



MCUXpresso SDK Documentation

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This documentation contains information specific to the lpcxpresso55s06 board.

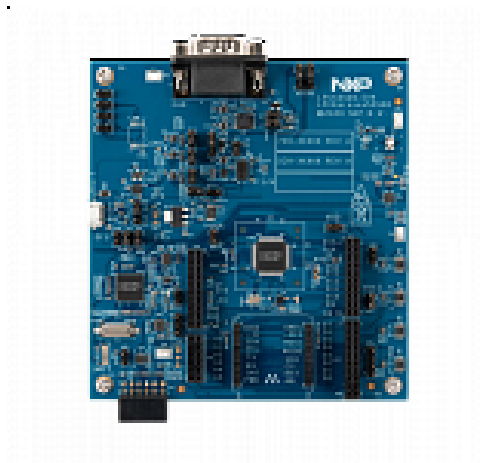
Chapter 1

LPCXpresso55S06

1.1 Overview

The LPCXpresso55S06 development board provides the ideal platform for evaluation of and development with the LPC550x/S0x MCU based on the Arm Cortex-M33 architecture. The board includes a high-performance onboard debug probe and accelerometer, with several options for adding off-the-shelf add-on boards for networking, sensors, displays, and other interfaces.

The LPCXpresso55S06 is fully supported by the MCUXpresso suite of tools, which provides device drivers, middleware and examples to allow rapid development, plus configuration tools and an optional free IDE. MCUXpresso software is compatible with the open source MCU operating system FreeRTOS, tools from popular tool vendors such as Arm and IAR, and the LPCXpresso55S06 may also be used with the popular debug probes available from SEGGER and P&E Micro.



MCU device and part on board is shown below:

- Device: LPC55S06
- PartNumber: LPC55S06JBD64

1.2 Getting Started with MCUXpresso SDK Package

1.2.1 Getting Started with Package

- Overview
- MCUXpresso SDK board support package folders

- Example application structure
 - Locating example application source files
- Run a demo using MCUXpresso IDE
 - Select the workspace location
 - Build an example application
 - Run an example application
 - Build a multicore example application
 - Run a multicore example application
 - Build a TrustZone example application
 - Run a TrustZone example application
- Run a demo application using IAR
 - Build an example application
 - Run an example application
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 - Run a multicore example application
 - Build a TrustZone example application
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 - Build a TrustZone example application
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 - * Install GCC Arm Embedded tool chain
 - * Install MinGW (only required on Windows OS)
 - * Add a new system environment variable for ARMGCC_DIR
 - * Install CMake
 - Build an example application
 - Run an example application
 - Build a multicore example application
 - Run a multicore example application
 - Build a TrustZone example application
 - Run a TrustZone example application
- MCUXpresso Config Tools
- MCUXpresso IDE New Project Wizard

- How to determine COM port
- How to define IRQ handler in CPP files
- Default debug interfaces
- Updating LPCXpresso board firmware
- Revision history
- Legal information

1.3 Getting Started with MCUXpresso SDK GitHub

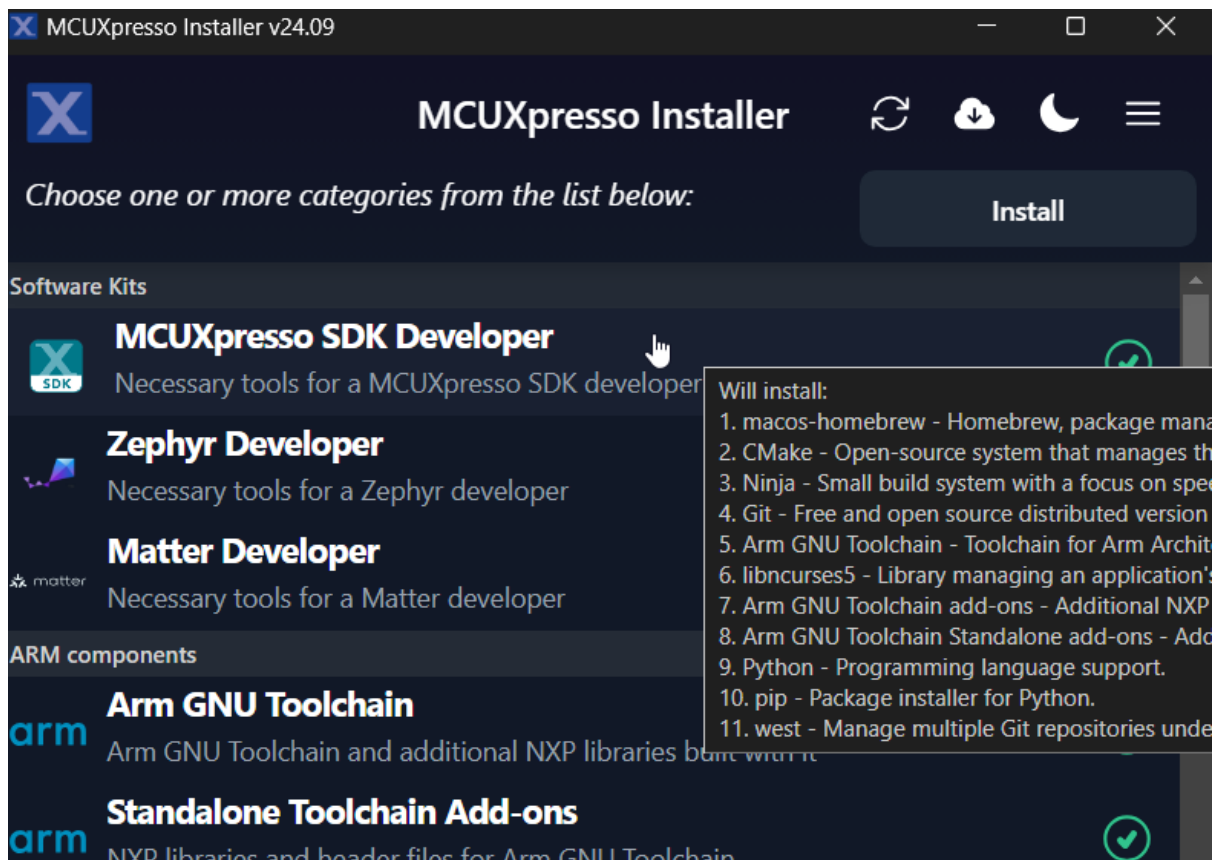
1.3.1 Getting Started with MCUXpresso SDK Repository

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.

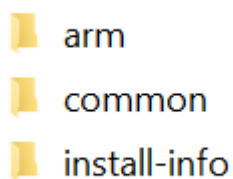
Toolchain MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

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

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

Toolchain	Environment Variable	Example	Cmd Line Argument
Armgcc	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

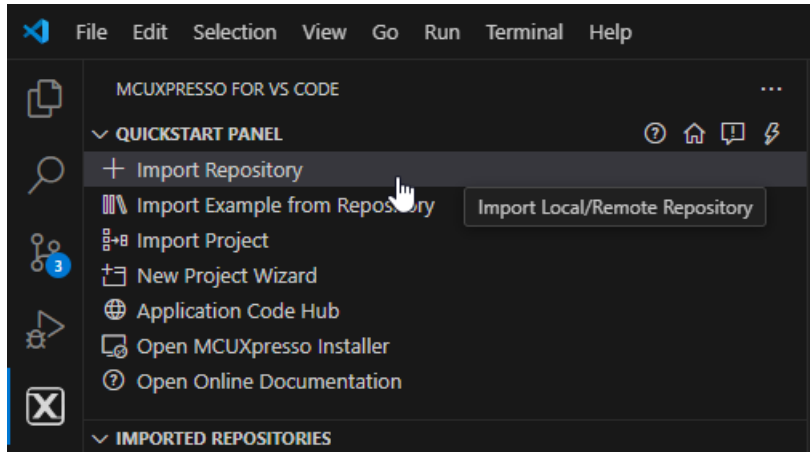
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the `hello_world` demo application as an example. However, these

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](#).

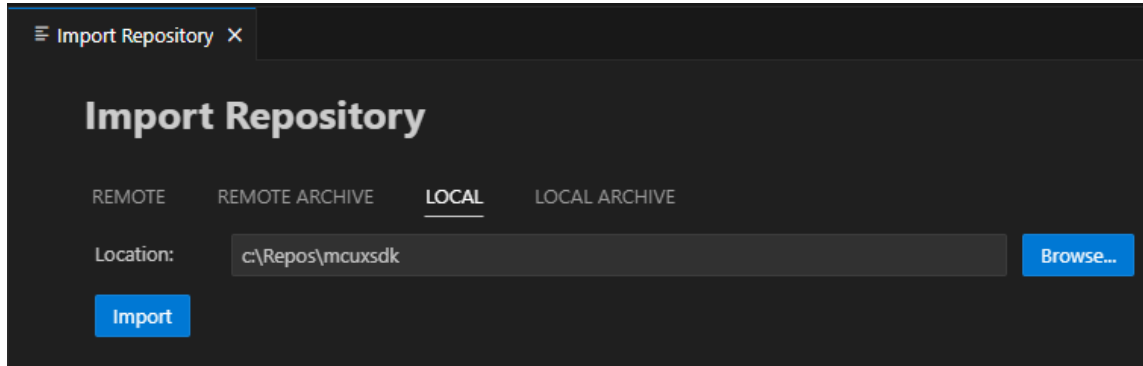
To build an example application:

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

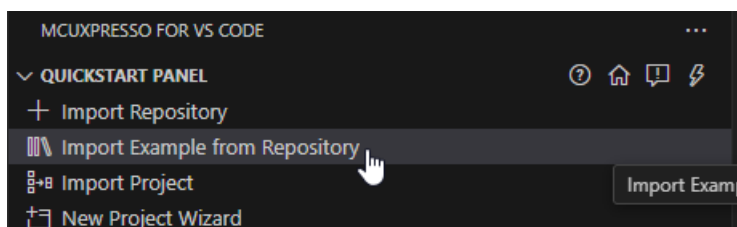


Note: You can import the SDK in several ways. Refer to [MCUXpresso for VS Code Wiki](#) for details.

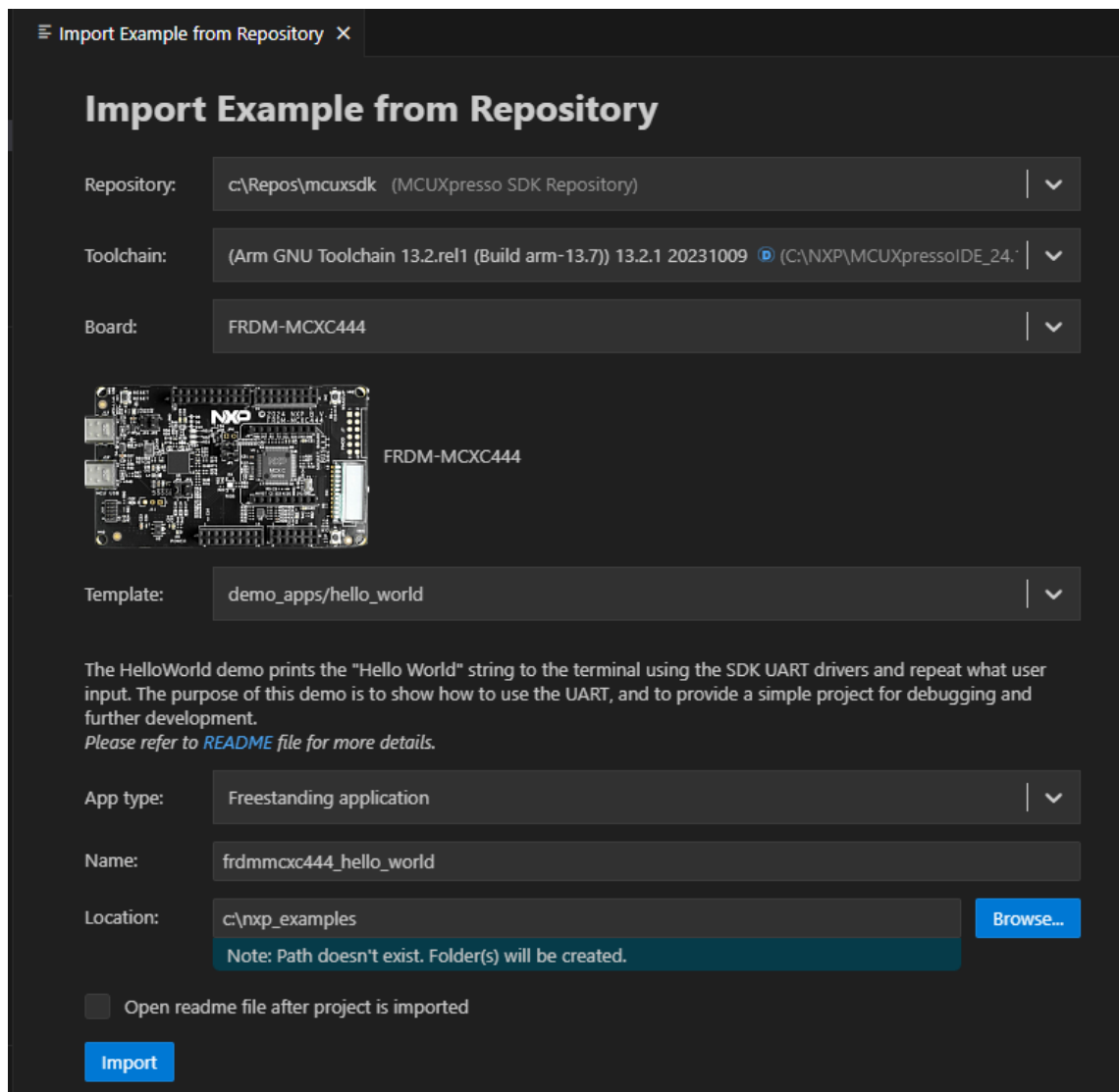
Select **Local** if you've already obtained the SDK as seen in [Get MCUXpresso SDK Repo](#). Select your location and click **Import**.



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...](#)

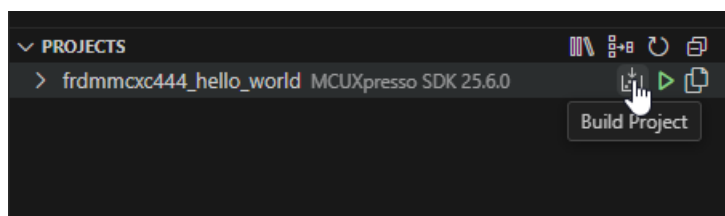
Note: Path doesn't exist. Folder(s) will be created.

☐ 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.

- VS Code will prompt you to confirm if the imported files are trusted. Click **Yes**.
- 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.

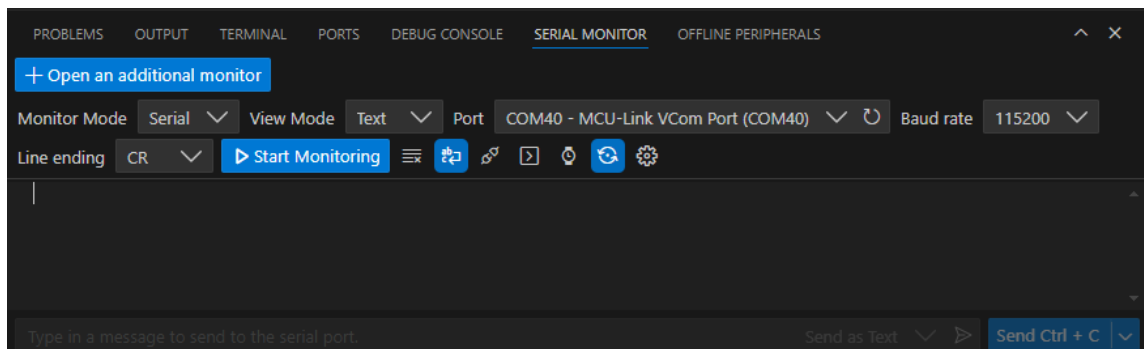
```

[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/MCXC/MCXC444/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.

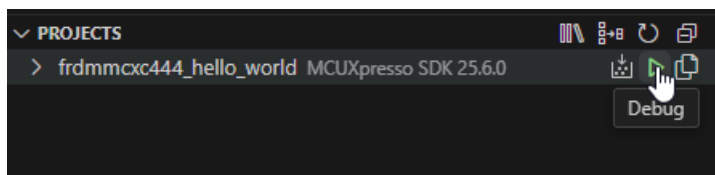
```

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] [Icons]
---- 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)

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```

↪ 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

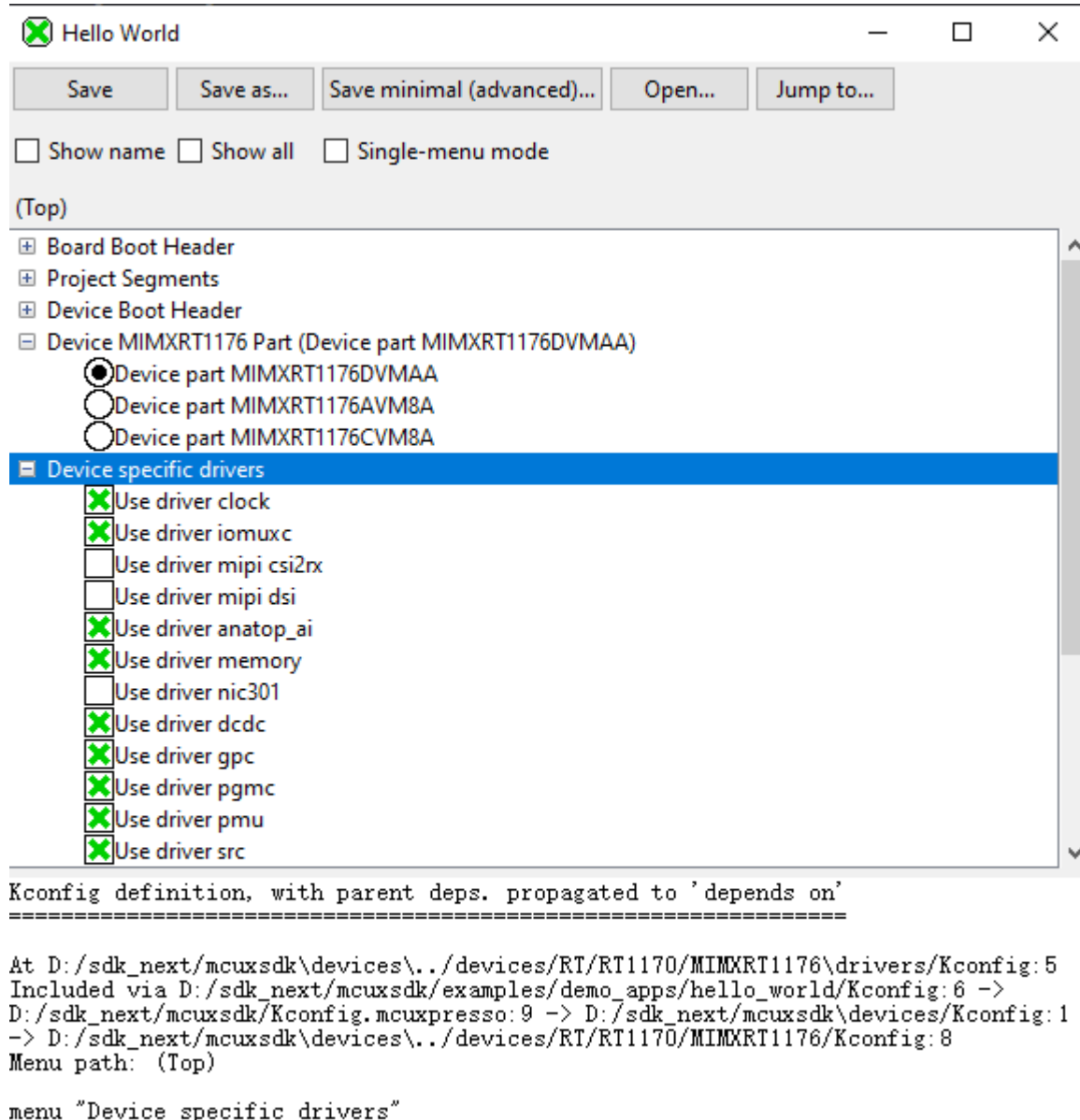
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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:

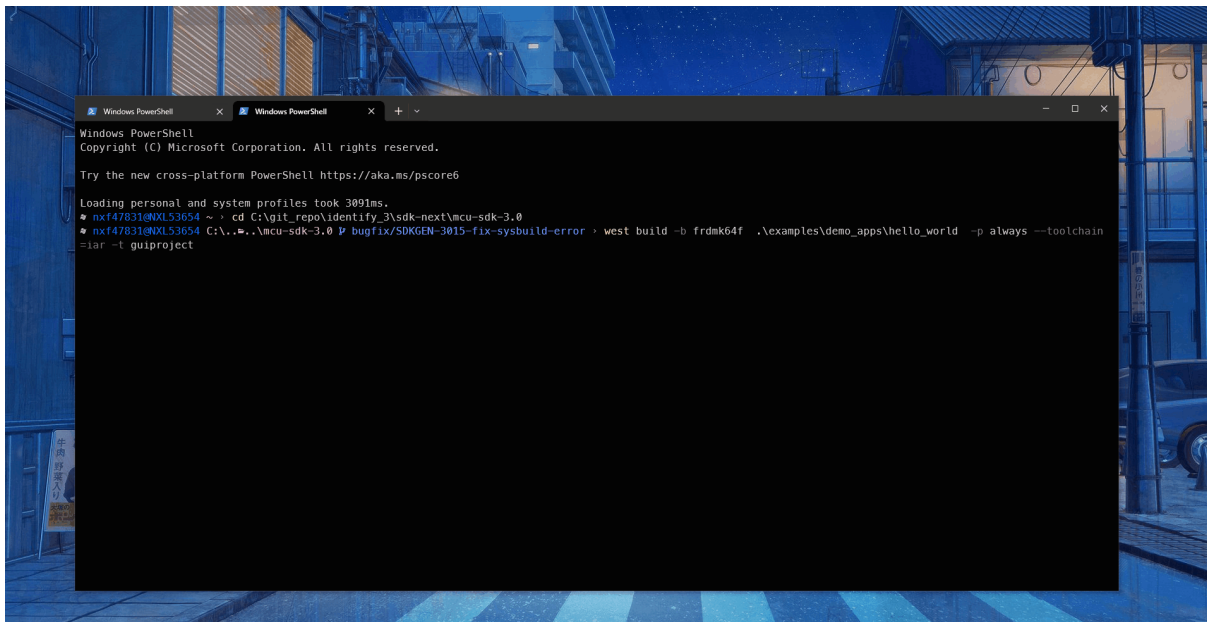
```
west debug -r linkserver
```

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.

Devel- opment boards	MCU devices
LPCX- presso55S0	LPC5502JBD64, LPC5502JHI48, LPC5504JBD64, LPC5504JHI48, LPC5506JBD64, LPC5506JHI48, LPC55S04JBD64, LPC55S04JHI48, LPC55S06JBD64 , LPC55S06JHI48

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.

coreHTTP coreHTTP

PSA Test Suite Arm Platform Security Architecture Test Suite

mbedTLS mbedtls SSL/TLS library v3.x

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

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

TinyCBOR Concise Binary Object Representation (CBOR) Library

TF-M Trusted Firmware - M Library

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

mbedtls mbedtls SSL/TLS library v2.x

LVGL LVGL Open Source Graphics Library

llhttp HTTP parser llhttp

FreeMASTER FreeMASTER communication driver for 32-bit platforms.

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

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

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

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.

Examples `hello_world_ns`, `secure_faults_ns`, and `secure_faults_trdc_ns` have incorrect library path in GUI projects

When the affected examples are generated as GUI projects, the library linking the secure and non-secure worlds has an incorrect path set. This causes linking errors during project compilation.

Examples: `hello_world_ns`, `hello_world_s`, `secure_faults_ns`, `secure_faults_s`, `secure_faults_trdc_ns`, `secure_faults_trdc_s`

Affected toolchains: `mdk`, `iar`

Workaround: In the IDE project settings for the non-secure (`_ns`) project, find the linked library (named `hello_world_s_CMSE_lib.o`, or similar, depending on the example project) and replace the path to the library with `<build_directory>/<secure_world_project_folder>/<IDE>/`, replacing the subdirectory names with the build directory, the secure world project name, and IDE name.

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
-

ANACTRL

[2.4.0]

- Improvements
 - Added some interrupt flags for devices containing BOD1 and BOD2 interrupt controls.
 - Added a control macro to enable/disable the 32MHz Crystal oscillator code in current driver.
 - Added a feature macro for bit field ENA_96MHZCLK in FRO192M_CTRL.
 - Added a feature macro for bit field BODCORE_INT_ENABLE in BOD_DCDC_INT_CTRL.

[2.3.1]

- Bug Fixes
 - Added casts to prevent overflow caused by capturing large target clock.

[2.3.0]

- Improvements
 - Added AUX_BIAS control APIs.

[2.2.0]

- Improvements
 - Added some macros to separate the scenes that some bit fields are reserved for some devices.
 - Optimized the comments.
 - Optimized the code implementation inside some functions.

[2.1.2]

- Bug Fixes
 - Fixed MISRA C-2012 rule 10.3 and rule 17.7.

[2.1.1]

- Bug Fixes
 - Removed AnalogTestBus configuration to align with new header.

[2.1.0]

- Improvements
 - Updates for LPC55xx A1.
 - * Removed the control of bitfield FRO192M_CTRL_ENA_48MHZCLK, XO32M_CTRL_ACBUF_PASS_ENABLE.
 - * Removed status bits in ANACTRL_STATUS: PMU_ID OSC_ID FINAL_TEST_DONE_VECT.
 - * Removed API ANACTRL_EnableAdcVBATDivider() and APIs which operate the RingOSC registers.
 - * Removed the configurations of 32 MHz Crystal oscillator voltage source supply control register.
 - * Added API ANACTRL_ClearInterrupts().

[2.0.0]

- Initial version.
-

CASSPER

[2.2.4]

- Fix MISRA-C 2012 issue.

[2.2.3]

- Added macro into CASPER_Init and CASPER_Deinit to support devices without clock and reset control.

[2.2.2]

- Enable hardware interleaving to RAMX0 and RAMX1 for CASPER by feature macro FSL_FEATURE_CASPER_RAM_HW_INTERLEAVE

[2.2.1]

- Fix MISRA C-2012 issue.

[2.2.0]

- Rework driver to support multiple curves at once.

[2.1.0]

- Add ECC NIST P-521 elliptic curve.

[2.0.10]

- Fix MISRA C-2012 issue.

[2.0.9]

- Remove unused function Jac_oncurve().
- Fix ECC384 build.

[2.0.8]

- Add feature macro for CASPER_RAM_OFFSET.

[2.0.7]

- Fix MISRA C-2012 issue.

[2.0.6]

- Bug Fixes
 - Fix IAR Pa082 warning

[2.0.5]

- Bug Fixes
 - Fix sign-compare warning

[2.0.4]

- For GCC compiler, enforce O1 optimize level, specifically to remove strict-aliasing option. This driver is very specific and requires -fno-strict-aliasing.

[2.0.3]

- Bug Fixes
 - Fixed the bug for KPSDK-28107 RSUB, FILL and ZERO operations not implemented in enum_casper_operation.

[2.0.2]

- Bug Fixes
 - Fixed KPSDK-25015 CASPER_MEMCPY hard-fault on LPC55xx when both source and destination buffers are outside of CASPER_RAM.

[2.0.1]

- Bug Fixes
 - Fixed the bug that KPSDK-24531 double_scalar_multiplication() result may be all zeroes for some specific input.

[2.0.0]

- Initial version.
-

CDOG

[2.1.3]

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

[2.1.2]

- Support multiple IRQs
- Fix default CONTROL values

[2.1.1]

- Remove bit CONTROL[CONTROL_CTRL].

[2.1.0]

- Rename CWT to CDOG.

[2.0.2]

- Fix MISRA-2012 issues.

[2.0.1]

- Fix doxygen issues.

[2.0.0]

- Initial version.
-

CLOCK

[2.3.8]

- Bug Fixes
 - Fixed an issue that ss_progmodfm_t, ss_progmoddp_t, and ss_modwvctrl_t use wrong shift value.

[2.3.7]

- Improvements
 - Add errata workaround for pll lock bit in `CLOCK_SetPLL0Freq()` and `CLOCK_SetPLL1Freq()`.

[2.3.6]

- Bug Fixes
 - Correct the fail status condition in `CLOCK_SetupExtClocking()`.

[2.3.5]

- Improvements
 - Added lost comments for some enumerations.

[2.3.4]

- Bug Fixes
 - Correct the clock name `kCLOCK_Cwt` to `kCLOCK_Cdog`.

[2.3.3]

- Bug Fixes
 - Fix `kCLOCK_DivFlexFrgx` setting in `CLOCK_SetClkDiv` function.

[2.3.2]

- Improvements
 - Removed USB component.

[2.3.1]

- Bug Fixes
 - Fixed violation of MISRA C-2012 rule 10.1, rule 10.4, rule 18.1 and so on.

[2.3.0]

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

[2.2.2]

- Bug Fixes
 - Corrected the `PLL.SELI` setting to align with new UM.
 - Changed the PLL lock reliable condition.

[2.2.1]

- Improvements
 - Removed redundant macro definitions.

[2.2.0]

- New Features
 - Added the `CLOCK_SetPLUClkInClocking()` to store the PLU CLKIN frequency.

[2.1.1]

- Improvements
 - Updated the `CLOCK_SetFLASHAccessCyclesForFreq()` to support up to 150MHz frequency.

[2.1.0]

- New features
 - Added new API `CLOCK_DelayAtLeastUs()` implemented by DWT to allow users to set delay in unit of microsecond.

[2.0.4]

- Bug Fixes
 - Fixed C++ build errors in `CLOCK_GetClockAttachId()` and `CLOCK_AttachClk()`.

[2.0.3]

- Bug Fixes
 - Fixed attach incorrect `attach_id`.

[2.0.2]

- New Features
 - Added get actual clock attach id api to allow users to obtain the actual clock source in target register.
- Bug Fixes
 - The attach clock and get actual clock attach id APIs should check combination of two clock sources.
- Optimizations
 - Made the judgement statements more clear.
 - Strengthened the compatibility of clock attach id.
 - Removed some unmeaningful definitions and add some useful ones to enhance readability.

[2.0.1]

- Some minor fixes.

[2.0.0]

- Initial version.
-

CMP**[2.2.1]**

- Bug Fixes
 - Fixed violations of MISRA C-2012 rule 10.1, rule 10.4, and rule 17.7.

[2.2.0]

- Improvements:
 - Added API to configure the sampling mode and clock divider of the CMP Filter.
 - Supported CMP filter sampling mode configuration.

[2.1.0]

- New Features:
 - Added API to get default CMP user configuration structure.
 - Supported CMP filter clock divider settings.
 - Combined the settings of VREF source and VREF value into one API `CMP_SetVREF()`.
 - Extracted CMP input source selection from `CMP_Init()` to `CMP_SetInputChannels()`.
- Improvements:
 - Formatted API naming, variable naming and comment style for better readability.
 - Added comments for APIs in source file.

[2.0.1]

- Bug Fixes
 - Fixed missing 'const' qualifier for structure variable in function parameter.

[2.0.0]

- Initial version.
-

COMMON**[2.6.0]**

- Bug Fixes
 - Fix CERT-C violations.

[2.5.0]

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

[2.4.3]

- Improvements
 - Enable irq 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.
-

CTIMER

[2.3.3]

- Bug Fixes
 - Fix CERT INT30-C INT31-C issue.
 - Make API CTIMER_SetupPwm and CTIMER_UpdatePwmDutycycle return fail if pulse width register overflow.

[2.3.2]

- Bug Fixes
 - Clear unexpected DMA request generated by RESET_PeripheralReset in API CTIMER_Init to avoid trigger DMA by mistake.

[2.3.1]

- Bug Fixes
 - MISRA C-2012 issue fixed: rule 10.7 and 12.2.

[2.3.0]

- Improvements
 - Added the CTIMER_SetPrescale(), CTIMER_GetCaptureValue(), CTIMER_EnableResetMatchChannel(), CTIMER_EnableStopMatchChannel(), CTIMER_EnableRisingEdgeCapture(), CTIMER_EnableFallingEdgeCapture(), CTIMER_SetShadowValue(), APIs Interface to reduce code complexity.

[2.2.2]

- Bug Fixes
 - Fixed SetupPwm() API only can use match 3 as period channel issue.

[2.2.1]

- Bug Fixes
 - Fixed use specified channel to setting the PWM period in SetupPwmPeriod() API.
 - Fixed Coverity Out-of-bounds issue.

[2.2.0]

- Improvements
 - Updated three API Interface to support Users to flexibly configure the PWM period and PWM output.
- Bug Fixes
 - MISRA C-2012 issue fixed: rule 8.4.

[2.1.0]

- Improvements
 - Added the CTIMER_GetOutputMatchStatus() API Interface.
 - Added feature macro for FSL_FEATURE_CTIMER_HAS_NO_CCR_CAP2 and FSL_FEATURE_CTIMER_HAS_NO_IR_CR2INT.

[2.0.3]

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

[2.0.2]

- New Features
 - Added new API “CTIMER_GetTimerCountValue” to get the current timer count value.
 - Added a control macro to enable/disable the RESET and CLOCK code in current driver.
 - Added a new feature macro to update the API of CTimer driver for lpc8n04.

[2.0.1]

- Improvements
 - API Interface Change
 - * Changed API interface by adding CTIMER_SetupPwmPeriod API and CTIMER_UpdatePwmPulsePeriod API, which both can set up the right PWM with high resolution.

[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_ChannelsBusy 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.

FLEXCOMM

[2.0.2]

- Bug Fixes
 - Fixed typos in FLEXCOMM15_DriverIRQHandler().
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.
- Improvements
 - Added instance calculation in FLEXCOMM16_DriverIRQHandler() to align with Flexcomm 14 and 15.

[2.0.1]

- Improvements
 - Added more IRQHandler code in drivers to adapt new devices.

[2.0.0]

- Initial version.
-

GINT

[2.1.1]

- Improvements
 - Added support for platforms with PORT_POL and PORT_ENA registers without arrays.

[2.1.0]

- Improvements
 - Updated for platforms which only has one port.

[2.0.3]

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

[2.0.2]

- Bug Fixes
 - Fixed issue for MISRA-2012 check.
 - * Fixed rule 17.7.

[2.0.1]

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

[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 mainin change is updating APIs with prefix of _PinXXX() and _PorortXXX

[2.1.0]

- New Features
 - Added GPIO initialize API.

[2.0.0]

- Initial version.
-

HASHCRYPT

[2.0.0]

- Initial version.

[2.0.1]

- Supported loading AES key from unaligned address.

[2.0.2]

- Supported loading AES key from unaligned address for different compiler and core variants.

[2.0.3]

- Remove SHA512 and AES ICB algorithm definitions

[2.0.4]

- Add SHA context switch support

[2.1.0]

- Update the register name and macro to align with new header.
- Fixed the sign-compare warning in hashcrypt_load_data.

[2.1.1]

- Fix MISRA C-2012.

[2.1.2]

- Support loading AES input data from unaligned address.

[2.1.3]

- Fix MISRA C-2012.

[2.1.4]

- Fix context switch cannot work when switching from AES.

[2.1.5]

- Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` to prevent possible optimization issue.

[2.2.0]

- Add AES-OFB and AES-CFB mixed IP/SW modes.

[2.2.1]

- Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` prevent compiler from reordering memory write when `-O2` or higher is used.

[2.2.2]

- Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` to fix optimization issue

[2.2.3]

- Added check for size in `hashcrypt_aes_one_block` to prevent overflowing COUNT field in MEMCTRL register, if its bigger than COUNT field do a multiple runs.

[2.2.4]

- In all `HASHCRYPT_AES_xx` functions have been added setting CTRL_MODE bitfield to 0 after processing data, which decreases power consumption.

[2.2.5]

- Add data synchronization barrier and instruction synchronization barrier inside `hashcrypt_sha_process_message_data()` to fix optimization issue

[2.2.6]

- Add data synchronization barrier inside `HASHCRYPT_SHA_Update()` and `hashcrypt_get_data()` function to fix optimization issue on MDK and ARMGCC release targets

[2.2.7]

- Add data synchronization barrier inside `HASHCRYPT_SHA_Update()` to fix optimization issue on MCUX IDE release target

[2.2.8]

- Unify hashcrypt hashing behavior between aligned and unaligned input data

[2.2.9]

- Add handling of set ERROR bit in the STATUS register

[2.2.10]

- Fix missing error statement in `hashcrypt_save_running_hash()`

[2.2.11]

- Fix incorrect SHA-256 calculation for long messages with reload

[2.2.12]

- Fix hardfault issue on the Keil compiler due to unaligned `memcpy()` input on some optimization levels

[2.2.13]

- Added function `hashcrypt_seed_prng()` which loading random number into PRNG_SEED register before AES operation for SCA protection

[2.2.14]

- Modify function `hashcrypt_get_data()` to prevent issue with unaligned access

[2.2.15]

- Add wait on DIGEST BIT inside `hashcrypt_sha_one_block()` to fix issues with some optimization flags

[2.2.16]

- Add DSB instruction inside `hashcrypt_sha_ldm_stm_16_words()` to fix issues with some optimization flags

[2.2.17]

- Fix context size when `hashcrypt` built with reload feature

I2C

[2.3.3]

- Bug Fixes
 - Fixed violations of the MISRA C-2012 rules 10.1.
 - Fixed issue that if master only sends address without data during I2C interrupt transfer, address nack cannot be detected.

[2.3.2]

- Improvement
 - Enable or disable timeout option according to enableTimeout.
- Bug Fixes
 - Fixed timeout value calculation error.
 - Fixed bug that the interrupt transfer cannot recover from the timeout error.

[2.3.1]

- Improvement
 - Before master transfer with transactional APIs, enable master function while disable slave function and vise versa for slave transfer to avoid the one affecting the other.
- Bug Fixes
 - Fixed bug in I2C_SlaveEnable that the slave enable/disable should not affect the other register bits.

[2.3.0]

- Improvement
 - Added new return codes kStatus_I2C_EventTimeout and kStatus_I2C_SclLowTimeout, and added the check for event timeout and SCL timeout in I2C master transfer.
 - Fixed bug in slave transfer that the address match event should be invoked before not after slave transmit/receive event.

[2.2.0]

- New Features
 - Added enumeration `_i2c_status_flags` to include all previous master and slave status flags, and added missing status flags.
 - Modified I2C_GetStatusFlags to get all I2C flags.
 - Added API I2C_ClearStatusFlags to clear all clearable flags not just master flags.
 - Modified master transactional APIs to enable bus event timeout interrupt during transfer, to avoid glitch on bus causing transfer hangs indefinitely.
- Bug Fixes
 - Fixed bug that status flags and interrupt enable masks share the same enumerations by adding enumeration `_i2c_interrupt_enable` for all master and slave interrupt sources.

[2.1.0]

- Bug Fixes
 - Fixed bug that during master transfer, when master is nacked during slave probing or sending subaddress, the return status should be kStatus_I2C_Addr_Nak rather than kStatus_I2C_Nak.
- Bug Fixes
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.4, 13.5.

- New Features
 - Added macro `I2C_MASTER_TRANSMIT_IGNORE_LAST_NACK`, so that user can configure whether to ignore the last byte being nacked by slave during master transfer.

[2.0.8]

- Bug Fixes
 - Fixed `I2C_MasterSetBaudRate` issue that `MSTSCLOW` and `MSTSCHIGH` are incorrect when `MSTTIME` is odd.

[2.0.7]

- Bug Fixes
 - Two dividers, `CLKDIV` and `MSTTIME` are used to configure baudrate. According to reference manual, in order to generate 400kHz baudrate, the clock frequency after `CLKDIV` must be less than 2mHz. Fixed the bug that, the clock frequency after `CLKDIV` may be larger than 2mHz using the previous calculation method.
 - Fixed MISRA 10.1 issues.
 - Fixed wrong baudrate calculation when feature `FSL_FEATURE_I2C_PREPCLKFRG_8MHZ` is enabled.

[2.0.6]

- New Features
 - Added master timeout self-recovery support for feature `FSL_FEATURE_I2C_TIMEOUT_RECOVERY`.
- Bug Fixes
 - Eliminated IAR Pa082 warning.
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.

[2.0.5]

- 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 transfered or nak is returned, handle state should be changed to idle.
- Improvements
 - Rounded up the calculated divider value in `I2C_MasterSetBaudRate`.

[2.0.4]

- Improvements
 - Updated the I2C_WATI_TIMEOUT macro to unified name I2C_RETRY_TIMES
 - Updated the “I2C_MasterSetBaudRate” API to support baudrate configuration for feature QN9090.
- Bug Fixes
 - Fixed build warning caused by uninitialized variable.
 - Fixed COVERITY issue of unchecked return value in I2C_RTOS_Transfer.

[2.0.3]

- Improvements
 - Unified the component full name to FLEXCOMM I2C(DMA/FREERTOS) driver.

[2.0.2]

- Improvements
 - In slave IRQ:
 1. Changed slave receive process to first set the I2C_SLVCTL_SLVCONTINUE_MASK to acknowledge the received data, then do data receive.
 2. Improved slave transmit process to set the I2C_SLVCTL_SLVCONTINUE_MASK immediately after writing the data.

[2.0.1]

- Improvements
 - Added I2C_WATI_TIMEOUT macro to allow users to specify the timeout times for waiting flags in functional API and blocking transfer API.

[2.0.0]

- Initial version.
-

I2S**[2.3.2]**

- Bug Fixes
 - Fixed warning for comparison between pointer and integer.

[2.3.1]

- Bug Fixes
 - Updated the value of TX/RX software transfer state machine after transfer contents are submitted to avoid race condition.

[2.3.0]

- Improvements
 - Added api I2S_InstallDMADescriptorMemory/I2S_TransferSendLoopDMA/I2S_TransferReceiveLoopDMA to support loop transfer.
 - Added api I2S_EmptyTxFifo to support blocking flush tx fifo.
 - Updated api I2S_TransferAbortDMA by removed the blocking flush tx fifo from this function.
- Bug Fixes
 - Removed the while loop in abort transfer function to fix the dead loop issue under specific user case.

[2.2.2]

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

[2.2.1]

- Improvements
 - Added feature FSL_FEATURE_FLEXCOMM_INSTANCE_I2S_SUPPORT_SECONDARY_CHANNELn for the SOC has parts of instance support secondary channel.
- Bug Fixes
 - Added volatile statement for the state variable of i2s_handle and enable the mainline channel pair before enable interrupt to avoid the issue of code execution reordering which may cause the interrupt generated unexpectedly.

[2.2.0]

- Improvements
 - Added 8/16/24 bits mono data format transfer support in I2S driver.
 - Added new apis I2S_SetBitClockRate.
- Bug Fixes
 - Fixed the PA082 build warning.
 - Fixed the sign-compare warning.
 - Fixed violations of the MISRA C-2012 rules 10.4, 10.8, 11.9, 10.1, 11.3, 13.5, 11.8, 10.3, 10.7.
 - Fixed the Operand don't affect result Coverity issue.

[2.1.0]

- Improvements
 - Added a feature for the FLEXCOMM which supports I2S and has interconnection with DMIC.
 - Used a feature to control PDMDATA instead of I2S_CFG1_PDMDATA.
 - Added member bytesPerFrame in i2s_dma_handle_t, used for DMA transfer width configure, instead of using sizeof(uint32_t) hardcoded.

- Used the macro provided by DMA driver to define the I2S DMA descriptor.
- Bug Fixes
 - Fixed the issue that I2S DMA driver always generated duplicate callback.

[2.0.3]

- New Features
 - Added a feature to remove configuration for the second channel on LPC51U68.

[2.0.2]

- New Features
 - Added ENABLE_IRQ handle after register I2S interrupt handle.

[2.0.1]

- Improvements
 - Unified the component full name to FLEXCOMM I2S (DMA) driver.

[2.0.0]

- Initial version.
-

I2S_DMA

[2.3.3]

- Bug Fixes
 - Fixed data size limit does not match the macro DMA_MAX_TRANSFER_BYTES issue.

[2.3.2]

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

[2.3.1]

- Refer I2S driver change log 2.0.1 to 2.3.1
-

IAP

[2.1.5]

- Improvements
 - Update Flash_Program src parameter to const.
 - Check CPU frequency <= 100MHZ for Flash Erase and Program.
 - Add BOOTLOADER_UserEntry API.

[2.1.4]

- Bug Fixes
 - Fixed misra issue.

[2.1.3]

- Bug Fixes
 - Fix the CFPA version wasn't transferred into SDK driver.

[2.1.2]

- Bug Fixes
 - Fix IAP driver status definitions don't match ROM_API.pdf from User Manual.

[2.1.1]

- Bug Fixes
 - The last 17 pages are reserved for chips with 640KB flash.

[2.1.0]

- New Features
 - Added new API FLASH_Read for users to read flash.
 - Added new API skboot_authenticate for image authentication api.
 - Added new AP kb_init, kb_deinit, kb_execute for users to operate BOOT ROM.

[2.0.3]

- Bug Fixes
 - Resolve incompatibility issue.

[2.0.2]

- Bug Fixes
 - MISRA C-2012 issue fixed: rule 11.1.
- Improvements
 - Improved the format of IAP driver version, using versionMajor to obtain the major version of bootloader.

[2.0.1]

- Improvements
 - Removed the enumeration item kSysToFlashFreq_100MHz which cannot be supported.
 - Removed the invalid FFR commands.
 - Improved the format of IAP driver version, using S_VersionMajor to obtain the major version of bootloader.

[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.
-

IOCON

[2.2.0]

- Improvements
 - Removed duplicate macro definitions.
 - Renamed 'IOCON_I2C_SLEW' macro to 'IOCON_I2C_MODE' to match its companion 'IOCON_GPIO_MODE'. The original is kept as a deprecated symbol.

[2.1.2]

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

[2.1.1]

- Updated left shift format with mask value instead of a constant value to automatically adapt to all platforms.

[2.1.0]

- Added a new IOCON_PinMuxSet() function with a feature IOCON_ONE_DIMENSION for LPC845MAX board.

[2.0.0]

- Initial version.
-

LPADC

[2.9.3]

- Improvements
 - Add timeout for while loop code.

[2.9.2]

- Improvements
 - Fixed CERT-C issues.

[2.9.1]

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

[2.9.0]

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

[2.8.4]

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

[2.8.3]

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

[2.8.2]

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

[2.8.1]

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

[2.8.0]

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

[2.7.2]

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

[2.7.1]

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

[2.7.0]

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

[2.6.2]

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

[2.6.1]

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

[2.6.0]

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

[2.5.2]

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

[2.5.1]

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

[2.5.0]

- Improvements
 - Added missing items to enable trigger interrupts.

[2.4.0]

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

[2.3.0]

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

[2.2.1]

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

[2.2.0]

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

[2.1.1]

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

[2.1.0]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

MCAN

[2.4.2]

- Bug Fixes
 - Fixed MISRA issue rule-10.3, rule-10.6, rule-10.7 and rule-15.7.

[2.4.1]

- Bug Fixes
 - Fixed incorrect fifo1 status on message lost.

[2.4.0]

- Improvements
 - Add MCAN_CalculateSpecifiedTimingValues() API to get CAN bit timing parameter with user-defined settings.
 - Add MCAN_FDCalculateSpecifiedTimingValues() API to get CANFD bit timing parameter with user-defined settings.

[2.3.2]

- Bug Fixes
 - Fix MISRA C-2012 issue 10.1 and 10.4.

[2.3.1]

- Bug Fixes
 - Fixed the issue that MCAN_TransferSendNonBlocking() API can't send remote frame.

[2.3.0]

- Improvements
 - Add MCAN_SetMessageRamConfig() API to perform global message RAM configure.
 - Add MCAN_EnterInitialMode() API.

[2.2.0]

- Improvements
 - Add MCAN_SetBaudRate/MCAN_SetBaudRateFD APIs to make users easy to set CAN baud rate.

[2.1.8]

- Bug Fixes
 - Add check FIFO status code in MCAN_ReadRxFifo() to avoid read back empty frame and wrong trigger the FIFO index increase.

[2.1.7]

- Bug Fixes
 - Fixed the clear error flags issue in MCAN_TransferHandleIRQ() API.
 - Fixed the Solve Tx interrupt issue in MCAN_TransferHandleIRQ() API which may abort the unhandled transfers.
 - Remove disable global tx interrupt from MCAN_TransferAbortSend API.

[2.1.6]

- Bug Fixes
 - Fixed the issue of writing 1 in the following functions.
 - MCAN_TransmitAddRequest
 - MCAN_TransmitCancelRequest
 - MCAN_ClearRxBufferStatusFlag

[2.1.5]

- Bug Fixes
 - Fix MISRA C-2012 issue.

[2.1.4]

- Improvements
 - Updated improve timing APIs to make it can calculate the CiA recommended timing configuration.
 - Implement Transmitter Delay Compensation feature.
 - Modify the default baudRateFD value to 2M.
- Bug Fixes
 - Fixed the code error issue in MCAN_ClearStatusFlag() to avoid clear all flags.

[2.1.3]

- Bug Fixes
 - Fixed the code error issue and simplified the algorithm in improved timing APIs.
 - * MCAN_CalculateImprovedTimingValues
 - * MCAN_FDCalculateImprovedTimingValues

[2.1.2]

- Bug Fixes
 - Fixed the non-divisible case in improved timing APIs.
 - * MCAN_CalculateImprovedTimingValues
 - * MCAN_FDCalculateImprovedTimingValues

[2.1.1]

- Bug Fixes
 - MISRA C-2012 issue check.
 - * Fixed rules, containing: rule-10.1, rule-10.3, rule-10.4, rule-10.6, rule-10.7, rule-10.8, rule-11.9, rule-14.4, rule-15.5, rule-15.6, rule-15.7, rule-17.7, rule-18.4, rule-2.2, rule-21.15, rule-5.8, rule-8.3.
 - * Fixed the Coverity issue of BAD_SHIFT in MCAN.
 - * Fixed the issue of Pa082 warning.
 - * Fixed the issue of dropping interrupt flags in handler function.

[2.1.0]

- Bug Fixes
 - Fixed Coverity issue FORWARD_NULL.
 - Fixed Clang issue.
 - Fixed legacy issue in the driver and changed default bus data baud rate for CANFD.
- Improvements
 - Implemented feature for improved timing configuration.

[2.0.3]

- Improvements
 - Used memset to initialize the structure before using.
 - Added function definition comment in c file.
 - Updated source file license to SPDX BSD_3.
 - Corrected capital mistake of Fifo and fifo.
 - Reset the MCAN module in LPC drivers after clock enable.

[2.0.2]

- Bug Fixes
 - Picked MISRA fixed in release 8 branch.
 - MISRA C 2012 fixed regarding FlexCAN and MCAN address update.
- Improvements
 - Implemented for delay/retry in MCAN driver.

[2.0.1]

- Improvements
 - LPC54608 chip did not support the FD feature, so added a feature macro for it.

[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.
-

OSTIMER

[2.2.5]

- Improvements
 - Support binary encoded ostimer.

[2.2.4]

- Bug Fixes
 - Fixed CERT INT31-C violations.

[2.2.3]

- Improvements
 - Disable and clear pending interrupts before disabling the OSTIMER clock to avoid interrupts being executed when the clock is already disabled.

[2.2.2]

- Improvements
 - Support devices with different OSTIMER instance name.

[2.2.1]

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

[2.2.0]

- Improvements
 - Move the PMC operation out of the OSTIMER driver to board specific files.
 - Added low level APIs to control OSTIMER MATCH and interrupt.

[2.1.2]

- Bug Fixes
 - Fixed MISRA-2012 rule 10.8.

[2.1.1]

- Bug Fixes
 - removes the suffix 'n' for some register names and bit fields' names
- Improvements
 - Added HW CODE GRAY feature supported by CODE GRAY in SYSCTRL register group.

[2.1.0]

- Bug Fixes
 - Added a workaround to fix the issue that no interrupt was reported when user set smaller period.
 - Fixed violation of MISRA C-2012 rule 10.3 and 11.9.
- Improvements
 - Added return value for the two APIs to set match value.
 - * OSTIMER_SetMatchRawValue
 - * OSTIMER_SetMatchValue

[2.0.3]

- Bug Fixes
 - Fixed violation of MISRA C-2012 rule 10.3, 14.4, 17.7.

[2.0.2]

- Improvements
 - Added support for OSTIMER0

[2.0.1]

- Improvements
 - Removed the software reset function out of the initialization API.
 - Enabled interrupt directly instead of enabling deep sleep interrupt. Users need to enable the deep sleep interrupt in application code if needed.

[2.0.0]

- Initial version.
-

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.
-

PLU

[2.2.1]

- Bug Fixes
 - Fixed MISRA C-2012 rule 10.3 and rule 17.7.

[2.2.0]

- Bug Fixes
 - Fixed wrong parameter of the PLU_EnableWakeIntRequest function.

[2.1.0]

- New Features
 - Added 4 new APIs to support Niobe4's wake-up/interrupt control feature, including PLU_GetDefaultWakeIntConfig(), PLU_EnableWakeIntRequest(), PLU_LatchInterrupt() and PLU_ClearLatchedInterrupt().
- Other Changes
 - Changed the register name LUT_INP to LUT_INP_MUX due to register map update.

[2.0.1]

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

[2.0.0]

- Initial version.
-

PRINCE

- Version 2.6.0
- Renamed CSS to ELS.
 - Version 2.5.1
- Fix build error due to renamed symbols.
 - Version 2.3.2
- Fix documentation of enumeration.
- Extend PRINCE example.
 - Version 2.3.1
- Fix MISRA-2012 issues.
- Add support for LPC55S0x series
 - Version 2.3.0
- Add support for LPC55S1x and LPC55S2x series
 - Version 2.2.0
- Add runtime checking of the A0 and A1 rev. of LPC55Sxx serie to support both silicone revisions.
 - Version 2.1.0
- Update for the A1 rev. of LPC55Sxx serie.

[2.0.0]

- Initial version.
-

PUF

[2.2.0]

- Add support for kPUF_KeySlot4.
- Add new PUF_ClearKey() function, that clears a desired PUF internal HW key register.

[2.1.6]

- Changed wait time in PUF_Init(), when initialization fails it will try PUF_Powercycle() with shorter time. If this shorter time will also fail, initialization will be tried with worst case time as before.

[2.1.5]

- Use common SDK delay in puf_wait_usec().

[2.1.4]

- Replace register uint32_t ticksCount with volatile uint32_t ticksCount in puf_wait_usec() to prevent optimization out delay loop.

[2.1.3]

- Fix MISRA C-2012 issue.

[2.1.2]

- Update: Add automatic big to little endian swap for user (pre-shared) keys destined to secret hardware bus (PUF key index 0).

[2.1.1]

- Fix ARMGCC build warning .

[2.1.0]

- Align driver with PUF SRAM controller registers on LPCXpresso55s16.
- Update initialization logic .

[2.0.3]

- Fix MISRA C-2012 issue.

[2.0.2]

- New feature:
 - Add PUF configuration structure and support for PUF SRAM controller.
- Improvements:
 - Remove magic constants.

[2.0.1]

- Bug Fixes:
 - Fixed puf_wait_usec function optimization issue.

[2.0.0]

- Initial version.
-

RESET

[2.4.0]

- Improvements
 - Add RESET_ReleasePeripheralReset API.

[2.3.3]

- Improvements
 - Add CASPER_RSTS, HASHCRYPT_RSTS and PUF_RSTS

[2.0.1]

- Improvements
 - Updated component full_name to “Reset Driver”.

[2.0.0]

- Initial version.
-

RNG**[2.0.3]**

- Modified RNG_Init and RNG_GetRandomData functions, added rng_accumulateEntropy and rng_readEntropy functions. These changes are reflecting recommended usage of RNG according to device UM

[2.0.2]

- Add RESET_PeripheralReset function inside RNG_Init and RNG_Deinit functions.

[2.0.1]

- Fix MISRA C-2012 issue.

[2.0.0]

- Initial version.
-

RTC**[2.2.0]**

- New Features
 - Created new APIs for the RTC driver.
 - * RTC_EnableSubsecCounter
 - * RTC_GetSubsecValue

[2.1.3]

- Bug Fixes
 - Fixed issue that RTC_GetWakeupCount may return wrong value.

[2.1.2]

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

[2.1.1]

- Bug Fixes
 - MISRA C-2012 issue fixed: rule 10.3 and 11.9.

[2.1.0]

- Bug Fixes
 - Created new APIs for the RTC driver.
 - * RTC_EnableTimer
 - * RTC_EnableWakeUpTimerInterruptFromDPD
 - * RTC_EnableAlarmTimerInterruptFromDPD
 - * RTC_EnableWakeupTimer
 - * RTC_GetEnabledWakeupTimer
 - * RTC_SetSecondsTimerMatch
 - * RTC_GetSecondsTimerMatch
 - * RTC_SetSecondsTimerCount
 - * RTC_GetSecondsTimerCount
 - deprecated legacy APIs for the RTC driver.
 - * RTC_StartTimer
 - * RTC_StopTimer
 - * RTC_EnableInterrupts
 - * RTC_DisableInterrupts
 - * RTC_GetEnabledInterrupts

[2.0.0]

- Initial version.
-

SCTIMER

[2.5.1]

- Bug Fixes
 - Fixed bug in SCTIMER_SetupCaptureAction: When kSCTIMER_Counter_H is selected, events 12-15 and capture registers 12-15 CAPn_H field can't be used.

[2.5.0]

- Improvements
 - Add SCTIMER_GetCaptureValue API to get capture value in capture registers.

[2.4.9]

- Improvements
 - Supported platforms which don't have system level SCTIMER reset.

[2.4.8]

- Bug Fixes
 - Fixed the issue that the SCTIMER_UpdatePwmDutycycle() can't writes MATCH_H bit and RELOADn_H.

[2.4.7]

- Bug Fixes
 - Fixed the issue that the SCTIMER_UpdatePwmDutycycle() can't configure 100% duty cycle PWM.

[2.4.6]

- Bug Fixes
 - Fixed the issue where the H register was not written as a word along with the L register.
 - Fixed the issue that the SCTIMER_SetCOUNTValue() is not configured with high 16 bits in unify mode.

[2.4.5]

- Bug Fixes
 - Fix SCT_EV_STATE_STATEMSKn macro build error.

[2.4.4]

- Bug Fixes
 - Fix MISRA C-2012 issue 10.8.

[2.4.3]

- Bug Fixes
 - Fixed the wrong way of writing CAPCTRL and REGMODE registers in SCTIMER_SetupCaptureAction.

[2.4.2]

- Bug Fixes
 - Fixed SCTIMER_SetupPwm 100% duty cycle issue.

[2.4.1]

- Bug Fixes
 - Fixed the issue that MATCHn_H bit and RELOADn_H bit could not be written.

[2.4.0]

[2.3.0]

- Bug Fixes
 - Fixed the potential overflow issue of pulseperiod variable in SCTIMER_SetupPwm/SCTIMER_UpdatePwmDutycycle API.
 - Fixed the issue of SCTIMER_CreateAndScheduleEvent API does not correctly work with 32 bit unified counter.
 - Fixed the issue of position of clear counter operation in SCTIMER_Init API.
- Improvements
 - Update SCTIMER_SetupPwm/SCTIMER_UpdatePwmDutycycle to support generate 0% and 100% PWM signal.
 - Add SCTIMER_SetupEventActiveDirection API to configure event activity direction.
 - Update SCTIMER_StartTimer/SCTIMER_StopTimer API to support start/stop low counter and high counter at the same time.
 - Add SCTIMER_SetCounterState/SCTIMER_GetCounterState API to write/read counter current state value.
 - Update APIs to make it meaningful.
 - * SCTIMER_SetEventInState
 - * SCTIMER_ClearEventInState
 - * SCTIMER_GetEventInState

[2.2.0]

- Improvements
 - Updated for 16-bit register access.

[2.1.3]

- Bug Fixes
 - Fixed the issue of uninitialized variables in SCTIMER_SetupPwm.
 - Fixed the issue that the Low 16-bit and high 16-bit work independently in SCTIMER driver.
- Improvements
 - Added an enumerable macro of unify counter for user.
 - * kSCTIMER_Counter_U
 - Created new APIs for the RTC driver.
 - * SCTIMER_SetupStateLdMethodAction
 - * SCTIMER_SetupNextStateActionwithLdMethod
 - * SCTIMER_SetCOUNTValue
 - * SCTIMER_GetCOUNTValue
 - * SCTIMER_SetEventInState
 - * SCTIMER_ClearEventInState

- * SCTIMER_GetEventInState
- Deprecated legacy APIs for the RTC driver.
- * SCTIMER_SetupNextStateAction

[2.1.2]

- Bug Fixes
 - MISRA C-2012 issue fixed: rule 10.3, 10.4, 10.6, 10.7, 11.9, 14.2 and 15.5.

[2.1.1]

- Improvements
 - Updated the register and macro names to align with the header of devices.

[2.1.0]

- Bug Fixes
 - Fixed issue where SCT application level Interrupt handler function is occupied by SCT driver.
 - Fixed issue where wrong value for INSYNC field inside SCTIMER_Init function.
 - Fixed issue to change Default value for INSYNC field inside SCTIMER_GetDefaultConfig.

[2.0.1]

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

[2.0.0]

- Initial version.
-

SPI

[2.3.2]

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

[2.3.1]

- Improvements
 - Changed SPI_DUMMYDATA to 0x00.

[2.3.0]

- Update version.

[2.2.2]

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

[2.2.1]

- Bug Fixes
 - Fixed MISRA 2012 10.4 issue.
 - Added code to clear FIFOs before transfer using DMA.

[2.2.0]

- Bug Fixes
 - Fixed bug that slave gets stuck during interrupt transfer.

[2.1.1]

- Improvements
 - Added timeout mechanism when waiting certain states in transfer driver.
- Bug Fixes
 - Fixed MISRA 10.1, 5.7 issues.

[2.1.0]

- Bug Fixes
 - Fixed Coverity issue of incrementing null pointer in SPI_TransferHandleIRQInternal.
 - Eliminated IAR Pa082 warnings.
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.
- New Features
 - Modified the definition of SPI_SSELPOL_MASK to support the socs that have only 3 SSEL pins.

[2.0.4]

- Bug Fixes
 - Fixed the bug of using read only mode in DMA transfer. In DMA transfer mode, if transfer->txData is NULL, code attempts to read data from the address of 0x0 for configuring the last frame.
 - Fixed wrong assignment of handle->state. During transfer handle->state should be kSPI_Busy rather than kStatus_SPI_Busy.
- Improvements
 - Rounded up the calculated divider value in SPI_MasterSetBaud.

[2.0.3]

- Improvements
 - Added “SPI_FIFO_DEPTH(base)” with more definition.

[2.0.2]

- Improvements
 - Unified the component full name to FLEXCOMM SPI(DMA/FREERTOS) driver.

[2.0.1]

- Changed the data buffer from uint32_t to uint8_t which matches the real applications for SPI DMA driver.
- Added dummy data setup API to allow users to configure the dummy data to be transferred.
- Added new APIs for half-duplex transfer function. Users can not only send and receive data by one API in polling/interrupt/DMA way, but choose either to transmit first or to receive first. Besides, the PCS pin can be configured as assert status in transmission (between transmit and receive) by setting the isPcsAssertInTransfer to true.

[2.0.0]

- Initial version.
-

SPI_DMA**[2.2.2]**

- Bug Fixes
 - Fixed the bug half duplex mode can't be used if data size is larger than 1024 bytes.

[2.2.1]

- Bug Fixes
 - Fixed MISRA 2012 11.6 issue..

[2.2.0]

- Improvements
 - Supported dataSize larger than 1024 data transmit.
-

SYSCTL**[2.0.5]**

- Bug Fixes:
 - Fixed violations of MISRA C-2012 rule 8.3, 10.1, 10.4, 10.7.

[2.0.4]

- Improvements:
 - Update macro name to align with the header of devices.

[2.0.3]

- Improvements:
 - Update the register and macro name to align with the header of devices.

[2.0.2]

- Removed kSYSCTL_Flexcomm3DataOut enumeration definition.

[2.0.1]

- Fixed some typo error comments and improved driver integral ability.

[2.0.0]

- Initial version.
-

USART

[2.8.5]

- Bug Fixes
 - Fixed race condition during call of USART_EnableTxDMA and USART_EnableRxDMA.

[2.8.4]

- Bug Fixes
 - Fixed exclusive access in USART_TransferReceiveNonBlocking and USART_TransferSendNonBlocking.

[2.8.3]

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

[2.8.2]

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

[2.8.1]

- Bug Fixes
 - Fixed the Baud Rate Generator(BRG) configuration in 32kHz mode.

[2.8.0]

- New Features
 - Added the rx timeout interrupts and status flags of bus status.
 - Added new rx timeout configuration item in `usart_config_t`.
 - Added API `USART_SetRxTimeoutConfig` for rx timeout configuration.
- Improvements
 - When the calculated baudrate cannot meet user's configuration, lower OSR value is allowed to use.

[2.7.0]

- New Features
 - Added the missing interrupts and status flags of bus status.
 - Added the check of tx error, noise error framing error and parity error in interrupt handler.

[2.6.0]

- 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.
- New Features
 - Added missing API `USART_TransferGetSendCountDMA` get send count using DMA.

[2.5.0]

- New Features
 - Added APIs `USART_GetRxFifoCount`/`USART_GetTxFifoCount` to get rx/tx FIFO data count.
 - Added APIs `USART_SetRxFifoWatermark`/`USART_SetTxFifoWatermark` to set rx/tx FIFO water mark.
- Bug Fixes
 - Fixed DMA transfer blocking issue by enabling tx idle interrupt after DMA transmission finishes.

[2.4.0]

- New Features
 - Modified `usart_config_t`, `USART_Init` and `USART_GetDefaultConfig` APIs so that the hardware flow control can be enabled during module initialization.
- Bug Fixes
 - Fixed MISRA 10.4 violation.

[2.3.1]

- Bug Fixes
 - Fixed bug that operation on INTENSET, INTENCLR, FIFOINTENSET and FIFOINTENCLR should use bitwise operation not ‘or’ operation.
 - Fixed bug that if rx interrupt occurs before TX interrupt is enabled and after txDataSize is configured, the data will be sent early by mistake, thus TX interrupt will be enabled after data is sent out.
- Improvements
 - Added check for baud rate’s accuracy that returns kStatus_USART_BaudrateNotSupport when the best achieved baud rate is not within 3% error of configured baud rate.

[2.3.0]

- New Features
 - Added APIs to configure 9-bit data mode, set slave address and send address.
 - Modified USART_TransferReceiveNonBlocking and USART_TransferHandleIRQ to use 9-bit mode in multi-slave system.

[2.2.0]

- New Features
 - Added the feature of supporting USART working at 32 kHz clocking mode.
- Improvements
 - Modified USART_TransferHandleIRQ so that txState will be set to idle only when all data has been sent out to bus.
 - Modified USART_TransferGetSendCount so that this API returns the real byte count that USART has sent out rather than the software buffer status.
 - Added timeout mechanism when waiting for certain states in transfer driver.
- Bug Fixes
 - Fixed MISRA 10.1 issues.
 - Fixed bug that operation on INTENSET, INTENCLR, FIFOINTENSET and FIFOINTENCLR should use bitwise operation not ‘or’ operation.
 - Fixed bug that if rx interrupt occurs before TX interrupt is enabled and after txDataSize is configured, the data will be sent early by mistake, thus TX interrupt will be enabled after data is sent out.

[2.1.1]

- Improvements
 - Added check for transmitter idle in USART_TransferHandleIRQ and USART_TransferSendDMACallback to ensure all the data would be sent out to bus.
 - 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.
- Bug Fixes
 - Eliminated IAR Pa082 warnings.

- Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.

[2.1.0]

- New Features
 - Added features to allow users to configure the USART to synchronous transfer(master and slave) mode.
- Bug Fixes
 - Modified USART_SetBaudRate to get more accurate configuration.

[2.0.3]

- New Features
 - Added new APIs to allow users to enable the CTS which determines whether CTS is used for flow control.

[2.0.2]

- Bug Fixes
 - Fixed the bug where transfer abort APIs could not disable the interrupts. The FIFOINTENSET register should not be used to disable the interrupts, so use the FIFOINTENCLR register instead.

[2.0.1]

- Improvements
 - Unified the component full name to FLEXCOMM USART (DMA/FREERTOS) driver.

[2.0.0]

- Initial version.
-

USART_DMA

[2.6.0]

- Refer USART driver change log 2.0.1 to 2.6.0
-

UTICK

[2.0.5]

- Improvements
 - Improved for SOC RW610.

[2.0.4]

- Bug Fixes
 - Fixed compile fail issue of no-supporting PD configuration in utick driver.

[2.0.3]

- Bug Fixes
 - Fixed violations of MISRA C-2012 rules: 8.4, 14.4, 17.7

[2.0.2]

- Added new feature definition macro to enable/disable power control in drivers for some devices have no power control function.

[2.0.1]

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

[2.0.0]

- Initial version.
-

WWDT

[2.1.10]

- Bug Fixes
 - Chek 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 WWWDT 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.

[LPC55S06](#)

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](#)

1.7.3 File systemFatfs

[fatfs](#)

Chapter 2

LPC55S06

2.1 ANACTRL: Analog Control Driver

void ANACTRL_Init(ANACTRL_Type *base)

Initializes the ANACTRL mode, the module's clock will be enabled by invoking this function.

Parameters

- base – ANACTRL peripheral base address.

void ANACTRL_Deinit(ANACTRL_Type *base)

De-initializes ANACTRL module, the module's clock will be disabled by invoking this function.

Parameters

- base – ANACTRL peripheral base address.

void ANACTRL_SetFro192M(ANACTRL_Type *base, const *anactrl_fro192M_config_t* *config)

Configures the on-chip high-speed Free Running Oscillator(FRO192M), such as enabling/disabling 12 MHz clock output and enable/disable 96MHz clock output.

Parameters

- base – ANACTRL peripheral base address.
- config – Pointer to FRO192M configuration structure. Refer to *anactrl_fro192M_config_t* structure.

void ANACTRL_GetDefaultFro192MConfig(*anactrl_fro192M_config_t* *config)

Gets the default configuration of FRO192M. The default values are:

```
config->enable12MHzClk = true;  
config->enable96MHzClk = false;
```

Parameters

- config – Pointer to FRO192M configuration structure. Refer to *anactrl_fro192M_config_t* structure.

void ANACTRL_SetXo32M(ANACTRL_Type *base, const *anactrl_xo32M_config_t* *config)

Configures the 32 MHz Crystal oscillator(High-speed crystal oscillator), such as enable/disable output to CPU system, and so on.

Parameters

- `base` – ANACTRL peripheral base address.
- `config` – Pointer to XO32M configuration structure. Refer to `anactrl_xo32M_config_t` structure.

`void ANACTRL_GetDefaultXo32MConfig(anactrl_xo32M_config_t *config)`

Gets the default configuration of XO32M. The default values are:

```
config->enableSysClkOutput = false;  
config->enableACBufferBypass = false;
```

Parameters

- `config` – Pointer to XO32M configuration structure. Refer to `anactrl_xo32M_config_t` structure.

`uint32_t ANACTRL_MeasureFrequency(ANACTRL_Type *base, uint8_t scale, uint32_t refClkFreq)`

Measures the frequency of the target clock source.

This function measures target frequency according to a accurate reference frequency. The formula is: $F_{target} = (CAPVAL * F_{reference}) / ((1 \ll SCALE) - 1)$

Note: Both target and reference clocks are selectable by programming the target clock select `FREQMEAS_TARGET` register in `INPUTMUX` and reference clock select `FREQMEAS_REF` register in `INPUTMUX`.

Parameters

- `base` – ANACTRL peripheral base address.
- `scale` – Define the power of 2 count that ref counter counts to during measurement, ranges from 2 to 31.
- `refClkFreq` – frequency of the reference clock.

Returns

frequency of the target clock.

`static inline void ANACTRL_EnableInterrupts(ANACTRL_Type *base, uint32_t mask)`

Enables the ANACTRL interrupts.

Parameters

- `base` – ANACTRL peripheral base address.
- `mask` – The interrupt mask. Refer to “`_anactrl_interrupt`” enumeration.

`static inline void ANACTRL_DisableInterrupts(ANACTRL_Type *base, uint32_t mask)`

Disables the ANACTRL interrupts.

Parameters

- `base` – ANACTRL peripheral base address.
- `mask` – The interrupt mask. Refer to “`_anactrl_interrupt`” enumeration.

`static inline void ANACTRL_ClearInterrupts(ANACTRL_Type *base, uint32_t mask)`

Clears the ANACTRL interrupts.

Parameters

- `base` – ANACTRL peripheral base address.
- `mask` – The interrupt mask. Refer to “`_anactrl_interrupt`” enumeration.

static inline uint32_t ANACTRL_GetStatusFlags(ANACTRL_Type *base)

Gets ANACTRL status flags.

This function gets Analog control status flags. The flags are returned as the logical OR value of the enumerators `_anactrl_flags`. To check for a specific status, compare the return value with enumerators in the `_anactrl_flags`. For example, to check whether the flash is in power down mode:

```
if (kANACTRL_FlashPowerDownFlag & ANACTRL_ANACTRL_GetStatusFlags(ANACTRL))
{
    ...
}
```

Parameters

- `base` – ANACTRL peripheral base address.

Returns

ANACTRL status flags which are given in the enumerators in the `_anactrl_flags`.

static inline uint32_t ANACTRL_GetOscStatusFlags(ANACTRL_Type *base)

Gets ANACTRL oscillators status flags.

This function gets Anactrl oscillators status flags. The flags are returned as the logical OR value of the enumerators `_anactrl_osc_flags`. To check for a specific status, compare the return value with enumerators in the `_anactrl_osc_flags`. For example, to check whether the FRO192M clock output is valid:

```
if (kANACTRL_OutputClkValidFlag & ANACTRL_ANACTRL_GetOscStatusFlags(ANACTRL))
{
    ...
}
```

Parameters

- `base` – ANACTRL peripheral base address.

Returns

ANACTRL oscillators status flags which are given in the enumerators in the `_anactrl_osc_flags`.

static inline uint32_t ANACTRL_GetInterruptStatusFlags(ANACTRL_Type *base)

Gets ANACTRL interrupt status flags.

This function gets Anactrl interrupt status flags. The flags are returned as the logical OR value of the enumerators `_anactrl_interrupt_flags`. To check for a specific status, compare the return value with enumerators in the `_anactrl_interrupt_flags`. For example, to check whether the VBAT voltage level is above the threshold:

```
if (kANACTRL_BodVbatPowerFlag & ANACTRL_ANACTRL_GetInterruptStatusFlags(ANACTRL))
{
    ...
}
```

Parameters

- `base` – ANACTRL peripheral base address.

Returns

ANACTRL oscillators status flags which are given in the enumerators in the `_anactrl_osc_flags`.

static inline void ANACTRL_EnableVref1V(ANACTRL_Type *base, bool enable)

Aux_Bias Control Interfaces.

Enables/disables 1V reference voltage buffer.

Parameters

- base – ANACTRL peripheral base address.
- enable – Used to enable or disable 1V reference voltage buffer.

enum __anactrl_interrupt_flags

ANACTRL interrupt flags.

Values:

enumerator kANACTRL_BodVbatFlag

BOD VBAT Interrupt status before Interrupt Enable.

enumerator kANACTRL_BodVbatInterruptFlag

BOD VBAT Interrupt status after Interrupt Enable.

enumerator kANACTRL_BodVbatPowerFlag

Current value of BOD VBAT power status output.

enumerator kANACTRL_BodCoreFlag

BOD CORE Interrupt status before Interrupt Enable.

enumerator kANACTRL_BodCoreInterruptFlag

BOD CORE Interrupt status after Interrupt Enable.

enumerator kANACTRL_BodCorePowerFlag

Current value of BOD CORE power status output.

enumerator kANACTRL_DcdcFlag

DCDC Interrupt status before Interrupt Enable.

enumerator kANACTRL_DcdcInterruptFlag

DCDC Interrupt status after Interrupt Enable.

enumerator kANACTRL_DcdcPowerFlag

Current value of DCDC power status output.

enum __anactrl_interrupt

ANACTRL interrupt control.

Values:

enumerator kANACTRL_BodVbatInterruptEnable

BOD VBAT interrupt control.

enumerator kANACTRL_BodCoreInterruptEnable

BOD CORE interrupt control.

enumerator kANACTRL_DcdcInterruptEnable

DCDC interrupt control.

enum __anactrl_flags

ANACTRL status flags.

Values:

enumerator kANACTRL_FlashPowerDownFlag

Flash power-down status.

enumerator kANACTRL_FlashInitErrorFlag

Flash initialization error status.

enum _anactrl_osc_flags

ANACTRL FRO192M and XO32M status flags.

Values:

enumerator kANACTRL_OutputClkValidFlag

Output clock valid signal.

enumerator kANACTRL_CCOTresholdVoltageFlag

CCO threshold voltage detector output (signal vcco_ok).

enumerator kANACTRL_XO32MOutputReadyFlag

Indicates XO out frequency statibility.

typedef struct *_anactrl_fro192M_config* anactrl_fro192M_config_t

Configuration for FRO192M.

This structure holds the configuration settings for the on-chip high-speed Free Running Oscillator. To initialize this structure to reasonable defaults, call the ANACTRL_GetDefaultFro192MConfig() function and pass a pointer to your config structure instance.

typedef struct *_anactrl_xo32M_config* anactrl_xo32M_config_t

Configuration for XO32M.

This structure holds the configuration settings for the 32 MHz crystal oscillator. To initialize this structure to reasonable defaults, call the ANACTRL_GetDefaultXo32MConfig() function and pass a pointer to your config structure instance.

FSL_ANACTRL_DRIVER_VERSION

ANACTRL driver version.

struct _anactrl_fro192M_config

#include <fsl_anactrl.h> Configuration for FRO192M.

This structure holds the configuration settings for the on-chip high-speed Free Running Oscillator. To initialize this structure to reasonable defaults, call the ANACTRL_GetDefaultFro192MConfig() function and pass a pointer to your config structure instance.

Public Members

bool enable12MHzClk

Enable 12MHz clock.

bool enable96MHzClk

Enable 96MHz clock.

struct _anactrl_xo32M_config

#include <fsl_anactrl.h> Configuration for XO32M.

This structure holds the configuration settings for the 32 MHz crystal oscillator. To initialize this structure to reasonable defaults, call the ANACTRL_GetDefaultXo32MConfig() function and pass a pointer to your config structure instance.

Public Members

`bool enableACBufferBypass`

Enable XO AC buffer bypass in pll and top level.

`bool enableSysCLkOutput`

Enable XO 32 MHz output to CPU system, SCT, and CLKOUT

`bool enableADCOutput`

Enable High speed crystal oscillator output to ADC.

2.2 CASPER: The Cryptographic Accelerator and Signal Processing Engine with RAM sharing

2.3 casper_driver

`FSL_CASPER_DRIVER_VERSION`

CASPER driver version. Version 2.2.4.

Current version: 2.2.4

Change log:

- Version 2.0.0
 - Initial version
- Version 2.0.1
 - Bug fix KPSDK-24531 `double_scalar_multiplication()` result may be all zeroes for some specific input
- Version 2.0.2
 - Bug fix KPSDK-25015 `CASPER_MEMCPY` hard-fault on LPC55xx when both source and destination buffers are outside of `CASPER_RAM`
- Version 2.0.3
 - Bug fix KPSDK-28107 `RSUB`, `FILL` and `ZERO` operations not implemented in `enum_casper_operation`.
- Version 2.0.4
 - For GCC compiler, enforce `O1` optimize level, specifically to remove strict-aliasing option. This driver is very specific and requires `-fno-strict-aliasing`.
- Version 2.0.5
 - Fix sign-compare warning.
- Version 2.0.6
 - Fix IAR Pa082 warning.
- Version 2.0.7
 - Fix MISRA-C 2012 issue.
- Version 2.0.8
 - Add feature macro for `CASPER_RAM_OFFSET`.
- Version 2.0.9
 - Remove unused function `Jac_oncurve()`.
 - Fix ECC384 build.

- Version 2.0.10
 - Fix MISRA-C 2012 issue.
- Version 2.1.0
 - Add ECC NIST P-521 elliptic curve.
- Version 2.2.0
 - Rework driver to support multiple curves at once.
- Version 2.2.1
 - Fix MISRA-C 2012 issue.
- Version 2.2.2
 - Enable hardware interleaving to RAMX0 and RAMX1 for CASPER by feature macro FSL_FEATURE_CASPER_RAM_HW_INTERLEAVE
- Version 2.2.3
 - Added macro into CASPER_Init and CASPER_Deinit to support devices without clock and reset control.
- Version 2.2.4
 - Fix MISRA-C 2012 issue.

enum _casper_operation
CASPER operation.

Values:

enumerator kCASPER_OpMul6464NoSum

enumerator kCASPER_OpMul6464Sum

Walking 1 or more of J loop, doing $r=a*b$ using $64x64=128$

enumerator kCASPER_OpMul6464FullSum

Walking 1 or more of J loop, doing $c,r=r+a*b$ using $64x64=128$, but assume inner j loop

enumerator kCASPER_OpMul6464Reduce

Walking 1 or more of J loop, doing $c,r=r+a*b$ using $64x64=128$, but sum all of w.

enumerator kCASPER_OpAdd64

Walking 1 or more of J loop, doing $c,r[-1]=r+a*b$ using $64x64=128$, but skip 1st write

enumerator kCASPER_OpSub64

Walking add with off_AB, and in/out off_RES doing $c,r=r+a+c$ using $64+64=65$

enumerator kCASPER_OpDouble64

Walking subtract with off_AB, and in/out off_RES doing $r=r-a$ using $64-64=64$, with last borrow implicit if any

enumerator kCASPER_OpXor64

Walking add to self with off_RES doing $c,r=r+r+c$ using $64+64=65$

enumerator kCASPER_OpRSub64

Walking XOR with off_AB, and in/out off_RES doing $r=r^a$ using $64^64=64$

enumerator kCASPER_OpShiftLeft32

Walking subtract with off_AB, and in/out off_RES using $r=a-r$

enumerator kCASPER_OpShiftRight32

Walking shift left doing $r1,r=(b*D)|r1$, where D is 2^{amt} and is loaded by app (off_CD not used)

enumerator kCASPER_OpCopy

Walking shift right doing $r, r1 = (b * D) | r1$, where D is $2^{(32 - \text{amt})}$ and is loaded by app (off_CD not used) and off_RES starts at MSW

enumerator kCASPER_OpRemask

Copy from ABoff to resoff, 64b at a time

enumerator kCASPER_OpFill

Copy and mask from ABoff to resoff, 64b at a time

enumerator kCASPER_OpZero

Fill RESOFF using 64 bits at a time with value in A and B

enumerator kCASPER_OpCompare

Fill RESOFF using 64 bits at a time of 0s

enumerator kCASPER_OpCompareFast

Compare two arrays, running all the way to the end

enum _casper_algo_t

Algorithm used for CASPER operation.

Values:

enumerator kCASPER_ECC_P256

ECC_P256

enumerator kCASPER_ECC_P384

ECC_P384

enumerator kCASPER_ECC_P521

ECC_P521

Values:

enumerator kCASPER_RamOffset_Result

enumerator kCASPER_RamOffset_Base

enumerator kCASPER_RamOffset_TempBase

enumerator kCASPER_RamOffset_Modulus

enumerator kCASPER_RamOffset_M64

typedef enum _casper_operation casper_operation_t

CASPER operation.

typedef enum _casper_algo_t casper_algo_t

Algorithm used for CASPER operation.

void CASPER_Init(CASPER_Type *base)

Enables clock and disables reset for CASPER peripheral.

Enable clock and disable reset for CASPER.

Parameters

- base – CASPER base address

void CASPER_Deinit(CASPER_Type *base)

Disables clock for CASPER peripheral.

Disable clock and enable reset.

Parameters

- base – CASPER base address

CASPER_CP

CASPER_CP_CTRL0

CASPER_CP_CTRL1

CASPER_CP_LOADER

CASPER_CP_STATUS

CASPER_CP_INTENSET

CASPER_CP_INTENCLR

CASPER_CP_INTSTAT

CASPER_CP_AREG

CASPER_CP_BREG

CASPER_CP_CREG

CASPER_CP_DREG

CASPER_CP_RES0

CASPER_CP_RES1

CASPER_CP_RES2

CASPER_CP_RES3

CASPER_CP_MASK

CASPER_CP_REMASK

CASPER_CP_LOCK

CASPER_CP_ID

CASPER_Wr32b(value, off)

CASPER_Wr64b(value, off)

CASPER_Rd32b(off)

N_wordlen_max

2.4 casper_driver_pkha

void CASPER_ModExp(CASPER_Type *base, const uint8_t *signature, const uint8_t *pubN,
size_t wordLen, uint32_t pubE, uint8_t *plaintext)

Performs modular exponentiation - $(A^E) \bmod N$.

This function performs modular exponentiation.

Parameters

- base – CASPER base address

- signature – first addend (in little endian format)
- pubN – modulus (in little endian format)
- wordLen – Size of pubN in bytes
- pubE – exponent
- plaintext – **[out]** Output array to store result of operation (in little endian format)

void CASPER_ecc_init(*casper_algo_t* curve)

Initialize prime modulus mod in Casper memory .

Set the prime modulus mod in Casper memory and set N_wordlen according to selected algorithm.

Parameters

- curve – elliptic curve algorithm

void CASPER_ECC_SECP256R1_Mul(CASPER_Type *base, uint32_t resX[8], uint32_t resY[8],
uint32_t X[8], uint32_t Y[8], uint32_t scalar[8])

Performs ECC secp256r1 point single scalar multiplication.

This function performs ECC secp256r1 point single scalar multiplication [resX; resY] = scalar * [X; Y] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address
- resX – **[out]** Output X affine coordinate in normal form, little endian.
- resY – **[out]** Output Y affine coordinate in normal form, little endian.
- X – Input X affine coordinate in normal form, little endian.
- Y – Input Y affine coordinate in normal form, little endian.
- scalar – Input scalar integer, in normal form, little endian.

void CASPER_ECC_SECP256R1_MulAdd(CASPER_Type *base, uint32_t resX[8], uint32_t
resY[8], uint32_t X1[8], uint32_t Y1[8], uint32_t
scalar1[8], uint32_t X2[8], uint32_t Y2[8], uint32_t
scalar2[8])

Performs ECC secp256r1 point double scalar multiplication.

This function performs ECC secp256r1 point double scalar multiplication [resX; resY] = scalar1 * [X1; Y1] + scalar2 * [X2; Y2] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address
- resX – **[out]** Output X affine coordinate.
- resY – **[out]** Output Y affine coordinate.
- X1 – Input X1 affine coordinate.
- Y1 – Input Y1 affine coordinate.
- scalar1 – Input scalar1 integer.
- X2 – Input X2 affine coordinate.

- Y2 – Input Y2 affine coordinate.
- scalar2 – Input scalar2 integer.

```
void CASPER_ECC_SECP384R1_Mul(CASPER_Type *base, uint32_t resX[12], uint32_t resY[12],  
                             uint32_t X[12], uint32_t Y[12], uint32_t scalar[12])
```

Performs ECC secp384r1 point single scalar multiplication.

This function performs ECC secp384r1 point single scalar multiplication [resX; resY] = scalar * [X; Y] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address
- resX – **[out]** Output X affine coordinate in normal form, little endian.
- resY – **[out]** Output Y affine coordinate in normal form, little endian.
- X – Input X affine coordinate in normal form, little endian.
- Y – Input Y affine coordinate in normal form, little endian.
- scalar – Input scalar integer, in normal form, little endian.

```
void CASPER_ECC_SECP384R1_MulAdd(CASPER_Type *base, uint32_t resX[12], uint32_t  
                                resY[12], uint32_t X1[12], uint32_t Y1[12], uint32_t  
                                scalar1[12], uint32_t X2[12], uint32_t Y2[12], uint32_t  
                                scalar2[12])
```

Performs ECC secp384r1 point double scalar multiplication.

This function performs ECC secp384r1 point double scalar multiplication [resX; resY] = scalar1 * [X1; Y1] + scalar2 * [X2; Y2] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address
- resX – **[out]** Output X affine coordinate.
- resY – **[out]** Output Y affine coordinate.
- X1 – Input X1 affine coordinate.
- Y1 – Input Y1 affine coordinate.
- scalar1 – Input scalar1 integer.
- X2 – Input X2 affine coordinate.
- Y2 – Input Y2 affine coordinate.
- scalar2 – Input scalar2 integer.

```
void CASPER_ECC_SECP521R1_Mul(CASPER_Type *base, uint32_t resX[18], uint32_t resY[18],  
                              uint32_t X[18], uint32_t Y[18], uint32_t scalar[18])
```

Performs ECC secp521r1 point single scalar multiplication.

This function performs ECC secp521r1 point single scalar multiplication [resX; resY] = scalar * [X; Y] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address

- resX – **[out]** Output X affine coordinate in normal form, little endian.
- resY – **[out]** Output Y affine coordinate in normal form, little endian.
- X – Input X affine coordinate in normal form, little endian.
- Y – Input Y affine coordinate in normal form, little endian.
- scalar – Input scalar integer, in normal form, little endian.

```
void CASPER_ECC_SECP521R1_MulAdd(CASPER_Type *base, uint32_t resX[18], uint32_t  
                                resY[18], uint32_t X1[18], uint32_t Y1[18], uint32_t  
                                scalar1[18], uint32_t X2[18], uint32_t Y2[18], uint32_t  
                                scalar2[18])
```

Performs ECC secp521r1 point double scalar multiplication.

This function performs ECC secp521r1 point double scalar multiplication [resX; resY] = scalar1 * [X1; Y1] + scalar2 * [X2; Y2] Coordinates are affine in normal form, little endian. Scalars are little endian. All arrays are little endian byte arrays, uint32_t type is used only to enforce the 32-bit alignment (0-mod-4 address).

Parameters

- base – CASPER base address
- resX – **[out]** Output X affine coordinate.
- resY – **[out]** Output Y affine coordinate.
- X1 – Input X1 affine coordinate.
- Y1 – Input Y1 affine coordinate.
- scalar1 – Input scalar1 integer.
- X2 – Input X2 affine coordinate.
- Y2 – Input Y2 affine coordinate.
- scalar2 – Input scalar2 integer.

```
void CASPER_ECC_equal(int *res, uint32_t *op1, uint32_t *op2)
```

```
void CASPER_ECC_equal_to_zero(int *res, uint32_t *op1)
```

2.5 CDOG

```
status_t CDOG_Init(CDOG_Type *base, cdog_config_t *conf)
```

Initialize CDOG.

This function initializes CDOG block and setting.

Parameters

- base – CDOG peripheral base address
- conf – CDOG configuration structure

Returns

Status of the init operation

```
void CDOG_Deinit(CDOG_Type *base)
```

Deinitialize CDOG.

This function deinitializes CDOG secure counter.

Parameters

- base – CDOG peripheral base address

void CDOG_GetDefaultConfig(*cdog_config_t* *conf)

Sets the default configuration of CDOG.

This function initialize CDOG config structure to default values.

Parameters

- conf – CDOG configuration structure

void CDOG_Stop(CDOG_Type *base, uint32_t stop)

Stops secure counter and instruction timer.

This function stops instruction timer and secure counter. This also change state of CDOG to IDLE.

Parameters

- base – CDOG peripheral base address
- stop – expected value which will be compared with value of secure counter

void CDOG_Start(CDOG_Type *base, uint32_t reload, uint32_t start)

Sets secure counter and instruction timer values.

This function sets value in RELOAD and START registers for instruction timer and secure counter

Parameters

- base – CDOG peripheral base address
- reload – reload value
- start – start value

void CDOG_Check(CDOG_Type *base, uint32_t check)

Checks secure counter.

This function compares stop value in handler with secure counter value by writing to RELOAD register.

Parameters

- base – CDOG peripheral base address
- check – expected (stop) value

void CDOG_Set(CDOG_Type *base, uint32_t stop, uint32_t reload, uint32_t start)

Sets secure counter and instruction timer values.

This function sets value in STOP, RELOAD and START registers for instruction timer and secure counter.

Parameters

- base – CDOG peripheral base address
- stop – expected value which will be compared with value of secure counter
- reload – reload value for instruction timer
- start – start value for secure timer

void CDOG_Add(CDOG_Type *base, uint32_t add)

Add value to secure counter.

This function add specified value to secure counter.

Parameters

- base – CDOG peripheral base address.
- add – Value to be added.

void CDOG__Add1(CDOG_Type *base)

Add 1 to secure counter.

This function add 1 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__Add16(CDOG_Type *base)

Add 16 to secure counter.

This function add 16 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__Add256(CDOG_Type *base)

Add 256 to secure counter.

This function add 256 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__Sub(CDOG_Type *base, uint32_t sub)

brief Subtract value to secure counter

This function subtract specified value to secure counter.

param base CDOG peripheral base address. param sub Value to be subtracted.

void CDOG__Sub1(CDOG_Type *base)

Subtract 1 from secure counter.

This function subtract specified 1 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__Sub16(CDOG_Type *base)

Subtract 16 from secure counter.

This function subtract specified 16 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__Sub256(CDOG_Type *base)

Subtract 256 from secure counter.

This function subtract specified 256 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG__WritePersistent(CDOG_Type *base, uint32_t value)

Set the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.

- value – The value to be written.

uint32_t CDOG_ReadPersistent(CDOG_Type *base)

Get the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.

Returns

The persistent word.

FSL_CDOG_DRIVER_VERSION

Defines CDOG driver version 2.1.3.

Change log:

- Version 2.1.3
 - Re-design multiple instance IRQs and Clocks
 - Add fix for RESTART command errata
- Version 2.1.2
 - Support multiple IRQs
 - Fix default CONTROL values
- Version 2.1.1
 - Remove bit CONTROL[CONTROL_CTRL]
- Version 2.1.0
 - Rename CWT to CDOG
- Version 2.0.2
 - Fix MISRA-2012 issues
- Version 2.0.1
 - Fix doxygen issues
- Version 2.0.0
 - initial version

enum __cdog_debug_Action_ctrl_enum

Values:

enumerator kCDOG_DebugHaltCtrl_Run

enumerator kCDOG_DebugHaltCtrl_Pause

enum __cdog_irq_pause_ctrl_enum

Values:

enumerator kCDOG_IrqPauseCtrl_Run

enumerator kCDOG_IrqPauseCtrl_Pause

enum __cdog_fault_ctrl_enum

Values:

enumerator kCDOG_FaultCtrl_EnableReset

enumerator kCDOG_FaultCtrl_EnableInterrupt

```
    enumerator kCDOG_FaultCtrl_NoAction  
enum __code_lock_ctrl_enum  
    Values:  
    enumerator kCDOG_LockCtrl_Lock  
    enumerator kCDOG_LockCtrl_Unlock  
typedef uint32_t secure_counter_t  
SC_ADD(add)  
SC_ADD1  
SC_ADD16  
SC_ADD256  
SC_SUB(sub)  
SC_SUB1  
SC_SUB16  
SC_SUB256  
SC_CHECK(val)  
struct cdog_config_t  
    #include <fsl_cdog.h>
```

2.6 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_Sram1  
        Clock gate name: Sram1.  
    enumerator kCLOCK_Sram2  
        Clock gate name: Sram2.  
    enumerator kCLOCK_Flash  
        Clock gate name: Flash.  
    enumerator kCLOCK_Fmc  
        Clock gate name: Fmc.  
    enumerator kCLOCK_InputMux  
        Clock gate name: InputMux.
```

enumerator kCLOCK_Iocon
Clock gate name: Iocon.

enumerator kCLOCK_Gpio0
Clock gate name: Gpio0.

enumerator kCLOCK_Gpio1
Clock gate name: Gpio1.

enumerator kCLOCK_Pint
Clock gate name: Pint.

enumerator kCLOCK_Gint
Clock gate name: Gint.

enumerator kCLOCK_Dma0
Clock gate name: Dma0.

enumerator kCLOCK_Crc
Clock gate name: Crc.

enumerator kCLOCK_Wwdt
Clock gate name: Wwdt.

enumerator kCLOCK_Rtc
Clock gate name: Rtc.

enumerator kCLOCK_Mailbox
Clock gate name: Mailbox.

enumerator kCLOCK_Adc0
Clock gate name: Adc0.

enumerator kCLOCK_Mrt
Clock gate name: Mrt.

enumerator kCLOCK_OsTimer0
Clock gate name: OsTimer0.

enumerator kCLOCK_Sct0
Clock gate name: Sct0.

enumerator kCLOCK_Mcan
Clock gate name: Mcan.

enumerator kCLOCK_Utick0
Clock gate name: Utick0.

enumerator kCLOCK_FlexComm0
Clock gate name: FlexComm0.

enumerator kCLOCK_FlexComm1
Clock gate name: FlexComm1.

enumerator kCLOCK_FlexComm2
Clock gate name: FlexComm2.

enumerator kCLOCK_FlexComm3
Clock gate name: FlexComm3.

enumerator kCLOCK_FlexComm4
Clock gate name: FlexComm4.

enumerator kCLOCK_FlexComm5
Clock gate name: FlexComm5.

enumerator kCLOCK_FlexComm6
Clock gate name: FlexComm6.

enumerator kCLOCK_FlexComm7
Clock gate name: FlexComm7.

enumerator kCLOCK_MinUart0
Clock gate name: MinUart0.

enumerator kCLOCK_MinUart1
Clock gate name: MinUart1.

enumerator kCLOCK_MinUart2
Clock gate name: MinUart2.

enumerator kCLOCK_MinUart3
Clock gate name: MinUart3.

enumerator kCLOCK_MinUart4
Clock gate name: MinUart4.

enumerator kCLOCK_MinUart5
Clock gate name: MinUart5.

enumerator kCLOCK_MinUart6
Clock gate name: MinUart6.

enumerator kCLOCK_MinUart7
Clock gate name: MinUart7.

enumerator kCLOCK_LSpi0
Clock gate name: LSpi0.

enumerator kCLOCK_LSpi1
Clock gate name: LSpi1.

enumerator kCLOCK_LSpi2
Clock gate name: LSpi2.

enumerator kCLOCK_LSpi3
Clock gate name: LSpi3.

enumerator kCLOCK_LSpi4
Clock gate name: LSpi4.

enumerator kCLOCK_LSpi5
Clock gate name: LSpi5.

enumerator kCLOCK_LSpi6
Clock gate name: LSpi6.

enumerator kCLOCK_LSpi7
Clock gate name: LSpi7.

enumerator kCLOCK_BI2c0
Clock gate name: BI2c0.

enumerator kCLOCK_BI2c1
Clock gate name: BI2c1.

enumerator kCLOCK_BI2c2
Clock gate name: BI2c2.

enumerator kCLOCK_BI2c3
Clock gate name: BI2c3.

enumerator kCLOCK_BI2c4
Clock gate name: BI2c4.

enumerator kCLOCK_BI2c5
Clock gate name: BI2c5.

enumerator kCLOCK_BI2c6
Clock gate name: BI2c6.

enumerator kCLOCK_BI2c7
Clock gate name: BI2c7.

enumerator kCLOCK_FlexI2s0
Clock gate name: FlexI2s0.

enumerator kCLOCK_FlexI2s1
Clock gate name: FlexI2s1.

enumerator kCLOCK_FlexI2s2
Clock gate name: FlexI2s2.

enumerator kCLOCK_FlexI2s3
Clock gate name: FlexI2s3.

enumerator kCLOCK_FlexI2s4
Clock gate name: FlexI2s4.

enumerator kCLOCK_FlexI2s5
Clock gate name: FlexI2s5.

enumerator kCLOCK_FlexI2s6
Clock gate name: FlexI2s6.

enumerator kCLOCK_FlexI2s7
Clock gate name: FlexI2s7.

enumerator kCLOCK_Timer2
Clock gate name: Timer2.

enumerator kCLOCK_Timer0
Clock gate name: Timer0.

enumerator kCLOCK_Timer1
Clock gate name: Timer1.

enumerator kCLOCK_Dma1
Clock gate name: Dma1.

enumerator kCLOCK_Comp
Clock gate name: Comp.

enumerator kCLOCK_Sram3
Clock gate name: Sram3.

enumerator kCLOCK_Freqme
Clock gate name: Freqme.

enumerator kCLOCK_Cdog
Clock gate name: Cdog.

enumerator kCLOCK_Rng
Clock gate name: Rng.

enumerator kCLOCK_Sysctl
Clock gate name: Sysctl.

enumerator kCLOCK_HashCrypt
Clock gate name: HashCrypt.

enumerator kCLOCK_PluLut
Clock gate name: PluLut.

enumerator kCLOCK_Timer3
Clock gate name: Timer3.

enumerator kCLOCK_Timer4
Clock gate name: Timer4.

enumerator kCLOCK_Puf
Clock gate name: Puf.

enumerator kCLOCK_Casper
Clock gate name: Casper.

enumerator kCLOCK_AnalogCtrl
Clock gate name: AnalogCtrl.

enumerator kCLOCK_Hs_Lspi
Clock gate name: Lspi.

enumerator kCLOCK_Gpio_Sec
Clock gate name: GPIO Sec.

enumerator kCLOCK_Gpio_Sec_Int
Clock gate name: Gpio Sec Int

enum _clock_name
Clock name used to get clock frequency.

Values:

enumerator kCLOCK_CoreSysClk
Core/system clock (aka MAIN_CLK)

enumerator kCLOCK_BusClk
Bus clock (AHB clock)

enumerator kCLOCK_ClockOut
CLOCKOUT

enumerator kCLOCK_FroHf
FRO48/96

enumerator kCLOCK_Pll1Out
PLL1 Output

enumerator kCLOCK_Mclk
MCLK

enumerator kCLOCK_Fro12M
FRO12M

enumerator kCLOCK_Fro1M
FRO1M

enumerator kCLOCK_ExtClk
External Clock

enumerator kCLOCK_Pll0Out
PLL0 Output

enumerator kCLOCK_FlexI2S
FlexI2S clock

enum _clock_attach_id

The enumerator of clock attach Id.

Values:

enumerator kFRO12M_to_MAIN_CLK
Attach FRO12M to MAIN_CLK.

enumerator kEXT_CLK_to_MAIN_CLK
Attach EXT_CLK to MAIN_CLK.

enumerator kFRO1M_to_MAIN_CLK
Attach FRO1M to MAIN_CLK.

enumerator kFRO_HF_to_MAIN_CLK
Attach FRO_HF to MAIN_CLK.

enumerator kPLL0_to_MAIN_CLK
Attach PLL0 to MAIN_CLK.

enumerator kPLL1_to_MAIN_CLK
Attach PLL1 to MAIN_CLK.

enumerator kOSC32K_to_MAIN_CLK
Attach OSC32K to MAIN_CLK.

enumerator kMAIN_CLK_to_CLKOUT
Attach MAIN_CLK to CLKOUT.

enumerator kPLL0_to_CLKOUT
Attach PLL0 to CLKOUT.

enumerator kEXT_CLK_to_CLKOUT
Attach EXT_CLK to CLKOUT.

enumerator kFRO_HF_to_CLKOUT
Attach FRO_HF to CLKOUT.

enumerator kFRO1M_to_CLKOUT
Attach FRO1M to CLKOUT.

enumerator kPLL1_to_CLKOUT
Attach PLL1 to CLKOUT.

enumerator kOSC32K_to_CLKOUT
Attach OSC32K to CLKOUT.

enumerator kNONE_to_SYS_CLKOUT
Attach NONE to SYS_CLKOUT.

enumerator kFRO12M_to_PLL0
Attach FRO12M to PLL0.

enumerator kEXT_CLK_to_PLL0
Attach EXT_CLK to PLL0.

enumerator kFRO1M_to_PLL0
Attach FRO1M to PLL0.

enumerator kOSC32K_to_PLL0
Attach OSC32K to PLL0.

enumerator kNONE_to_PLL0
Attach NONE to PLL0.

enumerator kMCAN_DIV_to_MCAN
Attach MCAN_DIV to MCAN.

enumerator kFRO1M_to_MCAN
Attach FRO1M to MCAN.

enumerator kOSC32K_to_MCAN
Attach OSC32K to MCAN.

enumerator kNONE_to_MCAN
Attach NONE to MCAN.

enumerator kMAIN_CLK_to_ADC_CLK
Attach MAIN_CLK to ADC_CLK.

enumerator kPLL0_to_ADC_CLK
Attach PLL0 to ADC_CLK.

enumerator kFRO_HF_to_ADC_CLK
Attach FRO_HF to ADC_CLK.

enumerator kEXT_CLK_to_ADC_CLK
Attach EXT_CLK to ADC_CLK.

enumerator kNONE_to_ADC_CLK
Attach NONE to ADC_CLK.

enumerator kOSC32K_to_CLK32K
Attach OSC32K to CLK32K.

enumerator kFRO1MDIV_to_CLK32K
Attach FRO1MDIV to CLK32K.

enumerator kNONE_to_CLK32K
Attach NONE to CLK32K.

enumerator kMAIN_CLK_to_FLEXCOMM0
Attach MAIN_CLK to FLEXCOMM0.

enumerator kPLL0_DIV_to_FLEXCOMM0
Attach PLL0_DIV to FLEXCOMM0.

enumerator kFRO12M_to_FLEXCOMM0
Attach FRO12M to FLEXCOMM0.

enumerator kFRO_HF_DIV_to_FLEXCOMM0
Attach FRO_HF_DIV to FLEXCOMM0.

enumerator kFRO1M_to_FLEXCOMM0
Attach FRO1M to FLEXCOMM0.

enumerator kMCLK_to_FLEXCOMM0
Attach MCLK to FLEXCOMM0.

enumerator kOSC32K_to_FLEXCOMM0
Attach OSC32K to FLEXCOMM0.

enumerator kNONE_to_FLEXCOMM0
Attach NONE to FLEXCOMM0.

enumerator kMAIN_CLK_to_FLEXCOMM1
Attach MAIN_CLK to FLEXCOMM1.

enumerator kPLL0_DIV_to_FLEXCOMM1
Attach PLL0_DIV to FLEXCOMM1.

enumerator kFRO12M_to_FLEXCOMM1
Attach FRO12M to FLEXCOMM1.

enumerator kFRO_HF_DIV_to_FLEXCOMM1
Attach FRO_HF_DIV to FLEXCOMM1.

enumerator kFRO1M_to_FLEXCOMM1
Attach FRO1M to FLEXCOMM1.

enumerator kMCLK_to_FLEXCOMM1
Attach MCLK to FLEXCOMM1.

enumerator kOSC32K_to_FLEXCOMM1
Attach OSC32K to FLEXCOMM1.

enumerator kNONE_to_FLEXCOMM1
Attach NONE to FLEXCOMM1.

enumerator kMAIN_CLK_to_FLEXCOMM2
Attach MAIN_CLK to FLEXCOMM2.

enumerator kPLL0_DIV_to_FLEXCOMM2
Attach PLL0_DIV to FLEXCOMM2.

enumerator kFRO12M_to_FLEXCOMM2
Attach FRO12M to FLEXCOMM2.

enumerator kFRO_HF_DIV_to_FLEXCOMM2
Attach FRO_HF_DIV to FLEXCOMM2.

enumerator kFRO1M_to_FLEXCOMM2
Attach FRO1M to FLEXCOMM2.

enumerator kMCLK_to_FLEXCOMM2
Attach MCLK to FLEXCOMM2.

enumerator kOSC32K_to_FLEXCOMM2
Attach OSC32K to FLEXCOMM2.

enumerator kNONE_to_FLEXCOMM2
Attach NONE to FLEXCOMM2.

enumerator kMAIN_CLK_to_FLEXCOMM3

Attach MAIN_CLK to FLEXCOMM3.

enumerator kPLL0_DIV_to_FLEXCOMM3

Attach PLL0_DIV to FLEXCOMM3.

enumerator kFRO12M_to_FLEXCOMM3

Attach FRO12M to FLEXCOMM3.

enumerator kFRO_HF_DIV_to_FLEXCOMM3

Attach FRO_HF_DIV to FLEXCOMM3.

enumerator kFRO1M_to_FLEXCOMM3

Attach FRO1M to FLEXCOMM3.

enumerator kMCLK_to_FLEXCOMM3

Attach MCLK to FLEXCOMM3.

enumerator kOSC32K_to_FLEXCOMM3

Attach OSC32K to FLEXCOMM3.

enumerator kNONE_to_FLEXCOMM3

Attach NONE to FLEXCOMM3.

enumerator kMAIN_CLK_to_FLEXCOMM4

Attach MAIN_CLK to FLEXCOMM4.

enumerator kPLL0_DIV_to_FLEXCOMM4

Attach PLL0_DIV to FLEXCOMM4.

enumerator kFRO12M_to_FLEXCOMM4

Attach FRO12M to FLEXCOMM4.

enumerator kFRO_HF_DIV_to_FLEXCOMM4

Attach FRO_HF_DIV to FLEXCOMM4.

enumerator kFRO1M_to_FLEXCOMM4

Attach FRO1M to FLEXCOMM4.

enumerator kMCLK_to_FLEXCOMM4

Attach MCLK to FLEXCOMM4.

enumerator kOSC32K_to_FLEXCOMM4

Attach OSC32K to FLEXCOMM4.

enumerator kNONE_to_FLEXCOMM4

Attach NONE to FLEXCOMM4.

enumerator kMAIN_CLK_to_FLEXCOMM5

Attach MAIN_CLK to FLEXCOMM5.

enumerator kPLL0_DIV_to_FLEXCOMM5

Attach PLL0_DIV to FLEXCOMM5.

enumerator kFRO12M_to_FLEXCOMM5

Attach FRO12M to FLEXCOMM5.

enumerator kFRO_HF_DIV_to_FLEXCOMM5

Attach FRO_HF_DIV to FLEXCOMM5.

enumerator kFRO1M_to_FLEXCOMM5

Attach FRO1M to FLEXCOMM5.

enumerator kMCLK_to_FLEXCOMM5
Attach MCLK to FLEXCOMM5.

enumerator kOSC32K_to_FLEXCOMM5
Attach OSC32K to FLEXCOMM5.

enumerator kNONE_to_FLEXCOMM5
Attach NONE to FLEXCOMM5.

enumerator kMAIN_CLK_to_FLEXCOMM6
Attach MAIN_CLK to FLEXCOMM6.

enumerator kPLL0_DIV_to_FLEXCOMM6
Attach PLL0_DIV to FLEXCOMM6.

enumerator kFRO12M_to_FLEXCOMM6
Attach FRO12M to FLEXCOMM6.

enumerator kFRO_HF_DIV_to_FLEXCOMM6
Attach FRO_HF_DIV to FLEXCOMM6.

enumerator kFRO1M_to_FLEXCOMM6
Attach FRO1M to FLEXCOMM6.

enumerator kMCLK_to_FLEXCOMM6
Attach MCLK to FLEXCOMM6.

enumerator kOSC32K_to_FLEXCOMM6
Attach OSC32K to FLEXCOMM6.

enumerator kNONE_to_FLEXCOMM6
Attach NONE to FLEXCOMM6.

enumerator kMAIN_CLK_to_FLEXCOMM7
Attach MAIN_CLK to FLEXCOMM7.

enumerator kPLL0_DIV_to_FLEXCOMM7
Attach PLL0_DIV to FLEXCOMM7.

enumerator kFRO12M_to_FLEXCOMM7
Attach FRO12M to FLEXCOMM7.

enumerator kFRO_HF_DIV_to_FLEXCOMM7
Attach FRO_HF_DIV to FLEXCOMM7.

enumerator kFRO1M_to_FLEXCOMM7
Attach FRO1M to FLEXCOMM7.

enumerator kMCLK_to_FLEXCOMM7
Attach MCLK to FLEXCOMM7.

enumerator kOSC32K_to_FLEXCOMM7
Attach OSC32K to FLEXCOMM7.

enumerator kNONE_to_FLEXCOMM7
Attach NONE to FLEXCOMM7.

enumerator kMAIN_CLK_to_HSLSPI
Attach MAIN_CLK to HSLSPI.

enumerator kPLL0_DIV_to_HSLSPI
Attach PLL0_DIV to HSLSPI.

enumerator kFRO12M_to_HSLSPI
Attach FRO12M to HSLSPI.

enumerator kFRO_HF_DIV_to_HSLSPI
Attach FRO_HF_DIV to HSLSPI.

enumerator kFRO1M_to_HSLSPI
Attach FRO1M to HSLSPI.

enumerator kOSC32K_to_HSLSPI
Attach OSC32K to HSLSPI.

enumerator kNONE_to_HSLSPI
Attach NONE to HSLSPI.

enumerator kFRO_HF_to_MCLK
Attach FRO_HF to MCLK.

enumerator kPLL0_to_MCLK
Attach PLL0 to MCLK.

enumerator kNONE_to_MCLK
Attach NONE to MCLK.

enumerator kMAIN_CLK_to_SCT_CLK
Attach MAIN_CLK to SCT_CLK.

enumerator kPLL0_to_SCT_CLK
Attach PLL0 to SCT_CLK.

enumerator kEXT_CLK_to_SCT_CLK
Attach EXT_CLK to SCT_CLK.

enumerator kFRO_HF_to_SCT_CLK
Attach FRO_HF to SCT_CLK.

enumerator kMCLK_to_SCT_CLK
Attach MCLK to SCT_CLK.

enumerator kNONE_to_SCT_CLK
Attach NONE to SCT_CLK.

enumerator kFRO32K_to_OSC32K
Attach FRO32K to OSC32K.

enumerator kXTAL32K_to_OSC32K
Attach XTAL32K to OSC32K.

enumerator kOSC32K_to_OSTIMER
Attach OSC32K to OSTIMER.

enumerator kFRO1M_to_OSTIMER
Attach FRO1M to OSTIMER.

enumerator kMAIN_CLK_to_OSTIMER
Attach MAIN_CLK to OSTIMER.

enumerator kTRACE_DIV_to_TRACE
Attach TRACE_DIV to TRACE.

enumerator kFRO1M_to_TRACE
Attach FRO1M to TRACE.

enumerator kOSC32K_to_TRACE

Attach OSC32K to TRACE.

enumerator kNONE_to_TRACE

Attach NONE to TRACE.

enumerator kSYSTICK_DIV0_to_SYSTICK0

Attach SYSTICK_DIV0 to SYSTICK0.

enumerator kFRO1M_to_SYSTICK0

Attach FRO1M to SYSTICK0.

enumerator kOSC32K_to_SYSTICK0

Attach OSC32K to SYSTICK0.

enumerator kNONE_to_SYSTICK0

Attach NONE to SYSTICK0.

enumerator kFRO12M_to_PLL1

Attach FRO12M to PLL1.

enumerator kEXT_CLK_to_PLL1

Attach EXT_CLK to PLL1.

enumerator kFRO1M_to_PLL1

Attach FRO1M to PLL1.

enumerator kOSC32K_to_PLL1

Attach OSC32K to PLL1.

enumerator kNONE_to_PLL1

Attach NONE to PLL1.

enumerator kMAIN_CLK_to_CTIMER0

Attach MAIN_CLK to CTIMER0.

enumerator kPLL0_to_CTIMER0

Attach PLL0 to CTIMER0.

enumerator kFRO_HF_to_CTIMER0

Attach FRO_HF to CTIMER0.

enumerator kFRO1M_to_CTIMER0

Attach FRO1M to CTIMER0.

enumerator kMCLK_to_CTIMER0

Attach MCLK to CTIMER0.

enumerator kOSC32K_to_CTIMER0

Attach OSC32K to CTIMER0.

enumerator kNONE_to_CTIMER0

Attach NONE to CTIMER0.

enumerator kMAIN_CLK_to_CTIMER1

Attach MAIN_CLK to CTIMER1.

enumerator kPLL0_to_CTIMER1

Attach PLL0 to CTIMER1.

enumerator kFRO_HF_to_CTIMER1

Attach FRO_HF to CTIMER1.

enumerator kFRO1M_to_CTIMER1
Attach FRO1M to CTIMER1.

enumerator kMCLK_to_CTIMER1
Attach MCLK to CTIMER1.

enumerator kOSC32K_to_CTIMER1
Attach OSC32K to CTIMER1.

enumerator kNONE_to_CTIMER1
Attach NONE to CTIMER1.

enumerator kMAIN_CLK_to_CTIMER2
Attach MAIN_CLK to CTIMER2.

enumerator kPLL0_to_CTIMER2
Attach PLL0 to CTIMER2.

enumerator kFRO_HF_to_CTIMER2
Attach FRO_HF to CTIMER2.

enumerator kFRO1M_to_CTIMER2
Attach FRO1M to CTIMER2.

enumerator kMCLK_to_CTIMER2
Attach MCLK to CTIMER2.

enumerator kOSC32K_to_CTIMER2
Attach OSC32K to CTIMER2.

enumerator kNONE_to_CTIMER2
Attach NONE to CTIMER2.

enumerator kMAIN_CLK_to_CTIMER3
Attach MAIN_CLK to CTIMER3.

enumerator kPLL0_to_CTIMER3
Attach PLL0 to CTIMER3.

enumerator kFRO_HF_to_CTIMER3
Attach FRO_HF to CTIMER3.

enumerator kFRO1M_to_CTIMER3
Attach FRO1M to CTIMER3.

enumerator kMCLK_to_CTIMER3
Attach MCLK to CTIMER3.

enumerator kOSC32K_to_CTIMER3
Attach OSC32K to CTIMER3.

enumerator kNONE_to_CTIMER3
Attach NONE to CTIMER3.

enumerator kMAIN_CLK_to_CTIMER4
Attach MAIN_CLK to CTIMER4.

enumerator kPLL0_to_CTIMER4
Attach PLL0 to CTIMER4.

enumerator kFRO_HF_to_CTIMER4
Attach FRO_HF to CTIMER4.

enumerator kFRO1M_to_CTIMER4

Attach FRO1M to CTIMER4.

enumerator kMCLK_to_CTIMER4

Attach MCLK to CTIMER4.

enumerator kOSC32K_to_CTIMER4

Attach OSC32K to CTIMER4.

enumerator kNONE_to_CTIMER4

Attach NONE to CTIMER4.

enumerator kNONE_to_NONE

Attach NONE to NONE.

enum _clock_div_name

Clock dividers.

Values:

enumerator kCLOCK_DivSystickClk0

Systick Clk0 Divider.

enumerator kCLOCK_DivArmTrClkDiv

Arm Tr Clk Div Divider.

enumerator kCLOCK_DivCanClk

Can Clock Divider.

enumerator kCLOCK_DivFlexFrg0

Flex Frg0 Divider.

enumerator kCLOCK_DivFlexFrg1

Flex Frg1 Divider.

enumerator kCLOCK_DivFlexFrg2

Flex Frg2 Divider.

enumerator kCLOCK_DivFlexFrg3

Flex Frg3 Divider.

enumerator kCLOCK_DivFlexFrg4

Flex Frg4 Divider.

enumerator kCLOCK_DivFlexFrg5

Flex Frg5 Divider.

enumerator kCLOCK_DivFlexFrg6

Flex Frg6 Divider.

enumerator kCLOCK_DivFlexFrg7

Flex Frg7 Divider.

enumerator kCLOCK_DivAhbClk

Ahb Clock Divider.

enumerator kCLOCK_DivClkOut

Clk Out Divider.

enumerator kCLOCK_DivFrohfClk

Frohf Clock Divider.

enumerator kCLOCK_DivWdtClk

Wdt Clock Divider.

enumerator kCLOCK_DivAdcAsyncClk

Adc Async Clock Divider.

enumerator kCLOCK_DivFro1mClk

Fro1m Clock Divider.

enumerator kCLOCK_DivMClk

I2S MCLK Clock Divider.

enumerator kCLOCK_DivSctClk

Sct Clock Divider.

enumerator kCLOCK_DivPll0Clk

PLL0 clock divider.

enum __ss_progmodfm

PLL Spread Spectrum (SS) Programmable modulation frequency See (MF) field in the PLL0SSCG1 register in the UM.

Values:

enumerator kSS_MF_512

Nss = 512 (fm ? 3.9 - 7.8 kHz)

enumerator kSS_MF_384

Nss ?= 384 (fm ? 5.2 - 10.4 kHz)

enumerator kSS_MF_256

Nss = 256 (fm ? 7.8 - 15.6 kHz)

enumerator kSS_MF_128

Nss = 128 (fm ? 15.6 - 31.3 kHz)

enumerator kSS_MF_64

Nss = 64 (fm ? 32.3 - 64.5 kHz)

enumerator kSS_MF_32

Nss = 32 (fm ? 62.5- 125 kHz)

enumerator kSS_MF_24

Nss ?= 24 (fm ? 83.3- 166.6 kHz)

enumerator kSS_MF_16

Nss = 16 (fm ? 125- 250 kHz)

enum __ss_progmoddp

PLL Spread Spectrum (SS) Programmable frequency modulation depth See (MR) field in the PLL0SSCG1 register in the UM.

Values:

enumerator kSS_MR_K0

k = 0 (no spread spectrum)

enumerator kSS_MR_K1

k = 1

enumerator kSS_MR_K1_5

k = 1.5

enumerator kSS_MR_K2

k = 2

enumerator kSS_MR_K3

k = 3

enumerator kSS_MR_K4

k = 4

enumerator kSS_MR_K6

k = 6

enumerator kSS_MR_K8

k = 8

enum _ss_modwvctrl

PLL Spread Spectrum (SS) Modulation waveform control See (MC) field in the PLL0SSCG1 register in the UM.

Compensation for low pass filtering of the PLL to get a triangular modulation at the output of the PLL, giving a flat frequency spectrum.

Values:

enumerator kSS_MC_NOC

no compensation

enumerator kSS_MC_RECC

recommended setting

enumerator kSS_MC_MAXC

max. compensation

enum _pll_error

PLL status definitions.

Values:

enumerator kStatus_PLL_Success

PLL operation was successful

enumerator kStatus_PLL_OutputTooLow

PLL output rate request was too low

enumerator kStatus_PLL_OutputTooHigh

PLL output rate request was too high

enumerator kStatus_PLL_InputTooLow

PLL input rate is too low

enumerator kStatus_PLL_InputTooHigh

PLL input rate is too high

enumerator kStatus_PLL_OutsideIntLimit

Requested output rate isn't possible

enumerator kStatus_PLL_CCOTooLow

Requested CCO rate isn't possible

enumerator kStatus_PLL_CCOTooHigh

Requested CCO rate isn't possible

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_attach_id* clock_attach_id_t

The enumerator of clock attach Id.

typedef enum *_clock_div_name* clock_div_name_t

Clock dividers.

typedef enum *_ss_progmodfm* ss_progmodfm_t

PLL Spread Spectrum (SS) Programmable modulation frequency See (MF) field in the PLL0SSCG1 register in the UM.

typedef enum *_ss_progmoddp* ss_progmoddp_t

PLL Spread Spectrum (SS) Programmable frequency modulation depth See (MR) field in the PLL0SSCG1 register in the UM.

typedef enum *_ss_modwvctrl* ss_modwvctrl_t

PLL Spread Spectrum (SS) Modulation waveform control See (MC) field in the PLL0SSCG1 register in the UM.

Compensation for low pass filtering of the PLL to get a triangular modulation at the output of the PLL, giving a flat frequency spectrum.

typedef struct *_pll_config* pll_config_t

PLL configuration structure.

This structure can be used to configure the settings for a PLL setup structure. Fill in the desired configuration for the PLL and call the PLL setup function to fill in a PLL setup structure.

typedef struct *_pll_setup* pll_setup_t

PLL0 setup structure This structure can be used to pre-build a PLL setup configuration at run-time and quickly set the PLL to the configuration. It can be populated with the PLL setup function. If powering up or waiting for PLL lock, the PLL input clock source should be configured prior to PLL setup.

typedef enum *_pll_error* pll_error_t

PLL status definitions.

static inline void CLOCK_EnableClock(*clock_ip_name_t* clk)

Enable the clock for specific IP.

Parameters

- *clk* – : Clock to be enabled.

Returns

Nothing

static inline void CLOCK_DisableClock(*clock_ip_name_t* clk)

Disable the clock for specific IP.

Parameters

- *clk* – : Clock to be Disabled.

Returns

Nothing

status_t CLOCK_SetupFROClocking(uint32_t iFreq)

Initialize the Core clock to given frequency (12, 48 or 96 MHz). Turns on FRO and uses default CCO, if freq is 12000000, then high speed output is off, else high speed output is enabled.

Parameters

- iFreq – : Desired frequency (must be one of CLK_FRO_12MHZ or CLK_FRO_48MHZ or CLK_FRO_96MHZ)

Returns

returns success or fail status.

void CLOCK_SetFLASHAccessCyclesForFreq(uint32_t system_freq_hz)

Set the flash wait states for the input frequency.

Parameters

- system_freq_hz – : Input frequency

Returns

Nothing

status_t CLOCK_SetupExtClocking(uint32_t iFreq)

Initialize the external osc clock to given frequency.

Parameters

- iFreq – : Desired frequency (must be equal to exact rate in Hz)

Returns

returns success or fail status.

status_t CLOCK_SetupI2SMClkClocking(uint32_t iFreq)

Initialize the I2S MCLK clock to given frequency.

Parameters

- iFreq – : Desired frequency (must be equal to exact rate in Hz)

Returns

returns success or fail status.

status_t CLOCK_SetupPLUClkInClocking(uint32_t iFreq)

Initialize the PLU CLKIN clock to given frequency.

Parameters

- iFreq – : Desired frequency (must be equal to exact rate in Hz)

Returns

returns success or fail status.

void CLOCK_AttachClk(*clock_attach_id_t* connection)

Configure the clock selection muxes.

Parameters

- connection – : Clock to be configured.

Returns

Nothing

clock_attach_id_t CLOCK_GetClockAttachId(*clock_attach_id_t* attachId)

Get the actual clock attach id. This function uses the offset in input attach id, then it reads the actual source value in the register and combine the offset to obtain an actual attach id.

Parameters

- attachId – : Clock attach id to get.

Returns

Clock source value.

void CLOCK_SetClkDiv(*clock_div_name_t* div_name, uint32_t divided_by_value, bool reset)

Setup peripheral clock dividers.

Parameters

- div_name – : Clock divider name
- divided_by_value – Value to be divided
- reset – : Whether to reset the divider counter.

Returns

Nothing

void CLOCK_SetRtc1khzClkDiv(uint32_t divided_by_value)

Setup rtc 1khz clock divider.

Parameters

- divided_by_value – Value to be divided

Returns

Nothing

void CLOCK_SetRtc1hzClkDiv(uint32_t divided_by_value)

Setup rtc 1hz clock divider.

Parameters

- divided_by_value – Value to be divided

Returns

Nothing

uint32_t CLOCK_SetFlexCommClock(uint32_t id, uint32_t freq)

Set the flexcomm output frequency.

Parameters

- id – : flexcomm instance id
- freq – : output frequency

Returns

0 : the frequency range is out of range. 1 : switch successfully.

uint32_t CLOCK_GetFlexCommInputClock(uint32_t id)

Return Frequency of flexcomm input clock.

Parameters

- id – : flexcomm instance id

Returns

Frequency value

uint32_t CLOCK_GetFreq(*clock_name_t* clockName)

Return Frequency of selected clock.

Returns

Frequency of selected clock

uint32_t CLOCK_GetFro12MFreq(void)

Return Frequency of FRO 12MHz.

Returns

Frequency of FRO 12MHz

uint32_t CLOCK_GetFro1MFreq(void)

Return Frequency of FRO 1MHz.

Returns

Frequency of FRO 1MHz

uint32_t CLOCK_GetClockOutClkFreq(void)

Return Frequency of ClockOut.

Returns

Frequency of ClockOut

uint32_t CLOCK_GetMCanClkFreq(void)

Return Frequency of Can Clock.

Returns

Frequency of Can.

uint32_t CLOCK_GetAdcClkFreq(void)

Return Frequency of Adc Clock.

Returns

Frequency of Adc.

uint32_t CLOCK_GetMclkClkFreq(void)

Return Frequency of MClk Clock.

Returns

Frequency of MClk Clock.

uint32_t CLOCK_GetSctClkFreq(void)

Return Frequency of SCTimer Clock.

Returns

Frequency of SCTimer Clock.

uint32_t CLOCK_GetExtClkFreq(void)

Return Frequency of External Clock.

Returns

Frequency of External Clock. If no external clock is used returns 0.

uint32_t CLOCK_GetWdtClkFreq(void)

Return Frequency of Watchdog.

Returns

Frequency of Watchdog

uint32_t CLOCK_GetFroHfFreq(void)

Return Frequency of High-Freq output of FRO.

Returns

Frequency of High-Freq output of FRO

uint32_t CLOCK_GetPll0OutFreq(void)

Return Frequency of PLL.

Returns

Frequency of PLL

uint32_t CLOCK_GetPll1OutFreq(void)

Return Frequency of USB PLL.

Returns

Frequency of PLL

uint32_t CLOCK_GetOsc32KFreq(void)

Return Frequency of 32kHz osc.

Returns

Frequency of 32kHz osc

uint32_t CLOCK_GetCoreSysClkFreq(void)

Return Frequency of Core System.

Returns

Frequency of Core System

uint32_t CLOCK_GetI2SMClkFreq(void)

Return Frequency of I2S MCLK Clock.

Returns

Frequency of I2S MCLK Clock

uint32_t CLOCK_GetPLUClkInFreq(void)

Return Frequency of PLU CLKIN Clock.

Returns

Frequency of PLU CLKIN Clock

uint32_t CLOCK_GetFlexCommClkFreq(uint32_t id)

Return Frequency of FlexComm Clock.

Returns

Frequency of FlexComm Clock

uint32_t CLOCK_GetHsLspiClkFreq(void)

Return Frequency of High speed SPI Clock.

Returns

Frequency of High speed SPI Clock

uint32_t CLOCK_GetCTimerClkFreq(uint32_t id)

Return Frequency of CTimer functional Clock.

Returns

Frequency of CTimer functional Clock

uint32_t CLOCK_GetSystickClkFreq(uint32_t id)

Return Frequency of SystickClock.

Returns

Frequency of Systick Clock

uint32_t CLOCK_GetPLL0InClockRate(void)

Return PLL0 input clock rate.

Returns

PLL0 input clock rate

uint32_t CLOCK_GetPLL1InClockRate(void)

Return PLL1 input clock rate.

Returns

PLL1 input clock rate

uint32_t CLOCK_GetPLL0OutClockRate(bool recompute)

Return PLL0 output clock rate.

Note: The PLL rate is cached in the driver in a variable as the rate computation function can take some time to perform. It is recommended to use ‘false’ with the ‘recompute’ parameter.

Parameters

- recompute – : Forces a PLL rate recomputation if true

Returns

PLL0 output clock rate

uint32_t CLOCK_GetPLL1OutClockRate(bool recompute)

Return PLL1 output clock rate.

Note: The PLL rate is cached in the driver in a variable as the rate computation function can take some time to perform. It is recommended to use ‘false’ with the ‘recompute’ parameter.

Parameters

- recompute – : Forces a PLL rate recomputation if true

Returns

PLL1 output clock rate

__STATIC_INLINE void CLOCK_SetBypassPLL0 (bool bypass)

Enables and disables PLL0 bypass mode.

bypass : true to bypass PLL0 (PLL0 output = PLL0 input, false to disable bypass)

Returns

PLL0 output clock rate

__STATIC_INLINE void CLOCK_SetBypassPLL1 (bool bypass)

Enables and disables PLL1 bypass mode.

bypass : true to bypass PLL1 (PLL1 output = PLL1 input, false to disable bypass)

Returns

PLL1 output clock rate

__STATIC_INLINE bool CLOCK_IsPLL0Locked (void)

Check if PLL is locked or not.

Returns

true if the PLL is locked, false if not locked

__STATIC_INLINE bool CLOCK_IsPLL1Locked (void)

Check if PLL1 is locked or not.

Returns

true if the PLL1 is locked, false if not locked

void CLOCK_SetStoredPLL0ClockRate(uint32_t rate)

Store the current PLL0 rate.

Parameters

- rate – Current rate of the PLL0

Returns

Nothing

uint32_t CLOCK_GetPLL0OutFromSetup(*pll_setup_t* *pSetup)

Return PLL0 output clock rate from setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

System PLL output clock rate the setup structure will generate

uint32_t CLOCK_GetPLL1OutFromSetup(*pll_setup_t* *pSetup)

Return PLL1 output clock rate from setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

PLL0 output clock rate the setup structure will generate

pll_error_t CLOCK_SetupPLL0Data(*pll_config_t* *pControl, *pll_setup_t* *pSetup)

Set PLL0 output based on the passed PLL setup data.

Note: Actual frequency for setup may vary from the desired frequency based on the accuracy of input clocks, rounding, non-fractional PLL mode, etc.

Parameters

- pControl – : Pointer to populated PLL control structure to generate setup with
- pSetup – : Pointer to PLL setup structure to be filled

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

pll_error_t CLOCK_SetupPLL0Prec(*pll_setup_t* *pSetup, uint32_t flagcfg)

Set PLL output from PLL setup structure (precise frequency)

Note: This function will power off the PLL, setup the PLL with the new setup data, and then optionally powerup the PLL, wait for PLL lock, and adjust system voltages to the new PLL rate. The function will not alter any source clocks (ie, main system clock) that may use the PLL, so these should be setup prior to and after exiting the function.

Parameters

- pSetup – : Pointer to populated PLL setup structure
- flagcfg – : Flag configuration for PLL config structure

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

pll_error_t CLOCK_SetPLL0Freq(const *pll_setup_t* *pSetup)

Set PLL output from PLL setup structure (precise frequency)

Note: This function will power off the PLL, setup the PLL with the new setup data, and then optionally powerup the PLL, wait for PLL lock, and adjust system voltages to the new

PLL rate. The function will not alter any source clocks (ie, main system clock) that may use the PLL, so these should be setup prior to and after exiting the function.

Parameters

- pSetup – : Pointer to populated PLL setup structure

Returns

kStatus_PLL_Success on success, or PLL setup error code

pll_error_t CLOCK_SetPLL1Freq(const *pll_setup_t* *pSetup)

Set PLL output from PLL setup structure (precise frequency)

Note: This function will power off the PLL, setup the PLL with the new setup data, and then optionally powerup the PLL, wait for PLL lock, and adjust system voltages to the new PLL rate. The function will not alter any source clocks (ie, main system clock) that may use the PLL, so these should be setup prior to and after exiting the function.

Parameters

- pSetup – : Pointer to populated PLL setup structure

Returns

kStatus_PLL_Success on success, or PLL setup error code

void CLOCK_SetupPLL0Mult(uint32_t multiply_by, uint32_t input_freq)

Set PLL0 output based on the multiplier and input frequency.

Note: Unlike the Chip_Clock_SetupSystemPLLPrec() function, this function does not disable or enable PLL power, wait for PLL lock, or adjust system voltages. These must be done in the application. The function will not alter any source clocks (ie, main system clock) that may use the PLL, so these should be setup prior to and after exiting the function.

Parameters

- multiply_by – : multiplier
- input_freq – : Clock input frequency of the PLL

Returns

Nothing

void CLOCK_EnableOstimer32kClock(void)

Enable the OSTIMER 32k clock.

Returns

Nothing

FSL_CLOCK_DRIVER_VERSION

CLOCK driver version 2.3.8.

FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL

Configure whether driver controls clock.

When set to 0, peripheral drivers will enable clock in initialize function and disable clock in de-initialize function. When set to 1, peripheral driver will not control the clock, application could control the clock out of the driver.

Note: All drivers share this feature switcher. If it is set to 1, application should handle clock enable and disable for all drivers.

CLOCK_USR_CFG_PLL_CONFIG_CACHE_COUNT

User-defined the size of cache for CLOCK_PllGetConfig() function.

Once define this MACRO to be non-zero value, CLOCK_PllGetConfig() function would cache the recent calculation and accelerate the execution to get the right settings.

SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY

ROM_CLOCKS

Clock ip name array for ROM.

SRAM_CLOCKS

Clock ip name array for SRAM.

FLASH_CLOCKS

Clock ip name array for FLASH.

FMC_CLOCKS

Clock ip name array for FMC.

INPUTMUX_CLOCKS

Clock ip name array for INPUTMUX.

IOCON_CLOCKS

Clock ip name array for IOCON.

GPIO_CLOCKS

Clock ip name array for GPIO.

PINT_CLOCKS

Clock ip name array for PINT.

GINT_CLOCKS

Clock ip name array for GINT.

DMA_CLOCKS

Clock ip name array for DMA.

CRC_CLOCKS

Clock ip name array for CRC.

WWDT_CLOCKS

Clock ip name array for WWDT.

RTC_CLOCKS

Clock ip name array for RTC.

MAILBOX_CLOCKS

Clock ip name array for Mailbox.

LPADC_CLOCKS

Clock ip name array for LPADC.

MRT_CLOCKS

Clock ip name array for MRT.

OSTIMER_CLOCKS

Clock ip name array for OSTIMER.

SCT_CLOCKS

Clock ip name array for SCT0.

MCAN_CLOCKS

Clock ip name array for MCAN.

UTICK_CLOCKS

Clock ip name array for UTICK.

FLEXCOMM_CLOCKS

Clock ip name array for FLEXCOMM.

LPUART_CLOCKS

Clock ip name array for LPUART.

BI2C_CLOCKS

Clock ip name array for BI2C.

LPSPI_CLOCKS

Clock ip name array for LSPI.

FLEXI2S_CLOCKS

Clock ip name array for FLEXI2S.

CTIMER_CLOCKS

Clock ip name array for CTIMER.

COMP_CLOCKS

Clock ip name array for COMP.

FREQME_CLOCKS

Clock ip name array for FREQME.

CDOG_CLOCKS

Clock ip name array for CDOG.

RNG_CLOCKS

Clock ip name array for RNG.

HASHCRYPT_CLOCKS

Clock ip name array for HashCrypt.

PLULUT_CLOCKS

Clock ip name array for PLULUT.

PUF_CLOCKS

Clock ip name array for PUF.

CASPER_CLOCKS

Clock ip name array for CASPER.

ANALOGCTRL_CLOCKS

Clock ip name array for ANALOGCTRL.

HS_LSPI_CLOCKS

Clock ip name array for HS_LSPI.

GPIO_SEC_CLOCKS

Clock ip name array for GPIO_SEC.

GPIO_SEC_INT_CLOCKS

Clock ip name array for GPIO_SEC_INT.

PLU_CLOCKS

SYSCTL_CLOCKS

CLK_GATE_REG_OFFSET_SHIFT

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

CLK_GATE_REG_OFFSET_MASK

CLK_GATE_BIT_SHIFT_SHIFT

CLK_GATE_BIT_SHIFT_MASK

CLK_GATE_DEFINE(reg_offset, bit_shift)

CLK_GATE_ABSTRACT_REG_OFFSET(x)

CLK_GATE_ABSTRACT_BITS_SHIFT(x)

AHB_CLK_CTRL0

AHB_CLK_CTRL1

AHB_CLK_CTRL2

BUS_CLK

Peripherals clock source definition.

I2C0_CLK_SRC

CLK_ATTACH_ID(mux, sel, pos)

Clock Mux Switches The encoding is as follows each connection identified is 32bits wide while 24bits are valuable starting from LSB upwards.

[4 bits for choice, 0 means invalid choice] [8 bits mux ID]*

MUX_A(mux, sel)

MUX_B(mux, sel, selector)

GET_ID_ITEM(connection)

GET_ID_NEXT_ITEM(connection)

GET_ID_ITEM_MUX(connection)

GET_ID_ITEM_SEL(connection)

GET_ID_SELECTOR(connection)

CM_SYSTICKCLKSEL0

CM_TRACECLKSEL

CM_TIMERCLKSEL0

CM_TIMERCLKSEL1

CM_TIMERCLKSEL2

CM_TIMERCLKSEL3

CM_TIMERCLKSEL4

CM_MAINCLKSELA

CM_MAINCLKSELB
CM_CLKOUTCLKSEL
CM_PLL0CLKSEL
CM_PLL1CLKSEL
CM_MCANCLKSEL
CM_ADCA SYNCCLKSEL
CM_CLK32KCLKSEL
CM_FXCOMCLKSEL0
CM_FXCOMCLKSEL1
CM_FXCOMCLKSEL2
CM_FXCOMCLKSEL3
CM_FXCOMCLKSEL4
CM_FXCOMCLKSEL5
CM_FXCOMCLKSEL6
CM_FXCOMCLKSEL7
CM_HSLSPICLKSEL
CM_MCLKCLKSEL
CM_SCTCLKSEL
CM_OSTIMERCLKSEL
CM_RTCOSC32KCLKSEL

PLL_CONFIGFLAG_USEINRATE

PLL configuration structure flags for 'flags' field These flags control how the PLL configuration function sets up the PLL setup structure.

When the PLL_CONFIGFLAG_USEINRATE flag is selected, the 'InputRate' field in the configuration structure must be assigned with the expected PLL frequency. If the PLL_CONFIGFLAG_USEINRATE is not used, 'InputRate' is ignored in the configuration function and the driver will determine the PLL rate from the currently selected PLL source. This flag might be used to configure the PLL input clock more accurately when using the WDT oscillator or a more dynamic CLKIN source.

When the PLL_CONFIGFLAG_FORCENOFRACT flag is selected, the PLL hardware for the automatic bandwidth selection, Spread Spectrum (SS) support, and fractional M-divider are not used.

Flag to use InputRate in PLL configuration structure for setup

PLL_CONFIGFLAG_FORCENOFRACT

Force non-fractional output mode, PLL output will not use the fractional, automatic bandwidth, or SS hardware

PLL_SETUPFLAG_POWERUP

PLL setup structure flags for 'flags' field These flags control how the PLL setup function sets up the PLL.

Setup will power on the PLL after setup

PLL_SETUPFLAG_WAITLOCK

Setup will wait for PLL lock, implies the PLL will be powered on

PLL_SETUPFLAG_ADGVOLT

Optimize system voltage for the new PLL rate

PLL_SETUPFLAG_USEFEEDBACKDIV2

Use feedback divider by 2 in divider path

uint32_t desiredRate

Desired PLL rate in Hz

uint32_t inputRate

PLL input clock in Hz, only used if PLL_CONFIGFLAG_USEINRATE flag is set

uint32_t flags

PLL configuration flags, Or'ed value of PLL_CONFIGFLAG_* definitions

ss_progmodfm_t ss_mf

SS Programmable modulation frequency, only applicable when not using PLL_CONFIGFLAG_FORCENOFRACT flag

ss_progmoddp_t ss_mr

SS Programmable frequency modulation depth, only applicable when not using PLL_CONFIGFLAG_FORCENOFRACT flag

ss_modwvctrl_t ss_mc

SS Modulation waveform control, only applicable when not using PLL_CONFIGFLAG_FORCENOFRACT flag

bool mfDither

false for fixed modulation frequency or true for dithering, only applicable when not using PLL_CONFIGFLAG_FORCENOFRACT flag

uint32_t pllctrl

PLL control register PLL0CTRL

uint32_t pllndec

PLL NDEC register PLL0NDEC

uint32_t pllpedec

PLL PDEC register PLL0PDEC

uint32_t pllmddec

PLL MDEC registers PLL0PDEC

uint32_t pllsscg[2]

PLL SSCTL registers PLL0SSCG

uint32_t pllRate

Actual PLL rate

uint32_t flags

PLL setup flags, Or'ed value of PLL_SETUPFLAG_* definitions

struct __pll_config

#include <fsl_clock.h> PLL configuration structure.

This structure can be used to configure the settings for a PLL setup structure. Fill in the desired configuration for the PLL and call the PLL setup function to fill in a PLL setup structure.

struct __pll_setup

#include <fsl_clock.h> PLL0 setup structure This structure can be used to pre-build a PLL setup configuration at run-time and quickly set the PLL to the configuration. It can be populated with the PLL setup function. If powering up or waiting for PLL lock, the PLL input clock source should be configured prior to PLL setup.

2.7 CMP: Analog Comparator Driver

void CMP_Init(const *cmp_config_t* *config)

CMP initialization.

This function enables the CMP module and do necessary settings.

Parameters

- config – Pointer to the configuration structure.

void CMP_Deinit(void)

CMP deinitialization.

This function gates the clock for CMP module.

void CMP_GetDefaultConfig(*cmp_config_t* *config)

Initializes the CMP user configuration structure.

This function initializes the user configuration structure to these default values.

```
config->enableHysteresis    = true;
config->enableLowPower      = true;
config->filterClockDivider  = kCMP_FilterClockDivide1;
config->filterSampleMode    = kCMP_FilterSampleMode0;
```

Parameters

- config – Pointer to the configuration structure.

static inline void CMP_SetInputChannels(uint8_t positiveChannel, uint8_t negativeChannel)

void CMP_SetVREF(const *cmp_vref_config_t* *config)

Configures the VREFINPUT.

Parameters

- config – Pointer to the configuration structure.

static inline bool CMP_GetOutput(void)

Get CMP compare output.

Returns

The output result. true: voltage on positive side is greater than negative side.
false: voltage on positive side is lower than negative side.

static inline void CMP_EnableInterrupt(uint32_t type)

CMP enable interrupt.

Parameters

- `type` – CMP interrupt type. See “`_cmp_interrupt_type`”.

static inline void `CMP_DisableInterrupt(void)`

CMP disable interrupt.

static inline void `CMP_ClearInterrupt(void)`

CMP clear interrupt.

static inline void `CMP_EnableFilteredInterruptSource(bool enable)`

Select which Analog comparator output (filtered or un-filtered) is used for interrupt detection.

Note: : When CMP is configured as the wakeup source in power down mode, this function must use the raw output as the interrupt source, that is, call this function and set parameter `enable` to false.

Parameters

- `enable` – false: Select Analog Comparator raw output (unfiltered) as input for interrupt detection. true: Select Analog Comparator filtered output as input for interrupt detection.

static inline bool `CMP_GetPreviousInterruptStatus(void)`

Get CMP interrupt status before interrupt enable.

Returns

Interrupt status. true: interrupt pending, false: no interrupt pending.

static inline bool `CMP_GetInterruptStatus(void)`

Get CMP interrupt status after interrupt enable.

Returns

Interrupt status. true: interrupt pending, false: no interrupt pending.

static inline void `CMP_FilterSampleConfig(cmp_filtercfg_samplemode_t filterSampleMode, cmp_filtercfg_clkdiv_t filterClockDivider)`

CMP Filter Sample Config.

This function allows the users to configure the sampling mode and clock divider of the CMP Filter.

Parameters

- `filterSampleMode` – CMP Select filter sample mode
- `filterClockDivider` – CMP Set filter clock divider

`FSL_CMP_DRIVER_VERSION`

Driver version 2.2.1.

enum `_cmp_input_mux`

CMP input mux for positive and negative sides.

Values:

enumerator `kCMP_InputVREF`

Cmp input from VREF.

enumerator `kCMP_Input1`

Cmp input source 1.

enumerator `kCMP_Input2`

Cmp input source 2.

enumerator kCMP_Input3
Cmp input source 3.

enumerator kCMP_Input4
Cmp input source 4.

enumerator kCMP_Input5
Cmp input source 5.

enum _cmp_interrupt_type
CMP interrupt type.

Values:

enumerator kCMP_EdgeDisable
Disable edge interrupt.

enumerator kCMP_EdgeRising
Interrupt on falling edge.

enumerator kCMP_EdgeFalling
Interrupt on rising edge.

enumerator kCMP_EdgeRisingFalling
Interrupt on both rising and falling edges.

enumerator kCMP_LevelDisable
Disable level interrupt.

enumerator kCMP_LevelHigh
Interrupt on high level.

enumerator kCMP_LevelLow
Interrupt on low level.

enum _cmp_vref_source
CMP Voltage Reference source.

Values:

enumerator KCMP_VREFSourceVDDA
Select VDDA as VREF.

enumerator KCMP_VREFSourceInternalVREF
Select internal VREF as VREF.

enum _cmp_filtercgf_samplemode
CMP Filter sample mode.

Values:

enumerator kCMP_FilterSampleMode0
Bypass mode. Filtering is disabled.

enumerator kCMP_FilterSampleMode1
Filter 1 clock period.

enumerator kCMP_FilterSampleMode2
Filter 2 clock period.

enumerator kCMP_FilterSampleMode3
Filter 3 clock period.

enum *_cmp_filtercgf_clkdiv*
CMP Filter clock divider.

Values:

enumerator *kCMP_FilterClockDivide1*
Filter clock period duration equals 1 analog comparator clock period.

enumerator *kCMP_FilterClockDivide2*
Filter clock period duration equals 2 analog comparator clock period.

enumerator *kCMP_FilterClockDivide4*
Filter clock period duration equals 4 analog comparator clock period.

enumerator *kCMP_FilterClockDivide8*
Filter clock period duration equals 8 analog comparator clock period.

enumerator *kCMP_FilterClockDivide16*
Filter clock period duration equals 16 analog comparator clock period.

enumerator *kCMP_FilterClockDivide32*
Filter clock period duration equals 32 analog comparator clock period.

enumerator *kCMP_FilterClockDivide64*
Filter clock period duration equals 64 analog comparator clock period.

typedef enum *_cmp_vref_source* *cmp_vref_source_t*
CMP Voltage Reference source.

typedef struct *_cmp_vref_config* *cmp_vref_config_t*

typedef enum *_cmp_filtercgf_samplemode* *cmp_filtercgf_samplemode_t*
CMP Filter sample mode.

typedef enum *_cmp_filtercgf_clkdiv* *cmp_filtercgf_clkdiv_t*
CMP Filter clock divider.

typedef struct *_cmp_config* *cmp_config_t*
CMP configuration structure.

struct *_cmp_vref_config*
#include <fsl_cmp.h>

Public Members

cmp_vref_source_t *vrefSource*
Reference voltage source.

uint8_t *vrefValue*
Reference voltage step. Available range is 0-31. Per step equals to VREFINPUT/31.

struct *_cmp_config*
#include <fsl_cmp.h> CMP configuration structure.

Public Members

bool *enableHysteresis*
Enable hysteresis.

bool *enableLowPower*
Enable low power mode.

2.8 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.

2.9 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

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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_3
Timer capture channel 3

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

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

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_EnableMatchChannelReload(CTIMER_Type *base, *ctimer_match_t* match, bool enable)

Enable reload channel falling edge.

Enable the specified match channel reload match shadow value.

Parameters

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

```
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.

```
static inline void CTIMER_SetShadowValue(CTIMER_Type *base, ctimer_match_t match,
                                         uint32_t matchvalue)
```

Set the specified match shadow channel.

Parameters

- base – Ctimer peripheral base address.
- match – match channel used.
- matchvalue – Reload the value of the corresponding match register.

```
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

2.10 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

2.11 IAP: In Application Programming Driver

enum _flash_driver_version_constants

Flash driver version for ROM.

Values:

enumerator kFLASH_DriverVersionName

Flash driver version name.

enumerator kFLASH_DriverVersionMajor

Major flash driver version.

enumerator kFLASH_DriverVersionMinor

Minor flash driver version.

enumerator kFLASH_DriverVersionBugfix

Bugfix for flash driver version.

MAKE_VERSION(major, minor, bugfix)

Constructs the version number for drivers.

FSL_FLASH_DRIVER_VERSION

Flash driver version for SDK.

Version 2.1.5.

enum _flash_status

Flash driver status codes.

Values:

enumerator kStatus_FLASH_Success

API is executed successfully

enumerator kStatus_FLASH_InvalidArgument

Invalid argument

enumerator kStatus_FLASH_SizeError

Error size

enumerator kStatus_FLASH_AlignmentError

Parameter is not aligned with the specified baseline

enumerator kStatus_FLASH_AddressError

Address is out of range

enumerator kStatus_FLASH_AccessError

Invalid instruction codes and out-of bound addresses

enumerator kStatus_FLASH_ProtectionViolation

The program/erase operation is requested to execute on protected areas

enumerator kStatus_FLASH_CommandFailure

Run-time error during command execution.

enumerator kStatus_FLASH_UnknownProperty

Unknown property.

enumerator kStatus_FLASH_EraseKeyError

API erase key is invalid.

enumerator kStatus_FLASH_RegionExecuteOnly

The current region is execute-only.

enumerator kStatus_FLASH_ExecuteInRamFunctionNotReady

Execute-in-RAM function is not available.

enumerator kStatus_FLASH_CommandNotSupported

Flash API is not supported.

enumerator kStatus_FLASH_ReadOnlyProperty

The flash property is read-only.

enumerator kStatus_FLASH_InvalidPropertyValue

The flash property value is out of range.

enumerator kStatus_FLASH_InvalidSpeculationOption

The option of flash prefetch speculation is invalid.

enumerator kStatus_FLASH_EccError

A correctable or uncorrectable error during command execution.

enumerator kStatus_FLASH_CompareError

Destination and source memory contents do not match.

enumerator kStatus_FLASH_RegulationLoss

A loss of regulation during read.

enumerator kStatus_FLASH_InvalidWaitStateCycles

The wait state cycle set to r/w mode is invalid.

enumerator kStatus_FLASH_OutOfDateCfpaPage

CFPA page version is out of date.

enumerator kStatus_FLASH_BlankIfrPageData

Blank page cannot be read.

enumerator kStatus_FLASH_EncryptedRegionsEraseNotDoneAtOnce

Encrypted flash subregions are not erased at once.

enumerator kStatus_FLASH_ProgramVerificationNotAllowed

Program verification is not allowed when the encryption is enabled.

enumerator kStatus_FLASH_HashCheckError

Hash check of page data is failed.

enumerator kStatus_FLASH_SealedFfrRegion

The FFR region is sealed.

enumerator kStatus_FLASH_FfrRegionWriteBroken

The FFR Spec region is not allowed to be written discontinuously.

enumerator kStatus_FLASH_NmpaAccessNotAllowed

The NMPA region is not allowed to be read/written/erased.

enumerator kStatus_FLASH_CmpaCfgDirectEraseNotAllowed

The CMPA Cfg region is not allowed to be erased directly.

enumerator kStatus_FLASH_FfrBankIsLocked

The FFR bank region is locked.

enumerator kStatus_FLASH_EraseFrequencyError

Core frequency is over 100MHZ.

enumerator kStatus_FLASH_ProgramFrequencyError

Core frequency is over 100MHZ.

kStatusGroupGeneric

Flash driver status group.

kStatusGroupFlashDriver

MAKE_STATUS(group, code)

Constructs a status code value from a group and a code number.

enum _flash_driver_api_keys

Enumeration for Flash driver API keys.

Note: The resulting value is built with a byte order such that the string being readable in expected order when viewed in a hex editor, if the value is treated as a 32-bit little endian value.

Values:

enumerator kFLASH_ApiEraseKey

Key value used to validate all flash erase APIs.

FOUR_CHAR_CODE(a, b, c, d)

Constructs the four character code for the Flash driver API key.

status_t FLASH_Init(flash_config_t *config)

Initializes the global flash properties structure members.

This function checks and initializes the Flash module for the other Flash APIs.

Parameters

- config – Pointer to the storage for the driver runtime state.

Return values

- kStatus_FLASH_Success – API was executed successfully.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.
- kStatus_FLASH_CommandFailure – Run-time error during the command execution.
- kStatus_FLASH_CommandNotSupported – Flash API is not supported.
- kStatus_FLASH_EccError – A correctable or uncorrectable error during command execution.

status_t FLASH_Erase(*flash_config_t* *config, uint32_t start, uint32_t lengthInBytes, uint32_t key)

Erases the flash sectors encompassed by parameters passed into function.

This function erases the appropriate number of flash sectors based on the desired start address and length.

Parameters

- config – The pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be erased. The start address need to be 512bytes-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words) to be erased. Must be 512bytes-aligned.
- key – The value used to validate all flash erase APIs.

Return values

- kStatus_FLASH_Success – API was executed successfully; the appropriate number of flash sectors based on the desired start address and length were erased successfully.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.
- kStatus_FLASH_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus_FLASH_AddressError – The address is out of range.
- kStatus_FLASH_EraseKeyError – The API erase key is invalid.
- kStatus_FLASH_CommandFailure – Run-time error during the command execution.
- kStatus_FLASH_CommandNotSupported – Flash API is not supported.
- kStatus_FLASH_EccError – A correctable or uncorrectable error during command execution.

status_t FLASH_Program(*flash_config_t* *config, uint32_t start, const uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters.

This function programs the flash memory with the desired data for a given flash area as determined by the start address and the length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be 512bytes-aligned.
- src – A pointer to the source buffer of data that is to be programmed into the flash.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be 512bytes-aligned.

Return values

- kStatus_FLASH_Success – API was executed successfully; the desired data were programed successfully into flash based on desired start address and length.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.

- `kStatus_FLASH_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FLASH_AddressError` – Address is out of range.
- `kStatus_FLASH_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandNotSupported` – Flash API is not supported.
- `kStatus_FLASH_EccError` – A correctable or uncorrectable error during command execution.

`status_t FLASH_VerifyErase(flash_config_t *config, uint32_t start, uint32_t lengthInBytes)`

Verifies an erasure of the desired flash area at a specified margin level.

This function checks the appropriate number of flash sectors based on the desired start address and length to check whether the flash is erased to the specified read margin level.

Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `start` – The start address of the desired flash memory to be verified. The start address need to be 512bytes-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be 512bytes-aligned.

Return values

- `kStatus_FLASH_Success` – API was executed successfully; the specified FLASH region has been erased.
- `kStatus_FLASH_InvalidArgument` – An invalid argument is provided.
- `kStatus_FLASH_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FLASH_AddressError` – Address is out of range.
- `kStatus_FLASH_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandNotSupported` – Flash API is not supported.
- `kStatus_FLASH_EccError` – A correctable or uncorrectable error during command execution.

`status_t FLASH_VerifyProgram(flash_config_t *config, uint32_t start, uint32_t lengthInBytes, const uint8_t *expectedData, uint32_t *failedAddress, uint32_t *failedData)`

Verifies programming of the desired flash area at a specified margin level.

This function verifies the data programed in the flash memory using the Flash Program Check Command and compares it to the expected data for a given flash area as determined by the start address and length.

Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `start` – The start address of the desired flash memory to be verified. need be 512bytes-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. need be 512bytes-aligned.
- `expectedData` – A pointer to the expected data that is to be verified against.
- `failedAddress` – A pointer to the returned failing address.
- `failedData` – A pointer to the returned failing data. Some derivatives do not include failed data as part of the FCCOBx registers. In this case, zeros are returned upon failure.

Return values

- `kStatus_FLASH_Success` – API was executed successfully; the desired data have been successfully programed into specified FLASH region.
- `kStatus_FLASH_InvalidArgument` – An invalid argument is provided.
- `kStatus_FLASH_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FLASH_AddressError` – Address is out of range.
- `kStatus_FLASH_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandFailure` – Run-time error during the command execution.
- `kStatus_FLASH_CommandNotSupported` – Flash API is not supported.
- `kStatus_FLASH_EccError` – A correctable or uncorrectable error during command execution.

`status_t` FLASH_GetProperty(*flash_config_t* **config*, *flash_property_tag_t* *whichProperty*, *uint32_t* **value*)

Returns the desired flash property.

Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `whichProperty` – The desired property from the list of properties in enum `flash_property_tag_t`
- `value` – A pointer to the value returned for the desired flash property.

Return values

- `kStatus_FLASH_Success` – API was executed successfully; the flash property was stored to `value`.
- `kStatus_FLASH_InvalidArgument` – An invalid argument is provided.
- `kStatus_FLASH_UnknownProperty` – An unknown property tag.

`void` BOOTLOADER_UserEntry(*void* **arg*)

Run the Bootloader API to force into the ISP mode base on the user arg.

Parameters

- `arg` – Indicates API prototype fields definition. Refer to the above `user_app_boot_invoke_option_t` structure

`FSL_FEATURE_FLASH_IP_IS_C040HD_ATFC`

Flash IP Type.

`FSL_FEATURE_FLASH_IP_IS_C040HD_FC`

`enum _flash_property_tag`

Enumeration for various flash properties.

Values:

`enumerator kFLASH_PropertyPflashSectorSize`

Pflash sector size property.

`enumerator kFLASH_PropertyPflashTotalSize`

Pflash total size property.

`enumerator kFLASH_PropertyPflashBlockSize`

Pflash block size property.

`enumerator kFLASH_PropertyPflashBlockCount`

Pflash block count property.

`enumerator kFLASH_PropertyPflashBlockBaseAddr`

Pflash block base address property.

`enumerator kFLASH_PropertyPflashPageSize`

Pflash page size property.

`enumerator kFLASH_PropertyPflashSystemFreq`

System Frequency System Frequency.

`enumerator kFLASH_PropertyFfrSectorSize`

FFR sector size property.

`enumerator kFLASH_PropertyFfrTotalSize`

FFR total size property.

`enumerator kFLASH_PropertyFfrBlockBaseAddr`

FFR block base address property.

`enumerator kFLASH_PropertyFfrPageSize`

FFR page size property.

`enum _flash_max_erase_page_value`

Enumeration for flash max pages to erase.

Values:

`enumerator kFLASH_MaxPagesToErase`

The max value in pages to erase.

`enum _flash_alignment_property`

Enumeration for flash alignment property.

Values:

`enumerator kFLASH_AlignementUnitVerifyErase`

The alignment unit in bytes used for verify erase operation.

`enumerator kFLASH_AlignementUnitProgram`

The alignment unit in bytes used for program operation.

enumerator kFLASH_AlignementUnitSingleWordRead

The alignment unit in bytes used for verify program operation. The alignment unit in bytes used for SingleWordRead command.

enum _flash_read_ecc_option

Enumeration for flash read ecc option.

Values:

enumerator kFLASH_ReadWithEccOn

enumerator kFLASH_ReadWithEccOff

ECC is on

enum _flash_freq_tag

Values:

enumerator kSysToFlashFreq_lowInMHz

enumerator kSysToFlashFreq_defaultInMHz

enum _flash_read_margin_option

Enumeration for flash read margin option.

Values:

enumerator kFLASH_ReadMarginNormal

Normal read

enumerator kFLASH_ReadMarginVsProgram

Margin vs. program

enumerator kFLASH_ReadMarginVsErase

Margin vs. erase

enumerator kFLASH_ReadMarginIllegalBitCombination

Illegal bit combination

enum _flash_read_dmacc_option

Enumeration for flash read dmacc option.

Values:

enumerator kFLASH_ReadDmaccDisabled

Memory word

enumerator kFLASH_ReadDmaccEnabled

DMACC word

enum _flash_ramp_control_option

Enumeration for flash ramp control option.

Values:

enumerator kFLASH_RampControlDivisionFactorReserved

Reserved

enumerator kFLASH_RampControlDivisionFactor256

$\text{clk48mhz} / 256 = 187.5\text{KHz}$

enumerator kFLASH_RampControlDivisionFactor128

$\text{clk48mhz} / 128 = 375\text{KHz}$

enumerator kFLASH_RampControlDivisionFactor64

$\text{clk48mhz} / 64 = 750\text{KHz}$

```
typedef enum _flash_property_tag flash_property_tag_t
```

Enumeration for various flash properties.

```
typedef struct _flash_ecc_log flash_ecc_log_t
```

Flash ECC log info.

```
typedef struct _flash_mode_config flash_mode_config_t
```

Flash controller paramter config.

```
typedef struct _flash_ffr_config flash_ffr_config_t
```

Flash controller paramter config.

```
typedef struct _flash_config flash_config_t
```

Flash driver state information.

An instance of this structure is allocated by the user of the flash driver and passed into each of the driver APIs.

```
status_t FLASH_Read(flash_config_t *config, uint32_t start, uint8_t *dest, uint32_t  
lengthInBytes)
```

Reads flash at locations passed in through parameters.

This function read the flash memory from a given flash area as determined by the start address and the length.

Parameters

- *config* – A pointer to the storage for the driver runtime state.
- *start* – The start address of the desired flash memory to be read.
- *dest* – A pointer to the dest buffer of data that is to be read from the flash.
- *lengthInBytes* – The length, given in bytes (not words or long-words), to be read.

Return values

- *kStatus_FLASH_Success* – API was executed successfully.
- *kStatus_FLASH_InvalidArgument* – An invalid argument is provided.
- *kStatus_FLASH_AlignmentError* – Parameter is not aligned with the specified baseline.
- *kStatus_FLASH_AddressError* – Address is out of range.
- *kStatus_FLASH_AccessError* – Invalid instruction codes and out-of bounds addresses.
- *kStatus_FLASH_CommandFailure* – Run-time error during the command execution.
- *kStatus_FLASH_CommandFailure* – Run-time error during the command execution.
- *kStatus_FLASH_CommandNotSupported* – Flash API is not supported.
- *kStatus_FLASH_EccError* – A correctable or uncorrectable error during command execution.

```
struct _flash_ecc_log
```

#include <fsl_iap.h> Flash ECC log info.

```
struct _flash_mode_config
```

#include <fsl_iap.h> Flash controller paramter config.

struct _flash_ffr_config
 #include <fsl_iap.h> Flash controller paramter config.

struct _flash_config
 #include <fsl_iap.h> Flash driver state information.

An instance of this structure is allocated by the user of the flash driver and passed into each of the driver APIs.

Public Members

uint32_t PFlashBlockBase
 A base address of the first PFlash block

uint32_t PFlashTotalSize
 The size of the combined PFlash block.

uint32_t PFlashBlockCount
 A number of PFlash blocks.

uint32_t PFlashPageSize
 The size in bytes of a page of PFlash.

uint32_t PFlashSectorSize
 The size in bytes of a sector of PFlash.

struct user_app_boot_invoke_option_t
 #include <fsl_iap.h>

struct readSingleWord

struct setWriteMode

struct setReadMode

union option

Public Members

struct user_app_boot_invoke_option_t B

uint32_t U

struct B

2.12 IAP_FFR Driver

status_t FFR_Init(flash_config_t *config)

Initializes the global FFR properties structure members.

Parameters

- config – A pointer to the storage for the driver runtime state.

Return values

- kStatus_FLASH_Success – API was executed successfully.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.

status_t FFR_Lock_All(*flash_config_t* *config)

Enable firewall for all flash banks.

CFPA, CMPA, and NMPA flash areas region will be locked, After this function executed; Unless the board is reset again.

Parameters

- config – A pointer to the storage for the driver runtime state.

Return values

- kStatus_FLASH_Success – An invalid argument is provided.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.

status_t FFR_InfieldPageWrite(*flash_config_t* *config, uint8_t *page_data, uint32_t valid_len)

APIs to access CFPA pages.

This routine will erase CFPA and program the CFPA page with passed data.

Parameters

- config – A pointer to the storage for the driver runtime state.
- page_data – A pointer to the source buffer of data that is to be programmed into the CFPA.
- valid_len – The length, given in bytes, to be programmed.

Return values

- kStatus_FLASH_Success – The desire page-data were programed successfully into CFPA.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FLASH_FfrBankIsLocked – The CFPA was locked.
- kStatus_FLASH_OutOfDateCfpaPage – It is not newest CFPA page.

status_t FFR_GetCustomerInfieldData(*flash_config_t* *config, uint8_t *pData, uint32_t offset, uint32_t len)

APIs to access CFPA pages.

Generic read function, used by customer to read data stored in ‘Customer In-field Page’.

Parameters

- config – A pointer to the storage for the driver runtime state.
- pData – A pointer to the dest buffer of data that is to be read from ‘Customer In-field Page’.
- offset – An offset from the ‘Customer In-field Page’ start address.
- len – The length, given in bytes, to be read.

Return values

- kStatus_FLASH_Success – Get data from ‘Customer In-field Page’.
- kStatus_FLASH_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FLASH_CommandFailure – access error.

status_t FFR_CustFactoryPageWrite(*flash_config_t* *config, uint8_t *page_data, bool seal_part)
APIs to access CMPA pages.

This routine will erase “customer factory page” and program the page with passed data. If ‘seal_part’ parameter is TRUE then the routine will compute SHA256 hash of the page contents and then programs the pages. 1.During development customer code uses this API with ‘seal_part’ set to FALSE. 2.During manufacturing this parameter should be set to TRUE to seal the part from further modifications 3.This routine checks if the page is sealed or not. A page is said to be sealed if the SHA256 value in the page has non-zero value. On boot ROM locks the firewall for the region if hash is programmed anyways. So, write/erase commands will fail eventually.

Parameters

- config – A pointer to the storage for the driver runtime state.
- page_data – A pointer to the source buffer of data that is to be programmed into the “customer factory page”.
- seal_part – Set false for During development customer code.

Return values

- kStatus_FLASH_Success – The desire page-data were programed successfully into CMPA.
- kStatus_FLASH_InvalidArgument – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FLASH_CommandFailure – access error.

status_t FFR_GetCustomerData(*flash_config_t* *config, uint8_t *pData, uint32_t offset, uint32_t len)

APIs to access CMPA page.

Read data stored in ‘Customer Factory CFG Page’.

Parameters

- config – A pointer to the storage for the driver runtime state.
- pData – A pointer to the dest buffer of data that is to be read from the Customer Factory CFG Page.
- offset – Address offset relative to the CMPA area.
- len – The length, given in bytes to be read.

Return values

- kStatus_FLASH_Success – Get data from ‘Customer Factory CFG Page’.
- kStatus_FLASH_InvalidArgument – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FLASH_CommandFailure – access error.

status_t FFR_GetUUID(*flash_config_t* *config, uint8_t *uuid)

APIs to access CMPA page.

1.SW should use this API routine to get the UUID of the chip. 2.Calling routine should pass a pointer to buffer which can hold 128-bit value.

status_t FFR_KeystoreWrite(*flash_config_t* *config, *ffr_key_store_t* *pKeyStore)

This routine writes the 3 pages allocated for Key store data,.

1.Used during manufacturing. Should write pages when ‘customer factory page’ is not in sealed state. 2.Optional routines to set individual data members (activation code, key codes etc) to construct the key store structure in RAM before committing it to IFR/FFR.

Parameters

- config – A pointer to the storage for the driver runtime state.
- pKeyStore – A Pointer to the 3 pages allocated for Key store data. that will be written to ‘customer factory page’.

Return values

- kStatus_FLASH_Success – The key were programed successfully into FFR.
- kStatus_FLASH_InvalidArgument – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FLASH_CommandFailure – access error.

status_t FFR_KeystoreGetAC(*flash_config_t* *config, *uint8_t* *pActivationCode)

Get/Read Key store code routines.

- a. Calling code should pass buffer pointer which can hold activation code 1192 bytes.
- b. Check if flash aperture is small or regular and read the data appropriately.

status_t FFR_KeystoreGetKC(*flash_config_t* *config, *uint8_t* *pKeyCode, *ffr_key_type_t* keyIndex)

Get/Read Key store code routines.

- a. Calling code should pass buffer pointer which can hold key code 52 bytes.
- b. Check if flash aperture is small or regular and read the data appropriately.
- c. keyIndex specifies which key code is read.

FSL_FLASH_IFR_DRIVER_VERSION

Flash IFR driver version for SDK.

Version 2.1.0.

enum _flash_ffr_page_offset

flash ffr page offset.

Values:

enumerator kFfrPageOffset_CFPA

Customer In-Field programmed area

enumerator kFfrPageOffset_CFPA_Scratch

CFPA Scratch page

enumerator kFfrPageOffset_CFPA_Cfg

CFPA Configuration area (Ping page)

enumerator kFfrPageOffset_CFPA_CfgPong

Same as CFPA page (Pong page)

enumerator kFfrPageOffset_CMPA

Customer Manufacturing programmed area

enumerator kFfrPageOffset__CMPA__Cfg
CMPA Configuration area (Part of CMPA)

enumerator kFfrPageOffset__CMPA__Key
Key Store area (Part of CMPA)

enumerator kFfrPageOffset__NMPA
NXP Manufacturing programmed area

enumerator kFfrPageOffset__NMPA__Romcp
ROM patch area (Part of NMPA)

enumerator kFfrPageOffset__NMPA__Repair
Repair area (Part of NMPA)

enumerator kFfrPageOffset__NMPA__Cfg
NMPA configuration area (Part of NMPA)

enumerator kFfrPageOffset__NMPA__End
Reserved (Part of NMPA)

enum __flash_ffr_page_num
flash ffr page number.

Values:

enumerator kFfrPageNum__CFPA
Customer In-Field programmed area

enumerator kFfrPageNum__CMPA
Customer Manufacturing programmed area

enumerator kFfrPageNum__NMPA
NXP Manufacturing programmed area

enumerator kFfrPageNum__CMPA__Cfg

enumerator kFfrPageNum__CMPA__Key

enumerator kFfrPageNum__NMPA__Romcp

enumerator kFfrPageNum__SpecArea

enumerator kFfrPageNum__Total

enum __flash_ffr_block_size

Values:

enumerator kFfrBlockSize__Key

enumerator kFfrBlockSize__ActivationCode

enum __cfpa_cfg_cmpa_prog_process

Values:

enumerator kFfrCmpaProgProcess__Pre

enumerator kFfrCmpaProgProcess__Post

enum __ffr_key_type

Values:

enumerator kFFR__KeyTypeSbkek

```
enumerator kFFR__KeyTypeUser
enumerator kFFR__KeyTypeUds
enumerator kFFR__KeyTypePrinceRegion0
enumerator kFFR__KeyTypePrinceRegion1
enumerator kFFR__KeyTypePrinceRegion2
enum __ffr_bank_type
    Values:
    enumerator kFFR__BankTypeBank0__NMPA
    enumerator kFFR__BankTypeBank1__CMPA
    enumerator kFFR__BankTypeBank2__CFPA
typedef enum __cfpa_cfg_cmpa_prog_process cmpa__prog__process__t
typedef struct __cfpa_cfg_iv_code cfpa__cfg__iv__code__t
typedef struct __cfpa_cfg_info cfpa__cfg__info__t
typedef struct __cmpa_cfg_info cmpa__cfg__info__t
typedef struct __cmpa_key_store_header cmpa__key__store__header__t
typedef struct __nmpa_cfg_info nmpa__cfg__info__t
typedef struct __ffr_key_store ffr__key__store__t
typedef enum __ffr_key_type ffr__key__type__t
typedef enum __ffr_bank_type ffr__bank__type__t
ALIGN_DOWN(x, a)
    Alignment(down) utility.
ALIGN_UP(x, a)
    Alignment(up) utility.
FLASH_FFR_MAX_PAGE_SIZE
FLASH_FFR_HASH_DIGEST_SIZE
FLASH_FFR_IV_CODE_SIZE
FFR_BOOTCFG_BOOTSPEED_MASK
FFR_BOOTCFG_BOOTSPEED_SHIFT
FFR_BOOTCFG_BOOTSPEED_48MHZ
FFR_BOOTCFG_BOOTSPEED_96MHZ
FFR_USBID_VENDORID_MASK
FFR_USBID_VENDORID_SHIFT
FFR_USBID_PRODUCTID_MASK
FFR_USBID_PRODUCTID_SHIFT
```

```
FFR_SYSTEM_SPEED_CODE_MASK
FFR_SYSTEM_SPEED_CODE_SHIFT
FFR_SYSTEM_SPEED_CODE_FRO12MHZ_12MHZ
FFR_SYSTEM_SPEED_CODE_FROHF96MHZ_24MHZ
FFR_SYSTEM_SPEED_CODE_FROHF96MHZ_48MHZ
FFR_SYSTEM_SPEED_CODE_FROHF96MHZ_96MHZ
FFR_PERIPHERALCFG_PERI_MASK
FFR_PERIPHERALCFG_PERI_SHIFT
FFR_PERIPHERALCFG_COREEN_MASK
FFR_PERIPHERALCFG_COREEN_SHIFT
struct _cfpa_cfg_iv_code
    #include <fsl_iap_ffr.h>
struct _cfpa_cfg_info
    #include <fsl_iap_ffr.h>
```

Public Members

```
uint32_t header
    [0x000-0x003]
uint32_t version
    [0x004-0x007]
uint32_t secureFwVersion
    [0x008-0x00b]
uint32_t nsFwVersion
    [0x00c-0x00f]
uint32_t imageKeyRevoke
    [0x010-0x013]
uint8_t reserved0[4]
    [0x014-0x017]
uint32_t rotkhRevoke
    [0x018-0x01b]
uint32_t vendorUsage
    [0x01c-0x01f]
uint32_t dcfgNsPin
    [0x020-0x013]
uint32_t dcfgNsDflt
    [0x024-0x017]
uint32_t enableFaMode
    [0x028-0x02b]
uint8_t reserved1[4]
    [0x02c-0x02f]
```

```
    cfpa_cfg_iv_code_t ivCodePrinceRegion[3]
        [0x030-0x0d7]
    uint8_t reserved2[264]
        [0x0d8-0x1df]
    uint8_t sha256[32]
        [0x1e0-0x1ff]
struct _cmpa_cfg_info
    #include <fsl_iap_ffr.h>
```

Public Members

```
uint32_t bootCfg
    [0x000-0x003]
uint32_t spiFlashCfg
    [0x004-0x007]
struct _cmpa_cfg_info usbId
    [0x008-0x00b]
uint32_t sdioCfg
    [0x00c-0x00f]
uint32_t dcfgPin
    [0x010-0x013]
uint32_t dcfgDflt
    [0x014-0x017]
uint32_t dapVendorUsage
    [0x018-0x01b]
uint32_t secureBootCfg
    [0x01c-0x01f]
uint32_t princeBaseAddr
    [0x020-0x023]
uint32_t princeSr[3]
    [0x024-0x02f]
uint8_t reserved0[32]
    [0x030-0x04f]
uint32_t rotkh[8]
    [0x050-0x06f]
uint8_t reserved1[368]
    [0x070-0x1df]
uint8_t sha256[32]
    [0x1e0-0x1ff]
struct _cmpa_key_store_header
    #include <fsl_iap_ffr.h>
struct _nmpa_cfg_info
    #include <fsl_iap_ffr.h>
```

Public Members

uint16_t fro32kCfg
[0x000-0x001]

uint8_t reserved0[6]
[0x002-0x007]

uint8_t sysCfg
[0x008-0x008]

uint8_t reserved1[7]
[0x009-0x00f]

struct *_nmpa_cfg_info* GpoInitData[3]
[0x010-0x03f]

uint32_t GpoDataChecksum[4]
[0x040-0x04f]

uint32_t finalTestBatchId[4]
[0x050-0x05f]

uint32_t deviceType
[0x060-0x063]

uint32_t finalTestProgVersion
[0x064-0x067]

uint32_t finalTestDate
[0x068-0x06b]

uint32_t finalTestTime
[0x06c-0x06f]

uint32_t uuid[4]
[0x070-0x07f]

uint8_t reserved2[32]
[0x080-0x09f]

uint32_t peripheralCfg
[0x0a0-0x0a3]

uint32_t ramSizeCfg
[0x0a4-0x0a7]

uint32_t flashSizeCfg
[0x0a8-0x0ab]

uint8_t reserved3[36]
[0x0ac-0x0cf]

uint8_t fro1mCfg
[0x0d0-0x0d0]

uint8_t reserved4[15]
[0x0d1-0x0df]

uint32_t dcde[4]
[0x0e0-0x0ef]

```
uint32_t bod
    [0x0f0-0x0f3]
uint8_t reserved5[12]
    [0x0f4-0x0ff]
uint8_t calcHashReserved[192]
    [0x100-0x1bf]
uint8_t sha256[32]
    [0x1c0-0x1df]
uint32_t ecdBackup[4]
    [0x1e0-0x1ef]
uint32_t pageChecksum[4]
    [0x1f0-0x1ff]
struct __ffr_key_store
    #include <fsl_iap_ffr.h>
struct usbId
struct GpoInitData
```

2.13 FLEXCOMM: FLEXCOMM Driver

2.14 FLEXCOMM Driver

```
FSL_FLEXCOMM_DRIVER_VERSION
    FlexCOMM driver version 2.0.2.
enum FLEXCOMM_PERIPH_T
    FLEXCOMM peripheral modes.
    Values:
    enumerator FLEXCOMM_PERIPH_NONE
        No peripheral
    enumerator FLEXCOMM_PERIPH_USART
        USART peripheral
    enumerator FLEXCOMM_PERIPH_SPI
        SPI Peripheral
    enumerator FLEXCOMM_PERIPH_I2C
        I2C Peripheral
    enumerator FLEXCOMM_PERIPH_I2S_TX
        I2S TX Peripheral
    enumerator FLEXCOMM_PERIPH_I2S_RX
        I2S RX Peripheral
typedef void (*flexcomm_irq_handler_t)(void *base, void *handle)
    Typedef for interrupt handler.
```

IRQn_Type const kFlexcommIrqs[]

Array with IRQ number for each FLEXCOMM module.

uint32_t FLEXCOMM_GetInstance(void *base)

Returns instance number for FLEXCOMM module with given base address.

status_t FLEXCOMM_Init(void *base, FLEXCOMM_PERIPH_T periph)

Initializes FLEXCOMM and selects peripheral mode according to the second parameter.

void FLEXCOMM_SetIRQHandler(void *base, flexcomm_irq_handler_t handler, void *flexcommHandle)

Sets IRQ handler for given FLEXCOMM module. It is used by drivers register IRQ handler according to FLEXCOMM mode.

2.15 GINT: Group GPIO Input Interrupt Driver

FSL_GINT_DRIVER_VERSION

Driver version.

enum _gint_comb

GINT combine inputs type.

Values:

enumerator kGINT_CombineOr

A grouped interrupt is generated when any one of the enabled inputs is active

enumerator kGINT_CombineAnd

A grouped interrupt is generated when all enabled inputs are active

enum _gint_trig

GINT trigger type.

Values:

enumerator kGINT_TrigEdge

Edge triggered based on polarity

enumerator kGINT_TrigLevel

Level triggered based on polarity

enum _gint_port

Values:

enumerator kGINT_Port0

typedef enum _gint_comb gint_comb_t

GINT combine inputs type.

typedef enum _gint_trig gint_trig_t

GINT trigger type.

typedef enum _gint_port gint_port_t

typedef void (*gint_cb_t)(void)

GINT Callback function.

void GINT_Init(GINT_Type *base)

Initialize GINT peripheral.

This function initializes the GINT peripheral and enables the clock.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

void GINT_SetCtrl(GINT_Type *base, *gint_comb_t* comb, *gint_trig_t* trig, *gint_cb_t* callback)

Setup GINT peripheral control parameters.

This function sets the control parameters of GINT peripheral.

Parameters

- base – Base address of the GINT peripheral.
- comb – Controls if the enabled inputs are logically ORed or ANDed for interrupt generation.
- trig – Controls if the enabled inputs are level or edge sensitive based on polarity.
- callback – This function is called when configured group interrupt is generated.

Return values

None. –

void GINT_GetCtrl(GINT_Type *base, *gint_comb_t* *comb, *gint_trig_t* *trig, *gint_cb_t* *callback)

Get GINT peripheral control parameters.

This function returns the control parameters of GINT peripheral.

Parameters

- base – Base address of the GINT peripheral.
- comb – Pointer to store combine input value.
- trig – Pointer to store trigger value.
- callback – Pointer to store callback function.

Return values

None. –

void GINT_ConfigPins(GINT_Type *base, *gint_port_t* port, uint32_t polarityMask, uint32_t enableMask)

Configure GINT peripheral pins.

This function enables and controls the polarity of enabled pin(s) of a given port.

Parameters

- base – Base address of the GINT peripheral.
- port – Port number.
- polarityMask – Each bit position selects the polarity of the corresponding enabled pin. 0 = The pin is active LOW. 1 = The pin is active HIGH.
- enableMask – Each bit position selects if the corresponding pin is enabled or not. 0 = The pin is disabled. 1 = The pin is enabled.

Return values

None. –

```
void GINT_GetConfigPins(GINT_Type *base, gint_port_t port, uint32_t *polarityMask, uint32_t *enableMask)
```

Get GINT peripheral pin configuration.

This function returns the pin configuration of a given port.

Parameters

- base – Base address of the GINT peripheral.
- port – Port number.
- polarityMask – Pointer to store the polarity mask Each bit position indicates the polarity of the corresponding enabled pin. 0 = The pin is active LOW. 1 = The pin is active HIGH.
- enableMask – Pointer to store the enable mask. Each bit position indicates if the corresponding pin is enabled or not. 0 = The pin is disabled. 1 = The pin is enabled.

Return values

None. –

```
void GINT_EnableCallback(GINT_Type *base)
```

Enable callback.

This function enables the interrupt for the selected GINT 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 GINT peripheral.

Return values

None. –

```
void GINT_DisableCallback(GINT_Type *base)
```

Disable callback.

This function disables the interrupt for the selected GINT 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. –

```
static inline void GINT_ClrStatus(GINT_Type *base)
```

Clear GINT status.

This function clears the GINT status bit.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

```
static inline uint32_t GINT_GetStatus(GINT_Type *base)
```

Get GINT status.

This function returns the GINT status.

Parameters

- base – Base address of the GINT peripheral.

Return values

status – = 0 No group interrupt request. = 1 Group interrupt request active.

void GINT_Deinit(GINT_Type *base)

Deinitialize GINT peripheral.

This function disables the GINT clock.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

2.16 Hashcrypt: The Cryptographic Accelerator

2.17 Hashcrypt Background HASH

void HASHCRYPT_SHA_SetCallback(HASHCRYPT_Type *base, *hashcrypt_hash_ctx_t* *ctx, *hashcrypt_callback_t* callback, void *userData)

Initializes the HASHCRYPT handle for background hashing.

This function initializes the hash context for background hashing (Non-blocking) APIs. This is less typical interface to hash function, but can be used for parallel processing, when main CPU has something else to do. Example is digital signature RSASSA-PKCS1-V1_5-VERIFY((n,e),M,S) algorithm, where background hashing of M can be started, then CPU can compute $S^e \bmod n$ (in parallel with background hashing) and once the digest becomes available, CPU can proceed to comparison of EM with EM'.

Parameters

- base – HASHCRYPT peripheral base address.
- ctx – **[out]** Hash context.
- callback – Callback function.
- userData – User data (to be passed as an argument to callback function, once callback is invoked from isr).

status_t HASHCRYPT_SHA_UpdateNonBlocking(HASHCRYPT_Type *base, *hashcrypt_hash_ctx_t* *ctx, const uint8_t *input, size_t inputSize)

Create running hash on given data.

Configures the HASHCRYPT to compute new running hash as AHB master and returns immediately. HASHCRYPT AHB Master mode supports only aligned input address and can be called only once per continuous block of data. Every call to this function must be preceded with HASHCRYPT_SHA_Init() and finished with HASHCRYPT_SHA_Finish(). Once callback function is invoked by HASHCRYPT isr, it should set a flag for the main application to finalize the hashing (padding) and to read out the final digest by calling HASHCRYPT_SHA_Finish().

Parameters

- base – HASHCRYPT peripheral base address
- ctx – Specifies callback. Last incomplete 512-bit block of the input is copied into clear buffer for padding.
- input – 32-bit word aligned pointer to Input data.
- inputSize – Size of input data in bytes (must be word aligned)

Returns

Status of the hash update operation.

2.18 Hashcrypt common functions

FSL_HASHCRYPT_DRIVER_VERSION

HASHCRYPT driver version. Version 2.2.16.

Current version: 2.2.16

Change log:

- Version 2.0.0
 - Initial version
- Version 2.0.1
 - Support loading AES key from unaligned address
- Version 2.0.2
 - Support loading AES key from unaligned address for different compiler and core variants
- Version 2.0.3
 - Remove SHA512 and AES ICB algorithm definitions
- Version 2.0.4
 - Add SHA context switch support
- Version 2.1.0
 - Update the register name and macro to align with new header.
- Version 2.1.1
 - Fix MISRA C-2012.
- Version 2.1.2
 - Support loading AES input data from unaligned address.
- Version 2.1.3
 - Fix MISRA C-2012.
- Version 2.1.4
 - Fix context switch cannot work when switching from AES.
- Version 2.1.5
 - Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` to prevent possible optimization issue.
- Version 2.2.0
 - Add AES-OFB and AES-CFB mixed IP/SW modes.
- Version 2.2.1
 - Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` to prevent compiler from reordering memory write when `-O2` or higher is used.
- Version 2.2.2
 - Add data synchronization barrier inside `hashcrypt_sha_ldm_stm_16_words()` to fix optimization issue

- Version 2.2.3
 - Added check for size in `hashcrypt_aes_one_block` to prevent overflowing COUNT field in MEMCTRL register, if its bigger than COUNT field do a multiple runs.
- Version 2.2.4
 - In all `HASHCRYPT_AES_xx` functions have been added setting CTRL_MODE bitfield to 0 after processing data, which decreases power consumption.
- Version 2.2.5
 - Add data synchronization barrier and instruction synchronization barrier inside `hashcrypt_sha_process_message_data()` to fix optimization issue
- Version 2.2.6
 - Add data synchronization barrier inside `HASHCRYPT_SHA_Update()` and `hashcrypt_get_data()` function to fix optimization issue on MDK and ARMGCC release targets
- Version 2.2.7
 - Add data synchronization barrier inside `HASHCRYPT_SHA_Update()` to fix optimization issue on MCUX IDE release target
- Version 2.2.8
 - Unify hashcrypt hashing behavior between aligned and unaligned input data
- Version 2.2.9
 - Add handling of set ERROR bit in the STATUS register
- Version 2.2.10
 - Fix missing error statement in `hashcrypt_save_running_hash()`
- Version 2.2.11
 - Fix incorrect SHA-256 calculation for long messages with reload
- Version 2.2.12
 - Fix hardfault issue on the Keil compiler due to unaligned `memcpy()` input on some optimization levels
- Version 2.2.13
 - Added function `hashcrypt_seed_prng()` which loading random number into PRNG_SEED register before AES operation for SCA protection
- Version 2.2.14
 - Modify function `hashcrypt_get_data()` to prevent issue with unaligned access
- Version 2.2.15
 - Add wait on DIGEST BIT inside `hashcrypt_sha_one_block()` to fix issues with some optimization flags
- Version 2.2.16
 - Add DSB instruction inside `hashcrypt_sha_ldm_stm_16_words()` to fix issues with some optimization flags
- Version 2.2.17
 - Fix context size when hashcrypt built with reload feature

enum _hashcrypt_algo_t

Algorithm used for Hashcrypt operation.

Values:

enumerator kHASHCRYPT_Sha1

SHA_1

enumerator kHASHCRYPT_Sha256

SHA_256

enumerator kHASHCRYPT_Aes

AES

typedef enum _hashcrypt_algo_t hashcrypt_algo_t

Algorithm used for Hashcrypt operation.

void HASHCRYPT_Init(HASHCRYPT_Type *base)

Enables clock and disables reset for HASHCRYPT peripheral.

Enable clock and disable reset for HASHCRYPT.

Parameters

- base – HASHCRYPT base address

void HASHCRYPT_Deinit(HASHCRYPT_Type *base)

Disables clock for HASHCRYPT peripheral.

Disable clock and enable reset.

Parameters

- base – HASHCRYPT base address

HASHCRYPT_MODE_SHA1

Algorithm definitions correspond with the values for Mode field in Control register !

HASHCRYPT_MODE_SHA256

HASHCRYPT_MODE_AES

2.19 Hashcrypt AES

enum _hashcrypt_aes_mode_t

AES mode.

Values:

enumerator kHASHCRYPT_AesEcb

AES ECB mode

enumerator kHASHCRYPT_AesCbc

AES CBC mode

enumerator kHASHCRYPT_AesCtr

AES CTR mode

enum _hashcrypt_aes_keysize_t

Size of AES key.

Values:

enumerator kHASHCRYPT__Aes128
AES 128 bit key

enumerator kHASHCRYPT__Aes192
AES 192 bit key

enumerator kHASHCRYPT__Aes256
AES 256 bit key

enumerator kHASHCRYPT__InvalidKey
AES invalid key

enum __hashcrypt__key
HASHCRYPT key source selection.

Values:

enumerator kHASHCRYPT__UserKey
HASHCRYPT user key

enumerator kHASHCRYPT__SecretKey
HASHCRYPT secret key (dedicated hw bus from PUF)

typedef enum __hashcrypt_aes_mode_t hashcrypt_aes_mode_t
AES mode.

typedef enum __hashcrypt_aes_keysize_t hashcrypt_aes_keysize_t
Size of AES key.

typedef enum __hashcrypt_key hashcrypt_key_t
HASHCRYPT key source selection.

typedef struct __hashcrypt_handle hashcrypt_handle_t

struct __hashcrypt_handle __attribute__((aligned))

status_t HASHCRYPT__AES_SetKey(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,
const uint8_t *key, size_t keySize)

Set AES key to hashcrypt_handle_t struct and optionally to HASHCRYPT.

Sets the AES key for encryption/decryption with the hashcrypt_handle_t structure. The hashcrypt_handle_t input argument specifies key source.

Parameters

- base – HASHCRYPT peripheral base address.
- handle – Handle used for the request.
- key – 0-mod-4 aligned pointer to AES key.
- keySize – AES key size in bytes. Shall equal 16, 24 or 32.

Returns

status from set key operation

status_t HASHCRYPT__AES_EncryptEcb(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,
const uint8_t *plaintext, uint8_t *ciphertext, size_t
size)

Encrypts AES on one or multiple 128-bit block(s).

Encrypts AES. The source plaintext and destination ciphertext can overlap in system memory.

Parameters

- base – HASHCRYPT peripheral base address

- `handle` – Handle used for this request.
- `plaintext` – Input plain text to encrypt
- `ciphertext` – **[out]** Output cipher text
- `size` – Size of input and output data in bytes. Must be multiple of 16 bytes.

Returns

Status from encrypt operation

```
status_t HASHCRYPT_AES_DecryptEcb(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,  
                                   const uint8_t *ciphertext, uint8_t *plaintext, size_t  
                                   size)
```

Decrypts AES on one or multiple 128-bit block(s).

Decrypts AES. The source ciphertext and destination plaintext can overlap in system memory.

Parameters

- `base` – HASHCRYPT peripheral base address
- `handle` – Handle used for this request.
- `ciphertext` – Input plain text to encrypt
- `plaintext` – **[out]** Output cipher text
- `size` – Size of input and output data in bytes. Must be multiple of 16 bytes.

Returns

Status from decrypt operation

```
status_t HASHCRYPT_AES_EncryptCbc(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,  
                                   const uint8_t *plaintext, uint8_t *ciphertext, size_t  
                                   size, const uint8_t iv[16])
```

Encrypts AES using CBC block mode.

Parameters

- `base` – HASHCRYPT peripheral base address
- `handle` – Handle used for this request.
- `plaintext` – Input plain text to encrypt
- `ciphertext` – **[out]** Output cipher text
- `size` – Size of input and output data in bytes. Must be multiple of 16 bytes.
- `iv` – Input initial vector to combine with the first input block.

Returns

Status from encrypt operation

```
status_t HASHCRYPT_AES_DecryptCbc(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,  
                                   const uint8_t *ciphertext, uint8_t *plaintext, size_t  
                                   size, const uint8_t iv[16])
```

Decrypts AES using CBC block mode.

Parameters

- `base` – HASHCRYPT peripheral base address
- `handle` – Handle used for this request.
- `ciphertext` – Input cipher text to decrypt
- `plaintext` – **[out]** Output plain text
- `size` – Size of input and output data in bytes. Must be multiple of 16 bytes.

- *iv* – Input initial vector to combine with the first input block.

Returns

Status from decrypt operation

```
status_t HASHCRYPT_AES_CryptCtr(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,  
                                const uint8_t *input, uint8_t *output, size_t size, uint8_t  
                                counter[16U], uint8_t counterlast[16U], size_t *szLeft)
```

Encrypts or decrypts AES using CTR block mode.

Encrypts or decrypts AES using CTR block mode. AES CTR mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Parameters

- *base* – HASHCRYPT peripheral base address
- *handle* – Handle used for this request.
- *input* – Input data for CTR block mode
- *output* – **[out]** Output data for CTR block mode
- *size* – Size of input and output data in bytes
- *counter* – **[inout]** Input counter (updates on return)
- *counterlast* – **[out]** Output cipher of last counter, for chained CTR calls (statefull encryption). NULL can be passed if chained calls are not used.
- *szLeft* – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.

Returns

Status from encrypt operation

```
status_t HASHCRYPT_AES_CryptOfb(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,  
                                const uint8_t *input, uint8_t *output, size_t size, const  
                                uint8_t iv[16U])
```

Encrypts or decrypts AES using OFB block mode.

Encrypts or decrypts AES using OFB block mode. AES OFB mode uses only forward AES cipher and same algorithm for encryption and decryption. The only difference between encryption and decryption is that, for encryption, the input argument is plain text and the output argument is cipher text. For decryption, the input argument is cipher text and the output argument is plain text.

Parameters

- *base* – HASHCRYPT peripheral base address
- *handle* – Handle used for this request.
- *input* – Input data for OFB block mode
- *output* – **[out]** Output data for OFB block mode
- *size* – Size of input and output data in bytes
- *iv* – Input initial vector to combine with the first input block.

Returns

Status from encrypt operation

```
status_t HASHCRYPT_AES_EncryptCfb(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,
                                  const uint8_t *plaintext, uint8_t *ciphertext, size_t size,
                                  const uint8_t iv[16])
```

Encrypts AES using CFB block mode.

Parameters

- base – HASHCRYPT peripheral base address
- handle – Handle used for this request.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.

Returns

Status from encrypt operation

```
status_t HASHCRYPT_AES_DecryptCfb(HASHCRYPT_Type *base, hashcrypt_handle_t *handle,
                                  const uint8_t *ciphertext, uint8_t *plaintext, size_t size,
                                  const uint8_t iv[16])
```

Decrypts AES using CFB block mode.

Parameters

- base – HASHCRYPT peripheral base address
- handle – Handle used for this request.
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plaintext text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input initial vector to combine with the first input block.

Returns

Status from encrypt operation

```
HASHCRYPT_AES_BLOCK_SIZE
```

AES block size in bytes

```
AES_ENCRYPT
```

```
AES_DECRYPT
```

```
struct _hashcrypt_handle
```

#include <fsl_hashcrypt.h> Specify HASHCRYPT's key resource.

Public Members

```
uint32_t keyWord[8]
```

Copy of user key (set by HASHCRYPT_AES_SetKey()).

```
hashcrypt_key_t keyType
```

For operations with key (such as AES encryption/decryption), specify key type.

2.20 Hashcrypt HASH

```
typedef struct hashcrypt_hash_ctx_t hashcrypt_hash_ctx_t
```

Storage type used to save hash context.

```
typedef void (*hashcrypt_callback_t)(HASHCRYPT_Type *base, hashcrypt_hash_ctx_t *ctx,  
status_t status, void *userData)
```

HASHCRYPT background hash callback function.

```
status_t HASHCRYPT_SHA(HASHCRYPT_Type *base, hashcrypt_algo_t algo, const uint8_t  
*input, size_t inputSize, uint8_t *output, size_t *outputSize)
```

Create HASH on given data.

Perform the full SHA in one function call. The function is blocking.

Parameters

- base – HASHCRYPT peripheral base address
- algo – Underlying algorithm to use for hash computation.
- input – Input data
- inputSize – Size of input data in bytes
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

Returns

Status of the one call hash operation.

```
status_t HASHCRYPT_SHA_Init(HASHCRYPT_Type *base, hashcrypt_hash_ctx_t *ctx,  
hashcrypt_algo_t algo)
```

Initialize HASH context.

This function initializes the HASH.

Parameters

- base – HASHCRYPT peripheral base address
- ctx – **[out]** Output hash context
- algo – Underlying algorithm to use for hash computation.

Returns

Status of initialization

```
status_t HASHCRYPT_SHA_Update(HASHCRYPT_Type *base, hashcrypt_hash_ctx_t *ctx, const  
uint8_t *input, size_t inputSize)
```

Add data to current HASH.

Add data to current HASH. This can be called repeatedly with an arbitrary amount of data to be hashed. The functions blocks. If it returns kStatus_Success, the running hash has been updated (HASHCRYPT has processed the input data), so the memory at *input* pointer can be released back to system. The HASHCRYPT context buffer is updated with the running hash and with all necessary information to support possible context switch.

Parameters

- base – HASHCRYPT peripheral base address
- ctx – **[inout]** HASH context
- input – Input data

- `inputSize` – Size of input data in bytes

Returns

Status of the hash update operation

```
status_t HASHCRYPT_SHA_Finish(HASHCRYPT_Type *base, hashcrypt_hash_ctx_t *ctx, uint8_t
                             *output, size_t *outputSize)
```

Finalize hashing.

Outputs the final hash (computed by `HASHCRYPT_HASH_Update()`) and erases the context.

Parameters

- `base` – HASHCRYPT peripheral base address
- `ctx` – **[inout]** Input hash context
- `output` – **[out]** Output hash data
- `outputSize` – **[inout]** Optional parameter (can be passed as `NULL`). On function entry, it specifies the size of `output[]` buffer. On function return, it stores the number of updated output bytes.

Returns

Status of the hash finish operation

```
HASHCRYPT_HASH_CTX_SIZE
```

HASHCRYPT HASH Context size.

```
struct __hashcrypt_hash_ctx_t
```

#include <fsl_hashcrypt.h> Storage type used to save hash context.

Public Members

```
uint32_t x[31]
```

storage

2.21 I2C: Inter-Integrated Circuit Driver

2.22 I2C DMA Driver

```
void I2C_MasterTransferCreateHandleDMA(I2C_Type *base, i2c_master_dma_handle_t *handle,
                                       i2c_master_dma_transfer_callback_t callback, void
                                       *userData, dma_handle_t *dmaHandle)
```

Init the I2C handle which is used in transactional functions.

Parameters

- `base` – I2C peripheral base address
- `handle` – pointer to `i2c_master_dma_handle_t` structure
- `callback` – pointer to user callback function
- `userData` – user param passed to the callback function
- `dmaHandle` – DMA handle pointer

```
status_t I2C_MasterTransferDMA(I2C_Type *base, i2c_master_dma_handle_t *handle,
                               i2c_master_transfer_t *xfer)
```

Performs a master dma non-blocking transfer on the I2C bus.

Parameters

- base – I2C peripheral base address
- handle – pointer to `i2c_master_dma_handle_t` structure
- xfer – pointer to transfer structure of `i2c_master_transfer_t`

Return values

- `kStatus_Success` – Sucesssully 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.
- `kStataus_I2C_Nak` – Transfer error, receive Nak during transfer.

`status_t` I2C_MasterTransferGetCountDMA(I2C_Type *base, *i2c_master_dma_handle_t* *handle, `size_t` *count)

Get master transfer status during a dma non-blocking transfer.

Parameters

- base – I2C peripheral base address
- handle – pointer to `i2c_master_dma_handle_t` structure
- count – Number of bytes transferred so far by the non-blocking transaction.

`void` I2C_MasterTransferAbortDMA(I2C_Type *base, *i2c_master_dma_handle_t* *handle)

Abort a master dma non-blocking transfer in a early time.

Parameters

- base – I2C peripheral base address
- handle – pointer to `i2c_master_dma_handle_t` structure

`FSL_I2C_DMA_DRIVER_VERSION`

I2C DMA driver version.

`typedef struct i2c_master_dma_handle` `i2c_master_dma_handle_t`

I2C master dma handle typedef.

`typedef void (*i2c_master_dma_transfer_callback_t)(I2C_Type *base, i2c_master_dma_handle_t *handle, status_t status, void *userData)`

I2C master dma transfer callback typedef.

`typedef void (*flexcomm_i2c_dma_master_irq_handler_t)(I2C_Type *base, i2c_master_dma_handle_t *handle)`

Typedef for master dma handler.

`I2C_MAX_DMA_TRANSFER_COUNT`

Maximum lenght of single DMA transfer (determined by capability of the DMA engine)

`struct i2c_master_dma_handle`

`#include <fsl_i2c_dma.h>` I2C master dma transfer structure.

Public Members

`uint8_t` state

Transfer state machine current state.

uint32_t transferCount

Indicates progress of the transfer

uint32_t remainingBytesDMA

Remaining byte count to be transferred using DMA.

uint8_t *buf

Buffer pointer for current state.

bool checkAddrNack

Whether to check the nack signal is detected during addressing.

dma_handle_t *dmaHandle

The DMA handler used.

i2c_master_transfer_t transfer

Copy of the current transfer info.

i2c_master_dma_transfer_callback_t completionCallback

Callback function called after dma transfer finished.

void *userData

Callback parameter passed to callback function.

2.23 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_Timeout

Timeout when waiting for I2C master/slave pending status to set to continue transfer.

enumerator kStatus_I2C_Addr_Nak

NAK received for Address

enumerator kStatus_I2C_EventTimeout

Timeout waiting for bus event.

enumerator kStatus_I2C_SclLowTimeout

Timeout SCL signal remains low.

enum _i2c_status_flags

I2C status 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. bit 0

enumerator kI2C_MasterArbitrationLostFlag

The arbitration of the bus was lost. There was collision on the bus. bit 4

enumerator kI2C_MasterStartStopErrorFlag

There was an error during start or stop phase of the transaction. bit 6

enumerator kI2C_MasterIdleFlag

The I2C master idle status. bit 5

enumerator kI2C_MasterRxReadyFlag

The I2C master rx ready status. bit 1

enumerator kI2C_MasterTxReadyFlag

The I2C master tx ready status. bit 2

enumerator kI2C_MasterAddrNackFlag

The I2C master address nack status. bit 7

enumerator kI2C_MasterDataNackFlag

The I2C master data nack status. bit 3

enumerator kI2C_SlavePendingFlag

The I2C module is waiting for software interaction. bit 8

enumerator kI2C_SlaveNotStretching

Indicates whether the slave is currently stretching clock (0 = yes, 1 = no). bit 11

enumerator kI2C_SlaveSelected

Indicates whether the slave is selected by an address match. bit 14

enumerator kI2C_SlaveDeselected

Indicates that slave was previously deselected (deselect event took place, w1c). bit 15

enumerator kI2C_SlaveAddressedFlag

One of the I2C slave's 4 addresses is matched. bit 22

enumerator kI2C_SlaveReceiveFlag
Slave receive data available. bit 9

enumerator kI2C_SlaveTransmitFlag
Slave data can be transmitted. bit 10

enumerator kI2C_SlaveAddress0MatchFlag
Slave address0 match. bit 20

enumerator kI2C_SlaveAddress1MatchFlag
Slave address1 match. bit 12

enumerator kI2C_SlaveAddress2MatchFlag
Slave address2 match. bit 13

enumerator kI2C_SlaveAddress3MatchFlag
Slave address3 match. bit 21

enumerator kI2C_MonitorReadyFlag
The I2C monitor ready interrupt. bit 16

enumerator kI2C_MonitorOverflowFlag
The monitor data overrun interrupt. bit 17

enumerator kI2C_MonitorActiveFlag
The monitor is active. bit 18

enumerator kI2C_MonitorIdleFlag
The monitor idle interrupt. bit 19

enumerator kI2C_EventTimeoutFlag
The bus event timeout interrupt. bit 24

enumerator kI2C_SclTimeoutFlag
The SCL timeout interrupt. bit 25

enumerator kI2C_MasterAllClearFlags

enumerator kI2C_SlaveAllClearFlags

enumerator kI2C_CommonAllClearFlags

enum _i2c_interrupt_enable
I2C interrupt enable.

Note: These enums are meant to be OR'd together to form a bit mask.

Values:

enumerator kI2C_MasterPendingInterruptEnable
The I2C master communication pending interrupt.

enumerator kI2C_MasterArbitrationLostInterruptEnable
The I2C master arbitration lost interrupt.

enumerator kI2C_MasterStartStopErrorInterruptEnable
The I2C master start/stop timing error interrupt.

enumerator kI2C_SlavePendingInterruptEnable
The I2C slave communication pending interrupt.

enumerator kI2C_SlaveNotStretchingInterruptEnable

The I2C slave not stretching interrupt, deep-sleep mode can be entered only when this interrupt occurs.

enumerator kI2C_SlaveDeselectedInterruptEnable

The I2C slave deselection interrupt.

enumerator kI2C_MonitorReadyInterruptEnable

The I2C monitor ready interrupt.

enumerator kI2C_MonitorOverflowInterruptEnable

The monitor data overrun interrupt.

enumerator kI2C_MonitorIdleInterruptEnable

The monitor idle interrupt.

enumerator kI2C_EventTimeoutInterruptEnable

The bus event timeout interrupt.

enumerator kI2C_SclTimeoutInterruptEnable

The SCL timeout interrupt.

enumerator kI2C_MasterAllInterruptEnable

enumerator kI2C_SlaveAllInterruptEnable

enumerator kI2C_CommonAllInterruptEnable

I2C_RETRY_TIMES

Retry times for waiting flag.

I2C_MASTER_TRANSMIT_IGNORE_LAST_NACK

Whether to ignore the nack signal of the last byte during master transmit.

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

2.24 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.

```
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_status_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_ClearStatusFlags(I2C_Type *base, uint32_t statusMask)
```

Clears the I2C status flag state.

Refer to `kI2C_CommonAllClearStatusFlags`, `kI2C_MasterAllClearStatusFlags` and `kI2C_SlaveAllClearStatusFlags` to see the clearable flags. Attempts to clear other flags has no effect.

See also:

`_i2c_status_flags`, `_i2c_master_status_flags` and `_i2c_slave_status_flags`.

Parameters

- base – The I2C peripheral base address.
- statusMask – A bitmask of status flags that are to be cleared. The mask is composed of the members in `kI2C_CommonAllClearStatusFlags`, `kI2C_MasterAllClearStatusFlags` and `kI2C_SlaveAllClearStatusFlags`. You may pass the result of a previous call to `I2C_GetStatusFlags()`.

```
static inline void I2C_MasterClearStatusFlags(I2C_Type *base, uint32_t statusMask)
```

Clears the I2C master status flag state.

Deprecated:

Do not use this function. It has been superseded by `I2C_ClearStatusFlags`. The following status register flags can be cleared:

- `kI2C_MasterArbitrationLostFlag`
- `kI2C_MasterStartStopErrorFlag`

Attempts to clear other flags has no effect.

See also:

`_i2c_status_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_status_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 interrupt requests.

Parameters

- `base` – The I2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_i2c_interrupt_enable` 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 interrupt requests.

Parameters

- `base` – The I2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to disable. See `_i2c_interrupt_enable` 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 interrupt requests.

Parameters

- `base` – The I2C peripheral base address.

Returns

A bitmask composed of `_i2c_interrupt_enable` 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.

```
void I2C_MasterSetTimeoutValue(I2C_Type *base, uint8_t timeout_Ms, uint32_t srcClock_Hz)
```

Sets the I2C bus timeout value.

If the SCL signal remains low or bus does not have event longer than the timeout value, `kI2C_SclTimeoutFlag` or `kI2C_EventTimeoutFlag` is set. This can indicate the bus is held by slave or any fault occurs to the I2C module.

Parameters

- `base` – The I2C peripheral base address.
- `timeout_Ms` – Timeout value in millisecond.
- `srcClock_Hz` – I2C functional clock frequency in Hertz.

`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.
- `kStatus_I2C_Addr_Nak` – Transfer error, receive NAK during addressing.

`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 – Timeout during polling for flags.

void I2C_MasterTransferHandleIRQ(I2C_Type *base, i2c_master_handle_t *handle)

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.
- handle – Pointer to the I2C master driver handle.

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.

uint8_t timeout_Ms

Event timeout and SCL low timeout value.

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.

uint8_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.

`bool checkAddrNack`

Whether to check the nack signal is detected during addressing.

`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.

2.25 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_SlaveTransmitEvent` 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_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.
- `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_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_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_SlaveReceiveEvent` 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_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.

- `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, i2c_slave_handle_t *handle)

Reusable routine to handle slave interrupts.

Note: This function does not need to be called unless you are reimplementing the non blocking API's interrupt handler routines to add special functionality.

Parameters

- base – The I2C peripheral base address.
- handle – Pointer to i2c_slave_handle_t structure which stores the transfer state.

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 (*flexcomm_i2c_master_irq_handler_t)(I2C_Type *base, i2c_master_handle_t *handle)`

Typedef for master interrupt handler.

`typedef void (*flexcomm_i2c_slave_irq_handler_t)(I2C_Type *base, i2c_slave_handle_t *handle)`
Typedef for slave 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.

2.26 I2S: I2S Driver

2.27 I2S DMA Driver

void I2S_TxTransferCreateHandleDMA(I2S_Type *base, *i2s_dma_handle_t* *handle, *dma_handle_t* *dmaHandle, *i2s_dma_transfer_callback_t* callback, void *userData)

Initializes handle for transfer of audio data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- dmaHandle – pointer to dma handle structure.
- callback – function to be called back when transfer is done or fails.
- userData – pointer to data passed to callback.

status_t I2S_TxTransferSendDMA(I2S_Type *base, *i2s_dma_handle_t* *handle, *i2s_transfer_t* transfer)

Begins or queue sending of the given data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- transfer – data buffer.

Return values

- `kStatus__Success` –
- `kStatus_I2S_Busy` – if all queue slots are occupied with unsent buffers.

`void I2S_TransferAbortDMA(I2S_Type *base, i2s_dma_handle_t *handle)`

Aborts transfer of data.

Parameters

- `base` – I2S base pointer.
- `handle` – pointer to handle structure.

`void I2S_RxTransferCreateHandleDMA(I2S_Type *base, i2s_dma_handle_t *handle, dma_handle_t *dmaHandle, i2s_dma_transfer_callback_t callback, void *userData)`

Initializes handle for reception of audio data.

Parameters

- `base` – I2S base pointer.
- `handle` – pointer to handle structure.
- `dmaHandle` – pointer to dma handle structure.
- `callback` – function to be called back when transfer is done or fails.
- `userData` – pointer to data passed to callback.

`status_t I2S_RxTransferReceiveDMA(I2S_Type *base, i2s_dma_handle_t *handle, i2s_transfer_t transfer)`

Begins or queue reception of data into given buffer.

Parameters

- `base` – I2S base pointer.
- `handle` – pointer to handle structure.
- `transfer` – data buffer.

Return values

- `kStatus__Success` –
- `kStatus_I2S_Busy` – if all queue slots are occupied with buffers which are not full.

`void I2S_DMACallback(dma_handle_t *handle, void *userData, bool transferDone, uint32_t tcDs)`

Invoked from DMA interrupt handler.

Parameters

- `handle` – pointer to DMA handle structure.
- `userData` – argument for user callback.
- `transferDone` – if transfer was done.
- `tcDs` –

`void I2S_TransferInstallLoopDMADescriptorMemory(i2s_dma_handle_t *handle, void *dmaDescriptorAddr, size_t dmaDescriptorNum)`

Install DMA descriptor memory for loop transfer only.

This function used to register DMA descriptor memory for the i2s loop dma transfer.

It must be called before I2S_TransferSendLoopDMA/I2S_TransferReceiveLoopDMA and after I2S_RxTransferCreateHandleDMA/I2S_TxTransferCreateHandleDMA.

User should be take care about the address of DMA descriptor pool which required align with 16BYTE at least.

Parameters

- handle – Pointer to i2s DMA transfer handle.
- dmaDescriptorAddr – DMA descriptor start address.
- dmaDescriptorNum – DMA descriptor number.

```
status_t I2S_TransferSendLoopDMA(I2S_Type *base, i2s_dma_handle_t *handle, i2s_transfer_t *xfer, uint32_t loopTransferCount)
```

Send link transfer data using DMA.

This function receives data using DMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

This function support loop transfer, such as A->B->...->A, the loop transfer chain will be converted into a chain of descriptor and submit to dma. Application must be aware of that the more counts of the loop transfer, then more DMA descriptor memory required, user can use function I2S_InstallDMADescriptorMemory to register the dma descriptor memory.

As the DMA support maximum 1024 transfer count, so application must be aware of that this transfer function support maximum 1024 samples in each transfer, otherwise assert error or error status will be returned. Once the loop transfer start, application can use function I2S_TransferAbortDMA to stop the loop transfer.

Parameters

- base – I2S peripheral base address.
- handle – Pointer to *usart_dma_handle_t* structure.
- xfer – I2S DMA transfer structure. See *i2s_transfer_t*.
- loopTransferCount – loop count

Return values

kStatus_Success –

```
status_t I2S_TransferReceiveLoopDMA(I2S_Type *base, i2s_dma_handle_t *handle, i2s_transfer_t *xfer, uint32_t loopTransferCount)
```

Receive link transfer data using DMA.

This function receives data using DMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

This function support loop transfer, such as A->B->...->A, the loop transfer chain will be converted into a chain of descriptor and submit to dma. Application must be aware of that the more counts of the loop transfer, then more DMA descriptor memory required, user can use function I2S_InstallDMADescriptorMemory to register the dma descriptor memory.

As the DMA support maximum 1024 transfer count, so application must be aware of that this transfer function support maximum 1024 samples in each transfer, otherwise assert error or error status will be returned. Once the loop transfer start, application can use function I2S_TransferAbortDMA to stop the loop transfer.

Parameters

- base – I2S peripheral base address.
- handle – Pointer to *usart_dma_handle_t* structure.
- xfer – I2S DMA transfer structure. See *i2s_transfer_t*.

- loopTransferCount – loop count

Return values

kStatus_Success –

FSL_I2S_DMA_DRIVER_VERSION

I2S DMA driver version 2.3.3.

typedef struct *i2s_dma_handle* i2s_dma_handle_t

Members not to be accessed / modified outside of the driver.

typedef void (*i2s_dma_transfer_callback_t)(I2S_Type *base, *i2s_dma_handle_t* *handle, *status_t* completionStatus, void *userData)

Callback function invoked from DMA API on completion.

Param base

I2S base pointer.

Param handle

pointer to I2S transaction.

Param completionStatus

status of the transaction.

Param userData

optional pointer to user arguments data.

struct *i2s_dma_handle*

#include <fsl_i2s_dma.h> i2s dma handle

Public Members

uint32_t state

Internal state of I2S DMA transfer

uint8_t bytesPerFrame

bytes per frame

i2s_dma_transfer_callback_t completionCallback

Callback function pointer

void *userData

Application data passed to callback

dma_handle_t *dmaHandle

DMA handle

volatile *i2s_transfer_t* i2sQueue[(4U)]

Transfer queue storing transfer buffers

volatile uint8_t queueUser

Queue index where user's next transfer will be stored

volatile uint8_t queueDriver

Queue index of buffer actually used by the driver

dma_descriptor_t *i2sLoopDMADescriptor

descriptor pool pointer

size_t i2sLoopDMADescriptorNum

number of descriptor in descriptors pool

2.28 I2S Driver

`void I2S_TxInit(I2S_Type *base, const i2s_config_t *config)`

Initializes the FLEXCOMM peripheral for I2S transmit functionality.

Ungates the FLEXCOMM clock and configures the module for I2S transmission using a configuration structure. The configuration structure can be custom filled or set with default values by `I2S_TxGetDefaultConfig()`.

Note: This API should be called at the beginning of the application to use the I2S driver.

Parameters

- `base` – I2S base pointer.
- `config` – pointer to I2S configuration structure.

`void I2S_RxInit(I2S_Type *base, const i2s_config_t *config)`

Initializes the FLEXCOMM peripheral for I2S receive functionality.

Ungates the FLEXCOMM clock and configures the module for I2S receive using a configuration structure. The configuration structure can be custom filled or set with default values by `I2S_RxGetDefaultConfig()`.

Note: This API should be called at the beginning of the application to use the I2S driver.

Parameters

- `base` – I2S base pointer.
- `config` – pointer to I2S configuration structure.

`void I2S_TxGetDefaultConfig(i2s_config_t *config)`

Sets the I2S Tx configuration structure to default values.

This API initializes the configuration structure for use in `I2S_TxInit()`. The initialized structure can remain unchanged in `I2S_TxInit()`, or it can be modified before calling `I2S_TxInit()`. Example:

```
i2s_config_t config;
I2S_TxGetDefaultConfig(&config);
```

Default values:

```
config->masterSlave = kI2S_MasterSlaveNormalMaster;
config->mode = kI2S_ModeI2sClassic;
config->rightLow = false;
config->leftJust = false;
config->pdmData = false;
config->sckPol = false;
config->wsPol = false;
config->divider = 1;
config->oneChannel = false;
config->dataLength = 16;
config->frameLength = 32;
config->position = 0;
config->watermark = 4;
config->txEmptyZero = true;
config->pack48 = false;
```

Parameters

- config – pointer to I2S configuration structure.

void I2S_RxGetDefaultConfig(*i2s_config_t* *config)

Sets the I2S Rx configuration structure to default values.

This API initializes the configuration structure for use in I2S_RxInit(). The initialized structure can remain unchanged in I2S_RxInit(), or it can be modified before calling I2S_RxInit(). Example:

```
i2s_config_t config;  
I2S_RxGetDefaultConfig(&config);
```

Default values:

```
config->masterSlave = kI2S_MasterSlaveNormalSlave;  
config->mode = kI2S_ModeI2sClassic;  
config->rightLow = false;  
config->leftJust = false;  
config->pdmData = false;  
config->sckPol = false;  
config->wsPol = false;  
config->divider = 1;  
config->oneChannel = false;  
config->dataLength = 16;  
config->frameLength = 32;  
config->position = 0;  
config->watermark = 4;  
config->txEmptyZero = false;  
config->pack48 = false;
```

Parameters

- config – pointer to I2S configuration structure.

void I2S_Deinit(I2S_Type *base)

De-initializes the I2S peripheral.

This API gates the FLEXCOMM clock. The I2S module can't operate unless I2S_TxInit or I2S_RxInit is called to enable the clock.

Parameters

- base – I2S base pointer.

void I2S_SetBitClockRate(I2S_Type *base, uint32_t sourceClockHz, uint32_t sampleRate, uint32_t bitWidth, uint32_t channelNumbers)

Transmitter/Receiver bit clock rate configurations.

Parameters

- base – SAI base pointer.
- sourceClockHz – bit clock source frequency.
- sampleRate – audio data sample rate.
- bitWidth – audio data bitWidth.
- channelNumbers – audio channel numbers.

void I2S_TxTransferCreateHandle(I2S_Type *base, *i2s_handle_t* *handle, *i2s_transfer_callback_t* callback, void *userData)

Initializes handle for transfer of audio data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- callback – function to be called back when transfer is done or fails.
- userData – pointer to data passed to callback.

status_t I2S_TxTransferNonBlocking(I2S_Type *base, *i2s_handle_t* *handle, *i2s_transfer_t* transfer)

Begins or queue sending of the given data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- transfer – data buffer.

Return values

- kStatus__Success –
- kStatus_I2S_Busy – if all queue slots are occupied with unsent buffers.

void I2S_TxTransferAbort(I2S_Type *base, *i2s_handle_t* *handle)

Aborts sending of data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.

void I2S_RxTransferCreateHandle(I2S_Type *base, *i2s_handle_t* *handle, *i2s_transfer_callback_t* callback, void *userData)

Initializes handle for reception of audio data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- callback – function to be called back when transfer is done or fails.
- userData – pointer to data passed to callback.

status_t I2S_RxTransferNonBlocking(I2S_Type *base, *i2s_handle_t* *handle, *i2s_transfer_t* transfer)

Begins or queue reception of data into given buffer.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- transfer – data buffer.

Return values

- kStatus__Success –
- kStatus_I2S_Busy – if all queue slots are occupied with buffers which are not full.

void I2S_RxTransferAbort(I2S_Type *base, *i2s_handle_t* *handle)

Aborts receiving of data.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.

status_t I2S_TransferGetCount(I2S_Type *base, *i2s_handle_t* *handle, *size_t* *count)

Returns number of bytes transferred so far.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- count – **[out]** number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_Success –
- kStatus_NoTransferInProgress – there is no non-blocking transaction currently in progress.

status_t I2S_TransferGetErrorCount(I2S_Type *base, *i2s_handle_t* *handle, *size_t* *count)

Returns number of buffer underruns or overruns.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.
- count – **[out]** number of transmit errors encountered so far by the non-blocking transaction.

Return values

- kStatus_Success –
- kStatus_NoTransferInProgress – there is no non-blocking transaction currently in progress.

static inline void I2S_Enable(I2S_Type *base)

Enables I2S operation.

Parameters

- base – I2S base pointer.

void I2S_EnableSecondaryChannel(I2S_Type *base, *uint32_t* channel, bool oneChannel, *uint32_t* position)

Enables I2S secondary channel.

Parameters

- base – I2S base pointer.
- channel – secondary channel number, reference `_i2s_secondary_channel`.
- oneChannel – true is treated as single channel, functionality left channel for this pair.
- position – define the location within the frame of the data, should not bigger than 0x1FFU.

static inline void I2S_DisableSecondaryChannel(I2S_Type *base, *uint32_t* channel)

Disables I2S secondary channel.

Parameters

- base – I2S base pointer.
- channel – secondary channel number, reference `_i2s_secondary_channel`.

static inline void I2S_Disable(I2S_Type *base)

Disables I2S operation.

Parameters

- base – I2S base pointer.

static inline void I2S_EnableInterrupts(I2S_Type *base, uint32_t interruptMask)

Enables I2S FIFO interrupts.

Parameters

- base – I2S base pointer.
- interruptMask – bit mask of interrupts to enable. See `i2s_flags_t` for the set of constants that should be OR'd together to form the bit mask.

static inline void I2S_DisableInterrupts(I2S_Type *base, uint32_t interruptMask)

Disables I2S FIFO interrupts.

Parameters

- base – I2S base pointer.
- interruptMask – bit mask of interrupts to enable. See `i2s_flags_t` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t I2S_GetEnabledInterrupts(I2S_Type *base)

Returns the set of currently enabled I2S FIFO interrupts.

Parameters

- base – I2S base pointer.

Returns

A bitmask composed of `i2s_flags_t` enumerators OR'd together to indicate the set of enabled interrupts.

status_t I2S_EmptyTxFifo(I2S_Type *base)

Flush the valid data in TX fifo.

Parameters

- base – I2S base pointer.

Returns

`kStatus_Fail` empty TX fifo failed, `kStatus_Success` empty tx fifo success.

void I2S_TxHandleIRQ(I2S_Type *base, *i2s_handle_t* *handle)

Invoked from interrupt handler when transmit FIFO level decreases.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.

void I2S_RxHandleIRQ(I2S_Type *base, *i2s_handle_t* *handle)

Invoked from interrupt handler when receive FIFO level decreases.

Parameters

- base – I2S base pointer.
- handle – pointer to handle structure.

FSL_I2S_DRIVER_VERSION

I2S driver version 2.3.2.

_i2s_status I2S status codes.

Values:

enumerator kStatus_I2S_BufferComplete

Transfer from/into a single buffer has completed

enumerator kStatus_I2S_Done

All buffers transfers have completed

enumerator kStatus_I2S_Busy

Already performing a transfer and cannot queue another buffer

enum _i2s_flags

I2S flags.

Note: These enums are meant to be OR'd together to form a bit mask.

Values:

enumerator kI2S_TxErrorFlag

TX error interrupt

enumerator kI2S_TxLevelFlag

TX level interrupt

enumerator kI2S_RxErrorFlag

RX error interrupt

enumerator kI2S_RxLevelFlag

RX level interrupt

enum _i2s_master_slave

Master / slave mode.

Values:

enumerator kI2S_MasterSlaveNormalSlave

Normal slave

enumerator kI2S_MasterSlaveWsSyncMaster

WS synchronized master

enumerator kI2S_MasterSlaveExtSckMaster

Master using existing SCK

enumerator kI2S_MasterSlaveNormalMaster

Normal master

enum _i2s_mode

I2S mode.

Values:

enumerator kI2S_ModeI2sClassic

I2S classic mode

enumerator kI2S_ModeDspWs50

DSP mode, WS having 50% duty cycle

enumerator `kI2S_ModeDspWsShort`
DSP mode, WS having one clock long pulse

enumerator `kI2S_ModeDspWsLong`
DSP mode, WS having one data slot long pulse

`_i2s_secondary_channel` I2S secondary channel.

Values:

enumerator `kI2S_SecondaryChannel1`
secondary channel 1

enumerator `kI2S_SecondaryChannel2`
secondary channel 2

enumerator `kI2S_SecondaryChannel3`
secondary channel 3

typedef enum `_i2s_flags` `i2s_flags_t`
I2S flags.

Note: These enums are meant to be OR'd together to form a bit mask.

typedef enum `_i2s_master_slave` `i2s_master_slave_t`
Master / slave mode.

typedef enum `_i2s_mode` `i2s_mode_t`
I2S mode.

typedef struct `_i2s_config` `i2s_config_t`
I2S configuration structure.

typedef struct `_i2s_transfer` `i2s_transfer_t`
Buffer to transfer from or receive audio data into.

typedef struct `_i2s_handle` `i2s_handle_t`
Transactional state of the initialized transfer or receive I2S operation.

typedef void (`*i2s_transfer_callback_t`)(`I2S_Type *base`, `i2s_handle_t *handle`, `status_t completionStatus`, void `*userData`)
Callback function invoked from transactional API on completion of a single buffer transfer.

Param base
I2S base pointer.

Param handle
pointer to I2S transaction.

Param completionStatus
status of the transaction.

Param userData
optional pointer to user arguments data.

`I2S_NUM_BUFFERS`
Number of buffers .

struct `_i2s_config`
`#include <fsl_i2s.h>` I2S configuration structure.

Public Members

i2s_master_slave_t masterSlave

Master / slave configuration

i2s_mode_t mode

I2S mode

bool rightLow

Right channel data in low portion of FIFO

bool leftJust

Left justify data in FIFO

bool pdmData

Data source is the D-Mic subsystem

bool sckPol

SCK polarity

bool wsPol

WS polarity

uint16_t divider

Flexcomm function clock divider (1 - 4096)

bool oneChannel

true mono, false stereo

uint8_t dataLength

Data length (4 - 32)

uint16_t frameLength

Frame width (4 - 512)

uint16_t position

Data position in the frame

uint8_t watermark

FIFO trigger level

bool txEmptyZero

Transmit zero when buffer becomes empty or last item

bool pack48

Packing format for 48-bit data (false - 24 bit values, true - alternating 32-bit and 16-bit values)

struct *_i2s_transfer*

#include <fsl_i2s.h> Buffer to transfer from or receive audio data into.

Public Members

uint8_t *data

Pointer to data buffer.

size_t dataSize

Buffer size in bytes.

struct *_i2s_handle*

#include <fsl_i2s.h> Members not to be accessed / modified outside of the driver.

Public Members

volatile uint32_t state

State of transfer

i2s_transfer_callback_t completionCallback

Callback function pointer

void *userData

Application data passed to callback

bool oneChannel

true mono, false stereo

uint8_t dataLength

Data length (4 - 32)

bool pack48

Packing format for 48-bit data (false - 24 bit values, true - alternating 32-bit and 16-bit values)

uint8_t watermark

FIFO trigger level

bool useFifo48H

When dataLength 17-24: true use FIFOWR48H, false use FIFOWR

volatile *i2s_transfer_t* i2sQueue[(4U)]

Transfer queue storing transfer buffers

volatile uint8_t queueUser

Queue index where user's next transfer will be stored

volatile uint8_t queueDriver

Queue index of buffer actually used by the driver

volatile uint32_t errorCount

Number of buffer underruns/overruns

volatile uint32_t transferCount

Number of bytes transferred

2.29 INPUTMUX: Input Multiplexing Driver

enum __inputmux_connection_t

INPUTMUX connections type.

Values:

enumerator kINPUTMUX__SctGpi0ToSct0
SCT0 INMUX.

enumerator kINPUTMUX__SctGpi1ToSct0

enumerator kINPUTMUX__SctGpi2ToSct0

enumerator kINPUTMUX__SctGpi3ToSct0

enumerator kINPUTMUX__SctGpi4ToSct0

enumerator kINPUTMUX__SctGpi5ToSct0
enumerator kINPUTMUX__SctGpi6ToSct0
enumerator kINPUTMUX__SctGpi7ToSct0
enumerator kINPUTMUX__Ctimer0M0ToSct0
enumerator kINPUTMUX__Ctimer1M0ToSct0
enumerator kINPUTMUX__Ctimer2M0ToSct0
enumerator kINPUTMUX__Ctimer3M0ToSct0
enumerator kINPUTMUX__Ctimer4M0ToSct0
enumerator kINPUTMUX__AdcIrqToSct0
enumerator kINPUTMUX__GpioIntBmatchToSct0
enumerator kINPUTMUX__CompOutToSct0
enumerator kINPUTMUX__I2sSharedSck0ToSct0
enumerator kINPUTMUX__I2sSharedSck1ToSct0
enumerator kINPUTMUX__I2sSharedWs0ToSct0
enumerator kINPUTMUX__I2sSharedWs1ToSct0
enumerator kINPUTMUX__ArmTxevToSct0
enumerator kINPUTMUX__DebugHaltedToSct0

TIMER0 CAPTSEL.

enumerator kINPUTMUX__CtimerInp0ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp1ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp2ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp3ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp4ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp5ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp6ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp7ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp8ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp9ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp10ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp11ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp12ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp13ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp14ToTimer0Captsel

enumerator kINPUTMUX__CtimerInp15ToTimer0Captsel
enumerator kINPUTMUX__CtimerInp16ToTimer0Captsel
enumerator kINPUTMUX__CompOutToTimer0Captsel
enumerator kINPUTMUX__I2sSharedWs0ToTimer0Captsel
enumerator kINPUTMUX__I2sSharedWs1ToTimer0Captsel
TIMER1 CAPTSEL.
enumerator kINPUTMUX__CtimerInp0ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp1ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp2ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp3ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp4ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp5ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp6ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp7ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp8ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp9ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp10ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp11ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp12ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp13ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp14ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp15ToTimer1Captsel
enumerator kINPUTMUX__CtimerInp16ToTimer1Captsel
enumerator kINPUTMUX__CompOutToTimer1Captsel
enumerator kINPUTMUX__I2sSharedWs0ToTimer1Captsel
enumerator kINPUTMUX__I2sSharedWs1ToTimer1Captsel
TIMER2 CAPTSEL.
enumerator kINPUTMUX__CtimerInp0ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp1ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp2ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp3ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp4ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp5ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp6ToTimer2Captsel

enumerator kINPUTMUX__CtimerInp7ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp8ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp9ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp10ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp11ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp12ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp13ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp14ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp15ToTimer2Captsel
enumerator kINPUTMUX__CtimerInp16ToTimer2Captsel
enumerator kINPUTMUX__CompOutToTimer2Captsel
enumerator kINPUTMUX__I2sSharedWs0ToTimer2Captsel
enumerator kINPUTMUX__I2sSharedWs1ToTimer2Captsel
Pin interrupt select.
enumerator kINPUTMUX__GpioPort0Pin0ToPintsel
enumerator kINPUTMUX__GpioPort0Pin1ToPintsel
enumerator kINPUTMUX__GpioPort0Pin2ToPintsel
enumerator kINPUTMUX__GpioPort0Pin3ToPintsel
enumerator kINPUTMUX__GpioPort0Pin4ToPintsel
enumerator kINPUTMUX__GpioPort0Pin5ToPintsel
enumerator kINPUTMUX__GpioPort0Pin6ToPintsel
enumerator kINPUTMUX__GpioPort0Pin7ToPintsel
enumerator kINPUTMUX__GpioPort0Pin8ToPintsel
enumerator kINPUTMUX__GpioPort0Pin9ToPintsel
enumerator kINPUTMUX__GpioPort0Pin10ToPintsel
enumerator kINPUTMUX__GpioPort0Pin11ToPintsel
enumerator kINPUTMUX__GpioPort0Pin12ToPintsel
enumerator kINPUTMUX__GpioPort0Pin13ToPintsel
enumerator kINPUTMUX__GpioPort0Pin14ToPintsel
enumerator kINPUTMUX__GpioPort0Pin15ToPintsel
enumerator kINPUTMUX__GpioPort0Pin16ToPintsel
enumerator kINPUTMUX__GpioPort0Pin17ToPintsel
enumerator kINPUTMUX__GpioPort0Pin18ToPintsel

enumerator kINPUTMUX_GpioPort0Pin19ToPintsel
enumerator kINPUTMUX_GpioPort0Pin20ToPintsel
enumerator kINPUTMUX_GpioPort0Pin21ToPintsel
enumerator kINPUTMUX_GpioPort0Pin22ToPintsel
enumerator kINPUTMUX_GpioPort0Pin23ToPintsel
enumerator kINPUTMUX_GpioPort0Pin24ToPintsel
enumerator kINPUTMUX_GpioPort0Pin25ToPintsel
enumerator kINPUTMUX_GpioPort0Pin26ToPintsel
enumerator kINPUTMUX_GpioPort0Pin27ToPintsel
enumerator kINPUTMUX_GpioPort0Pin28ToPintsel
enumerator kINPUTMUX_GpioPort0Pin29ToPintsel
enumerator kINPUTMUX_GpioPort0Pin30ToPintsel
enumerator kINPUTMUX_GpioPort0Pin31ToPintsel
enumerator kINPUTMUX_GpioPort1Pin0ToPintsel
enumerator kINPUTMUX_GpioPort1Pin1ToPintsel
enumerator kINPUTMUX_GpioPort1Pin2ToPintsel
enumerator kINPUTMUX_GpioPort1Pin3ToPintsel
enumerator kINPUTMUX_GpioPort1Pin4ToPintsel
enumerator kINPUTMUX_GpioPort1Pin5ToPintsel
enumerator kINPUTMUX_GpioPort1Pin6ToPintsel
enumerator kINPUTMUX_GpioPort1Pin7ToPintsel
enumerator kINPUTMUX_GpioPort1Pin8ToPintsel
enumerator kINPUTMUX_GpioPort1Pin9ToPintsel
enumerator kINPUTMUX_GpioPort1Pin10ToPintsel
enumerator kINPUTMUX_GpioPort1Pin11ToPintsel
enumerator kINPUTMUX_GpioPort1Pin12ToPintsel
enumerator kINPUTMUX_GpioPort1Pin13ToPintsel
enumerator kINPUTMUX_GpioPort1Pin14ToPintsel
enumerator kINPUTMUX_GpioPort1Pin15ToPintsel
enumerator kINPUTMUX_GpioPort1Pin16ToPintsel
enumerator kINPUTMUX_GpioPort1Pin17ToPintsel
enumerator kINPUTMUX_GpioPort1Pin18ToPintsel
enumerator kINPUTMUX_GpioPort1Pin19ToPintsel

enumerator kINPUTMUX_GpioPort1Pin20ToPintsel
enumerator kINPUTMUX_GpioPort1Pin21ToPintsel
enumerator kINPUTMUX_GpioPort1Pin22ToPintsel
enumerator kINPUTMUX_GpioPort1Pin23ToPintsel
enumerator kINPUTMUX_GpioPort1Pin24ToPintsel
enumerator kINPUTMUX_GpioPort1Pin25ToPintsel
enumerator kINPUTMUX_GpioPort1Pin26ToPintsel
enumerator kINPUTMUX_GpioPort1Pin27ToPintsel
enumerator kINPUTMUX_GpioPort1Pin28ToPintsel
enumerator kINPUTMUX_GpioPort1Pin29ToPintsel
enumerator kINPUTMUX_GpioPort1Pin30ToPintsel
enumerator kINPUTMUX_GpioPort1Pin31ToPintsel

DMA0 Input trigger.

enumerator kINPUTMUX_PinInt0ToDma0
enumerator kINPUTMUX_PinInt1ToDma0
enumerator kINPUTMUX_PinInt2ToDma0
enumerator kINPUTMUX_PinInt3ToDma0
enumerator kINPUTMUX_Ctimer0M0ToDma0
enumerator kINPUTMUX_Ctimer0M1ToDma0
enumerator kINPUTMUX_Ctimer1M0ToDma0
enumerator kINPUTMUX_Ctimer1M1ToDma0
enumerator kINPUTMUX_Ctimer2M0ToDma0
enumerator kINPUTMUX_Ctimer2M1ToDma0
enumerator kINPUTMUX_Ctimer3M0ToDma0
enumerator kINPUTMUX_Ctimer3M1ToDma0
enumerator kINPUTMUX_Ctimer4M0ToDma0
enumerator kINPUTMUX_Ctimer4M1ToDma0
enumerator kINPUTMUX_CompOutToDma0
enumerator kINPUTMUX_Otrig0ToDma0
enumerator kINPUTMUX_Otrig1ToDma0
enumerator kINPUTMUX_Otrig2ToDma0
enumerator kINPUTMUX_Otrig3ToDma0
enumerator kINPUTMUX_Sct0DmaReq0ToDma0

enumerator kINPUTMUX__Sct0DmaReq1ToDma0

enumerator kINPUTMUX__HashDmaRxToDma0

DMA0 output trigger.

enumerator kINPUTMUX__Dma0Hash0TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0HsLspiRxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0HsLspiTxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm0RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm0TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm1RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm1TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm3RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm3TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm2RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm2TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm4RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm4TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm5RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm5TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm6RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm6TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm7RxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Flexcomm7TxTrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Adc0Ch0TrigoutToTriginChannels

enumerator kINPUTMUX__Dma0Adc0Ch1TrigoutToTriginChannels

Selection for frequency measurement reference clock.

enumerator kINPUTMUX__ExternOscToFreqmeasRef

enumerator kINPUTMUX__Fro12MhzToFreqmeasRef

enumerator kINPUTMUX__Fro96MhzToFreqmeasRef

enumerator kINPUTMUX__WdtOscToFreqmeasRef

enumerator kINPUTMUX__32KhzOscToFreqmeasRef

enumerator kINPUTMUX__MainClkToFreqmeasRef

enumerator kINPUTMUX__FreqmeGpioClk_aRef

enumerator kINPUTMUX__FreqmeGpioClk_bRef

Selection for frequency measurement target clock.

enumerator kINPUTMUX_ExternOscToFreqmeasTarget

enumerator kINPUTMUX_Fro12MhzToFreqmeasTarget

enumerator kINPUTMUX_Fro96MhzToFreqmeasTarget

enumerator kINPUTMUX_WdtOscToFreqmeasTarget

enumerator kINPUTMUX_32KhzOscToFreqmeasTarget

enumerator kINPUTMUX_MainClkToFreqmeasTarget

enumerator kINPUTMUX_FreqmeGpioClk_aTarget

enumerator kINPUTMUX_FreqmeGpioClk_bTarget

TIMER3 CAPTSEL.

enumerator kINPUTMUX_CtimerInp0ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp1ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp2ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp3ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp4ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp5ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp6ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp7ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp8ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp9ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp10ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp11ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp12ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp13ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp14ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp15ToTimer3Cptsel

enumerator kINPUTMUX_CtimerInp16ToTimer3Cptsel

enumerator kINPUTMUX_CompOutToTimer3Cptsel

enumerator kINPUTMUX_I2sSharedWs0ToTimer3Cptsel

enumerator kINPUTMUX_I2sSharedWs1ToTimer3Cptsel

Timer4 CAPTSEL.

enumerator kINPUTMUX_CtimerInp0ToTimer4Cptsel

enumerator kINPUTMUX_CtimerInp1ToTimer4Cptsel

enumerator kINPUTMUX_CtimerInp2ToTimer4Cptsel

enumerator kINPUTMUX_CtimerInp3ToTimer4Cptsel

enumerator kINPUTMUX__CtimerInp4ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp5ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp6ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp7ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp8ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp9ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp10ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp11ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp12ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp13ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp14ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp15ToTimer4Captsel
enumerator kINPUTMUX__CtimerInp16ToTimer4Captsel
enumerator kINPUTMUX__CompOutToTimer4Captsel
enumerator kINPUTMUX__I2sSharedWs0ToTimer4Captsel
enumerator kINPUTMUX__I2sSharedWs1ToTimer4Captsel
enumerator kINPUTMUX__GpioPort0Pin0ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin1ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin2ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin3ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin4ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin5ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin6ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin7ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin8ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin9ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin10ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin11ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin12ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin13ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin14ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin15ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin16ToPintSecsel

enumerator kINPUTMUX__GpioPort0Pin17ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin18ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin19ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin20ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin21ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin22ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin23ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin24ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin25ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin26ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin27ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin28ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin29ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin30ToPintSecsel
enumerator kINPUTMUX__GpioPort0Pin31ToPintSecsel

DMA1 Input trigger.

enumerator kINPUTMUX__PinInt0ToDma1
enumerator kINPUTMUX__PinInt1ToDma1
enumerator kINPUTMUX__PinInt2ToDma1
enumerator kINPUTMUX__PinInt3ToDma1
enumerator kINPUTMUX__Ctimer0M0ToDma1
enumerator kINPUTMUX__Ctimer0M1ToDma1
enumerator kINPUTMUX__Ctimer2M0ToDma1
enumerator kINPUTMUX__Ctimer4M0ToDma1
enumerator kINPUTMUX__Otrig0ToDma1
enumerator kINPUTMUX__Otrig1ToDma1
enumerator kINPUTMUX__Otrig2ToDma1
enumerator kINPUTMUX__Otrig3ToDma1
enumerator kINPUTMUX__Sct0DmaReq0ToDma1
enumerator kINPUTMUX__Sct0DmaReq1ToDma1
enumerator kINPUTMUX__HashDmaRxToDma1

DMA1 output trigger.

enumerator kINPUTMUX__Dma1Hash0TxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1HsLspiRxTrigoutToTriginChannels

```

enumerator kINPUTMUX__Dma1HsLspiTxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm0RxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm0TxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm1RxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm1TxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm3RxTrigoutToTriginChannels
enumerator kINPUTMUX__Dma1Flexcomm3TxTrigoutToTriginChannels

```

```
enum _inputmux_signal_t
```

INPUTMUX signal enable/disable type.

Values:

```

enumerator kINPUTMUX__HashCryptToDmac0Ch0RequestEna
    DMA0 REQ signal.
enumerator kINPUTMUX__Flexcomm8RxToDmac0Ch2RequestEna
enumerator kINPUTMUX__Flexcomm8TxToDmac0Ch3RequestEna
enumerator kINPUTMUX__Flexcomm0RxToDmac0Ch4RequestEna
enumerator kINPUTMUX__Flexcomm0TxToDmac0Ch5RequestEna
enumerator kINPUTMUX__Flexcomm1RxToDmac0Ch6RequestEna
enumerator kINPUTMUX__Flexcomm1TxToDmac0Ch7RequestEna
enumerator kINPUTMUX__Flexcomm3RxToDmac0Ch8RequestEna
enumerator kINPUTMUX__Flexcomm3TxToDmac0Ch9RequestEna
enumerator kINPUTMUX__Flexcomm2RxToDmac0Ch10RequestEna
enumerator kINPUTMUX__Flexcomm2TxToDmac0Ch11RequestEna
enumerator kINPUTMUX__Flexcomm4RxToDmac0Ch12RequestEna
enumerator kINPUTMUX__Flexcomm4TxToDmac0Ch13RequestEna
enumerator kINPUTMUX__Flexcomm5RxToDmac0Ch14RequestEna
enumerator kINPUTMUX__Flexcomm5TxToDmac0Ch15RequestEna
enumerator kINPUTMUX__Flexcomm6RxToDmac0Ch16RequestEna
enumerator kINPUTMUX__Flexcomm6TxToDmac0Ch17RequestEna
enumerator kINPUTMUX__Flexcomm7RxToDmac0Ch18RequestEna
enumerator kINPUTMUX__Flexcomm7TxToDmac0Ch19RequestEna
enumerator kINPUTMUX__Adc0FIFO0ToDmac0Ch21RequestEna
enumerator kINPUTMUX__Adc0FIFO1ToDmac0Ch22RequestEna
    DMA1 REQ signal.
enumerator kINPUTMUX__HashCryptToDmac1Ch0RequestEna

```

enumerator kINPUTMUX_Flexcomm8RxToDmac1Ch2RequestEna
enumerator kINPUTMUX_Flexcomm8TxToDmac1Ch3RequestEna
enumerator kINPUTMUX_Flexcomm0RxToDmac1Ch4RequestEna
enumerator kINPUTMUX_Flexcomm0TxToDmac1Ch5RequestEna
enumerator kINPUTMUX_Flexcomm1RxToDmac1Ch6RequestEna
enumerator kINPUTMUX_Flexcomm1TxToDmac1Ch7RequestEna
enumerator kINPUTMUX_Flexcomm3RxToDmac1Ch8RequestEna
enumerator kINPUTMUX_Flexcomm3TxToDmac1Ch9RequestEna
DMA0 input trigger source enable.

enumerator kINPUTMUX_Dmac0InputTriggerPint0Ena
enumerator kINPUTMUX_Dmac0InputTriggerPint1Ena
enumerator kINPUTMUX_Dmac0InputTriggerPint2Ena
enumerator kINPUTMUX_Dmac0InputTriggerPint3Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer0M0Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer0M1Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer1M0Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer1M1Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer2M0Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer2M1Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer3M0Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer3M1Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer4M0Ena
enumerator kINPUTMUX_Dmac0InputTriggerCtimer4M1Ena
enumerator kINPUTMUX_Dmac0InputTriggerCompOutEna
enumerator kINPUTMUX_Dmac0InputTriggerDma0Out0Ena
enumerator kINPUTMUX_Dmac0InputTriggerDma0Out1Ena
enumerator kINPUTMUX_Dmac0InputTriggerDma0Out2Ena
enumerator kINPUTMUX_Dmac0InputTriggerDma0Out3Ena
enumerator kINPUTMUX_Dmac0InputTriggerSctDmac0Ena
enumerator kINPUTMUX_Dmac0InputTriggerSctDmac1Ena
enumerator kINPUTMUX_Dmac0InputTriggerHashOutEna

DMA1 input trigger source enable.

enumerator kINPUTMUX_Dmac1InputTriggerPint0Ena
enumerator kINPUTMUX_Dmac1InputTriggerPint1Ena

```
enumerator kINPUTMUX__Dmac1InputTriggerPint2Ena
enumerator kINPUTMUX__Dmac1InputTriggerPint3Ena
enumerator kINPUTMUX__Dmac1InputTriggerCtimer0M0Ena
enumerator kINPUTMUX__Dmac1InputTriggerCtimer0M1Ena
enumerator kINPUTMUX__Dmac1InputTriggerCtimer2M0Ena
enumerator kINPUTMUX__Dmac1InputTriggerCtimer4M0Ena
enumerator kINPUTMUX__Dmac1InputTriggerDma1Out0Ena
enumerator kINPUTMUX__Dmac1InputTriggerDma1Out1Ena
enumerator kINPUTMUX__Dmac1InputTriggerDma1Out2Ena
enumerator kINPUTMUX__Dmac1InputTriggerDma1Out3Ena
enumerator kINPUTMUX__Dmac1InputTriggerSctDmac0Ena
enumerator kINPUTMUX__Dmac1InputTriggerSctDmac1Ena
enumerator kINPUTMUX__Dmac1InputTriggerHashOutEna

typedef enum _inputmux_connection_t inputmux__connection__t
    INPUTMUX connections type.

typedef enum _inputmux_signal_t inputmux__signal__t
    INPUTMUX signal enable/disable type.

SCT0_INMUX0
    Periphinmux IDs.

TIMER0CAPTSEL0
TIMER1CAPTSEL0
TIMER2CAPTSEL0
PINTSEL_PMUX_ID
PINTSEL0
DMA0_ITRIG_INMUX0
DMA0_OTRIG_INMUX0
FREQMEAS_REF_REG
FREQMEAS_TARGET_REG
TIMER3CAPTSEL0
TIMER4CAPTSEL0
PINTSECSEL0
DMA1_ITRIG_INMUX0
DMA1_OTRIG_INMUX0
DMA0_REQ_ENA_ID
```

DMA1_REQ_ENA_ID

DMA0_ITRIG_ENA_ID

DMA1_ITRIG_ENA_ID

ENA_SHIFT

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_EnableSignal(void *base, inputmux_signal_t signal, bool enable)`

Enable/disable a signal.

This function gates the INPUTMUX clock.

Parameters

- `base` – Base address of the INPUTMUX peripheral.
- `signal` – Enable signal register id and bit offset.
- `enable` – Selects enable or disable.

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. –

2.30 IAP_KBP Driver

ROM API status codes.

Values:

enumerator `kStatus_RomApiExecuteCompleted`

ROM successfully process the whole sb file/boot image.

enumerator `kStatus_RomApiNeedMoreData`

ROM needs more data to continue processing the boot image.

enumerator `kStatus_RomApiBufferSizeNotEnough`

The user buffer is not enough for use by Kboot during execution of the operation.

enumerator `kStatus_RomApiInvalidBuffer`

The user buffer is not ok for sbloader or authentication.

enum `_kb_operation`

Details of the operation to be performed by the ROM.

The `kRomAuthenticateImage` operation requires the entire signed image to be available to the application.

Values:

enumerator `kRomAuthenticateImage`

Authenticate a signed image.

enumerator `kRomLoadImage`

Load SB file.

enumerator `kRomOperationCount`

enum `_kb_security_profile`

Security constraint flags, Security profile flags.

Values:

enumerator `kKbootMinRSA4096`

typedef enum `_kb_operation` `kb_operation_t`

Details of the operation to be performed by the ROM.

The `kRomAuthenticateImage` operation requires the entire signed image to be available to the application.

typedef struct `_kb_region` `kb_region_t`

Memory region definition.

typedef struct `_kb_load_sb` `kb_load_sb_t`

User-provided options passed into `kb_init()`.

The buffer field is a pointer to memory provided by the caller for use by Kboot during execution of the operation. Minimum size is the size of each certificate in the chain plus 432 bytes additional per certificate.

The profile field is a mask that specifies which features are required in the SB file or image being processed. This includes the minimum AES and RSA key sizes. See the `_kb_security_profile` enum for profile mask constants. The image being loaded or authenticated must match the profile or an error will be returned.

`minBuildNumber` is an optional field that can be used to prevent version rollback. The API will check the build number of the image, and if it is less than `minBuildNumber` will fail with an error.

`maxImageLength` is used to verify the `offsetToCertificateBlockHeaderInBytes` value at the beginning of a signed image. It should be set to the length of the SB file. If verifying an image in flash, it can be set to the internal flash size or a large number like `0x10000000`.

`userRHK` can optionally be used by the user to override the RHK in IFR. If `userRHK` is not NULL, it points to a 32-byte array containing the SHA-256 of the root certificate's RSA public key.

The `regions` field points to an array of memory regions that the SB file being loaded is allowed to access. If `regions` is NULL, then all memory is accessible by the SB file. This feature is required to prevent a malicious image from erasing good code or RAM contents while it is being loaded, only for us to find that the image is inauthentic when we hit the end of the section.

`overrideSBBootSectionID` lets the caller override the default section of the SB file that is processed during a `kKbootLoadSB` operation. By default, the section specified in the `firstBootableSectionID` field of the SB header is loaded. If `overrideSBBootSectionID` is non-zero, then the section with the given ID will be loaded instead.

The `userSBKEK` field lets a user provide their own AES-256 key for unwrapping keys in an SB file during the `kKbootLoadSB` operation. `userSBKEK` should point to a 32-byte AES-256 key. If `userSBKEK` is NULL then the IFR SBKEK will be used. After `kb_init()` returns, the caller should zero out the data pointed to by `userSBKEK`, as the API will have installed the key in the CAU3.

```
typedef struct _kb_authenticate kb_authenticate_t
```

```
typedef struct _kb_options kb_options_t
```

```
typedef struct _memory_region_interface memory_region_interface_t
```

Interface to memory operations for one region of memory.

```
typedef struct _memory_map_entry memory_map_entry_t
```

Structure of a memory map entry.

```
typedef struct _kb_opaque_session_ref kb_session_ref_t
```

```
status_t kb_init(kb_session_ref_t **session, const kb_options_t *options)
```

Initialize ROM API for a given operation.

Initials the ROM API based on the options provided by the application in the second argument. Every call to `rom_init()` should be paired with a call to `rom_deinit()`.

Return values

- `kStatus_Success` – API was executed successfully.
- `kStatus_InvalidArgument` – An invalid argument is provided.
- `kStatus_RomApiBufferSizeNotEnough` – The user buffer is not enough for use by Kboot during execution of the operation.
- `kStatus_RomApiInvalidBuffer` – The user buffer is not ok for sbloader or authentication.
- `kStatus_SKBOOT_Fail` – Return the failed status of secure boot.

- `kStatus_SKBOOT_KeyStoreMarkerInvalid` – The key code for the particular PRINCE region is not present in the keystore
- `kStatus_SKBOOT_Success` – Return the successful status of secure boot.

`status_t kb_deinit(kb_session_ref_t *session)`

Cleans up the ROM API context.

After this call, the context parameter can be reused for another operation by calling `rom_init()` again.

Return values

`kStatus_Success` – API was executed successfully

`status_t kb_execute(kb_session_ref_t *session, const uint8_t *data, uint32_t dataLength)`

Perform the operation configured during init.

This application must call this API repeatedly, passing in sequential chunks of data from the boot image (SB file) that is to be processed. The ROM will perform the selected operation on this data and return. The application may call this function with as much or as little data as it wishes, which can be used to select the granularity of time given to the application in between executing the operation.

Parameters

- `session` – Current ROM context pointer.
- `data` – Buffer of boot image data provided to the ROM by the application.
- `dataLength` – Length in bytes of the data in the buffer provided to the ROM.

Return values

- `kStatus_Success` – ROM successfully process the part of sb file/boot image.
- `kStatus_RomApiExecuteCompleted` – ROM successfully process the whole sb file/boot image.
- `kStatus_Fail` – An error occurred while executing the operation.
- `kStatus_RomApiNeedMoreData` – No error occurred, but the ROM needs more data to continue processing the boot image.
- `kStatus_RomApiBufferSizeNotEnough` – user buffer is not enough for use by Kboot during execution of the operation.

`kStatusGroup_RomApi`

ROM API status group number.

`struct _kb_region`

`#include <fsl_iap_kbp.h>` Memory region definition.

`struct _kb_load_sb`

`#include <fsl_iap_kbp.h>` User-provided options passed into `kb_init()`.

The buffer field is a pointer to memory provided by the caller for use by Kboot during execution of the operation. Minimum size is the size of each certificate in the chain plus 432 bytes additional per certificate.

The profile field is a mask that specifies which features are required in the SB file or image being processed. This includes the minimum AES and RSA key sizes. See the `_kb_security_profile` enum for profile mask constants. The image being loaded or authenticated must match the profile or an error will be returned.

`minBuildNumber` is an optional field that can be used to prevent version rollback. The API will check the build number of the image, and if it is less than `minBuildNumber` will fail with an error.

maxImageLength is used to verify the offsetToCertificateBlockHeaderInBytes value at the beginning of a signed image. It should be set to the length of the SB file. If verifying an image in flash, it can be set to the internal flash size or a large number like 0x10000000.

userRHK can optionally be used by the user to override the RHK in IFR. If userRHK is not NULL, it points to a 32-byte array containing the SHA-256 of the root certificate's RSA public key.

The regions field points to an array of memory regions that the SB file being loaded is allowed to access. If regions is NULL, then all memory is accessible by the SB file. This feature is required to prevent a malicious image from erasing good code or RAM contents while it is being loaded, only for us to find that the image is inauthentic when we hit the end of the section.

overrideSBBootSectionID lets the caller override the default section of the SB file that is processed during a kKbootLoadSB operation. By default, the section specified in the first-BootableSectionID field of the SB header is loaded. If overrideSBBootSectionID is non-zero, then the section with the given ID will be loaded instead.

The userSBKEK field lets a user provide their own AES-256 key for unwrapping keys in an SB file during the kKbootLoadSB operation. userSBKEK should point to a 32-byte AES-256 key. If userSBKEK is NULL then the IFR SBKEK will be used. After kb_init() returns, the caller should zero out the data pointed to by userSBKEK, as the API will have installed the key in the CAU3.

```
struct __kb_authenticate
    #include <fsl_iap_kbp.h>
```

```
struct __kb_options
    #include <fsl_iap_kbp.h>
```

Public Members

uint32_t version
Should be set to kKbootApiVersion.

uint8_t *buffer
Caller-provided buffer used by Kboot.

```
struct __memory_region_interface
    #include <fsl_iap_kbp.h> Interface to memory operations for one region of memory.
```

```
struct __memory_map_entry
    #include <fsl_iap_kbp.h> Structure of a memory map entry.
```

```
struct __kb_opaque_session_ref
    #include <fsl_iap_kbp.h>
```

```
union __unnamed11__
```

Public Members

kb_authenticate_t authenticate

kb_load_sb_t loadSB
Settings for kKbootAuthenticate operation.

2.31 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 specified by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR(*addr*, *bits*)

Clear the bits specified by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_TOGGLE(addr, bits)

Toggle the bits specified 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 specified by *clearBits* and set the bits specified 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 UART status codes.

enumerator kStatusGroup_LPSCI
Group number for LPSCI status codes.

enumerator kStatusGroup_LPUART
Group number for LPUART status codes.

enumerator kStatusGroup_SPI
Group number for SPI status code.

enumerator kStatusGroup_XRDC
Group number for XRDC status code.

enumerator kStatusGroup_SEMA42
Group number for SEMA42 status code.

enumerator kStatusGroup_SDHC
Group number for SDHC status code

enumerator kStatusGroup_SDMMC
Group number for SDMMC status code

enumerator kStatusGroup_SAI
Group number for SAI status code

enumerator kStatusGroup_MCG
Group number for MCG status codes.

enumerator kStatusGroup_SCG
Group number for SCG status codes.

enumerator kStatusGroup_SDSPI
Group number for SDSPI status codes.

enumerator kStatusGroup_FLEXIO_I2S
Group number for FLEXIO I2S status codes

enumerator kStatusGroup_FLEXIO_MCULCD
Group number for FLEXIO LCD status codes

enumerator kStatusGroup_FLASHIAP
Group number for FLASHIAP status codes

enumerator kStatusGroup_FLEXCOMM_I2C
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup_I2S
Group number for I2S status codes

enumerator kStatusGroup_IUART
Group number for IUART status codes

enumerator kStatusGroup_CSI
Group number for CSI status codes

enumerator kStatusGroup_MIPIDSI
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_CODECD`
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_SDIO_SLV`
Group number for SDIO_SLV status codes.

enumerator `kStatusGroup_MECC`
Group number for MECC status codes.

enumerator `kStatusGroup_ENET_QOS`
Group number for ENET_QOS status codes.

enumerator `kStatusGroup_LOG`
Group number for LOG status codes.

enumerator `kStatusGroup_I3CBUS`
Group number for I3CBUS status codes.

enumerator `kStatusGroup_QSCI`
Group number for QSCI status codes.

enumerator `kStatusGroup_ELEMU`
Group number for ELEMU status codes.

enumerator `kStatusGroup_QUEUEDSPI`
Group number for QSPI status codes.

enumerator `kStatusGroup_POWER_MANAGER`
Group number for POWER_MANAGER status codes.

enumerator `kStatusGroup_IPED`
Group number for IPED status codes.

enumerator `kStatusGroup_ELS_PKC`
Group number for ELS PKC status codes.

enumerator `kStatusGroup_CSS_PKC`
Group number for CSS PKC status codes.

enumerator `kStatusGroup_HOSTIF`
Group number for HOSTIF status codes.

enumerator `kStatusGroup_CLIF`
Group number for CLIF status codes.

enumerator `kStatusGroup_BMA`
Group number for BMA status codes.

enumerator `kStatusGroup_NETC`
Group number for NETC status codes.

enumerator `kStatusGroup_ELE`
Group number for ELE status codes.

enumerator `kStatusGroup_GLIKEY`
Group number for GLIKEY status codes.

enumerator `kStatusGroup_AON_POWER`
Group number for AON_POWER status codes.

enumerator `kStatusGroup_AON_COMMON`
Group number for AON_COMMON status codes.

enumerator `kStatusGroup_ENDAT3`
Group number for ENDAT3 status codes.

enumerator kStatusGroup_HIPERFACE

Group number for HIPERFACE status codes.

enumerator kStatusGroup_NPX

Group number for NPX status codes.

enumerator kStatusGroup_ELA_CSEC

Group number for ELA_CSEC status codes.

enumerator kStatusGroup_FLEXIO_T_FORMAT

Group number for T-format status codes.

enumerator kStatusGroup_FLEXIO_A_FORMAT

Group number for A-format status codes.

Generic status return codes.

Values:

enumerator kStatus_Success

Generic status for Success.

enumerator kStatus_Fail

Generic status for Fail.

enumerator kStatus_ReadOnly

Generic status for read only failure.

enumerator kStatus_OutOfRange

Generic status for out of range access.

enumerator kStatus_InvalidArgument

Generic status for invalid argument check.

enumerator kStatus_Timeout

Generic status for timeout.

enumerator kStatus_NoTransferInProgress

Generic status for no transfer in progress.

enumerator kStatus_Busy

Generic status for module is busy.

enumerator kStatus_NoData

Generic status for no data is found for the operation.

typedef int32_t status_t

Type used for all status and error return values.

void *SDK_Malloc(size_t size, size_t alignbytes)

Allocate memory with given alignment and aligned size.

This is provided to support the dynamically allocated memory used in cache-able region.

Parameters

- size – The length required to malloc.
- alignbytes – The alignment size.

Return values

The – allocated memory.

`void SDK_Free(void *ptr)`

Free memory.

Parameters

- `ptr` – The memory to be release.

`void SDK_DelayAtLeastUs(uint32_t delayTime_us, uint32_t coreClock_Hz)`

Delay at least for some time. Please note that, this API uses while loop for delay, different run-time environments make the time not precise, if precise delay count was needed, please implement a new delay function with hardware timer.

Parameters

- `delayTime_us` – Delay time in unit of microsecond.
- `coreClock_Hz` – Core clock frequency with Hz.

`static inline status_t EnableIRQ(IRQn_Type interrupt)`

Enable specific interrupt.

Enable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only enables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

Parameters

- `interrupt` – The IRQ number.

Return values

- `kStatus_Success` – Interrupt enabled successfully
- `kStatus_Fail` – Failed to enable the interrupt

`static inline status_t DisableIRQ(IRQn_Type interrupt)`

Disable specific interrupt.

Disable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only disables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

Parameters

- `interrupt` – The IRQ number.

Return values

- `kStatus_Success` – Interrupt disabled successfully
- `kStatus_Fail` – Failed to disable the interrupt

`static inline status_t EnableIRQWithPriority(IRQn_Type interrupt, uint8_t priNum)`

Enable the IRQ, and also set the interrupt priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

Parameters

- interrupt – The IRQ to Enable.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_SetPriority(IRQn_Type interrupt, uint8_t priNum)

Set the IRQ priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to set.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_ClearPendingIRQ(IRQn_Type interrupt)

Clear the pending IRQ flag.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The flag which IRQ to clear.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline uint32_t DisableGlobalIRQ(void)

Disable the global IRQ.

Disable the global interrupt and return the current primask register. User is required to provided the primask register for the EnableGlobalIRQ().

Returns

Current primask value.

static inline void EnableGlobalIRQ(uint32_t primask)

Enable the global IRQ.

Set the primask register with the provided primask value but not just enable the primask. The idea is for the convenience of integration of RTOS. some RTOS get its own management

mechanism of primask. User is required to use the EnableGlobalIRQ() and DisableGlobalIRQ() in pair.

Parameters

- primask – value of primask register to be restored. The primask value is supposed to be provided by the DisableGlobalIRQ().

```
static inline bool __SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t  
newValue)
```

```
static inline uint32_t __SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)
```

FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ

Macro to use the default weak IRQ handler in drivers.

MAKE_STATUS(group, code)

Construct a status code value from a group and code number.

MAKE_VERSION(major, minor, bugfix)

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms(such as Cortex M) and 16-bit platforms(such as DSC).

Unused	Major Version		Minor Version		Bug Fix		
31	25	24	17	16	9	8	0

ARRAY_SIZE(x)

Computes the number of elements in an array.

UINT64_H(X)

Macro to get upper 32 bits of a 64-bit value

UINT64_L(X)

Macro to get lower 32 bits of a 64-bit value

SUPPRESS_FALL_THROUGH_WARNING()

For switch case code block, if case section ends without “break;” statement, there 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.

2.32 LPADC: 12-bit SAR Analog-to-Digital Converter Driver

enum _lpadc_status_flags

Define hardware flags of the module.

Values:

enumerator kLPADC_ResultFIFO0OverflowFlag

Indicates that more data has been written to the Result FIFO 0 than it can hold.

enumerator kLPADC_ResultFIFO0ReadyFlag

Indicates when the number of valid datawords in the result FIFO 0 is greater than the setting watermark level.

enumerator kLPADC_TriggerExceptionFlag

Indicates that a trigger exception event has occurred.

enumerator kLPADC_TriggerCompletionFlag

Indicates that a trigger completion event has occurred.

enumerator kLPADC_CalibrationReadyFlag

Indicates that the calibration process is done.

enumerator kLPADC_ActiveFlag

Indicates that the ADC is in active state.

enumerator kLPADC_ResultFIFOOverflowFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowFlag as instead.

enumerator kLPADC_ResultFIFOReadyFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0ReadyFlag as instead.

enum _lpadc_interrupt_enable

Define interrupt switchers of the module.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_ResultFIFO0OverflowInterruptEnable

Configures ADC to generate overflow interrupt requests when FOF0 flag is asserted.

enumerator kLPADC_FIFO0WatermarkInterruptEnable

Configures ADC to generate watermark interrupt requests when RDY0 flag is asserted.

enumerator kLPADC_ResultFIFOOverflowInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowInterruptEnable as instead.

enumerator kLPADC_FIFOWatermarkInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_FIFO0WatermarkInterruptEnable as instead.

enumerator kLPADC_TriggerExceptionInterruptEnable

Configures ADC to generate trigger exception interrupt.

enumerator kLPADC_Trigger0CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 0 completion.

enumerator kLPADC_Trigger1CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 1 completion.

enumerator kLPADC_Trigger2CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 2 completion.

enumerator kLPADC_Trigger3CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 3 completion.

enumerator kLPADC_Trigger4CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 4 completion.

enumerator kLPADC_Trigger5CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 5 completion.

enumerator kLPADC_Trigger6CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 6 completion.

enumerator kLPADC_Trigger7CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 7 completion.

enumerator kLPADC_Trigger8CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 8 completion.

enumerator kLPADC_Trigger9CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 9 completion.

enumerator kLPADC_Trigger10CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 10 completion.

enumerator kLPADC_Trigger11CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 11 completion.

enumerator kLPADC_Trigger12CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 12 completion.

enumerator kLPADC_Trigger13CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 13 completion.

enumerator kLPADC_Trigger14CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 14 completion.

enumerator kLPADC_Trigger15CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 15 completion.

enum _lpadc_trigger_status_flags

The enumerator of lpadc trigger status flags, including interrupted flags and completed flags.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_Trigger0InterruptedFlag
Trigger 0 is interrupted by a high priority exception.

enumerator kLPADC_Trigger1InterruptedFlag
Trigger 1 is interrupted by a high priority exception.

enumerator kLPADC_Trigger2InterruptedFlag
Trigger 2 is interrupted by a high priority exception.

enumerator kLPADC_Trigger3InterruptedFlag
Trigger 3 is interrupted by a high priority exception.

enumerator kLPADC_Trigger4InterruptedFlag
Trigger 4 is interrupted by a high priority exception.

enumerator kLPADC_Trigger5InterruptedFlag
Trigger 5 is interrupted by a high priority exception.

enumerator kLPADC_Trigger6InterruptedFlag
Trigger 6 is interrupted by a high priority exception.

enumerator kLPADC_Trigger7InterruptedFlag

Trigger 7 is interrupted by a high priority exception.

enumerator kLPADC_Trigger8InterruptedFlag

Trigger 8 is interrupted by a high priority exception.

enumerator kLPADC_Trigger9InterruptedFlag

Trigger 9 is interrupted by a high priority exception.

enumerator kLPADC_Trigger10InterruptedFlag

Trigger 10 is interrupted by a high priority exception.

enumerator kLPADC_Trigger11InterruptedFlag

Trigger 11 is interrupted by a high priority exception.

enumerator kLPADC_Trigger12InterruptedFlag

Trigger 12 is interrupted by a high priority exception.

enumerator kLPADC_Trigger13InterruptedFlag

Trigger 13 is interrupted by a high priority exception.

enumerator kLPADC_Trigger14InterruptedFlag

Trigger 14 is interrupted by a high priority exception.

enumerator kLPADC_Trigger15InterruptedFlag

Trigger 15 is interrupted by a high priority exception.

enumerator kLPADC_Trigger0CompletedFlag

Trigger 0 is completed and trigger 0 has enabled completion interrupts.

enumerator kLPADC_Trigger1CompletedFlag

Trigger 1 is completed and trigger 1 has enabled completion interrupts.

enumerator kLPADC_Trigger2CompletedFlag

Trigger 2 is completed and trigger 2 has enabled completion interrupts.

enumerator kLPADC_Trigger3CompletedFlag

Trigger 3 is completed and trigger 3 has enabled completion interrupts.

enumerator kLPADC_Trigger4CompletedFlag

Trigger 4 is completed and trigger 4 has enabled completion interrupts.

enumerator kLPADC_Trigger5CompletedFlag

Trigger 5 is completed and trigger 5 has enabled completion interrupts.

enumerator kLPADC_Trigger6CompletedFlag

Trigger 6 is completed and trigger 6 has enabled completion interrupts.

enumerator kLPADC_Trigger7CompletedFlag

Trigger 7 is completed and trigger 7 has enabled completion interrupts.

enumerator kLPADC_Trigger8CompletedFlag

Trigger 8 is completed and trigger 8 has enabled completion interrupts.

enumerator kLPADC_Trigger9CompletedFlag

Trigger 9 is completed and trigger 9 has enabled completion interrupts.

enumerator kLPADC_Trigger10CompletedFlag

Trigger 10 is completed and trigger 10 has enabled completion interrupts.

enumerator kLPADC_Trigger11CompletedFlag

Trigger 11 is completed and trigger 11 has enabled completion interrupts.

enumerator kLPADC_Trigger12CompletedFlag

Trigger 12 is completed and trigger 12 has enabled completion interrupts.

enumerator kLPADC_Trigger13CompletedFlag

Trigger 13 is completed and trigger 13 has enabled completion interrupts.

enumerator kLPADC_Trigger14CompletedFlag

Trigger 14 is completed and trigger 14 has enabled completion interrupts.

enumerator kLPADC_Trigger15CompletedFlag

Trigger 15 is completed and trigger 15 has enabled completion interrupts.

enum __lpadc_sample_scale_mode

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

Values:

enumerator kLPADC_SamplePartScale

Use divided input voltage signal. (For scale select, please refer to the reference manual).

enumerator kLPADC_SampleFullScale

Full scale (Factor of 1).

enum __lpadc_sample_channel_mode

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

Values:

enumerator kLPADC_SampleChannelSingleEndSideA

Single-end mode, only A-side channel is converted.

enumerator kLPADC_SampleChannelSingleEndSideB

Single-end mode, only B-side channel is converted.

enumerator kLPADC_SampleChannelDiffBothSideAB

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDiffBothSideBA

Differential mode, the ADC result is (CHnB-CHnA).

enumerator kLPADC_SampleChannelDiffBothSide

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDualSingleEndBothSide

Dual-Single-Ended Mode. Both A side and B side channels are converted independently.

enum __lpadc_hardware_average_mode

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

Values:

enumerator kLPADC__HardwareAverageCount1

Single conversion.

enumerator kLPADC__HardwareAverageCount2

2 conversions averaged.

enumerator kLPADC__HardwareAverageCount4

4 conversions averaged.

enumerator kLPADC__HardwareAverageCount8

8 conversions averaged.

enumerator kLPADC__HardwareAverageCount16

16 conversions averaged.

enumerator kLPADC__HardwareAverageCount32

32 conversions averaged.

enumerator kLPADC__HardwareAverageCount64

64 conversions averaged.

enumerator kLPADC__HardwareAverageCount128

128 conversions averaged.

enum _lpadc_sample_time_mode

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

Values:

enumerator kLPADC__SampleTimeADCK3

3 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK5

5 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK7

7 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK11

11 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK19

19 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK35

35 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK67

69 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK131

131 ADCK cycles total sample time.

enum `_lpadc_hardware_compare_mode`

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

Values:

enumerator `kLPADC__HardwareCompareDisabled`

Compare disabled.

enumerator `kLPADC__HardwareCompareStoreOnTrue`

Compare enabled. Store on true.

enumerator `kLPADC__HardwareCompareRepeatUntilTrue`

Compare enabled. Repeat channel acquisition until true.

enum `_lpadc_conversion_resolution_mode`

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to `lpadc_sample_channel_mode_t`

Values:

enumerator `kLPADC__ConversionResolutionStandard`

Standard resolution. Single-ended 12-bit conversion, Differential 13-bit conversion with 2's complement output.

enumerator `kLPADC__ConversionResolutionHigh`

High resolution. Single-ended 16-bit conversion; Differential 16-bit conversion with 2's complement output.

enum `_lpadc_conversion_average_mode`

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of `CAL_AVGS` field in `CTRL` register.

Values:

enumerator `kLPADC__ConversionAverage1`

Single conversion.

enumerator `kLPADC__ConversionAverage2`

2 conversions averaged.

enumerator `kLPADC__ConversionAverage4`

4 conversions averaged.

enumerator `kLPADC__ConversionAverage8`

8 conversions averaged.

enumerator `kLPADC__ConversionAverage16`

16 conversions averaged.

enumerator `kLPADC__ConversionAverage32`

32 conversions averaged.

enumerator kLPADC_ConversionAverage64

64 conversions averaged.

enumerator kLPADC_ConversionAverage128

128 conversions averaged.

enum __lpadc_reference_voltage_mode

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

Values:

enumerator kLPADC_ReferenceVoltageAlt1

Option 1 setting.

enumerator kLPADC_ReferenceVoltageAlt2

Option 2 setting.

enumerator kLPADC_ReferenceVoltageAlt3

Option 3 setting.

enum __lpadc_power_level_mode

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

Values:

enumerator kLPADC_PowerLevelAlt1

Lowest power setting.

enumerator kLPADC_PowerLevelAlt2

Next lowest power setting.

enumerator kLPADC_PowerLevelAlt3

...

enumerator kLPADC_PowerLevelAlt4

Highest power setting.

enum __lpadc_offset_calibration_mode

Define enumeration of offset calibration mode.

Values:

enumerator kLPADC_OffsetCalibration12bitMode

12 bit offset calibration mode.

enumerator kLPADC_OffsetCalibration16bitMode

16 bit offset calibration mode.

enum __lpadc_trigger_priority_policy

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

Values:

enumerator `kLPADC_ConvPreemptImmediatelyNotAutoResumed`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion is not automatically resumed or restarted.

enumerator `kLPADC_ConvPreemptSoftlyNotAutoResumed`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion is not resumed or restarted.

enumerator `kLPADC_ConvPreemptImmediatelyAutoRestarted`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptSoftlyAutoRestarted`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptImmediatelyAutoResumed`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be resumed.

enumerator `kLPADC_ConvPreemptSoftlyAutoResumed`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will be automatically be resumed.

enumerator `kLPADC_TriggerPriorityPreemptImmediately`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityPreemptSoftly`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityExceptionDisabled`

High priority trigger exception disabled.

typedef enum *lpadc_sample_scale_mode* `lpadc_sample_scale_mode_t`

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

`typedef enum _lpadc_sample_channel_mode` `lpadc_sample_channel_mode_t`

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

`typedef enum _lpadc_hardware_average_mode` `lpadc_hardware_average_mode_t`

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

`typedef enum _lpadc_sample_time_mode` `lpadc_sample_time_mode_t`

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

`typedef enum _lpadc_hardware_compare_mode` `lpadc_hardware_compare_mode_t`

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

`typedef enum _lpadc_conversion_resolution_mode` `lpadc_conversion_resolution_mode_t`

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to `lpadc_sample_channel_mode_t`

`typedef enum _lpadc_conversion_average_mode` `lpadc_conversion_average_mode_t`

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

`typedef enum _lpadc_reference_voltage_mode` `lpadc_reference_voltage_source_t`

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

`typedef enum _lpadc_power_level_mode` `lpadc_power_level_mode_t`

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

`typedef enum _lpadc_offset_calibration_mode` `lpadc_offset_calibration_mode_t`

Define enumeration of offset calibration mode.

typedef enum *lpadc_trigger_priority_policy* lpadc_trigger_priority_policy_t

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

typedef struct *lpadc_calibration_value* lpadc_calibration_value_t

A structure of calibration value.

LPADC_CONVERSION_COMPLETE_TIMEOUT

Max loops to wait for LPADC conversion complete.

When doing calibration, driver will wait for the completion of conversion. This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

LPADC_CALIBRATION_READY_TIMEOUT

Max loops to wait for LPADC calibration ready.

Before doing calibration, driver will wait for the calibration ready. This parameter defines how many loops to check the calibration ready. If defined as 0, driver will wait forever until ready.

LPADC_GAIN_CAL_READY_TIMEOUT

Max loops to wait for LPADC gain calibration GAIN_CAL ready.

Before doing calibration, driver will wait for the gain calibration GAIN_CAL ready. This parameter defines how many loops to check the gain calibration GAIN_CAL ready. If defined as 0, driver will wait forever until ready.

ADC_OFSTRIM_OFSTRIM_MAX

ADC_OFSTRIM_OFSTRIM_SIGN

LPADC_GET_ACTIVE_COMMAND_STATUS(statusVal)

Define the MACRO function to get command status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

LPADC_GET_ACTIVE_TRIGGER_STATUE(statusVal)

Define the MACRO function to get trigger status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

void LPADC_Init(ADC_Type *base, const *lpadc_config_t* *config)

Initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.
- config – Pointer to configuration structure. See “*lpadc_config_t*”.

void LPADC_GetDefaultConfig(*lpadc_config_t* *config)

Gets an available pre-defined settings for initial configuration.

This function initializes the converter configuration structure with an available settings. The default values are:

```

config->enableInDozeMode      = true;
config->enableAnalogPreliminary = false;
config->powerUpDelay          = 0x80;
config->referenceVoltageSource = kLPADC_ReferenceVoltageAlt1;
config->powerLevelMode        = kLPADC_PowerLevelAlt1;
config->triggerPriorityPolicy  = kLPADC_TriggerPriorityPreemptImmediately;
config->enableConvPause       = false;
config->convPauseDelay        = 0U;
config->FIFOWatermark         = 0U;

```

Parameters

- config – Pointer to configuration structure.

void LPADC_Deinit(ADC_Type *base)

De-initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_Enable(ADC_Type *base, bool enable)

Switch on/off the LPADC module.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the module.

static inline void LPADC_DoResetFIFO(ADC_Type *base)

Do reset the conversion FIFO.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_DoResetConfig(ADC_Type *base)

Do reset the module's configuration.

Reset all ADC internal logic and registers, except the Control Register (ADCx_CTRL).

Parameters

- base – LPADC peripheral base address.

static inline uint32_t LPADC_GetStatusFlags(ADC_Type *base)

Get status flags.

Parameters

- base – LPADC peripheral base address.

Returns

status flags' mask. See to `_lpadc_status_flags`.

static inline void LPADC_ClearStatusFlags(ADC_Type *base, uint32_t mask)

Clear status flags.

Only the flags can be cleared by writing ADCx_STATUS register would be cleared by this API.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for flags to be cleared. See to `_lpadc_status_flags`.

static inline uint32_t LPADC_GetTriggerStatusFlags(ADC_Type *base)

Get trigger status flags to indicate which trigger sequences have been completed or interrupted by a high priority trigger exception.

Parameters

- base – LPADC peripheral base address.

Returns

The OR'ed value of `_lpadc_trigger_status_flags`.

static inline void LPADC_ClearTriggerStatusFlags(ADC_Type *base, uint32_t mask)

Clear trigger status flags.

Parameters

- base – LPADC peripheral base address.
- mask – The mask of trigger status flags to be cleared, should be the OR'ed value of `_lpadc_trigger_status_flags`.

static inline void LPADC_EnableInterrupts(ADC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.

static inline void LPADC_DisableInterrupts(ADC_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.

static inline void LPADC_EnableFIFOWatermarkDMA(ADC_Type *base, bool enable)

Switch on/off the DMA trigger for FIFO watermark event.

Parameters

- base – LPADC peripheral base address.
- enable – Switcher to the event.

static inline uint32_t LPADC_GetConvResultCount(ADC_Type *base)

Get the count of result kept in conversion FIFO.

Parameters

- base – LPADC peripheral base address.

Returns

The count of result kept in conversion FIFO.

bool LPADC_GetConvResult(ADC_Type *base, *lpadc_conv_result_t* *result)

Get the result in conversion FIFO.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

Returns

Status whether FIFO entry is valid.

```
void LPADC_GetConvResultBlocking(ADC_Type *base, lpadc_conv_result_t *result)
```

Get the result in conversion FIFO using blocking method.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

```
void LPADC_SetConvTriggerConfig(ADC_Type *base, uint32_t triggerId, const
                                lpadc_conv_trigger_config_t *config)
```

Configure the conversion trigger source.

Each programmable trigger can launch the conversion command in command buffer.

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- config – Pointer to configuration structure. See to `lpadc_conv_trigger_config_t`.

```
void LPADC_GetDefaultConvTriggerConfig(lpadc_conv_trigger_config_t *config)
```

Gets an available pre-defined settings for trigger's configuration.

This function initializes the trigger's configuration structure with an available settings. The default values are:

```
config->targetCommandId    = 0U;
config->delayPower          = 0U;
config->priority            = 0U;
config->channelAFIFOSelect  = 0U;
config->channelBFIFOSelect  = 0U;
config->enableHardwareTrigger = false;
```

Parameters

- config – Pointer to configuration structure.

```
static inline void LPADC_DoSoftwareTrigger(ADC_Type *base, uint32_t triggerIdMask)
```

Do software trigger to conversion command.

Parameters

- base – LPADC peripheral base address.
- triggerIdMask – Mask value for software trigger indexes, which count from zero.

```
void LPADC_SetConvCommandConfig(ADC_Type *base, uint32_t commandId, const
                                lpadc_conv_command_config_t *config)
```

Configure conversion command.

Note: The number of compare value register on different chips is different, that is mean in some chips, some command buffers do not have the compare functionality.

Parameters

- base – LPADC peripheral base address.

- `commandId` – ID for command in command buffer. Typically, the available value range is 1 - 15.
- `config` – Pointer to configuration structure. See to `lpadc_conv_command_config_t`.

`void LPADC_GetDefaultConvCommandConfig(lpadc_conv_command_config_t *config)`

Gets an available pre-defined settings for conversion command's configuration.

This function initializes the conversion command's configuration structure with an available settings. The default values are:

```
config->sampleScaleMode      = kLPADC_SampleFullScale;
config->channelBScaleMode    = kLPADC_SampleFullScale;
config->sampleChannelMode    = kLPADC_SampleChannelSingleEndSideA;
config->channelNumber        = 0U;
config->channelBNumber       = 0U;
config->chainedNextCommandNumber = 0U;
config->enableAutoChannelIncrement = false;
config->loopCount            = 0U;
config->hardwareAverageMode   = kLPADC_HardwareAverageCount1;
config->sampleTimeMode       = kLPADC_SampleTimeADCK3;
config->hardwareCompareMode   = kLPADC_HardwareCompareDisabled;
config->hardwareCompareValueHigh = 0U;
config->hardwareCompareValueLow  = 0U;
config->conversionResolutionMode = kLPADC_ConversionResolutionStandard;
config->enableWaitTrigger      = false;
config->enableChannelB        = false;
```

Parameters

- `config` – Pointer to configuration structure.

`void LPADC_EnableCalibration(ADC_Type *base, bool enable)`

Enable the calibration function.

When CALOFS is set, the ADC is configured to perform a calibration function anytime the ADC executes a conversion. Any channel selected is ignored and the value returned in the RESFIFO is a signed value between -31 and 31. -32 is not a valid and is never a returned value. Software should copy the lower 6- bits of the conversion result stored in the RESFIFO after a completed calibration conversion to the OFSTRIM field. The OFSTRIM field is used in normal operation for offset correction.

Parameters

- `base` – LPADC peripheral base address.
- `enable` – switcher to the calibration function.

`static inline void LPADC_SetOffsetValue(ADC_Type *base, uint32_t value)`

Set proper offset value to trim ADC.

To minimize the offset during normal operation, software should read the conversion result from the RESFIFO calibration operation and write the lower 6 bits to the OFSTRIM register.

Parameters

- `base` – LPADC peripheral base address.
- `value` – Setting offset value.

`status_t LPADC_DoAutoCalibration(ADC_Type *base)`

Do auto calibration.

Calibration function should be executed before using converter in application. It used the software trigger and a dummy conversion, get the offset and write them into the OFSTRIM register. It called some of functional

API including: -LPADC_EnableCalibration(...) -LPADC_LPADC_SetOffsetValue(...) -LPADC_SetConvCommandConfig(...) -LPADC_SetConvTriggerConfig(...)

Parameters

- base – LPADC peripheral base address.
- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

static inline void LPADC_SetOffsetValue(ADC_Type *base, int16_t value)

Set trim value for offset.

Note: For 16-bit conversions, each increment is 1/2 LSB resulting in a programmable offset range of -256 LSB to 255.5 LSB; For 12-bit conversions, each increment is 1/32 LSB resulting in a programmable offset range of -16 LSB to 15.96875 LSB.

Parameters

- base – LPADC peripheral base address.
- value – Offset trim value, is a 10-bit signed value between -512 and 511.

static inline void LPADC_GetOffsetValue(ADC_Type *base, int16_t *pValue)

Get trim value of offset.

Parameters

- base – LPADC peripheral base address.
- pValue – Pointer to the variable in type of int16_t to store offset value.

static inline void LPADC_EnableOffsetCalibration(ADC_Type *base, bool enable)

Enable the offset calibration function.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the calibration function.

static inline void LPADC_SetOffsetCalibrationMode(ADC_Type *base,
lpadc_offset_calibration_mode_t mode)

Set offset calibration mode.

Parameters

- base – LPADC peripheral base address.
- mode – set offset calibration mode.see to lpadc_offset_calibration_mode_t.

status_t LPADC_DoOffsetCalibration(ADC_Type *base)

Do offset calibration.

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_PrepAutoCalibration(ADC_Type *base)

Prepare auto calibration, LPADC_FinishAutoCalibration has to be called before using the LPADC. LPADC_DoAutoCalibration has been split in two API to avoid to be stuck too long in the function.

Parameters

- base – LPADC peripheral base address.

status_t LPADC_FinishAutoCalibration(ADC_Type *base)

Finish auto calibration start with LPADC_PrepAutoCalibration.

Note: This feature is used for LPADC with CTRL[CALOFSMODE].

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_GetCalibrationValue(ADC_Type *base, lpadc_calibration_value_t *ptrCalibrationValue)

Get calibration value into the memory which is defined by invoker.

Note: Please note the ADC will be disabled temporary.

Note: This function should be used after finish calibration.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to lpadc_calibration_value_t structure, this memory block should be always powered on even in low power modes.

status_t LPADC_SetCalibrationValue(ADC_Type *base, const lpadc_calibration_value_t *ptrCalibrationValue)

Set calibration value into ADC calibration registers.

Note: Please note the ADC will be disabled temporary.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to lpadc_calibration_value_t structure which contains ADC's calibration value.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

FSL_LPADC_DRIVER_VERSION

LPADC driver version 2.9.3.

struct lpadc_config_t

#include <fsl_lpadc.h> LPADC global configuration.

This structure would used to keep the settings for initialization.

Public Members

bool enableInternalClock

Enables the internally generated clock source. The clock source is used in clock selection logic at the chip level and is optionally used for the ADC clock source.

bool enableVref1LowVoltage

If voltage reference option1 input is below 1.8V, it should be “true”. If voltage reference option1 input is above 1.8V, it should be “false”.

bool enableInDozeMode

Control system transition to Stop and Wait power modes while ADC is converting. When enabled in Doze mode, immediate entries to Wait or Stop are allowed. When disabled, the ADC will wait for the current averaging iteration/FIFO storage to complete before acknowledging stop or wait mode entry.

lpadc_conversion_average_mode_t conversionAverageMode

Auto-Calibration Averages.

bool enableAnalogPreliminary

ADC analog circuits are pre-enabled and ready to execute conversions without startup delays(at the cost of higher DC current consumption).

uint32_t powerUpDelay

When the analog circuits are not pre-enabled, the ADC analog circuits are only powered while the ADC is active and there is a counted delay defined by this field after an initial trigger transitions the ADC from its Idle state to allow time for the analog circuits to stabilize. The startup delay count of (powerUpDelay * 4) ADCK cycles must result in a longer delay than the analog startup time.

lpadc_reference_voltage_source_t referenceVoltageSource

Selects the voltage reference high used for conversions.

lpadc_power_level_mode_t powerLevelMode

Power Configuration Selection.

lpadc_trigger_priority_policy_t triggerPriorityPolicy

Control how higher priority triggers are handled, see to lpadc_trigger_priority_policy_t.

bool enableConvPause

Enables the ADC pausing function. When enabled, a programmable delay is inserted during command execution sequencing between LOOP iterations, between commands in a sequence, and between conversions when command is executing in “Compare Until True” configuration.

uint32_t convPauseDelay

Controls the duration of pausing during command execution sequencing. The pause delay is a count of (convPauseDelay*4) ADCK cycles. Only available when ADC pausing function is enabled. The available value range is in 9-bit.

uint32_t FIFOWatermark

FIFOWatermark is a programmable threshold setting. When the number of datawords stored in the ADC Result FIFO is greater than the value in this field, the ready flag would be asserted to indicate stored data has reached the programmable threshold.

struct lpadc_conv_command_config_t

#include <fsl_lpadc.h> Define structure to keep the configuration for conversion command.

Public Members

lpadc_sample_scale_mode_t sampleScaleMode

Sample scale mode.

lpadc_sample_scale_mode_t channelBScaleMode

Alternate channel B Scale mode.

lpadc_sample_channel_mode_t sampleChannelMode

Channel sample mode.

uint32_t channelNumber

Channel number, select the channel or channel pair.

uint32_t channelBNumber

Alternate Channel B number, select the channel.

uint32_t chainedNextCommandNumber

Selects the next command to be executed after this command completes. 1-15 is available, 0 is to terminate the chain after this command.

bool enableAutoChannelIncrement

Loop with increment: when disabled, the “loopCount” field selects the number of times the selected channel is converted consecutively; when enabled, the “loopCount” field defines how many consecutive channels are converted as part of the command execution.

uint32_t loopCount

Selects how many times this command executes before finish and transition to the next command or Idle state. Command executes LOOP+1 times. 0-15 is available.

lpadc_hardware_average_mode_t hardwareAverageMode

Hardware average selection.

lpadc_sample_time_mode_t sampleTimeMode

Sample time selection.

lpadc_hardware_compare_mode_t hardwareCompareMode

Hardware compare selection.

uint32_t hardwareCompareValueHigh

Compare Value High. The available value range is in 16-bit.

uint32_t hardwareCompareValueLow

Compare Value Low. The available value range is in 16-bit.

lpadc_conversion_resolution_mode_t conversionResolutionMode

Conversion resolution mode.

bool enableWaitTrigger

Wait for trigger assertion before execution: when disabled, this command will be automatically executed; when enabled, the active trigger must be asserted again before executing this command.

struct lpadc_conv_trigger_config_t

#include <fsl_lpadc.h> Define structure to keep the configuration for conversion trigger.

Public Members

uint32_t targetCommandId

Select the command from command buffer to execute upon detect of the associated trigger event.

uint32_t delayPower

Select the trigger delay duration to wait at the start of servicing a trigger event. When this field is clear, then no delay is incurred. When this field is set to a non-zero value, the duration for the delay is $2^{\text{delayPower}}$ ADCK cycles. The available value range is 4-bit.

uint32_t priority

Sets the priority of the associated trigger source. If two or more triggers have the same priority level setting, the lower order trigger event has the higher priority. The lower value for this field is for the higher priority, the available value range is 1-bit.

bool enableHardwareTrigger

Enable hardware trigger source to initiate conversion on the rising edge of the input trigger source or not. The software trigger is always available.

struct lpadc_conv_result_t

#include <fsl_lpadc.h> Define the structure to keep the conversion result.

Public Members

uint32_t commandIdSource

Indicate the command buffer being executed that generated this result.

uint32_t loopCountIndex

Indicate the loop count value during command execution that generated this result.

uint32_t triggerIdSource

Indicate the trigger source that initiated a conversion and generated this result.

uint16_t convValue

Data result.

struct __lpadc_calibration_value

#include <fsl_lpadc.h> A structure of calibration value.

2.33 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

2.34 IOCON: I/O pin configuration

FSL_IOCON_DRIVER_VERSION

IOCON driver version.

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 port, uint8_t pin, uint32_t modefunc)

Sets I/O Control pin mux.

Parameters

- base – : The base of IOCON peripheral on the chip
- port – : GPIO port to mux
- pin – : GPIO pin 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

IOCON_FUNC0

IOCON function and mode selection definitions.

Note: See the User Manual for specific modes and functions supported by the various pins.
Selects pin function 0

IOCON_FUNC1

Selects pin function 1

IOCON_FUNC2

Selects pin function 2

IOCON_FUNC3

Selects pin function 3

IOCON_FUNC4

Selects pin function 4

IOCON_FUNC5

Selects pin function 5

IOCON_FUNC6

Selects pin function 6

IOCON_FUNC7

Selects pin function 7

struct __iocon_group

#include <fsl_iocon.h> Array of IOCON pin definitions passed to IOCON_SetPinMuxing() must be in this format.

2.35 MCAN: Controller Area Network Driver

void MCAN_Init(CAN_Type *base, const *mcan_config_t* *config, uint32_t sourceClock_Hz)

Initializes an MCAN instance.

This function initializes the MCAN module with user-defined settings. This example shows how to set up the *mcan_config_t* parameters and how to call the MCAN_Init function by passing in these parameters.

```
mcan_config_t config;
config->baudRateA = 500000U;
config->baudRateD = 1000000U;
config->enableCanfdNormal = false;
config->enableCanfdSwitch = false;
config->enableLoopBackInt = false;
config->enableLoopBackExt = false;
config->enableBusMon = false;
MCAN_Init(CANFD0, &config, 8000000UL);
```

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the user-defined configuration structure.
- sourceClock_Hz – MCAN Protocol Engine clock source frequency in Hz.

void MCAN_Deinit(CAN_Type *base)

Deinitializes an MCAN instance.

This function deinitializes the MCAN module.

Parameters

- base – MCAN peripheral base address.

void MCAN_GetDefaultConfig(*mcan_config_t* *config)

Gets the default configuration structure.

This function initializes the MCAN configuration structure to default values. The default values are as follows. config->baudRateA = 500000U; config->baudRateD = 1000000U; config->enableCanfdNormal = false; config->enableCanfdSwitch = false; config->enableLoopBackInt = false; config->enableLoopBackExt = false; config->enableBusMon = false;

Parameters

- config – Pointer to the MCAN configuration structure.

static inline void MCAN_EnterInitialMode(CAN_Type *base)

MCAN enters initialization mode.

After enter initialization mode, users can write access to the protected configuration registers.

Parameters

- base – MCAN peripheral base address.

static inline void MCAN_EnterNormalMode(CAN_Type *base)

MCAN enters normal mode.

After initialization, INIT bit in CCCR register must be cleared to enter normal mode thus synchronizes to the CAN bus and ready for communication.

Parameters

- base – MCAN peripheral base address.

static inline void MCAN_SetMsgRAMBase(CAN_Type *base, uint32_t value)

Sets the MCAN Message RAM base address.

This function sets the Message RAM base address.

Parameters

- base – MCAN peripheral base address.
- value – Desired Message RAM base.

static inline uint32_t MCAN_GetMsgRAMBase(CAN_Type *base)

Gets the MCAN Message RAM base address.

This function gets the Message RAM base address.

Parameters

- base – MCAN peripheral base address.

Returns

Message RAM base address.

bool MCAN_CalculateImprovedTimingValues(uint32_t baudRate, uint32_t sourceClock_Hz, *mcan_timing_config_t* *pconfig)

Calculates the improved timing values by specific baudrates for classical CAN.

Parameters

- baudRate – The classical CAN speed in bps defined by user
- sourceClock_Hz – The Source clock data speed in bps. Zero to disable baudrate switching
- pconfig – Pointer to the MCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

bool MCAN_CalculateSpecifiedTimingValues(uint32_t sourceClock_Hz, *mcan_timing_config_t* *pconfig, const *mcan_timing_param_t* *pParamConfig)

Calculates the specified timing values for classical CAN with user-defined settings.

User can specify baudrates, sample point position, bus length, and transceiver propagation delay. This example shows how to set up the *mcan_timing_param_t* parameters and how to call the this function by passing in these parameters.

```

mcan_timing_config_t timing_config;
mcan_timing_param_t timing_param;
timing_param.busLength = 1U;
timing_param.propTxRx = 230U;
timing_param.nominalbaudRate = 500000U;
timing_param.nominalSP = 800U;
MCAN_CalculateSpecifiedTimingValues(MCAN_CLK_FREQ, &timing_config, &timing_param);

```

Note that due to integer division will sacrifice the precision, actual sample point may not equal to expected. If actual sample point is not in allowed 2% range, this function will return false. So it is better to select higher source clock when baudrate is relatively high. This will ensure more time quanta and higher precision of sample point. Parameter busLength and propTxRx are optional and intended to verify whether propagation delay is too long to corrupt sample point. User can set these parameter zero if you do not want to consider this factor.

Parameters

- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.
- config – Pointer to the MCAN timing parameters structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

```
void MCAN_SetArbitrationTimingConfig(CAN_Type *base, const mcan_timing_config_t *config)
```

Sets the MCAN protocol arbitration phase timing characteristic.

This function gives user settings to CAN bus timing characteristic. The function is for an experienced user. For less experienced users, call the MCAN_Init() and fill the baud rate field with a desired value. This provides the default arbitration phase timing characteristics.

Note that calling MCAN_SetArbitrationTimingConfig() overrides the baud rate set in MCAN_Init().

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the timing configuration structure.

```
status_t MCAN_SetBaudRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t
                        baudRate_Bps)
```

Set Baud Rate of MCAN classic mode.

This function set the baud rate of MCAN base on MCAN_CalculateImprovedTimingValues() API calculated timing values.

Parameters

- base – MCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- baudRate_Bps – Baud Rate in Bps.

Returns

kStatus_Success - Set CAN baud rate (only has Nominal phase) successfully.

```
bool MCAN_FDCalculateImprovedTimingValues(uint32_t baudRate, uint32_t baudRateFD,
                                         uint32_t sourceClock_Hz, mcan_timing_config_t
                                         *pconfig)
```

Calculates the improved timing values by specific baudrates for CANFD.

Parameters

- baudRate – The CANFD bus control speed in bps defined by user
- baudRateFD – The CANFD bus data speed in bps defined by user
- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

```
bool MCAN_FDCalculateSpecifiedTimingValues(uint32_t sourceClock_Hz, mcan_timing_config_t
                                           *pconfig, const mcan_timing_param_t
                                           *pParamConfig)
```

Calculates the specified timing values for CANFD with user-defined settings.

User can specify baudrates, sample point position, bus length, and transceiver propagation delay. This example shows how to set up the `mcan_timing_param_t` parameters and how to call the this function by passing in these parameters.

```
mcan_timing_config_t timing_config;
mcan_timing_param_t timing_param;
timing_param.busLength = 1U;
timing_param.propTxRx = 230U;
timing_param.nominalbaudRate = 500000U;
timing_param.nominalSP = 800U;
timing_param.databaudRate = 4000000U;
timing_param.dataSP = 700U;
MCAN_FDCalculateSpecifiedTimingValues(MCAN_CLK_FREQ, &timing_config, &timing_param);
```

Note that due to integer division will sacrifice the precision, actual sample point may not equal to expected. So it is better to select higher source clock when baudrate is relatively high. Select higher nominal baudrate when source clock is relatively high because large clock predivider will lead to less time quanta in data phase. This function will set predivider in arbitration phase equal to data phase. These methods will ensure more time quanta and higher precision of sample point. Parameter `busLength` and `propTxRx` are optional and intended to verify whether propagation delay is too long to corrupt sample point. User can set these parameter zero if you do not want to consider this factor.

Parameters

- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.
- config – Pointer to the MCAN timing parameters structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

```
status_t MCAN_SetBaudRateFD(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t
                           baudRateN_Bps, uint32_t baudRateD_Bps)
```

Set Baud Rate of MCAN FD mode.

This function set the baud rate of MCAN FD base on MCAN_FDCalculateImprovedTimingValues API calculated timing values.

Parameters

- base – MCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- baudRateN_Bps – Nominal Baud Rate in Bps.
- baudRateD_Bps – Data Baud Rate in Bps.

Returns

kStatus_Success - Set CAN FD baud rate (include Nominal and Data phase) successfully.

void MCAN_SetDataTimingConfig(CAN_Type *base, const *mcan_timing_config_t* *config)

Sets the MCAN protocol data phase timing characteristic.

This function gives user settings to CAN bus timing characteristic. The function is for an experienced user. For less experienced users, call the MCAN_Init() and fill the baud rate field with a desired value. This provides the default data phase timing characteristics.

Note that calling MCAN_SetArbitrationTimingConfig() overrides the baud rate set in MCAN_Init().

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the timing configuration structure.

void MCAN_SetRxFifo0Config(CAN_Type *base, const *mcan_rx_fifo_config_t* *config)

Configures an MCAN receive fifo 0 buffer.

This function sets start address, element size, watermark, operation mode and datafield size of the receive fifo 0.

Parameters

- base – MCAN peripheral base address.
- config – The receive fifo 0 configuration structure.

void MCAN_SetRxFifo1Config(CAN_Type *base, const *mcan_rx_fifo_config_t* *config)

Configures an MCAN receive fifo 1 buffer.

This function sets start address, element size, watermark, operation mode and datafield size of the receive fifo 1.

Parameters

- base – MCAN peripheral base address.
- config – The receive fifo 1 configuration structure.

void MCAN_SetRxBufferConfig(CAN_Type *base, const *mcan_rx_buffer_config_t* *config)

Configures an MCAN receive buffer.

This function sets start address and datafield size of the receive buffer.

Parameters

- base – MCAN peripheral base address.
- config – The receive buffer configuration structure.

void MCAN_SetTxEventFifoConfig(CAN_Type *base, const *mcan_tx_fifo_config_t* *config)

Configures an MCAN transmit event fifo.

This function sets start address, element size, watermark of the transmit event fifo.

Parameters

- base – MCAN peripheral base address.
- config – The transmit event fifo configuration structure.

void MCAN_SetTxBufferConfig(CAN_Type *base, const *mcan_tx_buffer_config_t* *config)

Configures an MCAN transmit buffer.

This function sets start address, element size, fifo/queue mode and datafield size of the transmit buffer.

Parameters

- base – MCAN peripheral base address.
- config – The transmit buffer configuration structure.

void MCAN_SetFilterConfig(CAN_Type *base, const *mcan_frame_filter_config_t* *config)

Set filter configuration.

This function sets remote and non masking frames in global filter configuration, also the start address, list size in standard/extended ID filter configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.

status_t MCAN_SetMessageRamConfig(CAN_Type *base, const *mcan_memory_config_t* *config)

Set Message RAM related configuration.

Note: This function include Standard/extended ID filter, Rx FIFO 0/1, Rx buffer, Tx event FIFO and Tx buffer configurations

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.

Return values

- kStatus_Success – - Message RAM related configuration Successfully.
- kStatus_Fail – - Message RAM related configure fail due to wrong address parameter.

void MCAN_SetSTDFilterElement(CAN_Type *base, const *mcan_frame_filter_config_t* *config, const *mcan_std_filter_element_config_t* *filter, uint8_t idx)

Set standard message ID filter element configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.
- filter – The MCAN standard message ID filter element configuration.
- idx – The standard message ID filter element index.

void MCAN_SetEXTFilterElement(CAN_Type *base, const *mcan_frame_filter_config_t* *config, const *mcan_ext_filter_element_config_t* *filter, uint8_t idx)

Set extended message ID filter element configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.
- filter – The MCAN extended message ID filter element configuration.
- idx – The extended message ID filter element index.

```
static inline uint32_t MCAN_GetStatusFlag(CAN_Type *base, uint32_t mask)
```

Gets the MCAN module interrupt flags.

This function gets all MCAN interrupt status flags.

Parameters

- base – MCAN peripheral base address.
- mask – The ORed MCAN interrupt mask.

Returns

MCAN status flags which are ORed.

```
static inline void MCAN_ClearStatusFlag(CAN_Type *base, uint32_t mask)
```

Clears the MCAN module interrupt flags.

This function clears MCAN interrupt status flags.

Parameters

- base – MCAN peripheral base address.
- mask – The ORed MCAN interrupt mask.

```
static inline bool MCAN_GetRxBufferStatusFlag(CAN_Type *base, uint8_t idx)
```

Gets the new data flag of specific Rx Buffer.

This function gets new data flag of specific Rx Buffer.

Parameters

- base – MCAN peripheral base address.
- idx – Rx Buffer index.

Returns

Rx Buffer new data status flag.

```
static inline void MCAN_ClearRxBufferStatusFlag(CAN_Type *base, uint8_t idx)
```

Clears the new data flag of specific Rx Buffer.

This function clears new data flag of specific Rx Buffer.

Parameters

- base – MCAN peripheral base address.
- idx – Rx Buffer index.

```
static inline void MCAN_EnableInterrupts(CAN_Type *base, uint32_t line, uint32_t mask)
```

Enables MCAN interrupts according to the provided interrupt line and mask.

This function enables the MCAN interrupts according to the provided interrupt line and mask. The mask is a logical OR of enumeration members.

Parameters

- base – MCAN peripheral base address.
- line – Interrupt line number, 0 or 1.
- mask – The interrupts to enable.

```
static inline void MCAN_EnableTransmitBufferInterrupts(CAN_Type *base, uint8_t idx)
```

Enables MCAN Tx Buffer interrupts according to the provided index.

This function enables the MCAN Tx Buffer interrupts.

Parameters

- base – MCAN peripheral base address.

- idx – Tx Buffer index.

static inline void MCAN_DisableTransmitBufferInterrupts(CAN_Type *base, uint8_t idx)

Disables MCAN Tx Buffer interrupts according to the provided index.

This function disables the MCAN Tx Buffer interrupts.

Parameters

- base – MCAN peripheral base address.
- idx – Tx Buffer index.

static inline void MCAN_DisableInterrupts(CAN_Type *base, uint32_t mask)

Disables MCAN interrupts according to the provided mask.

This function disables the MCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members.

Parameters

- base – MCAN peripheral base address.
- mask – The interrupts to disable.

uint32_t MCAN_IsTransmitRequestPending(CAN_Type *base, uint8_t idx)

Gets the Tx buffer request pending status.

This function returns Tx Message Buffer transmission request pending status.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.

uint32_t MCAN_IsTransmitOccurred(CAN_Type *base, uint8_t idx)

Gets the Tx buffer transmission occurred status.

This function returns Tx Message Buffer transmission occurred status.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.

status_t MCAN_WriteTxBuffer(CAN_Type *base, uint8_t idx, const *mcan_tx_buffer_frame_t* *pTxFrame)

Writes an MCAN Message to the Transmit Buffer.

This function writes a CAN Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN Message transmit. After that the function returns immediately.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

status_t MCAN_ReadRxBuffer(CAN_Type *base, uint8_t idx, *mcan_rx_buffer_frame_t* *pRxFrame)

Reads an MCAN Message from Rx Buffer.

This function reads a CAN message from the Rx Buffer in the Message RAM.

Parameters

- base – MCAN peripheral base address.

- `idx` – The MCAN Rx Buffer index.
- `pRxFrame` – Pointer to CAN message frame structure for reception.

Return values

`kStatus_Success` – - Read Message from Rx Buffer successfully.

```
status_t MCAN_ReadRxFifo(CAN_Type *base, uint8_t fifoBlock, mcan_rx_buffer_frame_t *pRxFrame)
```

Reads an MCAN Message from Rx FIFO.

This function reads a CAN message from the Rx FIFO in the Message RAM.

Parameters

- `base` – MCAN peripheral base address.
- `fifoBlock` – Rx FIFO block 0 or 1.
- `pRxFrame` – Pointer to CAN message frame structure for reception.

Return values

`kStatus_Success` – - Read Message from Rx FIFO successfully.

```
static inline void MCAN_TransmitAddRequest(CAN_Type *base, uint8_t idx)
```

Tx Buffer add request to send message out.

This function add sending request to corresponding Tx Buffer.

Parameters

- `base` – MCAN peripheral base address.
- `idx` – Tx Buffer index.

```
static inline void MCAN_TransmitCancelRequest(CAN_Type *base, uint8_t idx)
```

Tx Buffer cancel sending request.

This function clears Tx buffer request pending bit.

Parameters

- `base` – MCAN peripheral base address.
- `idx` – Tx Buffer index.

```
status_t MCAN_TransferSendBlocking(CAN_Type *base, uint8_t idx, mcan_tx_buffer_frame_t *pTxFrame)
```

Performs a polling send transaction on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- `base` – MCAN peripheral base pointer.
- `idx` – The MCAN buffer index.
- `pTxFrame` – Pointer to CAN message frame to be sent.

Return values

- `kStatus_Success` – - Write Tx Message Buffer Successfully.
- `kStatus_Fail` – - Tx Message Buffer is currently in use.

```
status_t MCAN_TransferReceiveBlocking(CAN_Type *base, uint8_t idx, mcan_rx_buffer_frame_t *pRxFrame)
```

Performs a polling receive transaction on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- base – MCAN peripheral base pointer.
- idx – The MCAN buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – Read Rx Message Buffer Successfully.
- kStatus_Fail – No new message.

status_t MCAN_TransferReceiveFifoBlocking(CAN_Type *base, uint8_t fifoBlock,
mcan_rx_buffer_frame_t *pRxFrame)

Performs a polling receive transaction from Rx FIFO on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- base – MCAN peripheral base pointer.
- fifoBlock – Rx FIFO block, 0 or 1.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – Read Message from Rx FIFO successfully.
- kStatus_Fail – No new message in Rx FIFO.

void MCAN_TransferCreateHandle(CAN_Type *base, mcan_handle_t *handle,
mcan_transfer_callback_t callback, void *userData)

Initializes the MCAN handle.

This function initializes the MCAN handle, which can be used for other MCAN transactional APIs. Usually, for a specified MCAN instance, call this API once to get the initialized handle.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

status_t MCAN_TransferSendNonBlocking(CAN_Type *base, mcan_handle_t *handle,
mcan_buffer_transfer_t *xfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- xfer – MCAN Buffer transfer structure. See the mcan_buffer_transfer_t.

Return values

- kStatus_Success – Start Tx Buffer sending process successfully.
- kStatus_Fail – Write Tx Buffer failed.
- kStatus_MCAN_TxBusy – Tx Buffer is in use.

```
status_t MCAN_TransferReceiveFifoNonBlocking(CAN_Type *base, uint8_t fifoBlock,  
                                              mcan_handle_t *handle, mcan_fifo_transfer_t  
                                              *xfer)
```

Receives a message from Rx FIFO using IRQ.

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- fifoBlock – Rx FIFO block, 0 or 1.
- xfer – MCAN Rx FIFO transfer structure. See the *mcan_fifo_transfer_t*.

Return values

- *kStatus_Success* – - Start Rx FIFO receiving process successfully.
- *kStatus_MCAN_RxFifo0Busy* – - Rx FIFO 0 is currently in use.
- *kStatus_MCAN_RxFifo1Busy* – - Rx FIFO 1 is currently in use.

```
void MCAN_TransferAbortSend(CAN_Type *base, mcan_handle_t *handle, uint8_t bufferIdx)
```

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- bufferIdx – The MCAN Buffer index.

```
void MCAN_TransferAbortReceiveFifo(CAN_Type *base, uint8_t fifoBlock, mcan_handle_t  
                                   *handle)
```

Aborts the interrupt driven message receive from Rx FIFO process.

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

- base – MCAN peripheral base address.
- fifoBlock – MCAN Fifo block, 0 or 1.
- handle – MCAN handle pointer.

```
void MCAN_TransferHandleIRQ(CAN_Type *base, mcan_handle_t *handle)
```

MCAN IRQ handle function.

This function handles the MCAN Error, the Buffer, and the Rx FIFO IRQ request.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.

```
FSL_MCAN_DRIVER_VERSION
```

MCAN driver version.

MCAN transfer status.

Values:

enumerator kStatus_MCAN_TxBusy

Tx Buffer is Busy.

enumerator kStatus_MCAN_TxIdle

Tx Buffer is Idle.

enumerator kStatus_MCAN_RxBusy

Rx Buffer is Busy.

enumerator kStatus_MCAN_RxIdle

Rx Buffer is Idle.

enumerator kStatus_MCAN_RxFifo0New

New message written to Rx FIFO 0.

enumerator kStatus_MCAN_RxFifo0Idle

Rx FIFO 0 is Idle.

enumerator kStatus_MCAN_RxFifo0Watermark

Rx FIFO 0 fill level reached watermark.

enumerator kStatus_MCAN_RxFifo0Full

Rx FIFO 0 full.

enumerator kStatus_MCAN_RxFifo0Lost

Rx FIFO 0 message lost.

enumerator kStatus_MCAN_RxFifo1New

New message written to Rx FIFO 1.

enumerator kStatus_MCAN_RxFifo1Idle

Rx FIFO 1 is Idle.

enumerator kStatus_MCAN_RxFifo1Watermark

Rx FIFO 1 fill level reached watermark.

enumerator kStatus_MCAN_RxFifo1Full

Rx FIFO 1 full.

enumerator kStatus_MCAN_RxFifo1Lost

Rx FIFO 1 message lost.

enumerator kStatus_MCAN_RxFifo0Busy

Rx FIFO 0 is busy.

enumerator kStatus_MCAN_RxFifo1Busy

Rx FIFO 1 is busy.

enumerator kStatus_MCAN_ErrorStatus

MCAN Module Error and Status.

enumerator kStatus_MCAN_UnHandled

UnHandled Interrupt asserted.

enum _mcan_flags

MCAN status flags.

This provides constants for the MCAN status flags for use in the MCAN functions. Note: The CPU read action clears MCAN_ErrorFlag, therefore user need to read MCAN_ErrorFlag and distinguish which error is occur using _mcan_error_flags enumerations.

Values:

enumerator kMCAN_AccesstoRsvdFlag
CAN Synchronization Status.

enumerator kMCAN_ProtocolErrDIntFlag
Tx Warning Interrupt Flag.

enumerator kMCAN_ProtocolErrAIntFlag
Rx Warning Interrupt Flag.

enumerator kMCAN_BusOffIntFlag
Tx Error Warning Status.

enumerator kMCAN_ErrorWarningIntFlag
Rx Error Warning Status.

enumerator kMCAN_ErrorPassiveIntFlag
Rx Error Warning Status.

enum _mcan_rx_fifo_flags

MCAN Rx FIFO status flags.

The MCAN Rx FIFO Status enumerations are used to determine the status of the Rx FIFO.

Values:

enumerator kMCAN_RxFifo0NewFlag
Rx FIFO 0 new message flag.

enumerator kMCAN_RxFifo0WatermarkFlag
Rx FIFO 0 watermark reached flag.

enumerator kMCAN_RxFifo0FullFlag
Rx FIFO 0 full flag.

enumerator kMCAN_RxFifo0LostFlag
Rx FIFO 0 message lost flag.

enumerator kMCAN_RxFifo1NewFlag
Rx FIFO 0 new message flag.

enumerator kMCAN_RxFifo1WatermarkFlag
Rx FIFO 0 watermark reached flag.

enumerator kMCAN_RxFifo1FullFlag
Rx FIFO 0 full flag.

enumerator kMCAN_RxFifo1LostFlag
Rx FIFO 0 message lost flag.

enum _mcan_tx_flags

MCAN Tx status flags.

The MCAN Tx Status enumerations are used to determine the status of the Tx Buffer/Event FIFO.

Values:

enumerator kMCAN_TxTransmitCompleteFlag
Transmission completed flag.

enumerator kMCAN_TxTransmitCancelFinishFlag
Transmission cancellation finished flag.

enumerator kMCAN_TxEventFifoLostFlag

Tx Event FIFO element lost.

enumerator kMCAN_TxEventFifoFullFlag

Tx Event FIFO full.

enumerator kMCAN_TxEventFifoWatermarkFlag

Tx Event FIFO fill level reached watermark.

enumerator kMCAN_TxEventFifoNewFlag

Tx Handler wrote Tx Event FIFO element flag.

enumerator kMCAN_TxEventFifoEmptyFlag

Tx FIFO empty flag.

enum _mcan_interrupt_enable

MCAN interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the MCAN Module interrupt configurations.

Values:

enumerator kMCAN_BusOffInterruptEnable

Bus Off interrupt.

enumerator kMCAN_ErrorInterruptEnable

Error interrupt.

enumerator kMCAN_WarningInterruptEnable

Rx Warning interrupt.

enum _mcan_frame_idformat

MCAN frame format.

Values:

enumerator kMCAN_FrameIDStandard

Standard frame format attribute.

enumerator kMCAN_FrameIDExtend

Extend frame format attribute.

enum _mcan_frame_type

MCAN frame type.

Values:

enumerator kMCAN_FrameTypeData

Data frame type attribute.

enumerator kMCAN_FrameTypeRemote

Remote frame type attribute.

enum _mcan_bytes_in_datafield

MCAN frame datafield size.

Values:

enumerator kMCAN_8ByteDatafield

8 byte data field.

enumerator kMCAN_12ByteDatafield

12 byte data field.

enumerator kMCAN_16ByteDatafield
16 byte data field.

enumerator kMCAN_20ByteDatafield
20 byte data field.

enumerator kMCAN_24ByteDatafield
24 byte data field.

enumerator kMCAN_32ByteDatafield
32 byte data field.

enumerator kMCAN_48ByteDatafield
48 byte data field.

enumerator kMCAN_64ByteDatafield
64 byte data field.

enum _mcan_fifo_type
MCAN Rx FIFO block number.

Values:

enumerator kMCAN_Fifo0
CAN Rx FIFO 0.

enumerator kMCAN_Fifo1
CAN Rx FIFO 1.

enum _mcan_fifo_opmode_config
MCAN FIFO Operation Mode.

Values:

enumerator kMCAN_FifoBlocking
FIFO blocking mode.

enumerator kMCAN_FifoOverwrite
FIFO overwrite mode.

enum _mcan_txmode_config
MCAN Tx FIFO/Queue Mode.

Values:

enumerator kMCAN_txFifo
Tx FIFO operation.

enumerator kMCAN_txQueue
Tx Queue operation.

enum _mcan_remote_frame_config
MCAN remote frames treatment.

Values:

enumerator kMCAN_filterFrame
Filter remote frames.

enumerator kMCAN_rejectFrame
Reject all remote frames.

enum `_mcan_nonmasking_frame_config`

MCAN non-masking frames treatment.

Values:

enumerator `kMCAN_acceptinFifo0`

Accept non-masking frames in Rx FIFO 0.

enumerator `kMCAN_acceptinFifo1`

Accept non-masking frames in Rx FIFO 1.

enumerator `kMCAN_reject0`

Reject non-masking frames.

enumerator `kMCAN_reject1`

Reject non-masking frames.

enum `_mcan_fec_config`

MCAN Filter Element Configuration.

Values:

enumerator `kMCAN_disable`

Disable filter element.

enumerator `kMCAN_storeinFifo0`

Store in Rx FIFO 0 if filter matches.

enumerator `kMCAN_storeinFifo1`

Store in Rx FIFO 1 if filter matches.

enumerator `kMCAN_reject`

Reject ID if filter matches.

enumerator `kMCAN_setprio`

Set priority if filter matches.

enumerator `kMCAN_setpriofifo0`

Set priority and store in FIFO 0 if filter matches.

enumerator `kMCAN_setpriofifo1`

Set priority and store in FIFO 1 if filter matches.

enumerator `kMCAN_storeinbuffer`

Store into Rx Buffer or as debug message.

enum `_mcan_std_filter_type`

MCAN Filter Type.

Values:

enumerator `kMCAN_range`

Range filter from SFID1 to SFID2.

enumerator `kMCAN_dual`

Dual ID filter for SFID1 or SFID2.

enumerator `kMCAN_classic`

Classic filter: SFID1 = filter; SFID2 = mask.

enumerator `kMCAN_disableORrange2`

Filter element disabled for standard filter or Range filter; XIDAM mask not applied for extended filter.

`typedef enum _mcan_frame_idformat mcan_frame_idformat_t`
MCAN frame format.

`typedef enum _mcan_frame_type mcan_frame_type_t`
MCAN frame type.

`typedef enum _mcan_bytes_in_datafield mcan_bytes_in_datafield_t`
MCAN frame datafield size.

`typedef struct _mcan_tx_buffer_frame mcan_tx_buffer_frame_t`
MCAN Tx Buffer structure.

`typedef struct _mcan_rx_buffer_frame mcan_rx_buffer_frame_t`
MCAN Rx FIFO/Buffer structure.

`typedef enum _mcan_fifo_type mcan_fifo_type_t`
MCAN Rx FIFO block number.

`typedef enum _mcan_fifo_opmode_config mcan_fifo_opmode_config_t`
MCAN FIFO Operation Mode.

`typedef enum _mcan_txmode_config mcan_txmode_config_t`
MCAN Tx FIFO/Queue Mode.

`typedef enum _mcan_remote_frame_config mcan_remote_frame_config_t`
MCAN remote frames treatment.

`typedef enum _mcan_nonmasking_frame_config mcan_nonmasking_frame_config_t`
MCAN non-masking frames treatment.

`typedef enum _mcan_fec_config mcan_fec_config_t`
MCAN Filter Element Configuration.

`typedef struct _mcan_rx_fifo_config mcan_rx_fifo_config_t`
MCAN Rx FIFO configuration.

`typedef struct _mcan_rx_buffer_config mcan_rx_buffer_config_t`
MCAN Rx Buffer configuration.

`typedef struct _mcan_tx_fifo_config mcan_tx_fifo_config_t`
MCAN Tx Event FIFO configuration.

`typedef struct _mcan_tx_buffer_config mcan_tx_buffer_config_t`
MCAN Tx Buffer configuration.

`typedef enum _mcan_std_filter_type mcan_filter_type_t`
MCAN Filter Type.

`typedef struct _mcan_std_filter_element_config mcan_std_filter_element_config_t`
MCAN Standard Message ID Filter Element.

`typedef struct _mcan_ext_filter_element_config mcan_ext_filter_element_config_t`
MCAN Extended Message ID Filter Element.

`typedef struct _mcan_frame_filter_config mcan_frame_filter_config_t`
MCAN Rx filter configuration.

`typedef struct _mcan_timing_config mcan_timing_config_t`
MCAN protocol timing characteristic configuration structure.

`typedef struct _mcan_timing_param mcan_timing_param_t`
MCAN bit timing parameter configuration structure.

```
typedef struct _mcan_memory_config mcan_memory_config_t
```

MCAN Message RAM related configuration structure.

```
typedef struct _mcan_config mcan_config_t
```

MCAN module configuration structure.

```
typedef struct _mcan_buffer_transfer mcan_buffer_transfer_t
```

MCAN Buffer transfer.

```
typedef struct _mcan_fifo_transfer mcan_fifo_transfer_t
```

MCAN Rx FIFO transfer.

```
typedef struct _mcan_handle mcan_handle_t
```

MCAN handle structure definition.

```
typedef void (*mcan_transfer_callback_t)(CAN_Type *base, mcan_handle_t *handle, status_t  
status, uint32_t result, void *userData)
```

MCAN transfer callback function.

The MCAN transfer callback returns a value from the underlying layer. If the status equals to `kStatus_MCAN_ErrorStatus`, the result parameter is the Content of MCAN status register which can be used to get the working status(or error status) of MCAN module. If the status equals to other MCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other MCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

MCAN_RETRY_TIMES

```
struct _mcan_tx_buffer_frame
```

#include <fsl_mcan.h> MCAN Tx Buffer structure.

Public Members

uint8_t size

classical CAN is 8(bytes), FD is 12/64 such.

```
struct _mcan_rx_buffer_frame
```

#include <fsl_mcan.h> MCAN Rx FIFO/Buffer structure.

Public Members

uint8_t size

classical CAN is 8(bytes), FD is 12/64 such.

```
struct _mcan_rx_fifo_config
```

#include <fsl_mcan.h> MCAN Rx FIFO configuration.

Public Members

uint32_t address

FIFO start address.

uint32_t elementSize

FIFO element number.

uint32_t watermark

FIFO watermark level.

mcan_fifo_opmode_config_t opmode
FIFO blocking/overwrite mode.

mcan_bytes_in_datafield_t datafieldSize
Data field size per frame, size>8 is for CANFD.

struct *_mcan_rx_buffer_config*
#include <fsl_mcan.h> MCAN Rx Buffer configuration.

Public Members

uint32_t address
Rx Buffer start address.

mcan_bytes_in_datafield_t datafieldSize
Data field size per frame, size>8 is for CANFD.

struct *_mcan_tx_fifo_config*
#include <fsl_mcan.h> MCAN Tx Event FIFO configuration.

Public Members

uint32_t address
Event fifo start address.

uint32_t elementSize
FIFO element number.

uint32_t watermark
FIFO watermark level.

struct *_mcan_tx_buffer_config*
#include <fsl_mcan.h> MCAN Tx Buffer configuration.

Public Members

uint32_t address
Tx Buffers Start Address.

uint32_t dedicatedSize
Number of Dedicated Transmit Buffers.

uint32_t fqSize
Transmit FIFO/Queue Size.

mcan_txmode_config_t mode
Tx FIFO/Queue Mode.

mcan_bytes_in_datafield_t datafieldSize
Data field size per frame, size>8 is for CANFD.

struct *_mcan_std_filter_element_config*
#include <fsl_mcan.h> MCAN Standard Message ID Filter Element.

Public Members

uint32_t sfid2

Standard Filter ID 2.

uint32_t ____pad0____

Reserved.

uint32_t sfid1

Standard Filter ID 1.

uint32_t sfec

Standard Filter Element Configuration.

uint32_t sft

Standard Filter Type.

struct __mcan_ext_filter_element_config

#include <fsl_mcan.h> MCAN Extended Message ID Filter Element.

Public Members

uint32_t efid1

Extended Filter ID 1.

uint32_t efec

Extended Filter Element Configuration.

uint32_t efid2

Extended Filter ID 2.

uint32_t ____pad0____

Reserved.

uint32_t eft

Extended Filter Type.

struct __mcan_frame_filter_config

#include <fsl_mcan.h> MCAN Rx filter configuration.

Public Members

uint32_t address

Filter start address.

uint32_t listSize

Filter list size.

mcan_frame_idformat_t idFormat

Frame format.

mcan_remote_frame_config_t remFrame

Remote frame treatment.

mcan_nonmasking_frame_config_t nmFrame

Non-masking frame treatment.

struct __mcan_timing_config

#include <fsl_mcan.h> MCAN protocol timing characteristic configuration structure.

Public Members

uint16_t preDivider
Nominal Clock Pre-scaler Division Factor.

uint8_t rJumpwidth
Nominal Re-sync Jump Width.

uint8_t seg1
Nominal Time Segment 1.

uint8_t seg2
Nominal Time Segment 2.

uint16_t datapreDivider
Data Clock Pre-scaler Division Factor.

uint8_t datarJumpwidth
Data Re-sync Jump Width.

uint8_t dataseg1
Data Time Segment 1.

uint8_t dataseg2
Data Time Segment 2.

struct _mcan_timing_param
#include <fsl_mcan.h> MCAN bit timing parameter configuration structure.

Public Members

uint32_t busLength
Maximum Bus length in meter.

uint32_t propTxRx
Transceiver propagation delay in nanosecond.

uint32_t nominalbaudRate
Baud rate of Arbitration phase in bps.

uint32_t nominalSP
Sample point of Arbitration phase, range in 10 ~ 990, 800 means 80%.

uint32_t databaudRate
Baud rate of Data phase in bps.

uint32_t dataSP
Sample point of Data phase, range in 0 ~ 1000, 800 means 80%.

struct _mcan_memory_config
#include <fsl_mcan.h> MCAN Message RAM related configuration structure.

Public Members

uint32_t baseAddr
Message RAM base address, should be 4k alignment.

struct _mcan_config
#include <fsl_mcan.h> MCAN module configuration structure.

Public Members

uint32_t baudRateA

Baud rate of Arbitration phase in bps.

uint32_t baudRateD

Baud rate of Data phase in bps.

bool enableCanfdNormal

Enable or Disable CANFD normal.

bool enableCanfdSwitch

Enable or Disable CANFD with baudrate switch.

bool enableLoopBackInt

Enable or Disable Internal Back.

bool enableLoopBackExt

Enable or Disable External Loop Back.

bool enableBusMon

Enable or Disable Bus Monitoring Mode.

mcan_timing_config_t timingConfig

Protocol timing .

struct *_mcan_buffer_transfer*

#include <fsl_mcan.h> MCAN Buffer transfer.

Public Members

mcan_tx_buffer_frame_t *frame

The buffer of CAN Message to be transfer.

uint8_t bufferIdx

The index of Message buffer used to transfer Message.

struct *_mcan_fifo_transfer*

#include <fsl_mcan.h> MCAN Rx FIFO transfer.

Public Members

mcan_rx_buffer_frame_t *frame

The buffer of CAN Message to be received from Rx FIFO.

struct *_mcan_handle*

#include <fsl_mcan.h> MCAN handle structure.

Public Members

mcan_transfer_callback_t callback

Callback function.

void *userData

MCAN callback function parameter.

mcan_tx_buffer_frame_t *volatile bufferFrameBuf[64]

The buffer for received data from Buffers.

mcan_rx_buffer_frame_t *volatile rxFifoFrameBuf
The buffer for received data from Rx FIFO.

volatile uint8_t bufferState[64]
Message Buffer transfer state.

volatile uint8_t rxFifoState
Rx FIFO transfer state.

struct __unnamed18__

Public Members

uint32_t id
CAN Frame Identifier.

uint32_t rtr
CAN Frame Type(DATA or REMOTE).

uint32_t xtd
CAN Frame Type(STD or EXT).

uint32_t esi
CAN Frame Error State Indicator.

struct __unnamed20__

Public Members

uint32_t dlc
Data Length Code 9 10 11 12 13 14 15 Number of data bytes 12 16 20 24 32 48 64

uint32_t brs
Bit Rate Switch.

uint32_t fdf
CAN FD format.

uint32_t __pad1__
Reserved.

uint32_t efc
Event FIFO control.

uint32_t mm
Message Marker.

struct __unnamed22__

Public Members

uint32_t id
CAN Frame Identifier.

uint32_t rtr
CAN Frame Type(DATA or REMOTE).

uint32_t xtd
CAN Frame Type(STD or EXT).

```
uint32_t esi
    CAN Frame Error State Indicator.
struct __unnamed24__
```

Public Members

```
uint32_t rxts
    Rx Timestamp.
uint32_t dlc
    Data Length Code 9 10 11 12 13 14 15 Number of data bytes 12 16 20 24 32 48 64
uint32_t brs
    Bit Rate Switch.
uint32_t fdf
    CAN FD format.
uint32_t __pad0__
    Reserved.
uint32_t fidx
    Filter Index.
uint32_t anmf
    Accepted Non-matching Frame.
```

2.36 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

```
static inline void MRT_ReleaseChannel(MRT_Type *base, mrt_chnl_t channel)
```

Release the channel when the timer is using the multi-task mode.

In multi-task mode, the INUSE flags allow more control over when MRT channels are released for further use. The user can hold on to a channel acquired by calling MRT_GetIdleChannel() for as long as it is needed and release it by calling this function. This removes the need to ask for an available channel for every use.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.

```
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

2.37 OSTIMER: OS Event Timer Driver

void `OSTIMER_Init(OSTIMER_Type *base)`

Initializes an OSTIMER by turning its bus clock on.

`void OSTIMER_Deinit(OSTIMER_Type *base)`

Deinitializes a OSTIMER instance.

This function shuts down OSTIMER bus clock

Parameters

- `base` – OSTIMER peripheral base address.

`uint64_t OSTIMER_GrayToDecimal(uint64_t gray)`

Translate the value from gray-code to decimal.

Parameters

- `gray` – The gray value input.

Returns

The decimal value.

`static inline uint64_t OSTIMER_DecimalToGray(uint64_t dec)`

Translate the value from decimal to gray-code.

Parameters

- `dec` – The decimal value.

Returns

The gray code of the input value.

`uint32_t OSTIMER_GetStatusFlags(OSTIMER_Type *base)`

Get OSTIMER status Flags.

This returns the status flag. Currently, only match interrupt flag can be got.

Parameters

- `base` – OSTIMER peripheral base address.

Returns

status register value

`void OSTIMER_ClearStatusFlags(OSTIMER_Type *base, uint32_t mask)`

Clear Status Interrupt Flags.

This clears intrrupt status flag. Currently, only match interrupt flag can be cleared.

Parameters

- `base` – OSTIMER peripheral base address.
- `mask` – Clear bit mask.

Returns

none

`status_t OSTIMER_SetMatchRawValue(OSTIMER_Type *base, uint64_t count, ostimer_callback_t cb)`

Set the match raw value for OSTIMER.

This function will set a match value for OSTIMER with an optional callback. And this callback will be called while the data in dedicated pair match register is equals to the value of central EVTIMER. Please note that, the data format may be gray-code, if so, please using `OSTIMER_SetMatchValue()`.

Parameters

- `base` – OSTIMER peripheral base address.
- `count` – OSTIMER timer match value.(Value may be gray-code format)

- `cb` – OSTIMER callback (can be left as NULL if none, otherwise should be a `void func(void)`).

Return values

- `kStatus__Success` – - Set match raw value and enable interrupt Successfully.
- `kStatus__Fail` – - Set match raw value fail.

`status_t OSTIMER_SetMatchValue(OSTIMER_Type *base, uint64_t count, ostimer_callback_t cb)`
Set the match value for OSTIMER.

This function will set a match value for OSTIMER with an optional callback. And this callback will be called while the data in dedicated pair match register is equals to the value of central OS TIMER.

Parameters

- `base` – OSTIMER peripheral base address.
- `count` – OSTIMER timer match value.(Value is decimal format, and this value will be translate to Gray code in API if the IP counter is gray encoded.)
- `cb` – OSTIMER callback (can be left as NULL if none, otherwise should be a `void func(void)`).

Return values

- `kStatus__Success` – - Set match value and enable interrupt Successfully.
- `kStatus__Fail` – - Set match value fail.

`static inline void OSTIMER_SetMatchRegister(OSTIMER_Type *base, uint64_t value)`
Set value to OSTIMER MATCH register directly.

This function writes the input value to OSTIMER MATCH register directly, it does not touch any other registers. Note that, the data format is gray-code. The function `OSTIMER_DecimalToGray` could convert decimal value to gray code.

Parameters

- `base` – OSTIMER peripheral base address.
- `value` – OSTIMER timer match value (Value is gray-code format).

`static inline uint64_t OSTIMER_GetMatchRegister(OSTIMER_Type *base)`
Get the match value from OSTIMER.

This function will get the match value from OSTIMER. The value of timer match is gray code format.

Parameters

- `base` – OSTIMER peripheral base address.

Returns

Value of match register, data format is gray code.

`static inline uint64_t OSTIMER_GetMatchValue(OSTIMER_Type *base)`
Get the match value from OSTIMER.

This function will get a match value from OSTIMER.

Parameters

- `base` – OSTIMER peripheral base address.

Returns

Value of match register.

static inline void OSTIMER_EnableMatchInterrupt(OSTIMER_Type *base)

Enable the OSTIMER counter match interrupt.

Enable the timer counter match interrupt. The interrupt happens when OSTIMER counter matches the value in MATCH registers.

Parameters

- base – OSTIMER peripheral base address.

static inline void OSTIMER_DisableMatchInterrupt(OSTIMER_Type *base)

Disable the OSTIMER counter match interrupt.

Disable the timer counter match interrupt. The interrupt happens when OSTIMER counter matches the value in MATCH registers.

Parameters

- base – OSTIMER peripheral base address.

static inline uint64_t OSTIMER_GetCurrentTimerRawValue(OSTIMER_Type *base)

Get current timer raw count value from OSTIMER.

This function will get the timer count value from OS timer register. The raw value of timer count may be gray code format.

Parameters

- base – OSTIMER peripheral base address.

Returns

Raw value of OSTIMER, may be gray code format.

uint64_t OSTIMER_GetCurrentTimerValue(OSTIMER_Type *base)

Get current timer count value from OSTIMER.

This function will get a decimal timer count value. If the RAW value of timer count is gray code format, it will be translated to decimal data internally.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of OSTIMER which will be formatted to decimal value.

static inline uint64_t OSTIMER_GetCaptureRawValue(OSTIMER_Type *base)

Get the capture value from OSTIMER.

This function will get a captured value from OSTIMER. The Raw value of timer capture may be gray code format.

Parameters

- base – OSTIMER peripheral base address.

Returns

Raw value of capture register, data format may be gray code.

uint64_t OSTIMER_GetCaptureValue(OSTIMER_Type *base)

Get the capture value from OSTIMER.

This function will get a capture decimal-value from OSTIMER. If the RAW value of timer count is gray code format, it will be translated to decimal data internally.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of capture register, data format is decimal.

void OSTIMER_HandleIRQ(OSTIMER_Type *base, *ostimer_callback_t* cb)

OS timer interrupt Service Handler.

This function handles the interrupt and refers to the callback array in the driver to callback user (as per request in OSTIMER_SetMatchValue()). if no user callback is scheduled, the interrupt will simply be cleared.

Parameters

- base – OS timer peripheral base address.
- cb – callback scheduled for this instance of OS timer

Returns

none

FSL_OSTIMER_DRIVER_VERSION

OSTIMER driver version.

enum *_ostimer_flags*

OSTIMER status flags.

Values:

enumerator kOSTIMER_MatchInterruptFlag

Match interrupt flag bit, sets if the match value was reached.

typedef void (**ostimer_callback_t*)(void)

ostimer callback function.

2.38 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

enumerator `kPINT_SecPinInt0`

Secure 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

enumerator `kPINT_SecPatternMatchBSlice0`

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, pin_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, pin_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, pin_t bslice, pin_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>

2.39 PLU: Programmable Logic Unit

void PLU_Init(PLU_Type *base)

Enable the PLU clock and reset the module.

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

Parameters

- base – PLU peripheral base address

void PLU_Deinit(PLU_Type *base)

Gate the PLU clock.

Parameters

- base – PLU peripheral base address

static inline void PLU_SetLutInputSource(PLU_Type *base, *plu_lut_index_t* lutIndex, *plu_lut_in_index_t* lutInIndex, *plu_lut_input_source_t* inputSrc)

Set Input source of LUT.

Note: An external clock must be applied to the PLU_CLKIN input when using FFs. For each LUT, the slot associated with the output from LUTn itself is tied low.

Parameters

- base – PLU peripheral base address.
- lutIndex – LUT index (see *plu_lut_index_t* typedef enumeration).
- lutInIndex – LUT input index (see *plu_lut_in_index_t* typedef enumeration).
- inputSrc – LUT input source (see *plu_lut_input_source_t* typedef enumeration).

static inline void PLU_SetOutputSource(PLU_Type *base, *plu_output_index_t* outputIndex, *plu_output_source_t* outputSrc)

Set Output source of PLU.

Note: An external clock must be applied to the PLU_CLKIN input when using FFs.

Parameters

- base – PLU peripheral base address.
- outputIndex – PLU output index (see *plu_output_index_t* typedef enumeration).
- outputSrc – PLU output source (see *plu_output_source_t* typedef enumeration).

static inline void PLU_SetLutTruthTable(PLU_Type *base, *plu_lut_index_t* lutIndex, uint32_t truthTable)

Set Truth Table of LUT.

Parameters

- base – PLU peripheral base address.
- lutIndex – LUT index (see *plu_lut_index_t* typedef enumeration).
- truthTable – Truth Table value.

static inline uint32_t PLU_ReadOutputState(PLU_Type *base)

Read the current state of the 8 designated PLU Outputs.

Note: The PLU bus clock must be re-enabled prior to reading the Output Register if PLU bus clock is shut-off.

Parameters

- base – PLU peripheral base address.

Returns

Current PLU output state value.

void PLU_GetDefaultWakeIntConfig(*plu_wakeint_config_t* *config)

Gets an available pre-defined settings for wakeup/interrupt control.

This function initializes the initial configuration structure with an available settings. The default values are:

```
config->filterMode = kPLU_WAKEINT_FILTER_MODE_BYPASS;  
config->clockSource = kPLU_WAKEINT_FILTER_CLK_SRC_1MHZ_LPOSC;
```

Parameters

- config – Pointer to configuration structure.

void PLU_EnableWakeIntRequest(PLU_Type *base, uint32_t interruptMask, const *plu_wakeint_config_t* *config)

Enable PLU outputs wakeup/interrupt request.

This function enables Any of the eight selected PLU outputs to contribute to an asynchronous wake-up or an interrupt request.

Note: If a PLU_CLKIN is provided, the raw wake-up/interrupt request will be set on the rising-edge of the PLU_CLKIN whenever the raw request signal is high. This registered signal will be glitch-free and just use the default wakeint config by PLU_GetDefaultWakeIntConfig(). If not, have to specify the filter mode and clock source to eliminate the glitches caused by long and widely disparate delays through the network of LUTs making up the PLU. This way may increase power consumption in low-power operating modes and inject delay before the wake-up/interrupt request is generated.

Parameters

- base – PLU peripheral base address.
- interruptMask – PLU interrupt mask (see `_plu_interrupt_mask` enumeration).
- config – Pointer to configuration structure (see `plu_wakeint_config_t` typedef enumeration)

static inline void PLU_LatchInterrupt(PLU_Type *base)

Latch an interrupt.

This function latches the interrupt and then it can be cleared with PLU_ClearLatchedInterrupt().

Note: This mode is not compatible with use of the glitch filter. If this bit is set, the FILTER MODE should be set to `kPLU_WAKEINT_FILTER_MODE_BYPASS` (Bypass Mode) and PLU_CLKIN should be provided. If this bit is set, the wake-up/interrupt request will be set on the rising-edge of PLU_CLKIN whenever the raw wake-up/interrupt signal is high. The request must be cleared by software.

Parameters

- base – PLU peripheral base address.

`void PLU_ClearLatchedInterrupt(PLU_Type *base)`

Clear the latched interrupt.

This function clears the wake-up/interrupt request flag latched by `PLU_LatchInterrupt()`

Note: It is not necessary for the PLU bus clock to be enabled in order to write-to or read-back this bit.

Parameters

- `base` – PLU peripheral base address.

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`enum __plu_lut_index`

Index of LUT.

Values:

enumerator `kPLU_LUT_0`

5-input Look-up Table 0

enumerator `kPLU_LUT_1`

5-input Look-up Table 1

enumerator `kPLU_LUT_2`

5-input Look-up Table 2

enumerator `kPLU_LUT_3`

5-input Look-up Table 3

enumerator `kPLU_LUT_4`

5-input Look-up Table 4

enumerator `kPLU_LUT_5`

5-input Look-up Table 5

enumerator `kPLU_LUT_6`

5-input Look-up Table 6

enumerator `kPLU_LUT_7`

5-input Look-up Table 7

enumerator `kPLU_LUT_8`

5-input Look-up Table 8

enumerator `kPLU_LUT_9`

5-input Look-up Table 9

enumerator `kPLU_LUT_10`

5-input Look-up Table 10

enumerator `kPLU_LUT_11`

5-input Look-up Table 11

enumerator `kPLU_LUT_12`

5-input Look-up Table 12

enumerator `kPLU_LUT_13`

5-input Look-up Table 13

enumerator `kPLU_LUT_14`

5-input Look-up Table 14

enumerator kPLU_LUT_15
5-input Look-up Table 15

enumerator kPLU_LUT_16
5-input Look-up Table 16

enumerator kPLU_LUT_17
5-input Look-up Table 17

enumerator kPLU_LUT_18
5-input Look-up Table 18

enumerator kPLU_LUT_19
5-input Look-up Table 19

enumerator kPLU_LUT_20
5-input Look-up Table 20

enumerator kPLU_LUT_21
5-input Look-up Table 21

enumerator kPLU_LUT_22
5-input Look-up Table 22

enumerator kPLU_LUT_23
5-input Look-up Table 23

enumerator kPLU_LUT_24
5-input Look-up Table 24

enumerator kPLU_LUT_25
5-input Look-up Table 25

enum _plu_lut_in_index

Inputs of LUT. 5 input present for each LUT.

Values:

enumerator kPLU_LUT_IN_0
LUT input 0

enumerator kPLU_LUT_IN_1
LUT input 1

enumerator kPLU_LUT_IN_2
LUT input 2

enumerator kPLU_LUT_IN_3
LUT input 3

enumerator kPLU_LUT_IN_4
LUT input 4

enum _plu_lut_input_source

Available sources of LUT input.

Values:

enumerator kPLU_LUT_IN_SRC_PLU_IN_0
Select PLU input 0 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_PLU_IN_1
Select PLU input 1 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_PLU_IN_2

Select PLU input 2 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_PLU_IN_3

Select PLU input 3 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_PLU_IN_4

Select PLU input 4 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_PLU_IN_5

Select PLU input 5 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_0

Select LUT output 0 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_1

Select LUT output 1 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_2

Select LUT output 2 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_3

Select LUT output 3 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_4

Select LUT output 4 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_5

Select LUT output 5 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_6

Select LUT output 6 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_7

Select LUT output 7 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_8

Select LUT output 8 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_9

Select LUT output 9 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_10

Select LUT output 10 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_11

Select LUT output 11 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_12

Select LUT output 12 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_13

Select LUT output 13 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_14

Select LUT output 14 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_15

Select LUT output 15 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_16

Select LUT output 16 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_17
Select LUT output 17 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_18
Select LUT output 18 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_19
Select LUT output 19 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_20
Select LUT output 20 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_21
Select LUT output 21 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_22
Select LUT output 22 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_23
Select LUT output 23 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_24
Select LUT output 24 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_LUT_OUT_25
Select LUT output 25 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_FLIPFLOP_0
Select Flip-Flops state 0 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_FLIPFLOP_1
Select Flip-Flops state 1 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_FLIPFLOP_2
Select Flip-Flops state 2 to be connected to LUTn Input x

enumerator kPLU_LUT_IN_SRC_FLIPFLOP_3
Select Flip-Flops state 3 to be connected to LUTn Input x

enum _plu_output_index

PLU output multiplexer registers.

Values:

enumerator kPLU_OUTPUT_0
PLU OUTPUT 0

enumerator kPLU_OUTPUT_1
PLU OUTPUT 1

enumerator kPLU_OUTPUT_2
PLU OUTPUT 2

enumerator kPLU_OUTPUT_3
PLU OUTPUT 3

enumerator kPLU_OUTPUT_4
PLU OUTPUT 4

enumerator kPLU_OUTPUT_5
PLU OUTPUT 5

enumerator kPLU_OUTPUT_6
PLU OUTPUT 6

enumerator kPLU_OUTPUT_7
PLU OUTPUT 7

enum __plu_output_source

Available sources of PLU output.

Values:

enumerator kPLU_OUT_SRC_LUT_0
Select LUT0 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_1
Select LUT1 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_2
Select LUT2 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_3
Select LUT3 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_4
Select LUT4 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_5
Select LUT5 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_6
Select LUT6 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_7
Select LUT7 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_8
Select LUT8 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_9
Select LUT9 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_10
Select LUT10 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_11
Select LUT11 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_12
Select LUT12 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_13
Select LUT13 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_14
Select LUT14 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_15
Select LUT15 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_16
Select LUT16 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_17

Select LUT17 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_18

Select LUT18 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_19

Select LUT19 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_20

Select LUT20 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_21

Select LUT21 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_22

Select LUT22 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_23

Select LUT23 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_24

Select LUT24 output to be connected to PLU output

enumerator kPLU_OUT_SRC_LUT_25

Select LUT25 output to be connected to PLU output

enumerator kPLU_OUT_SRC_FLIPFLOP_0

Select Flip-Flops state(0) to be connected to PLU output

enumerator kPLU_OUT_SRC_FLIPFLOP_1

Select Flip-Flops state(1) to be connected to PLU output

enumerator kPLU_OUT_SRC_FLIPFLOP_2

Select Flip-Flops state(2) to be connected to PLU output

enumerator kPLU_OUT_SRC_FLIPFLOP_3

Select Flip-Flops state(3) to be connected to PLU output

enum _plu_interrupt_mask

The enumerator of PLU Interrupt.

Values:

enumerator kPLU_OUTPUT_0_INTERRUPT_MASK

Select PLU output 0 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_1_INTERRUPT_MASK

Select PLU output 1 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_2_INTERRUPT_MASK

Select PLU output 2 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_3_INTERRUPT_MASK

Select PLU output 3 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_4_INTERRUPT_MASK

Select PLU output 4 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_5_INTERRUPT_MASK

Select PLU output 5 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_6_INTERRUPT_MASK
Select PLU output 6 contribute to interrupt/wake-up generation

enumerator kPLU_OUTPUT_7_INTERRUPT_MASK
Select PLU output 7 contribute to interrupt/wake-up generation

enum __plu_wakeint_filter_mode
Control input of the PLU, add filtering for glitch.
Values:

enumerator kPLU_WAKEINT_FILTER_MODE_BYPASS
Select Bypass mode

enumerator kPLU_WAKEINT_FILTER_MODE_1_CLK_PERIOD
Filter 1 clock period

enumerator kPLU_WAKEINT_FILTER_MODE_2_CLK_PERIOD
Filter 2 clock period

enumerator kPLU_WAKEINT_FILTER_MODE_3_CLK_PERIOD
Filter 3 clock period

enum __plu_wakeint_filter_clock_source
Clock source for filter mode.
Values:

enumerator kPLU_WAKEINT_FILTER_CLK_SRC_1MHZ_LPOSC
Select the 1MHz low-power oscillator as the filter clock

enumerator kPLU_WAKEINT_FILTER_CLK_SRC_12MHZ_FRO
Select the 12MHz FRO as the filter clock

enumerator kPLU_WAKEINT_FILTER_CLK_SRC_ALT
Select a third clock source

typedef enum __plu_lut_index plu_lut_index_t
Index of LUT.

typedef enum __plu_lut_in_index plu_lut_in_index_t
Inputs of LUT. 5 input present for each LUT.

typedef enum __plu_lut_input_source plu_lut_input_source_t
Available sources of LUT input.

typedef enum __plu_output_index plu_output_index_t
PLU output multiplexer registers.

typedef enum __plu_output_source plu_output_source_t
Available sources of PLU output.

typedef enum __plu_wakeint_filter_mode plu_wakeint_filter_mode_t
Control input of the PLU, add filtering for glitch.

typedef enum __plu_wakeint_filter_clock_source plu_wakeint_filter_clock_source_t
Clock source for filter mode.

typedef struct __plu_wakeint_config plu_wakeint_config_t
Wake configuration.

struct __plu_wakeint_config
#include <fsl_plu.h> Wake configuration.

Public Members

plu_wakeint_filter_mode_t filterMode

Filter Mode.

plu_wakeint_filter_clock_source_t clockSource

The clock source for filter mode.

2.40 Power Driver

enum __power_mode_config

Values:

enumerator kPmu__Sleep

enumerator kPmu__Deep__Sleep

enumerator kPmu__PowerDown

enumerator kPmu__Deep__PowerDown

enum pd_bits

Analog components power modes control during low power modes.

Values:

enumerator kPDRUNCFG_PD_DCDC

enumerator kPDRUNCFG_PD_BIAS

enumerator kPDRUNCFG_PD_BODCORE

enumerator kPDRUNCFG_PD_BODVBAT

enumerator kPDRUNCFG_PD_FRO1M

enumerator kPDRUNCFG_PD_FRO192M

enumerator kPDRUNCFG_PD_FRO32K

enumerator kPDRUNCFG_PD_XTAL32K

enumerator kPDRUNCFG_PD_XTAL32M

enumerator kPDRUNCFG_PD_PLL0

enumerator kPDRUNCFG_PD_PLL1

enumerator kPDRUNCFG_PD_COMP

enumerator kPDRUNCFG_PD_TEMPSENS

enumerator kPDRUNCFG_PD_GPADC

enumerator kPDRUNCFG_PD_LDOMEM

enumerator kPDRUNCFG_PD_LDODEEPSLEEP

enumerator kPDRUNCFG_PD_LDOGPADC

enumerator kPDRUNCFG_PD_LDOXO32M

enumerator kPDRUNCFG_PD_LDOFLASHNV

enumerator kPDRUNCFG_PD_RNG

enumerator kPDRUNCFG_PD_PLL0_SSCG

enumerator kPDRUNCFG_PD_ROM

enumerator kPDRUNCFG_ForceUnsigned

enum __power_bod_vbat_level

BOD VBAT level.

Values:

enumerator kPOWER_BodVbatLevel1000mv

Brown out detector VBAT level 1V

enumerator kPOWER_BodVbatLevel1100mv

Brown out detector VBAT level 1.1V

enumerator kPOWER_BodVbatLevel1200mv

Brown out detector VBAT level 1.2V

enumerator kPOWER_BodVbatLevel1300mv

Brown out detector VBAT level 1.3V

enumerator kPOWER_BodVbatLevel1400mv

Brown out detector VBAT level 1.4V

enumerator kPOWER_BodVbatLevel1500mv

Brown out detector VBAT level 1.5V

enumerator kPOWER_BodVbatLevel1600mv

Brown out detector VBAT level 1.6V

enumerator kPOWER_BodVbatLevel1650mv

Brown out detector VBAT level 1.65V

enumerator kPOWER_BodVbatLevel1700mv

Brown out detector VBAT level 1.7V

enumerator kPOWER_BodVbatLevel1750mv

Brown out detector VBAT level 1.75V

enumerator kPOWER_BodVbatLevel1800mv

Brown out detector VBAT level 1.8V

enumerator kPOWER_BodVbatLevel1900mv

Brown out detector VBAT level 1.9V

enumerator kPOWER_BodVbatLevel2000mv

Brown out detector VBAT level 2V

enumerator kPOWER_BodVbatLevel2100mv

Brown out detector VBAT level 2.1V

enumerator kPOWER_BodVbatLevel2200mv

Brown out detector VBAT level 2.2V

enumerator kPOWER_BodVbatLevel2300mv

Brown out detector VBAT level 2.3V

enumerator kPOWER__BodVbatLevel2400mv

Brown out detector VBAT level 2.4V

enumerator kPOWER__BodVbatLevel2500mv

Brown out detector VBAT level 2.5V

enumerator kPOWER__BodVbatLevel2600mv

Brown out detector VBAT level 2.6V

enumerator kPOWER__BodVbatLevel2700mv

Brown out detector VBAT level 2.7V

enumerator kPOWER__BodVbatLevel2806mv

Brown out detector VBAT level 2.806V

enumerator kPOWER__BodVbatLevel2900mv

Brown out detector VBAT level 2.9V

enumerator kPOWER__BodVbatLevel3000mv

Brown out detector VBAT level 3.0V

enumerator kPOWER__BodVbatLevel3100mv

Brown out detector VBAT level 3.1V

enumerator kPOWER__BodVbatLevel3200mv

Brown out detector VBAT level 3.2V

enumerator kPOWER__BodVbatLevel3300mv

Brown out detector VBAT level 3.3V

enum __power_bod_hyst

BOD Hysteresis control.

Values:

enumerator kPOWER__BodHystLevel25mv

BOD Hysteresis control level 25mv

enumerator kPOWER__BodHystLevel50mv

BOD Hysteresis control level 50mv

enumerator kPOWER__BodHystLevel75mv

BOD Hysteresis control level 75mv

enumerator kPOWER__BodHystLevel100mv

BOD Hysteresis control level 100mv

enum __power_bod_core_level

BOD core level.

Values:

enumerator kPOWER__BodCoreLevel600mv

Brown out detector core level 600mV

enumerator kPOWER__BodCoreLevel650mv

Brown out detector core level 650mV

enumerator kPOWER__BodCoreLevel700mv

Brown out detector core level 700mV

enumerator kPOWER__BodCoreLevel750mv

Brown out detector core level 750mV

enumerator kPOWER__BodCoreLevel800mv

Brown out detector core level 800mV

enumerator kPOWER__BodCoreLevel850mv

Brown out detector core level 850mV

enumerator kPOWER__BodCoreLevel900mv

Brown out detector core level 900mV

enumerator kPOWER__BodCoreLevel950mv

Brown out detector core level 950mV

enum __power_device_reset_cause

Device Reset Causes.

Values:

enumerator kRESET__CAUSE_POR

Power On Reset

enumerator kRESET__CAUSE_PADRESET

Hardware Pin Reset

enumerator kRESET__CAUSE_BODRESET

Brown-out Detector reset (either BODVBAT or BODCORE)

enumerator kRESET__CAUSE_ARMSYSTEMRESET

ARM System Reset

enumerator kRESET__CAUSE_WDTRESET

Watchdog Timer Reset

enumerator kRESET__CAUSE_SWRESET

Software Reset

enumerator kRESET__CAUSE_CDOGRESET

Code Watchdog Reset

enumerator kRESET__CAUSE_DPDRESET_WAKEUIO

Any of the 4 wake-up pins

enumerator kRESET__CAUSE_DPDRESET_RTC

Real Time Counter (RTC)

enumerator kRESET__CAUSE_DPDRESET_OSTIMER

OS Event Timer (OSTIMER)

enumerator kRESET__CAUSE_DPDRESET_WAKEUIO_RTC

Any of the 4 wake-up pins and RTC (it is not possible to distinguish which of these 2 events occurred first)

enumerator kRESET__CAUSE_DPDRESET_WAKEUIO_OSTIMER

Any of the 4 wake-up pins and OSTIMER (it is not possible to distinguish which of these 2 events occurred first)

enumerator kRESET__CAUSE_DPDRESET_RTC_OSTIMER

Real Time Counter or OS Event Timer (it is not possible to distinguish which of these 2 events occurred first)

enumerator kRESET__CAUSE_DPDRESET_WAKEUIO_RTC_OSTIMER

Any of the 4 wake-up pins (it is not possible to distinguish which of these 3 events occurred first)

enumerator `kRESET_CAUSE_NOT_RELEVANT`

No reset cause (for example, this code is used when waking up from DEEP-SLEEP low power mode)

enumerator `kRESET_CAUSE_NOT_DETERMINISTIC`

Unknown Reset Cause. Should be treated like “Hardware Pin Reset” from an application point of view.

enum `_power_device_boot_mode`

Device Boot Modes.

Values:

enumerator `kBOOT_MODE_POWER_UP`

All non Low Power Mode wake up (Power On Reset, Pin Reset, BoD Reset, ARM System Reset ...)

enumerator `kBOOT_MODE_LP_DEEP_SLEEP`

Wake up from DEEP-SLEEP Low Power mode

enumerator `kBOOT_MODE_LP_POWER_DOWN`

Wake up from POWER-DOWN Low Power mode

enumerator `kBOOT_MODE_LP_DEEP_POWER_DOWN`

Wake up from DEEP-POWER-DOWN Low Power mode

typedef enum `_power_mode_config` `power_mode_cfg_t`

typedef enum `pd_bits` `pd_bit_t`

Analog components power modes control during low power modes.

typedef enum `_power_bod_vbat_level` `power_bod_vbat_level_t`

BOD VBAT level.

typedef enum `_power_bod_hyst` `power_bod_hyst_t`

BOD Hysteresis control.

typedef enum `_power_bod_core_level` `power_bod_core_level_t`

BOD core level.

typedef enum `_power_device_reset_cause` `power_device_reset_cause_t`

Device Reset Causes.

typedef enum `_power_device_boot_mode` `power_device_boot_mode_t`

Device Boot Modes.

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

void POWER_SetBodVbatLevel(*power_bod_vbat_level_t* level, *power_bod_hyst_t* hyst, bool enBodVbatReset)

set BOD VBAT level.

Parameters

- level – BOD detect level
- hyst – BoD Hysteresis control
- enBodVbatReset – VBAT brown out detect reset

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_CycleCpuAndFlash(void)

Shut off the Flash and execute the _WFI(), then power up the Flash after wake-up event This MUST BE EXECUTED outside the Flash: either from ROM or from SRAM. The rest could stay in Flash. But, for consistency, it is preferable to have all functions defined in this file implemented in ROM.

Returns

Nothing

void POWER_EnterDeepSleep(uint32_t exclude_from_pd, uint32_t sram_retention_ctrl, uint64_t wakeup_interrupts, uint32_t hardware_wake_ctrl)

Configures and enters in DEEP-SLEEP low power mode.

Parameters

- exclude_from_pd –
- sram_retention_ctrl –
- wakeup_interrupts –
- hardware_wake_ctrl –

Returns

Nothing

!!! IMPORTANT NOTES :

0 - CPU0 & System CLock frequency is switched to FRO12MHz and is NOT restored back by the API. 1 - CPU0 Interrupt Enable registers (NVIC->ISER) are modified by this function. They are restored back in case of CPU retention or if POWERDOWN is not taken (for instance because an interrupt is pending). 2 - The Non Maskable Interrupt (NMI) is disabled and its configuration before calling this function will be restored back if POWERDOWN is not taken (for instance because an RTC or OSTIMER interrupt is pending). 3 - The HARD FAULT handler should execute from SRAM. (The Hard fault handler should initiate a full chip reset) reset)

```
void POWER_EnterPowerDown(uint32_t exclude_from_pd, uint32_t sram_retention_ctrl,  
                           uint64_t wakeup_interrupts, uint32_t cpu_retention_ctrl)
```

Configures and enters in POWERDOWN low power mode.

Parameters

- `exclude_from_pd` –
- `sram_retention_ctrl` –
- `wakeup_interrupts` –
- `cpu_retention_ctrl` – 0 = CPU retention is disable / 1 = CPU retention is enabled, all other values are RESERVED.

Returns

Nothing

!!! IMPORTANT NOTES :

0 - CPU0 & System CLock frequency is switched to FRO12MHz and is NOT restored back by the API. 1 - CPU0 Interrupt Enable registers (NVIC->ISER) are modified by this function. They are restored back in case of CPU retention or if POWERDOWN is not taken (for instance because an interrupt is pending). 2 - The Non Maskable Interrupt (NMI) is disabled and its configuration before calling this function will be restored back if POWERDOWN is not taken (for instance because an RTC or OSTIMER interrupt is pending). 3 - In case of CPU retention, it is the responsibility of the user to make sure that SRAM instance containing the stack used to call this function WILL BE preserved during low power (via parameter “sram_retention_ctrl”) 4 - The HARD FAULT handler should execute from SRAM. (The Hard fault handler should initiate a full chip reset) reset)

```
void POWER_EnterDeepPowerDown(uint32_t exclude_from_pd, uint32_t sram_retention_ctrl,  
                               uint64_t wakeup_interrupts, uint32_t wakeup_io_ctrl)
```

Configures and enters in DEEPPOWERDOWN low power mode.

Parameters

- `exclude_from_pd` –
- `sram_retention_ctrl` –
- `wakeup_interrupts` –
- `wakeup_io_ctrl` –

Returns

Nothing

!!! IMPORTANT NOTES :

0 - CPU0 & System CLock frequency is switched to FRO12MHz and is NOT restored back by the API. 1 - CPU0 Interrupt Enable registers (NVIC->ISER) are modified by this function. They are restored back if DEEPPOWERDOWN is not taken (for instance because an RTC or OSTIMER interrupt is pending). 2 - The Non Maskable Interrupt (NMI) is disabled and its configuration before calling this function will be restored back if DEEPPOWERDOWN is not taken (for instance because an RTC or OSTIMER interrupt is pending). 3 - The HARD FAULT handler should execute from SRAM. (The Hard fault handler should initiate a full chip reset)

```
void POWER_EnterSleep(void)
```

Configures and enters in SLEEP low power mode.

Returns

Nothing

void POWER_SetVoltageForFreq(uint32_t system_freq_hz)

Power Library API to choose normal regulation and set the voltage for the desired operating frequency.

Parameters

- system_freq_hz – - The desired frequency (in Hertz) at which the part would like to operate, note that the voltage and flash wait states should be set before changing frequency

Returns

none

void POWER_Xtal16mhzCapabankTrim(int32_t pi32_16MfXtalIecLoadpF_x100, int32_t pi32_16MfXtalPPcbParCappF_x100, int32_t pi32_16MfXtalNPcbParCappF_x100)

Sets board-specific trim values for 16MHz XTAL.

Note: Following default Values can be used: pi32_32MfXtalIecLoadpF_x100 Load capacitance, pF x 100 : 600 pi32_32MfXtalPPcbParCappF_x100 PCB +ve parasitic capacitance, pF x 100 : 20 pi32_32MfXtalNPcbParCappF_x100 PCB -ve parasitic capacitance, pF x 100 : 40

Parameters

- pi32_16MfXtalIecLoadpF_x100 – Load capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120
- pi32_16MfXtalPPcbParCappF_x100 – PCB +ve parasitic capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120
- pi32_16MfXtalNPcbParCappF_x100 – PCB -ve parasitic capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120

Returns

none

void POWER_Xtal32khzCapabankTrim(int32_t pi32_32kfXtalIecLoadpF_x100, int32_t pi32_32kfXtalPPcbParCappF_x100, int32_t pi32_32kfXtalNPcbParCappF_x100)

Sets board-specific trim values for 32kHz XTAL.

Note: Following default Values can be used: pi32_32kfXtalIecLoadpF_x100 Load capacitance, pF x 100 : 600 pi32_32kfXtalPPcbParCappF_x100 PCB +ve parasitic capacitance, pF x 100 : 40 pi32_32kfXtalNPcbParCappF_x100 PCB -ve parasitic capacitance, pF x 100 : 40

Parameters

- pi32_32kfXtalIecLoadpF_x100 – Load capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120
- pi32_32kfXtalPPcbParCappF_x100 – PCB +ve parasitic capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120
- pi32_32kfXtalNPcbParCappF_x100 – PCB -ve parasitic capacitance, pF x 100. For example, 6pF becomes 600, 1.2pF becomes 120

Returns

none

`void POWER_SetXtal16mhzLdo(void)`

Enables and sets LDO for 16MHz XTAL.

Returns

none

`void POWER_SetXtal16mhzTrim(uint32_t amp, uint32_t gm)`

Set up 16-MHz XTAL Trimmings.

Parameters

- `amp` – Amplitude
- `gm` – Transconductance

Returns

none

`void POWER_GetWakeUpCause(power_device_reset_cause_t *p_reset_cause,
power_device_boot_mode_t *p_boot_mode, uint32_t
*p_wakeupio_cause)`

Return some key information related to the device reset causes / wake-up sources, for all power modes.

Parameters

- `p_reset_cause` – : the device reset cause, according to the definition of `power_device_reset_cause_t` type.
- `p_boot_mode` – : the device boot mode, according to the definition of `power_device_boot_mode_t` type.
- `p_wakeupio_cause` – the wake-up pin sources, according to the definition of register `PMC->WAKEIOCAUSE[3:0]`.

Returns

Nothing

!!! IMPORTANT ERRATA - IMPORTANT ERRATA - IMPORTANT ERRATA !!!
→!
!!! valid ONLY for LPC55S69 (not for LPC55S16 and LPC55S06) !!!
!!! when FALLING EDGE DETECTION is enabled on wake-up pins: !!!
- 1. `p_wakeupio_cause` is NOT ACCURATE
- 2. Spurious `kRESET_CAUSE_DPDRESET_WAKEUIO*` event is reported when several wake-up sources are enabled during DEEP-POWER-DOWN (like enabling wake-up on RTC and Falling edge wake-up pins)

`FSL_POWER_DRIVER_VERSION`

power driver version 2.3.2.

`LOWPOWER_SRAMRETCTRL_RETEN_RAMX0`

SRAM instances retention control during low power modes.

Enable `SRAMX_0` retention when entering in Low power modes

`LOWPOWER_SRAMRETCTRL_RETEN_RAMX1`

Enable `SRAMX_1` retention when entering in Low power modes

`LOWPOWER_SRAMRETCTRL_RETEN_RAMX2`

Enable `SRAMX_2` retention when entering in Low power modes

`LOWPOWER_SRAMRETCTRL_RETEN_RAMX3`

Enable `SRAMX_3` retention when entering in Low power modes

LOWPOWER_SRAMRETCTRL_RETEN_RAM00

Enable SRAM0_0 retention when entering in Low power modes

LOWPOWER_SRAMRETCTRL_RETEN_RAM10

Enable SRAM1_0 retention when entering in Low power modes

LOWPOWER_SRAMRETCTRL_RETEN_RAM20

Enable SRAM2_0 retention when entering in Low power modes

LOWPOWER_SRAMRETCTRL_RETEN_RAM3

Enable SRAM3 retention when entering in Low power modes

WAKEUP_SYS

Low Power Modes Wake up sources.

WAKEUP_SDMA0

[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_GLOBALINT0

[SLEEP, DEEP SLEEP, POWER DOWN]

WAKEUP_GPIO_GLOBALINT1

[SLEEP, DEEP SLEEP, POWER DOWN]

WAKEUP_GPIO_INT0_0

[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_1

[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_2

[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_3

[SLEEP, DEEP SLEEP]

WAKEUP_UTICK

[SLEEP,]

WAKEUP_MRT

[SLEEP,]

WAKEUP_CTIMER0

[SLEEP, DEEP SLEEP]

WAKEUP_CTIMER1

[SLEEP, DEEP SLEEP]

WAKEUP_SCT

[SLEEP,]

WAKEUP_CTIMER3

[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM0

[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM1

[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM2

[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM3
[SLEEP, DEEP SLEEP, POWER DOWN]

WAKEUP_FLEXCOMM4
[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM5
[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM6
[SLEEP, DEEP SLEEP]

WAKEUP_FLEXCOMM7
[SLEEP, DEEP SLEEP]

WAKEUP_ADC
[SLEEP,]

WAKEUP_ACOMP
[SLEEP, DEEP SLEEP, POWER DOWN]

WAKEUP_RTC_LITE_ALARM_WAKEUP
[SLEEP, DEEP SLEEP, POWER DOWN, DEEP POWER DOWN]

WAKEUP_GPIO_INT0_4
[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_5
[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_6
[SLEEP, DEEP SLEEP]

WAKEUP_GPIO_INT0_7
[SLEEP, DEEP SLEEP]

WAKEUP_TIMER2
[SLEEP, DEEP SLEEP]

WAKEUP_TIMER4
[SLEEP, DEEP SLEEP]

WAKEUP_OS_EVENT_TIMER
[SLEEP, DEEP SLEEP, POWER DOWN, DEEP POWER DOWN]

CAN0_INT0
[SLEEP,]

CAN1_INT0
[SLEEP,]

WAKEUP_SEC_HYPERSVISOR_CALL
[SLEEP,]

WAKEUP_SEC_GPIO_INT0_0
[SLEEP, DEEP SLEEP]

WAKEUP_SEC_GPIO_INT0_1
[SLEEP, DEEP SLEEP]

WAKEUP_PLU
[SLEEP, DEEP SLEEP]

WAKEUP_SEC_VIO

WAKEUP_SHA

[SLEEP,]

WAKEUP_CASPER

[SLEEP,]

WAKEUP_PUF

[SLEEP,]

WAKEUP_SDMA1

[SLEEP, DEEP SLEEP]

WAKEUP_LSPI_HS

[SLEEP, DEEP SLEEP]

WAKEUP_ALLWAKEUPIOS

[, DEEP POWER DOWN]

LOWPOWER_HWWAKE_FORCED

Sleep Postpone.

Force peripheral clocking to stay on during deep-sleep mode.

LOWPOWER_HWWAKE_PERIPHERALS

Wake for Flexcomms. Any Flexcomm FIFO reaching the level specified by its own TXLVL will cause \ peripheral clocking to wake up temporarily while the related status is asserted

LOWPOWER_HWWAKE_SDMA0

Wake for DMA0. DMA0 being busy will cause peripheral clocking to remain running until DMA \ completes. Used in conjunction with LOWPOWER_HWWAKE_PERIPHERALS

LOWPOWER_HWWAKE_SDMA1

Wake for DMA1. DMA0 being busy will cause peripheral clocking to remain running until DMA \ completes. Used in conjunction with LOWPOWER_HWWAKE_PERIPHERALS

LOWPOWER_HWWAKE_ENABLE_FRO192M

Need to be set if FRO192M is disable - via PDCTRL0 - in Deep Sleep mode and any of \ LOWPOWER_HWWAKE_PERIPHERALS, LOWPOWER_HWWAKE_SDMA0 or LOWPOWER_HWWAKE_SDMA1 is set

LOWPOWER_CPURETCTRL_ENA_DISABLE

In POWER DOWN mode, CPU Retention is disabled

LOWPOWER_CPURETCTRL_ENA_ENABLE

In POWER DOWN mode, CPU Retention is enabled

LOWPOWER_WAKEUPIOSRC_PIO0_INDEX

Wake up I/O sources.

Pin P1(1)

LOWPOWER_WAKEUPIOSRC_PIO1_INDEX

Pin P0(28)

LOWPOWER_WAKEUPIOSRC_PIO2_INDEX

Pin P1(18)

LOWPOWER_WAKEUPIOSRC_PIO3_INDEX

Pin P1(30)

LOWPOWER_WAKEUPIOSRC_DISABLE

Wake up is disable

LOWPOWER_WAKEUPIOSRC_RISING

Wake up on rising edge

LOWPOWER_WAKEUPIOSRC_FALLING

Wake up on falling edge

LOWPOWER_WAKEUPIOSRC_RISING_FALLING

Wake up on both rising or falling edges

LOWPOWER_WAKEUPIOSRC_PIO0MODE_INDEX

Pin P1(1)

LOWPOWER_WAKEUPIOSRC_PIO1MODE_INDEX

Pin P0(28)

LOWPOWER_WAKEUPIOSRC_PIO2MODE_INDEX

Pin P1(18)

LOWPOWER_WAKEUPIOSRC_PIO3MODE_INDEX

Pin P1(30)

LOWPOWER_WAKEUPIOSRC_IO_MODE_PLAIN

Wake up Pad is plain input

LOWPOWER_WAKEUPIOSRC_IO_MODE_PULLDOWN

Wake up Pad is pull-down

LOWPOWER_WAKEUPIOSRC_IO_MODE_PULLUP

Wake up Pad is pull-up

LOWPOWER_WAKEUPIOSRC_IO_MODE_REPEATER

Wake up Pad is in repeater

LOWPOWER_WAKEUPIO_PIO0_PULLUPDOWN_INDEX

Wake-up I/O 0 pull-up/down configuration index

LOWPOWER_WAKEUPIO_PIO1_PULLUPDOWN_INDEX

Wake-up I/O 1 pull-up/down configuration index

LOWPOWER_WAKEUPIO_PIO2_PULLUPDOWN_INDEX

Wake-up I/O 2 pull-up/down configuration index

LOWPOWER_WAKEUPIO_PIO3_PULLUPDOWN_INDEX

Wake-up I/O 3 pull-up/down configuration index

LOWPOWER_WAKEUPIO_PIO0_PULLUPDOWN_MASK

Wake-up I/O 0 pull-up/down mask

LOWPOWER_WAKEUPIO_PIO1_PULLUPDOWN_MASK

Wake-up I/O 1 pull-up/down mask

LOWPOWER_WAKEUPIO_PIO2_PULLUPDOWN_MASK

Wake-up I/O 2 pull-up/down mask

LOWPOWER_WAKEUPIO_PIO3_PULLUPDOWN_MASK

Wake-up I/O 3 pull-up/down mask

LOWPOWER_WAKEUPIO_PULLDOWN

Select pull-down

LOWPOWER_WAKEUIO_PULLUP

Select pull-up

LOWPOWER_WAKEUIO_PIO0_DISABLEPULLUPDOWN_INDEX

Wake-up I/O 0 pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO1_DISABLEPULLUPDOWN_INDEX

Wake-up I/O 1 pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO2_DISABLEPULLUPDOWN_INDEX

Wake-up I/O 2 pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO3_DISABLEPULLUPDOWN_INDEX

Wake-up I/O 3 pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO0_DISABLEPULLUPDOWN_MASK

Wake-up I/O 0 pull-up/down disable/enable mask

LOWPOWER_WAKEUIO_PIO1_DISABLEPULLUPDOWN_MASK

Wake-up I/O 1 pull-up/down disable/enable mask

LOWPOWER_WAKEUIO_PIO2_DISABLEPULLUPDOWN_MASK

Wake-up I/O 2 pull-up/down disable/enable mask

LOWPOWER_WAKEUIO_PIO3_DISABLEPULLUPDOWN_MASK

Wake-up I/O 3 pull-up/down disable/enable mask

LOWPOWER_WAKEUIO_PIO0_USEEXTERNALPULLUPDOWN_INDEX

Wake-up I/O 0 use external pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO1_USEEXTERNALPULLUPDOWN_INDEX

Wake-up I/O 1 use external pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO2_USEEXTERNALPULLUPDOWN_INDEX

Wake-up I/O 2 use external pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO3_USEEXTERNALPULLUPDOWN_INDEX

Wake-up I/O 3 use external pull-up/down disable/enable control index

LOWPOWER_WAKEUIO_PIO0_USEEXTERNALPULLUPDOWN_MASK

Wake-up I/O 0 use external pull-up/down \ disable/enable mask, 0: disable, 1: enable

LOWPOWER_WAKEUIO_PIO1_USEEXTERNALPULLUPDOWN_MASK

Wake-up I/O 1 use external pull-up/down \ disable/enable mask, 0: disable, 1: enable

LOWPOWER_WAKEUIO_PIO2_USEEXTERNALPULLUPDOWN_MASK

Wake-up I/O 2 use external pull-up/down \ disable/enable mask, 0: disable, 1: enable

LOWPOWER_WAKEUIO_PIO3_USEEXTERNALPULLUPDOWN_MASK

Wake-up I/O 3 use external pull-up/down \ disable/enable mask, 0: disable, 1: enable

2.41 PRINCE: PRINCE bus crypto engine

FSL_PRINCE_DRIVER_VERSION

PRINCE driver version 2.6.0.

Current version: 2.6.0

Change log:

- Version 2.0.0

- Initial version.
- Version 2.1.0
 - Update for the A1 rev. of LPC55Sxx serie.
- Version 2.2.0
 - Add runtime checking of the A0 and A1 rev. of LPC55Sxx serie to support both silicone revisions.
- Version 2.3.0
 - Add support for LPC55S1x and LPC55S2x series
- Version 2.3.0
 - Fix MISRA-2012 issues.
- Version 2.3.1
 - Add support for LPC55S0x series
- Version 2.3.2
 - Fix documentation of enumeration. Extend PRINCE example.
- Version 2.4.0
 - Add support for LPC55S3x series
- Version 2.5.0
 - Add PRINCE_Config() and PRINCE_Reconfig() features.
- Version 2.5.1
 - Fix build error due to renamed symbols
- Version 2.6.0
 - Renamed CSS to ELS

enum __skboot_status

Secure status enumeration.

Values:

enumerator kStatus_SKBOOT_Success

PRINCE Success

enumerator kStatus_SKBOOT_Fail

PRINCE Fail

enumerator kStatus_SKBOOT_InvalidArgument

PRINCE Invalid argument

enumerator kStatus_SKBOOT_KeyStoreMarkerInvalid

PRINCE Invalid marker

enum __secure_bool

Secure boolean enumeration.

Values:

enumerator kSECURE_TRUE

PRINCE true

enumerator kSECURE_FALSE

PRINCE false

enum `_prince_region`

Prince region.

Values:

enumerator `kPRINCE_Region0`

PRINCE region 0

enumerator `kPRINCE_Region1`

PRINCE region 1

enumerator `kPRINCE_Region2`

PRINCE region 2

enum `_prince_lock`

Prince lock.

Values:

enumerator `kPRINCE_Region0Lock`

PRINCE region 0 lock

enumerator `kPRINCE_Region1Lock`

PRINCE region 1 lock

enumerator `kPRINCE_Region2Lock`

PRINCE region 2 lock

enumerator `kPRINCE_MaskLock`

PRINCE mask register lock

enum `_prince_flags`

Prince flag.

Values:

enumerator `kPRINCE_Flag_None`

PRINCE Flag None

enumerator `kPRINCE_Flag_EraseCheck`

PRINCE Flag Erase check

enumerator `kPRINCE_Flag_WriteCheck`

PRINCE Flag Write check

typedef enum `_skboot_status` `skboot_status_t`

Secure status enumeration.

typedef enum `_secure_bool` `secure_bool_t`

Secure boolean enumeration.

typedef enum `_prince_region` `prince_region_t`

Prince region.

typedef enum `_prince_lock` `prince_lock_t`

Prince lock.

typedef enum `_prince_flags` `prince_flags_t`

Prince flag.

static inline void `PRINCE_EncryptEnable(PRINCE_Type *base)`

Enable data encryption.

This function enables PRINCE on-the-fly data encryption.

Parameters

- base – PRINCE peripheral address.

static inline void PRINCE_EncryptDisable(PRINCE_Type *base)

Disable data encryption.

This function disables PRINCE on-the-fly data encryption.

Parameters

- base – PRINCE peripheral address.

static inline bool PRINCE_IsEncryptEnable(PRINCE_Type *base)

Is Enable data encryption.

This function test if PRINCE on-the-fly data encryption is enabled.

Parameters

- base – PRINCE peripheral address.

Returns

true if enabled, false if not

static inline void PRINCE_SetMask(PRINCE_Type *base, uint64_t mask)

Sets PRINCE data mask.

This function sets the PRINCE mask that is used to mask decrypted data.

Parameters

- base – PRINCE peripheral address.
- mask – 64-bit data mask value.

static inline void PRINCE_SetLock(PRINCE_Type *base, uint32_t lock)

Locks access for specified region registers or data mask register.

This function sets lock on specified region registers or mask register.

Parameters

- base – PRINCE peripheral address.
- lock – registers to lock. This is a logical OR of members of the enumeration prince_lock_t

status_t PRINCE_GenNewIV(*prince_region_t* region, uint8_t *iv_code, bool store, *flash_config_t* *flash_context)

Generate new IV code.

This function generates new IV code and stores it into the persistent memory. Ensure about 800 bytes free space on the stack when calling this routine with the store parameter set to true!

Parameters

- region – PRINCE region index.
- iv_code – IV code pointer used for storing the newly generated 52 bytes long IV code.
- store – flag to allow storing the newly generated IV code into the persistent memory (FFR).
- flash_context – pointer to the flash driver context structure.

Returns

kStatus_Success upon success

Returns

kStatus_Fail otherwise, kStatus_Fail is also returned if the key code for the particular PRINCE region is not present in the keystore (though new IV code has been provided)

status_t PRINCE_LoadIV(*prince_region_t* region, uint8_t *iv_code)

Load IV code.

This function enables IV code loading into the PRINCE bus encryption engine.

Parameters

- region – PRINCE region index.
- iv_code – IV code pointer used for passing the IV code.

Returns

kStatus_Success upon success

Returns

kStatus_Fail otherwise

status_t PRINCE_SetEncryptForAddressRange(*prince_region_t* region, uint32_t start_address, uint32_t length, *flash_config_t* *flash_context, bool regenerate_iv)

Allow encryption/decryption for specified address range.

This function sets the encryption/decryption for specified address range. The SR mask value for the selected Prince region is calculated from provided start_address and length parameters. This calculated value is OR'ed with the actual SR mask value and stored into the PRINCE SR_ENABLE register and also into the persistent memory (FFR) to be used after the device reset. It is possible to define several nonadjacent encrypted areas within one Prince region when calling this function repeatedly. If the length parameter is set to 0, the SR mask value is set to 0 and thus the encryption/decryption for the whole selected Prince region is disabled. Ensure about 800 bytes free space on the stack when calling this routine!

Parameters

- region – PRINCE region index.
- start_address – start address of the area to be encrypted/decrypted.
- length – length of the area to be encrypted/decrypted.
- flash_context – pointer to the flash driver context structure.
- regenerate_iv – flag to allow IV code regenerating, storing into the persistent memory (FFR) and loading into the PRINCE engine

Returns

kStatus_Success upon success

Returns

kStatus_Fail otherwise

status_t PRINCE_GetRegionSREnable(PRINCE_Type *base, *prince_region_t* region, uint32_t *sr_enable)

Gets the PRINCE Sub-Region Enable register.

This function gets PRINCE SR_ENABLE register.

Parameters

- base – PRINCE peripheral address.
- region – PRINCE region index.
- sr_enable – Sub-Region Enable register pointer.

Returns

kStatus_Success upon success

Returns

kStatus_InvalidArgument

status_t PRINCE_GetRegionBaseAddress(PRINCE_Type *base, *prince_region_t* region, uint32_t *region_base_addr)

Gets the PRINCE region base address register.

This function gets PRINCE BASE_ADDR register.

Parameters

- base – PRINCE peripheral address.
- region – PRINCE region index.
- region_base_addr – Region base address pointer.

Returns

kStatus_Success upon success

Returns

kStatus_InvalidArgument

status_t PRINCE_SetRegionIV(PRINCE_Type *base, *prince_region_t* region, const uint8_t iv[8])

Sets the PRINCE region IV.

This function sets specified AES IV for the given region.

Parameters

- base – PRINCE peripheral address.
- region – Selection of the PRINCE region to be configured.
- iv – 64-bit AES IV in little-endian byte order.

status_t PRINCE_SetRegionBaseAddress(PRINCE_Type *base, *prince_region_t* region, uint32_t region_base_addr)

Sets the PRINCE region base address.

This function configures PRINCE region base address.

Parameters

- base – PRINCE peripheral address.
- region – Selection of the PRINCE region to be configured.
- region_base_addr – Base Address for region.

status_t PRINCE_SetRegionSREnable(PRINCE_Type *base, *prince_region_t* region, uint32_t sr_enable)

Sets the PRINCE Sub-Region Enable register.

This function configures PRINCE SR_ENABLE register.

Parameters

- base – PRINCE peripheral address.
- region – Selection of the PRINCE region to be configured.
- sr_enable – Sub-Region Enable register value.

status_t PRINCE_FlashEraseWithChecker(*flash_config_t* *config, uint32_t start, uint32_t lengthInBytes, uint32_t key)

Erases the flash sectors encompassed by parameters passed into function.

This function erases the appropriate number of flash sectors based on the desired start address and length. It deals with the flash erase function complementary to the standard erase API of the IAP1 driver. This implementation additionally checks if the whole encrypted PRINCE subregions are erased at once to avoid secrets revealing. The checker implementation is limited to one contiguous PRINCE-controlled memory area.

Parameters

- config – The pointer to the flash driver context structure.
- start – The start address of the desired flash memory to be erased. The start address needs to be prince-sburegion-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words) to be erased. Must be prince-sburegion-size-aligned.
- key – The value used to validate all flash erase APIs.

Returns

kStatus_FLASH_Success API was executed successfully.

Returns

kStatus_FLASH_InvalidArgument An invalid argument is provided.

Returns

kStatus_FLASH_AlignmentError The parameter is not aligned with the specified baseline.

Returns

kStatus_FLASH_AddressError The address is out of range.

Returns

kStatus_FLASH_EraseKeyError The API erase key is invalid.

Returns

kStatus_FLASH_CommandFailure Run-time error during the command execution.

Returns

kStatus_FLASH_CommandNotSupported Flash API is not supported.

Returns

kStatus_FLASH_EccError A correctable or uncorrectable error during command execution.

Returns

kStatus_FLASH_EncryptedRegionsEraseNotDoneAtOnce Encrypted flash subregions are not erased at once.

status_t PRINCE_FlashProgramWithChecker(*flash_config_t* *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters.

This function programs the flash memory with the desired data for a given flash area as determined by the start address and the length. It deals with the flash program function complementary to the standard program API of the IAP1 driver. This implementation additionally checks if the whole PRINCE subregions are programmed at once to avoid secrets revealing. The checker implementation is limited to one contiguous PRINCE-controlled memory area.

Parameters

- config – The pointer to the flash driver context structure.

- `start` – The start address of the desired flash memory to be programmed. Must be prince-sburegion-aligned.
- `src` – A pointer to the source buffer of data that is to be programmed into the flash.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be programmed. Must be prince-sburegion-size-aligned.

Returns

`kStatus_FLASH_Success` API was executed successfully.

Returns

`kStatus_FLASH_InvalidArgument` An invalid argument is provided.

Returns

`kStatus_FLASH_AlignmentError` Parameter is not aligned with the specified baseline.

Returns

`kStatus_FLASH_AddressError` Address is out of range.

Returns

`kStatus_FLASH_AccessError` Invalid instruction codes and out-of bounds addresses.

Returns

`kStatus_FLASH_CommandFailure` Run-time error during the command execution.

Returns

`kStatus_FLASH_CommandFailure` Run-time error during the command execution.

Returns

`kStatus_FLASH_CommandNotSupported` Flash API is not supported.

Returns

`kStatus_FLASH_EccError` A correctable or uncorrectable error during command execution.

Returns

`kStatus_FLASH_SizeError` Encrypted flash subregions are not programmed at once.

`FSL_PRINCE_DRIVER_SUBREGION_SIZE_IN_KB`

`FSL_PRINCE_DRIVER_MAX_FLASH_ADDR`

`ALIGN_DOWN(x, a)`

2.42 PUF: Physical Unclonable Function

`FSL_PUF_DRIVER_VERSION`

PUF driver version. Version 2.2.0.

Current version: 2.2.0

Change log:

- 2.0.0
 - Initial version.
- 2.0.1

- Fixed puf_wait_usec function optimization issue.
- 2.0.2
 - Add PUF configuration structure and support for PUF SRAM controller. Remove magic constants.
- 2.0.3
 - Fix MISRA C-2012 issue.
- 2.1.0
 - Align driver with PUF SRAM controller registers on LPCXpresso55s16.
 - Update initialization logic .
- 2.1.1
 - Fix ARMGCC build warning .
- 2.1.2
 - Update: Add automatic big to little endian swap for user (pre-shared) keys destined to secret hardware bus (PUF key index 0).
- 2.1.3
 - Fix MISRA C-2012 issue.
- 2.1.4
 - Replace register uint32_t ticksCount with volatile uint32_t ticksCount in puf_wait_usec() to prevent optimization out delay loop.
- 2.1.5
 - Use common SDK delay in puf_wait_usec()
- 2.1.6
 - Changed wait time in PUF_Init(), when initialization fails it will try PUF_Powercycle() with shorter time. If this shorter time will also fail, initialization will be tried with worst case time as before.
- 2.2.0
- Add support for kPUF_KeySlot4.
- Add new PUF_ClearKey() function, that clears a desired PUF internal HW key register.

enum __puf_key_index_register

Values:

enumerator kPUF_KeyIndex_00

enumerator kPUF_KeyIndex_01

enumerator kPUF_KeyIndex_02

enumerator kPUF_KeyIndex_03

enumerator kPUF_KeyIndex_04

enumerator kPUF_KeyIndex_05

enumerator kPUF_KeyIndex_06

enumerator kPUF_KeyIndex_07

enumerator kPUF_KeyIndex_08

```
enumerator kPUF__KeyIndex__09
enumerator kPUF__KeyIndex__10
enumerator kPUF__KeyIndex__11
enumerator kPUF__KeyIndex__12
enumerator kPUF__KeyIndex__13
enumerator kPUF__KeyIndex__14
enumerator kPUF__KeyIndex__15

enum __puf_min_max
    Values:
    enumerator kPUF__KeySizeMin
    enumerator kPUF__KeySizeMax
    enumerator kPUF__KeyIndexMax

enum __puf_key_slot
    PUF key slot.
    Values:
    enumerator kPUF__KeySlot0
        PUF key slot 0
    enumerator kPUF__KeySlot1
        PUF key slot 1

    PUF status return codes.
    Values:
    enumerator kStatus__EnrollNotAllowed
    enumerator kStatus__StartNotAllowed

typedef enum _puf_key_index_register puf_key_index_register_t
typedef enum _puf_min_max puf_min_max_t
typedef enum _puf_key_slot puf_key_slot_t
    PUF key slot.

PUF_GET_KEY_CODE_SIZE_FOR_KEY_SIZE(x)
    Get Key Code size in bytes from key size in bytes at compile time.
PUF_MIN_KEY_CODE_SIZE
PUF_ACTIVATION_CODE_SIZE
KEYSTORE_PUF_DISCHARGE_TIME_FIRST_TRY_MS
KEYSTORE_PUF_DISCHARGE_TIME_MAX_MS

struct puf_config_t
    #include <fsl_puf.h>
```

2.43 Reset Driver

enum _SYSCON_RSTn

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in PRESETCTRL/ASYNCPRESETCTRL registers

Values:

enumerator kROM_RST_SHIFT_RSTn
ROM reset control

enumerator kSRAM1_RST_SHIFT_RSTn
SRAM1 reset control

enumerator kSRAM2_RST_SHIFT_RSTn
SRAM2 reset control

enumerator kFLASH_RST_SHIFT_RSTn
Flash controller reset control

enumerator kFMC_RST_SHIFT_RSTn
Flash accelerator reset control

enumerator kMUX0_RST_SHIFT_RSTn
Input mux0 reset control

enumerator kIOCON_RST_SHIFT_RSTn
IOCON reset control

enumerator kGPIO0_RST_SHIFT_RSTn
GPIO0 reset control

enumerator kGPIO1_RST_SHIFT_RSTn
GPIO1 reset control

enumerator kPINT_RST_SHIFT_RSTn
Pin interrupt (PINT) reset control

enumerator kGINT_RST_SHIFT_RSTn
Grouped interrupt (PINT) reset control.

enumerator kDMA0_RST_SHIFT_RSTn
DMA reset control

enumerator kCRC_RST_SHIFT_RSTn
CRC reset control

enumerator kWWDT_RST_SHIFT_RSTn
Watchdog timer reset control

enumerator kRTC_RST_SHIFT_RSTn
RTC reset control

enumerator kMAILBOX_RST_SHIFT_RSTn
Mailbox reset control

enumerator kADC0_RST_SHIFT_RSTn
ADC0 reset control

enumerator kMRT_RST_SHIFT_RSTn
Multi-rate timer (MRT) reset control

enumerator kOSTIMER0_RST_SHIFT_RSTn
OSTimer0 reset control

enumerator kSCT0_RST_SHIFT_RSTn
SCTimer/PWM 0 (SCT0) reset control

enumerator kMCAN_RST_SHIFT_RSTn
MCAN reset control

enumerator kUTICK_RST_SHIFT_RSTn
Micro-tick timer reset control

enumerator kFC0_RST_SHIFT_RSTn
Flexcomm Interface 0 reset control

enumerator kFC1_RST_SHIFT_RSTn
Flexcomm Interface 1 reset control

enumerator kFC2_RST_SHIFT_RSTn
Flexcomm Interface 2 reset control

enumerator kFC3_RST_SHIFT_RSTn
Flexcomm Interface 3 reset control

enumerator kFC4_RST_SHIFT_RSTn
Flexcomm Interface 4 reset control

enumerator kFC5_RST_SHIFT_RSTn
Flexcomm Interface 5 reset control

enumerator kFC6_RST_SHIFT_RSTn
Flexcomm Interface 6 reset control

enumerator kFC7_RST_SHIFT_RSTn
Flexcomm Interface 7 reset control

enumerator kCTIMER2_RST_SHIFT_RSTn
CTimer 2 reset control

enumerator kCTIMER0_RST_SHIFT_RSTn
CTimer 0 reset control

enumerator kCTIMER1_RST_SHIFT_RSTn
CTimer 1 reset control

enumerator kEZHA_RST_SHIFT_RSTn
EZHA reset control

enumerator kEZHB_RST_SHIFT_RSTn
EZHB reset control

enumerator kDMA1_RST_SHIFT_RSTn
DMA1 reset control

enumerator kCMP_RST_SHIFT_RSTn
CMP reset control

enumerator kSRAM3_RST_SHIFT_RSTn
SRAM3 reset control

enumerator kFREQME_RST_SHIFT_RSTn
FREQME reset control

enumerator kCDOG_RST_SHIFT_RSTn
Code Watchdog reset control

enumerator kRNG_RST_SHIFT_RSTn
RNG reset control

enumerator kSYSCTL_RST_SHIFT_RSTn
SYSCTL reset control

enumerator kHASHCRYPT_RST_SHIFT_RSTn
HASHCRYPT reset control

enumerator kPLULUT_RST_SHIFT_RSTn
PLU LUT reset control

enumerator kCTIMER3_RST_SHIFT_RSTn
CTimer 3 reset control

enumerator kCTIMER4_RST_SHIFT_RSTn
CTimer 4 reset control

enumerator kPUF_RST_SHIFT_RSTn
PUF reset control

enumerator kCASPER_RST_SHIFT_RSTn
CASPER reset control

enumerator kANALOGCTL_RST_SHIFT_RSTn
ANALOG_CTL reset control

enumerator kHSLSPI_RST_SHIFT_RSTn
HS LSPI reset control

enumerator kGPIOSEC_RST_SHIFT_RSTn
GPIO Secure reset control

enumerator kGPIOSECINT_RST_SHIFT_RSTn
GPIO Secure int 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

`ADC_RSTS`

Array initializers with peripheral reset bits

`MCAN_RSTS`

`CRC_RSTS`

`CTIMER_RSTS`

`DMA_RSTS_N`

`FLEXCOMM_RSTS`

`GINT_RSTS`

`GPIO_RSTS_N`

`INPUTMUX_RSTS`

`IOCON_RSTS`

`FLASH_RSTS`

`MRT_RSTS`

`PINT_RSTS`

`CDOG_RSTS`

`RNG_RSTS`

`SCT_RSTS`

`UTICK_RSTS`

`WWDT_RSTS`

`PLU_RSTS_N`

`OSTIMER_RSTS`

`CASPER_RSTS`

`HASHCRYPT_RSTS`

`PUF_RSTS`

2.44 RNG: Random Number Generator

FSL_RNG_DRIVER_VERSION

RNG driver version. Version 2.0.3.

Current version: 2.0.3

Change log:

- Version 2.0.0
 - Initial version
- Version 2.0.1
 - Fix MISRA C-2012 issue.
- Version 2.0.2
 - Add RESET_PeripheralReset function inside RNG_Init and RNG_Deinit functions.
- Version 2.0.3
 - Modified RNG_Init and RNG_GetRandomData functions, added rng_accumulateEntropy and rng_readEntropy functions.
 - These changes are reflecting recommended usage of RNG according to device UM.

void RNG_Init(RNG_Type *base)

Initializes the RNG.

This function initializes the RNG. When called, the RNG module and ring oscillator is enabled.

Parameters

- base – RNG base address

Returns

If successful, returns the kStatus_RNG_Success. Otherwise, it returns an error.

void RNG_Deinit(RNG_Type *base)

Shuts down the RNG.

This function shuts down the RNG.

Parameters

- base – RNG base address.

status_t RNG_GetRandomData(RNG_Type *base, void *data, size_t dataSize)

Gets random data.

This function gets random data from the RNG.

Parameters

- base – RNG base address.
- data – Pointer address used to store random data.
- dataSize – Size of the buffer pointed by the data parameter.

Returns

random data

static inline uint32_t RNG_GetRandomWord(RNG_Type *base)

Returns random 32-bit number.

This function gets random number from the RNG.

Parameters

- base – RNG base address.

Returns

random number

2.45 RTC: Real Time Clock

`void RTC_Init(RTC_Type *base)`

Un-gate the RTC clock and enable the RTC oscillator.

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

Parameters

- base – RTC peripheral base address

`static inline void RTC_Deinit(RTC_Type *base)`

Stop the timer and gate the RTC clock.

Parameters

- base – RTC peripheral base address

`status_t RTC_SetDatetime(RTC_Type *base, const rtc_datetime_t *datetime)`

Set the RTC date and time according to the given time structure.

The RTC counter must be stopped prior to calling this function as writes to the RTC seconds register will fail if the RTC counter is running.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the date and time details to set are stored

Returns

`kStatus_Success`: Success in setting the time and starting the RTC
`kStatus_InvalidArgument`: Error because the datetime format is incorrect

`void RTC_GetDatetime(RTC_Type *base, rtc_datetime_t *datetime)`

Get the RTC time and stores it in the given time structure.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the date and time details are stored.

`status_t RTC_SetAlarm(RTC_Type *base, const rtc_datetime_t *alarmTime)`

Set the RTC alarm time.

The function checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error.

Parameters

- base – RTC peripheral base address
- alarmTime – Pointer to structure where the alarm time is stored.

Returns

kStatus_Success: success in setting the RTC alarm
kStatus_InvalidArgument: Error because the alarm datetime format is incorrect
kStatus_Fail: Error because the alarm time has already passed

void RTC_GetAlarm(RTC_Type *base, rtc_datetime_t *datetime)

Return the RTC alarm time.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the alarm date and time details are stored.

static inline void RTC_EnableWakeupTimer(RTC_Type *base, bool enable)

Enable the RTC wake-up timer (1KHZ).

After calling this function, the RTC driver will use/un-use the RTC wake-up (1KHZ) at the same time.

Parameters

- base – RTC peripheral base address
- enable – Use/Un-use the RTC wake-up timer.
 - true: Use RTC wake-up timer at the same time.
 - false: Un-use RTC wake-up timer, RTC only use the normal seconds timer by default.

static inline uint32_t RTC_GetEnabledWakeupTimer(RTC_Type *base)

Get the enabled status of the RTC wake-up timer (1KHZ).

Parameters

- base – RTC peripheral base address

Returns

The enabled status of RTC wake-up timer (1KHZ).

static inline void RTC_EnableSubsecCounter(RTC_Type *base, bool enable)

Enable the RTC Sub-second counter (32KHZ).

Note: Only enable sub-second counter after RTC_ENA bit has been set to 1.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable RTC sub-second counter.
 - true: Enable RTC sub-second counter.
 - false: Disable RTC sub-second counter.

static inline uint32_t RTC_GetSubsecValue(const RTC_Type *base)

A read of 32KHZ sub-seconds counter.

Parameters

- base – RTC peripheral base address

Returns

Current value of the SUBSEC register

static inline void RTC_EnableWakeUpTimerInterruptFromDPD(RTC_Type *base, bool enable)
Enable the wake-up timer interrupt from deep power down mode.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable wake-up timer interrupt from deep power down mode.
 - true: Enable wake-up timer interrupt from deep power down mode.
 - false: Disable wake-up timer interrupt from deep power down mode.

static inline void RTC_EnableAlarmTimerInterruptFromDPD(RTC_Type *base, bool enable)
Enable the alarm timer interrupt from deep power down mode.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable alarm timer interrupt from deep power down mode.
 - true: Enable alarm timer interrupt from deep power down mode.
 - false: Disable alarm timer interrupt from deep power down mode.

static inline void RTC_EnableInterrupts(RTC_Type *base, uint32_t mask)
Enables the selected RTC interrupts.

Deprecated:

Do not use this function. It has been superseded by RTC_EnableAlarmTimerInterruptFromDPD and RTC_EnableWakeUpTimerInterruptFromDPD

Parameters

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

static inline void RTC_DisableInterrupts(RTC_Type *base, uint32_t mask)
Disables the selected RTC interrupts.

Deprecated:

Do not use this function. It has been superseded by RTC_EnableAlarmTimerInterruptFromDPD and RTC_EnableWakeUpTimerInterruptFromDPD

Parameters

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

static inline uint32_t RTC_GetEnabledInterrupts(RTC_Type *base)
Get the enabled RTC interrupts.

Deprecated:

Do not use this function. It will be deleted in next release version.

Parameters

- base – RTC peripheral base address

Returns

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

```
static inline uint32_t RTC_GetStatusFlags(RTC_Type *base)
```

Get the RTC status flags.

Parameters

- base – RTC peripheral base address

Returns

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

```
static inline void RTC_ClearStatusFlags(RTC_Type *base, uint32_t mask)
```

Clear the RTC status flags.

Parameters

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

```
static inline void RTC_EnableTimer(RTC_Type *base, bool enable)
```

Enable the RTC timer counter.

After calling this function, the RTC inner counter increments once a second when only using the RTC seconds timer (1hz), while the RTC inner wake-up timer countdown once a millisecond when using RTC wake-up timer (1KHZ) at the same time. RTC timer contain two timers, one is the RTC normal seconds timer, the other one is the RTC wake-up timer, the RTC enable bit is the master switch for the whole RTC timer, so user can use the RTC seconds (1HZ) timer independently, but they can't use the RTC wake-up timer (1KHZ) independently.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable RTC Timer counter.
 - true: Enable RTC Timer counter.
 - false: Disable RTC Timer counter.

```
static inline void RTC_StartTimer(RTC_Type *base)
```

Starts the RTC time counter.

Deprecated:

Do not use this function. It has been superceded by `RTC_EnableTimer`

After calling this function, the timer counter increments once a second provided `SR[TOF]` or `SR[TIF]` are not set.

Parameters

- base – RTC peripheral base address

static inline void RTC_StopTimer(RTC_Type *base)

Stops the RTC time counter.

Deprecated:

Do not use this function. It has been superceded by RTC_EnableTimer
RTC's seconds register can be written to only when the timer is stopped.

Parameters

- base – RTC peripheral base address

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enum _rtc_interrupt_enable

List of RTC interrupts.

Values:

enumerator kRTC_AlarmInterruptEnable

Alarm interrupt.

enumerator kRTC_WakeupInterruptEnable

Wake-up interrupt.

enum _rtc_status_flags

List of RTC flags.

Values:

enumerator kRTC_AlarmFlag

Alarm flag

enumerator kRTC_WakeupFlag

1kHz wake-up timer flag

typedef enum _rtc_interrupt_enable rtc_interrupt_enable_t

List of RTC interrupts.

typedef enum _rtc_status_flags rtc_status_flags_t

List of RTC flags.

typedef struct _rtc_datetime rtc_datetime_t

Structure is used to hold the date and time.

static inline void RTC_SetSecondsTimerMatch(RTC_Type *base, uint32_t matchValue)

Set the RTC seconds timer (1HZ) MATCH value.

Parameters

- base – RTC peripheral base address
- matchValue – The value to be set into the RTC MATCH register

static inline uint32_t RTC_GetSecondsTimerMatch(RTC_Type *base)

Read actual RTC seconds timer (1HZ) MATCH value.

Parameters

- base – RTC peripheral base address

Returns

The actual RTC seconds timer (1HZ) MATCH value.

```
static inline void RTC_SetSecondsTimerCount(RTC_Type *base, uint32_t countValue)
```

Set the RTC seconds timer (1HZ) COUNT value.

Parameters

- base – RTC peripheral base address
- countValue – The value to be loaded into the RTC COUNT register

```
static inline uint32_t RTC_GetSecondsTimerCount(RTC_Type *base)
```

Read the actual RTC seconds timer (1HZ) COUNT value.

Parameters

- base – RTC peripheral base address

Returns

The actual RTC seconds timer (1HZ) COUNT value.

```
static inline void RTC_SetWakeupCount(RTC_Type *base, uint16_t wakeupValue)
```

Enable the RTC wake-up timer (1KHZ) and set countdown value to the RTC WAKE register.

Parameters

- base – RTC peripheral base address
- wakeupValue – The value to be loaded into the WAKE register in RTC wake-up timer (1KHZ).

```
static inline uint16_t RTC_GetWakeupCount(RTC_Type *base)
```

Read the actual value from the WAKE register value in RTC wake-up timer (1KHZ)

Read the WAKE register twice and compare the result, if the value match, the time can be used.

Parameters

- base – RTC peripheral base address

Returns

The actual value of the WAKE register value in RTC wake-up timer (1KHZ).

```
static inline void RTC_Reset(RTC_Type *base)
```

Perform a software reset on the RTC module.

This resets all RTC registers to their reset value. The bit is cleared by software explicitly clearing it.

Parameters

- base – RTC peripheral base address

```
struct _rtc_datetime
```

#include <fsl_rtc.h> Structure is used to hold the date and time.

Public Members

uint16_t year

Range from 1970 to 2099.

uint8_t month

Range from 1 to 12.

uint8_t day

Range from 1 to 31 (depending on month).

uint8_t hour

Range from 0 to 23.

uint8_t minute

Range from 0 to 59.

uint8_t second

Range from 0 to 59.

2.46 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 duty cycle 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_STATEMSK_N(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);

2.47 skboot_authenticate

enum `_skboot_status`

SKBOOT return status.

Values:

enumerator `kStatus_SKBOOT_Success`

SKBOOT return success status.

enumerator `kStatus_SKBOOT_Fail`

SKBOOT return fail status.

enumerator `kStatus_SKBOOT_InvalidArgument`

SKBOOT return invalid argument status.

enumerator `kStatus_SKBOOT_KeyStoreMarkerInvalid`

SKBOOT return Keystore invalid Marker status.

enumerator `kStatus_SKBOOT_HashcryptFinishedWithStatusSuccess`

SKBOOT return Hashcrypt finished with the success status.

enumerator `kStatus_SKBOOT_HashcryptFinishedWithStatusFail`

SKBOOT return Hashcrypt finished with the fail status.

enum `_secure_bool`

Secure bool flag.

Values:

enumerator `kSECURE_TRUE`

Secure true flag.

enumerator `kSECURE_FALSE`

Secure false flag.

enumerator `kSECURE_CALLPROTECT_SECURITY_FLAGS`

Secure call protect the security flag.

enumerator `kSECURE_CALLPROTECT_IS_APP_READY`

Secure call protect the app is ready flag.

enumerator `kSECURE_TRACKER_VERIFIED`

Secure tracker verified flag.

typedef enum `_skboot_status` `skboot_status_t`

SKBOOT return status.

typedef enum `_secure_bool` `secure_bool_t`

Secure bool flag.

`skboot_status_t` `skboot_authenticate`(const uint8_t *imageStartAddr, `secure_bool_t` *isSignVerified)

Authenticate entry function with ARENA allocator init.

This is called by ROM boot or by ROM API `g_skbootAuthenticateInterface`

void `HASH_IRQHandler`(void)

Interface for image authentication API.

2.48 SPI: Serial Peripheral Interface Driver

2.49 SPI DMA Driver

```
status_t SPI_MasterTransferCreateHandleDMA(SPI_Type *base, spi_dma_handle_t *handle,  
                                           spi_dma_callback_t callback, void *userData,  
                                           dma_handle_t *txHandle, dma_handle_t  
                                           *rxHandle)
```

Initialize the SPI master DMA handle.

This function initializes the SPI master DMA handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, user need only call this API once to get the initialized handle.

Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – User callback function called at the end of a transfer.
- userData – User data for callback.
- txHandle – DMA handle pointer for SPI Tx, the handle shall be static allocated by users.
- rxHandle – DMA handle pointer for SPI Rx, the handle shall be static allocated by users.

```
status_t SPI_MasterTransferDMA(SPI_Type *base, spi_dma_handle_t *handle, spi_transfer_t  
                               *xfer)
```

Perform a non-blocking SPI transfer using DMA.

Note: This interface returned immediately after transfer initiates, users should call SPI_GetTransferStatus to poll the transfer status to check whether SPI transfer finished.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- xfer – Pointer to dma transfer 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_MasterHalfDuplexTransferDMA(SPI_Type *base, spi_dma_handle_t *handle,  
                                          spi_half_duplex_transfer_t *xfer)
```

Transfers a block of data using a DMA method.

This function using polling way to do the first half transimission and using DMA way to do the srcond half transimission, the transfer mechanism is half-duplex. When do the second half transimission, code will return right away. When all data is transferred, the callback function is called.

Parameters

- base – SPI base pointer
- handle – A pointer to the spi_master_dma_handle_t structure which stores the transfer state.
- xfer – A pointer to the spi_half_duplex_transfer_t structure.

Returns

status of status_t.

```
static inline status_t SPI_SlaveTransferCreateHandleDMA(SPI_Type *base, spi_dma_handle_t
*handle, spi_dma_callback_t callback,
void *userData, dma_handle_t
*txHandle, dma_handle_t *rxHandle)
```

Initialize the SPI slave DMA handle.

This function initializes the SPI slave DMA handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, user need only call this API once to get the initialized handle.

Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – User callback function called at the end of a transfer.
- userData – User data for callback.
- txHandle – DMA handle pointer for SPI Tx, the handle shall be static allocated by users.
- rxHandle – DMA handle pointer for SPI Rx, the handle shall be static allocated by users.

```
static inline status_t SPI_SlaveTransferDMA(SPI_Type *base, spi_dma_handle_t *handle,
spi_transfer_t *xfer)
```

Perform a non-blocking SPI transfer using DMA.

Note: This interface returned immediately after transfer initiates, users should call SPI_GetTransferStatus to poll the transfer status to check whether SPI transfer finished.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- xfer – Pointer to dma transfer 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.

```
void SPI_MasterTransferAbortDMA(SPI_Type *base, spi_dma_handle_t *handle)
```

Abort a SPI transfer using DMA.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.

```
status_t SPI_MasterTransferGetCountDMA(SPI_Type *base, spi_dma_handle_t *handle, size_t
*count)
```

Gets the master DMA transfered bytes.

This function gets the master DMA transfered bytes.

Parameters

- `base` – SPI peripheral base address.
- `handle` – A pointer to the `spi_dma_handle_t` structure which stores the transfer state.
- `count` – A number of bytes transferred by the non-blocking transaction.

Returns

status of `status_t`.

```
static inline void SPI_SlaveTransferAbortDMA(SPI_Type *base, spi_dma_handle_t *handle)
```

Abort a SPI transfer using DMA.

Parameters

- `base` – SPI peripheral base address.
- `handle` – SPI DMA handle pointer.

```
static inline status_t SPI_SlaveTransferGetCountDMA(SPI_Type *base, spi_dma_handle_t  
*handle, size_t *count)
```

Gets the slave DMA transferred bytes.

This function gets the slave DMA transferred bytes.

Parameters

- `base` – SPI peripheral base address.
- `handle` – A pointer to the `spi_dma_handle_t` structure which stores the transfer state.
- `count` – A number of bytes transferred by the non-blocking transaction.

Returns

status of `status_t`.

```
FSL_SPI_DMA_DRIVER_VERSION
```

SPI DMA driver version.

```
typedef struct _spi_dma_handle spi_dma_handle_t
```

```
typedef void (*spi_dma_callback_t)(SPI_Type *base, spi_dma_handle_t *handle, status_t status,  
void *userData)
```

SPI DMA callback called at the end of transfer.

```
struct _spi_dma_handle
```

`#include <fsl_spi_dma.h>` SPI DMA transfer handle, users should not touch the content of the handle.

Public Members

```
SPI_Type *base
```

SPI base address

```
volatile bool txInProgress
```

Send transfer finished

```
volatile bool rxInProgress
```

Receive transfer finished

```
uint8_t bytesPerFrame
```

Bytes in a frame for SPI transfer

`uint8_t lastwordBytes`
The Bytes of lastword for master

`uint16_t txDummy`
The dummy data for TX.

`uint32_t lastword`
The last word for master TX.

`dma_handle_t *txHandle`
DMA handler for SPI send

`dma_handle_t *rxHandle`
DMA handler for SPI receive

`spi_dma_callback_t callback`
Callback for SPI DMA transfer

`void *userData`
User Data for SPI DMA callback

`uint32_t state`
Internal state of SPI DMA transfer

`size_t transferSize`
Bytes need to be transfer

`uint32_t instance`
Index of SPI instance

`const uint8_t *txNextData`
The pointer of next time tx data

`size_t txRemainingBytes`
lastwordBytes + txRemainingBytes is number of data to be send [in bytes]

`uint8_t *rxNextData`
The pointer of next time rx data

`size_t rxRemainingBytes`
Number of data to be received [in bytes]

`bool isSlave`
SPI work in slave mode.

2.50 SPI Driver

`FSL_SPI_DRIVER_VERSION`
SPI driver version.

`enum _spi_xfer_option`
SPI transfer option.

Values:

`enumerator kSPI_FrameDelay`
A delay may be inserted, defined in the DLY register.

`enumerator kSPI_FrameAssert`
SSEL will be deasserted at the end of a transfer

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_txfifo_watermark`

txFIFO watermark values

Values:

enumerator `kSPI_TxFifo0`

SPI tx watermark is empty

enumerator `kSPI_TxFifo1`

SPI tx watermark at 1 item

enumerator `kSPI_TxFifo2`

SPI tx watermark at 2 items

enumerator `kSPI_TxFifo3`

SPI tx watermark at 3 items

enumerator `kSPI_TxFifo4`

SPI tx watermark at 4 items

enumerator `kSPI_TxFifo5`

SPI tx watermark at 5 items

enumerator `kSPI_TxFifo6`

SPI tx watermark at 6 items

enumerator `kSPI_TxFifo7`

SPI tx watermark at 7 items

enum _spi_rxfifo_watermark

rxFIFO watermark values

Values:

enumerator kSPI_RxFifo1

SPI rx watermark at 1 item

enumerator kSPI_RxFifo2

SPI rx watermark at 2 items

enumerator kSPI_RxFifo3

SPI rx watermark at 3 items

enumerator kSPI_RxFifo4

SPI rx watermark at 4 items

enumerator kSPI_RxFifo5

SPI rx watermark at 5 items

enumerator kSPI_RxFifo6

SPI rx watermark at 6 items

enumerator kSPI_RxFifo7

SPI rx watermark at 7 items

enumerator kSPI_RxFifo8

SPI rx watermark at 8 items

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

enum _spi_ssel

Slave select.

Values:

enumerator kSPI_Ssel0

Slave select 0

enumerator kSPI_Ssel1

Slave select 1

enumerator kSPI_Ssel2

Slave select 2

enumerator kSPI_Ssel3

Slave select 3

enum _spi_spol

ssel polarity

Values:

enumerator kSPI_Spol0ActiveHigh

enumerator kSPI_Spol1ActiveHigh

enumerator kSPI_Spol3ActiveHigh

enumerator kSPI_SpolActiveAllHigh

enumerator kSPI_SpolActiveAllLow

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_RxLvlIrq`
Rx level interrupt

enumerator `kSPI_TxLvlIrq`
Tx level interrupt

enum `_spi_statusflags`
SPI status flags.

Values:

enumerator `kSPI_TxEmptyFlag`
txFifo is empty

enumerator `kSPI_TxNotFullFlag`
txFifo is not full

enumerator `kSPI_RxNotEmptyFlag`
rxFIFO is not empty

enumerator `kSPI_RxFullFlag`
rxFIFO is full

typedef enum `_spi_xfer_option` `spi_xfer_option_t`
SPI transfer option.

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_txfifo_watermark` `spi_txfifo_watermark_t`
txFIFO watermark values

typedef enum `_spi_rxfifo_watermark` `spi_rxfifo_watermark_t`
rxFIFO watermark values

typedef enum `_spi_data_width` `spi_data_width_t`
Transfer data width.

typedef enum `_spi_ssel` `spi_ssel_t`
Slave select.

typedef enum `_spi_spol` `spi_spol_t`
ssel polarity

typedef struct `_spi_delay_config` `spi_delay_config_t`
SPI delay time configure structure. Note: The DLY register controls several programmable delays related to SPI signalling, it stands for how many SPI clock time will be inserted. The maxinum value of these delay time is 15.

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_half_duplex_transfer spi_half_duplex_transfer_t
```

SPI half-duplex(master only) transfer structure.

```
typedef struct _spi_config spi_config_t
```

Internal configuration structure used in 'spi' and 'spi_dma' driver.

```
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.

```
typedef void (*flexcomm_spi_master_irq_handler_t)(SPI_Type *base, spi_master_handle_t *handle)
```

Typedef for master interrupt handler.

```
typedef void (*flexcomm_spi_slave_irq_handler_t)(SPI_Type *base, spi_slave_handle_t *handle)
```

Typedef for slave interrupt handler.

```
volatile uint8_t s_dummyData[]
```

SPI default SSEL COUNT.

Global variable for dummy data value setting.

SPI_DUMMYDATA

SPI dummy transfer data, the data is sent while txBuff is NULL.

SPI_RETRY_TIMES

Retry times for waiting flag.

SPI_DATA(n)

SPI_CTRLMASK

SPI_ASSERTNUM_SSEL(n)

SPI_DEASSERTNUM_SSEL(n)

SPI_DEASSERT_ALL

SPI_FIFOWR_FLAGS_MASK

SPI_FIFOTRIG_TXLVL_GET(base)

SPI_FIFOTRIG_RXLVL_GET(base)

```
struct _spi_delay_config
```

#include <fsl_spi.h> SPI delay time configure structure. Note: The DLY register controls several programmable delays related to SPI signalling, it stands for how many SPI clock time will be inserted. The maxinum value of these delay time is 15.

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

spi_clock_polarity_t polarity

Clock polarity

spi_clock_phase_t phase

Clock phase

spi_shift_direction_t direction

MSB or LSB

uint32_t baudRate_Bps

Baud Rate for SPI in Hz

spi_data_width_t dataWidth

Width of the data

spi_ssel_t sselNum

Slave select number

spi_spol_t sselPol

Configure active CS polarity

uint8_t txWatermark

txFIFO watermark

uint8_t rxWatermark

rxFIFO watermark

spi_delay_config_t delayConfig

Delay configuration.

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 polarity
 Clock polarity

spi_clock_phase_t phase
 Clock phase

spi_shift_direction_t direction
 MSB or LSB

spi_data_width_t dataWidth
 Width of the data

spi_spol_t sselPol
 Configure active CS polarity

uint8_t txWatermark
 txFIFO watermark

uint8_t rxWatermark
 rxFIFO watermark

struct *_spi_transfer*
 #include <fsl_spi.h> SPI transfer structure.

Public Members

const uint8_t *txData
 Send buffer

uint8_t *rxData
 Receive buffer

uint32_t configFlags
 Additional option to control transfer, *spi_xfer_option_t*.

size_t dataSize
 Transfer bytes

struct *_spi_half_duplex_transfer*
 #include <fsl_spi.h> SPI half-duplex(master only) transfer structure.

Public Members

const uint8_t *txData
 Send buffer

uint8_t *rxData
 Receive buffer

size_t txDataSize
 Transfer bytes for transmit

size_t rxDataSize
 Transfer bytes

uint32_t configFlags

Transfer configuration flags, spi_xfer_option_t.

bool isPcsAssertInTransfer

If PCS pin keep assert between transmit and receive. true for assert and false for de-assert.

bool isTransmitFirst

True for transmit first and false for receive first.

struct __spi_config

#include <fsl_spi.h> Internal configuration structure used in 'spi' and 'spi_dma' driver.

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]

volatile int8_t toReceiveCount

The number of data expected to receive in data width. Since the received count and sent count should be the same to complete the transfer, if the sent count is x and the received count is y, toReceiveCount is x-y.

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]

uint8_t sselNum

Slave select number to be asserted when transferring data [Valid values: 0 to 3]

uint32_t configFlags

Additional option to control transfer

uint8_t txWatermark

txFIFO watermark

uint8_t rxWatermark

rxFIFO watermark

2.51 SYCTL: I2S bridging and signal sharing Configuration

void SYCTL_Init(SYCTL_Type *base)
SYCTL initial.

Parameters

- base – Base address of the SYCTL peripheral.

void SYCTL_Deinit(SYCTL_Type *base)
SYCTL deinit.

Parameters

- base – Base address of the SYCTL peripheral.

void SYCTL_SetFlexcommShareSet(SYCTL_Type *base, uint32_t flexCommIndex, uint32_t sckSet, uint32_t wsSet, uint32_t dataInSet, uint32_t dataOutSet)

SYCTL share set configure for flexcomm.

Parameters

- base – Base address of the SYCTL peripheral.
- flexCommIndex – index of flexcomm, reference `_sysctl_share_src`
- sckSet – share set for sck, reference `_sysctl_share_set_index`
- wsSet – share set for ws, reference `_sysctl_share_set_index`
- dataInSet – share set for data in, reference `_sysctl_share_set_index`
- dataOutSet – share set for data out, reference `_sysctl_dataout_mask`

void SYCTL_SetShareSet(SYCTL_Type *base, uint32_t flexCommIndex, *sysctl_fcctrlsel_signal_t* signal, uint32_t set)

SYCTL share set configure for separate signal.

Parameters

- base – Base address of the SYCTL peripheral
- flexCommIndex – index of flexcomm, reference `_sysctl_share_src`
- signal – FCCTRLSEL signal shift
- set – share set for sck, reference `_sysctl_share_set_index`

void SYCTL_SetShareSetSrc(SYCTL_Type *base, uint32_t setIndex, uint32_t sckShareSrc, uint32_t wsShareSrc, uint32_t dataInShareSrc, uint32_t dataOutShareSrc)

SYCTL share set source configure.

Parameters

- base – Base address of the SYCTL peripheral
- setIndex – index of share set, reference `_sysctl_share_set_index`
- sckShareSrc – sck source for this share set, reference `_sysctl_share_src`
- wsShareSrc – ws source for this share set, reference `_sysctl_share_src`
- dataInShareSrc – data in source for this share set, reference `_sysctl_share_src`
- dataOutShareSrc – data out source for this share set, reference `_sysctl_dataout_mask`

```
void SYSCTL_SetShareSignalSrc(SYSCTL_Type *base, uint32_t setIndex,
                             sysctl_sharedctrlset_signal_t signal, uint32_t shareSrc)
```

SYSCTL sck source configure.

Parameters

- base – Base address of the SYSCTL peripheral
- setIndex – index of share set, reference `_sysctl_share_set_index`
- signal – FCCTRLSEL signal shift
- shareSrc – sck source fro this share set,reference `_sysctl_share_src`

FSL_SYSCTL_DRIVER_VERSION

Group sysctl driver version for SDK.

Version 2.0.5.

```
enum _sysctl_share_set_index
```

SYSCTL share set.

Values:

```
enumerator kSYSCTL_ShareSet0
```

share set 0

```
enumerator kSYSCTL_ShareSet1
```

share set 1

```
enum _sysctl_fcctrlsel_signal
```

SYSCTL flexcomm signal.

Values:

```
enumerator kSYSCTL_FlexcommSignalSCK
```

SCK signal

```
enumerator kSYSCTL_FlexcommSignalWS
```

WS signal

```
enumerator kSYSCTL_FlexcommSignalDataIn
```

Data in signal

```
enumerator kSYSCTL_FlexcommSignalDataOut
```

Data out signal

```
enum _sysctl_share_src
```

SYSCTL flexcomm index.

Values:

```
enumerator kSYSCTL_Flexcomm0
```

share set 0

```
enumerator kSYSCTL_Flexcomm1
```

share set 1

```
enumerator kSYSCTL_Flexcomm2
```

share set 2

```
enumerator kSYSCTL_Flexcomm4
```

share set 4

```
enumerator kSYSCTL_Flexcomm5
```

share set 5

```
    enumerator kSYSCTL_Flexcomm6
        share set 6
    enumerator kSYSCTL_Flexcomm7
        share set 7
enum __sysctl_dataout_mask
    SYSCTL shared data out mask.
    Values:
    enumerator kSYSCTL_Flexcomm0DataOut
        share set 0
    enumerator kSYSCTL_Flexcomm1DataOut
        share set 1
    enumerator kSYSCTL_Flexcomm2DataOut
        share set 2
    enumerator kSYSCTL_Flexcomm4DataOut
        share set 4
    enumerator kSYSCTL_Flexcomm5DataOut
        share set 5
    enumerator kSYSCTL_Flexcomm6DataOut
        share set 6
    enumerator kSYSCTL_Flexcomm7DataOut
        share set 7
enum __sysctl_sharedctrlset_signal
    SYSCTL flexcomm signal.
    Values:
    enumerator kSYSCTL_SharedCtrlSignalSCK
        SCK signal
    enumerator kSYSCTL_SharedCtrlSignalWS
        WS signal
    enumerator kSYSCTL_SharedCtrlSignalDataIn
        Data in signal
    enumerator kSYSCTL_SharedCtrlSignalDataOut
        Data out signal
typedef enum __sysctl_fcctrlsel_signal sysctl_fcctrlsel_signal_t
    SYSCTL flexcomm signal.
typedef enum __sysctl_sharedctrlset_signal sysctl_sharedctrlset_signal_t
    SYSCTL flexcomm signal.
```

2.52 USART: Universal Synchronous/Asynchronous Receiver/Transmitter Driver

2.53 USART DMA Driver

```
status_t USART_TransferCreateHandleDMA(USART_Type *base, usart_dma_handle_t *handle,  
                                       usart_dma_transfer_callback_t callback, void  
                                       *userData, dma_handle_t *txDmaHandle,  
                                       dma_handle_t *rxDmaHandle)
```

Initializes the USART handle which is used in transactional functions.

Parameters

- base – USART peripheral base address.
- handle – Pointer to `usart_dma_handle_t` structure.
- callback – Callback function.
- userData – User data.
- txDmaHandle – User-requested DMA handle for TX DMA transfer.
- rxDmaHandle – User-requested DMA handle for RX DMA transfer.

```
status_t USART_TransferSendDMA(USART_Type *base, usart_dma_handle_t *handle,  
                               usart_transfer_t *xfer)
```

Sends data using DMA.

This function sends data using DMA. This is a non-blocking function, which returns right away. When all data is sent, the send callback function is called.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- xfer – USART DMA transfer structure. See `usart_transfer_t`.

Return values

- `kStatus_Success` – if succeed, others failed.
- `kStatus_USART_TxBusy` – Previous transfer on going.
- `kStatus_InvalidArgument` – Invalid argument.

```
status_t USART_TransferReceiveDMA(USART_Type *base, usart_dma_handle_t *handle,  
                                  usart_transfer_t *xfer)
```

Receives data using DMA.

This function receives data using DMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

- base – USART peripheral base address.
- handle – Pointer to `usart_dma_handle_t` structure.
- xfer – USART DMA transfer structure. See `usart_transfer_t`.

Return values

- `kStatus_Success` – if succeed, others failed.
- `kStatus_USART_RxBusy` – Previous transfer on going.
- `kStatus_InvalidArgument` – Invalid argument.

```
void USART_TransferAbortSendDMA(USART_Type *base, usart_dma_handle_t *handle)
```

Aborts the sent data using DMA.

This function aborts send data using DMA.

Parameters

- base – USART peripheral base address
- handle – Pointer to `usart_dma_handle_t` structure

`void USART__TransferAbortReceiveDMA(USART_Type *base, usart_dma_handle_t *handle)`

Aborts the received data using DMA.

This function aborts the received data using DMA.

Parameters

- base – USART peripheral base address
- handle – Pointer to `usart_dma_handle_t` structure

`status_t USART__TransferGetReceiveCountDMA(USART_Type *base, usart_dma_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;

`status_t USART__TransferGetSendCountDMA(USART_Type *base, usart_dma_handle_t *handle, uint32_t *count)`

Get the number of bytes that have been sent.

This function gets the number of bytes that have been sent.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- count – Sent bytes count.

Return values

- `kStatus__NoTransferInProgress` – No receive in progress.
- `kStatus__InvalidArgument` – Parameter is invalid.
- `kStatus__Success` – Get successfully through the parameter count;

`FSL_USART_DMA_DRIVER_VERSION`

USART dma driver version.

`typedef struct usart_dma_handle usart_dma_handle_t`

`typedef void (*usart_dma_transfer_callback_t)(USART_Type *base, usart_dma_handle_t *handle, status_t status, void *userData)`

UART transfer callback function.

`struct usart_dma_handle`

`#include <fsl_usart_dma.h>` UART DMA handle.

Public Members

USART_Type *base

UART peripheral base address.

usart_dma_transfer_callback_t callback

Callback function.

void *userData

UART callback function parameter.

size_t rxDataSizeAll

Size of the data to receive.

size_t txDataSizeAll

Size of the data to send out.

dma_handle_t *txDmaHandle

The DMA TX channel used.

dma_handle_t *rxDmaHandle

The DMA RX channel used.

volatile uint8_t txState

TX transfer state.

volatile uint8_t rxState

RX transfer state

2.54 USART Driver

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 TX and RX, and 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 = 115200U`; `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.

status_t USART_Enable32kMode(USART_Type *base, uint32_t baudRate_Bps, bool enableMode32k, uint32_t srcClock_Hz)

Enable 32 kHz mode which USART uses clock from the RTC oscillator as the clock source.

Please note that in order to use a 32 kHz clock to operate USART properly, the RTC oscillator and its 32 kHz output must be manually enabled by user, by calling RTC_Init and setting SYSCON_RTCOSCCTRL_EN bit to 1. And in 32kHz clocking mode the USART can only work at 9600 baudrate or at the baudrate that 9600 can evenly divide, eg: 4800, 3200.

Parameters

- base – USART peripheral base address.
- baudRate_Bps – USART baudrate to be set..
- enableMode32k – true is 32k mode, false is normal mode.
- 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.

`void USART_Enable9bitMode(USART_Type *base, bool enable)`

Enable 9-bit data mode for USART.

This function set the 9-bit mode for USART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- `base` – USART peripheral base address.
- `enable` – true to enable, false to disable.

`static inline void USART_SetMatchAddress(USART_Type *base, uint8_t address)`

Set the USART slave address.

This function configures the address for USART module that works as slave in 9-bit data mode. When the address detection is enabled, the frame it receives with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note: Any USART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

- `base` – USART peripheral base address.
- `address` – USART slave address.

`static inline void USART_EnableMatchAddress(USART_Type *base, bool match)`

Enable the USART match address feature.

Parameters

- `base` – USART peripheral base address.
- `match` – true to enable match address, false to disable.

`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 TX is empty:

```
if (kUSART_TxFifoNotFullFlag & 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. The mask is a logical OR of enumeration members. See `kUSART_AllClearFlags`. For example:

```
USART_ClearStatusFlags(USART1, kUSART_TxError | kUSART_RxError)
```

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 empty interrupt and RX full interrupt:

```
USART_EnableInterrupts(USART1, kUSART_TxLevelInterruptEnable | kUSART_
↳ RxLevelInterruptEnable);
```

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 empty interrupt and RX full interrupt:

```
USART_DisableInterrupts(USART1, kUSART_TxLevelInterruptEnable | kUSART_
↳ RxLevelInterruptEnable);
```

Parameters

- base – USART peripheral base address.
- mask – The interrupts to disable. Logical OR of `_usart_interrupt_enable`.

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_EnableTxDMA(USART_Type *base, bool enable)

Enable DMA for Tx.

static inline void USART_EnableRxDMA(USART_Type *base, bool enable)

Enable DMA for Rx.

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__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__SetRxFifoWatermark(USART_Type *base, uint8_t water)

Sets the rx FIFO watermark.

Parameters

- base – USART peripheral base address.
- water – Rx FIFO watermark.

static inline void USART__SetTxFifoWatermark(USART_Type *base, uint8_t water)

Sets the tx FIFO watermark.

Parameters

- base – USART peripheral base address.
- water – Tx FIFO watermark.

static inline void USART__WriteByte(USART_Type *base, uint8_t data)

Writes to the FIFOWR register.

This function writes data to the txFIFO directly. The upper layer must ensure that txFIFO 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 FIFORD register directly.

This function reads data from the rxFIFO directly. The upper layer must ensure that the rxFIFO is not empty before calling this function.

Parameters

- base – USART peripheral base address.

Returns

The byte read from USART data register.

```
static inline uint8_t USART_GetRxFifoCount(USART_Type *base)
```

Gets the rx FIFO data count.

Parameters

- base – USART peripheral base address.

Returns

rx FIFO data count.

```
static inline uint8_t USART_GetTxFifoCount(USART_Type *base)
```

Gets the tx FIFO data count.

Parameters

- base – USART peripheral base address.

Returns

tx FIFO data count.

```
void USART_SendAddress(USART_Type *base, uint8_t address)
```

Transmit an address frame in 9-bit data mode.

Parameters

- base – USART peripheral base address.
- address – USART slave address.

```
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 or for the TX FIFO to have room and writes data to the TX buffer.

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_InvalidArgument – Invalid argument.
- 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 or for RX FIFO to have data and read data from the TX register.

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 rxFIFO 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.

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 `remainBtyes` 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 sent out to bus.

This function gets the number of bytes that have been sent out to bus 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 txFIFO.

enumerator `kStatus_USART_RxError`

Error happens on rxFIFO.

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_BaudrateNotSupport`

Baudrate is not support in current clock source

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_parity_mode

USART parity mode.

Values:

enumerator kUSART_ParityDisabled

Parity disabled

enumerator kUSART_ParityEven

Parity enabled, type even, bit setting: PE | PT = 10

enumerator kUSART_ParityOdd

Parity enabled, type odd, bit setting: PE | PT = 11

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_txfifo_watermark

txFIFO watermark values

Values:

enumerator kUSART_TxFifo0

USART tx watermark is empty

enumerator kUSART_TxFifo1

USART tx watermark at 1 item

enumerator kUSART_TxFifo2

USART tx watermark at 2 items

enumerator kUSART_TxFifo3

USART tx watermark at 3 items

enumerator kUSART_TxFifo4
USART tx watermark at 4 items

enumerator kUSART_TxFifo5
USART tx watermark at 5 items

enumerator kUSART_TxFifo6
USART tx watermark at 6 items

enumerator kUSART_TxFifo7
USART tx watermark at 7 items

enum _usart_rxfifo_watermark
rxFIFO watermark values

Values:

enumerator kUSART_RxFifo1
USART rx watermark at 1 item

enumerator kUSART_RxFifo2
USART rx watermark at 2 items

enumerator kUSART_RxFifo3
USART rx watermark at 3 items

enumerator kUSART_RxFifo4
USART rx watermark at 4 items

enumerator kUSART_RxFifo5
USART rx watermark at 5 items

enumerator kUSART_RxFifo6
USART rx watermark at 6 items

enumerator kUSART_RxFifo7
USART rx watermark at 7 items

enumerator kUSART_RxFifo8
USART rx watermark at 8 items

enum _usart_interrupt_enable
USART interrupt configuration structure, default settings all disabled.

Values:

enumerator kUSART_TxErrorInterruptEnable

enumerator kUSART_RxErrorInterruptEnable

enumerator kUSART_TxLevelInterruptEnable

enumerator kUSART_RxLevelInterruptEnable

enumerator kUSART_TxIdleInterruptEnable
Transmitter idle.

enumerator kUSART_CtsChangeInterruptEnable
Change in the state of the CTS input.

enumerator kUSART_RxBreakChangeInterruptEnable
Break condition asserted or deasserted.

enumerator kUSART_RxStartInterruptEnable

Rx start bit detected.

enumerator kUSART_FramingErrorInterruptEnable

Framing error detected.

enumerator kUSART_ParityErrorInterruptEnable

Parity error detected.

enumerator kUSART_NoiseErrorInterruptEnable

Noise error detected.

enumerator kUSART_AutoBaudErrorInterruptEnable

Auto baudrate error detected.

enumerator kUSART_AllInterruptEnables

enum __usart_flags

USART status flags.

This provides constants for the USART status flags for use in the USART functions.

Values:

enumerator kUSART_TxError

TXERR bit, sets if TX buffer is error

enumerator kUSART_RxError

RXERR bit, sets if RX buffer is error

enumerator kUSART_TxFifoEmptyFlag

TXEMPTY bit, sets if TX buffer is empty

enumerator kUSART_TxFifoNotFullFlag

TXNOTFULL bit, sets if TX buffer is not full

enumerator kUSART_RxFifoNotEmptyFlag

RXNOEMPTY bit, sets if RX buffer is not empty

enumerator kUSART_RxFifoFullFlag

RXFULL bit, sets if RX buffer is full

enumerator kUSART_RxIdleFlag

Receiver idle.

enumerator kUSART_TxIdleFlag

Transmitter idle.

enumerator kUSART_CtsAssertFlag

CTS signal high.

enumerator kUSART_CtsChangeFlag

CTS signal changed interrupt status.

enumerator kUSART_BreakDetectFlag

Break detected. Self cleared when rx pin goes high again.

enumerator kUSART_BreakDetectChangeFlag

Break detect change interrupt flag. A change in the state of receiver break detection.

enumerator kUSART_RxStartFlag

Rx start bit detected interrupt flag.

enumerator `kUSART_FramingErrorFlag`

Framing error interrupt flag.

enumerator `kUSART_ParityErrorFlag`

parity error interrupt flag.

enumerator `kUSART_NoiseErrorFlag`

Noise error interrupt flag.

enumerator `kUSART_AutobaudErrorFlag`

Auto baudrate error interrupt flag, caused by the baudrate counter timeout before the end of start bit.

enumerator `kUSART_AllClearFlags`

typedef enum `_usart_sync_mode` `usart_sync_mode_t`

USART synchronous mode.

typedef enum `_usart_parity_mode` `usart_parity_mode_t`

USART parity 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 enum `_usart_txfifo_watermark` `usart_txfifo_watermark_t`

txFIFO watermark values

typedef enum `_usart_rxfifo_watermark` `usart_rxfifo_watermark_t`

rxFIFO watermark values

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.

typedef void (*`flexcomm_usart_irq_handler_t`)(`USART_Type` *`base`, `usart_handle_t` *`handle`)

Typedef for usart interrupt handler.

uint32_t `USART_GetInstance(USART_Type *base)`

Returns instance number for USART peripheral base address.

`USART_FIFOTRIG_TXLVL_GET(base)`

`USART_FIFOTRIG_RXLVL_GET(base)`

`UART_RETRY_TIMES`

Retry times for waiting flag.

Defining to zero means to keep waiting for the flag until it is assert/deassert in blocking transfer, otherwise the program will wait until the `UART_RETRY_TIMES` counts down to 0, if the flag still remains unchanged then program will return `kStatus_USART_Timeout`. It is

not advised to use this macro in formal application to prevent any hardware error because the actual wait period is affected by the compiler and optimization.

```
struct __usart_config
```

#include <fsl_usart.h> USART configuration structure.

Public Members

```
uint32_t baudRate_Bps
```

USART baud rate

```
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

```
bool loopback
```

Enable peripheral loopback

```
bool enableRx
```

Enable RX

```
bool enableTx
```

Enable TX

```
bool enableContinuousSCLK
```

USART continuous Clock generation enable in synchronous master mode.

```
bool enableMode32k
```

USART uses 32 kHz clock from the RTC oscillator as the clock source.

```
bool enableHardwareFlowControl
```

Enable hardware control RTS/CTS

```
usart_txfifo_watermark_t txWatermark
```

txFIFO watermark

```
usart_rxfifo_watermark_t rxWatermark
```

rxFIFO watermark

```
usart_sync_mode_t syncMode
```

Transfer mode select - asynchronous, synchronous master, synchronous slave.

```
usart_clock_polarity_t clockPolarity
```

Selects the clock polarity and sampling edge in synchronous mode.

```
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

`uint8_t txWatermark`
txFIFO watermark

`uint8_t rxWatermark`
rxFIFO watermark

`union __unnamed32__`

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.

2.55 UTICK: MictoTick Timer Driver

`void UTICK_Init(UTICK_Type *base)`

Initializes an UTICK by turning its bus clock on.

`void UTICK_Deinit(UTICK_Type *base)`

Deinitializes a UTICK instance.

This function shuts down Utick bus clock

Parameters

- `base` – UTICK peripheral base address.

`uint32_t UTICK_GetStatusFlags(UTICK_Type *base)`

Get Status Flags.

This returns the status flag

Parameters

- `base` – UTICK peripheral base address.

Returns

status register value

`void UTICK_ClearStatusFlags(UTICK_Type *base)`

Clear Status Interrupt Flags.

This clears intr status flag

Parameters

- `base` – UTICK peripheral base address.

Returns

none

`void UTICK_SetTick(UTICK_Type *base, utick_mode_t mode, uint32_t count, utick_callback_t cb)`

Starts UTICK.

This function starts a repeat/onetime countdown with an optional callback

Parameters

- `base` – UTICK peripheral base address.
- `mode` – UTICK timer mode (ie `kUTICK_onetime` or `kUTICK_repeat`)
- `count` – UTICK timer mode (ie `kUTICK_onetime` or `kUTICK_repeat`)
- `cb` – UTICK callback (can be left as `NULL` if none, otherwise should be a `void func(void)`)

Returns

none

`void UTICK_HandleIRQ(UTICK_Type *base, utick_callback_t cb)`

UTICK Interrupt Service Handler.

This function handles the interrupt and refers to the callback array in the driver to callback user (as per request in `UTICK_SetTick()`). if no user callback is scheduled, the interrupt will simply be cleared.

Parameters

- `base` – UTICK peripheral base address.

- `cb` – callback scheduled for this instance of UTICK

Returns

none

FSL_UTICK_DRIVER_VERSION

UTICK driver version 2.0.5.

enum `_utick_mode`

UTICK timer operational mode.

Values:

enumerator `kUTICK_Onetime`

Trigger once

enumerator `kUTICK_Repeat`

Trigger repeatedly

typedef enum `_utick_mode` `utick_mode_t`

UTICK timer operational mode.

typedef void (`*utick_callback_t`)(void)

UTICK callback function.

2.56 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 = 0xFFFFFfU;
config->timeoutValue = 0xFFFFFfU;
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 0xFFFFFFFF (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

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 FM-STR_PipeOpen for more details.

Internal types The table describes the data types used internally by the FreeMASTER driver. The data types are declared in the platform-specific header file and they are not available in the application code.

<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
- FreeMASTER community area: community.nxp.com/community/freemaster
- FreeMASTER GitHub code repo: <https://github.com/nxp-mcuxpresso/mcux-freemaster>
- MCUXpresso SDK home: www.nxp.com/mcuxpresso
- MCUXpresso SDK builder: mcuxpresso.nxp.com/en

Documents

- *FreeMASTER Usage Serial Driver Implementation* (document [AN4752](#))
- *Integrating FreeMASTER Time Debugging Tool With CodeWarrior For Microcontrollers v10.X Project* (document [AN4771](#))
- *Flash Driver Library For MC56F847xx And MC56F827xx DSC Family* (document [AN4860](#))

Revision history This Table summarizes the changes done to this document since the initial release.

Revision	Date	Description
1.0	03/2006	Limited initial release
2.0	09/2007	Updated for FreeMASTER version. New Freescale document template used.
2.1	12/2007	Added description of the new Fast Recorder feature and its API.
2.2	04/2010	Added support for MPC56xx platform, Added new API for use CAN interface.
2.3	04/2011	Added support for Kxx Kinetis platform and MQX operating system.
2.4	06/2011	Serial driver update, adds support for USB CDC interface.
2.5	08/2011	Added Packet Driven BDM interface.
2.7	12/2013	Added FLEXCAN32 interface, byte access and isr callback configuration option.
2.8	06/2014	Removed obsolete license text, see the software package content for up-to-date license.
2.9	03/2015	Update for driver version 1.8.2 and 1.9: FreeMASTER Pipes, TSA Active Content, LIN Transport Layer support, DEBUG-TX communication troubleshooting, Kinetis SDK support.
3.0	08/2016	Update for driver version 2.0: Added support for MPC56xx, MPC57xx, KEAxx and S32Kxx platforms. New NXP document template as well as new license agreement used. added MCAN interface. Folders structure at the installation destination was rearranged.
4.0	04/2019	Update for driver released as part of FreeMASTER v3.0 and MCUXpresso SDK 2.6. Updated to match new V4 serial communication protocol and new configuration options. This version of the document removes substantial portion of outdated information related to S08, S12, ColdFire, Power and other legacy platforms.
4.1	04/2020	Minor update for FreeMASTER driver included in MCUXpresso SDK 2.8.
4.2	09/2020	Added example applications description and information about the MCUXpresso Config Tools. Fixed the pipe-related API description.
4.3	10/2024	Added description of Network and Segger J-Link RTT interface configuration. Accompanying the MCUXpresso SDK version 24.12.00.
4.4	04/2025	Added Zephyr-specific information. Accompanying the MCUXpresso SDK version 25.06.00.

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.

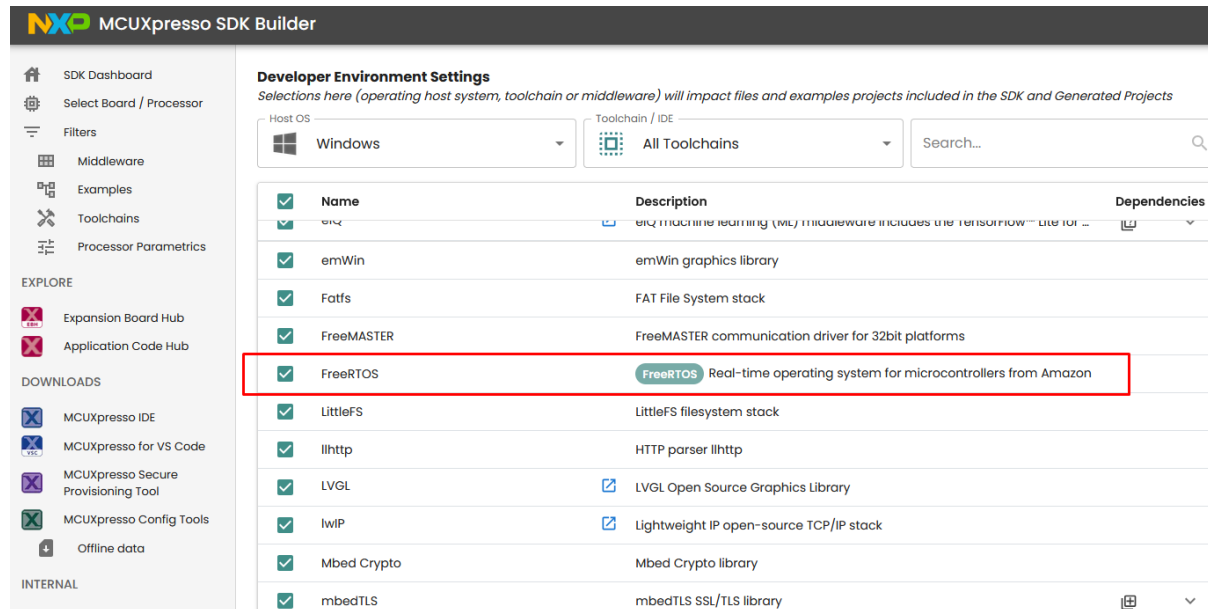
The MCUXpresso SDK framework also contains a set of FreeRTOS examples which show basic FreeRTOS OS features. This makes it easy to start a new FreeRTOS project or begin experimenting with FreeRTOS OS. Selected drivers and middleware are RTOS ready with related FreeRTOS adaptation layer.

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

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 );
    }
```

(continues on next page)

(continued from previous page)

```

/* 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
AWS IoT Device SDK for Embedded C FreeRTOS.org

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
AWS IoT Device SDK for Embedded C FreeRTOS.org

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	AWS IoT Device SDK for Embedded C	POSIX sockets for TCP/IP and OpenSSL for TLS stack
FreeRTOS	FreeRTOS/FreeRTOS	FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack
FreeRTOS	FreeRTOS AWS Reference Integrations	Based on Secure Sockets Abstraction

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of 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
coreMQTT Agent Demos
FreeRTOS/FreeRTOS

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
AWS IoT Device SDK for Embedded C FreeRTOS.org

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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```
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/compiler.
- 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](#).