2C/I3C bus.

---

**Note:** The API does not return until the transfer succeeds or fails due to error happens during transfer.

---

#### Parameters

- *base* – The I3C peripheral base address.
- *transfer* – Pointer to the transfer structure.

#### Return values

- *kStatus\_Success* – Data was received successfully.
- *kStatus\_I3C\_Busy* – Another master is currently utilizing the bus.
- *kStatus\_I3C\_IBIWon* – The I3C slave event IBI or MR or HJ won the arbitration on a header address.
- *kStatus\_I3C\_Timeout* – The module has stalled too long in a frame.
- *kStatus\_I3C\_Nak* – The slave device sent a NAK in response to an address.

- `kStatus_I3C_WriteAbort` – The slave device sent a NAK in response to a write.
- `kStatus_I3C_Term` – The master terminates slave read.
- `kStatus_I3C_HdrParityError` – Parity error from DDR read.
- `kStatus_I3C_CrcError` – CRC error from DDR read.
- `kStatus_I3C_MsgError` – Message SDR/DDR mismatch or read/write message in wrong state.
- `kStatus_I3C_ReadFifoError` – Read from M/SRDATA register when FIFO empty.
- `kStatus_I3C_WriteFifoError` – Write to M/SWDATA register when FIFO full.
- `kStatus_I3C_InvalidReq` – Invalid use of request.

`void I3C_SlaveRequestEvent(I3C_Type *base, i3c_slave_event_t event)`  
I3C slave request event.

#### Parameters

- `base` – The I3C peripheral base address.
- `event` – I3C slave event of type `i3c_slave_event_t`

`status_t I3C_SlaveSend(I3C_Type *base, const void *txBuff, size_t txSize)`  
Performs a polling send transfer on the I3C bus.

#### Parameters

- `base` – The I3C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

#### Returns

Error or success status returned by API.

`status_t I3C_SlaveReceive(I3C_Type *base, void *rxBuff, size_t rxSize)`  
Performs a polling receive transfer on the I3C bus.

#### Parameters

- `base` – The I3C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.

#### Returns

Error or success status returned by API.

`void I3C_MasterTransferCreateHandle(I3C_Type *base, i3c_master_handle_t *handle, const i3c_master_transfer_callback_t *callback, void *userData)`

Creates a new handle for the I3C 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 `I3C_MasterTransferAbort()` API shall be called.

---

**Note:** The function also enables the NVIC IRQ for the input I3C. Need to notice that on some SoCs the I3C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

---

**Parameters**

- base – The I3C peripheral base address.
- handle – **[out]** Pointer to the I3C master driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

*status\_t* I3C\_MasterTransferNonBlocking(I3C\_Type \*base, *i3c\_master\_handle\_t* \*handle, *i3c\_master\_transfer\_t* \*transfer)

Performs a non-blocking transaction on the I2C/I3C bus.

**Parameters**

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.
- transfer – The pointer to the transfer descriptor.

**Return values**

- kStatus\_\_Success – The transaction was started successfully.
- kStatus\_I3C\_Busy – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

*status\_t* I3C\_MasterTransferGetCount(I3C\_Type \*base, *i3c\_master\_handle\_t* \*handle, *size\_t* \*count)

Returns number of bytes transferred so far.

**Parameters**

- base – The I3C peripheral base address.
- handle – Pointer to the I3C 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* I3C\_MasterTransferAbort(I3C\_Type \*base, *i3c\_master\_handle\_t* \*handle)

Terminates a non-blocking I3C master transmission early.

---

**Note:** It is not safe to call this function from an IRQ handler that has a higher priority than the I3C peripheral's IRQ priority.

---

**Parameters**

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.

**Return values**

- kStatus\_\_Success – A transaction was successfully aborted.
- kStatus\_I3C\_Idle – There is not a non-blocking transaction currently in progress.

void I3C\_MasterTransferHandleIRQ(I3C\_Type \*base, void \*intHandle)

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 I3C peripheral base address.
- intHandle – Pointer to the I3C master driver handle.

enum \_i3c\_master\_flags

I3C master peripheral flags.

The following status register flags can be cleared:

- kI3C\_MasterSlaveStartFlag
- kI3C\_MasterControlDoneFlag
- kI3C\_MasterCompleteFlag
- kI3C\_MasterArbitrationWonFlag
- kI3C\_MasterSlave2MasterFlag

All flags except kI3C\_MasterBetweenFlag and kI3C\_MasterNackDetectFlag can be enabled as interrupts.

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

#### Values:

enumerator kI3C\_MasterBetweenFlag

Between messages/DAA's flag

enumerator kI3C\_MasterNackDetectFlag

NACK detected flag

enumerator kI3C\_MasterSlaveStartFlag

Slave request start flag

enumerator kI3C\_MasterControlDoneFlag

Master request complete flag

enumerator kI3C\_MasterCompleteFlag

Transfer complete flag

enumerator kI3C\_MasterRxReadyFlag

Rx data ready in Rx buffer flag

enumerator kI3C\_MasterTxReadyFlag

Tx buffer ready for Tx data flag

enumerator kI3C\_MasterArbitrationWonFlag

Header address won arbitration flag

enumerator kI3C\_MasterErrorFlag

Error occurred flag

enumerator kI3C\_MasterSlave2MasterFlag

Switch from slave to master flag

enumerator kI3C\_MasterClearFlags

enum \_\_i3c\_master\_error\_flags

I3C master error flags to indicate the causes.

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

*Values:*

enumerator kI3C\_MasterErrorNackFlag

Slave NACKed the last address

enumerator kI3C\_MasterErrorWriteAbortFlag

Slave NACKed the write data

enumerator kI3C\_MasterErrorParityFlag

Parity error from DDR read

enumerator kI3C\_MasterErrorCrcFlag

CRC error from DDR read

enumerator kI3C\_MasterErrorReadFlag

Read from MRDATAB register when FIFO empty

enumerator kI3C\_MasterErrorWriteFlag

Write to MWDATAB register when FIFO full

enumerator kI3C\_MasterErrorMsgFlag

Message SDR/DDR mismatch or read/write message in wrong state

enumerator kI3C\_MasterErrorInvalidReqFlag

Invalid use of request

enumerator kI3C\_MasterErrorTimeoutFlag

The module has stalled too long in a frame

enumerator kI3C\_MasterAllErrorFlags

All error flags

enum \_\_i3c\_master\_state

I3C working master state.

*Values:*

enumerator kI3C\_MasterStateIdle

Bus stopped.

enumerator kI3C\_MasterStateSlvReq

Bus stopped but slave holding SDA low.

enumerator kI3C\_MasterStateMsgSdr

In SDR Message mode from using MWMSG\_SDR.

enumerator kI3C\_MasterStateNormAct

In normal active SDR mode.

enumerator kI3C\_MasterStateDdr

In DDR Message mode.



enumerator kI3C\_MasterStateDaa

In ENTDAAs mode.

enumerator kI3C\_MasterStateIbiAck

Waiting on IBI ACK/NACK decision.

enumerator kI3C\_MasterStateIbiRcv

Receiving IBI.

enum \_i3c\_master\_enable

I3C master enable configuration.

*Values:*

enumerator kI3C\_MasterOff

Master off.

enumerator kI3C\_MasterOn

Master on.

enumerator kI3C\_MasterCapable

Master capable.

enum \_i3c\_master\_hkeep

I3C high keeper configuration.

*Values:*

enumerator kI3C\_MasterHighKeeperNone

Use PUR to hold SCL high.

enumerator kI3C\_MasterHighKeeperWiredIn

Use pin\_HK controls.

enumerator kI3C\_MasterPassiveSDA

Hi-Z for Bus Free and hold SDA.

enumerator kI3C\_MasterPassiveSDASCL

Hi-Z both for Bus Free, and can Hi-Z SDA for hold.

enum \_i3c\_bus\_request

Emits the requested operation when doing in pieces vs. by message.

*Values:*

enumerator kI3C\_RequestNone

No request.

enumerator kI3C\_RequestEmitStartAddr

Request to emit start and address on bus.

enumerator kI3C\_RequestEmitStop

Request to emit stop on bus.

enumerator kI3C\_RequestIbiAckNack

Manual IBI ACK or NACK.

enumerator kI3C\_RequestProcessDAA

Process DAA.

enumerator kI3C\_RequestForceExit

Request to force exit.

enumerator kI3C\_RequestAutoIbi

Hold in stopped state, but Auto-emit START,7E.

enum \_i3c\_bus\_type

Bus type with EmitStartAddr.

*Values:*

enumerator kI3C\_TypeI3CSdr

SDR mode of I3C.

enumerator kI3C\_TypeI2C

Standard i2c protocol.

enumerator kI3C\_TypeI3CDdr

HDR-DDR mode of I3C.

enum \_i3c\_ibi\_response

IBI response.

*Values:*

enumerator kI3C\_IbiRespAck

ACK with no mandatory byte.

enumerator kI3C\_IbiRespNack

NACK.

enumerator kI3C\_IbiRespAckMandatory

ACK with mandatory byte.

enumerator kI3C\_IbiRespManual

Reserved.

enum \_i3c\_ibi\_type

IBI type.

*Values:*

enumerator kI3C\_IbiNormal

In-band interrupt.

enumerator kI3C\_IbiHotJoin

slave hot join.

enumerator kI3C\_IbiMasterRequest

slave master ship request.

enum \_i3c\_ibi\_state

IBI state.

*Values:*

enumerator kI3C\_IbiReady

In-band interrupt ready state, ready for user to handle.

enumerator kI3C\_IbiDataBuffNeed

In-band interrupt need data buffer for data receive.

enumerator kI3C\_IbiAckNackPending

In-band interrupt Ack/Nack pending for decision.

enum \_i3c\_direction

Direction of master and slave transfers.

*Values:*

enumerator kI3C\_Write

Master transmit.

enumerator kI3C\_Read

Master receive.

enum \_i3c\_tx\_trigger\_level

Watermark of TX int/dma trigger level.

*Values:*

enumerator kI3C\_TxTriggerOnEmpty

Trigger on empty.

enumerator kI3C\_TxTriggerUntilOneQuarterOrLess

Trigger on 1/4 full or less.

enumerator kI3C\_TxTriggerUntilOneHalfOrLess

Trigger on 1/2 full or less.

enumerator kI3C\_TxTriggerUntilOneLessThanFull

Trigger on 1 less than full or less.

enum \_i3c\_rx\_trigger\_level

Watermark of RX int/dma trigger level.

*Values:*

enumerator kI3C\_RxTriggerOnNotEmpty

Trigger on not empty.

enumerator kI3C\_RxTriggerUntilOneQuarterOrMore

Trigger on 1/4 full or more.

enumerator kI3C\_RxTriggerUntilOneHalfOrMore

Trigger on 1/2 full or more.

enumerator kI3C\_RxTriggerUntilThreeQuarterOrMore

Trigger on 3/4 full or more.

enum \_i3c\_rx\_term\_ops

I3C master read termination operations.

*Values:*

enumerator kI3C\_RxTermDisable

Master doesn't terminate read, used for CCC transfer.

enumerator kI3C\_RxAutoTerm

Master auto terminate read after receiving specified bytes(<=255).

enumerator kI3C\_RxTermLastByte

Master terminates read at any time after START, no length limitation.

enum \_i3c\_start\_scl\_delay

I3C start SCL delay options.

*Values:*

enumerator kI3C\_NoDelay

No delay.

enumerator kI3C\_IncreaseSclHalfPeriod

Increases SCL clock period by 1/2.

enumerator kI3C\_IncreaseSclOnePeriod

Increases SCL clock period by 1.

enumerator kI3C\_IncreaseSclOneAndHalfPeriod

Increases SCL clock period by 1 1/2

enum \_i3c\_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 `_i3c_master_transfer::flags` field.

---

*Values:*

enumerator kI3C\_TransferDefaultFlag

Transfer starts with a start signal, stops with a stop signal.

enumerator kI3C\_TransferNoStartFlag

Don't send a start condition, address, and sub address

enumerator kI3C\_TransferRepeatedStartFlag

Send a repeated start condition

enumerator kI3C\_TransferNoStopFlag

Don't send a stop condition.

enumerator kI3C\_TransferWordsFlag

Transfer in words, else transfer in bytes.

enumerator kI3C\_TransferDisableRxTermFlag

Disable Rx termination. Note: It's for I3C CCC transfer.

enumerator kI3C\_TransferRxAutoTermFlag

Set Rx auto-termination. Note: It's adaptive based on Rx size(<=255 bytes) except in I3C\_MasterReceive.

enumerator kI3C\_TransferStartWithBroadcastAddr

Start transfer with 0x7E, then read/write data with device address.

typedef enum \_i3c\_master\_state i3c\_master\_state\_t

I3C working master state.

typedef enum \_i3c\_master\_enable i3c\_master\_enable\_t

I3C master enable configuration.

typedef enum \_i3c\_master\_hkeep i3c\_master\_hkeep\_t

I3C high keeper configuration.

typedef enum \_i3c\_bus\_request i3c\_bus\_request\_t

Emits the requested operation when doing in pieces vs. by message.

typedef enum \_i3c\_bus\_type i3c\_bus\_type\_t

Bus type with EmitStartAddr.

```
typedef enum _i3c_ibi_response i3c_ibi_response_t
    IBI response.
```

```
typedef enum _i3c_ibi_type i3c_ibi_type_t
    IBI type.
```

```
typedef enum _i3c_ibi_state i3c_ibi_state_t
    IBI state.
```

```
typedef enum _i3c_direction i3c_direction_t
    Direction of master and slave transfers.
```

```
typedef enum _i3c_tx_trigger_level i3c_tx_trigger_level_t
    Watermark of TX int/dma trigger level.
```

```
typedef enum _i3c_rx_trigger_level i3c_rx_trigger_level_t
    Watermark of RX int/dma trigger level.
```

```
typedef enum _i3c_rx_term_ops i3c_rx_term_ops_t
    I3C master read termination operations.
```

```
typedef enum _i3c_start_scl_delay i3c_start_scl_delay_t
    I3C start SCL delay options.
```

```
typedef struct _i3c_register_ibi_addr i3c_register_ibi_addr_t
    Structure with setting master IBI rules and slave registry.
```

```
typedef struct _i3c_baudrate i3c_baudrate_hz_t
    Structure with I3C baudrate settings.
```

```
typedef struct _i3c_master_daa_baudrate i3c_master_daa_baudrate_t
    I3C DAA baud rate configuration.
```

```
typedef struct _i3c_master_config i3c_master_config_t
    Structure with settings to initialize the I3C master module.
```

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_MasterGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

```
typedef struct _i3c_master_transfer i3c_master_transfer_t
```

```
typedef struct _i3c_master_handle i3c_master_handle_t
```

```
typedef struct _i3c_master_transfer_callback i3c_master_transfer_callback_t
    i3c master callback functions.
```

```
typedef void (*i3c_master_isr_t)(I3C_Type *base, void *handle)
    Typedef for master interrupt handler.
```

```
struct _i3c_register_ibi_addr
    #include <fsl_i3c.h> Structure with setting master IBI rules and slave registry.
```

### Public Members

```
uint8_t address[5]
    Address array for registry.
```

```
bool i3cFastStart
    Allow the START header to run as push-pull speed if all dynamic addresses take MSB 0.
```

bool ibiHasPayload

Whether the address array has mandatory IBI byte.

struct \_\_i3c\_\_baudrate

*#include <fsl\_i3c.h>* Structure with I3C baudrate settings.

### Public Members

uint32\_t i2cBaud

Desired I2C baud rate in Hertz.

uint32\_t i3cPushPullBaud

Desired I3C push-pull baud rate in Hertz.

uint32\_t i3cOpenDrainBaud

Desired I3C open-drain baud rate in Hertz.

struct \_\_i3c\_\_master\_\_daa\_\_baudrate

*#include <fsl\_i3c.h>* I3C DAA baud rate configuration.

### Public Members

uint32\_t sourceClock\_Hz

FCLK, function clock in Hertz.

uint32\_t i3cPushPullBaud

Desired I3C push-pull baud rate in Hertz.

uint32\_t i3cOpenDrainBaud

Desired I3C open-drain baud rate in Hertz.

struct \_\_i3c\_\_master\_\_config

*#include <fsl\_i3c.h>* Structure with settings to initialize the I3C master module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C\_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

i3c\_master\_enable\_t enableMaster

Enable master mode.

bool disableTimeout

Whether to disable timeout to prevent the ERRWARN.

i3c\_master\_hkeep\_t hKeep

High keeper mode setting.

bool enableOpenDrainStop

Whether to emit open-drain speed STOP.

bool enableOpenDrainHigh

Enable Open-Drain High to be 1 PPBAUD count for i3c messages, or 1 ODBAUD.

i3c\_baudrate\_hz\_t baudRate\_Hz

Desired baud rate settings.

```
struct _i3c_master_transfer_callback
    #include <fsl_i3c.h> i3c master callback functions.
```

### Public Members

```
void (*slave2Master)(I3C_Type *base, void *userData)
```

Transfer complete callback

```
void (*ibiCallback)(I3C_Type *base, i3c_master_handle_t *handle, i3c_ibi_type_t ibiType,
i3c_ibi_state_t ibiState)
```

IBI event callback

```
void (*transferComplete)(I3C_Type *base, i3c_master_handle_t *handle, status_t
completionStatus, void *userData)
```

Transfer complete callback

```
struct _i3c_master_transfer
    #include <fsl_i3c.h> Non-blocking transfer descriptor structure.
```

This structure is used to pass transaction parameters to the I3C\_MasterTransferNonBlocking() API.

### Public Members

```
uint32_t flags
```

Bit mask of options for the transfer. See enumeration `_i3c_master_transfer_flags` for available options. Set to 0 or `kI3C_TransferDefaultFlag` for normal transfers.

```
uint8_t slaveAddress
```

The 7-bit slave address.

```
i3c_direction_t direction
```

Either `kI3C_Read` or `kI3C_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.

```
i3c_bus_type_t busType
```

bus type.

```
i3c_ibi_response_t ibiResponse
```

ibi response during transfer.

```
struct _i3c_master_handle
    #include <fsl_i3c.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.

`uint32_t` remainingBytes  
Remaining byte count in current state.

`i3c_rx_term_ops_t` rxTermOps  
Read termination operation.

`i3c_master_transfer_t` transfer  
Copy of the current transfer info.

`uint8_t` ibiAddress  
Slave address which request IBI.

`uint8_t` \*ibiBuff  
Pointer to IBI buffer to keep ibi bytes.

`size_t` ibiPayloadSize  
IBI payload size.

`i3c_ibi_type_t` ibiType  
IBI type.

`i3c_master_transfer_callback_t` callback  
Callback functions pointer.

`void` \*userData  
Application data passed to callback.

## 2.14 I3C Slave DMA Driver

```
void I3C_SlaveTransferCreateHandleDMA(I3C_Type *base, i3c_slave_dma_handle_t *handle,
                                     i3c_slave_dma_callback_t callback, void *userData,
                                     dma_handle_t *rxDmaHandle, dma_handle_t
                                     *txDmaHandle)
```

Create a new handle for the I3C slave 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 `I3C_SlaveTransferAbortDMA()` API shall be called.

For devices where the I3C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

### Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C slave driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.
- rxDmaHandle – Handle for the DMA receive channel. Created by the user prior to calling this function.
- txDmaHandle – Handle for the DMA transmit channel. Created by the user prior to calling this function.



```
status_t I3C_SlaveTransferDMA(I3C_Type *base, i3c_slave_dma_handle_t *handle,  
                             i3c_slave_dma_transfer_t *transfer, uint32_t eventMask)
```

Prepares for a non-blocking DMA-based transaction on the I3C bus.

The API will do DMA configuration according to the input transfer descriptor, and the data will be transferred when there's bus master requesting transfer from/to this slave. So the timing of call to this API need be aligned with master application to ensure the transfer is executed as expected. Callback specified when the *handle* was created is invoked when the transaction has completed.

#### Parameters

- *base* – The I3C peripheral base address.
- *handle* – Pointer to the I3C slave driver handle.
- *transfer* – The pointer to the transfer descriptor.
- *eventMask* – Bit mask formed by OR'ing together *i3c\_slave\_transfer\_event\_t* enumerators to specify which events to send to the callback. The transmit and receive events is not allowed to be enabled.

#### Return values

- *kStatus\_Success* – The transaction was started successfully.
- *kStatus\_I3C\_Busy* – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

```
void I3C_SlaveTransferAbortDMA(I3C_Type *base, i3c_slave_dma_handle_t *handle)
```

Abort a slave dma non-blocking transfer in a early time.

#### Parameters

- *base* – I3C peripheral base address
- *handle* – pointer to *i3c\_slave\_dma\_handle\_t* structure

```
void I3C_SlaveTransferDMAHandleIRQ(I3C_Type *base, void *i3CHandle)
```

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 I3C peripheral base address.
- *handle* – Pointer to the I3C slave DMA driver handle.

```
typedef struct _i3c_slave_dma_handle i3c_slave_dma_handle_t
```

```
typedef struct _i3c_slave_dma_transfer i3c_slave_dma_transfer_t
```

I3C slave transfer structure.

```
typedef void (*i3c_slave_dma_callback_t)(I3C_Type *base, i3c_slave_dma_transfer_t *transfer,  
void *userData)
```

Slave event callback function pointer type.

This callback is used only for the slave DMA transfer API.

#### Param base

Base address for the I3C instance on which the event occurred.

#### Param handle

Pointer to slave DMA transfer handle.

**Param transfer**

Pointer to transfer descriptor containing values passed to and/or from the call-back.

**Param userData**

Arbitrary pointer-sized value passed from the application.

```
struct __i3c_slave_dma_transfer
```

```
#include <fsl_i3c_dma.h> I3C slave transfer structure.
```

```
struct __i3c_slave_dma_handle
```

```
#include <fsl_i3c_dma.h> I3C slave dma handle structure.
```

---

**Note:** The contents of this structure are private and subject to change.

---

## 2.15 I3C Slave Driver

```
void I3C_SlaveGetDefaultConfig(i3c_slave_config_t *slaveConfig)
```

Provides a default configuration for the I3C slave peripheral.

This function provides the following default configuration for the I3C slave peripheral:

```
slaveConfig->enableSlave = true;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the slave driver with `I3C_SlaveInit()`.

**Parameters**

- `slaveConfig` – **[out]** User provided configuration structure for default values. Refer to `i3c_slave_config_t`.

```
void I3C_SlaveInit(I3C_Type *base, const i3c_slave_config_t *slaveConfig, uint32_t  
slowClock_Hz)
```

Initializes the I3C slave peripheral.

This function enables the peripheral clock and initializes the I3C slave peripheral as described by the user provided configuration.

**Parameters**

- `base` – The I3C peripheral base address.
- `slaveConfig` – User provided peripheral configuration. Use `I3C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- `slowClock_Hz` – Frequency in Hertz of the I3C slow clock. Used to calculate the bus match condition values. If `FSL_FEATURE_I3C_HAS_NO_SCONFIG_BAMATCH` defines as 1, this parameter is useless.

```
void I3C_SlaveDeinit(I3C_Type *base)
```

Deinitializes the I3C slave peripheral.

This function disables the I3C slave peripheral and gates the clock.

**Parameters**

- `base` – The I3C peripheral base address.

static inline void I3C\_SlaveEnable(I3C\_Type \*base, bool isEnabled)  
Enable/Disable Slave.

**Parameters**

- base – The I3C peripheral base address.
- isEnabled – Enable or disable.

static inline uint32\_t I3C\_SlaveGetStatusFlags(I3C\_Type \*base)  
Gets the I3C slave status flags.

A bit mask with the state of all I3C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_slave_flags`

**Parameters**

- base – The I3C 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 I3C\_SlaveClearStatusFlags(I3C\_Type \*base, uint32\_t statusMask)  
Clears the I3C slave status flag state.

The following status register flags can be cleared:

- kI3C\_SlaveBusStartFlag
- kI3C\_SlaveMatchedFlag
- kI3C\_SlaveBusStopFlag

Attempts to clear other flags has no effect.

**See also:**

`_i3c_slave_flags`.

**Parameters**

- base – The I3C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetStatusFlags()`.

static inline uint32\_t I3C\_SlaveGetErrorStatusFlags(I3C\_Type \*base)  
Gets the I3C slave error status flags.

A bit mask with the state of all I3C slave error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_i3c_slave_error_flags`

**Parameters**

- `base` – The I3C peripheral base address.

**Returns**

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I3C_SlaveClearErrorStatusFlags(I3C_Type *base, uint32_t statusMask)
```

Clears the I3C slave error status flag state.

**See also:**

`_i3c_slave_error_flags`.

**Parameters**

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_slave_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetErrorStatusFlags()`.

```
i3c_slave_activity_state_t I3C_SlaveGetActivityState(I3C_Type *base)
```

Gets the I3C slave state.

**Parameters**

- `base` – The I3C peripheral base address.

**Returns**

I3C slave activity state, refer `i3c_slave_activity_state_t`.

```
status_t I3C_SlaveCheckAndClearError(I3C_Type *base, uint32_t status)
```

```
static inline void I3C_SlaveEnableInterrupts(I3C_Type *base, uint32_t interruptMask)
```

Enables the I3C slave interrupt requests.

Only below flags can be enabled as interrupts.

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`
- `kI3C_SlaveRxReadyFlag`
- `kI3C_SlaveTxReadyFlag`
- `kI3C_SlaveDynamicAddrChangedFlag`
- `kI3C_SlaveReceivedCCCFlag`
- `kI3C_SlaveErrorFlag`
- `kI3C_SlaveHDRCommandMatchFlag`
- `kI3C_SlaveCCCHandledFlag`
- `kI3C_SlaveEventSentFlag`

**Parameters**

- `base` – The I3C peripheral base address.

- interruptMask – Bit mask of interrupts to enable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline void I3C\_SlaveDisableInterrupts(I3C\_Type \*base, uint32\_t interruptMask)

Disables the I3C slave interrupt requests.

Only below flags can be disabled as interrupts.

- kI3C\_SlaveBusStartFlag
- kI3C\_SlaveMatchedFlag
- kI3C\_SlaveBusStopFlag
- kI3C\_SlaveRxReadyFlag
- kI3C\_SlaveTxReadyFlag
- kI3C\_SlaveDynamicAddrChangedFlag
- kI3C\_SlaveReceivedCCCFlag
- kI3C\_SlaveErrorFlag
- kI3C\_SlaveHDRCommandMatchFlag
- kI3C\_SlaveCCCHandledFlag
- kI3C\_SlaveEventSentFlag

#### Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32\_t I3C\_SlaveGetEnabledInterrupts(I3C\_Type \*base)

Returns the set of currently enabled I3C slave interrupt requests.

#### Parameters

- base – The I3C peripheral base address.

#### Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

static inline uint32\_t I3C\_SlaveGetPendingInterrupts(I3C\_Type \*base)

Returns the set of pending I3C slave interrupt requests.

#### Parameters

- base – The I3C peripheral base address.

#### Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of pending interrupts.

static inline void I3C\_SlaveEnableDMA(I3C\_Type \*base, bool enableTx, bool enableRx, uint32\_t width)

Enables or disables I3C slave DMA requests.

#### Parameters

- base – The I3C 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.
- `width` – DMA read/write unit in bytes.

static inline uint32\_t I3C\_SlaveGetTxFifoAddress(I3C\_Type \*base, uint32\_t width)

Gets I3C slave transmit data register address for DMA transfer.

#### Parameters

- `base` – The I3C peripheral base address.
- `width` – DMA read/write unit in bytes.

#### Returns

The I3C Slave Transmit Data Register address.

static inline uint32\_t I3C\_SlaveGetRxFifoAddress(I3C\_Type \*base, uint32\_t width)

Gets I3C slave receive data register address for DMA transfer.

#### Parameters

- `base` – The I3C peripheral base address.
- `width` – DMA read/write unit in bytes.

#### Returns

The I3C Slave Receive Data Register address.

static inline void I3C\_SlaveSetWatermarks(I3C\_Type \*base, *i3c\_tx\_trigger\_level\_t* txLvl, *i3c\_rx\_trigger\_level\_t* rxLvl, bool flushTx, bool flushRx)

Sets the watermarks for I3C slave FIFOs.

#### Parameters

- `base` – The I3C peripheral base address.
- `txLvl` – Transmit FIFO watermark level. The `kI3C_SlaveTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches *txLvl*.
- `rxLvl` – Receive FIFO watermark level. The `kI3C_SlaveRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches *rxLvl*.
- `flushTx` – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- `flushRx` – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

static inline void I3C\_SlaveGetFifoCounts(I3C\_Type \*base, size\_t \*rxCount, size\_t \*txCount)

Gets the current number of bytes in the I3C slave FIFOs.

#### Parameters

- `base` – The I3C 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.

void I3C\_SlaveRequestEvent(I3C\_Type \*base, *i3c\_slave\_event\_t* event)

I3C slave request event.

#### Parameters

- `base` – The I3C peripheral base address.

- `event` – I3C slave event of type `i3c_slave_event_t`

`status_t I3C_SlaveSend(I3C_Type *base, const void *txBuff, size_t txSize)`

Performs a polling send transfer on the I3C bus.

#### Parameters

- `base` – The I3C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

#### Returns

Error or success status returned by API.

`status_t I3C_SlaveReceive(I3C_Type *base, void *rxBuff, size_t rxSize)`

Performs a polling receive transfer on the I3C bus.

#### Parameters

- `base` – The I3C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.

#### Returns

Error or success status returned by API.

`void I3C_SlaveTransferCreateHandle(I3C_Type *base, i3c_slave_handle_t *handle,  
i3c_slave_transfer_callback_t callback, void *userData)`

Creates a new handle for the I3C 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 `I3C_SlaveTransferAbort()` API shall be called.

---

**Note:** The function also enables the NVIC IRQ for the input I3C. Need to notice that on some SoCs the I3C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

---

#### Parameters

- `base` – The I3C peripheral base address.
- `handle` – **[out]** Pointer to the I3C slave driver handle.
- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

`status_t I3C_SlaveTransferNonBlocking(I3C_Type *base, i3c_slave_handle_t *handle, uint32_t  
eventMask)`

Starts accepting slave transfers.

Call this API after calling `I2C_SlaveInit()` and `I3C_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 `I3C_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 `i3c_slave_transfer_event_t` enumerators for the events you wish to receive. The `kI3C_SlaveTransmitEvent` and `kI3C_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 `kI3C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

#### Parameters

- `base` – The I3C peripheral base address.
- `handle` – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.
- `eventMask` – Bit mask formed by OR'ing together `i3c_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 `kI3C_SlaveAllEvents` to enable all events.

#### Return values

- `kStatus__Success` – Slave transfers were successfully started.
- `kStatus__I3C__Busy` – Slave transfers have already been started on this handle.

`status_t I3C_SlaveTransferGetCount(I3C_Type *base, i3c_slave_handle_t *handle, size_t *count)`

Gets the slave transfer status during a non-blocking transfer.

#### Parameters

- `base` – The I3C 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 I3C_SlaveTransferAbort(I3C_Type *base, i3c_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 I3C peripheral base address.
- `handle` – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.

#### Return values

- `kStatus__Success` –
- `kStatus__I3C__Idle` –

`void I3C_SlaveTransferHandleIRQ(I3C_Type *base, void *intHandle)`

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 I3C peripheral base address.
- `intHandle` – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.

`void I3C_SlaveRequestIBIWithData(I3C_Type *base, uint8_t *data, size_t dataSize)`  
I3C slave request IBI event with data payload(mandatory and extended).

**Parameters**

- `base` – The I3C peripheral base address.
- `data` – Pointer to IBI data to be sent in the request.
- `dataSize` – IBI data size.

`void I3C_SlaveRequestIBIWithSingleData(I3C_Type *base, uint8_t data, size_t dataSize)`  
I3C slave request IBI event with single data.

*Deprecated:*

Do not use this function. It has been superseded by `I3C_SlaveRequestIBIWithData`.

**Parameters**

- `base` – The I3C peripheral base address.
- `data` – IBI data to be sent in the request.
- `dataSize` – IBI data size.

`enum _i3c_slave_flags`

I3C slave peripheral flags.

The following status register flags can be cleared:

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`

Only below flags can be enabled as interrupts.

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`
- `kI3C_SlaveRxReadyFlag`
- `kI3C_SlaveTxReadyFlag`
- `kI3C_SlaveDynamicAddrChangedFlag`
- `kI3C_SlaveReceivedCCCFlag`
- `kI3C_SlaveErrorFlag`
- `kI3C_SlaveHDRCommandMatchFlag`
- `kI3C_SlaveCCCHandledFlag`
- `kI3C_SlaveEventSentFlag`

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

*Values:*

enumerator kI3C\_SlaveNotStopFlag  
Slave status not stop flag

enumerator kI3C\_SlaveMessageFlag  
Slave status message, indicating slave is listening to the bus traffic or responding

enumerator kI3C\_SlaveRequiredReadFlag  
Slave status required, either is master doing SDR read from slave, or is IBI pushing out.

enumerator kI3C\_SlaveRequiredWriteFlag  
Slave status request write, master is doing SDR write to slave, except slave in ENTDAAMode

enumerator kI3C\_SlaveBusDAAModeFlag  
I3C bus is in ENTDAAMode

enumerator kI3C\_SlaveBusHDRModeFlag  
I3C bus is in HDR mode

enumerator kI3C\_SlaveBusStartFlag  
Start/Re-start event is seen since the bus was last cleared

enumerator kI3C\_SlaveMatchedFlag  
Slave address(dynamic/static) matched since last cleared

enumerator kI3C\_SlaveBusStopFlag  
Stop event is seen since the bus was last cleared

enumerator kI3C\_SlaveRxReadyFlag  
Rx data ready in rx buffer flag

enumerator kI3C\_SlaveTxReadyFlag  
Tx buffer ready for Tx data flag

enumerator kI3C\_SlaveDynamicAddrChangedFlag  
Slave dynamic address has been assigned, re-assigned, or lost

enumerator kI3C\_SlaveReceivedCCCFlag  
Slave received Common command code

enumerator kI3C\_SlaveErrorFlag  
Error occurred flag

enumerator kI3C\_SlaveHDRCommandMatchFlag  
High data rate command match

enumerator kI3C\_SlaveCCCHandledFlag  
Slave received Common command code is handled by I3C module

enumerator kI3C\_SlaveEventSentFlag  
Slave IBI/P2P/MR/HJ event has been sent

enumerator kI3C\_SlaveIbiDisableFlag  
Slave in band interrupt is disabled.

enumerator kI3C\_SlaveMasterRequestDisabledFlag  
Slave master request is disabled.

enumerator kI3C\_SlaveHotJoinDisabledFlag  
Slave Hot-Join is disabled.

enumerator kI3C\_SlaveClearFlags  
All flags which are cleared by the driver upon starting a transfer.

enumerator kI3C\_SlaveAllIrqFlags

enum \_i3c\_slave\_error\_flags

I3C slave error flags to indicate the causes.

---

**Note:** These enums are meant to be OR'd together to form a bit mask.

---

*Values:*

enumerator kI3C\_SlaveErrorOverrunFlag

Slave internal from-bus buffer/FIFO overrun.

enumerator kI3C\_SlaveErrorUnderrunFlag

Slave internal to-bus buffer/FIFO underrun

enumerator kI3C\_SlaveErrorUnderrunNakFlag

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kI3C\_SlaveErrorTermFlag

Terminate error from master

enumerator kI3C\_SlaveErrorInvalidStartFlag

Slave invalid start flag

enumerator kI3C\_SlaveErrorSdrParityFlag

SDR parity error

enumerator kI3C\_SlaveErrorHdrParityFlag

HDR parity error

enumerator kI3C\_SlaveErrorHdrCRCFlag

HDR-DDR CRC error

enumerator kI3C\_SlaveErrorS0S1Flag

S0 or S1 error

enumerator kI3C\_SlaveErrorOverreadFlag

Over-read error

enumerator kI3C\_SlaveErrorOverwriteFlag

Over-write error

enum \_i3c\_slave\_event

I3C slave.event.

*Values:*

enumerator kI3C\_SlaveEventNormal

Normal mode.

enumerator kI3C\_SlaveEventIBI

In band interrupt event.

enumerator kI3C\_SlaveEventMasterReq

Master request event.

enumerator kI3C\_SlaveEventHotJoinReq

Hot-join event.

enum \_i3c\_slave\_activity\_state

I3C slave.activity state.

*Values:*

enumerator kI3C\_SlaveNoLatency

Normal bus operation

enumerator kI3C\_SlaveLatency1Ms

1ms of latency.

enumerator kI3C\_SlaveLatency100Ms

100ms of latency.

enumerator kI3C\_SlaveLatency10S

10s latency.

enum \_i3c\_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 I3C\_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 kI3C\_SlaveAddressMatchEvent

Received the slave address after a start or repeated start.

enumerator kI3C\_SlaveTransmitEvent

Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kI3C\_SlaveReceiveEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C\_SlaveRequiredTransmitEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C\_SlaveStartEvent

A start/repeated start was detected.

enumerator kI3C\_SlaveHDRCommandMatchEvent

Slave Match HDR Command.

enumerator kI3C\_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator kI3C\_SlaveRequestSentEvent

Slave request event sent.

enumerator kI3C\_SlaveReceivedCCCEvent

Slave received CCC event, need to handle by application.

enumerator kI3C\_SlaveAllEvents

Bit mask of all available events.

typedef enum \_i3c\_slave\_event i3c\_slave\_event\_t

I3C slave.event.

typedef enum \_i3c\_slave\_activity\_state i3c\_slave\_activity\_state\_t

I3C slave.activity state.

```
typedef struct _i3c_slave_config i3c_slave_config_t
```

Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C\_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 _i3c_slave_transfer_event i3c_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 I3C\_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 _i3c_slave_transfer i3c_slave_transfer_t
```

I3C slave transfer structure.

```
typedef struct _i3c_slave_handle i3c_slave_handle_t
```

```
typedef void (*i3c_slave_transfer_callback_t)(I3C_Type *base, i3c_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 I3C\_SlaveSetCallback() function after you have created a handle.

**Param base**

Base address for the I3C 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.

```
typedef void (*i3c_slave_isr_t)(I3C_Type *base, void *handle)
```

Typedef for slave interrupt handler.

```
struct _i3c_slave_config
```

*#include <fsl\_i3c.h>* Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C\_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

Whether to enable slave.

bool isHotJoin

Whether to enable slave hotjoin before enable slave.

`uint8_t staticAddr`  
Static address.

`uint16_t vendorID`  
Device vendor ID(manufacture ID).

`uint32_t partNumber`  
Device part number info

`uint8_t dcr`  
Device characteristics register information.

`uint8_t bcr`  
Bus characteristics register information.

`uint8_t hdrMode`  
Support hdr mode, could be OR logic in enumeration:`i3c_hdr_mode_t`.

`bool nakAllRequest`  
Whether to reply NAK to all requests except broadcast CCC.

`bool ignoreS0S1Error`  
Whether to ignore S0/S1 error in SDR mode.

`bool offline`  
Whether to wait 60 us of bus quiet or HDR request to ensure slave track SDR mode safely.

`bool matchSlaveStartStop`  
Whether to assert start/stop status only the time slave is addressed.

`uint32_t maxWriteLength`  
Maximum write length.

`uint32_t maxReadLength`  
Maximum read length.

`struct _i3c_slave_transfer`  
*#include <fsl\_i3c.h>* I3C slave transfer structure.

### Public Members

`uint32_t event`  
Reason the callback is being invoked.

`uint8_t *txData`  
Transfer buffer

`size_t txDataSize`  
Transfer size

`uint8_t *rxData`  
Transfer buffer

`size_t rxDataSize`  
Transfer size

`status_t completionStatus`  
Success or error code describing how the transfer completed. Only applies for `kI3C_SlaveCompletionEvent`.

size\_t transferredCount

Number of bytes actually transferred since start or last repeated start.

struct \_\_i3c\_slave\_handle

#include <fsl\_i3c.h> I3C slave handle structure.

---

**Note:** The contents of this structure are private and subject to change.

---

### Public Members

i3c\_slave\_transfer\_t transfer

I3C 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.

i3c\_slave\_transfer\_callback\_t callback

Callback function called at transfer event.

void \*userData

Callback parameter passed to callback.

uint8\_t txFifoSize

Tx Fifo size

## 2.16 IAP: In Application Programming Driver

status\_t IAP\_ReadPartID(uint32\_t \*partID)

Read part identification number.

This function is used to read the part identification number.

### Parameters

- partID – Address to store the part identification number.

### Return values

kStatus\_IAP\_Success – Api has been executed successfully.

status\_t IAP\_ReadBootCodeVersion(uint32\_t \*bootCodeVersion)

Read boot code version number.

This function is used to read the boot code version number.

note Boot code version is two 32-bit words. Word 0 is the major version, word 1 is the minor version.

### Parameters

- `bootCodeVersion` – Address to store the boot code version.

**Return values**

`kStatus_IAP_Success` – Api has been executed successfully.

`void IAP_ReinvokeISP(uint8_t ispType, uint32_t *status)`

Reinvoke ISP.

This function is used to invoke the boot loader in ISP mode. It maps boot vectors and configures the peripherals for ISP.

note The error response will be returned when IAP is disabled or an invalid ISP type selection appears. The call won't return unless an error occurs, so there can be no status code.

**Parameters**

- `ispType` – ISP type selection.
- `status` – store the possible status.

**Return values**

`kStatus_IAP_ReinvokeISPConfig` – reinvoke configuration error.

`status_t IAP_ReadUniqueID(uint32_t *uniqueID)`

Read unique identification.

This function is used to read the unique id.

**Parameters**

- `uniqueID` – store the uniqueID.

**Return values**

`kStatus_IAP_Success` – Api has been executed successfully.

`status_t IAP_PrepareSectorForWrite(uint32_t startSector, uint32_t endSector)`

Prepare sector for write operation.

This function prepares sector(s) for write/erase operation. This function must be called before calling the `IAP_CopyRamToFlash()` or `IAP_EraseSector()` or `IAP_ErasePage()` function. The end sector number must be greater than or equal to the start sector number.

**Parameters**

- `startSector` – Start sector number.
- `endSector` – End sector number.

**Return values**

- `kStatus_IAP_Success` – Api has been executed successfully.
- `kStatus_IAP_NoPower` – Flash memory block is powered down.
- `kStatus_IAP_NoClock` – Flash memory block or controller is not clocked.
- `kStatus_IAP_InvalidSector` – Sector number is invalid or end sector number is greater than start sector number.
- `kStatus_IAP_Busy` – Flash programming hardware interface is busy.

`status_t IAP_CopyRamToFlash(uint32_t dstAddr, uint32_t *srcAddr, uint32_t numOfBytes, uint32_t systemCoreClock)`

Copy RAM to flash.

This function programs the flash memory. Corresponding sectors must be prepared via `IAP_PrepareSectorForWrite` before calling this function.



**Parameters**

- `dstAddr` – Destination flash address where data bytes are to be written, the address should be multiples of `FSL_FEATURE_SYSCON_FLASH_PAGE_SIZE_BYTES` boundary.
- `srcAddr` – Source ram address from where data bytes are to be read.
- `numOfBytes` – Number of bytes to be written, it should be multiples of `FSL_FEATURE_SYSCON_FLASH_PAGE_SIZE_BYTES`, and ranges from `FSL_FEATURE_SYSCON_FLASH_PAGE_SIZE_BYTES` to `FSL_FEATURE_SYSCON_FLASH_SECTOR_SIZE_BYTES`.
- `systemCoreClock` – SystemCoreClock in Hz. It is converted to KHz before calling the rom IAP function. When the flash controller has a fixed reference clock, this parameter is bypassed.

**Return values**

- `kStatus_IAP_Success` – Api has been executed successfully.
- `kStatus_IAP_NoPower` – Flash memory block is powered down.
- `kStatus_IAP_NoClock` – Flash memory block or controller is not clocked.
- `kStatus_IAP_SrcAddrError` – Source address is not on word boundary.
- `kStatus_IAP_DstAddrError` – Destination address is not on a correct boundary.
- `kStatus_IAP_SrcAddrNotMapped` – Source address is not mapped in the memory map.
- `kStatus_IAP_DstAddrNotMapped` – Destination address is not mapped in the memory map.
- `kStatus_IAP_CountError` – Byte count is not multiple of 4 or is not a permitted value.
- `kStatus_IAP_NotPrepared` – Command to prepare sector for write operation has not been executed.
- `kStatus_IAP_Busy` – Flash programming hardware interface is busy.

*status\_t* IAP\_EraseSector(uint32\_t startSector, uint32\_t endSector, uint32\_t systemCoreClock)

Erase sector.

This function erases sector(s). The end sector number must be greater than or equal to the start sector number.

**Parameters**

- `startSector` – Start sector number.
- `endSector` – End sector number.
- `systemCoreClock` – SystemCoreClock in Hz. It is converted to KHz before calling the rom IAP function. When the flash controller has a fixed reference clock, this parameter is bypassed.

**Return values**

- `kStatus_IAP_Success` – Api has been executed successfully.
- `kStatus_IAP_NoPower` – Flash memory block is powered down.
- `kStatus_IAP_NoClock` – Flash memory block or controller is not clocked.
- `kStatus_IAP_InvalidSector` – Sector number is invalid or end sector number is greater than start sector number.

- `kStatus_IAP_NotPrepared` – Command to prepare sector for write operation has not been executed.
- `kStatus_IAP_Busy` – Flash programming hardware interface is busy.

*status\_t* IAP\_ErasePage(uint32\_t startPage, uint32\_t endPage, uint32\_t systemCoreClock)

Erase page.

This function erases page(s). The end page number must be greater than or equal to the start page number.

#### Parameters

- `startPage` – Start page number.
- `endPage` – End page number.
- `systemCoreClock` – SystemCoreClock in Hz. It is converted to KHz before calling the rom IAP function. When the flash controller has a fixed reference clock, this parameter is bypassed.

#### Return values

- `kStatus_IAP_Success` – Api has been executed successfully.
- `kStatus_IAP_NoPower` – Flash memory block is powered down.
- `kStatus_IAP_NoClock` – Flash memory block or controller is not clocked.
- `kStatus_IAP_InvalidSector` – Page number is invalid or end page number is greater than start page number.
- `kStatus_IAP_NotPrepared` – Command to prepare sector for write operation has not been executed.
- `kStatus_IAP_Busy` – Flash programming hardware interface is busy.

*status\_t* IAP\_BlankCheckSector(uint32\_t startSector, uint32\_t endSector)

Blank check sector(s)

Blank check single or multiples sectors of flash memory. The end sector number must be greater than or equal to the start sector number. It can be used to verify the sector erasure after IAP\_EraseSector call.

#### Parameters

- `startSector` – Start sector number.
- `endSector` – End sector number.

#### Return values

- `kStatus_IAP_Success` – One or more sectors are in erased state.
- `kStatus_IAP_NoPower` – Flash memory block is powered down.
- `kStatus_IAP_NoClock` – Flash memory block or controller is not clocked.
- `kStatus_IAP_SectorNotblank` – One or more sectors are not blank.

*status\_t* IAP\_Compare(uint32\_t dstAddr, uint32\_t \*srcAddr, uint32\_t numOfBytes)

Compare memory contents of flash with ram.

This function compares the contents of flash and ram. It can be used to verify the flash memory contents after IAP\_CopyRamToFlash call.

#### Parameters

- `dstAddr` – Destination flash address.
- `srcAddr` – Source ram address.

- numOfBytes – Number of bytes to be compared.

**Return values**

- kStatus\_IAP\_Success – Contents of flash and ram match.
- kStatus\_IAP\_NoPower – Flash memory block is powered down.
- kStatus\_IAP\_NoClock – Flash memory block or controller is not clocked.
- kStatus\_IAP\_AddrError – Address is not on word boundary.
- kStatus\_IAP\_AddrNotMapped – Address is not mapped in the memory map.
- kStatus\_IAP\_CountError – Byte count is not multiple of 4 or is not a permitted value.
- kStatus\_IAP\_CompareError – Destination and source memory contents do not match.

*status\_t* IAP\_ExtendedFlashSignatureRead(uint32\_t startPage, uint32\_t endPage, uint32\_t numOfStates, uint32\_t \*signature)

Extended Read signature.

This function calculates the signature value for one or more pages of on-chip flash memory.

**Parameters**

- startPage – Start page number.
- endPage – End page number.
- numOfStates – Number of wait states.
- signature – Address to store the signature value.

**Return values**

kStatus\_IAP\_Success – Api has been executed successfully.

*status\_t* IAP\_ReadFlashSignature(uint32\_t \*signature)

Read flash signature.

This function is used to obtain a 32-bit signature value of the entire flash memory.

**Parameters**

- signature – Address to store the 32-bit generated signature value.

**Return values**

kStatus\_IAP\_Success – Api has been executed successfully.

*status\_t* IAP\_ReadFAIMPage(uint32\_t pageNumber, uint32\_t \*dstAddr)

Read FAIM page.

This function is used to read given page of FAIM into the memory provided.

**Parameters**

- pageNumber – FAIM page number.
- dstAddr – Memory address to store the value read from FAIM.

**Return values**

- kStatus\_IAP\_Success – Api has been executed successfully.
- kStatus\_IAP\_DstAddrNotMapped – Destination address is not mapped in the memory map.

*status\_t* IAP\_WriteFAIMPage(uint32\_t pageNumber, uint32\_t \*srcAddr)

Write FAIM page.

This function is used to write given data in the provided memory to a page of G.

#### Parameters

- pageNumber – FAIM page number.
- srcAddr – Memory address holding data to be stored on to FAIM page.

#### Return values

- kStatus\_IAP\_Success – Api has been executed successfully.
- kStatus\_IAP\_SrcAddrNotMapped – Source address is not mapped in the memory map.

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iap status codes.

*Values:*

enumerator kStatus\_IAP\_Success

Api is executed successfully

enumerator kStatus\_IAP\_InvalidCommand

Invalid command

enumerator kStatus\_IAP\_SrcAddrError

Source address is not on word boundary

enumerator kStatus\_IAP\_DstAddrError

Destination address is not on a correct boundary

enumerator kStatus\_IAP\_SrcAddrNotMapped

Source address is not mapped in the memory map

enumerator kStatus\_IAP\_DstAddrNotMapped

Destination address is not mapped in the memory map

enumerator kStatus\_IAP\_CountError

Byte count is not multiple of 4 or is not a permitted value

enumerator kStatus\_IAP\_InvalidSector

Sector/page number is invalid or end sector/page number is greater than start sector/page number

enumerator kStatus\_IAP\_SectorNotblank

One or more sectors are not blank

enumerator kStatus\_IAP\_NotPrepared

Command to prepare sector for write operation has not been executed

enumerator kStatus\_IAP\_CompareError

Destination and source memory contents do not match

enumerator kStatus\_IAP\_Busy

Flash programming hardware interface is busy

enumerator kStatus\_IAP\_ParamError

Insufficient number of parameters or invalid parameter

enumerator kStatus\_IAP\_AddrError

Address is not on word boundary

enumerator kStatus\_IAP\_AddrNotMapped

Address is not mapped in the memory map

enumerator kStatus\_IAP\_NoPower

Flash memory block is powered down

enumerator kStatus\_IAP\_NoClock

Flash memory block or controller is not clocked

enumerator kStatus\_IAP\_ReinvokeISPConfig

Reinvoke configuration error

enum \_iap\_commands

iap command codes.

*Values:*

enumerator kIapCmd\_IAP\_ReadFactorySettings

Read the factory settings

enumerator kIapCmd\_IAP\_PrepareSectorforWrite

Prepare Sector for write

enumerator kIapCmd\_IAP\_CopyRamToFlash

Copy RAM to flash

enumerator kIapCmd\_IAP\_EraseSector

Erase Sector

enumerator kIapCmd\_IAP\_BlankCheckSector

Blank check sector

enumerator kIapCmd\_IAP\_ReadPartId

Read part id

enumerator kIapCmd\_IAP\_Read\_BootromVersion

Read bootrom version

enumerator kIapCmd\_IAP\_Compare

Compare

enumerator kIapCmd\_IAP\_ReinvokeISP

Reinvoke ISP

enumerator kIapCmd\_IAP\_ReadUid

Read Uid

enumerator kIapCmd\_IAP\_ErasePage

Erase Page

enumerator kIapCmd\_IAP\_ReadSignature

Read Signature

enumerator kIapCmd\_IAP\_ExtendedReadSignature

Extended Read Signature

enumerator kIapCmd\_IAP\_ReadFAIMPage

Read FAIM page

enumerator kIapCmd\_IAP\_WriteFAIMPage  
Write FAIM page

enum \_flash\_access\_time  
Flash memory access time.

*Values:*

enumerator kFlash\_IAP\_OneSystemClockTime

enumerator kFlash\_IAP\_TwoSystemClockTime  
1 system clock flash access time

enumerator kFlash\_IAP\_ThreeSystemClockTime  
2 system clock flash access time

## 2.17 INPUTMUX: Input Multiplexing Driver

enum \_inputmux\_connection\_t  
INPUTMUX connections type.

*Values:*

enumerator kINPUTMUX\_DmaChannel0TrigoutToTriginChannels  
DMA OTRIG.

enumerator kINPUTMUX\_DmaChannel1TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel2TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel3TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel4TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel5TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel6TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel7TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel8TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel9TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel10TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel11TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel12TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel13TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel14TrigoutToTriginChannels

enumerator kINPUTMUX\_DmaChannel15TrigoutToTriginChannels  
DMA ITRIG.

enumerator kINPUTMUX\_GpioInt4ToDma

enumerator kINPUTMUX\_GpioInt5ToDma

enumerator kINPUTMUX\_GpioInt6ToDma

```

enumerator kINPUTMUX_GpioInt7ToDma
enumerator kINPUTMUX_Adc0SeqaIrqToDma
enumerator kINPUTMUX_Adc0SeqbIrqToDma
enumerator kINPUTMUX_Comp0OutToDma
enumerator kINPUTMUX_Ftm0InitTrigToDma
enumerator kINPUTMUX_Ftm1InitTrigToDma
enumerator kINPUTMUX_Ftm0Ch0ToCh5ToDma
enumerator kINPUTMUX_Ftm1Ch0ToCh3ToDma
enumerator kINPUTMUX_SdmaTrigoutAToDma
enumerator kINPUTMUX_SdmaTrigoutBToDma

```

```

typedef enum inputmux_connection_t inputmux_connection_t
    INPUTMUX connections type.

```

```

DMA_OTRIG_PMUX_ID
    Periphinmux IDs.

```

```

DMA_TRIG0_PMUX_ID

```

```

PMUX_SHIFT

```

```

FSL_INPUTMUX_DRIVER_VERSION
    Group interrupt driver version for SDK.

```

```

void INPUTMUX_Init(void *base)
    Initialize INPUTMUX peripheral.
    This function enables the INPUTMUX clock.

```

#### Parameters

- *base* – Base address of the INPUTMUX peripheral.

#### Return values

None. –

```

void INPUTMUX_AttachSignal(void *base, uint32_t index, inputmux_connection_t connection)
    Attaches a signal.

```

This function attaches multiplexed signals from INPUTMUX to target signals. For example, to attach GPIO PORT0 Pin 5 to PINT peripheral, do the following:

```
INPUTMUX_AttachSignal(INPUTMUX, 2, kINPUTMUX_GpioPort0Pin5ToPintsel);
```

In this example, INTMUX has 8 registers for PINT, PINT\_SEL0~PINT\_SEL7. With parameter *index* specified as 2, this function configures register PINT\_SEL2.

#### Parameters

- *base* – Base address of the INPUTMUX peripheral.
- *index* – The serial number of destination register in the group of INPUTMUX registers with same name.
- *connection* – Applies signal from source signals collection to target signal.

#### Return values

None. –

`void INPUTMUX_Deinit(void *base)`

Deinitialize INPUTMUX peripheral.

This function disables the INPUTMUX clock.

**Parameters**

- `base` – Base address of the INPUTMUX peripheral.

**Return values**

None. –

## 2.18 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\_SIZEALIGN(var, alignbytes)

Macro to define a variable with L1 d-cache line size alignment

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value

AT\_NONCACHEABLE\_SECTION(var)

Define a variable *var*, and place it in non-cacheable section.

AT\_NONCACHEABLE\_SECTION\_ALIGN(var, alignbytes)

Define a variable *var*, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

AT\_NONCACHEABLE\_SECTION\_INIT(var)

Define a variable *var* with initial value, and place it in non-cacheable section.

AT\_NONCACHEABLE\_SECTION\_ALIGN\_INIT(var, alignbytes)

Define a variable *var* with initial value, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

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 I2C 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 SDSPIC 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\_AUDMIX  
Group number for AUDMIX 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\_CODEEC  
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 provide 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().

void EnableDeepSleepIRQ(IRQn\_Type interrupt)

Enable specific interrupt for wake-up from deep-sleep mode.

Enable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

---

**Note:** This function also enables the interrupt in the NVIC (EnableIRQ() is called internally).

---

#### Parameters

- interrupt – The IRQ number.

void DisableDeepSleepIRQ(IRQn\_Type interrupt)

Disable specific interrupt for wake-up from deep-sleep mode.

Disable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

---

**Note:** This function also disables the interrupt in the NVIC (DisableIRQ() is called internally).

---

#### Parameters

- interrupt – The IRQ number.

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 will 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.

## 2.19 LPC\_ACOMP: Analog comparator Driver

**void ACOMP\_Init(ACOMP\_Type \*base, const *acomp\_config\_t* \*config)**

Initialize the ACOMP module.

### Parameters

- base – ACOMP peripheral base address.
- config – Pointer to “acomp\_config\_t” structure.

**void ACOMP\_Deinit(ACOMP\_Type \*base)**

De-initialize the ACOMP module.

### Parameters

- base – ACOMP peripheral base address.

**void ACOMP\_GetDefaultConfig(*acomp\_config\_t* \*config)**

Gets an available pre-defined settings for the ACOMP’s configuration.

This function initializes the converter configuration structure with available settings. The default values are:

config->enableSyncToBusClk = false;
config->hysteresisSelection = kACOMP_hysteresisNoneSelection;

In default configuration, the ACOMP's output would be used directly and switch as the voltages cross.

**Parameters**

- `config` – Pointer to the configuration structure.

```
void ACOMP_EnableInterrupts(ACOMP_Type *base, acomp_interrupt_enable_t enable)
```

Enable ACOMP interrupts.

**Parameters**

- `base` – ACOMP peripheral base address.
- `enable` – Enable/Disable interrupt feature.

```
static inline bool ACOMP_GetInterruptsStatusFlags(ACOMP_Type *base)
```

Get interrupts status flags.

**Parameters**

- `base` – ACOMP peripheral base address.

**Returns**

Reflect the state ACOMP edge-detect status, true or false.

```
static inline void ACOMP_ClearInterruptsStatusFlags(ACOMP_Type *base)
```

Clear the ACOMP interrupts status flags.

**Parameters**

- `base` – ACOMP peripheral base address.

```
static inline bool ACOMP_GetOutputStatusFlags(ACOMP_Type *base)
```

Get ACOMP output status flags.

**Parameters**

- `base` – ACOMP peripheral base address.

**Returns**

Reflect the state of the comparator output, true or false.

```
static inline void ACOMP_SetInputChannel(ACOMP_Type *base, uint32_t postiveInputChannel,  
                                         uint32_t negativeInputChannel)
```

Set the ACOMP postive and negative input channel.

**Parameters**

- `base` – ACOMP peripheral base address.
- `postiveInputChannel` – The index of postive input channel.
- `negativeInputChannel` – The index of negative input channel.

```
void ACOMP_SetLadderConfig(ACOMP_Type *base, const acomp_ladder_config_t *config)
```

Set the voltage ladder configuration.

**Parameters**

- `base` – ACOMP peripheral base address.
- `config` – The structure for voltage ladder. If the config is NULL, voltage ladder would be diasbled, otherwise the voltage ladder would be configured and enabled.

```
FSL_ACOMP_DRIVER_VERSION
```

ACOMP driver version 2.1.0.

enum *\_acomp\_ladder\_reference\_voltage*

The ACOMP ladder reference voltage.

*Values:*

enumerator *kACOMP\_LadderRefVoltagePinVDD*

Supply from pin VDD.

enumerator *kACOMP\_LadderRefVoltagePinVDDCMP*

Supply from pin VDDCMP.

enum *\_acomp\_interrupt\_enable*

The ACOMP interrupts enable.

*Values:*

enumerator *kACOMP\_InterruptsFallingEdgeEnable*

Enable the falling edge interrupts.

enumerator *kACOMP\_InterruptsRisingEdgeEnable*

Enable the rising edge interrupts.

enumerator *kACOMP\_InterruptsBothEdgesEnable*

Enable the both edges interrupts.

enumerator *kACOMP\_InterruptsDisable*

Disable the interrupts.

enum *\_acomp\_hysteresis\_selection*

The ACOMP hysteresis selection.

*Values:*

enumerator *kACOMP\_HysteresisNoneSelection*

None (the output will switch as the voltages cross).

enumerator *kACOMP\_Hysteresis5MVSelection*

5mV.

enumerator *kACOMP\_Hysteresis10MVSelection*

10mV.

enumerator *kACOMP\_Hysteresis20MVSelection*

20mV.

typedef enum *\_acomp\_ladder\_reference\_voltage* *acomp\_ladder\_reference\_voltage\_t*

The ACOMP ladder reference voltage.

typedef enum *\_acomp\_interrupt\_enable* *acomp\_interrupt\_enable\_t*

The ACOMP interrupts enable.

typedef enum *\_acomp\_hysteresis\_selection* *acomp\_hysteresis\_selection\_t*

The ACOMP hysteresis selection.

typedef struct *\_acomp\_config* *acomp\_config\_t*

The structure for ACOMP basic configuration.

typedef struct *\_acomp\_ladder\_config* *acomp\_ladder\_config\_t*

The structure for ACOMP voltage ladder.

struct *\_acomp\_config*

*#include <fsl\_acomp.h>* The structure for ACOMP basic configuration.

**Public Members**

**bool** enableSyncToBusClk

If true, Comparator output is synchronized to the bus clock for output to other modules.  
If false, Comparator output is used directly.

**acomp\_hysteresis\_selection\_t** hysteresisSelection

Controls the hysteresis of the comparator.

**struct** \_acomp\_ladder\_config

*#include <fsl\_acomp.h>* The structure for ACOMP voltage ladder.

**Public Members**

**uint8\_t** ladderValue

Voltage ladder value. 00000 = Vss, 00001 = 1\*Vref/31, ..., 11111 = Vref.

**acomp\_ladder\_reference\_voltage\_t** referenceVoltage

Selects the reference voltage(Vref) for the voltage ladder.

## 2.20 ADC: 12-bit SAR Analog-to-Digital Converter Driver

**void** ADC\_Init(ADC\_Type \*base, const *adc\_config\_t* \*config)

Initialize the ADC module.

**Parameters**

- base – ADC peripheral base address.
- config – Pointer to configuration structure, see to *adc\_config\_t*.

**void** ADC\_Deinit(ADC\_Type \*base)

Deinitialize the ADC module.

**Parameters**

- base – ADC peripheral base address.

**void** ADC\_GetDefaultConfig(*adc\_config\_t* \*config)

Gets an available pre-defined settings for initial configuration.

This function initializes the initial configuration structure with an available settings. The default values are:

```
config->clockMode = kADC_ClockSynchronousMode;
config->clockDividerNumber = 0U;
config->resolution = kADC_Resolution12bit;
config->enableBypassCalibration = false;
config->sampleTimeNumber = 0U;
config->extendSampleTimeNumber = kADC_ExtendSampleTimeNotUsed;
```

**Parameters**

- config – Pointer to configuration structure.

**bool** ADC\_DoSelfCalibration(ADC\_Type \*base)

Do the hardware self-calibration.

**Deprecated:**

Do not use this function. It has been superceded by `ADC_DoOffsetCalibration`.

To calibrate the ADC, set the ADC clock to 500 kHz. In order to achieve the specified ADC accuracy, the A/D converter must be recalibrated, at a minimum, following every chip reset before initiating normal ADC operation.

**Parameters**

- `base` – ADC peripheral base address.

**Return values**

- `true` – Calibration succeed.
- `false` – Calibration failed.

```
bool ADC_DoOffsetCalibration(ADC_Type *base, uint32_t frequency)
```

Do the hardware offset-calibration.

To calibrate the ADC, set the ADC clock to no more than 30 MHz. In order to achieve the specified ADC accuracy, the A/D converter must be recalibrated, at a minimum, following every chip reset before initiating normal ADC operation.

**Parameters**

- `base` – ADC peripheral base address.
- `frequency` – The clock frequency that ADC operates at.

**Return values**

- `true` – Calibration succeed.
- `false` – Calibration failed.

```
static inline void ADC_EnableConvSeqA(ADC_Type *base, bool enable)
```

Enable the conversion sequence A.

In order to avoid spuriously triggering the sequence, the trigger to conversion sequence should be ready before the sequence is ready. when the sequence is disabled, the trigger would be ignored. Also, it is suggested to disable the sequence during changing the sequence's setting.

**Parameters**

- `base` – ADC peripheral base address.
- `enable` – Switcher to enable the feature or not.

```
void ADC_SetConvSeqAConfig(ADC_Type *base, const adc_conv_seq_config_t *config)
```

Configure the conversion sequence A.

**Parameters**

- `base` – ADC peripheral base address.
- `config` – Pointer to configuration structure, see to `adc_conv_seq_config_t`.

```
static inline void ADC_DoSoftwareTriggerConvSeqA(ADC_Type *base)
```

Do trigger the sequence's conversion by software.

**Parameters**

- `base` – ADC peripheral base address.



static inline void ADC\_EnableConvSeqABurstMode(ADC\_Type \*base, bool enable)

Enable the burst conversion of sequence A.

Enable the burst mode would cause the conversion sequence to be continuously cycled through. Other triggers would be ignored while this mode is enabled. Repeated conversions could be halted by disabling this mode. And the sequence currently in process will be completed before conversions are terminated. Note that a new sequence could begin just before the burst mode is disabled.

**Parameters**

- base – ADC peripheral base address.
- enable – Switcher to enable this feature.

static inline void ADC\_SetConvSeqAHighPriority(ADC\_Type \*base)

Set the high priority for conversion sequence A.

**Parameters**

- base – ADC peripheral base address.

static inline void ADC\_EnableConvSeqB(ADC\_Type \*base, bool enable)

Enable the conversion sequence B.

In order to avoid spuriously triggering the sequence, the trigger to conversion sequence should be ready before the sequence is ready. When the sequence is disabled, the trigger would be ignored. Also, it is suggested to disable the sequence during changing the sequence's setting.

**Parameters**

- base – ADC peripheral base address.
- enable – Switcher to enable the feature or not.

void ADC\_SetConvSeqBConfig(ADC\_Type \*base, const *adc\_conv\_seq\_config\_t* \*config)

Configure the conversion sequence B.

**Parameters**

- base – ADC peripheral base address.
- config – Pointer to configuration structure, see to *adc\_conv\_seq\_config\_t*.

static inline void ADC\_DoSoftwareTriggerConvSeqB(ADC\_Type \*base)

Do trigger the sequence's conversion by software.

**Parameters**

- base – ADC peripheral base address.

static inline void ADC\_EnableConvSeqBBurstMode(ADC\_Type \*base, bool enable)

Enable the burst conversion of sequence B.

Enable the burst mode would cause the conversion sequence to be continuously cycled through. Other triggers would be ignored while this mode is enabled. Repeated conversions could be halted by disabling this mode. And the sequence currently in process will be completed before conversions are terminated. Note that a new sequence could begin just before the burst mode is disabled.

**Parameters**

- base – ADC peripheral base address.
- enable – Switcher to enable this feature.

```
static inline void ADC_SetConvSeqBHighPriority(ADC_Type *base)
```

Set the high priority for conversion sequence B.

**Parameters**

- `base` – ADC peripheral base address.

```
bool ADC_GetConvSeqAGlobalConversionResult(ADC_Type *base, adc_result_info_t *info)
```

Get the global ADC conversion information of sequence A.

**Parameters**

- `base` – ADC peripheral base address.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

**Return values**

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
bool ADC_GetConvSeqBGlobalConversionResult(ADC_Type *base, adc_result_info_t *info)
```

Get the global ADC conversion information of sequence B.

**Parameters**

- `base` – ADC peripheral base address.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

**Return values**

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
bool ADC_GetChannelConversionResult(ADC_Type *base, uint32_t channel, adc_result_info_t *info)
```

Get the channel's ADC conversion completed under each conversion sequence.

**Parameters**

- `base` – ADC peripheral base address.
- `channel` – The indicated channel number.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

**Return values**

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
static inline void ADC_SetThresholdPair0(ADC_Type *base, uint32_t lowValue, uint32_t highValue)
```

Set the threshold pair 0 with low and high value.

**Parameters**

- `base` – ADC peripheral base address.
- `lowValue` – LOW threshold value.
- `highValue` – HIGH threshold value.

```
static inline void ADC_SetThresholdPair1(ADC_Type *base, uint32_t lowValue, uint32_t highValue)
```

Set the threshold pair 1 with low and high value.

**Parameters**

- `base` – ADC peripheral base address.
- `lowValue` – LOW threshold value. The available value is with 12-bit.
- `highValue` – HIGH threshold value. The available value is with 12-bit.

static inline void ADC\_SetChannelWithThresholdPair0(ADC\_Type \*base, uint32\_t channelMask)  
Set given channels to apply the threshold pare 0.

**Parameters**

- `base` – ADC peripheral base address.
- `channelMask` – Indicated channels' mask.

static inline void ADC\_SetChannelWithThresholdPair1(ADC\_Type \*base, uint32\_t channelMask)  
Set given channels to apply the threshold pare 1.

**Parameters**

- `base` – ADC peripheral base address.
- `channelMask` – Indicated channels' mask.

static inline void ADC\_EnableInterrupts(ADC\_Type \*base, uint32\_t mask)  
Enable interrupts for conversion sequences.

**Parameters**

- `base` – ADC peripheral base address.
- `mask` – Mask of interrupt mask value for global block except each channel, see to `_adc_interrupt_enable`.

static inline void ADC\_DisableInterrupts(ADC\_Type \*base, uint32\_t mask)  
Disable interrupts for conversion sequence.

**Parameters**

- `base` – ADC peripheral base address.
- `mask` – Mask of interrupt mask value for global block except each channel, see to `_adc_interrupt_enable`.

static inline void ADC\_EnableThresholdCompareInterrupt(ADC\_Type \*base, uint32\_t channel,  
*adc\_threshold\_interrupt\_mode\_t mode*)  
Enable the interrupt of threshold compare event for each channel.

**Parameters**

- `base` – ADC peripheral base address.
- `channel` – Channel number.
- `mode` – Interrupt mode for threshold compare event, see to `adc_threshold_interrupt_mode_t`.

static inline uint32\_t ADC\_GetStatusFlags(ADC\_Type \*base)  
Get status flags of ADC module.

**Parameters**

- `base` – ADC peripheral base address.

**Returns**

Mask of status flags of module, see to `_adc_status_flags`.

static inline void ADC\_ClearStatusFlags(ADC\_Type \*base, uint32\_t mask)

Clear status flags of ADC module.

**Parameters**

- base – ADC peripheral base address.
- mask – Mask of status flags of module, see to `_adc_status_flags`.

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ADC driver version 2.6.0.

enum \_adc\_status\_flags

Flags.

*Values:*

enumerator kADC\_ThresholdCompareFlagOnChn0

Threshold comparison event on Channel 0.

enumerator kADC\_ThresholdCompareFlagOnChn1

Threshold comparison event on Channel 1.

enumerator kADC\_ThresholdCompareFlagOnChn2

Threshold comparison event on Channel 2.

enumerator kADC\_ThresholdCompareFlagOnChn3

Threshold comparison event on Channel 3.

enumerator kADC\_ThresholdCompareFlagOnChn4

Threshold comparison event on Channel 4.

enumerator kADC\_ThresholdCompareFlagOnChn5

Threshold comparison event on Channel 5.

enumerator kADC\_ThresholdCompareFlagOnChn6

Threshold comparison event on Channel 6.

enumerator kADC\_ThresholdCompareFlagOnChn7

Threshold comparison event on Channel 7.

enumerator kADC\_ThresholdCompareFlagOnChn8

Threshold comparison event on Channel 8.

enumerator kADC\_ThresholdCompareFlagOnChn9

Threshold comparison event on Channel 9.

enumerator kADC\_ThresholdCompareFlagOnChn10

Threshold comparison event on Channel 10.

enumerator kADC\_ThresholdCompareFlagOnChn11

Threshold comparison event on Channel 11.

enumerator kADC\_OverrunFlagForChn0

Mirror the OVERRUN status flag from the result register for ADC channel 0.

enumerator kADC\_OverrunFlagForChn1

Mirror the OVERRUN status flag from the result register for ADC channel 1.

enumerator kADC\_OverrunFlagForChn2

Mirror the OVERRUN status flag from the result register for ADC channel 2.

enumerator kADC\_OverrunFlagForChn3

Mirror the OVERRUN status flag from the result register for ADC channel 3.

enumerator kADC\_OverrunFlagForChn4

Mirror the OVERRUN status flag from the result register for ADC channel 4.

enumerator kADC\_OverrunFlagForChn5

Mirror the OVERRUN status flag from the result register for ADC channel 5.

enumerator kADC\_OverrunFlagForChn6

Mirror the OVERRUN status flag from the result register for ADC channel 6.

enumerator kADC\_OverrunFlagForChn7

Mirror the OVERRUN status flag from the result register for ADC channel 7.

enumerator kADC\_OverrunFlagForChn8

Mirror the OVERRUN status flag from the result register for ADC channel 8.

enumerator kADC\_OverrunFlagForChn9

Mirror the OVERRUN status flag from the result register for ADC channel 9.

enumerator kADC\_OverrunFlagForChn10

Mirror the OVERRUN status flag from the result register for ADC channel 10.

enumerator kADC\_OverrunFlagForChn11

Mirror the OVERRUN status flag from the result register for ADC channel 11.

enumerator kADC\_GlobalOverrunFlagForSeqA

Mirror the global OVERRUN status flag for conversion sequence A.

enumerator kADC\_GlobalOverrunFlagForSeqB

Mirror the global OVERRUN status flag for conversion sequence B.

enumerator kADC\_ConvSeqAInterruptFlag

Sequence A interrupt/DMA trigger.

enumerator kADC\_ConvSeqBInterruptFlag

Sequence B interrupt/DMA trigger.

enumerator kADC\_ThresholdCompareInterruptFlag

Threshold comparison interrupt flag.

enumerator kADC\_OverrunInterruptFlag

Overrun interrupt flag.

enum \_adc\_interrupt\_enable

Interrupts.

---

**Note:** Not all the interrupt options are listed here

---

*Values:*

enumerator kADC\_ConvSeqAInterruptEnable

Enable interrupt upon completion of each individual conversion in sequence A, or entire sequence.

enumerator kADC\_ConvSeqBInterruptEnable

Enable interrupt upon completion of each individual conversion in sequence B, or entire sequence.

enumerator kADC\_OverrunInterruptEnable

Enable the detection of an overrun condition on any of the channel data registers will cause an overrun interrupt/DMA trigger.

enum \_adc\_clock\_mode

Define selection of clock mode.

*Values:*

enumerator kADC\_ClockSynchronousMode

The ADC clock would be derived from the system clock based on “clockDividerNumber”.

enumerator kADC\_ClockAsynchronousMode

The ADC clock would be based on the SYSCON block’s divider.

enum \_adc\_resolution

Define selection of resolution.

*Values:*

enumerator kADC\_Resolution6bit

6-bit resolution.

enumerator kADC\_Resolution8bit

8-bit resolution.

enumerator kADC\_Resolution10bit

10-bit resolution.

enumerator kADC\_Resolution12bit

12-bit resolution.

enum \_adc\_voltage\_range

Define range of the analog supply voltage VDDA.

*Values:*

enumerator kADC\_HighVoltageRange

enumerator kADC\_LowVoltageRange

enum \_adc\_trigger\_polarity

Define selection of polarity of selected input trigger for conversion sequence.

*Values:*

enumerator kADC\_TriggerPolarityNegativeEdge

A negative edge launches the conversion sequence on the trigger(s).

enumerator kADC\_TriggerPolarityPositiveEdge

A positive edge launches the conversion sequence on the trigger(s).

enum \_adc\_priority

Define selection of conversion sequence’s priority.

*Values:*

enumerator kADC\_PriorityLow

This sequence would be preempted when another sequence is started.

enumerator kADC\_PriorityHigh

This sequence would preempt other sequence even when it is started.

enum \_adc\_seq\_interrupt\_mode

Define selection of conversion sequence’s interrupt.

*Values:*

enumerator kADC\_InterruptForEachConversion

The sequence interrupt/DMA trigger will be set at the end of each individual ADC conversion inside this conversion sequence.

enumerator kADC\_InterruptForEachSequence

The sequence interrupt/DMA trigger will be set when the entire set of this sequence conversions completes.

enum \_adc\_threshold\_compare\_status

Define status of threshold compare result.

*Values:*

enumerator kADC\_ThresholdCompareInRange

LOW threshold  $\leq$  conversion value  $\leq$  HIGH threshold.

enumerator kADC\_ThresholdCompareBelowRange

conversion value  $<$  LOW threshold.

enumerator kADC\_ThresholdCompareAboveRange

conversion value  $>$  HIGH threshold.

enum \_adc\_threshold\_crossing\_status

Define status of threshold crossing detection result.

*Values:*

enumerator kADC\_ThresholdCrossingNoDetected

No threshold Crossing detected.

enumerator kADC\_ThresholdCrossingDownward

Downward Threshold Crossing detected.

enumerator kADC\_ThresholdCrossingUpward

Upward Threshold Crossing Detected.

enum \_adc\_threshold\_interrupt\_mode

Define interrupt mode for threshold compare event.

*Values:*

enumerator kADC\_ThresholdInterruptDisabled

Threshold comparison interrupt is disabled.

enumerator kADC\_ThresholdInterruptOnOutside

Threshold comparison interrupt is enabled on outside threshold.

enumerator kADC\_ThresholdInterruptOnCrossing

Threshold comparison interrupt is enabled on crossing threshold.

enum \_adc\_inforeresultshift

Define the info result mode of different resolution.

*Values:*

enumerator kADC\_Resolution12bitInfoResultShift

Info result shift of Resolution12bit.

enumerator kADC\_Resolution10bitInfoResultShift

Info result shift of Resolution10bit.

enumerator kADC\_Resolution8bitInfoResultShift

Info result shift of Resolution8bit.

enumerator kADC\_Resolution6bitInfoResultShift

Info result shift of Resolution6bit.

enum \_adc\_tempsensor\_common\_mode

Define common modes for Temperature sensor.

*Values:*

enumerator kADC\_HighNegativeOffsetAdded

Temperature sensor common mode: high negative offset added.

enumerator kADC\_IntermediateNegativeOffsetAdded

Temperature sensor common mode: intermediate negative offset added.

enumerator kADC\_NoOffsetAdded

Temperature sensor common mode: no offset added.

enumerator kADC\_LowPositiveOffsetAdded

Temperature sensor common mode: low positive offset added.

enum \_adc\_second\_control

Define source impedance modes for GPADC control.

*Values:*

enumerator kADC\_Impedance621Ohm

Extend ADC sampling time according to source impedance 1: 0.621 kOhm.

enumerator kADC\_Impedance55kOhm

Extend ADC sampling time according to source impedance 20 (default): 55 kOhm.

enumerator kADC\_Impedance87kOhm

Extend ADC sampling time according to source impedance 31: 87 kOhm.

enumerator kADC\_NormalFunctionalMode

TEST mode: Normal functional mode.

enumerator kADC\_MultiplexeTestMode

TEST mode: Multiplexer test mode.

enumerator kADC\_ADCInUnityGainMode

TEST mode: ADC in unity gain mode.

typedef enum \_adc\_clock\_mode adc\_clock\_mode\_t

Define selection of clock mode.

typedef enum \_adc\_resolution adc\_resolution\_t

Define selection of resolution.

typedef enum \_adc\_voltage\_range adc\_vdda\_range\_t

Define range of the analog supply voltage VDDA.

typedef enum \_adc\_trigger\_polarity adc\_trigger\_polarity\_t

Define selection of polarity of selected input trigger for conversion sequence.

typedef enum \_adc\_priority adc\_priority\_t

Define selection of conversion sequence's priority.

typedef enum \_adc\_seq\_interrupt\_mode adc\_seq\_interrupt\_mode\_t

Define selection of conversion sequence's interrupt.

typedef enum \_adc\_threshold\_compare\_status adc\_threshold\_compare\_status\_t

Define status of threshold compare result.



typedef enum *\_adc\_threshold\_crossing\_status* adc\_threshold\_crossing\_status\_t

Define status of threshold crossing detection result.

typedef enum *\_adc\_threshold\_interrupt\_mode* adc\_threshold\_interrupt\_mode\_t

Define interrupt mode for threshold compare event.

typedef enum *\_adc\_inforeresultshift* adc\_inforeresult\_t

Define the info result mode of different resolution.

typedef enum *\_adc\_tempsensor\_common\_mode* adc\_tempsensor\_common\_mode\_t

Define common modes for Temperature sensor.

typedef enum *\_adc\_second\_control* adc\_second\_control\_t

Define source impedance modes for GPADC control.

typedef struct *\_adc\_config* adc\_config\_t

Define structure for configuring the block.

typedef struct *\_adc\_conv\_seq\_config* adc\_conv\_seq\_config\_t

Define structure for configuring conversion sequence.

typedef struct *\_adc\_result\_info* adc\_result\_info\_t

Define structure of keeping conversion result information.

struct *\_adc\_config*

*#include <fsl\_adc.h>* Define structure for configuring the block.

### Public Members

*adc\_clock\_mode\_t* clockMode

Select the clock mode for ADC converter.

uint32\_t clockDividerNumber

This field is only available when using kADC\_ClockSynchronousMode for “clockMode” field. The divider would be plused by 1 based on the value in this field. The available range is in 8 bits.

*adc\_resolution\_t* resolution

Select the conversion bits.

bool enableBypassCalibration

By default, a calibration cycle must be performed each time the chip is powered-up. Re-calibration may be warranted periodically - especially if operating conditions have changed. To enable this option would avoid the need to calibrate if offset error is not a concern in the application.

uint32\_t sampleTimeNumber

By default, with value as “0U”, the sample period would be 2.5 ADC clocks. Then, to plus the “sampleTimeNumber” value here. The available value range is in 3 bits.

bool enableLowPowerMode

If disable low-power mode, ADC remains activated even when no conversions are requested. If enable low-power mode, The ADC is automatically powered-down when no conversions are taking place.

*adc\_vdda\_range\_t* voltageRange

Configure the ADC for the appropriate operating range of the analog supply voltage VDDA. Failure to set the area correctly causes the ADC to return incorrect conversion results.

struct *\_adc\_conv\_seq\_config*

*#include <fsl\_adc.h>* Define structure for configuring conversion sequence.

### Public Members

`uint32_t channelMask`

Selects which one or more of the ADC channels will be sampled and converted when this sequence is launched. The masked channels would be involved in current conversion sequence, beginning with the lowest-order. The available range is in 12-bit.

`uint32_t triggerMask`

Selects which one or more of the available hardware trigger sources will cause this conversion sequence to be initiated. The available range is 6-bit.

`adc_trigger_polarity_t triggerPolarity`

Select the trigger to launch conversion sequence.

`bool enableSyncBypass`

To enable this feature allows the hardware trigger input to bypass synchronization flip-flop stages and therefore shorten the time between the trigger input signal and the start of a conversion.

`bool enableSingleStep`

When enabling this feature, a trigger will launch a single conversion on the next channel in the sequence instead of the default response of launching an entire sequence of conversions.

`adc_seq_interrupt_mode_t interruptMode`

Select the interrupt/DMA trigger mode.

`uint8_t seqSampleTimeNumber`

Conversion sequence sampling time.

`struct _adc_result_info`

*#include <fsl\_adc.h>* Define structure of keeping conversion result information.

### Public Members

`uint32_t result`

Keep the conversion data value.

`adc_threshold_compare_status_t thresholdCompareStatus`

Keep the threshold compare status.

`adc_threshold_crossing_status_t thresholdCorssingStatus`

Keep the threshold crossing status.

`uint32_t channelNumber`

Keep the channel number for this conversion.

`bool overrunFlag`

Keep the status whether the conversion is overrun or not.

## 2.21 GPIO: General Purpose I/O

`void GPIO_PortInit(GPIO_Type *base, uint32_t port)`

Initializes the GPIO peripheral.

This function ungates the GPIO clock.

### Parameters

- base – GPIO peripheral base pointer.
- port – GPIO port number.

```
void GPIO_PinInit(GPIO_Type *base, uint32_t port, uint32_t pin, const gpio_pin_config_t
                  *config)
```

Initializes a GPIO pin used by the board.

To initialize the GPIO, define a pin configuration, either input or output, in the user file. Then, call the GPIO\_PinInit() function.

This is an example to define an input pin or output pin configuration:

```
Define a digital input pin configuration,
gpio_pin_config_t config =
{
    kGPIO_DigitalInput,
    0,
}
Define a digital output pin configuration,
gpio_pin_config_t config =
{
    kGPIO_DigitalOutput,
    0,
}
```

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- pin – GPIO pin number
- config – GPIO pin configuration pointer

```
static inline void GPIO_PinWrite(GPIO_Type *base, uint32_t port, uint32_t pin, uint8_t output)
```

Sets the output level of the one GPIO pin to the logic 1 or 0.

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- pin – GPIO pin number
- output – GPIO pin output logic level.
  - 0: corresponding pin output low-logic level.
  - 1: corresponding pin output high-logic level.

```
static inline uint32_t GPIO_PinRead(GPIO_Type *base, uint32_t port, uint32_t pin)
```

Reads the current input value of the GPIO PIN.

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- pin – GPIO pin number

#### Return values

GPIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

FSL\_GPIO\_DRIVER\_VERSION

LPC GPIO driver version.

enum \_gpio\_pin\_direction

LPC GPIO direction definition.

*Values:*

enumerator kGPIO\_DigitalInput

Set current pin as digital input

enumerator kGPIO\_DigitalOutput

Set current pin as digital output

typedef enum \_gpio\_pin\_direction gpio\_pin\_direction\_t

LPC GPIO direction definition.

typedef struct \_gpio\_pin\_config gpio\_pin\_config\_t

The GPIO pin configuration structure.

Every pin can only be configured as either output pin or input pin at a time. If configured as a input pin, then leave the outputConfig unused.

static inline void GPIO\_PortSet(GPIO\_Type \*base, uint32\_t port, uint32\_t mask)

Sets the output level of the multiple GPIO pins to the logic 1.

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

static inline void GPIO\_PortClear(GPIO\_Type \*base, uint32\_t port, uint32\_t mask)

Sets the output level of the multiple GPIO pins to the logic 0.

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

static inline void GPIO\_PortToggle(GPIO\_Type \*base, uint32\_t port, uint32\_t mask)

Reverses current output logic of the multiple GPIO pins.

#### Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

struct \_gpio\_pin\_config

*#include <fsl\_gpio.h>* The GPIO pin configuration structure.

Every pin can only be configured as either output pin or input pin at a time. If configured as a input pin, then leave the outputConfig unused.

#### Public Members

*gpio\_pin\_direction\_t* pinDirection

GPIO direction, input or output

uint8\_t outputLogic

Set default output logic, no use in input

## 2.22 IOCON: I/O pin configuration

LPC\_IOCON\_DRIVER\_VERSION

IOCON driver version 2.0.2.

typedef struct *\_iocon\_group* iocon\_group\_t

Array of IOCON pin definitions passed to IOCON\_SetPinMuxing() must be in this format.

\_\_STATIC\_INLINE void IOCON\_PinMuxSet (IOCON\_Type \*base, uint8\_t ionumber, uint32\_t modefunc)

IOCON function and mode selection definitions.

Sets I/O Control pin mux

---

**Note:** See the User Manual for specific modes and functions supported by the various pins.

---

### Parameters

- base – : The base of IOCON peripheral on the chip
- ionumber – : GPIO number to mux
- modefunc – : OR'ed values of type IOCON\_\*

### Returns

Nothing

\_\_STATIC\_INLINE void IOCON\_SetPinMuxing (IOCON\_Type \*base, const iocon\_group\_t \*pinArray, uint32\_t arrayLength)

Set all I/O Control pin muxing.

### Parameters

- base – : The base of IOCON peripheral on the chip
- pinArray – : Pointer to array of pin mux selections
- arrayLength – : Number of entries in pinArray

### Returns

Nothing

FSL\_COMPONENT\_ID

struct *\_iocon\_group*

*#include <fsl\_iocon.h>* Array of IOCON pin definitions passed to IOCON\_SetPinMuxing() must be in this format.

## 2.23 MRT: Multi-Rate Timer

```
void MRT_Init(MRT_Type *base, const mrt_config_t *config)
```

Ungates the MRT clock and configures the peripheral for basic operation.

---

**Note:** This API should be called at the beginning of the application using the MRT driver.

---

#### Parameters

- *base* – Multi-Rate timer peripheral base address
- *config* – Pointer to user's MRT config structure. If MRT has MULTITASK bit field in MODCFG register, param config is useless.

```
void MRT_Deinit(MRT_Type *base)
```

Gate the MRT clock.

#### Parameters

- *base* – Multi-Rate timer peripheral base address

```
static inline void MRT_GetDefaultConfig(mrt_config_t *config)
```

Fill in the MRT config struct with the default settings.

The default values are:

```
config->enableMultiTask = false;
```

#### Parameters

- *config* – Pointer to user's MRT config structure.

```
static inline void MRT_SetupChannelMode(MRT_Type *base, mrt_chnl_t channel, const  
                                         mrt_timer_mode_t mode)
```

Sets up an MRT channel mode.

#### Parameters

- *base* – Multi-Rate timer peripheral base address
- *channel* – Channel that is being configured.
- *mode* – Timer mode to use for the channel.

```
static inline void MRT_EnableInterrupts(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Enables the MRT interrupt.

#### Parameters

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number
- *mask* – The interrupts to enable. This is a logical OR of members of the enumeration *mrt\_interrupt\_enable\_t*

```
static inline void MRT_DisableInterrupts(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Disables the selected MRT interrupt.

#### Parameters

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number
- *mask* – The interrupts to disable. This is a logical OR of members of the enumeration *mrt\_interrupt\_enable\_t*

```
static inline uint32_t MRT_GetEnabledInterrupts(MRT_Type *base, mrt_chnl_t channel)
```

Gets the enabled MRT interrupts.

**Parameters**

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number

**Returns**

The enabled interrupts. This is the logical OR of members of the enumeration *mrt\_interrupt\_enable\_t*

```
static inline uint32_t MRT_GetStatusFlags(MRT_Type *base, mrt_chnl_t channel)
```

Gets the MRT status flags.

**Parameters**

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number

**Returns**

The status flags. This is the logical OR of members of the enumeration *mrt\_status\_flags\_t*

```
static inline void MRT_ClearStatusFlags(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Clears the MRT status flags.

**Parameters**

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number
- *mask* – The status flags to clear. This is a logical OR of members of the enumeration *mrt\_status\_flags\_t*

```
void MRT_UpdateTimerPeriod(MRT_Type *base, mrt_chnl_t channel, uint32_t count, bool  
                           immediateLoad)
```

Used to update the timer period in units of count.

The new value will be immediately loaded or will be loaded at the end of the current time interval. For one-shot interrupt mode the new value will be immediately loaded.

---

**Note:** User can call the utility macros provided in *fsl\_common.h* to convert to ticks

---

**Parameters**

- *base* – Multi-Rate timer peripheral base address
- *channel* – Timer channel number
- *count* – Timer period in units of ticks
- *immediateLoad* – *true*: Load the new value immediately into the TIMER register; *false*: Load the new value at the end of current timer interval

```
static inline uint32_t MRT_GetCurrentTimerCount(MRT_Type *base, mrt_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:** User can call the utility macros provided in *fsl\_common.h* to convert ticks to usec or msec

---

**Parameters**

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number

**Returns**

Current timer counting value in ticks

```
static inline void MRT_StartTimer(MRT_Type *base, mrt_chnl_t channel, uint32_t count)
```

Starts the timer counting.

After calling this function, timers load period value, counts down to 0 and depending on the timer mode it will either load the respective start value again or stop.

---

**Note:** User can call the utility macros provided in fsl\_common.h to convert to ticks

---

**Parameters**

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.
- count – Timer period in units of ticks. Count can contain the LOAD bit, which control the force load feature.

```
static inline void MRT_StopTimer(MRT_Type *base, mrt_chnl_t channel)
```

Stops the timer counting.

This function stops the timer from counting.

**Parameters**

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.

```
static inline uint32_t MRT_GetIdleChannel(MRT_Type *base)
```

Find the available channel.

This function returns the lowest available channel number.

**Parameters**

- base – Multi-Rate timer peripheral base address

FSL\_MRT\_DRIVER\_VERSION

```
enum __mrt_chnl
```

List of MRT channels.

*Values:*

enumerator kMRT\_Channel\_0

MRT channel number 0

enumerator kMRT\_Channel\_1

MRT channel number 1

enumerator kMRT\_Channel\_2

MRT channel number 2

enumerator kMRT\_Channel\_3

MRT channel number 3



enum `_mrt_timer_mode`

List of MRT timer modes.

*Values:*

enumerator `kMRT_RepeatMode`

Repeat Interrupt mode

enumerator `kMRT_OneShotMode`

One-shot Interrupt mode

enumerator `kMRT_OneShotStallMode`

One-shot stall mode

enum `_mrt_interrupt_enable`

List of MRT interrupts.

*Values:*

enumerator `kMRT_TimerInterruptEnable`

Timer interrupt enable

enum `_mrt_status_flags`

List of MRT status flags.

*Values:*

enumerator `kMRT_TimerInterruptFlag`

Timer interrupt flag

enumerator `kMRT_TimerRunFlag`

Indicates state of the timer

typedef enum `_mrt_chnl` `mrt_chnl_t`

List of MRT channels.

typedef enum `_mrt_timer_mode` `mrt_timer_mode_t`

List of MRT timer modes.

typedef enum `_mrt_interrupt_enable` `mrt_interrupt_enable_t`

List of MRT interrupts.

typedef enum `_mrt_status_flags` `mrt_status_flags_t`

List of MRT status flags.

typedef struct `_mrt_config` `mrt_config_t`

MRT configuration structure.

This structure holds the configuration settings for the MRT peripheral. To initialize this structure to reasonable defaults, call the `MRT_GetDefaultConfig()` function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

struct `_mrt_config`

`#include <fsl_mrt.h>` MRT configuration structure.

This structure holds the configuration settings for the MRT peripheral. To initialize this structure to reasonable defaults, call the `MRT_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 enableMultiTask

true: Timers run in multi-task mode; false: Timers run in hardware status mode

## 2.24 PINT: Pin Interrupt and Pattern Match Driver

FSL\_PINT\_DRIVER\_VERSION

enum \_\_pint\_pin\_enable

PINT Pin Interrupt enable type.

*Values:*

enumerator kPINT\_PinIntEnableNone

Do not generate Pin Interrupt

enumerator kPINT\_PinIntEnableRiseEdge

Generate Pin Interrupt on rising edge

enumerator kPINT\_PinIntEnableFallEdge

Generate Pin Interrupt on falling edge

enumerator kPINT\_PinIntEnableBothEdges

Generate Pin Interrupt on both edges

enumerator kPINT\_PinIntEnableLowLevel

Generate Pin Interrupt on low level

enumerator kPINT\_PinIntEnableHighLevel

Generate Pin Interrupt on high level

enum \_\_pint\_int

PINT Pin Interrupt type.

*Values:*

enumerator kPINT\_PinInt0

Pin Interrupt 0

enum \_\_pint\_pmatch\_input\_src

PINT Pattern Match bit slice input source type.

*Values:*

enumerator kPINT\_PatternMatchInp0Src

Input source 0

enumerator kPINT\_PatternMatchInp1Src

Input source 1

enumerator kPINT\_PatternMatchInp2Src

Input source 2

enumerator kPINT\_PatternMatchInp3Src

Input source 3

enumerator kPINT\_PatternMatchInp4Src

Input source 4

enumerator kPINT\_PatternMatchInp5Src  
Input source 5

enumerator kPINT\_PatternMatchInp6Src  
Input source 6

enumerator kPINT\_PatternMatchInp7Src  
Input source 7

enumerator kPINT\_SecPatternMatchInp0Src  
Input source 0

enumerator kPINT\_SecPatternMatchInp1Src  
Input source 1

enum \_pint\_pmatch\_bslice  
PINT Pattern Match bit slice type.

*Values:*

enumerator kPINT\_PatternMatchBSlice0  
Bit slice 0

enum \_pint\_pmatch\_bslice\_cfg  
PINT Pattern Match configuration type.

*Values:*

enumerator kPINT\_PatternMatchAlways  
Always Contributes to product term match

enumerator kPINT\_PatternMatchStickyRise  
Sticky Rising edge

enumerator kPINT\_PatternMatchStickyFall  
Sticky Falling edge

enumerator kPINT\_PatternMatchStickyBothEdges  
Sticky Rising or Falling edge

enumerator kPINT\_PatternMatchHigh  
High level

enumerator kPINT\_PatternMatchLow  
Low level

enumerator kPINT\_PatternMatchNever  
Never contributes to product term match

enumerator kPINT\_PatternMatchBothEdges  
Either rising or falling edge

typedef enum \_pint\_pin\_enable pint\_pin\_enable\_t  
PINT Pin Interrupt enable type.

typedef enum \_pint\_int pint\_pin\_int\_t  
PINT Pin Interrupt type.

typedef enum \_pint\_pmatch\_input\_src pint\_pmatch\_input\_src\_t  
PINT Pattern Match bit slice input source type.

typedef enum \_pint\_pmatch\_bslice pint\_pmatch\_bslice\_t  
PINT Pattern Match bit slice type.

```
typedef enum _pint_pmatch_bslice_cfg pint_pmatch_bslice_cfg_t
```

PINT Pattern Match configuration type.

```
typedef struct _pint_status pint_status_t
```

PINT event status.

```
typedef void (*pint_cb_t)(pint_pin_int_t pintr, pint_status_t *status)
```

PINT Callback function.

```
typedef struct _pint_pmatch_cfg pint_pmatch_cfg_t
```

```
void PINT_Init(PINT_Type *base)
```

Initialize PINT peripheral.

This function initializes the PINT peripheral and enables the clock.

#### Parameters

- base – Base address of the PINT peripheral.

#### Return values

None. –

```
void PINT_SetCallback(PINT_Type *base, pint_cb_t callback)
```

Set PINT callback.

This function set the callback for PINT interrupt handler.

#### Parameters

- base – Base address of the PINT peripheral.
- callback – Callback.

#### Return values

None. –

```
void PINT_PinInterruptConfig(PINT_Type *base, pint_pin_int_t intr, pint_pin_enable_t enable)
```

Configure PINT peripheral pin interrupt.

This function configures a given pin interrupt.

#### Parameters

- base – Base address of the PINT peripheral.
- intr – Pin interrupt.
- enable – Selects detection logic.

#### Return values

None. –

```
void PINT_PinInterruptGetConfig(PINT_Type *base, pint_pin_int_t pintr, pint_pin_enable_t *enable)
```

Get PINT peripheral pin interrupt configuration.

This function returns the configuration of a given pin interrupt.

#### Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.
- enable – Pointer to store the detection logic.

#### Return values

None. –

```
void PINT_PinInterruptClrStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt status only when the pin was triggered by edge-sensitive.

This function clears the selected pin interrupt status.

#### Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

#### Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Get Selected pin interrupt status.

This function returns the selected pin interrupt status.

#### Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

#### Return values

status – = 0 No pin interrupt request. = 1 Selected Pin interrupt request active.

```
void PINT_PinInterruptClrStatusAll(PINT_Type *base)
```

Clear all pin interrupts status only when pins were triggered by edge-sensitive.

This function clears the status of all pin interrupts.

#### Parameters

- base – Base address of the PINT peripheral.

#### Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetStatusAll(PINT_Type *base)
```

Get all pin interrupts status.

This function returns the status of all pin interrupts.

#### Parameters

- base – Base address of the PINT peripheral.

#### Return values

status – Each bit position indicates the status of corresponding pin interrupt.  
= 0 No pin interrupt request. = 1 Pin interrupt request active.

```
static inline void PINT_PinInterruptClrFallFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt fall flag.

This function clears the selected pin interrupt fall flag.

#### Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

#### Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetFallFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Get selected pin interrupt fall flag.

This function returns the selected pin interrupt fall flag.

**Parameters**

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

**Return values**

flag – = 0 Falling edge has not been detected. = 1 Falling edge has been detected.

```
static inline void PINT_PinInterruptClrFallFlagAll(PINT_Type *base)
```

Clear all pin interrupt fall flags.

This function clears the fall flag for all pin interrupts.

**Parameters**

- base – Base address of the PINT peripheral.

**Return values**

None. –

```
static inline uint32_t PINT_PinInterruptGetFallFlagAll(PINT_Type *base)
```

Get all pin interrupt fall flags.

This function returns the fall flag of all pin interrupts.

**Parameters**

- base – Base address of the PINT peripheral.

**Return values**

flags – Each bit position indicates the falling edge detection of the corresponding pin interrupt. 0 Falling edge has not been detected. = 1 Falling edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt rise flag.

This function clears the selected pin interrupt rise flag.

**Parameters**

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

**Return values**

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Get selected pin interrupt rise flag.

This function returns the selected pin interrupt rise flag.

**Parameters**

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

**Return values**

flag – = 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlagAll(PINT_Type *base)
```

Clear all pin interrupt rise flags.

This function clears the rise flag for all pin interrupts.

**Parameters**

- base – Base address of the PINT peripheral.

**Return values**

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlagAll(PINT_Type *base)
```

Get all pin interrupt rise flags.

This function returns the rise flag of all pin interrupts.

**Parameters**

- base – Base address of the PINT peripheral.

**Return values**

flags – Each bit position indicates the rising edge detection of the corresponding pin interrupt. 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
void PINT_PatternMatchConfig(PINT_Type *base, pint_pmatch_bslice_t bslice, pint_pmatch_cfg_t *cfg)
```

Configure PINT pattern match.

This function configures a given pattern match bit slice.

**Parameters**

- base – Base address of the PINT peripheral.
- bslice – Pattern match bit slice number.
- cfg – Pointer to bit slice configuration.

**Return values**

None. –

```
void PINT_PatternMatchGetConfig(PINT_Type *base, pint_pmatch_bslice_t bslice, pint_pmatch_cfg_t *cfg)
```

Get PINT pattern match configuration.

This function returns the configuration of a given pattern match bit slice.

**Parameters**

- base – Base address of the PINT peripheral.
- bslice – Pattern match bit slice number.
- cfg – Pointer to bit slice configuration.

**Return values**

None. –

```
static inline uint32_t PINT_PatternMatchGetStatus(PINT_Type *base, pint_pmatch_bslice_t bslice)
```

Get pattern match bit slice status.

This function returns the status of selected bit slice.

**Parameters**

- base – Base address of the PINT peripheral.
- bslice – Pattern match bit slice number.

**Return values**

status – = 0 Match has not been detected. = 1 Match has been detected.

```
static inline uint32_t PINT_PatternMatchGetStatusAll(PINT_Type *base)
```

Get status of all pattern match bit slices.

This function returns the status of all bit slices.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

`status` – Each bit position indicates the match status of corresponding bit slice.  
= 0 Match has not been detected. = 1 Match has been detected.

`uint32_t PINT_PatternMatchResetDetectLogic(PINT_Type *base)`

Reset pattern match detection logic.

This function resets the pattern match detection logic if any of the product term is matching.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

`pmstatus` – Each bit position indicates the match status of corresponding bit slice.  
= 0 Match was detected. = 1 Match was not detected.

`static inline void PINT_PatternMatchEnable(PINT_Type *base)`

Enable pattern match function.

This function enables the pattern match function.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –

`static inline void PINT_PatternMatchDisable(PINT_Type *base)`

Disable pattern match function.

This function disables the pattern match function.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –

`static inline void PINT_PatternMatchEnableRXEV(PINT_Type *base)`

Enable RXEV output.

This function enables the pattern match RXEV output.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –

`static inline void PINT_PatternMatchDisableRXEV(PINT_Type *base)`

Disable RXEV output.

This function disables the pattern match RXEV output.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –



`void PINT_EnableCallback(PINT_Type *base)`

Enable callback.

This function enables the interrupt for the selected PINT peripheral. Although the pin(s) are monitored as soon as they are enabled, the callback function is not enabled until this function is called.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –

`void PINT_DisableCallback(PINT_Type *base)`

Disable callback.

This function disables the interrupt for the selected PINT peripheral. Although the pins are still being monitored but the callback function is not called.

**Parameters**

- `base` – Base address of the peripheral.

**Return values**

None. –

`void PINT_Deinit(PINT_Type *base)`

Deinitialize PINT peripheral.

This function disables the PINT clock.

**Parameters**

- `base` – Base address of the PINT peripheral.

**Return values**

None. –

`void PINT_EnableCallbackByIndex(PINT_Type *base, pint_pin_int_t pintIdx)`

enable callback by pin index.

This function enables callback by pin index instead of enabling all pins.

**Parameters**

- `base` – Base address of the peripheral.
- `pintIdx` – pin index.

**Return values**

None. –

`void PINT_DisableCallbackByIndex(PINT_Type *base, pint_pin_int_t pintIdx)`

disable callback by pin index.

This function disables callback by pin index instead of disabling all pins.

**Parameters**

- `base` – Base address of the peripheral.
- `pintIdx` – pin index.

**Return values**

None. –

`PINT_USE_LEGACY_CALLBACK`

`PININT_BITSLICE_SRC_START`

```
PININT_BITSLICE_SRC_MASK
PININT_BITSLICE_CFG_START
PININT_BITSLICE_CFG_MASK
PININT_BITSLICE_ENDP_MASK
PINT_PIN_INT_LEVEL
PINT_PIN_INT_EDGE
PINT_PIN_INT_FALL_OR_HIGH_LEVEL
PINT_PIN_INT_RISE
PINT_PIN_RISE_EDGE
PINT_PIN_FALL_EDGE
PINT_PIN_BOTH_EDGE
PINT_PIN_LOW_LEVEL
PINT_PIN_HIGH_LEVEL

struct __pint_status
    #include <fsl_pint.h> PINT event status.

struct __pint_pmatch_cfg
    #include <fsl_pint.h>
```

## 2.25 Power

```
enum pd_bits
    power down configurations mask
    Values:
    enumerator kPDRUNCFG_PD_FRO_OUT
    enumerator kPDRUNCFG_PD_FRO
    enumerator kPDRUNCFG_PD_FLASH
    enumerator kPDRUNCFG_PD_BOD
    enumerator kPDRUNCFG_PD_ADC0
    enumerator kPDRUNCFG_PD_SYSOSC
    enumerator kPDRUNCFG_PD_LPO_OSC
    enumerator kPDRUNCFG_PD_SYSPLL
    enumerator kPDRUNCFG_PD_ACMP
    enumerator kPDRUNCFG_ForceUnsigned

enum __power_wakeup
    Deep sleep and power down mode wake up configurations.
    Values:
```

enumerator kPDAWAKECFG\_Wakeup\_FRO\_OUT

enumerator kPDAWAKECFG\_Wakeup\_FRO

enumerator kPDAWAKECFG\_Wakeup\_FLASH

enumerator kPDAWAKECFG\_Wakeup\_BOD

enumerator kPDAWAKECFG\_Wakeup\_ADC

enumerator kPDAWAKECFG\_Wakeup\_SYSOSC

enumerator kPDAWAKECFG\_Wakeup\_LP\_OSC

enumerator kPDAWAKECFG\_Wakeup\_ACMP

enum \_\_power\_deep\_sleep\_active

Deep sleep/power down mode active part.

*Values:*

enumerator kPDSLEEP\_CFG\_DeepSleepBODActive

enumerator kPDSLEEP\_CFG\_DeepSleepLPOscActive

enum \_\_power\_gen\_reg

pmu general purpose register index

*Values:*

enumerator kPmu\_GenReg0

general purpose register0

enumerator kPmu\_GenReg1

general purpose register1

enumerator kPmu\_GenReg2

general purpose register2

enumerator kPmu\_GenReg3

general purpose register3

enumerator kPmu\_GenReg4

DPDCTRL bit 31-8

enum \_\_power\_mode\_config

*Values:*

enumerator kPmu\_Sleep

enumerator kPmu\_Deep\_Sleep

enumerator kPmu\_PowerDown

enumerator kPmu\_Deep\_PowerDown

enum \_\_power\_bod\_reset\_level

BOD reset level, if VDD below reset level value, the reset will be asserted.

*Values:*

enumerator kBod\_ResetLevelReserved

BOD Reset Level reserved.

enumerator kBod\_ResetLevel1  
BOD Reset Level1: 2.05V

enumerator kBod\_ResetLevel2  
BOD Reset Level2: 2.35V

enumerator kBod\_ResetLevel3  
BOD Reset Level3: 2.63V

enum \_\_power\_bod\_interrupt\_level  
BOD interrupt level, if VDD below interrupt level value, the BOD interrupt will be asserted.  
*Values:*

enumerator kBod\_InterruptLevelReserved  
BOD interrupt level reserved.

enumerator kBod\_InterruptLevel1  
BOD interrupt level1: 2.25V.

enumerator kBod\_InterruptLevel2  
BOD interrupt level2: 2.55V.

enumerator kBod\_InterruptLevel3  
BOD interrupt level3: 2.84V.

typedef enum *pd\_bits* pd\_bit\_t  
power down configurations mask

typedef enum *\_power\_gen\_reg* power\_gen\_reg\_t  
pmu general purpose register index

typedef enum *\_power\_mode\_config* power\_mode\_cfg\_t

typedef enum *\_power\_bod\_reset\_level* power\_bod\_reset\_level\_t  
BOD reset level, if VDD below reset level value, the reset will be asserted.

typedef enum *\_power\_bod\_interrupt\_level* power\_bod\_interrupt\_level\_t  
BOD interrupt level, if VDD below interrupt level value, the BOD interrupt will be asserted.

FSL\_POWER\_DRIVER\_VERSION  
power driver version 2.1.0.

PMUC\_PCON\_RESERVED\_MASK  
PMU PCON reserved mask, used to clear reserved field which should not write 1.

POWER\_EnbaleLPO

POWER\_EnbaleLPOInDeepPowerDownMode

static inline void POWER\_EnablePD(*pd\_bit\_t* en)  
API to enable PDRUNCFG bit in the Syscon. Note that enabling the bit powers down the peripheral.

**Parameters**

- en – peripheral for which to enable the PDRUNCFG bit

**Returns**  
none

static inline void POWER\_DisablePD(*pd\_bit\_t* en)

API to disable PDRUNCFG bit in the Syscon. Note that disabling the bit powers up the peripheral.

**Parameters**

- en – peripheral for which to disable the PDRUNCFG bit

**Returns**

none

static inline void POWER\_WakeUpConfig(uint32\_t mask, bool powerDown)

API to config wakeup configurations for deep sleep mode and power down mode.

**Parameters**

- mask – wake up configurations for deep sleep mode and power down mode, reference `_power_wakeup`.
- powerDown – true is power down the mask part, false is powered part.

static inline void POWER\_DeepSleepConfig(uint32\_t mask, bool powerDown)

API to config active part for deep sleep mode and power down mode.

**Parameters**

- mask – active part configurations for deep sleep mode and power down mode, reference `_power_deep_sleep_active`.
- powerDown – true is power down the mask part, false is powered part.

static inline void POWER\_EnableDeepSleep(void)

API to enable deep sleep bit in the ARM Core.

**Returns**

none

static inline void POWER\_DisableDeepSleep(void)

API to disable deep sleep bit in the ARM Core.

**Returns**

none

void POWER\_EnterSleep(void)

API to enter sleep power mode.

**Returns**

none

void POWER\_EnterDeepSleep(uint32\_t activePart)

API to enter deep sleep power mode.

**Parameters**

- activePart – should be a single or combine value of `_power_deep_sleep_active`.

**Returns**

none

void POWER\_EnterPowerDown(uint32\_t activePart)

API to enter power down mode.

**Parameters**

- activePart – should be a single or combine value of `_power_deep_sleep_active`.

**Returns**

none

`void POWER_EnterDeepPowerDownMode(void)`

API to enter deep power down mode.

**Returns**

none

`static inline uint32_t POWER_GetSleepModeFlag(void)`

API to get sleep mode flag.

**Returns**

sleep mode flag: 0 is active mode, 1 is sleep mode entered.

`static inline void POWER_ClrSleepModeFlag(void)`

API to clear sleep mode flag.

`static inline uint32_t POWER_GetDeepPowerDownModeFlag(void)`

API to get deep power down mode flag.

**Returns**

sleep mode flag: 0 not deep power down, 1 is deep power down mode entered.

`static inline void POWER_ClrDeepPowerDownModeFlag(void)`

API to clear deep power down mode flag.

`static inline void POWER_EnableNonDpd(bool enable)`

API to enable non deep power down mode.

**Parameters**

- enable – true is enable non deep power down, otherwise disable.

`static inline void POWER_EnableLPO(bool enable)`

API to enable LPO.

**Parameters**

- enable – true to enable LPO, false to disable LPO.

`static inline void POWER_EnableLPOInDeepPowerDownMode(bool enable)`

API to enable LPO in deep power down mode.

**Parameters**

- enable – true to enable LPO, false to disable LPO.

`static inline void POWER_SetRetainData(power_gen_reg_t index, uint32_t data)`

API to restore data to general purpose register which can be retain during deep power down mode. Note the kPMU\_GenReg4 can restore 3 byte data only, so the general purpose register can store 19bytes data.

**Parameters**

- index – general purpose data register index.
- data – data to restore.

`static inline uint32_t POWER_GetRetainData(power_gen_reg_t index)`

API to get data from general purpose register which retain during deep power down mode. Note the kPMU\_GenReg4 can restore 3 byte data only, so the general purpose register can store 19bytes data.

**Parameters**

- index – general purpose data register index.

**Returns**

data stored in the general purpose register.

static inline void POWER\_EnableWktClkIn(bool enable, bool enHysteresis)

API to enable external clock input for self wake up timer.

**Parameters**

- enable – true is enable external clock input for self-wake-up timer, otherwise disable.
- enHysteresis – true is enable Hysteresis for the pin, otherwise disable.

static inline void POWER\_EnableWakeupPinForDeepPowerDown(bool enable, bool enHysteresis)

API to enable wake up pin for deep power down mode.

**Parameters**

- enable – true is enable, otherwise disable.
- enHysteresis – true is enable Hysteresis for the pin, otherwise disable.

static inline void POWER\_EnableResetPinForDeepPowerDown(bool enable, bool enHysteresis)

API to enable external clock input for self wake up timer.

**Parameters**

- enable – true is enable , otherwise disable.
- enHysteresis – true is enable Hysteresis for the pin, otherwise disable.

static inline void POWER\_SetBodLevel(*power\_bod\_reset\_level\_t* resetLevel,  
*power\_bod\_interrupt\_level\_t* interruptLevel, bool  
 enable)

Set Bod interrupt level and reset level.

**Parameters**

- resetLevel – BOD reset threshold level, please refer to *power\_bod\_reset\_level\_t*.
- interruptLevel – BOD interrupt threshold level, please refer to *power\_bod\_interrupt\_level\_t*.
- enable – Used to enable/disable the BOD interrupt and BOD reset.

## 2.26 Reset

enum \_\_SYSCON\_RSTn

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in PRESETCTRL/ASYNCPRESETCTRL registers

Values:

enumerator kFLASH\_RST\_N\_SHIFT\_RSTn

Flash controller reset control

enumerator kI2C0\_RST\_N\_SHIFT\_RSTn

I2C0 reset control

enumerator kGPIO0\_RST\_N\_SHIFT\_RSTn

GPIO0 reset control

enumerator kSWM\_RST\_N\_SHIFT\_RSTn  
SWM reset control

enumerator kWKT\_RST\_N\_SHIFT\_RSTn  
Self-wake-up timer(WKT) reset control

enumerator kMRT\_RST\_N\_SHIFT\_RSTn  
Multi-rate timer(MRT) reset control

enumerator kSPI0\_RST\_N\_SHIFT\_RSTn  
SPI0 reset control.

enumerator kSPI1\_RST\_N\_SHIFT\_RSTn  
SPI1 reset control

enumerator kCRC\_RST\_SHIFT\_RSTn  
CRC reset control

enumerator kUART0\_RST\_N\_SHIFT\_RSTn  
UART0 reset control

enumerator kUART1\_RST\_N\_SHIFT\_RSTn  
UART1 reset control

enumerator kUART2\_RST\_N\_SHIFT\_RSTn  
UART2 reset control

enumerator kIOCON\_RST\_N\_SHIFT\_RSTn  
IOCON reset control

enumerator kACMP\_RST\_N\_SHIFT\_RSTn  
Analog comparator reset control

enumerator kGPIO1\_RST\_N\_SHIFT\_RSTn  
GPIO1 reset control

enumerator kFTM0\_RST\_N\_SHIFT\_RSTn  
FTM0 reset control

enumerator kFTM1\_RST\_N\_SHIFT\_RSTn  
FTM1 reset control

enumerator kI3C\_RST\_N\_SHIFT\_RSTn  
I3C reset control

enumerator kADC\_RST\_N\_SHIFT\_RSTn  
ADC reset control

enumerator kGPIOINT\_RST\_N\_SHIFT\_RSTn  
GPIOINT reset control

enumerator kDMA\_RST\_N\_SHIFT\_RSTn  
DMA reset control

enumerator kFRG0\_RST\_N\_SHIFT\_RSTn  
Fractional baud rate generator 0 reset control

enumerator kFRG1\_RST\_N\_SHIFT\_RSTn  
Fractional baud rate generator 1 reset control



```
typedef enum _SYSCON_RSTn SYSCON_RSTn_t
```

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in PRESETCTRL/ASYNCPRESETCTRL registers

```
typedef SYSCON_RSTn_t reset_ip_name_t
```

```
void RESET_SetPeripheralReset(reset_ip_name_t peripheral)
```

Assert reset to peripheral.

Asserts reset signal to specified peripheral module.

#### Parameters

- peripheral – Assert reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

```
void RESET_ClearPeripheralReset(reset_ip_name_t peripheral)
```

Clear reset to peripheral.

Clears reset signal to specified peripheral module, allows it to operate.

#### Parameters

- peripheral – Clear reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

```
void RESET_PeripheralReset(reset_ip_name_t peripheral)
```

Reset peripheral module.

Reset peripheral module.

#### Parameters

- peripheral – Peripheral to reset. The enum argument contains encoding of reset register and reset bit position in the reset register.

```
static inline void RESET_ReleasePeripheralReset(reset_ip_name_t peripheral)
```

Release peripheral module.

Release peripheral module.

#### Parameters

- peripheral – Peripheral to release. The enum argument contains encoding of reset register and reset bit position in the reset register.

```
FSL_RESET_DRIVER_VERSION
```

reset driver version 2.4.0

```
FLASH_RSTS_N
```

Array initializers with peripheral reset bits

```
I2C_RSTS_N
```

```
GPIO_RSTS_N
```

```
SWM_RSTS_N
```

```
WKT_RSTS_N
```

```
MRT_RSTS_N
```

```
SPI_RSTS_N
```

```
CRC_RSTS_N
```

UART\_RSTS\_N

IOCON\_RSTS\_N

ACMP\_RSTS\_N

FTM\_RSTS\_N

I3C\_RSTS

ADC\_RSTS\_N

GPIOINT\_RSTS\_N

DMA\_RSTS\_N

FRG\_RSTS\_N

## 2.27 SCTimer: SCTimer/PWM (SCT)

*status\_t* SCTIMER\_Init(SCT\_Type \*base, const *sctimer\_config\_t* \*config)

Ungates the SCTimer clock and configures the peripheral for basic operation.

---

**Note:** This API should be called at the beginning of the application using the SCTimer driver.

---

### Parameters

- base – SCTimer peripheral base address
- config – Pointer to the user configuration structure.

### Returns

kStatus\_Success indicates success; Else indicates failure.

void SCTIMER\_Deinit(SCT\_Type \*base)

Gates the SCTimer clock.

### Parameters

- base – SCTimer peripheral base address

void SCTIMER\_GetDefaultConfig(*sctimer\_config\_t* \*config)

Fills in the SCTimer configuration structure with the default settings.

The default values are:

```
config->enableCounterUnify = true;
config->clockMode = kSCTIMER_System_ClockMode;
config->clockSelect = kSCTIMER_Clock_On_Rise_Input_0;
config->enableBidirection_l = false;
config->enableBidirection_h = false;
config->prescale_l = 0U;
config->prescale_h = 0U;
config->outInitState = 0U;
config->inputsync = 0xFU;
```

### Parameters

- config – Pointer to the user configuration structure.

```
status_t SCTIMER_SetupPwm(SCT_Type *base, const sctimer_pwm_signal_param_t
                          *pwmParams, sctimer_pwm_mode_t mode, uint32_t
                          pwmFreq_Hz, uint32_t srcClock_Hz, uint32_t *event)
```

Configures the PWM signal parameters.

Call this function to configure the PWM signal period, mode, duty cycle, and edge. This function will create 2 events; one of the events will trigger on match with the pulse value and the other will trigger when the counter matches the PWM period. The PWM period event is also used as a limit event to reset the counter or change direction. Both events are enabled for the same state. The state number can be retrieved by calling the function `SCTIMER_GetCurrentStateNumber()`. The counter is set to operate as one 32-bit counter (unify bit is set to 1). The counter operates in bi-directional mode when generating a center-aligned PWM.

---

**Note:** When setting PWM output from multiple output pins, they all should use the same PWM mode i.e all PWM's should be either edge-aligned or center-aligned. When using this API, the PWM signal frequency of all the initialized channels must be the same. Otherwise all the initialized channels' PWM signal frequency is equal to the last call to the API's `pwmFreq_Hz`.

---

#### Parameters

- `base` – SCTimer peripheral base address
- `pwmParams` – PWM parameters to configure the output
- `mode` – PWM operation mode, options available in enumeration `sctimer_pwm_mode_t`
- `pwmFreq_Hz` – PWM signal frequency in Hz
- `srcClock_Hz` – SCTimer counter clock in Hz
- `event` – Pointer to a variable where the PWM period event number is stored

#### Returns

`kStatus_Success` on success `kStatus_Fail` If we have hit the limit in terms of number of events created or if an incorrect PWM dutycycle is passed in.

```
void SCTIMER_UpdatePwmDutycycle(SCT_Type *base, sctimer_out_t output, uint8_t
                                dutyCyclePercent, uint32_t event)
```

Updates the duty cycle of an active PWM signal.

Before calling this function, the counter is set to operate as one 32-bit counter (unify bit is set to 1).

#### Parameters

- `base` – SCTimer peripheral base address
- `output` – The output to configure
- `dutyCyclePercent` – New PWM pulse width; the value should be between 1 to 100
- `event` – Event number associated with this PWM signal. This was returned to the user by the function `SCTIMER_SetupPwm()`.

```
static inline void SCTIMER_EnableInterrupts(SCT_Type *base, uint32_t mask)
```

Enables the selected SCTimer interrupts.

#### Parameters

- `base` – SCTimer peripheral base address

- mask – The interrupts to enable. This is a logical OR of members of the enumeration `sctimer_interrupt_enable_t`

static inline void SCTIMER\_DisableInterrupts(SCT\_Type \*base, uint32\_t mask)

Disables the selected SCTimer interrupts.

#### Parameters

- base – SCTimer peripheral base address
- mask – The interrupts to enable. This is a logical OR of members of the enumeration `sctimer_interrupt_enable_t`

static inline uint32\_t SCTIMER\_GetEnabledInterrupts(SCT\_Type \*base)

Gets the enabled SCTimer interrupts.

#### Parameters

- base – SCTimer peripheral base address

#### Returns

The enabled interrupts. This is the logical OR of members of the enumeration `sctimer_interrupt_enable_t`

static inline uint32\_t SCTIMER\_GetStatusFlags(SCT\_Type \*base)

Gets the SCTimer status flags.

#### Parameters

- base – SCTimer peripheral base address

#### Returns

The status flags. This is the logical OR of members of the enumeration `sctimer_status_flags_t`

static inline void SCTIMER\_ClearStatusFlags(SCT\_Type \*base, uint32\_t mask)

Clears the SCTimer status flags.

#### Parameters

- base – SCTimer peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration `sctimer_status_flags_t`

static inline void SCTIMER\_StartTimer(SCT\_Type \*base, uint32\_t countertoStart)

Starts the SCTimer counter.

---

**Note:** In 16-bit mode, we can enable both Counter\_L and Counter\_H, In 32-bit mode, we only can select Counter\_U.

---

#### Parameters

- base – SCTimer peripheral base address
- countertoStart – The SCTimer counters to enable. This is a logical OR of members of the enumeration `sctimer_counter_t`.

static inline void SCTIMER\_StopTimer(SCT\_Type \*base, uint32\_t countertoStop)

Halts the SCTimer counter.

#### Parameters

- base – SCTimer peripheral base address
- countertoStop – The SCTimer counters to stop. This is a logical OR of members of the enumeration `sctimer_counter_t`.

```
status_t SCTIMER_CreateAndScheduleEvent(SCT_Type *base, sctimer_event_t howToMonitor,
                                         uint32_t matchValue, uint32_t whichIO,
                                         sctimer_counter_t whichCounter, uint32_t *event)
```

Create an event that is triggered on a match or IO and schedule in current state.

This function will configure an event using the options provided by the user. If the event type uses the counter match, then the function will set the user provided match value into a match register and put this match register number into the event control register. The event is enabled for the current state and the event number is increased by one at the end. The function returns the event number; this event number can be used to configure actions to be done when this event is triggered.

#### Parameters

- base – SCTimer peripheral base address
- howToMonitor – Event type; options are available in the enumeration `sctimer_interrupt_enable_t`
- matchValue – The match value that will be programmed to a match register
- whichIO – The input or output that will be involved in event triggering. This field is ignored if the event type is “match only”
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.
- event – Pointer to a variable where the new event number is stored

#### Returns

`kStatus_Success` on success `kStatus_Error` if we have hit the limit in terms of number of events created or if we have reached the limit in terms of number of match registers

```
void SCTIMER_ScheduleEvent(SCT_Type *base, uint32_t event)
```

Enable an event in the current state.

This function will allow the event passed in to trigger in the current state. The event must be created earlier by either calling the function `SCTIMER_SetupPwm()` or function `SCTIMER_CreateAndScheduleEvent()`.

#### Parameters

- base – SCTimer peripheral base address
- event – Event number to enable in the current state

```
status_t SCTIMER_IncreaseState(SCT_Type *base)
```

Increase the state by 1.

All future events created by calling the function `SCTIMER_ScheduleEvent()` will be enabled in this new state.

#### Parameters

- base – SCTimer peripheral base address

#### Returns

`kStatus_Success` on success `kStatus_Error` if we have hit the limit in terms of states used

```
uint32_t SCTIMER_GetCurrentState(SCT_Type *base)
```

Provides the current state.

User can use this to set the next state by calling the function `SCTIMER_SetupNextStateAction()`.

#### Parameters

- base – SCTimer peripheral base address

**Returns**

The current state

```
static inline void SCTIMER_SetCounterState(SCT_Type *base, sctimer_counter_t whichCounter,
                                           uint32_t state)
```

Set the counter current state.

The function is to set the state variable bit field of STATE register. Writing to the STATE\_L, STATE\_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

**Parameters**

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.
- state – The counter current state number (only support range from 0~31).

```
static inline uint16_t SCTIMER_GetCounterState(SCT_Type *base, sctimer_counter_t
                                              whichCounter)
```

Get the counter current state value.

The function is to get the state variable bit field of STATE register.

**Parameters**

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.

**Returns**

The the counter current state value.

```
status_t SCTIMER_SetupCaptureAction(SCT_Type *base, sctimer_counter_t whichCounter,
                                     uint32_t *captureRegister, uint32_t event)
```

Setup capture of the counter value on trigger of a selected event.

**Parameters**

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.
- captureRegister – Pointer to a variable where the capture register number will be returned. User can read the captured value from this register when the specified event is triggered.
- event – Event number that will trigger the capture

**Returns**

kStatus\_Success on success kStatus\_Error if we have hit the limit in terms of number of match/capture registers available

```
void SCTIMER_SetCallback(SCT_Type *base, sctimer_event_callback_t callback, uint32_t event)
```

Receive notification when the event trigger an interrupt.

If the interrupt for the event is enabled by the user, then a callback can be registered which will be invoked when the event is triggered

**Parameters**

- base – SCTimer peripheral base address

- event – Event number that will trigger the interrupt
- callback – Function to invoke when the event is triggered

```
static inline void SCTIMER_SetupStateLdMethodAction(SCT_Type *base, uint32_t event, bool
                                                    fgLoad)
```

Change the load method of transition to the specified state.

Change the load method of transition, it will be triggered by the event number that is passed in by the user.

#### Parameters

- base – SCTimer peripheral base address
- event – Event number that will change the method to trigger the state transition
- fgLoad – The method to load highest-numbered event occurring for that state to the STATE register.
  - true: Load the STATEV value to STATE when the event occurs to be the next state.
  - false: Add the STATEV value to STATE when the event occurs to be the next state.

```
static inline void SCTIMER_SetupNextStateActionwithLdMethod(SCT_Type *base, uint32_t
                                                            nextState, uint32_t event, bool
                                                            fgLoad)
```

Transition to the specified state with Load method.

This transition will be triggered by the event number that is passed in by the user, the method decide how to load the highest-numbered event occurring for that state to the STATE register.

#### Parameters

- base – SCTimer peripheral base address
- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition
- fgLoad – The method to load the highest-numbered event occurring for that state to the STATE register.
  - true: Load the STATEV value to STATE when the event occurs to be the next state.
  - false: Add the STATEV value to STATE when the event occurs to be the next state.

```
static inline void SCTIMER_SetupNextStateAction(SCT_Type *base, uint32_t nextState, uint32_t
                                                event)
```

Transition to the specified state.

#### Deprecated:

Do not use this function. It has been superceded by SCTIMER\_SetupNextStateActionwithLdMethod

This transition will be triggered by the event number that is passed in by the user.

#### Parameters

- base – SCTimer peripheral base address

- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition

```
static inline void SCTIMER_SetupEventActiveDirection(SCT_Type *base,  
                                                    sctimer_event_active_direction_t  
                                                    activeDirection, uint32_t event)
```

Setup event active direction when the counters are operating in BIDIR mode.

#### Parameters

- base – SCTimer peripheral base address
- activeDirection – Event generation active direction, see `sctimer_event_active_direction_t`.
- event – Event number that need setup the active direction.

```
static inline void SCTIMER_SetupOutputSetAction(SCT_Type *base, uint32_t whichIO, uint32_t  
                                              event)
```

Set the Output.

This output will be set when the event number that is passed in by the user is triggered.

#### Parameters

- base – SCTimer peripheral base address
- whichIO – The output to set
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupOutputClearAction(SCT_Type *base, uint32_t whichIO,  
                                                  uint32_t event)
```

Clear the Output.

This output will be cleared when the event number that is passed in by the user is triggered.

#### Parameters

- base – SCTimer peripheral base address
- whichIO – The output to clear
- event – Event number that will trigger the output change

```
void SCTIMER_SetupOutputToggleAction(SCT_Type *base, uint32_t whichIO, uint32_t event)
```

Toggle the output level.

This change in the output level is triggered by the event number that is passed in by the user.

#### Parameters

- base – SCTimer peripheral base address
- whichIO – The output to toggle
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupCounterLimitAction(SCT_Type *base, sctimer_counter_t  
                                                  whichCounter, uint32_t event)
```

Limit the running counter.

The counter is limited when the event number that is passed in by the user is triggered.

#### Parameters

- base – SCTimer peripheral base address



- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select `Counter_L` and `Counter_H`, In 32-bit mode, we can select `Counter_U`.
- `event` – Event number that will trigger the counter to be limited

```
static inline void SCTIMER_SetupCounterStopAction(SCT_Type *base, sctimer_counter_t
                                                whichCounter, uint32_t event)
```

Stop the running counter.

The counter is stopped when the event number that is passed in by the user is triggered.

#### Parameters

- `base` – SCTimer peripheral base address
- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select `Counter_L` and `Counter_H`, In 32-bit mode, we can select `Counter_U`.
- `event` – Event number that will trigger the counter to be stopped

```
static inline void SCTIMER_SetupCounterStartAction(SCT_Type *base, sctimer_counter_t
                                                  whichCounter, uint32_t event)
```

Re-start the stopped counter.

The counter will re-start when the event number that is passed in by the user is triggered.

#### Parameters

- `base` – SCTimer peripheral base address
- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select `Counter_L` and `Counter_H`, In 32-bit mode, we can select `Counter_U`.
- `event` – Event number that will trigger the counter to re-start

```
static inline void SCTIMER_SetupCounterHaltAction(SCT_Type *base, sctimer_counter_t
                                                  whichCounter, uint32_t event)
```

Halt the running counter.

The counter is disabled (halted) when the event number that is passed in by the user is triggered. When the counter is halted, all further events are disabled. The HALT condition can only be removed by calling the `SCTIMER_StartTimer()` function.

#### Parameters

- `base` – SCTimer peripheral base address
- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select `Counter_L` and `Counter_H`, In 32-bit mode, we can select `Counter_U`.
- `event` – Event number that will trigger the counter to be halted

```
static inline void SCTIMER_SetupDmaTriggerAction(SCT_Type *base, uint32_t dmaNumber,
                                                uint32_t event)
```

Generate a DMA request.

DMA request will be triggered by the event number that is passed in by the user.

#### Parameters

- `base` – SCTimer peripheral base address
- `dmaNumber` – The DMA request to generate
- `event` – Event number that will trigger the DMA request

```
static inline void SCTIMER_SetCOUNTValue(SCT_Type *base, sctimer_counter_t whichCounter,
                                          uint32_t value)
```

Set the value of counter.

The function is to set the value of Count register, Writing to the COUNT\_L, COUNT\_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

#### Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.
- value – the counter value update to the COUNT register.

```
static inline uint32_t SCTIMER_GetCOUNTValue(SCT_Type *base, sctimer_counter_t
                                              whichCounter)
```

Get the value of counter.

The function is to read the value of Count register, software can read the counter registers at any time..

#### Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.

#### Returns

The value of counter selected.

```
static inline void SCTIMER_SetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Set the state mask bit field of EV\_STATE register.

#### Parameters

- base – SCTimer peripheral base address
- event – The EV\_STATE register be set.
- state – The state value in which the event is enabled to occur.

```
static inline void SCTIMER_ClearEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Clear the state mask bit field of EV\_STATE register.

#### Parameters

- base – SCTimer peripheral base address
- event – The EV\_STATE register be clear.
- state – The state value in which the event is disabled to occur.

```
static inline bool SCTIMER_GetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Get the state mask bit field of EV\_STATE register.

---

**Note:** This function is to check whether the event is enabled in a specific state.

---

#### Parameters

- base – SCTimer peripheral base address
- event – The EV\_STATE register be read.
- state – The state value.

**Returns**

The the state mask bit field of EV\_STATE register.

- true: The event is enable in state.
- false: The event is disable in state.

```
static inline uint32_t SCTIMER_GetCaptureValue(SCT_Type *base, sctimer_counter_t
                                              whichCounter, uint8_t capChannel)
```

Get the value of capture register.

This function returns the captured value upon occurrence of the events selected by the corresponding Capture Control registers occurred.

**Parameters**

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter\_L and Counter\_H, In 32-bit mode, we can select Counter\_U.
- capChannel – SCTimer capture register of capture channel.

**Returns**

The SCTimer counter value at which this register was last captured.

```
void SCTIMER_EventHandleIRQ(SCT_Type *base)
```

SCTimer interrupt handler.

**Parameters**

- base – SCTimer peripheral base address.

```
FSL_SCTIMER_DRIVER_VERSION
```

Version

```
enum _sctimer_pwm_mode
```

SCTimer PWM operation modes.

*Values:*

```
enumerator kSCTIMER_EdgeAlignedPwm
```

Edge-aligned PWM

```
enumerator kSCTIMER_CenterAlignedPwm
```

Center-aligned PWM

```
enum _sctimer_counter
```

SCTimer counters type.

*Values:*

```
enumerator kSCTIMER_Counter_L
```

16-bit Low counter.

```
enumerator kSCTIMER_Counter_H
```

16-bit High counter.

```
enumerator kSCTIMER_Counter_U
```

32-bit Unified counter.

```
enum _sctimer_input
```

List of SCTimer input pins.

*Values:*

enumerator kSCTIMER\_Input\_0

SCTIMER input 0

enumerator kSCTIMER\_Input\_1

SCTIMER input 1

enumerator kSCTIMER\_Input\_2

SCTIMER input 2

enumerator kSCTIMER\_Input\_3

SCTIMER input 3

enumerator kSCTIMER\_Input\_4

SCTIMER input 4

enumerator kSCTIMER\_Input\_5

SCTIMER input 5

enumerator kSCTIMER\_Input\_6

SCTIMER input 6

enumerator kSCTIMER\_Input\_7

SCTIMER input 7

enum \_sctimer\_out

List of SCTimer output pins.

*Values:*

enumerator kSCTIMER\_Out\_0

SCTIMER output 0

enumerator kSCTIMER\_Out\_1

SCTIMER output 1

enumerator kSCTIMER\_Out\_2

SCTIMER output 2

enumerator kSCTIMER\_Out\_3

SCTIMER output 3

enumerator kSCTIMER\_Out\_4

SCTIMER output 4

enumerator kSCTIMER\_Out\_5

SCTIMER output 5

enumerator kSCTIMER\_Out\_6

SCTIMER output 6

enumerator kSCTIMER\_Out\_7

SCTIMER output 7

enumerator kSCTIMER\_Out\_8

SCTIMER output 8

enumerator kSCTIMER\_Out\_9

SCTIMER output 9

enum \_sctimer\_pwm\_level\_select

SCTimer PWM output pulse mode: high-true, low-true or no output.

*Values:*

enumerator kSCTIMER\_LowTrue

Low true pulses

enumerator kSCTIMER\_HighTrue

High true pulses

enum \_sctimer\_clock\_mode

SCTimer clock mode options.

*Values:*

enumerator kSCTIMER\_System\_ClockMode

System Clock Mode

enumerator kSCTIMER\_Sampled\_ClockMode

Sampled System Clock Mode

enumerator kSCTIMER\_Input\_ClockMode

SCT Input Clock Mode

enumerator kSCTIMER\_Asynchronous\_ClockMode

Asynchronous Mode

enum \_sctimer\_clock\_select

SCTimer clock select options.

*Values:*

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_0

Rising edges on input 0

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_0

Falling edges on input 0

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_1

Rising edges on input 1

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_1

Falling edges on input 1

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_2

Rising edges on input 2

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_2

Falling edges on input 2

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_3

Rising edges on input 3

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_3

Falling edges on input 3

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_4

Rising edges on input 4

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_4

Falling edges on input 4

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_5

Rising edges on input 5

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_5

Falling edges on input 5

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_6

Rising edges on input 6

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_6

Falling edges on input 6

enumerator kSCTIMER\_Clock\_On\_Rise\_Input\_7

Rising edges on input 7

enumerator kSCTIMER\_Clock\_On\_Fall\_Input\_7

Falling edges on input 7

enum \_sctimer\_conflict\_resolution

SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

*Values:*

enumerator kSCTIMER\_ResolveNone

No change

enumerator kSCTIMER\_ResolveSet

Set output

enumerator kSCTIMER\_ResolveClear

Clear output

enumerator kSCTIMER\_ResolveToggle

Toggle output

enum \_sctimer\_event\_active\_direction

List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

*Values:*

enumerator kSCTIMER\_ActiveIndependent

This event is triggered regardless of the count direction.

enumerator kSCTIMER\_ActiveInCountUp

This event is triggered only during up-counting when BIDIR = 1.

enumerator kSCTIMER\_ActiveInCountDown

This event is triggered only during down-counting when BIDIR = 1.

enum \_sctimer\_event

List of SCTimer event types.

*Values:*

enumerator kSCTIMER\_InputLowOrMatchEvent

enumerator kSCTIMER\_InputRiseOrMatchEvent

enumerator kSCTIMER\_InputFallOrMatchEvent

enumerator kSCTIMER\_InputHighOrMatchEvent

enumerator kSCTIMER\_MatchEventOnly

enumerator kSCTIMER\_InputLowEvent

enumerator kSCTIMER\_InputRiseEvent  
enumerator kSCTIMER\_InputFallEvent  
enumerator kSCTIMER\_InputHighEvent  
enumerator kSCTIMER\_InputLowAndMatchEvent  
enumerator kSCTIMER\_InputRiseAndMatchEvent  
enumerator kSCTIMER\_InputFallAndMatchEvent  
enumerator kSCTIMER\_InputHighAndMatchEvent  
enumerator kSCTIMER\_OutputLowOrMatchEvent  
enumerator kSCTIMER\_OutputRiseOrMatchEvent  
enumerator kSCTIMER\_OutputFallOrMatchEvent  
enumerator kSCTIMER\_OutputHighOrMatchEvent  
enumerator kSCTIMER\_OutputLowEvent  
enumerator kSCTIMER\_OutputRiseEvent  
enumerator kSCTIMER\_OutputFallEvent  
enumerator kSCTIMER\_OutputHighEvent  
enumerator kSCTIMER\_OutputLowAndMatchEvent  
enumerator kSCTIMER\_OutputRiseAndMatchEvent  
enumerator kSCTIMER\_OutputFallAndMatchEvent  
enumerator kSCTIMER\_OutputHighAndMatchEvent

enum \_sctimer\_interrupt\_enable

List of SCTimer interrupts.

*Values:*

enumerator kSCTIMER\_Event0InterruptEnable  
    Event 0 interrupt  
enumerator kSCTIMER\_Event1InterruptEnable  
    Event 1 interrupt  
enumerator kSCTIMER\_Event2InterruptEnable  
    Event 2 interrupt  
enumerator kSCTIMER\_Event3InterruptEnable  
    Event 3 interrupt  
enumerator kSCTIMER\_Event4InterruptEnable  
    Event 4 interrupt  
enumerator kSCTIMER\_Event5InterruptEnable  
    Event 5 interrupt  
enumerator kSCTIMER\_Event6InterruptEnable  
    Event 6 interrupt

enumerator kSCTIMER\_Event7InterruptEnable

Event 7 interrupt

enumerator kSCTIMER\_Event8InterruptEnable

Event 8 interrupt

enumerator kSCTIMER\_Event9InterruptEnable

Event 9 interrupt

enumerator kSCTIMER\_Event10InterruptEnable

Event 10 interrupt

enumerator kSCTIMER\_Event11InterruptEnable

Event 11 interrupt

enumerator kSCTIMER\_Event12InterruptEnable

Event 12 interrupt

enum \_sctimer\_status\_flags

List of SCTimer flags.

*Values:*

enumerator kSCTIMER\_Event0Flag

Event 0 Flag

enumerator kSCTIMER\_Event1Flag

Event 1 Flag

enumerator kSCTIMER\_Event2Flag

Event 2 Flag

enumerator kSCTIMER\_Event3Flag

Event 3 Flag

enumerator kSCTIMER\_Event4Flag

Event 4 Flag

enumerator kSCTIMER\_Event5Flag

Event 5 Flag

enumerator kSCTIMER\_Event6Flag

Event 6 Flag

enumerator kSCTIMER\_Event7Flag

Event 7 Flag

enumerator kSCTIMER\_Event8Flag

Event 8 Flag

enumerator kSCTIMER\_Event9Flag

Event 9 Flag

enumerator kSCTIMER\_Event10Flag

Event 10 Flag

enumerator kSCTIMER\_Event11Flag

Event 11 Flag

enumerator kSCTIMER\_Event12Flag

Event 12 Flag



enumerator `kSCTIMER_BusErrorLFlag`  
 Bus error due to write when L counter was not halted

enumerator `kSCTIMER_BusErrorHFlag`  
 Bus error due to write when H counter was not halted

typedef enum `_sctimer_pwm_mode` `sctimer_pwm_mode_t`  
 SCTimer PWM operation modes.

typedef enum `_sctimer_counter` `sctimer_counter_t`  
 SCTimer counters type.

typedef enum `_sctimer_input` `sctimer_input_t`  
 List of SCTimer input pins.

typedef enum `_sctimer_out` `sctimer_out_t`  
 List of SCTimer output pins.

typedef enum `_sctimer_pwm_level_select` `sctimer_pwm_level_select_t`  
 SCTimer PWM output pulse mode: high-true, low-true or no output.

typedef struct `_sctimer_pwm_signal_param` `sctimer_pwm_signal_param_t`  
 Options to configure a SCTimer PWM signal.

typedef enum `_sctimer_clock_mode` `sctimer_clock_mode_t`  
 SCTimer clock mode options.

typedef enum `_sctimer_clock_select` `sctimer_clock_select_t`  
 SCTimer clock select options.

typedef enum `_sctimer_conflict_resolution` `sctimer_conflict_resolution_t`  
 SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

typedef enum `_sctimer_event_active_direction` `sctimer_event_active_direction_t`  
 List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

typedef enum `_sctimer_event` `sctimer_event_t`  
 List of SCTimer event types.

typedef void (\*`sctimer_event_callback_t`)(void)  
 SCTimer callback typedef.

typedef enum `_sctimer_interrupt_enable` `sctimer_interrupt_enable_t`  
 List of SCTimer interrupts.

typedef enum `_sctimer_status_flags` `sctimer_status_flags_t`  
 List of SCTimer flags.

typedef struct `_sctimer_config` `sctimer_config_t`  
 SCTimer configuration structure.

This structure holds the configuration settings for the SCTimer peripheral. To initialize this structure to reasonable defaults, call the `SCTMR_GetDefaultConfig()` function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

`SCT_EV_STATE_STATEMSKn(x)`

struct `_sctimer_pwm_signal_param`  
`#include <fsl_sctimer.h>` Options to configure a SCTimer PWM signal.

## Public Members

*sctimer\_out\_t* output

The output pin to use to generate the PWM signal

*sctimer\_pwm\_level\_select\_t* level

PWM output active level select.

*uint8\_t* dutyCyclePercent

PWM pulse width, value should be between 0 to 100 0 = always inactive signal (0% duty cycle) 100 = always active signal (100% duty cycle).

struct *\_sctimer\_config*

*#include <fsl\_sctimer.h>* SCTimer configuration structure.

This structure holds the configuration settings for the SCTimer peripheral. To initialize this structure to reasonable defaults, call the *SCTMR\_GetDefaultConfig()* function and pass a pointer to the configuration structure instance.

The configuration structure can be made constant so as to reside in flash.

## Public Members

bool *enableCounterUnify*

true: SCT operates as a unified 32-bit counter; false: SCT operates as two 16-bit counters. User can use the 16-bit low counter and the 16-bit high counters at the same time; for Hardware limit, user can not use unified 32-bit counter and any 16-bit low/high counter at the same time.

*sctimer\_clock\_mode\_t* clockMode

SCT clock mode value

*sctimer\_clock\_select\_t* clockSelect

SCT clock select value

bool *enableBidirection\_l*

true: Up-down count mode for the L or unified counter false: Up count mode only for the L or unified counter

bool *enableBidirection\_h*

true: Up-down count mode for the H or unified counter false: Up count mode only for the H or unified counter. This field is used only if the *enableCounterUnify* is set to false

*uint8\_t* *prescale\_l*

Prescale value to produce the L or unified counter clock

*uint8\_t* *prescale\_h*

Prescale value to produce the H counter clock. This field is used only if the *enableCounterUnify* is set to false

*uint8\_t* *outInitState*

Defines the initial output value

*uint8\_t* *inputsync*

SCT INSYNC value, INSYNC field in the CONFIG register, from bit9 to bit 16. it is used to define synchronization for input N: bit 9 = input 0 bit 10 = input 1 bit 11 = input 2 bit 12 = input 3 All other bits are reserved (bit13 ~bit 16). How User to set the the value for the member *inputsync*. IE: delay for input0, and input 1, bypasses for input 2 and input 3 MACRO definition in user level. *#define INPUTSYNC0 (0U) #define INPUTSYNC1 (1U) #define INPUTSYNC2 (2U) #define INPUTSYNC3 (3U)* User Code. *sctimerInfo.inputsync = (1 « INPUTSYNC2) | (1 « INPUTSYNC3);*

## 2.28 SPI: Serial Peripheral Interface Driver

### 2.29 SPI Driver

`void SPI_MasterGetDefaultConfig(spi_master_config_t *config)`

Sets the SPI master configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in `SPI_MasterInit()`. User may use the initialized structure unchanged in `SPI_MasterInit()`, or modify some fields of the structure before calling `SPI_MasterInit()`. After calling this API, the master is ready to transfer. Example:

```
spi_master_config_t config;
SPI_MasterGetDefaultConfig(&config);
```

#### Parameters

- `config` – pointer to master config structure

`status_t SPI_MasterInit(SPI_Type *base, const spi_master_config_t *config, uint32_t srcClock_Hz)`

Initializes the SPI with master configuration.

The configuration structure can be filled by user from scratch, or be set with default values by `SPI_MasterGetDefaultConfig()`. After calling this API, the slave is ready to transfer. Example

```
spi_master_config_t config = {
    .baudRate_Bps = 500000,
    ...
};
SPI_MasterInit(SPI0, &config);
```

#### Parameters

- `base` – SPI base pointer
- `config` – pointer to master configuration structure
- `srcClock_Hz` – Source clock frequency.

`void SPI_SlaveGetDefaultConfig(spi_slave_config_t *config)`

Sets the SPI slave configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in `SPI_SlaveInit()`. Modify some fields of the structure before calling `SPI_SlaveInit()`. Example:

```
spi_slave_config_t config;
SPI_SlaveGetDefaultConfig(&config);
```

#### Parameters

- `config` – pointer to slave configuration structure

`status_t SPI_SlaveInit(SPI_Type *base, const spi_slave_config_t *config)`

Initializes the SPI with slave configuration.

The configuration structure can be filled by user from scratch or be set with default values by `SPI_SlaveGetDefaultConfig()`. After calling this API, the slave is ready to transfer. Example

```
spi_slave_config_t config = {  
    .polarity = kSPI_ClockPolarityActiveHigh;  
    .phase = kSPI_ClockPhaseFirstEdge;  
    .direction = kSPI_MsbFirst;  
    ...  
};  
SPI_SlaveInit(SPI0, &config);
```

### Parameters

- base – SPI base pointer
- config – pointer to slave configuration structure

void SPI\_Deinit(SPI\_Type \*base)

De-initializes the SPI.

Calling this API resets the SPI module, gates the SPI clock. Disable the fifo if enabled. The SPI module can't work unless calling the SPI\_MasterInit/SPI\_SlaveInit to initialize module.

### Parameters

- base – SPI base pointer

static inline void SPI\_Enable(SPI\_Type \*base, bool enable)

Enable or disable the SPI Master or Slave.

### Parameters

- base – SPI base pointer
- enable – or disable ( true = enable, false = disable)

static inline uint32\_t SPI\_GetStatusFlags(SPI\_Type \*base)

Gets the status flag.

### Parameters

- base – SPI base pointer

### Returns

SPI Status, use status flag to AND \_spi\_status\_flags could get the related status.

static inline void SPI\_ClearStatusFlags(SPI\_Type \*base, uint32\_t mask)

Clear the status flag.

### Parameters

- base – SPI base pointer
- mask – SPI Status, use status flag to AND \_spi\_status\_flags could get the related status.

static inline void SPI\_EnableInterrupts(SPI\_Type \*base, uint32\_t irq)

Enables the interrupt for the SPI.

### Parameters

- base – SPI base pointer
- irq – SPI interrupt source. The parameter can be any combination of the following values:
  - kSPI\_RxReadyInterruptEnable
  - kSPI\_TxReadyInterruptEnable

static inline void SPI\_DisableInterrupts(SPI\_Type \*base, uint32\_t irqs)

Disables the interrupt for the SPI.

**Parameters**

- base – SPI base pointer
- irqs – SPI interrupt source. The parameter can be any combination of the following values:
  - kSPI\_RxReadyInterruptEnable
  - kSPI\_TxReadyInterruptEnable

static inline bool SPI\_IsMaster(SPI\_Type \*base)

Returns whether the SPI module is in master mode.

**Parameters**

- base – SPI peripheral address.

**Returns**

Returns true if the module is in master mode or false if the module is in slave mode.

status\_t SPI\_MasterSetBaudRate(SPI\_Type \*base, uint32\_t baudrate\_Bps, uint32\_t srcClock\_Hz)

Sets the baud rate for SPI transfer. This is only used in master.

**Parameters**

- base – SPI base pointer
- baudrate\_Bps – baud rate needed in Hz.
- srcClock\_Hz – SPI source clock frequency in Hz.

static inline void SPI\_WriteData(SPI\_Type \*base, uint16\_t data)

Writes a data into the SPI data register directly.

**Parameters**

- base – SPI base pointer
- data – needs to be write.

static inline void SPI\_WriteConfigFlags(SPI\_Type \*base, uint32\_t configFlags)

Writes a data into the SPI TXCTL register directly.

**Parameters**

- base – SPI base pointer
- configFlags – control command needs to be written.

void SPI\_WriteDataWithConfigFlags(SPI\_Type \*base, uint16\_t data, uint32\_t configFlags)

Writes a data control info and data into the SPI TX register directly.

**Parameters**

- base – SPI base pointer
- data – value needs to be written.
- configFlags – control command needs to be written.

static inline uint32\_t SPI\_ReadData(SPI\_Type \*base)

Gets a data from the SPI data register.

**Parameters**

- base – SPI base pointer

**Returns**

Data in the register.

void SPI\_SetTransferDelay(SPI\_Type \*base, const *spi\_delay\_config\_t* \*config)

Set delay time for transfer. the delay uint is SPI clock time, maximum value is 0xF.

**Parameters**

- base – SPI base pointer
- config – configuration for delay option *spi\_delay\_config\_t*.

void SPI\_SetDummyData(SPI\_Type \*base, uint16\_t dummyData)

Set up the dummy data. This API can change the default data to be transferred when users set the tx buffer to NULL.

**Parameters**

- base – SPI peripheral address.
- dummyData – Data to be transferred when tx buffer is NULL.

*status\_t* SPI\_MasterTransferBlocking(SPI\_Type \*base, *spi\_transfer\_t* \*xfer)

Transfers a block of data using a polling method.

**Parameters**

- base – SPI base pointer
- xfer – pointer to *spi\_xfer\_config\_t* structure

**Return values**

- kStatus\_Success – Successfully start a transfer.
- kStatus\_InvalidArgument – Input argument is invalid.
- kStatus\_SPI\_Timeout – The transfer timed out and was aborted.

*status\_t* SPI\_MasterTransferCreateHandle(SPI\_Type \*base, *spi\_master\_handle\_t* \*handle, *spi\_master\_callback\_t* callback, void \*userData)

Initializes the SPI master handle.

This function initializes the SPI master handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

**Parameters**

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – Callback function.
- userData – User data.

*status\_t* SPI\_MasterTransferNonBlocking(SPI\_Type \*base, *spi\_master\_handle\_t* \*handle, *spi\_transfer\_t* \*xfer)

Performs a non-blocking SPI interrupt transfer.

**Parameters**

- base – SPI peripheral base address.
- handle – pointer to *spi\_master\_handle\_t* structure which stores the transfer state
- xfer – pointer to *spi\_xfer\_config\_t* structure

**Return values**

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_SPI_Busy` – SPI is not idle, is running another transfer.

*status\_t* SPI\_MasterTransferGetCount(*SPI\_Type* \*base, *spi\_master\_handle\_t* \*handle, *size\_t* \*count)

Gets the master transfer count.

This function gets the master transfer count.

#### Parameters

- base – SPI peripheral base address.
- handle – Pointer to the `spi_master_handle_t` structure which stores the transfer state.
- count – The number of bytes transferred by using the non-blocking transaction.

#### Returns

status of `status_t`.

*void* SPI\_MasterTransferAbort(*SPI\_Type* \*base, *spi\_master\_handle\_t* \*handle)

SPI master aborts a transfer using an interrupt.

This function aborts a transfer using an interrupt.

#### Parameters

- base – SPI peripheral base address.
- handle – Pointer to the `spi_master_handle_t` structure which stores the transfer state.

*void* SPI\_MasterTransferHandleIRQ(*SPI\_Type* \*base, *spi\_master\_handle\_t* \*handle)

Interrupts the handler for the SPI.

#### Parameters

- base – SPI peripheral base address.
- handle – pointer to `spi_master_handle_t` structure which stores the transfer state.

*status\_t* SPI\_SlaveTransferCreateHandle(*SPI\_Type* \*base, *spi\_slave\_handle\_t* \*handle, *spi\_slave\_callback\_t* callback, *void* \*userData)

Initializes the SPI slave handle.

This function initializes the SPI slave handle which can be used for other SPI slave transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

#### Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – Callback function.
- userData – User data.

*status\_t* SPI\_SlaveTransferNonBlocking(*SPI\_Type* \*base, *spi\_slave\_handle\_t* \*handle, *spi\_transfer\_t* \*xfer)

Performs a non-blocking SPI slave interrupt transfer.

---

**Note:** The API returns immediately after the transfer initialization is finished.

---

### Parameters

- `base` – SPI peripheral base address.
- `handle` – pointer to `spi_master_handle_t` structure which stores the transfer state
- `xfer` – pointer to `spi_xfer_config_t` structure

### Return values

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_SPI_Busy` – SPI is not idle, is running another transfer.

```
static inline status_t SPI_SlaveTransferGetCount(SPI_Type *base, spi_slave_handle_t *handle,
                                                size_t *count)
```

Gets the slave transfer count.

This function gets the slave transfer count.

### Parameters

- `base` – SPI peripheral base address.
- `handle` – Pointer to the `spi_master_handle_t` structure which stores the transfer state.
- `count` – The number of bytes transferred by using the non-blocking transaction.

### Returns

status of `status_t`.

```
static inline void SPI_SlaveTransferAbort(SPI_Type *base, spi_slave_handle_t *handle)
```

SPI slave aborts a transfer using an interrupt.

This function aborts a transfer using an interrupt.

### Parameters

- `base` – SPI peripheral base address.
- `handle` – Pointer to the `spi_slave_handle_t` structure which stores the transfer state.

```
void SPI_SlaveTransferHandleIRQ(SPI_Type *base, spi_slave_handle_t *handle)
```

Interrupts a handler for the SPI slave.

### Parameters

- `base` – SPI peripheral base address.
- `handle` – pointer to `spi_slave_handle_t` structure which stores the transfer state

```
FSL_SPI_DRIVER_VERSION
```

SPI driver version.

```
enum __spi_xfer_option
```

SPI transfer option.

*Values:*



enumerator kSPI\_EndOfFrame

Add delay at the end of each frame(the last clk edge).

enumerator kSPI\_EndOfTransfer

Re-assert the CS signal after transfer finishes to deselect slave.

enumerator kSPI\_ReceiveIgnore

Ignore the receive data.

enum \_spi\_shift\_direction

SPI data shifter direction options.

*Values:*

enumerator kSPI\_MsbFirst

Data transfers start with most significant bit.

enumerator kSPI\_LsbFirst

Data transfers start with least significant bit.

enum \_spi\_clock\_polarity

SPI clock polarity configuration.

*Values:*

enumerator kSPI\_ClockPolarityActiveHigh

Active-high SPI clock (idles low).

enumerator kSPI\_ClockPolarityActiveLow

Active-low SPI clock (idles high).

enum \_spi\_clock\_phase

SPI clock phase configuration.

*Values:*

enumerator kSPI\_ClockPhaseFirstEdge

First edge on SCK occurs at the middle of the first cycle of a data transfer.

enumerator kSPI\_ClockPhaseSecondEdge

First edge on SCK occurs at the start of the first cycle of a data transfer.

enum \_spi\_ssel

Slave select.

*Values:*

enumerator kSPI\_Ssel0Assert

Slave select 0

enumerator kSPI\_SselDeAssertAll

enum \_spi\_spol

ssel polarity

*Values:*

enumerator kSPI\_Spol0ActiveHigh

enumerator kSPI\_Spol1ActiveHigh

enumerator kSPI\_Spol2ActiveHigh

enumerator kSPI\_Spol3ActiveHigh

enumerator kSPI\_SpolActiveAllHigh

enumerator kSPI\_SpolActiveAllLow

enum \_spi\_data\_width

Transfer data width.

*Values:*

enumerator kSPI\_Data4Bits

4 bits data width

enumerator kSPI\_Data5Bits

5 bits data width

enumerator kSPI\_Data6Bits

6 bits data width

enumerator kSPI\_Data7Bits

7 bits data width

enumerator kSPI\_Data8Bits

8 bits data width

enumerator kSPI\_Data9Bits

9 bits data width

enumerator kSPI\_Data10Bits

10 bits data width

enumerator kSPI\_Data11Bits

11 bits data width

enumerator kSPI\_Data12Bits

12 bits data width

enumerator kSPI\_Data13Bits

13 bits data width

enumerator kSPI\_Data14Bits

14 bits data width

enumerator kSPI\_Data15Bits

15 bits data width

enumerator kSPI\_Data16Bits

16 bits data width

SPI transfer status.

*Values:*

enumerator kStatus\_SPI\_Busy

SPI bus is busy

enumerator kStatus\_SPI\_Idle

SPI is idle

enumerator kStatus\_SPI\_Error

SPI error

enumerator kStatus\_SPI\_BaudrateNotSupport

Baudrate is not support in current clock source

enumerator kStatus\_SPI\_Timeout  
SPI Timeout polling status flags.

enum \_spi\_interrupt\_enable  
SPI interrupt sources.

*Values:*

enumerator kSPI\_RxReadyInterruptEnable  
Rx ready interrupt

enumerator kSPI\_TxReadyInterruptEnable  
Tx ready interrupt

enumerator kSPI\_RxOverrunInterruptEnable  
Rx overrun interrupt

enumerator kSPI\_TxUnderrunInterruptEnable  
Tx underrun interrupt

enumerator kSPI\_SlaveSelectAssertInterruptEnable  
Slave select assert interrupt

enumerator kSPI\_SlaveSelectDeassertInterruptEnable  
Slave select deassert interrupt

enumerator kSPI\_AllInterruptEnable

enum \_spi\_status\_flags  
SPI status flags.

*Values:*

enumerator kSPI\_RxReadyFlag  
Receive ready flag.

enumerator kSPI\_TxReadyFlag  
Transmit ready flag.

enumerator kSPI\_RxOverrunFlag  
Receive overrun flag.

enumerator kSPI\_TxUnderrunFlag  
Transmit underrun flag.

enumerator kSPI\_SlaveSelectAssertFlag  
Slave select assert flag.

enumerator kSPI\_SlaveSelectDeassertFlag  
slave select deassert flag.

enumerator kSPI\_StallFlag  
Stall flag.

enumerator kSPI\_EndTransferFlag  
End transfer bit.

enumerator kSPI\_MasterIdleFlag  
Master in idle status flag.

typedef enum \_spi\_shift\_direction spi\_shift\_direction\_t  
SPI data shifter direction options.

typedef enum *\_spi\_clock\_polarity* spi\_clock\_polarity\_t  
SPI clock polarity configuration.

typedef enum *\_spi\_clock\_phase* spi\_clock\_phase\_t  
SPI clock phase configuration.

typedef enum *\_spi\_ssel* spi\_ssel\_t  
Slave select.

typedef enum *\_spi\_spol* spi\_spol\_t  
ssel polarity

typedef enum *\_spi\_data\_width* spi\_data\_width\_t  
Transfer data width.

typedef struct *\_spi\_delay\_config* spi\_delay\_config\_t  
SPI delay time configure structure.

typedef struct *\_spi\_master\_config* spi\_master\_config\_t  
SPI master user configure structure.

typedef struct *\_spi\_slave\_config* spi\_slave\_config\_t  
SPI slave user configure structure.

typedef struct *\_spi\_transfer* spi\_transfer\_t  
SPI transfer structure.

typedef struct *\_spi\_master\_handle* spi\_master\_handle\_t  
Master handle type.

typedef *spi\_master\_handle\_t* spi\_slave\_handle\_t  
Slave handle type.

typedef void (\*spi\_master\_callback\_t)(SPI\_Type \*base, *spi\_master\_handle\_t* \*handle, *status\_t* status, void \*userData)  
SPI master callback for finished transmit.

typedef void (\*spi\_slave\_callback\_t)(SPI\_Type \*base, *spi\_slave\_handle\_t* \*handle, *status\_t* status, void \*userData)  
SPI slave callback for finished transmit.

volatile uint16\_t s\_dummyData[]

uint32\_t SPI\_GetInstance(SPI\_Type \*base)  
Returns instance number for SPI peripheral base address.

SPI\_DUMMYDATA  
SPI dummy transfer data, the data is sent while txBuff is NULL.

FSL\_SDK\_ENABLE\_SPI\_DRIVER\_TRANSACTIONAL\_APIS

SPI\_RETRY\_TIMES  
Retry times for waiting flag.

struct *\_spi\_delay\_config*  
*#include <fsl\_spi.h>* SPI delay time configure structure.

## Public Members

uint8\_t preDelay  
Delay between SSEL assertion and the beginning of transfer.

uint8\_t postDelay

Delay between the end of transfer and SSEL deassertion.

uint8\_t frameDelay

Delay between frame to frame.

uint8\_t transferDelay

Delay between transfer to transfer.

struct \_\_spi\_master\_config

*#include <fsl\_spi.h>* SPI master user configure structure.

### Public Members

bool enableLoopback

Enable loopback for test purpose

bool enableMaster

Enable SPI at initialization time

uint32\_t baudRate\_Bps

Baud Rate for SPI in Hz

*spi\_clock\_polarity\_t* clockPolarity

Clock polarity

*spi\_clock\_phase\_t* clockPhase

Clock phase

*spi\_shift\_direction\_t* direction

MSB or LSB

uint8\_t dataWidth

Width of the data

*spi\_ssel\_t* sselNumber

Slave select number

*spi\_spol\_t* sselPolarity

Configure active CS polarity

*spi\_delay\_config\_t* delayConfig

Configure for delay time.

struct \_\_spi\_slave\_config

*#include <fsl\_spi.h>* SPI slave user configure structure.

### Public Members

bool enableSlave

Enable SPI at initialization time

*spi\_clock\_polarity\_t* clockPolarity

Clock polarity

*spi\_clock\_phase\_t* clockPhase

Clock phase

*spi\_shift\_direction\_t* direction

MSB or LSB

uint8\_t dataWidth

Width of the data

*spi\_spol\_t* sselPolarity

Configure active CS polarity

struct *\_spi\_transfer*

*#include <fsl\_spi.h>* SPI transfer structure.

### Public Members

const uint8\_t \*txData

Send buffer

uint8\_t \*rxData

Receive buffer

size\_t dataSize

Transfer bytes

uint32\_t configFlags

Additional option to control transfer *\_spi\_xfer\_option*.

struct *\_spi\_master\_handle*

*#include <fsl\_spi.h>* SPI transfer handle structure.

### Public Members

const uint8\_t \*volatile txData

Transfer buffer

uint8\_t \*volatile rxData

Receive buffer

volatile size\_t txRemainingBytes

Number of data to be transmitted [in bytes]

volatile size\_t rxRemainingBytes

Number of data to be received [in bytes]

size\_t totalByteCount

A number of transfer bytes

volatile uint32\_t state

SPI internal state

*spi\_master\_callback\_t* callback

SPI callback

void \*userData

Callback parameter

uint8\_t dataWidth

Width of the data [Valid values: 1 to 16]

uint32\_t lastCommand

Last command for transfer.

## 2.30 SWM: Switch Matrix Module

enum \_swm\_port\_pin\_type\_t

SWM port\_pin number.

*Values:*

enumerator kSWM\_PortPin\_P0\_0

port\_pin number P0\_0.

enumerator kSWM\_PortPin\_P0\_1

port\_pin number P0\_1.

enumerator kSWM\_PortPin\_P0\_2

port\_pin number P0\_2.

enumerator kSWM\_PortPin\_P0\_3

port\_pin number P0\_3.

enumerator kSWM\_PortPin\_P0\_4

port\_pin number P0\_4.

enumerator kSWM\_PortPin\_P0\_5

port\_pin number P0\_5.

enumerator kSWM\_PortPin\_P0\_6

port\_pin number P0\_6.

enumerator kSWM\_PortPin\_P0\_7

port\_pin number P0\_7.

enumerator kSWM\_PortPin\_P0\_8

port\_pin number P0\_8.

enumerator kSWM\_PortPin\_P0\_9

port\_pin number P0\_9.

enumerator kSWM\_PortPin\_P0\_10

port\_pin number P0\_10.

enumerator kSWM\_PortPin\_P0\_11

port\_pin number P0\_11.

enumerator kSWM\_PortPin\_P0\_12

port\_pin number P0\_12.

enumerator kSWM\_PortPin\_P0\_13

port\_pin number P0\_13.

enumerator kSWM\_PortPin\_P0\_14

port\_pin number P0\_14.

enumerator kSWM\_PortPin\_P0\_15

port\_pin number P0\_15.

enumerator kSWM\_PortPin\_P0\_16

port\_pin number P0\_16.

enumerator kSWM\_PortPin\_P0\_17

port\_pin number P0\_17.

enumerator kSWM\_PortPin\_P0\_18  
port\_pin number P0\_18.

enumerator kSWM\_PortPin\_P0\_19  
port\_pin number P0\_19.

enumerator kSWM\_PortPin\_P0\_20  
port\_pin number P0\_20.

enumerator kSWM\_PortPin\_P0\_21  
port\_pin number P0\_21.

enumerator kSWM\_PortPin\_P0\_22  
port\_pin number P0\_22.

enumerator kSWM\_PortPin\_P0\_23  
port\_pin number P0\_23.

enumerator kSWM\_PortPin\_P0\_24  
port\_pin number P0\_24.

enumerator kSWM\_PortPin\_P0\_25  
port\_pin number P0\_25.

enumerator kSWM\_PortPin\_P0\_26  
port\_pin number P0\_26.

enumerator kSWM\_PortPin\_P0\_27  
port\_pin number P0\_27.

enumerator kSWM\_PortPin\_P0\_28  
port\_pin number P0\_28.

enumerator kSWM\_PortPin\_P0\_29  
port\_pin number P0\_29.

enumerator kSWM\_PortPin\_P0\_30  
port\_pin number P0\_30.

enumerator kSWM\_PortPin\_P0\_31  
port\_pin number P0\_31.

enumerator kSWM\_PortPin\_P1\_0  
port\_pin number P1\_0.

enumerator kSWM\_PortPin\_P1\_1  
port\_pin number P1\_1.

enumerator kSWM\_PortPin\_P1\_2  
port\_pin number P1\_2.

enumerator kSWM\_PortPin\_P1\_3  
port\_pin number P1\_3.

enumerator kSWM\_PortPin\_P1\_4  
port\_pin number P1\_4.

enumerator kSWM\_PortPin\_P1\_5  
port\_pin number P1\_5.

enumerator kSWM\_PortPin\_P1\_6  
port\_pin number P1\_6.



enumerator kSWM\_PortPin\_P1\_7  
port\_pin number P1\_7.

enumerator kSWM\_PortPin\_P1\_8  
port\_pin number P1\_8.

enumerator kSWM\_PortPin\_P1\_9  
port\_pin number P1\_9.

enumerator kSWM\_PortPin\_P1\_10  
port\_pin number P1\_10.

enumerator kSWM\_PortPin\_P1\_11  
port\_pin number P1\_11.

enumerator kSWM\_PortPin\_P1\_12  
port\_pin number P1\_12.

enumerator kSWM\_PortPin\_P1\_13  
port\_pin number P1\_13.

enumerator kSWM\_PortPin\_P1\_14  
port\_pin number P1\_14.

enumerator kSWM\_PortPin\_P1\_15  
port\_pin number P1\_15.

enumerator kSWM\_PortPin\_P1\_16  
port\_pin number P1\_16.

enumerator kSWM\_PortPin\_P1\_17  
port\_pin number P1\_17.

enumerator kSWM\_PortPin\_P1\_18  
port\_pin number P1\_18.

enumerator kSWM\_PortPin\_P1\_19  
port\_pin number P1\_19.

enumerator kSWM\_PortPin\_P1\_20  
port\_pin number P1\_20.

enumerator kSWM\_PortPin\_P1\_21  
port\_pin number P1\_21.

enumerator kSWM\_PortPin\_Reset  
port\_pin reset number.

enum \_swm\_select\_movable\_t  
SWM movable selection.

*Values:*

enumerator kSWM\_USART0\_TXD  
Movable function as USART0\_TXD.

enumerator kSWM\_USART0\_RXD  
Movable function as USART0\_RXD.

enumerator kSWM\_USART0\_RTS  
Movable function as USART0\_RTS.

enumerator kSWM\_USART0\_CTS  
Movable function as USART0\_CTS.

enumerator kSWM\_USART0\_SCLK  
Movable function as USART0\_SCLK.

enumerator kSWM\_USART1\_TXD  
Movable function as USART1\_TXD.

enumerator kSWM\_USART1\_RXD  
Movable function as USART1\_RXD.

enumerator kSWM\_USART1\_RTS  
Movable function as USART1\_RTS.

enumerator kSWM\_USART1\_CTS  
Movable function as USART1\_CTS.

enumerator kSWM\_USART1\_SCLK  
Movable function as USART1\_SCLK.

enumerator kSWM\_USART2\_TXD  
Movable function as USART2\_TXD.

enumerator kSWM\_USART2\_RXD  
Movable function as USART2\_RXD.

enumerator kSWM\_USART2\_RTS  
Movable function as USART2\_RTS.

enumerator kSWM\_USART2\_CTS  
Movable function as USART2\_CTS.

enumerator kSWM\_USART2\_SCLK  
Movable function as USART2\_SCLK.

enumerator kSWM\_SPI0\_SCK  
Movable function as SPI0\_SCK.

enumerator kSWM\_SPI0\_MOSI  
Movable function as SPI0\_MOSI.

enumerator kSWM\_SPI0\_MISO  
Movable function as SPI0\_MISO.

enumerator kSWM\_SPI0\_SSEL0  
Movable function as SPI0\_SSEL0.

enumerator kSWM\_SPI0\_SSEL1  
Movable function as SPI0\_SSEL1.

enumerator kSWM\_SPI0\_SSEL2  
Movable function as SPI0\_SSEL2.

enumerator kSWM\_SPI0\_SSEL3  
Movable function as SPI0\_SSEL3.

enumerator kSWM\_SPI1\_SCK  
Movable function as SPI1\_SCK.

enumerator kSWM\_SPI1\_MOSI  
Movable function as SPI1\_MOSI.

enumerator kSWM\_SPI1\_MISO  
Movable function as SPI1\_MISO.

enumerator kSWM\_SPI1\_SSEL0  
Movable function as SPI1\_SSEL0.

enumerator kSWM\_SPI1\_SSEL1  
Movable function as SPI1\_SSEL1.

enumerator kSWM\_I2C0\_SDA  
Movable function as I2C0\_SDA.

enumerator kSWM\_I2C0\_SCL  
Movable function as I2C0\_SCL.

enumerator kSWM\_I3C0\_SDA  
Movable function as I3C0\_SDA.

enumerator kSWM\_I3C0\_SCL  
Movable function as I3C0\_SCL.

enumerator kSWM\_I3C0\_PUR  
Movable function as I3C0\_PUR.

enumerator kSWM\_ACMP\_O  
Movable function as COMP0\_OUT.

enumerator kSWM\_CLKOUT  
Movable function as CLKOUT.

enumerator kSWM\_GPIO\_INT\_BMAT  
Movable function as GPIO\_INT\_BMAT.

enumerator kSWM\_MOVABLE\_NUM\_FUNCS  
Movable function number.

enum \_swm\_select\_fixed\_pin\_t  
SWM fixed pin selection.

*Values:*

enumerator kSWM\_ACMP\_INPUT1  
Fixed-pin function as ACMP\_INPUT1.

enumerator kSWM\_ACMP\_INPUT2  
Fixed-pin function as ACMP\_INPUT2.

enumerator kSWM\_ACMP\_INPUT3  
Fixed-pin function as ACMP\_INPUT3.

enumerator kSWM\_ACMP\_INPUT4  
Fixed-pin function as ACMP\_INPUT4.

enumerator kSWM\_ACMP\_INPUT5  
Fixed-pin function as ACMP\_INPUT5.

enumerator kSWM\_SWCLK  
Fixed-pin function as SWCLK.

enumerator kSWM\_SWDIO  
Fixed-pin function as SWDIO.

enumerator kSWM\_RESETN

Fixed-pin function as RESETN.

enumerator kSWM\_CLKIN

Fixed-pin function as CLKIN.

enumerator kSWM\_CMPVREF

Fixed-pin function as CMPVREF.

enumerator kSWM\_XTALIN

Fixed-pin function as XTALIN.

enumerator kSWM\_XTALOUT

Fixed-pin function as XTALOUT.

enumerator kSWM\_ADC\_CHN0

Fixed-pin function as ADC\_CHN0.

enumerator kSWM\_ADC\_CHN1

Fixed-pin function as ADC\_CHN1.

enumerator kSWM\_ADC\_CHN2

Fixed-pin function as ADC\_CHN2.

enumerator kSWM\_ADC\_CHN3

Fixed-pin function as ADC\_CHN3.

enumerator kSWM\_ADC\_CHN4

Fixed-pin function as ADC\_CHN4.

enumerator kSWM\_ADC\_CHN5

Fixed-pin function as ADC\_CHN5.

enumerator kSWM\_ADC\_CHN6

Fixed-pin function as ADC\_CHN6.

enumerator kSWM\_ADC\_CHN7

Fixed-pin function as ADC\_CHN7.

enumerator kSWM\_ADC\_CHN8

Fixed-pin function as ADC\_CHN8.

enumerator kSWM\_ADC\_CHN9

Fixed-pin function as ADC\_CHN9.

enumerator kSWM\_ADC\_CHN10

Fixed-pin function as ADC\_CHN10.

enumerator kSWM\_ADC\_CHN11

Fixed-pin function as ADC\_CHN11.

enumerator kSWM\_FIXEDPIN\_NUM\_FUNCS

Fixed-pin function number.

enum \_swm\_flextimer\_pin\_func\_t

SWM flextimer pin function.

*Values:*

enumerator kSWM\_FTM0\_EXTCLK

Flextimer function as FTM0\_EXTCLK.

enumerator kSWM\_FTM0\_CH0  
Flextimer function as FTM0\_CH0.

enumerator kSWM\_FTM0\_CH1  
Flextimer function as FTM0\_CH1.

enumerator kSWM\_FTM0\_CH2  
Flextimer function as FTM0\_CH2.

enumerator kSWM\_FTM0\_CH3  
Flextimer function as FTM0\_CH3.

enumerator kSWM\_FTM0\_CH4  
Flextimer function as FTM0\_CH4.

enumerator kSWM\_FTM0\_CH5  
Flextimer function as FTM0\_CH5.

enumerator kSWM\_FTM0\_FAULT0  
Flextimer function as FTM0\_FAULT0.

enumerator kSWM\_FTM0\_FAULT1  
Flextimer function as FTM0\_FAULT1.

enumerator kSWM\_FTM0\_FAULT2  
Flextimer function as FTM0\_FAULT2.

enumerator kSWM\_FTM0\_FAULT3  
Flextimer function as FTM0\_FAULT3.

enumerator kSWM\_FTM1\_EXTCLK  
Flextimer function as FTM1\_EXTCLK.

enumerator kSWM\_FTM1\_CH0  
Flextimer function as FTM1\_CH0.

enumerator kSWM\_FTM1\_CH1  
Flextimer function as FTM1\_CH1.

enumerator kSWM\_FTM1\_CH2  
Flextimer function as FTM1\_CH2.

enumerator kSWM\_FTM1\_CH3  
Flextimer function as FTM1\_CH3.

enumerator kSWM\_FTM1\_QD\_PHA  
Flextimer function as FTM1\_QD\_PHA.

enumerator kSWM\_FTM1\_QD\_PHB  
Flextimer function as FTM1\_QD\_PHB.

enumerator kSWM\_FTM\_NUM\_FUNCS  
Flextimer function function number.

enum \_swm\_select\_flextimer\_pin\_sel\_t  
SWM flextimer pin selection.

*Values:*

enumerator kSWM\_FTM\_Selection0  
Flextimer pin selection0.



## 2.31 SYSCON: System Configuration

enum `_syscon_connection_t`

SYSCON connections type.

*Values:*

enumerator `kSYSCON_GpioPort0Pin0ToPintsel`

Pin Interrupt.

enumerator `kSYSCON_GpioPort0Pin1ToPintsel`

enumerator `kSYSCON_GpioPort0Pin2ToPintsel`

enumerator `kSYSCON_GpioPort0Pin3ToPintsel`

enumerator `kSYSCON_GpioPort0Pin4ToPintsel`

enumerator `kSYSCON_GpioPort0Pin5ToPintsel`

enumerator `kSYSCON_GpioPort0Pin6ToPintsel`

enumerator `kSYSCON_GpioPort0Pin7ToPintsel`

enumerator `kSYSCON_GpioPort0Pin8ToPintsel`

enumerator `kSYSCON_GpioPort0Pin9ToPintsel`

enumerator `kSYSCON_GpioPort0Pin10ToPintsel`

enumerator `kSYSCON_GpioPort0Pin11ToPintsel`

enumerator `kSYSCON_GpioPort0Pin12ToPintsel`

enumerator `kSYSCON_GpioPort0Pin13ToPintsel`

enumerator `kSYSCON_GpioPort0Pin14ToPintsel`

enumerator `kSYSCON_GpioPort0Pin15ToPintsel`

enumerator `kSYSCON_GpioPort0Pin16ToPintsel`

enumerator `kSYSCON_GpioPort0Pin17ToPintsel`

enumerator `kSYSCON_GpioPort0Pin18ToPintsel`

enumerator `kSYSCON_GpioPort0Pin19ToPintsel`

enumerator `kSYSCON_GpioPort0Pin20ToPintsel`

enumerator `kSYSCON_GpioPort0Pin21ToPintsel`

enumerator `kSYSCON_GpioPort0Pin22ToPintsel`

enumerator `kSYSCON_GpioPort0Pin23ToPintsel`

enumerator `kSYSCON_GpioPort0Pin24ToPintsel`

enumerator `kSYSCON_GpioPort0Pin25ToPintsel`

enumerator `kSYSCON_GpioPort0Pin26ToPintsel`

enumerator `kSYSCON_GpioPort0Pin27ToPintsel`

enumerator `kSYSCON_GpioPort0Pin28ToPintsel`

enumerator kSYSCON\_GpioPort0Pin29ToPintsel  
enumerator kSYSCON\_GpioPort0Pin30ToPintsel  
enumerator kSYSCON\_GpioPort0Pin31ToPintsel  
enumerator kSYSCON\_GpioPort1Pin0ToPintsel  
enumerator kSYSCON\_GpioPort1Pin1ToPintsel  
enumerator kSYSCON\_GpioPort1Pin2ToPintsel  
enumerator kSYSCON\_GpioPort1Pin3ToPintsel  
enumerator kSYSCON\_GpioPort1Pin4ToPintsel  
enumerator kSYSCON\_GpioPort1Pin5ToPintsel  
enumerator kSYSCON\_GpioPort1Pin6ToPintsel  
enumerator kSYSCON\_GpioPort1Pin7ToPintsel  
enumerator kSYSCON\_GpioPort1Pin8ToPintsel  
enumerator kSYSCON\_GpioPort1Pin9ToPintsel  
enumerator kSYSCON\_GpioPort1Pin10ToPintsel  
enumerator kSYSCON\_GpioPort1Pin11ToPintsel  
enumerator kSYSCON\_GpioPort1Pin12ToPintsel  
enumerator kSYSCON\_GpioPort1Pin13ToPintsel  
enumerator kSYSCON\_GpioPort1Pin14ToPintsel  
enumerator kSYSCON\_GpioPort1Pin15ToPintsel  
enumerator kSYSCON\_GpioPort1Pin16ToPintsel  
enumerator kSYSCON\_GpioPort1Pin17ToPintsel  
enumerator kSYSCON\_GpioPort1Pin18ToPintsel  
enumerator kSYSCON\_GpioPort1Pin19ToPintsel  
enumerator kSYSCON\_GpioPort1Pin20ToPintsel  
enumerator kSYSCON\_GpioPort1Pin21ToPintsel  
enumerator kSYSCON\_GpioPort1Pin22ToPintsel  
enumerator kSYSCON\_GpioPort1Pin23ToPintsel  
enumerator kSYSCON\_GpioPort1Pin24ToPintsel  
enumerator kSYSCON\_GpioPort1Pin25ToPintsel  
enumerator kSYSCON\_GpioPort1Pin26ToPintsel  
enumerator kSYSCON\_GpioPort1Pin27ToPintsel  
enumerator kSYSCON\_GpioPort1Pin28ToPintsel  
enumerator kSYSCON\_GpioPort1Pin29ToPintsel



enumerator kSYSCON\_GpioPort1Pin30ToPintsel

enumerator kSYSCON\_GpioPort1Pin31ToPintsel

typedef enum *syscon\_connection\_t* syscon\_connection\_t  
SYSCON connections type.

PINTSEL\_ID

Periphinmux IDs.

SYSCON\_SHIFT

FSL\_SYSCON\_DRIVER\_VERSION

Group syscon driver version for SDK.

Version 2.0.1.

void SYSCON\_AttachSignal(SYSCON\_Type \*base, uint32\_t index, *syscon\_connection\_t* connection)

Attaches a signal.

This function gates the SYSCON clock.

#### Parameters

- base – Base address of the SYSCON peripheral.
- index – Destination peripheral to attach the signal to.
- connection – Selects connection.

#### Return values

None. –

## 2.32 USART: Universal Asynchronous Receiver/Transmitter Driver

### 2.33 USART Driver

uint32\_t USART\_GetInstance(USART\_Type \*base)

Returns instance number for USART peripheral base address.

*status\_t* USART\_Init(USART\_Type \*base, const *usart\_config\_t* \*config, uint32\_t srcClock\_Hz)

Initializes a USART instance with user configuration structure and peripheral clock.

This function configures the USART module with the user-defined settings. The user can configure the configuration structure and also get the default configuration by using the USART\_GetDefaultConfig() function. Example below shows how to use this API to configure USART.

```
usart_config_t usartConfig;
usartConfig.baudRate_Bps = 115200U;
usartConfig.parityMode = kUSART_ParityDisabled;
usartConfig.stopBitCount = kUSART_OneStopBit;
USART_Init(USART1, &usartConfig, 20000000U);
```

#### Parameters

- base – USART peripheral base address.
- config – Pointer to user-defined configuration structure.

- `srcClock_Hz` – USART clock source frequency in HZ.

#### Return values

- `kStatus_USART_BaudrateNotSupport` – Baudrate is not support in current clock source.
- `kStatus_InvalidArgument` – USART base address is not valid
- `kStatus_Success` – Status USART initialize succeed

`void USART_Deinit(USART_Type *base)`

Deinitializes a USART instance.

This function waits for TX complete, disables the USART clock.

#### Parameters

- `base` – USART peripheral base address.

`void USART_GetDefaultConfig(usart_config_t *config)`

Gets the default configuration structure.

This function initializes the USART configuration structure to a default value. The default values are: `usartConfig->baudRate_Bps = 9600U`; `usartConfig->parityMode = kUSART_ParityDisabled`; `usartConfig->stopBitCount = kUSART_OneStopBit`; `usartConfig->bitCountPerChar = kUSART_8BitsPerChar`; `usartConfig->loopback = false`; `usartConfig->enableTx = false`; `usartConfig->enableRx = false`; ...

#### Parameters

- `config` – Pointer to configuration structure.

`status_t USART_SetBaudRate(USART_Type *base, uint32_t baudrate_Bps, uint32_t srcClock_Hz)`

Sets the USART instance baud rate.

This function configures the USART module baud rate. This function is used to update the USART module baud rate after the USART module is initialized by the `USART_Init`.

```
USART_SetBaudRate(USART1, 115200U, 20000000U);
```

#### Parameters

- `base` – USART peripheral base address.
- `baudrate_Bps` – USART baudrate to be set.
- `srcClock_Hz` – USART clock source frequency in HZ.

#### Return values

- `kStatus_USART_BaudrateNotSupport` – Baudrate is not support in current clock source.
- `kStatus_Success` – Set baudrate succeed.
- `kStatus_InvalidArgument` – One or more arguments are invalid.

`static inline uint32_t USART_GetStatusFlags(USART_Type *base)`

Get USART status flags.

This function get all USART status flags, the flags are returned as the logical OR value of the enumerators `_usart_flags`. To check a specific status, compare the return value with enumerators in `_usart_flags`. For example, to check whether the RX is ready:

```
if (kUSART_RxReady & USART_GetStatusFlags(USART1))
{
    ...
}
```

**Parameters**

- base – USART peripheral base address.

**Returns**

USART status flags which are ORed by the enumerators in the `_usart_flags`.

```
static inline void USART_ClearStatusFlags(USART_Type *base, uint32_t mask)
```

Clear USART status flags.

This function clear supported USART status flags For example:

```
USART_ClearStatusFlags(USART1, kUSART_HardwareOverrunFlag)
```

**Parameters**

- base – USART peripheral base address.
- mask – status flags to be cleared.

```
static inline void USART_EnableInterrupts(USART_Type *base, uint32_t mask)
```

Enables USART interrupts according to the provided mask.

This function enables the USART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See `_usart_interrupt_enable`. For example, to enable TX ready interrupt and RX ready interrupt:

```
USART_EnableInterrupts(USART1, kUSART_RxReadyInterruptEnable | kUSART_
↳ TxReadyInterruptEnable);
```

**Parameters**

- base – USART peripheral base address.
- mask – The interrupts to enable. Logical OR of `_usart_interrupt_enable`.

```
static inline void USART_DisableInterrupts(USART_Type *base, uint32_t mask)
```

Disables USART interrupts according to a provided mask.

This function disables the USART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See `_usart_interrupt_enable`. This example shows how to disable the TX ready interrupt and RX ready interrupt:

```
USART_DisableInterrupts(USART1, kUSART_TxReadyInterruptEnable | kUSART_
↳ RxReadyInterruptEnable);
```

**Parameters**

- base – USART peripheral base address.
- mask – The interrupts to disable. Logical OR of `_usart_interrupt_enable`.

```
static inline void USART_SetRxIdleTimeout(USART_Type *base, uint8_t rxIdleTimeout)
```

Config the USART instance rx idle timeout.

This function configures the number idle character of USART rx idle. For 115200,8n1, 1 character timing is 86.81uS = 1/ (115200/(1start+8data+0parity+1stop))

```
USART_SetRxIdleTimeout(USART1, 1);
```

**Parameters**

- base – USART peripheral base address.
- rxIdleTimeout – The configuration of UART rx idle .

```
static inline uint32_t USART__GetEnabledInterrupts(USART_Type *base)
```

Returns enabled USART interrupts.

This function returns the enabled USART interrupts.

#### Parameters

- base – USART peripheral base address.

```
static inline void USART__EnableContinuousSCLK(USART_Type *base, bool enable)
```

Continuous Clock generation. By default, SCLK is only output while data is being transmitted in synchronous mode. Enable this function, SCLK will run continuously in synchronous mode, allowing characters to be received on Un\_RxD independently from transmission on Un\_TXD).

#### Parameters

- base – USART peripheral base address.
- enable – Enable Continuous Clock generation mode or not, true for enable and false for disable.

```
static inline void USART__EnableAutoClearSCLK(USART_Type *base, bool enable)
```

Enable Continuous Clock generation bit auto clear. While enable this function, the Continuous Clock bit is automatically cleared when a complete character has been received. This bit is cleared at the same time.

#### Parameters

- base – USART peripheral base address.
- enable – Enable auto clear or not, true for enable and false for disable.

```
static inline void USART__EnableCTS(USART_Type *base, bool enable)
```

Enable CTS. This function will determine whether CTS is used for flow control.

#### Parameters

- base – USART peripheral base address.
- enable – Enable CTS or not, true for enable and false for disable.

```
static inline void USART__EnableTx(USART_Type *base, bool enable)
```

Enable the USART transmit.

This function will enable or disable the USART transmit.

#### Parameters

- base – USART peripheral base address.
- enable – true for enable and false for disable.

```
static inline void USART__EnableRx(USART_Type *base, bool enable)
```

Enable the USART receive.

This function will enable or disable the USART receive. Note: if the transmit is enabled, the receive will not be disabled.

#### Parameters

- base – USART peripheral base address.
- enable – true for enable and false for disable.

```
static inline void USART__WriteByte(USART_Type *base, uint8_t data)
```

Writes to the TXDAT register.

This function will write data to the TXDAT automatically. The upper layer must ensure that TXDATA has space for data to write before calling this function.

**Parameters**

- base – USART peripheral base address.
- data – The byte to write.

`static inline uint8_t USART_ReadByte(USART_Type *base)`

Reads the RXDAT directly.

This function reads data from the RXDAT automatically. The upper layer must ensure that the RXDAT is not empty before calling this function.

**Parameters**

- base – USART peripheral base address.

**Returns**

The byte read from USART data register.

`status_t USART_WriteBlocking(USART_Type *base, const uint8_t *data, size_t length)`

Writes to the TX register using a blocking method.

This function polls the TX register, waits for the TX register to be empty.

**Parameters**

- base – USART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

**Return values**

- `kStatus_USART_Timeout` – Transmission timed out and was aborted.
- `kStatus_Success` – Successfully wrote all data.

`status_t USART_ReadBlocking(USART_Type *base, uint8_t *data, size_t length)`

Read RX data register using a blocking method.

This function polls the RX register, waits for the RX register to be full.

**Parameters**

- base – USART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

**Return values**

- `kStatus_USART_FramingError` – Receiver overrun happened while receiving data.
- `kStatus_USART_ParityError` – Noise error happened while receiving data.
- `kStatus_USART_NoiseError` – Framing error happened while receiving data.
- `kStatus_USART_RxError` – Overflow or underflow happened.
- `kStatus_USART_Timeout` – Transmission timed out and was aborted.
- `kStatus_Success` – Successfully received all data.

`status_t USART_TransferCreateHandle(USART_Type *base, usart_handle_t *handle, usart_transfer_callback_t callback, void *userData)`

Initializes the USART handle.

This function initializes the USART handle which can be used for other USART transactional APIs. Usually, for a specified USART instance, call this API once to get the initialized handle.

### Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

*status\_t* USART\_TransferSendNonBlocking(USART\_Type \*base, *usart\_handle\_t* \*handle, *usart\_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 the IRQ handler, the USART driver calls the callback function and passes the `kStatus_USART_TxIdle` as status parameter.

---

**Note:** The `kStatus_USART_TxIdle` is passed to the upper layer when all data is written to the TX register. However it does not ensure that all data are sent out. Before disabling the TX, check the `kUSART_TransmissionCompleteFlag` to ensure that the TX is finished.

---

### Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- xfer – USART transfer structure. See `usart_transfer_t`.

### Return values

- `kStatus_Success` – Successfully start the data transmission.
- `kStatus_USART_TxBusy` – Previous transmission still not finished, data not all written to TX register yet.
- `kStatus_InvalidArgument` – Invalid argument.

*void* USART\_TransferStartRingBuffer(USART\_Type \*base, *usart\_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 USART handle.

When the RX ring buffer is used, data received are stored into the ring buffer even when the user doesn't call the `USART_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 the 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 – USART peripheral base address.
- handle – USART handle pointer.
- ringBuffer – Start address of the ring buffer for background receiving. Pass `NULL` to disable the ring buffer.
- ringBufferSize – size of the ring buffer.

`void USART_TransferStopRingBuffer(USART_Type *base, usart_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` – USART peripheral base address.
- `handle` – USART handle pointer.

`size_t USART_TransferGetRxRingBufferLength(usart_handle_t *handle)`

Get the length of received data in RX ring buffer.

#### Parameters

- `handle` – USART handle pointer.

#### Returns

Length of received data in RX ring buffer.

`void USART_TransferAbortSend(USART_Type *base, usart_handle_t *handle)`

Aborts the interrupt-driven data transmit.

This function aborts the interrupt driven data sending. The user can get the remainBytes to find out how many bytes are still not sent out.

#### Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.

`status_t USART_TransferGetSendCount(USART_Type *base, usart_handle_t *handle, uint32_t *count)`

Get the number of bytes that have been written to USART TX register.

This function gets the number of bytes that have been written to USART TX register by interrupt method.

#### Parameters

- `base` – USART peripheral base address.
- `handle` – USART 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 USART_TransferReceiveNonBlocking(USART_Type *base, usart_handle_t *handle, usart_transfer_t *xfer, size_t *receivedBytes)`

Receives a buffer of data using an interrupt method.

This function receives data using an 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 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 to read, the receive request is saved by the USART driver. When the new data arrives, the receive request is serviced first. When all data is received, the USART driver notifies the upper layer through a callback function and passes the status parameter `kStatus_USART_RxIdle`. For example, the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer. The 5 bytes are copied to the `xfer->data` and this function returns

with the parameter `receivedBytes` set to 5. For the left 5 bytes, newly arrived data is saved from the `xfer->data[5]`. When 5 bytes are received, the USART 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 the `xfer->data`. When all data is received, the upper layer is notified.

#### Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.
- `xfer` – USART transfer structure, see `usart_transfer_t`.
- `receivedBytes` – Bytes received from the ring buffer directly.

#### Return values

- `kStatus__Success` – Successfully queue the transfer into transmit queue.
- `kStatus__USART__RxBusy` – Previous receive request is not finished.
- `kStatus__InvalidArgument` – Invalid argument.

`void USART__TransferAbortReceive(USART_Type *base, usart_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` – USART peripheral base address.
- `handle` – USART handle pointer.

`status_t USART__TransferGetReceiveCount(USART_Type *base, usart_handle_t *handle, uint32_t *count)`

Get the number of bytes that have been received.

This function gets the number of bytes that have been received.

#### Parameters

- `base` – USART peripheral base address.
- `handle` – USART 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 USART__TransferHandleIRQ(USART_Type *base, usart_handle_t *handle)`

USART IRQ handle function.

This function handles the USART transmit and receive IRQ request.

#### Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.

`FSL_USART_DRIVER_VERSION`

USART driver version.



Error codes for the USART driver.

*Values:*

enumerator kStatus\_USART\_TxBusy  
Transmitter is busy.

enumerator kStatus\_USART\_RxBusy  
Receiver is busy.

enumerator kStatus\_USART\_TxIdle  
USART transmitter is idle.

enumerator kStatus\_USART\_RxIdle  
USART receiver is idle.

enumerator kStatus\_USART\_TxError  
Error happens on tx.

enumerator kStatus\_USART\_RxError  
Error happens on rx.

enumerator kStatus\_USART\_RxRingBufferOverrun  
Error happens on rx ring buffer

enumerator kStatus\_USART\_NoiseError  
USART noise error.

enumerator kStatus\_USART\_FramingError  
USART framing error.

enumerator kStatus\_USART\_ParityError  
USART parity error.

enumerator kStatus\_USART\_HardwareOverrun  
USART hardware over flow.

enumerator kStatus\_USART\_BaudrateNotSupport  
Baudrate is not support in current clock source

enumerator kStatus\_USART\_Timeout  
USART times out.

enumerator kStatus\_USART\_RxIdleTimeout  
USART receive idle times out.

enum \_usart\_parity\_mode  
USART parity mode.

*Values:*

enumerator kUSART\_ParityDisabled  
Parity disabled

enumerator kUSART\_ParityEven  
Parity enabled, type even, bit setting: PARITYSEL = 10

enumerator kUSART\_ParityOdd  
Parity enabled, type odd, bit setting: PARITYSEL = 11

enum \_usart\_sync\_mode  
USART synchronous mode.

*Values:*

enumerator kUSART\_SyncModeDisabled

Asynchronous mode.

enumerator kUSART\_SyncModeSlave

Synchronous slave mode.

enumerator kUSART\_SyncModeMaster

Synchronous master mode.

enum \_\_usart\_stop\_bit\_count

USART stop bit count.

*Values:*

enumerator kUSART\_OneStopBit

One stop bit

enumerator kUSART\_TwoStopBit

Two stop bits

enum \_\_usart\_data\_len

USART data size.

*Values:*

enumerator kUSART\_7BitsPerChar

Seven bit mode

enumerator kUSART\_8BitsPerChar

Eight bit mode

enum \_\_usart\_clock\_polarity

USART clock polarity configuration, used in sync mode.

*Values:*

enumerator kUSART\_RxSampleOnFallingEdge

Un\_RXD is sampled on the falling edge of SCLK.

enumerator kUSART\_RxSampleOnRisingEdge

Un\_RXD is sampled on the rising edge of SCLK.

enum \_\_usart\_interrupt\_enable

USART interrupt configuration structure, default settings all disabled.

*Values:*

enumerator kUSART\_RxReadyInterruptEnable

Receive ready interrupt.

enumerator kUSART\_TxReadyInterruptEnable

Transmit ready interrupt.

enumerator kUSART\_TxIdleInterruptEnable

Transmit idle interrupt.

enumerator kUSART\_DeltaCtsInterruptEnable

Cts pin change interrupt.

enumerator kUSART\_TxDisableInterruptEnable

Transmit disable interrupt.

enumerator kUSART\_HardwareOverRunInterruptEnable

hardware ove run interrupt.

enumerator kUSART\_RxBreakInterruptEnable  
Receive break interrupt.

enumerator kUSART\_RxStartInterruptEnable  
Receive ready interrupt.

enumerator kUSART\_FramErrorInterruptEnable  
Receive start interrupt.

enumerator kUSART\_ParityErrorInterruptEnable  
Receive frame error interrupt.

enumerator kUSART\_RxNoiseInterruptEnable  
Receive noise error interrupt.

enumerator kUSART\_RxIdleTimeoutInterruptEnable  
Receive idle timeout interrupt.

enumerator kUSART\_AutoBaudErrorInterruptEnable  
Receive auto baud error interrupt.

enumerator kUSART\_AllInterruptEnable  
All interrupt.

enum \_usart\_flags

USART status flags.

This provides constants for the USART status flags for use in the USART functions.

*Values:*

enumerator kUSART\_RxReady  
Receive ready flag.

enumerator kUSART\_RxIdleFlag  
Receive IDLE flag.

enumerator kUSART\_TxReady  
Transmit ready flag.

enumerator kUSART\_TxIdleFlag  
Transmit idle flag.

enumerator kUSART\_CtsState  
Cts pin status.

enumerator kUSART\_DeltaCtsFlag  
Cts pin change flag.

enumerator kUSART\_TxDisableFlag  
Transmit disable flag.

enumerator kUSART\_HardwareOverrunFlag  
Hardware over run flag.

enumerator kUSART\_RxBreakFlag  
Receive break flag.

enumerator kUSART\_RxStartFlag  
receive start flag.

enumerator kUSART\_FramErrorFlag  
Frame error flag.

enumerator `kUSART_ParityErrorFlag`  
Parity error flag.

enumerator `kUSART_RxNoiseFlag`  
Receive noise flag.

enumerator `kUSART_AutoBaudErrorFlag`  
Auto baud error flag.

enumerator `kUSART_RxIdleTimeoutFlag`  
Receive idle timeout flag.

typedef enum `_usart_parity_mode` `usart_parity_mode_t`  
USART parity mode.

typedef enum `_usart_sync_mode` `usart_sync_mode_t`  
USART synchronous mode.

typedef enum `_usart_stop_bit_count` `usart_stop_bit_count_t`  
USART stop bit count.

typedef enum `_usart_data_len` `usart_data_len_t`  
USART data size.

typedef enum `_usart_clock_polarity` `usart_clock_polarity_t`  
USART clock polarity configuration, used in sync mode.

typedef struct `_usart_config` `usart_config_t`  
USART configuration structure.

typedef struct `_usart_transfer` `usart_transfer_t`  
USART transfer structure.

typedef struct `_usart_handle` `usart_handle_t`

typedef void (\*`usart_transfer_callback_t`)(`USART_Type` \*`base`, `usart_handle_t` \*`handle`, `status_t` `status`, void \*`userData`)  
USART transfer callback function.

`FSL_SDK_ENABLE_USART_DRIVER_TRANSACTIONAL_APIS`  
Macro gate for enable transaction API. 1 for enable, 0 for disable.

`FSL_SDK_USART_DRIVER_ENABLE_BAUDRATE_AUTO_GENERATE`  
USART baud rate auto generate switch gate. 1 for enable, 0 for disable.

`UART_RETRY_TIMES`  
Retry times for waiting flag.  
Defining to zero means to keep waiting for the flag until it is assert/deassert.

struct `_usart_config`  
`#include <fsl_usart.h>` USART configuration structure.

### Public Members

uint32\_t `baudRate_Bps`  
USART baud rate

bool `enableRx`  
USART receive enable.

`bool enableTx`

USART transmit enable.

`bool loopback`

Enable peripheral loopback

`bool enableContinuousSCLK`

USART continuous Clock generation enable in synchronous master mode.

`bool enableHardwareFlowControl`

Enable hardware control RTS/CTS

`usart_parity_mode_t parityMode`

Parity mode, disabled (default), even, odd

`usart_stop_bit_count_t stopBitCount`

Number of stop bits, 1 stop bit (default) or 2 stop bits

`usart_data_len_t bitCountPerChar`

Data length - 7 bit, 8 bit

`usart_sync_mode_t syncMode`

Transfer mode - asynchronous, synchronous master, synchronous slave.

`usart_clock_polarity_t clockPolarity`

Selects the clock polarity and sampling edge in sync mode.

`uint8_t rxIdleTimeout`

Receive idle bytes. Value [0,7]. Set the value to n then the idle byte count will be the (n)th power of 2.

`struct __usart_transfer`

*#include <fsl\_usart.h>* USART transfer structure.

### Public Members

`size_t dataSize`

The byte count to be transfer.

`struct __usart_handle`

*#include <fsl\_usart.h>* USART 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.

`size_t txDataSizeAll`

Size of the data to send out.

`uint8_t *volatile rxData`

Address of remaining data to receive.

`volatile size_t rxDataSize`

Size of the remaining data to receive.

`size_t rxDataSizeAll`  
Size of the data to receive.

`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.

`usart_transfer_callback_t callback`  
Callback function.

`void *userData`  
USART callback function parameter.

`volatile uint8_t txState`  
TX transfer state.

`volatile uint8_t rxState`  
RX transfer state

`union __unnamed12__`

### 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.

## 2.34 WKT: Self-wake-up Timer

`void WKT_Init(WKT_Type *base, const wkt_config_t *config)`  
Ungates the WKT clock and configures the peripheral for basic operation.

---

**Note:** This API should be called at the beginning of the application using the WKT driver.

---

### Parameters

- `base` – WKT peripheral base address
- `config` – Pointer to user's WKT config structure.

`void WKT_Deinit(WKT_Type *base)`  
Gate the WKT clock.

### Parameters

- `base` – WKT peripheral base address

static inline void WKT\_GetDefaultConfig(*wkt\_config\_t* \*config)

Initializes the WKT configuration structure.

This function initializes the WKT configuration structure to default values. The default values are as follows.

```
config->clockSource = kWKT_DividedFROClockSource;
```

**See also:**

*wkt\_config\_t*

**Parameters**

- config – Pointer to the WKT configuration structure.

static inline uint32\_t WKT\_GetCounterValue(WKT\_Type \*base)

Read actual WKT counter value.

**Parameters**

- base – WKT peripheral base address

static inline uint32\_t WKT\_GetStatusFlags(WKT\_Type \*base)

Gets the WKT status flags.

**Parameters**

- base – WKT peripheral base address

**Returns**

The status flags. This is the logical OR of members of the enumeration *wkt\_status\_flags\_t*

static inline void WKT\_ClearStatusFlags(WKT\_Type \*base, uint32\_t mask)

Clears the WKT status flags.

**Parameters**

- base – WKT peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration *wkt\_status\_flags\_t*

static inline void WKT\_StartTimer(WKT\_Type \*base, uint32\_t count)

Starts the timer counting.

After calling this function, timer loads a count value, counts down to 0, then stops.

---

**Note:** User can call the utility macros provided in *fsl\_common.h* to convert to ticks Do not write to Counter register while the counting is in progress

---

**Parameters**

- base – WKT peripheral base address.
- count – The value to be loaded into the WKT Count register

static inline void WKT\_StopTimer(WKT\_Type \*base)

Stops the timer counting.

This function Clears the counter and stops the timer from counting.

**Parameters**

- base – WKT peripheral base address

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enum \_\_wkt\_clock\_source

Describes WKT clock source.

*Values:*

enumerator kWKT\_DividedFROClockSource

WKT clock sourced from the divided FRO clock

enumerator kWKT\_LowPowerClockSource

WKT clock sourced from the Low power clock Use this clock, LPOSCEN bit of DPDCTRL register must be enabled

enumerator kWKT\_ExternalClockSource

WKT clock sourced from the Low power clock Use this clock, WAKECLKPAD\_DISABLE bit of DPDCTRL register must be enabled

enum \_\_wkt\_status\_flags

List of WKT flags.

*Values:*

enumerator kWKT\_AlarmFlag

Alarm flag

typedef enum \_\_wkt\_clock\_source wkt\_clock\_source\_t

Describes WKT clock source.

typedef struct \_\_wkt\_config wkt\_config\_t

Describes WKT configuration structure.

typedef enum \_\_wkt\_status\_flags wkt\_status\_flags\_t

List of WKT flags.

struct \_\_wkt\_config

*#include <fsl\_wkt.h>* Describes WKT configuration structure.

### Public Members

*wkt\_clock\_source\_t* clockSource

External or internal clock source select

## 2.35 WWDT: Windowed Watchdog Timer Driver

void WWDT\_GetDefaultConfig(*wwdt\_config\_t* \*config)

Initializes WWDT configure structure.

This function initializes the WWDT configure structure to default value. The default value are:

```
config->enableWwdt = true;
config->enableWatchdogReset = false;
config->enableWatchdogProtect = false;
config->enableLockOscillator = false;
config->windowValue = 0xFFFFFU;
```

(continues on next page)



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```
config->timeoutValue = 0xFFFFFU;
config->warningValue = 0;
```

**See also:**

wwdt\_config\_t

**Parameters**

- config – Pointer to WWDT config structure.

```
void WWDT_Init(WWDT_Type *base, const wwdt_config_t *config)
```

Initializes the WWDT.

This function initializes the WWDT. When called, the WWDT runs according to the configuration.

Example:

```
wwdt_config_t config;
WWDT_GetDefaultConfig(&config);
config.timeoutValue = 0x7ffU;
WWDT_Init(wwdt_base,&config);
```

**Parameters**

- base – WWDT peripheral base address
- config – The configuration of WWDT

```
void WWDT_Deinit(WWDT_Type *base)
```

Shuts down the WWDT.

This function shuts down the WWDT.

**Parameters**

- base – WWDT peripheral base address

```
static inline void WWDT_Enable(WWDT_Type *base)
```

Enables the WWDT module.

This function write value into WWDT\_MOD register to enable the WWDT, it is a write-once bit; once this bit is set to one and a watchdog feed is performed, the watchdog timer will run permanently.

**Parameters**

- base – WWDT peripheral base address

```
static inline void WWDT_Disable(WWDT_Type *base)
```

Disables the WWDT module.

*Deprecated:*

Do not use this function. It will be deleted in next release version, for once the bit field of WDEN written with a 1, it can not be re-written with a 0.

This function write value into WWDT\_MOD register to disable the WWDT.

**Parameters**

- base – WWDT peripheral base address

```
static inline uint32_t WWDT_GetStatusFlags(WWDT_Type *base)
```

Gets all WWDT status flags.

This function gets all status flags.

Example for getting Timeout Flag:

```
uint32_t status;  
status = WWDT_GetStatusFlags(wwdt_base) & kWWDT_TimeoutFlag;
```

#### Parameters

- base – WWDT peripheral base address

#### Returns

The status flags. This is the logical OR of members of the enumeration `_wwdt_status_flags_t`

```
void WWDT_ClearStatusFlags(WWDT_Type *base, uint32_t mask)
```

Clear WWDT flag.

This function clears WWDT status flag.

Example for clearing warning flag:

```
WWDT_ClearStatusFlags(wwdt_base, kWWDT_WarningFlag);
```

#### Parameters

- base – WWDT peripheral base address
- mask – The status flags to clear. This is a logical OR of members of the enumeration `_wwdt_status_flags_t`

```
static inline void WWDT_SetWarningValue(WWDT_Type *base, uint32_t warningValue)
```

Set the WWDT warning value.

The WDWARNINT register determines the watchdog timer counter value that will generate a watchdog interrupt. When the watchdog timer counter is no longer greater than the value defined by WARNINT, an interrupt will be generated after the subsequent WDCLK.

#### Parameters

- base – WWDT peripheral base address
- warningValue – WWDT warning value.

```
static inline void WWDT_SetTimeoutValue(WWDT_Type *base, uint32_t timeoutCount)
```

Set the WWDT timeout value.

This function sets the timeout value. Every time a feed sequence occurs the value in the TC register is loaded into the Watchdog timer. Writing a value below 0xFF will cause 0xFF to be loaded into the TC register. Thus the minimum time-out interval is  $TWDCLK * 256 * 4$ . If `enableWatchdogProtect` flag is true in `wwdt_config_t` config structure, any attempt to change the timeout value before the watchdog counter is below the warning and window values will cause a watchdog reset and set the WDTOF flag.

#### Parameters

- base – WWDT peripheral base address
- timeoutCount – WWDT timeout value, count of WWDT clock tick.

static inline void WWDT\_SetWindowValue(WWDT\_Type \*base, uint32\_t windowValue)

Sets the WWDT window value.

The WINDOW register determines the highest TV value allowed when a watchdog feed is performed. If a feed sequence occurs when timer value is greater than the value in WINDOW, a watchdog event will occur. To disable windowing, set windowValue to 0xFFFFF (maximum possible timer value) so windowing is not in effect.

#### Parameters

- base – WWDT peripheral base address
- windowValue – WWDT window value.

void WWDT\_Refresh(WWDT\_Type \*base)

Refreshes the WWDT timer.

This function feeds the WWDT. This function should be called before WWDT timer is in timeout. Otherwise, a reset is asserted.

#### Parameters

- base – WWDT peripheral base address

FSL\_WWDT\_DRIVER\_VERSION

Defines WWDT driver version.

WWDT\_FIRST\_WORD\_OF\_REFRESH

First word of refresh sequence

WWDT\_SECOND\_WORD\_OF\_REFRESH

Second word of refresh sequence

enum \_wwdt\_status\_flags\_t

WWDT status flags.

This structure contains the WWDT status flags for use in the WWDT functions.

*Values:*

enumerator kWWDT\_TimeoutFlag

Time-out flag, set when the timer times out

enumerator kWWDT\_WarningFlag

Warning interrupt flag, set when timer is below the value WDWARNINT

typedef struct \_wwdt\_config wwdt\_config\_t

Describes WWDT configuration structure.

struct \_wwdt\_config

*#include <fsl\_wwdt.h>* Describes WWDT configuration structure.

#### Public Members

bool enableWwdt

Enables or disables WWDT

bool enableWatchdogReset

true: Watchdog timeout will cause a chip reset false: Watchdog timeout will not cause a chip reset

bool enableWatchdogProtect

true: Enable watchdog protect i.e timeout value can only be changed after counter is below warning & window values false: Disable watchdog protect; timeout value can be changed at any time

bool enableLockOscillator

true: Disabling or powering down the watchdog oscillator is prevented Once set, this bit can only be cleared by a reset false: Do not lock oscillator

uint32\_t windowValue

Window value, set this to 0xFFFFFFFF if windowing is not in effect

uint32\_t timeoutValue

Timeout value

uint32\_t warningValue

Watchdog time counter value that will generate a warning interrupt. Set this to 0 for no warning

uint32\_t clockFreq\_Hz

Watchdog clock source frequency.

# Chapter 3

## Middleware

### 3.1 Motor Control

#### 3.1.1 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 applications** 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\_QUEUE\_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-language 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_UINTn	Unsigned integer type of size <i>n</i> bits (n=8,16,32,64)
FMSTR_TSA_SINTn	Signed integer type of size <i>n</i> bits (n=8,16,32,64)
FMSTR_TSA_FRACn	Fractional number of size <i>n</i> bits (n=16,32,64).
FMSTR_TSA_FRAC_Q( <i>m,n</i> )	Signed fractional number in general Q form (m+n+1 total bits)
FMSTR_TSA_FRAC_UQ( <i>m,n</i> )	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)
FM-STR_TSA_USERTYPE( <i>name</i> )	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 *fmrstr:* 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 */
```

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```

/* 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")

/* 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
<i>FM-STR_ADDR</i> 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.	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.
<i>FM-STR_SIZE</i> It is required that this type is unsigned and at least 16 bits wide integer.	Data type used to hold the memory block size.
<i>FM-STR_BOOL</i> This type is used only in zero/non-zero conditions in the driver code.	Data type used as a general boolean type.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to hold the Application Command code.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to create the Application Command data buffer.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to hold the Application Command result code.

**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.

<i>FM-STR_TSA_TII</i>	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 <i>FM-STR_SIZE</i> .
<i>FM-STR_TSA_TS</i>	Data type used to hold a memory block size, as used in the TSA descriptors. By default, this is defined as <i>FM-STR_SIZE</i> .

**Public Pipes types** The table describes the data types used by the FreeMASTER Pipes API:

<i>FM-STR_HPIPE</i>	Pipe handle that identifies the open-pipe object. Generally, this is a pointer to a void type.
<i>FM-STR_PIPE_PC</i>	Integer type required to hold at least 7 bits of data. Generally, this is an unsigned 8-bit or 16-bit type.
<i>FM-STR_PIPE_SI</i>	Integer type required to hold at least 16 bits of data. This is used to store the data buffer sizes.
<i>FM-STR_PPIPEF</i>	Pointer to the pipe handler function. See <a href="#">FM-STR_PipeOpen</a> 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.

<i>FMSTR_U8</i>	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.	
<i>FMSTR_U16</i>	Unsigned 16-bit integer.
<i>FMSTR_U32</i>	Unsigned 32-bit integer.
<i>FMSTR_S8</i>	Signed 8-bit integer.
<i>FMSTR_S16</i>	Signed 16-bit integer.
<i>FMSTR_S32</i>	Signed 32-bit integer.
<i>FMSTR_FLOAT</i>	4-byte standard IEEE floating-point type.
<i>FMSTR_FLAGS</i>	Data type forming a union with a structure of flag bit-fields.
<i>FMSTR_SIZE8</i>	Data type holding a general size value, at least 8 bits wide.
<i>FMSTR_INDEX</i>	General for-loop index. Must be signed, at least 16 bits wide.
<i>FMSTR_BCHR</i>	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.	
<i>FMSTR_BPTR</i>	A pointer to the communication buffer (an array of <i>FMSTR_BCHR</i> ).

## 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](http://www.nxp.com/freemaster)
- FreeMASTER community area: [community.nxp.com/community/freemaster](http://community.nxp.com/community/freemaster)
- FreeMASTER GitHub code repo: <https://github.com/nxp-mcuxpresso/mcux-freemaster>
- MCUXpresso SDK home: [www.nxp.com/mcuxpresso](http://www.nxp.com/mcuxpresso)
- MCUXpresso SDK builder: [mcuxpresso.nxp.com/en](http://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.

# 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**

**Overview** The purpose of this document is to describes the [FreeRTOS kernel repo](#) integration into the [NXP MCUXpresso Software Development Kit: mcuxsdk](#). MCUXpresso SDK provides a comprehensive development solutions designed to optimize, ease, and help accelerate embedded system development of applications based on MCUs from NXP. This project involves the FreeRTOS kernel repo fork with:

- cmake and Kconfig support to allow the configuration and build in MCUXpresso SDK ecosystem
- FreeRTOS OS additions, such as [FreeRTOS driver wrappers](#), RTOS ready FatFs file system, and the implementation of FreeRTOS tickless mode

The history of changes in FreeRTOS kernel repo for MCUXpresso SDK are summarized in [CHANGELOG\\_mcuxsdk.md](#) file.

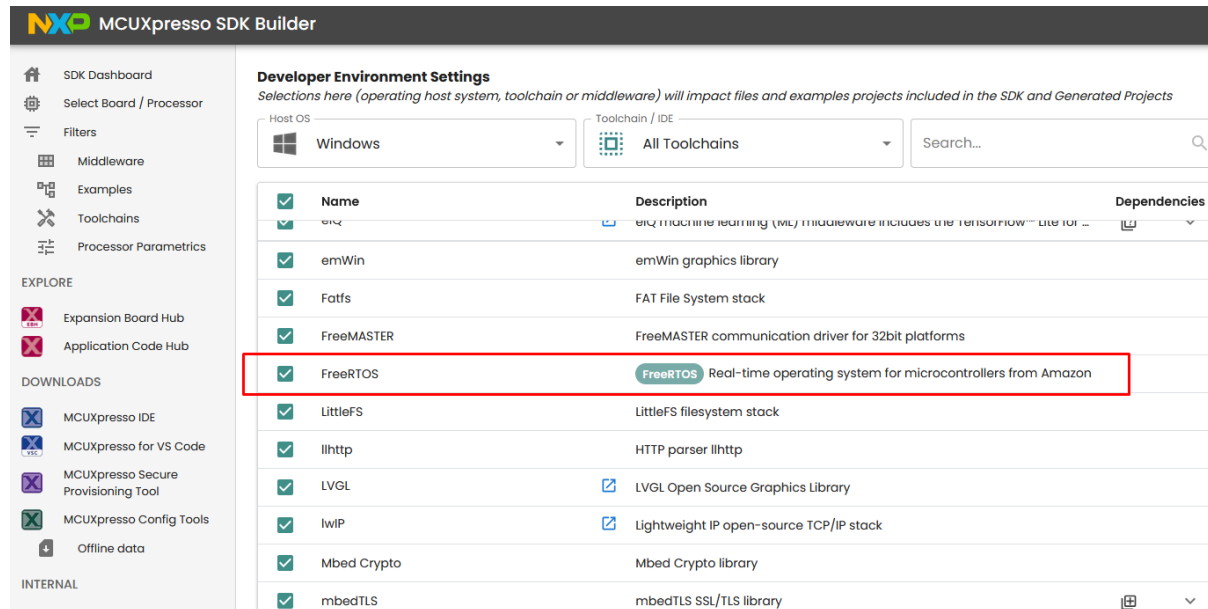
The MCUXpresso SDK framework also contains a set of FreeRTOS examples which show basic FreeRTOS OS features. This makes it easy to start a new FreeRTOS project or begin experimenting with FreeRTOS OS. Selected drivers and middleware are RTOS ready with related FreeRTOS adaptation layer.

**FreeRTOS example applications** The FreeRTOS examples are written to demonstrate basic FreeRTOS features and the interaction between peripheral drivers and the RTOS.

**List of examples** The list of freertos\_examples, their description and availability for individual supported MCUXpresso SDK development boards can be obtained here: [https://mcuxpresso.nxp.com/mcuxsdk/latest/html/examples/freertos\\_examples/index.html](https://mcuxpresso.nxp.com/mcuxsdk/latest/html/examples/freertos_examples/index.html)

**Location of examples** The FreeRTOS examples are located in [mcuxsdk-examples](#) repository, see the `freertos_examples` folder.

Once using MCUXpresso SDK zip packages created via the [MCUXpresso SDK Builder](#) the FreeRTOS kernel library and associated `freertos_examples` are added into final zip package once FreeRTOS components is selected on the Developer Environment Settings page:



The FreeRTOS examples in MCUXpresso SDK zip packages are located in `<MCUXpressoSDK_install_dir>/boards/<board_name>/freertos_examples/` subfolders.

**Building a FreeRTOS example application** For information how to use the cmake and Kconfig based build and configuration system and how to build `freertos_examples` visit: [MCUXpresso SDK documentation for Build And Configuration MCUXpresso SDK Getting Start Guide](#)

Tip: To list all FreeRTOS example projects and targets that can be built via the west build command, use this `west list_project` command in `mcuxsdk` workspace:

```
west list_project -p examples/freertos_examples
```

**FreeRTOS aware debugger plugin** NXP provides FreeRTOS task aware debugger for GDB. The plugin is compatible with Eclipse-based (MCUXpressoIDE) and is available after the installation.

Task List (FreeRTOS)							
TCB#	Task Name	Task Handle	Task State	Priority	Stack Usage	Event Object	Runtime
1	task_one	0x1fffecc8	Blocked	1 (1)	0 B / 880 B	MyCountingSemaphore (Rx)	0x0 (0.0%)
2	task_two	0x1ffff130	Blocked	2 (2)	0 B / 888 B	MyCountingSemaphore (Rx)	0x1 (0.1%)
3	IDLE	0x1ffff330	Running	0 (0)	0 B / 296 B		0x3e5 (99.6%)
4	Tmr Svc	0x1ffff6b8	Blocked	17 (17)	28 B / 672 B	TmrQ (Rx)	0x3 (0.3%)

## FreeRTOS kernel for MCUXpresso SDK ChangeLog

**Changelog FreeRTOS kernel for MCUXpresso 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](#).

**[Unreleased]****Added**

- Kconfig added `CONFIG_FREERTOS_USE_CUSTOM_CONFIG_FRAGMENT` config to optionally include custom FreeRTOSConfig fragment include file `FreeRTOSConfig_frag.h`. File must be provided by application.
- Added missing Kconfig option for `configUSE_PICOLIBC_TLS`.
- Add correct header files to build when `configUSE_NEWLIB_REENTRANT` and `configUSE_PICOLIBC_TLS` is selected in config.

**[11.1.0\_rev0]**

- update amazon freertos version

**[11.0.1\_rev0]**

- update amazon freertos version

**[10.5.1\_rev0]**

- update amazon freertos version

**[10.4.3\_rev1]**

- Apply CM33 security fix from 10.4.3-LTS-Patch-2. See `rtos/freertos/freertos_kernel/History.txt`
- Apply CM33 security fix from 10.4.3-LTS-Patch-1. See `rtos/freertos/freertos_kernel/History.txt`

**[10.4.3\_rev0]**

- update amazon freertos version.

**[10.4.3\_rev0]**

- update amazon freertos version.

**[9.0.0\_rev3]**

- New features:
  - Tickless idle mode support for Cortex-A7. Add `fsl_tickless_epit.c` and `fsl_tickless_generic.h` in `portable/IAR/ARM_CA9` folder.
  - Enabled float context saving in IAR for Cortex-A7. Added `configUSE_TASK_FPU_SUPPORT` macros. Modified `port.c` and `portmacro.h` in `portable/IAR/ARM_CA9` folder.
- Other changes:
  - Transformed ARM\_CM core specific tickless low power support into generic form under `freertos/Source/portable/low_power_tickless/`.

### [9.0.0\_rev2]

- New features:
  - Enabled MCUXpresso thread aware debugging. Add `freertos_tasks_c_additions.h` and `configINCLUDE_FREERTOS_TASK_C_ADDITIONS_H` and `configFREERTOS_MEMORY_SCHEME` macros.

### [9.0.0\_rev1]

- New features:
  - Enabled `-flto` optimization in GCC by adding `attribute((used))` for `vTaskSwitchContext`.
  - Enabled KDS Task Aware Debugger. Apply FreeRTOS patch to enable `configRECORD_STACK_HIGH_ADDRESS` macro. Modified files are `task.c` and `FreeRTOS.h`.

### [9.0.0\_rev0]

- New features:
  - Example `freertos_sem_static`.
  - Static allocation support RTOS driver wrappers.
- Other changes:
  - Tickless idle rework. Support for different timers is in separated files (`fsl_tickless_systick.c`, `fsl_tickless_lptmr.c`).
  - Removed configuration option `configSYSTICK_USE_LOW_POWER_TIMER`. Low power timer is now selected by linking of appropriate file `fsl_tickless_lptmr.c`.
  - Removed `configOVERRIDE_DEFAULT_TICK_CONFIGURATION` in RVDS port. Use of `attribute((weak))` is the preferred solution. Not same as `_weak`!

### [8.2.3]

- New features:
  - Tickless idle mode support.
  - Added template application for Kinetis Expert (KEx) tool (`template_application`).
- Other changes:
  - Folder structure reduction. Keep only Kinetis related parts.

## FreeRTOS kernel Readme

**MCUXpresso SDK: FreeRTOS kernel** This repository is a fork of FreeRTOS kernel (<https://github.com/FreeRTOS/FreeRTOS-Kernel>)(11.1.0). Modifications have been made to adapt to NXP MCUXpresso SDK. `CMakeLists.txt` and `Kconfig` added to enable FreeRTOS kernel repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository `mcuxsdk-manifests`(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

For more information about the FreeRTOS kernel repo adoption see [README\\_mcuxsdk.md: FreeRTOS kernel for MCUXpresso SDK Readme](#) document.



**Getting started** This repository contains FreeRTOS kernel source/header files and kernel ports only. This repository is referenced as a submodule in [FreeRTOS/FreeRTOS](#) repository, which contains pre-configured demo application projects under [FreeRTOS/Demo](#) directory.

The easiest way to use FreeRTOS is to start with one of the pre-configured demo application projects. That way you will have the correct FreeRTOS source files included, and the correct include paths configured. Once a demo application is building and executing you can remove the demo application files, and start to add in your own application source files. See the [FreeRTOS Kernel Quick Start Guide](#) for detailed instructions and other useful links.

Additionally, for FreeRTOS kernel feature information refer to the [Developer Documentation](#), and [API Reference](#).

Also for contributing and creating a Pull Request please refer to *the instructions here*.

**Getting help** If you have any questions or need assistance troubleshooting your FreeRTOS project, we have an active community that can help on the [FreeRTOS Community Support Forum](#).

## To consume FreeRTOS-Kernel

**Consume with CMake** If using CMake, it is recommended to use this repository using FetchContent. Add the following into your project's main or a subdirectory's CMakeLists.txt:

- Define the source and version/tag you want to use:

```
FetchContent_Declare( freertos_kernel
  GIT_REPOSITORY https://github.com/FreeRTOS/FreeRTOS-Kernel.git
  GIT_TAG         main #Note: Best practice to use specific git-hash or tagged version
)
```

In case you prefer to add it as a git submodule, do:

```
git submodule add https://github.com/FreeRTOS/FreeRTOS-Kernel.git <path of the submodule>
git submodule update --init
```

- Add a freertos\_config library (typically an INTERFACE library) The following assumes the directory structure:

– include/FreeRTOSConfig.h

```
add_library(freertos_config INTERFACE)

target_include_directories(freertos_config SYSTEM
  INTERFACE
    include
)

target_compile_definitions(freertos_config
  INTERFACE
    projCOVERAGE_TEST=0
)
```

In case you installed FreeRTOS-Kernel as a submodule, you will have to add it as a subdirectory:

```
add_subdirectory(${FREERTOS_PATH})
```

- Configure the FreeRTOS-Kernel and make it available
  - this particular example supports a native and cross-compiled build option.

```
set( FREERTOS_HEAP "4" CACHE STRING "" FORCE)
# Select the native compile PORT
set( FREERTOS_PORT "GCC_POSIX" CACHE STRING "" FORCE)
# Select the cross-compile PORT
if (CMAKE_CROSSCOMPILING)
  set(FREERTOS_PORT "GCC_ARM_CA9" CACHE STRING "" FORCE)
endif()

FetchContent_MakeAvailable(freertos_kernel)
```

- In case of cross compilation, you should also add the following to `freertos_config`:

```
target_compile_definitions(freertos_config INTERFACE ${definitions})
target_compile_options(freertos_config INTERFACE ${options})
```

### Consuming stand-alone - Cloning this repository

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/FreeRTOS-Kernel.git
```

Using SSH:

```
git clone git@github.com:FreeRTOS/FreeRTOS-Kernel.git
```

### Repository structure

- The root of this repository contains the three files that are common to every port - `list.c`, `queue.c` and `tasks.c`. The kernel is contained within these three files. `croutine.c` implements the optional co-routine functionality - which is normally only used on very memory limited systems.
- The `./portable` directory contains the files that are specific to a particular microcontroller and/or compiler. See the readme file in the `./portable` directory for more information.
- The `./include` directory contains the real time kernel header files.
- The `./template_configuration` directory contains a sample `FreeRTOSConfig.h` to help jumpstart a new project. See the *FreeRTOSConfig.h* file for instructions.

**Code Formatting** FreeRTOS files are formatted using the “`uncrustify`” tool. The configuration file used by `uncrustify` can be found in the [FreeRTOS/CI-CD-GitHub-Actions's uncrustify.cfg](#) file.

**Line Endings** File checked into the FreeRTOS-Kernel repository use unix-style LF line endings for the best compatibility with git.

For optimal compatibility with Microsoft Windows tools, it is best to enable the git `autocrlf` feature. You can enable this setting for the current repository using the following command:

```
git config core.autocrlf true
```

**Git History Optimizations** Some commits in this repository perform large refactors which touch many lines and lead to unwanted behavior when using the `git blame` command. You can configure git to ignore the list of large refactor commits in this repository with the following command:

```
git config blame.ignoreRevsFile .git-blame-ignore-revs
```



**Spelling and Formatting** We recommend using [Visual Studio Code](#), commonly referred to as VSCode, when working on the FreeRTOS-Kernel. The FreeRTOS-Kernel also uses [cSpell](#) as part of its spelling check. The config file for which can be found at [cspell.config.yaml](#). There is additionally a [cSpell plugin for VSCode](#) that can be used as well. [.cSpellWords.txt](#) contains words that are not traditionally found in an English dictionary. It is used by the spellchecker to verify the various jargon, variable names, and other odd words used in the FreeRTOS code base are correct. If your pull request fails to pass the spelling and you believe this is a mistake, then add the word to [.cSpellWords.txt](#). When adding a word please then sort the list, which can be done by running the bash command: `sort -u .cSpellWords.txt -o .cSpellWords.txt`. Note that only the FreeRTOS-Kernel Source Files, *include*, *portable/MemMang*, and *portable/Common* files are checked for proper spelling, and formatting at this time.

### 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

**MCUXpresso SDK: backoffAlgorithm Library** This repository is a fork of backoffAlgorithm library (<https://github.com/FreeRTOS/backoffalgorithm>)(1.3.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable backoffAlgorithm repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk-manifests](https://github.com/nxp-mcuxpresso/mcuxsdk-manifests)(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**backoffAlgorithm Library** This repository contains the backoffAlgorithm library, a utility library to calculate backoff period using an exponential backoff with jitter algorithm for retrying network operations (like failed network connection with server). This library uses the “Full Jitter” strategy for the exponential backoff with jitter algorithm. More information about the algorithm can be seen in the [Exponential Backoff and Jitter](#) AWS blog.

The backoffAlgorithm library is distributed under the *MIT Open Source License*.

Exponential backoff with jitter is typically used when retrying a failed network connection or operation request with the server. An exponential backoff with jitter helps to mitigate failed network operations with servers, that are caused due to network congestion or high request load on the server, by spreading out retry requests across multiple devices attempting network operations. Besides, in an environment with poor connectivity, a client can get disconnected at any time. A backoff strategy helps the client to conserve battery by not repeatedly attempting reconnections when they are unlikely to succeed.

See memory requirements for this library [here](#).

**backoffAlgorithm v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**backoffAlgorithm v1.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

**Reference example** The example below shows how to use the backoffAlgorithm library on a POSIX platform to retry a DNS resolution query for amazon.com.

```
#include "backoff_algorithm.h"
#include <stdlib.h>
#include <string.h>
#include <netdb.h>
#include <unistd.h>
#include <time.h>

/* The maximum number of retries for the example code. */
#define RETRY_MAX_ATTEMPTS      ( 5U )

/* The maximum back-off delay (in milliseconds) for between retries in the example. */
#define RETRY_MAX_BACKOFF_DELAY_MS  ( 5000U )

/* The base back-off delay (in milliseconds) for retry configuration in the example. */
#define RETRY_BACKOFF_BASE_MS      ( 500U )

int main()
{
    /* Variables used in this example. */
    BackoffAlgorithmStatus_t retryStatus = BackoffAlgorithmSuccess;
    BackoffAlgorithmContext_t retryParams;
    char serverAddress[] = "amazon.com";
    uint16_t nextRetryBackoff = 0;

    int32_t dnsStatus = -1;
    struct addrinfo hints;
    struct addrinfo ** pListHead = NULL;
    struct timespec tp;

    /* Add hints to retrieve only TCP sockets in getaddrinfo. */
    ( void ) memset( &hints, 0, sizeof( hints ) );

    /* Address family of either IPv4 or IPv6. */
    hints.ai_family = AF_UNSPEC;
    /* TCP Socket. */
    hints.ai_socktype = ( int32_t ) SOCK_STREAM;
    hints.ai_protocol = IPPROTO_TCP;

    /* Initialize reconnect attempts and interval. */
    BackoffAlgorithm_InitializeParams( &retryParams,
                                      RETRY_BACKOFF_BASE_MS,
                                      RETRY_MAX_BACKOFF_DELAY_MS,
                                      RETRY_MAX_ATTEMPTS );

    /* Seed the pseudo random number generator used in this example (with call to
     * rand() function provided by ISO C standard library) for use in backoff period
     * calculation when retrying failed DNS resolution. */

    /* Get current time to seed pseudo random number generator. */
    ( void ) clock_gettime( CLOCK_REALTIME, &tp );
    /* Seed pseudo random number generator with seconds. */
    srand( tp.tv_sec );

    do
    {
        /* Perform a DNS lookup on the given host name. */
        dnsStatus = getaddrinfo( serverAddress, NULL, &hints, pListHead );
    }
```

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```

/* Retry if DNS resolution query failed. */
if( dnsStatus != 0 )
{
    /* Generate a random number and get back-off value (in milliseconds) for the next retry.
    * Note: It is recommended to use a random number generator that is seeded with
    * device-specific entropy source so that backoff calculation across devices is different
    * and possibility of network collision between devices attempting retries can be avoided.
    *
    * For the simplicity of this code example, the pseudo random number generator, rand()
    * function is used. */
    retryStatus = BackoffAlgorithm_GetNextBackoff( &retryParams, rand(), &nextRetryBackoff );

    /* Wait for the calculated backoff period before the next retry attempt of querying DNS.
    * As usleep() takes nanoseconds as the parameter, we multiply the backoff period by 1000. */
    ( void ) usleep( nextRetryBackoff * 1000U );
}
} while( ( dnsStatus != 0 ) && ( retryStatus != BackoffAlgorithmRetriesExhausted ) );

return dnsStatus;
}

```

**Building the library** A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses a header file introduced in ISO C99, *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdint.readme*, which can be renamed to *stdint.h* to build the backoffAlgorithm library.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/backoff_algorithm.c -o example
./example
```

*gcc* can also produce an output file to be linked:

```
gcc -I source/include -c source/backoff_algorithm.c
```

## 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 (like [amazon-freertos](#) that submodules 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
  - C89 or later compiler like *gcc*
  - CMake 3.13.0 or later
- For running the coverage target, *gcov* 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.

#### 4.1.4 corehttp

C language HTTP client library designed for embedded platforms.

#### MCUXpresso SDK: coreHTTP Client Library

This repository is a fork of coreHTTP Client library (<https://github.com/FreeRTOS/corehttp>)(3.0.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreHTTP Client repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

#### coreHTTP Client Library

This repository contains a C language HTTP client library designed for embedded platforms. It has no dependencies on any additional libraries other than the standard C library, [llhttp](#), and a customer-implemented transport interface. 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 both static code analysis from [Coverity static analysis](#), and validation of memory safety and data structure invariance through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

**coreHTTP v3.0.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**coreHTTP v2.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

**coreHTTP Config File** The HTTP client library exposes configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *core\_http\_config\_defaults.h*. To provide custom values for the configuration macros, a custom config file named *core\_http\_config.h* can be provided by the user application to the library.

By default, a *core\_http\_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `HTTP_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

**The HTTP client library can be built by either:**

- Defining a `core_http_config.h` file in the application, and adding it to the include directories for the library build. **OR**
- Defining the `HTTP_DO_NOT_USE_CUSTOM_CONFIG` preprocessor macro for the library build.

**Building the Library** The `httpFilePaths.cmake` file contains the information of all source files and header include paths required to build the HTTP client library.

As mentioned in the *previous section*, either a custom config file (i.e. `core_http_config.h`) OR `HTTP_DO_NOT_USE_CUSTOM_CONFIG` macro needs to be provided to build the HTTP client library.

For a CMake example of building the HTTP library with the `httpFilePaths.cmake` file, refer to the `coverity_analysis` library target in `test/CMakeLists.txt` file.

## Building Unit Tests

### Platform Prerequisites

- For running unit tests, the following are required:
  - **C90 compiler** like `gcc`
  - **CMake 3.13.0 or later**
  - **Ruby 2.0.0 or later** is required for this repository's [CMock test framework](#).
- For running the coverage target, the following are required:
  - `gcov`
  - `lcov`

### 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 Device SDK for Embedded C repository contains demos of using the HTTP client library [here](#) on a POSIX platform. These can be used as reference examples for the library API.

## Documentation

**Existing Documentation** For pre-generated documentation, please see the documentation linked in the locations below:

Location
<a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a>

Note that the latest included version of coreHTTP 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.

## 4.1.5 corejson

JSON parser.

### Readme

**MCUXpresso SDK: coreJSON Library** This repository is a fork of coreJSON library (<https://github.com/FreeRTOS/corejson>)(3.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreJSON repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**coreJSON Library** This repository contains the coreJSON library, a parser that strictly enforces the ECMA-404 JSON standard and is suitable for low memory footprint embedded devices. The coreJSON 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 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](#).

**coreJSON v3.2.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**coreJSON v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

### Reference example

```

#include <stdio.h>
#include "core_json.h"

int main()
{
    // Variables used in this example.
    JSONStatus_t result;
    char buffer[] = "{\"foo\":\"abc\", \"bar\":{\"foo\":\"xyz\"}}";
    size_t bufferLength = sizeof( buffer ) - 1;
    char queryKey[] = "bar.foo";
    size_t queryKeyLength = sizeof( queryKey ) - 1;
    char * value;
    size_t valueLength;

    // Calling JSON_Validate() is not necessary if the document is guaranteed to be valid.
    result = JSON_Validate( buffer, bufferLength );

    if( result == JSONSuccess )
    {
        result = JSON_Search( buffer, bufferLength, queryKey, queryKeyLength,
                             &value, &valueLength );
    }

    if( result == JSONSuccess )
    {
        // The pointer "value" will point to a location in the "buffer".
        char save = value[ valueLength ];
        // After saving the character, set it to a null byte for printing.
        value[ valueLength ] = '\0';
        // "Found: bar.foo -> xyz" will be printed.
        printf( "Found: %s -> %s\n", queryKey, value );
        // Restore the original character.
        value[ valueLength ] = save;
    }

    return 0;
}

```

A search may descend through nested objects when the queryKey contains matching key strings joined by a separator, .. In the example above, bar has the value { "foo": "xyz" }. Therefore, a search for query key bar.foo would output xyz.

**Building coreJSON** A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses 2 header files introduced in ISO C99, *stdbool.h* and *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h* respectively.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/core_json.c -o example
./example
```

*gcc* can also produce an output file to be linked:

```
gcc -I source/include -c source/core_json.c
```

## Documentation

**Existing documentation** For pre-generated documentation, please see the documentation linked in the locations below:

Location
<a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a>

Note that the latest included version of the coreJSON 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 (like [amazon-freertos](#) that submodules 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, gcov 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.



**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](#).

**Contributing** See *CONTRIBUTING.md* for information on contributing.

### 4.1.6 coremqtt

MQTT publish/subscribe messaging library.

#### MCUXpresso SDK: coreMQTT Library

This repository is a fork of coreMQTT library (<https://github.com/FreeRTOS/coremqtt>)(2.1.1). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

#### coreMQTT Client Library

This repository contains the coreMQTT library that has been optimized for a low memory footprint. The coreMQTT library is compliant with the [MQTT 3.1.1](#) standard. It has no dependencies on any additional libraries other than the standard C library, a customer-implemented network transport interface, and *optionally* a user-implemented platform time function. 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 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](#).

**coreMQTT v2.1.1 source code is part of the FreeRTOS 20210.01 LTS release.**

**MQTT Config File** The MQTT 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 *core\_mqtt\_config\_defaults.h*. To provide custom values for the configuration macros, a custom config file named *core\_mqtt\_config.h* can be provided by the application to the library.

By default, a *core\_mqtt\_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `MQTT_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

**Thus, the MQTT library can be built by either:**

- Defining a *core\_mqtt\_config.h* file in the application, and adding it to the include directories list of the library
- OR**
- Defining the `MQTT_DO_NOT_USE_CUSTOM_CONFIG` preprocessor macro for the library build.

**Sending metrics to AWS IoT** When establishing a connection with AWS IoT, users can optionally report the Operating System, Hardware Platform and MQTT client version information of their device to AWS. This information can help AWS IoT provide faster issue resolution and technical support. If users want to report this information, they can send a specially formatted string (see below) in the username field of the MQTT CONNECT packet.

#### Format

The format of the username string with metrics is:

```
<Actual_Username>?SDK=<OS_Name>&Version=<OS_Version>&Platform=<Hardware_Platform>&MQTTLib=<MQTT_Library_name>@<MQTT_Library_version>
```

#### Where

- <Actual\_Username> is the actual username used for authentication, if username and password are used for authentication. When username and password based authentication is not used, this is an empty value.
- <OS\_Name> is the Operating System the application is running on (e.g. FreeRTOS)
- <OS\_Version> is the version number of the Operating System (e.g. V10.4.3)
- <Hardware\_Platform> is the Hardware Platform the application is running on (e.g. WinSim)
- <MQTT\_Library\_name> is the MQTT Client library being used (e.g. coreMQTT)
- <MQTT\_Library\_version> is the version of the MQTT Client library being used (e.g. 1.0.2)

#### Example

- Actual\_Username = "iotuser", OS\_Name = FreeRTOS, OS\_Version = V10.4.3, Hardware\_Platform\_Name = WinSim, MQTT\_Library\_Name = coremqtt, MQTT\_Library\_version = 2.1.1. If username is not used, then "iotuser" can be removed.

```
/* Username string:
 * iotuser?SDK=FreeRTOS&Version=v10.4.3&Platform=WinSim&MQTTLib=coremqtt@2.1.1
 */

#define OS_NAME           "FreeRTOS"
#define OS_VERSION        "V10.4.3"
#define HARDWARE_PLATFORM_NAME  "WinSim"
#define MQTT_LIB          "coremqtt@2.1.1"

#define USERNAME_STRING   "iotuser?SDK=" OS_NAME "&Version=" OS_VERSION "&Platform=" HARDWARE_PLATFORM_NAME "&MQTTLib=" MQTT_LIB
#define USERNAME_STRING_LENGTH  ( ( uint16_t ) ( sizeof( USERNAME_STRING ) - 1 ) )

MQTTConnectInfo_t connectInfo;
connectInfo.userName = USERNAME_STRING;
connectInfo.userNameLength = USERNAME_STRING_LENGTH;
mqttStatus = MQTT_Connect( pMqttContext, &connectInfo, NULL, CONNACK_RECV_TIMEOUT_MS,
↳ pSessionPresent );
```

**Upgrading to v2.0.0 and above** With coreMQTT versions >=v2.0.0, there are breaking changes. Please refer to the *coreMQTT version >=v2.0.0 Migration Guide*.

**Building the Library** The *mqttFilePaths.cmake* file contains the information of all source files and the header include path required to build the MQTT library.

Additionally, the MQTT library requires two header files that are not part of the ISO C90 standard library, *stdbool.h* and *stdint.h*. For compilers that do not provide these header files, the

*source/include* directory contains the files *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h*, respectively, to provide the type definitions required by MQTT.

As mentioned in the previous section, either a custom config file (i.e. *core\_mqtt\_config.h*) OR `MQTT_DO_NOT_USE_CUSTOM_CONFIG` macro needs to be provided to build the MQTT library.

For a CMake example of building the MQTT library with the *mqttFilePaths.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

- Docker

or the following:

- 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. If using docker, launch the container:
  1. `docker build -t coremqtt .`
  2. `docker run -it -v "$PWD":/workspaces/coreMQTT -w /workspaces/coreMQTT coremqtt`
2. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#))
3. Run the *cmake* command: `cmake -S test -B build`
4. Run this command to build the library and unit tests: `make -C build all`
5. The generated test executables will be present in *build/bin/tests* folder.
6. 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 MQTT client library in the following locations for reference examples on POSIX and FreeRTOS platforms:

Platform	Location	Transport Interface Implementation
POSIX	<a href="#">AWS IoT Device SDK for Embedded C</a>	POSIX sockets for TCP/IP and OpenSSL for TLS stack
FreeRTOS	<a href="#">FreeRTOS/FreeRTOS</a>	FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack
FreeRTOS	<a href="#">FreeRTOS AWS Reference Integrations</a>	Based on Secure Sockets Abstraction

## Documentation

**Existing Documentation** For pre-generated documentation, please see the documentation linked in the locations below:

Location
<a href="#">AWS IoT Device SDK for Embedded C</a>
<a href="#">FreeRTOS.org</a>

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.

### 4.1.7 coremqtt-agent

The coreMQTT Agent library is a high level API that adds thread safety to the coreMQTT library.

#### Readme

**MCUXpresso SDK: coreMQTT Agent Library** This repository is a fork of coreMQTT Agent library (<https://github.com/FreeRTOS/coremqtt-agent>)(1.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT Agent repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**coreMQTT Agent Library** The coreMQTT Agent library is a high level API that adds thread safety to the [coreMQTT](#) library. The library provides thread safe equivalents to the coreMQTT's APIs, greatly simplifying its use in multi-threaded environments. The coreMQTT Agent library manages the MQTT connection by serializing the access to the coreMQTT library and reducing implementation overhead (e.g., removing the need for the application to repeatedly call to MQTT\_ProcessLoop). This allows your multi-threaded applications to share the same MQTT connection, and enables you to design an embedded application without having to worry about coreMQTT thread safety.

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](#).

**Cloning this repository** This repo uses [Git Submodules](#) to bring in dependent components.

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

Using SSH:

```
git clone git@github.com:FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

If you have downloaded the repo without using the `--recurse-submodules` argument, you need to run:

```
git submodule update --init --recursive
```

**coreMQTT Agent Library Configurations** The MQTT Agent library uses the same `core_mqtt_config.h` configuration file as coreMQTT, with the addition of configuration constants listed at the top of `core_mqtt_agent.h` and `core_mqtt_agent_command_functions.h`. Documentation for these configurations can be found [here](#).

To provide values for these configuration values, they must be either:

- Defined in `core_mqtt_config.h` used by coreMQTT **OR**
- Passed as compile time preprocessor macros

**Porting the coreMQTT Agent Library** In order to use the MQTT Agent library on a platform, you need to supply thread safe functions for the agent's *messaging interface*.

**Messaging Interface** Each of the following functions must be thread safe.

Function Pointer	Description
MQTTAgentMessageSend_t	A function that sends commands (as MQTTAgentCommand_t * pointers) to be received by MQTTAgent_CommandLoop. This can be implemented by pushing to a thread safe queue.
MQTTAgentMessageRecv_t	A function used by MQTTAgent_CommandLoop to receive MQTTAgentCommand_t * pointers that were sent by API functions. This can be implemented by receiving from a thread safe queue.
MQTTAgentCommandGet_t	A function that returns a pointer to an allocated MQTTAgentCommand_t structure, which is used to hold information and arguments for a command to be executed in MQTTAgent_CommandLoop(). If using dynamic memory, this can be implemented using malloc().
MQTTAgentCommandRelease_t	A function called to indicate that a command structure that had been allocated with the MQTTAgentCommandGet_t function pointer will no longer be used by the agent, so it may be freed or marked as not in use. If using dynamic memory, this can be implemented with free().

Reference implementations for the interface functions can be found in the [reference examples](#) below.

### Additional Considerations

**Static Memory** If only static allocation is used, then the MQTTAgentCommandGet\_t and MQTTAgentCommandRelease\_t could instead be implemented with a pool of MQTTAgentCommand\_t structures, with a queue or semaphore used to control access and provide thread safety. The below [reference examples](#) use static memory with a command pool.

**Subscription Management** The MQTT Agent does not track subscriptions for MQTT topics. The receipt of any incoming PUBLISH packet will result in the invocation of a single MQTTAgentIncomingPublishCallback\_t callback, which is passed to MQTTAgent\_Init() for initialization. If it is desired for different handlers to be invoked for different incoming topics, then the publish callback will have to manage subscriptions and fan out messages. A platform independent subscription manager example is implemented in the [reference examples](#) below.

**Building the Library** You can build the MQTT Agent source files that are in the *source* directory, and add *source/include* to your compiler's include path. Additionally, the MQTT Agent library requires the coreMQTT library, whose files follow the same *source/* and *source/include* pattern as the agent library; its build instructions can be found [here](#).

If using CMake, the *mqttAgentFilePaths.cmake* file contains the above information of the source files and the header include path from this repository. The same information is found for coreMQTT from *mqttFilePaths.cmake* in the *coreMQTT submodule*.

For a CMake example of building the MQTT Agent library with the *mqttAgentFilePaths.cmake* file, refer to the *coverity\_analysis* library target in *test/CMakeLists.txt* file.

### Building Unit Tests

**Checkout CMock Submodule** 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
```

### Unit Test 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. (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 MQTT Agent library in the following locations for reference examples on FreeRTOS platforms:

Location
<a href="#">coreMQTT Agent Demos</a>
<a href="#">FreeRTOS/FreeRTOS</a>

**Documentation** The MQTT Agent API documentation can be found [here](#).

**Generating documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages yourself, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

**Getting help** You can use your Github login to get support from both the FreeRTOS community and directly from the primary FreeRTOS developers on our [active support forum](#). You can find a list of [frequently asked questions](#) [here](#).



**Contributing** See *CONTRIBUTING.md* for information on contributing.

**License** This library is licensed under the MIT License. See the *LICENSE* file.

### 4.1.8 corepkcs11

PKCS #11 key management library.

#### Readme

**MCUXpresso SDK: corePKCS11 Library** This repository is a fork of PKCS #11 key management library (<https://github.com/FreeRTOS/corePKCS11/tree/v3.5.0>)(v3.5.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable corepkcs11 repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**corePKCS11 Library** PKCS #11 is a standardized and widely used API for manipulating common cryptographic objects. It is important because the functions it specifies allow application software to use, create, modify, and delete cryptographic objects, without ever exposing those objects to the application's memory. For example, FreeRTOS AWS reference integrations use a small subset of the PKCS #11 API to, among other things, access the secret (private) key necessary to create a network connection that is authenticated and secured by the [Transport Layer Security \(TLS\)](#) protocol – without the application ever ‘seeing’ the key.

The Cryptoki or PKCS #11 standard defines a platform-independent API to manage and use cryptographic tokens. The name, “PKCS #11”, is used interchangeably to refer to the API itself and the standard which defines it.

This repository contains a software based mock implementation of the PKCS #11 interface (API) that uses the cryptographic functionality provided by Mbed TLS. Using a software mock enables rapid development and flexibility, but it is expected that the mock be replaced by an implementation specific to your chosen secure key storage in production devices.

Only a subset of the PKCS #11 standard is implemented, with a focus on operations involving asymmetric keys, random number generation, and hashing.

The targeted use cases include certificate and key management for TLS authentication and code-sign signature verification, on small embedded devices.

corePKCS11 is implemented on PKCS #11 v2.4.0, the full PKCS #11 standard can be found on the [oasis website](#).

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](#).

**corePKCS11 v3.5.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**corePKCS11 v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**



**Purpose** Generally vendors for secure cryptoprocessors such as Trusted Platform Module (TPM), Hardware Security Module (HSM), Secure Element, or any other type of secure hardware enclave, distribute a PKCS #11 implementation with the hardware. The purpose of the corePKCS11 software only mock library is therefore to provide a non hardware specific PKCS #11 implementation that allows for rapid prototyping and development before switching to a cryptoprocessor specific PKCS #11 implementation in production devices.

Since the PKCS #11 interface is defined as part of the PKCS #11 [specification](#) replacing this library with another implementation should require little porting effort, as the interface will not change. The system tests distributed in this repository can be leveraged to verify the behavior of a different implementation is similar to corePKCS11.

**corePKCS11 Configuration** The corePKCS11 library exposes preprocessor macros which must be defined prior to building the library. A list of all the configurations and their default values are defined in the doxygen documentation for this library.

## Build Prerequisites

**Library Usage** For building the library the following are required:

- **A C99 compiler**
- **mbedcrypto** library from [mbedtls](#) version 2.x or 3.x.
- **pkcs11 API header(s)** available from [OASIS](#) or [OpenSC](#)

Optionally, variables from the `pkcsFilePaths.cmake` file may be referenced if your project uses `cmake`.

**Integration and Unit Tests** In order to run the integration and unit test suites the following are dependencies are necessary:

- **C Compiler**
- **CMake 3.13.0 or later**
- **Ruby 2.0.0 or later** required by CMock.
- **Python 3** required for configuring mbedtls.
- **git** required for fetching dependencies.
- **GNU Make** or **Ninja**

The *mbedtls*, *CMock*, and *Unity* libraries are downloaded and built automatically using the `cmake` `FetchContent` feature.

**Coverage Measurement and Instrumentation** The following software is required to run the coverage target:

- Linux, MacOS, or another POSIX-like environment.
- A recent version of **GCC** or **Clang** with support for gcov-like coverage instrumentation.
- **gcov** binary corresponding to your chosen compiler
- **lcov** from the [Linux Test Project](#)
- **perl** needed to run the `lcov` utility.

Coverage builds are validated on recent versions of Ubuntu Linux.

## Running the Integration and Unit Tests

1. Navigate to the root directory of this repository in your shell.
2. Run **cmake** to construct a build tree: `cmake -S test -B build`
  - You may specify your preferred build tool by appending `-G'Unix Makefiles'` or `-GNinja` to the command above.
  - You may append `-DUNIT_TESTS=0` or `-DSYSTEM_TESTS=0` to disable Unit Tests or Integration Tests respectively.
3. Build the test binaries: `cmake --build ./build --target all`
4. Run `ctest --test-dir ./build` or `cmake --build ./build --target test` to run the tests without capturing coverage.
5. Run `cmake --build ./build --target coverage` to run the tests and capture coverage data.

**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 FreeRTOS-Labs repository contains demos using the PKCS #11 library [here](#) using FreeRTOS on the Windows simulator platform. These can be used as reference examples for the library API.

**Porting Guide** Documentation for porting corePKCS11 to a new platform can be found on the AWS [docs](#) web page.

corePKCS11 is not meant to be ported to projects that have a TPM, HSM, or other hardware for offloading crypto-processing. This library is specifically meant to be used for development and prototyping.

**Related Example Implementations** These projects implement the PKCS #11 interface on real hardware and have similar behavior to corePKCS11. It is preferred to use these, over corePKCS11, as they allow for offloading Cryptography to separate hardware.

- ARM's [Platform Security Architecture](#).
- Microchip's [cryptoauthlib](#).
- Infineon's [Optiga Trust X](#).

## Documentation

**Existing Documentation** For pre-generated documentation, please see the documentation linked in the locations below:

Location
<a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a>

Note that the latest included version of corePKCS11 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
```

**Security** See *CONTRIBUTING* for more information.

**License** This library is licensed under the MIT-0 License. See the LICENSE file.

### 4.1.9 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

#### Readme

**MCUXpresso SDK: FreeRTOS-Plus-TCP Library** This repository is a fork of FreeRTOS-Plus-TCP library (<https://github.com/FreeRTOS/freertos-plus-tcp>)(4.3.3). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable FreeRTOS-Plus-TCP repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**FreeRTOS-Plus-TCP Library** FreeRTOS-Plus-TCP is a lightweight TCP/IP stack for FreeRTOS. It provides a familiar Berkeley sockets interface, making it as simple to use and learn as possible. FreeRTOS-Plus-TCP's features and RAM footprint are fully scalable, making FreeRTOS-Plus-TCP equally applicable to smaller lower throughput microcontrollers as well as larger higher throughput microprocessors.

This library has undergone static code analysis and checks for compliance with the [MISRA coding standard](#). Any deviations from the MISRA C:2012 guidelines are documented under [MISRA Deviations](#). The library is validated for memory safety and data structure invariance through the [CBMC automated reasoning tool](#) for the functions that parse data originating from the network. The library is also protocol tested using Maxwell protocol tester for both IPv4 and IPv6.

**FreeRTOS-Plus-TCP Library V4.2.2 source code is part of the FreeRTOS 202406.01 LTS release.**

**Getting started** The easiest way to use version 4.0.0 and later of FreeRTOS-Plus-TCP is to refer the Getting started Guide (found [here](#)) Another way is to start with the pre-configured IPv4 Windows Simulator demo (found in [this directory](#)) or IPv6 Multi-endpoint Windows Simulator demo (found in [this directory](#)). That way you will have the correct FreeRTOS source files included, and the correct include paths configured. Once a demo application is building and executing you can remove the demo application files, and start to add in your own application source files. See the [FreeRTOS Kernel Quick Start Guide](#) for detailed instructions and other useful links.

Additionally, for FreeRTOS-Plus-TCP source code organization refer to the [Documentation](#), and [API Reference](#).

**Getting help** If you have any questions or need assistance troubleshooting your FreeRTOS project, we have an active community that can help on the [FreeRTOS Community Support Forum](#). Please also refer to [FAQ](#) for frequently asked questions.

Also see the [Submitting a bug/feature request](#) section of CONTRIBUTING.md for more details.

**Note:** All the remaining sections are generic and applies to all the versions from V3.0.0 onwards.

**Upgrading to V4.3.0 and above** For users of STM32 network interfaces:

Starting from version V4.3.0, the STM32 network interfaces have been consolidated into a single unified implementation located at `source/portable/NetworkInterface/STM32/NetworkInterface.c`, supporting STM32 F4, F7, and H7 series microcontrollers, with newly added support for STM32 H5. The new interface has been tested with the STM32 HAL Ethernet (ETH) drivers, available at `source/portable/NetworkInterface/STM32/Drivers`. For compatibility, the legacy interfaces (STM32Fxx and STM32Hxx) have been retained and relocated to `source/portable/NetworkInterface/STM32/Legacy`.

**Upgrading to V3.0.0 and V3.1.0** In version 3.0.0 or 3.1.0, the folder structure of FreeRTOS-Plus-TCP has changed and the files have been broken down into smaller logically separated modules. This change makes the code more modular and conducive to unit-tests. FreeRTOS-Plus-TCP V3.0.0 improves the robustness, security, and modularity of the library. Version 3.0.0 adds comprehensive unit test coverage for all lines and branches of code and has undergone protocol testing, and penetration testing by AWS Security to reduce the exposure to security vulnerabilities. Additionally, the source files have been moved to a `source` directory. This change requires modification of any existing project(s) to include the modified source files and directories.

**FreeRTOS-Plus-TCP V3.1.0 [source code\(.c .h\)](#) is part of the [FreeRTOS 20210.00 LTS](#) release.**

**Generating pre V3.0.0 folder structure for backward compatibility:** If you wish to continue using a version earlier than V3.0.0 i.e. continue to use your existing source code organization, a script is provided to generate the folder structure similar to [this](#).

**Note:** After running the script, while the `.c` files will have same names as the pre V3.0.0 source, the files in the `include` directory will have different names and the number of files will differ as well. This should, however, not pose any problems to most projects as projects generally include all files in a given directory.

Running the script to generate pre V3.0.0 folder structure: For running the script, you will need Python version > 3.7. You can download/install it from [here](#).

Once python is downloaded and installed, you can verify the version from your terminal/command window by typing `python --version`.

To run the script, you should switch to the FreeRTOS-Plus-TCP directory Then run `python <Path/to/the/script>/GenerateOriginalFiles.py`.

## To consume FreeRTOS+TCP

**Consume with CMake** If using CMake, it is recommended to use this repository using FetchContent. Add the following into your project's main or a subdirectory's `CMakeLists.txt`:

- Define the source and version/tag you want to use:

```
FetchContent_Declare( freertos_plus_tcp
  GIT_REPOSITORY https://github.com/FreeRTOS/FreeRTOS-Plus-TCP.git
  GIT_TAG        main #Note: Best practice to use specific git-hash or tagged version
```

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(continued from previous page)

```
GIT_SUBMODULES "" # Don't grab any submodules since not latest
)
```

- Configure the FreeRTOS-Kernel and make it available
  - this particular example supports a native and cross-compiled build option.

```
# Select the native compile PORT
set( FREERTOS_PLUS_TCP_NETWORK_IF "POSIX" CACHE STRING "" FORCE)
# Or: select a cross-compile PORT
if (CMAKE_CROSSCOMPILING)
  # Eg. STM32Hxx version of port
  set(FREERTOS_PLUS_TCP_NETWORK_IF "STM32HXX" CACHE STRING "" FORCE)
endif()

FetchContent_MakeAvailable(freertos_plus_tcp)
```

**Consuming stand-alone** This repository uses [Git Submodules](#) to bring in dependent components.

Note: If you download the ZIP file provided by GitHub UI, you will not get the contents of the submodules. (The ZIP file is also not a valid Git repository)

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/FreeRTOS-Plus-TCP.git ./FreeRTOS-Plus-TCP
cd ./FreeRTOS-Plus-TCP
git submodule update --checkout --init --recursive tools/CMock test/FreeRTOS-Kernel
```

Using SSH:

```
git clone git@github.com:FreeRTOS/FreeRTOS-Plus-TCP.git ./FreeRTOS-Plus-TCP
cd ./FreeRTOS-Plus-TCP
git submodule update --checkout --init --recursive tools/CMock test/FreeRTOS-Kernel
```

**Porting** The porting guide is available on [this page](#).

**Repository structure** This repository contains the FreeRTOS-Plus-TCP repository and a number of supplementary libraries for testing/PR Checks. Below is the breakdown of what each directory contains:

- tools
  - This directory contains the tools and related files (CMock/uncrustify) required to run tests/checks on the TCP source code.
- tests
  - This directory contains all the tests (unit tests and CBMC) and the dependencies ([FreeRTOS-Kernel/Litani-port](#)) the tests require.
- source/portable
  - This directory contains the portable files required to compile the FreeRTOS-Plus-TCP source code for different hardware/compilers.
- source/include
  - The include directory has all the ‘core’ header files of FreeRTOS-Plus-TCP source.
- source

- This directory contains all the [.c] source files.

**Note** At this time it is recommended to use `BufferAllocation_2.c` in which case it is essential to use the `heap_4.c` memory allocation scheme. See [memory management](#).

**Kernel sources** The FreeRTOS Kernel Source is in [FreeRTOS/FreeRTOS-Kernel repository](#), and it is consumed by testing/PR checks as a submodule in this repository.

The version of the FreeRTOS Kernel Source in use could be accessed at `./test/FreeRTOS-Kernel` directory.

**CBMC** The `test/cbmc/proofs` directory contains CBMC proofs.

To learn more about CBMC and proofs specifically, review the training material [here](#).

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).