



MCUXpresso SDK Documentation

Release 25.09.00



NXP
Sep 19, 2025



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This documentation contains information specific to the frdmk32l3a6 board.

Chapter 1

FRDM-K32L3A6

1.1 Overview

The NXP FRDM-K32L3A6 is a development board for the Kinetis K32L3A60 72 MHz 32-bit ARM Cortex-M4 and ARM Cortex-M0P MCUs



MCU device and part on board is shown below:

- Device: K32L3A60
- PartNumber: K32L3A60VPJ1A

1.2 Getting Started with MCUXpresso SDK Package

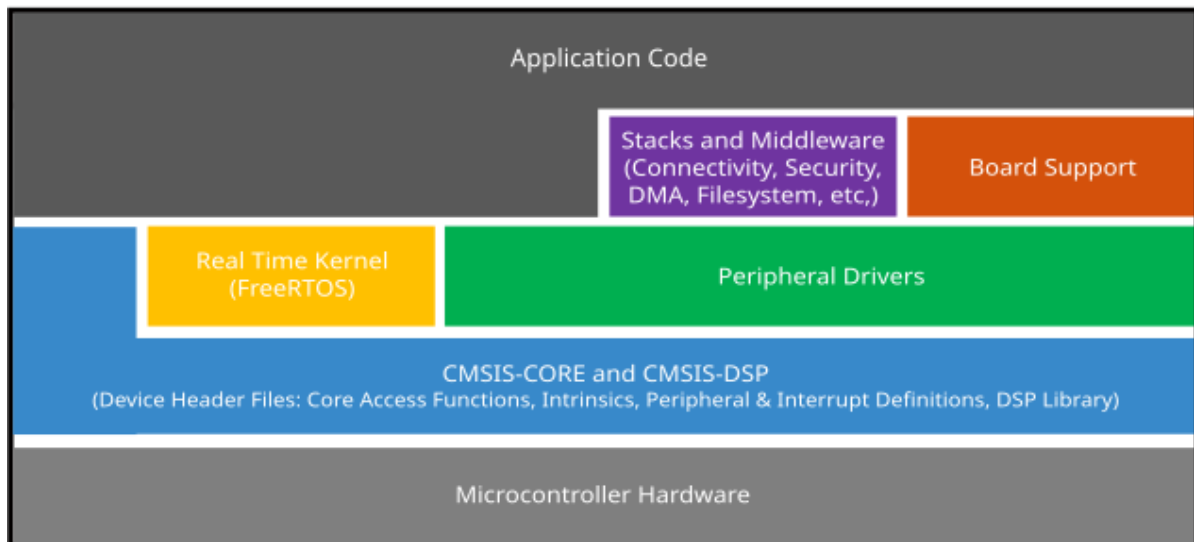
1.2.1 Getting Started with MCUXpresso SDK Package

Overview

The NXP MCUXpresso software and tools offer comprehensive development solutions designed to optimize, ease, and help accelerate embedded system development of applications based on general purpose, crossover, and Bluetooth-enabled MCUs from NXP. The MCUXpresso SDK includes a flexible set of peripheral drivers designed to speed up and simplify development of embedded applications. Along with the peripheral drivers, the MCUXpresso SDK provides an extensive and rich set of example applications covering everything from basic peripheral use case examples to full demo applications. The MCUXpresso SDK contains optional RTOS integrations such as FreeRTOS and Azure RTOS, and various other middleware to support rapid development.

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

For more details about MCUXpresso SDK, see [MCUXpresso Software Development Kit \(SDK\)](#).



MCUXpresso SDK board support package folders

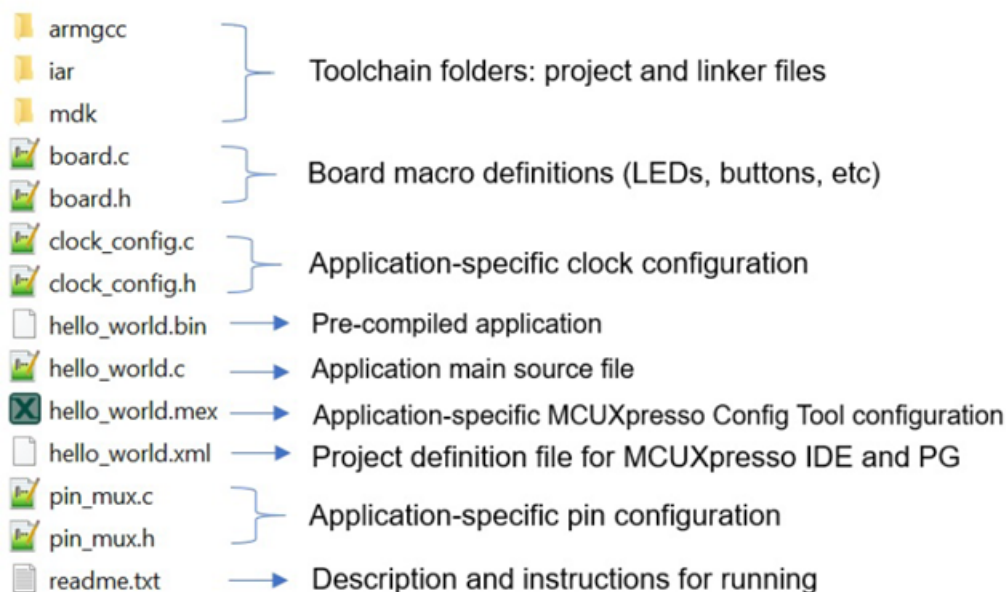
MCUXpresso SDK board support package provides example applications for NXP development and evaluation boards for Arm Cortex-M cores including Freedom, Tower System, and LPCXpresso boards. Board support packages are found inside the top-level boards folder and each supported board has its own folder (an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

- `cmsis_driver_examples`: Simple applications intended to show how to use CMSIS drivers.
- `demo_apps`: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- `driver_examples`: Simple applications that show how to use the MCUXpresso SDK's peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI conversion using DMA).
- `emwin_examples`: Applications that use the emWin GUI widgets.
- `rtos_examples`: Basic FreeRTOS OS examples that show the use of various RTOS objects (semaphores, queues, and so on) and interfaces with the MCUXpresso SDK's RTOS drivers
- `usb_examples`: Applications that use the USB host/device/OTG stack.

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

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

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



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

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

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

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

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

Run a demo using MCUXpresso IDE

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

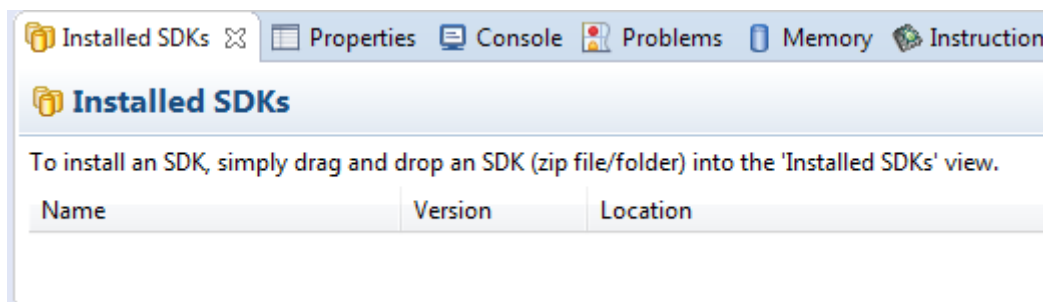
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The `hello_world` demo application targeted for the hardware platform is

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

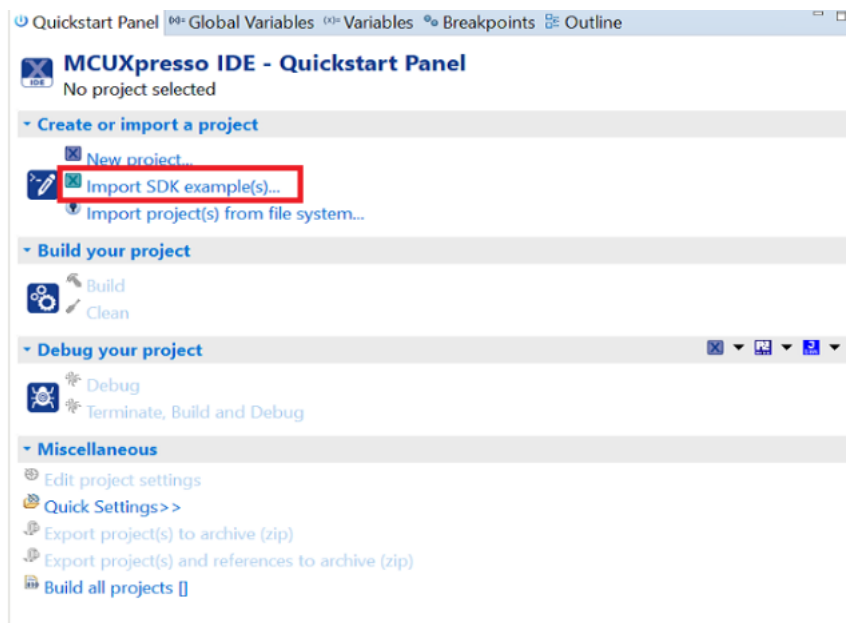
Select the workspace location Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse which uses workspace to store information about its current configuration, and in some use cases, source files for the projects are in the workspace.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

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

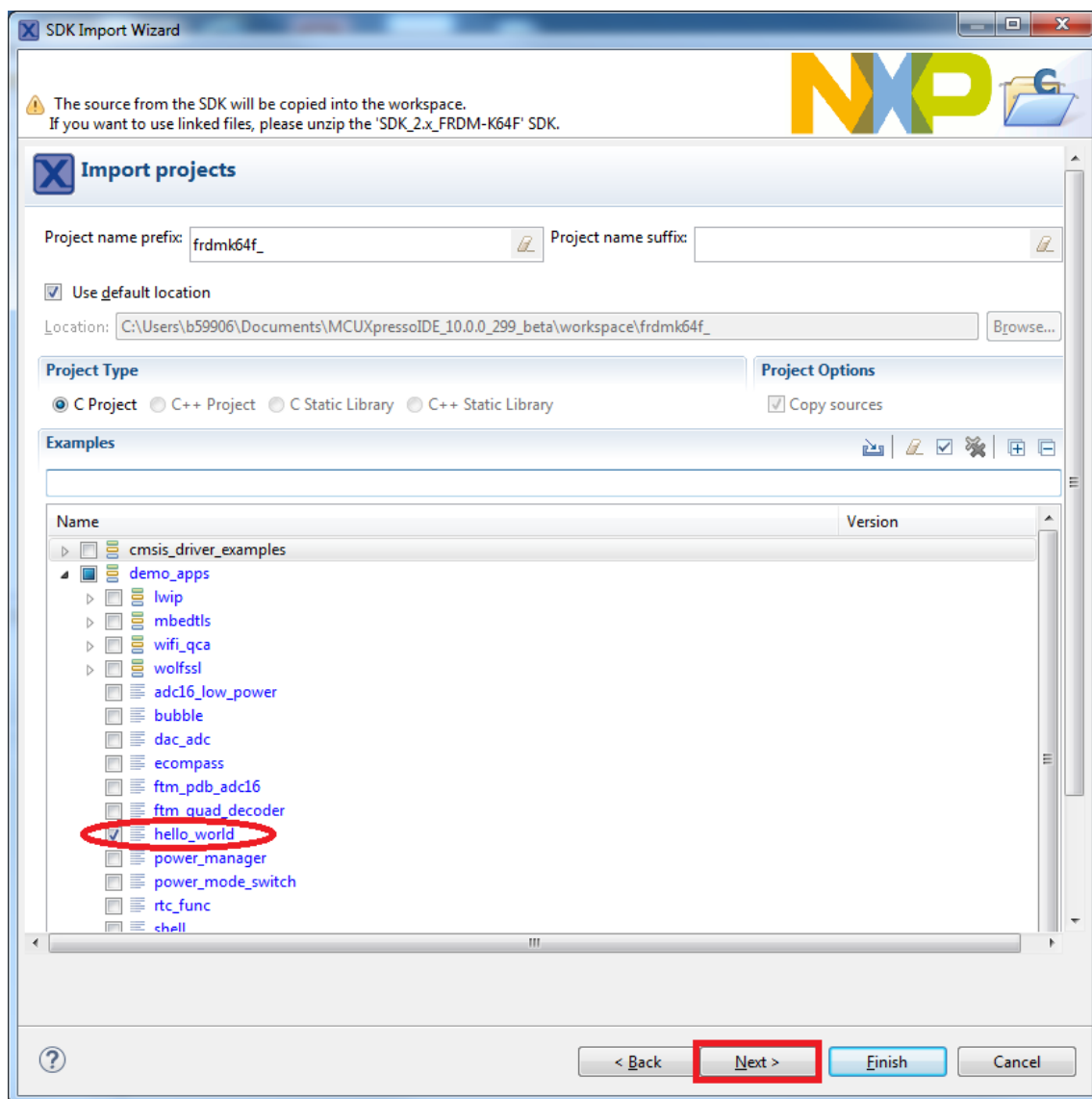
1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.



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



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



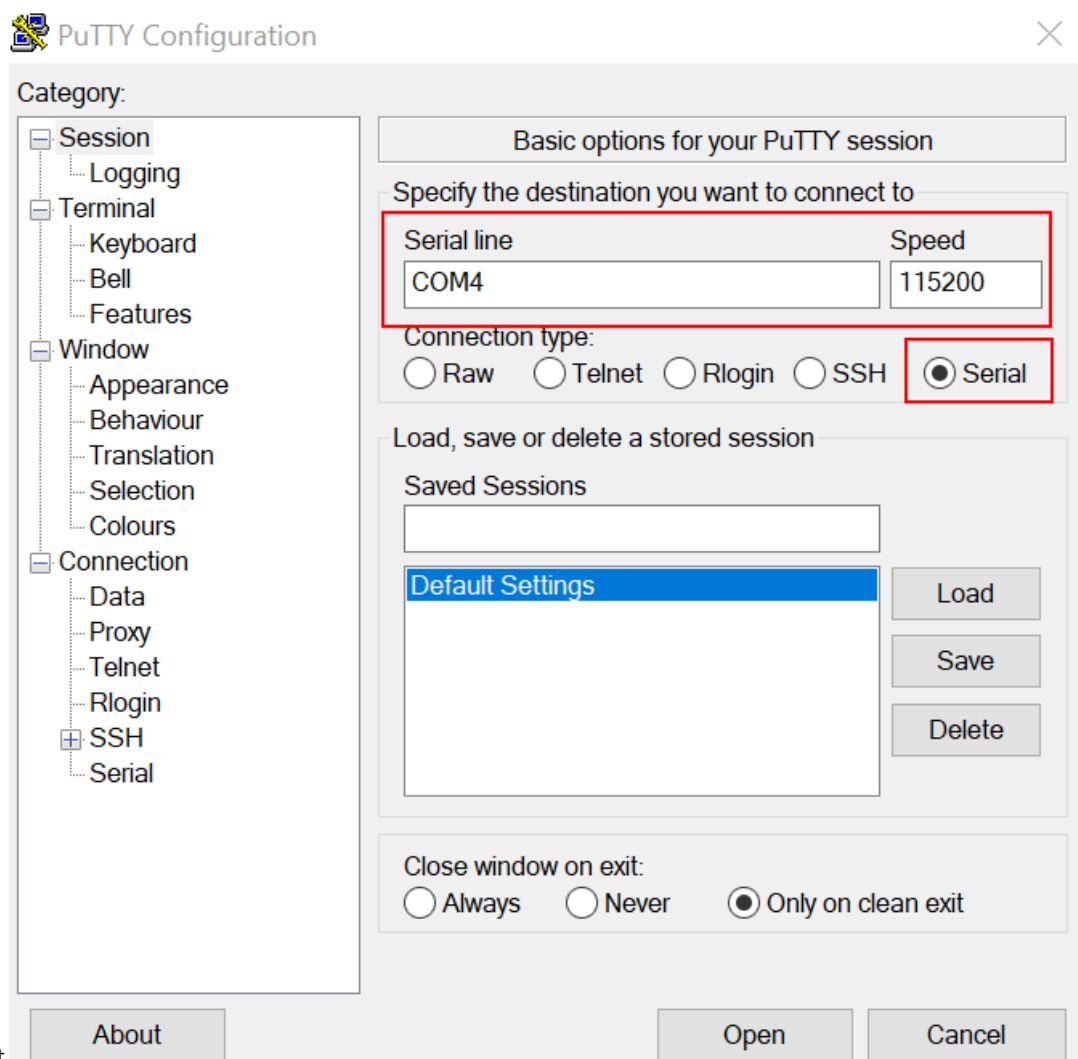
5. Ensure **Redlib: Use floating-point version of printf** is selected if the example prints floating-point numbers on the terminal for demo applications such as `adc_basic`, `adc_burst`, `adc_dma`, and `adc_interrupt`. Otherwise, it is not necessary to select this option. Then, click **Finish**.

Run an example application For more information on debug probe support in the MCUXpresso IDE, see community.nxp.com.

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

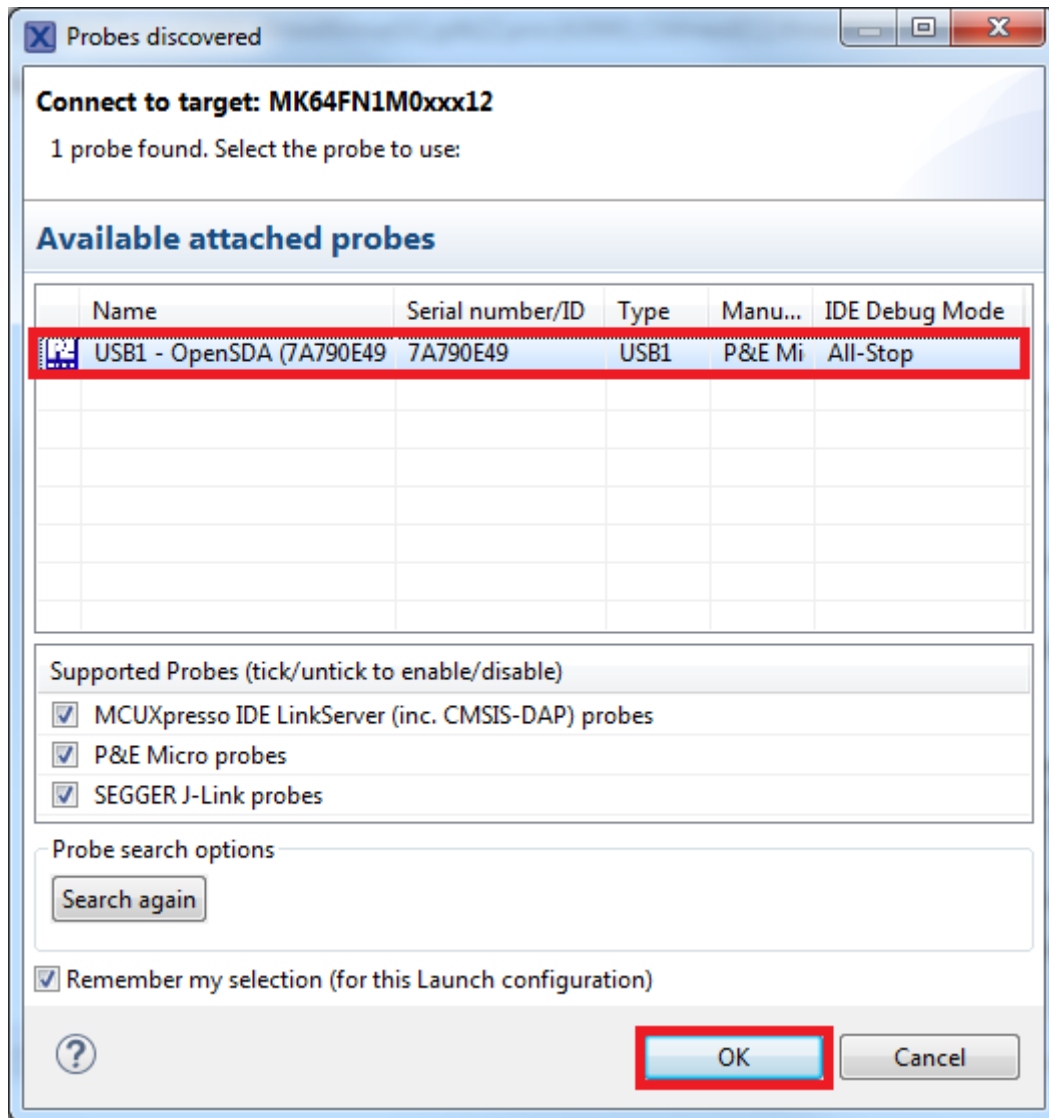
1. Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
2. Connect the development platform to your PC via a USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference `BOARD_DEBUG_UART_BAUDRATE` variable in `board.h` file)
 2. No parity

3. 8 data bits



4. 1 stop bit

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



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

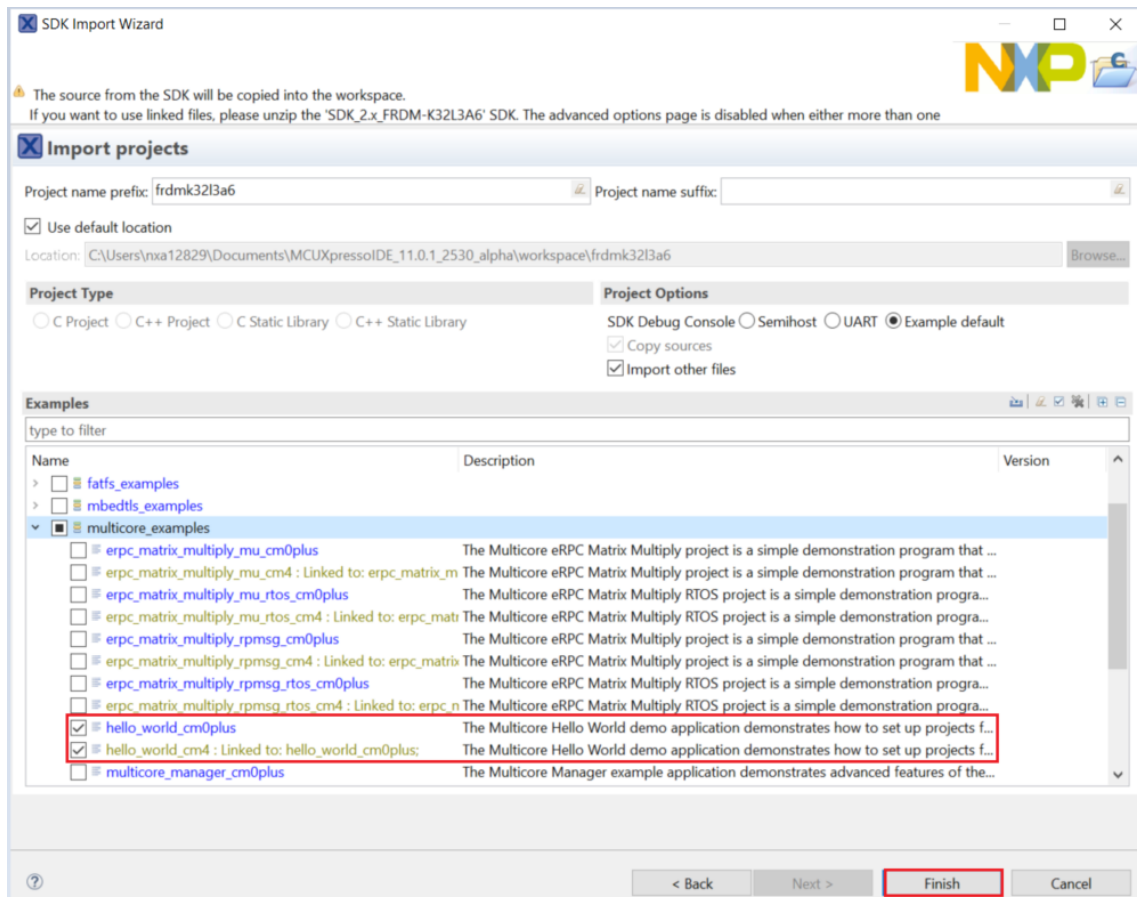


The `hello_world` application is now running and a banner is displayed on the terminal. If not, check your terminal settings and connections.

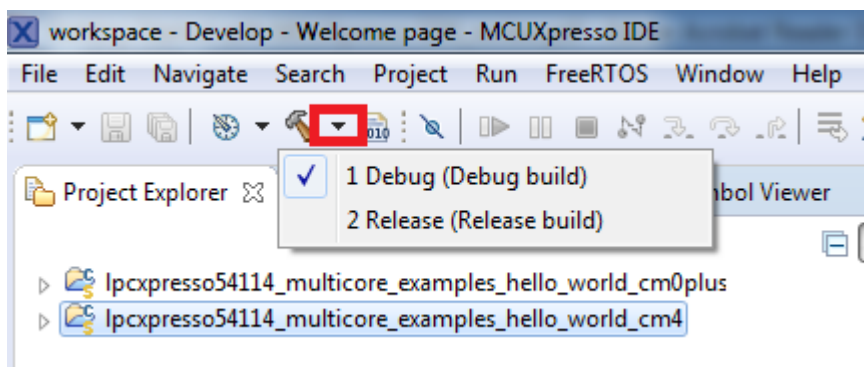


Build a multicore example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of hello_world example application targeted for the LPCXpresso54114 hardware platform is used as an example.

1. Multicore examples are imported into the workspace in a similar way as single core applications, explained in **Build an example application**. When the SDK zip package for LPCXpresso54114 is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, expand the **LPCxx** folder and select **LPC54114J256**. Then, select **lpcxpresso54114** and click **Next**.
2. Expand the multicore_examples/hello_world folder and select **cm4**. The cm0plus counterpart project is automatically imported with the cm4 project, because the multicore examples are linked together and there is no need to select it explicitly. Click **Finish**.

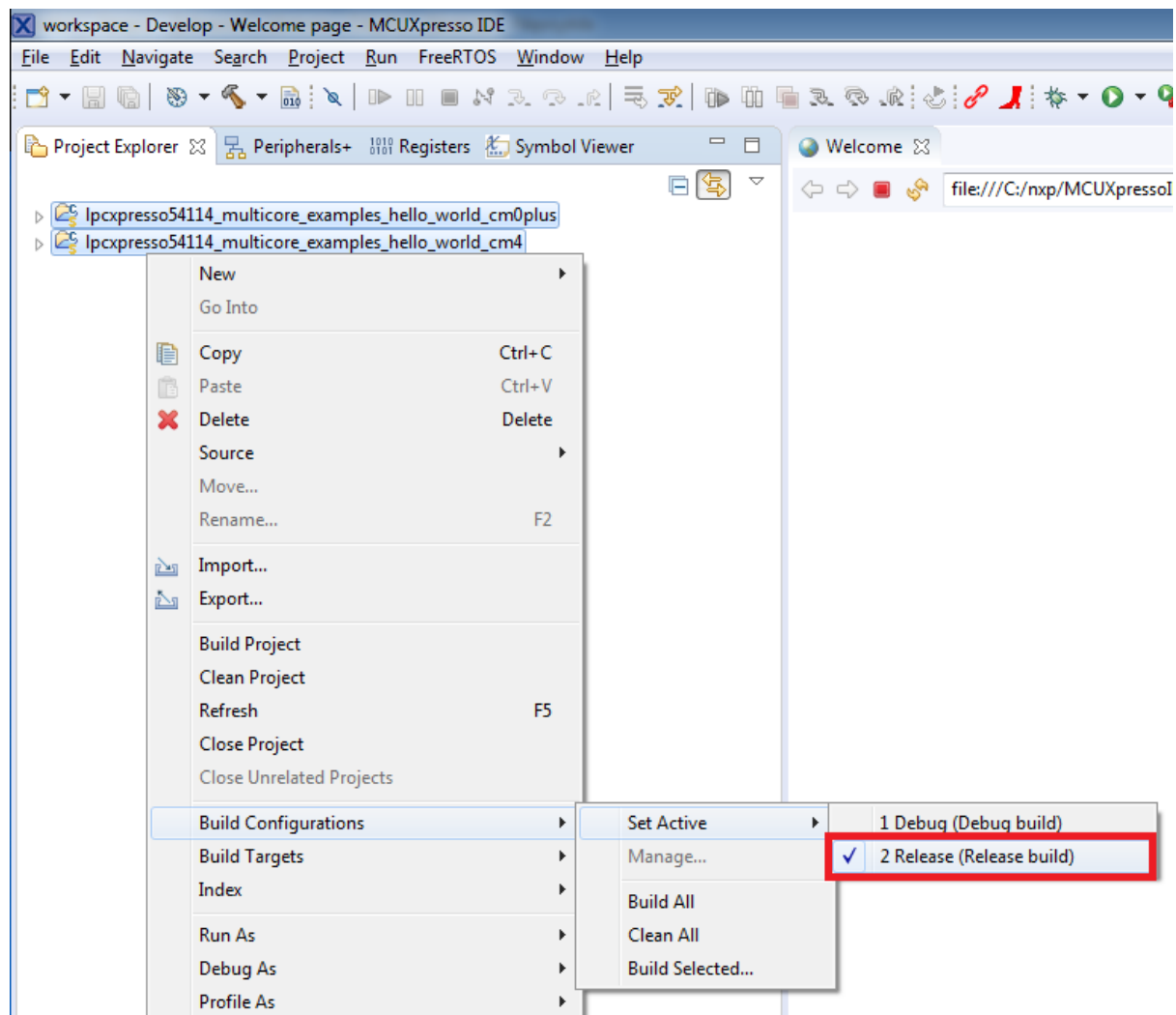


3. Now, two projects should be imported into the workspace. To start building the multicore application, highlight the `lpcxpresso54114_multicore_examples_hello_world_cm4` project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by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

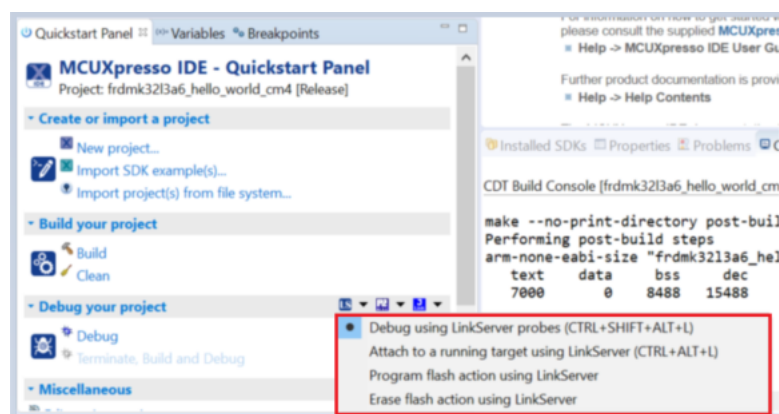


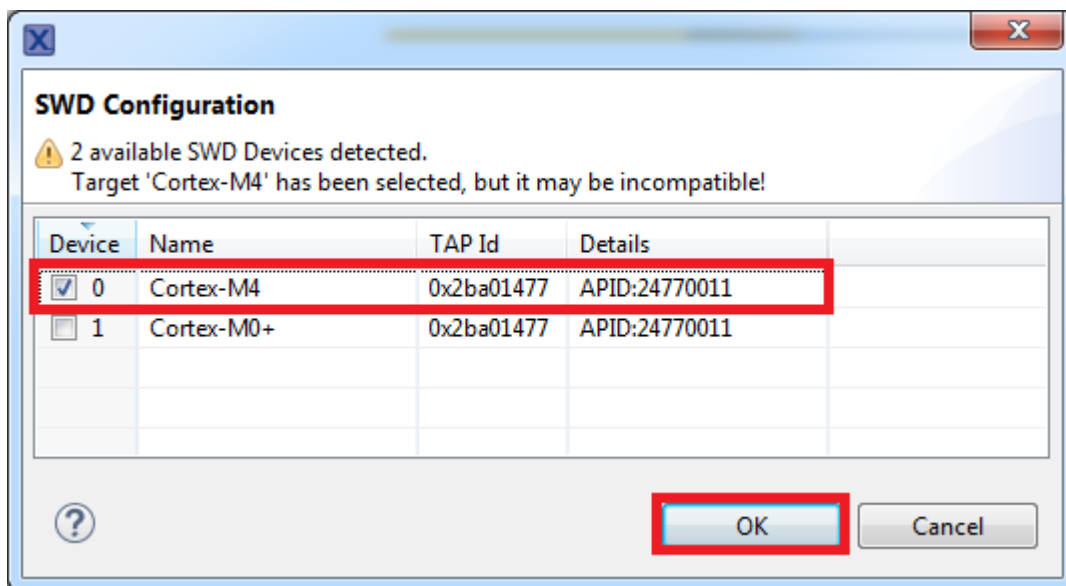
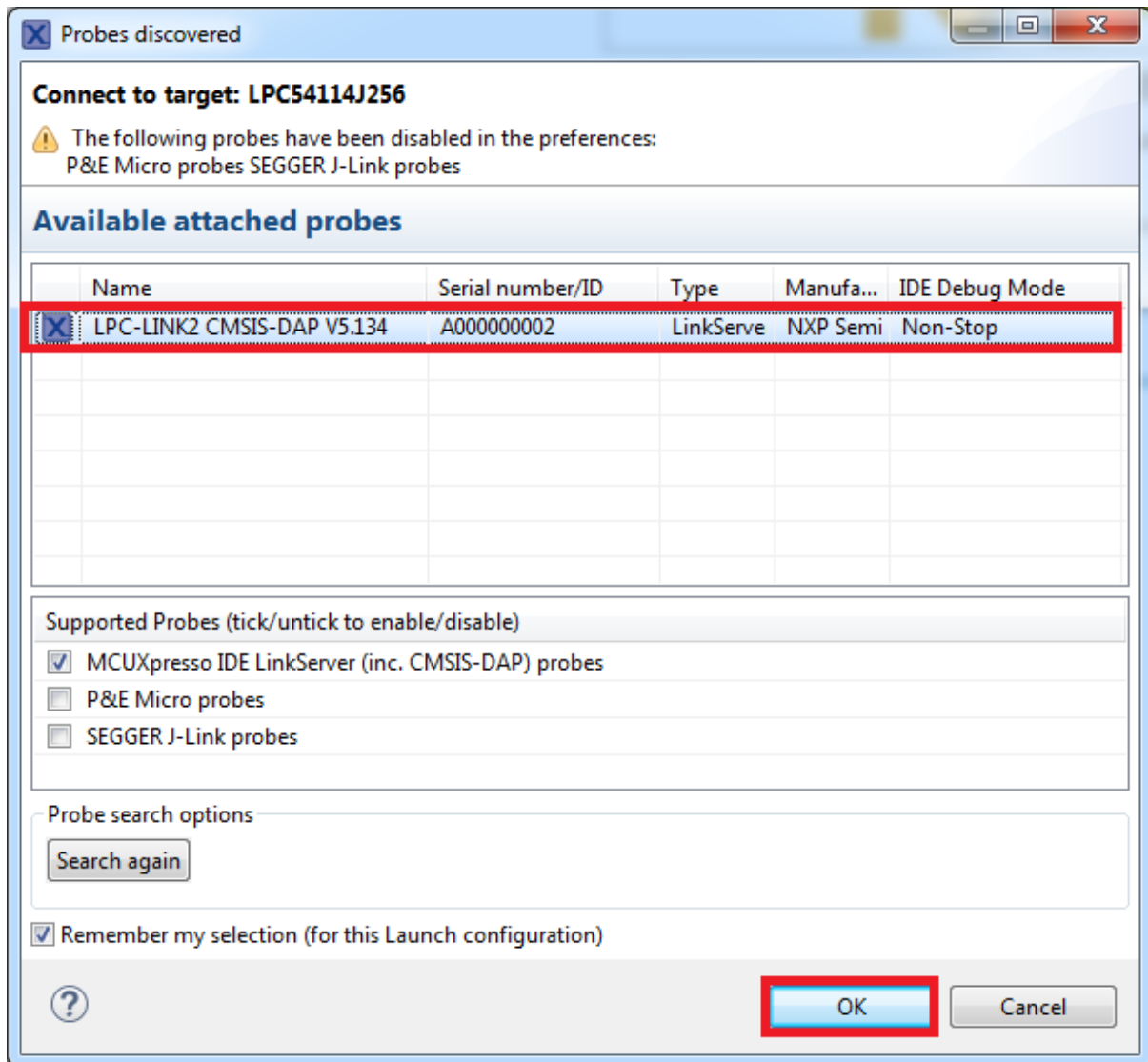
The project starts building after the build target is selected. Because of the project reference settings in multicore projects, triggering the build of the primary core application (cm4) also causes the referenced auxiliary core application (cm0plus) to build.

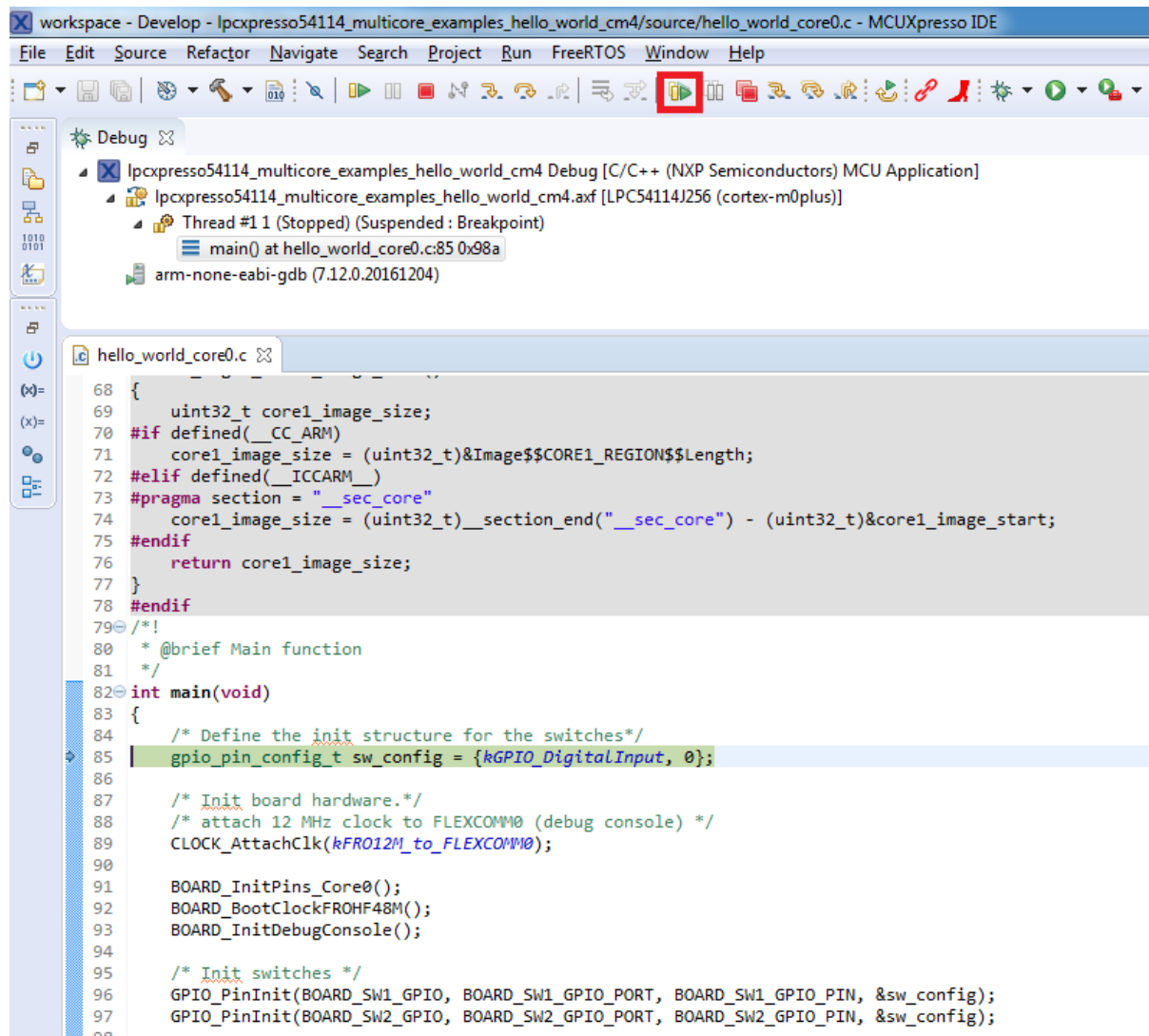
Note: When the **Release** build is requested, it is necessary to change the build configuration of both the primary and auxiliary core application projects first. To do this, select both projects in the Project Explorer view and then right click which displays the context-sensitive menu. Select **Build Configurations -> Set Active -> Release**. This alternate navigation using the menu item is **Project -> Build Configuration -> Set Active -> Release**. After switching to the **Release** build configuration, the build of the multicore example can be started by triggering the primary core application (cm4) build.



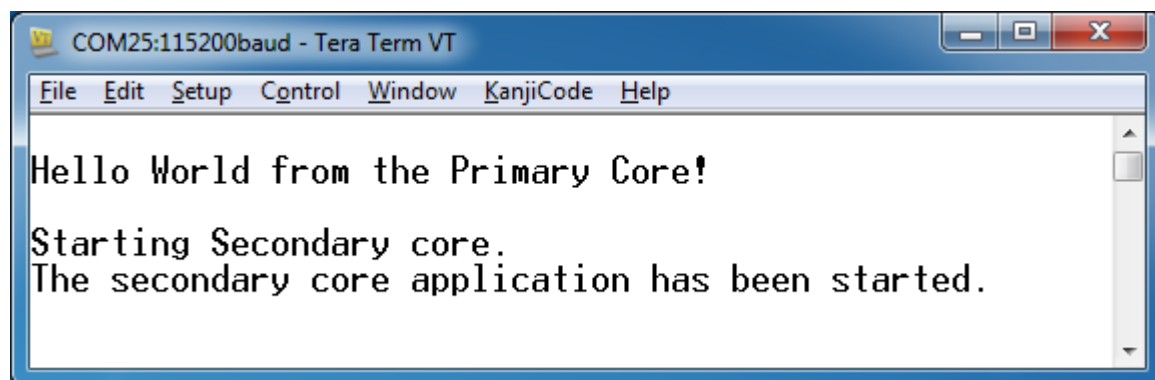
Run a multicore example application The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in **Run an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





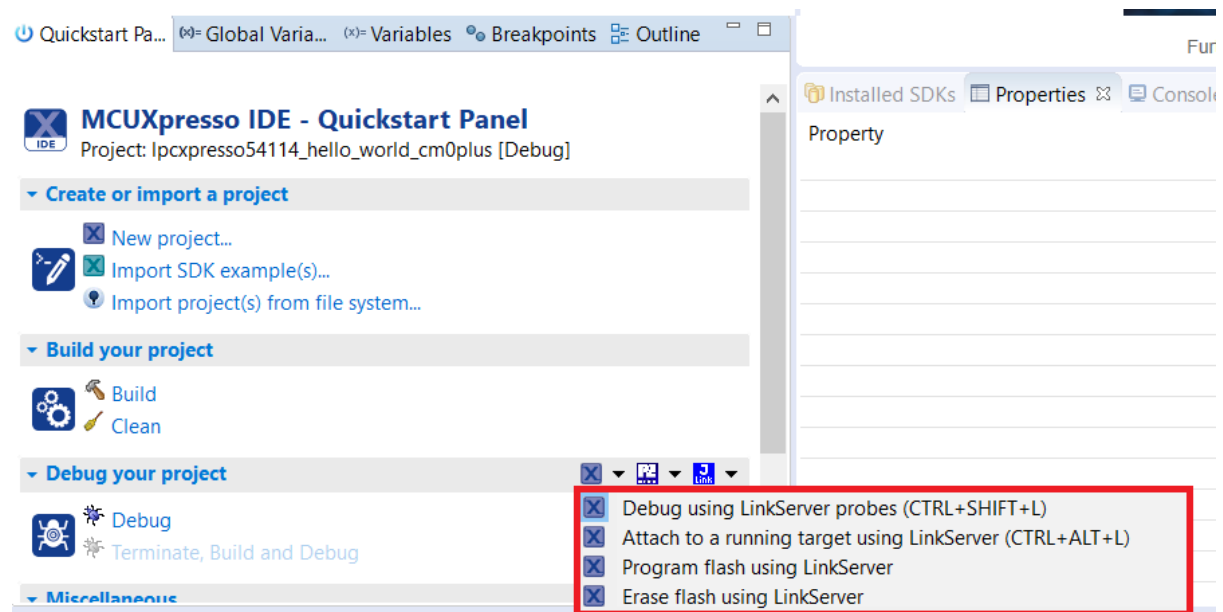


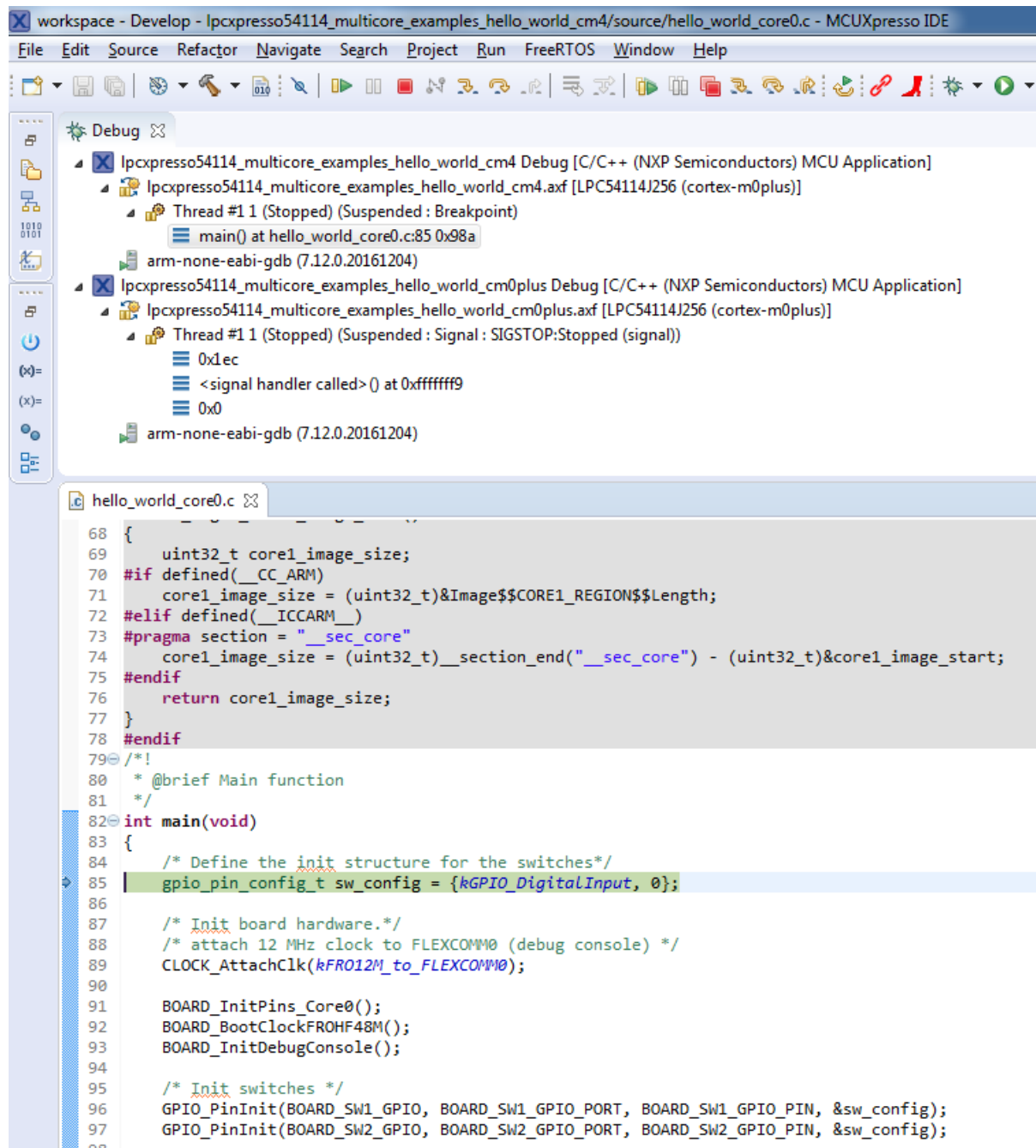
After clicking the “Resume All Debug sessions” button, the hello_world multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.



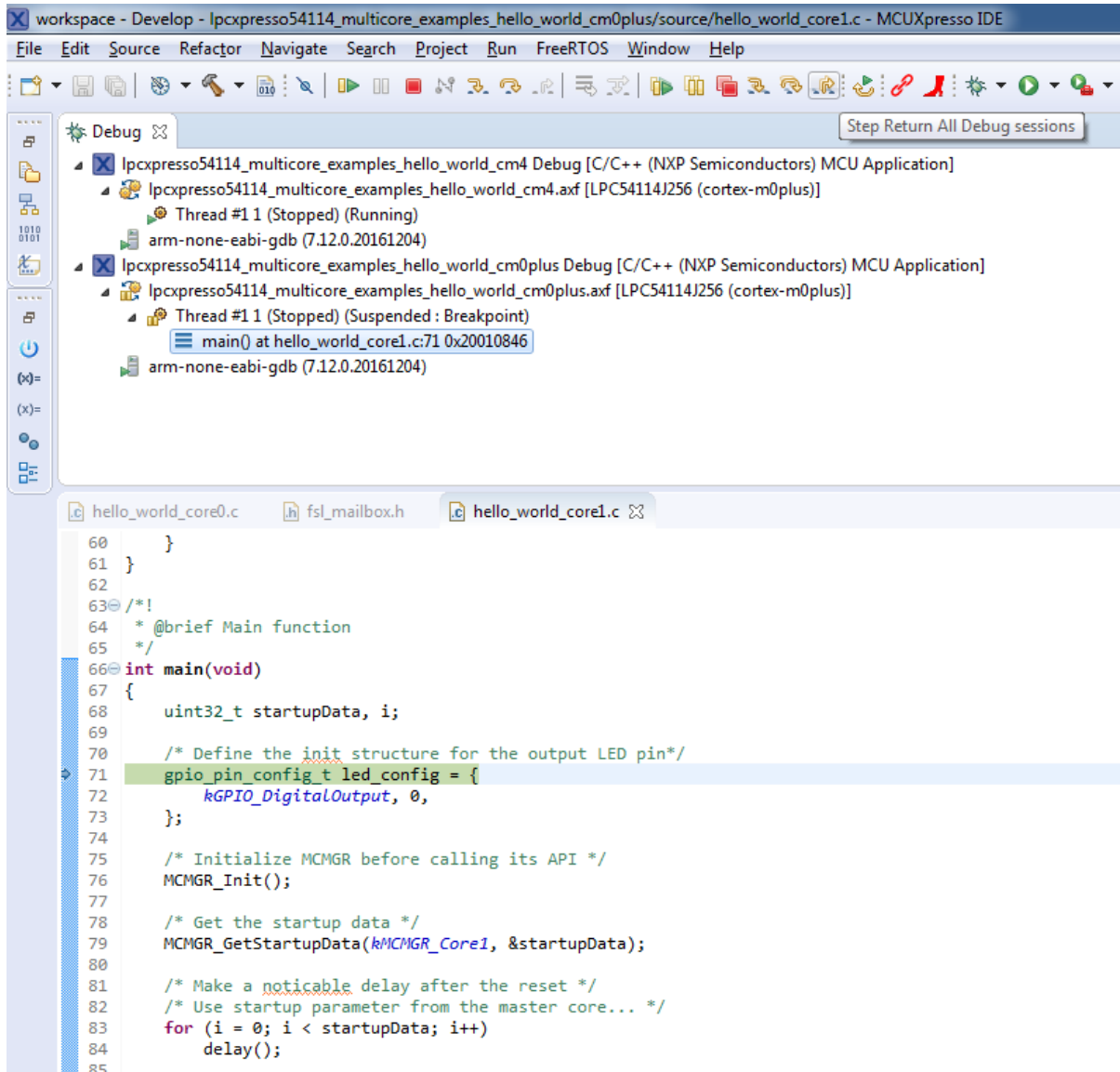
An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and running correctly. It is also possible to debug both sides of the multicore application in parallel. After creating the debug session for the primary core, perform same steps also for the auxiliary core application. Highlight the lpcxpresso54114_multicore_examples_hello_world_cm0plus project (multicore slave project) in the Project Explorer. On the Quickstart Panel, click “Debug ‘lpcxpresso54114_multicore_examples_hello_world_cm0plus’ [Debug]” to launch the second debug

session.

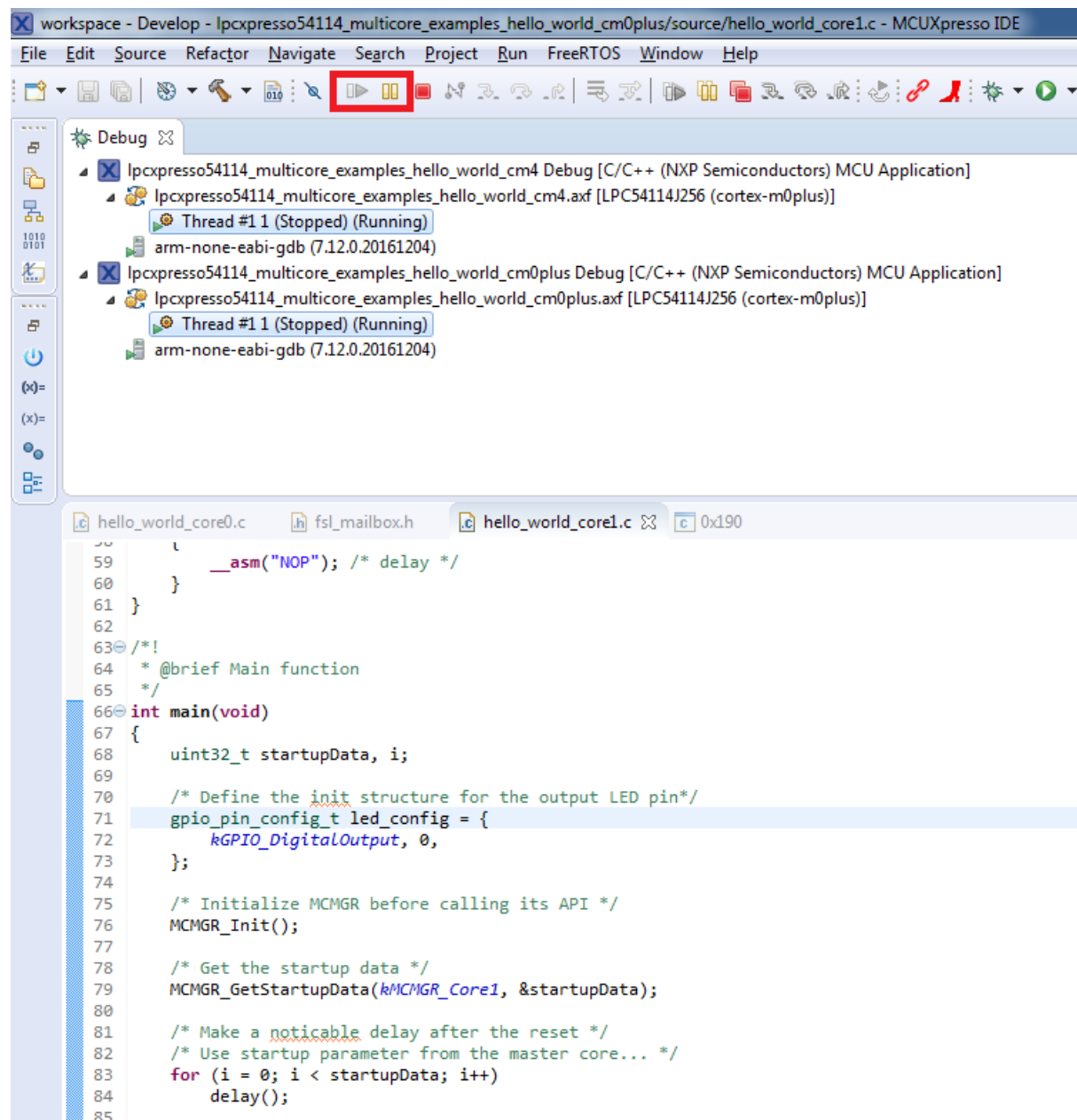


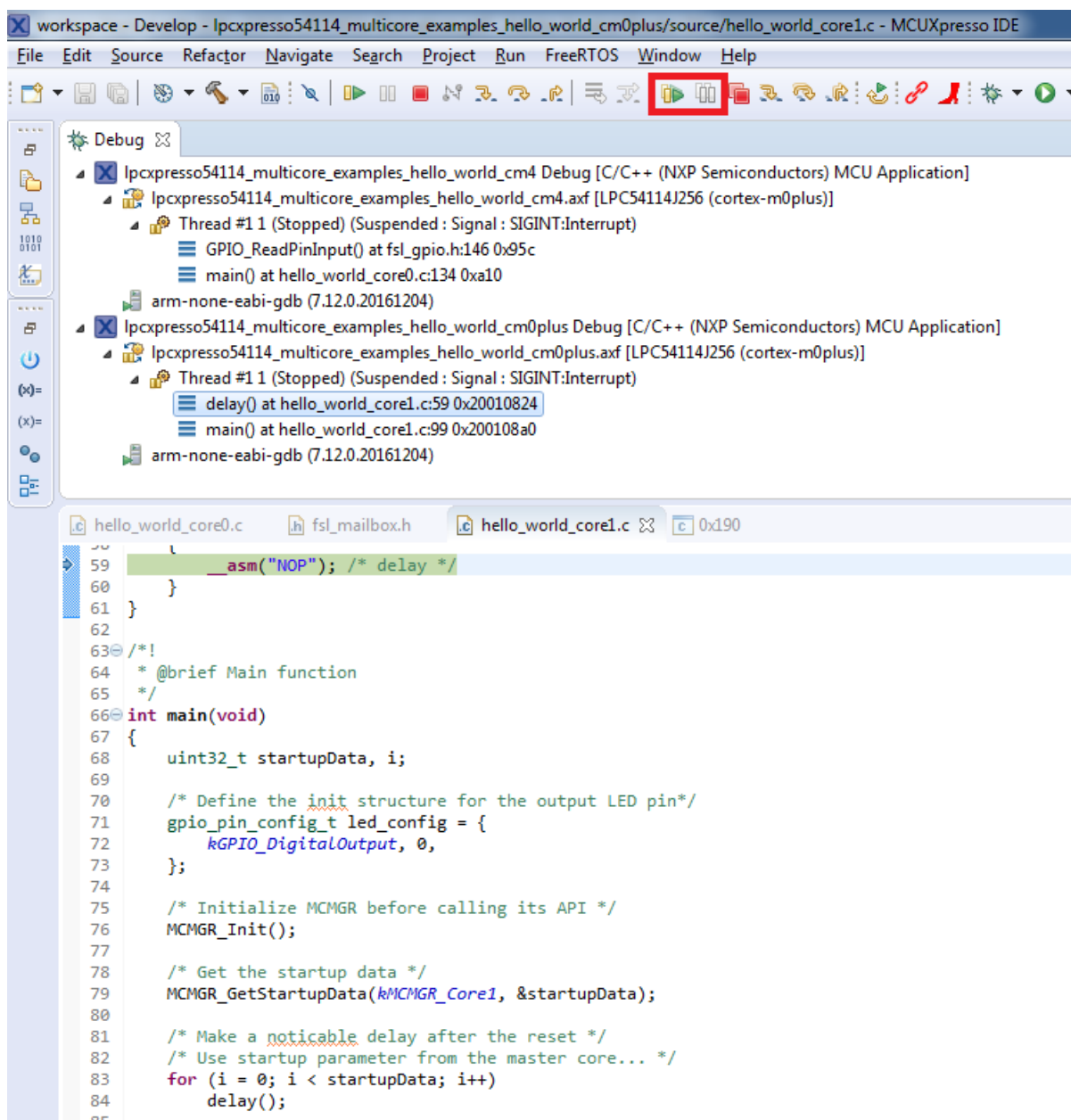


Now, the two debug sessions should be opened, and the debug controls can be used for both debug sessions depending on the debug session selection. Keep the primary core debug session selected by clicking the “Resume” button. The hello_world multicore application then starts running. The primary core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



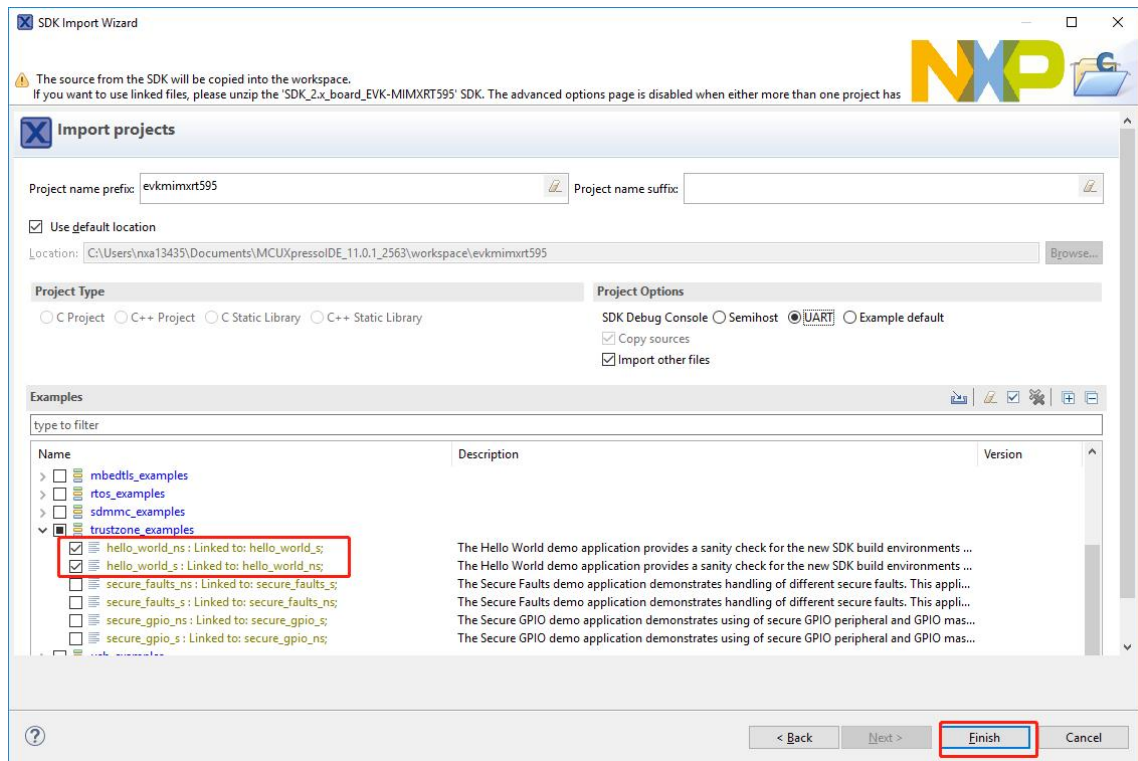
At this point, it is possible to suspend and resume individual cores independently. It is also possible to make synchronous suspension and resumption of both the cores. This is done either by selecting both opened debug sessions (multiple selections) and clicking the “Suspend” / “Resume” control button,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



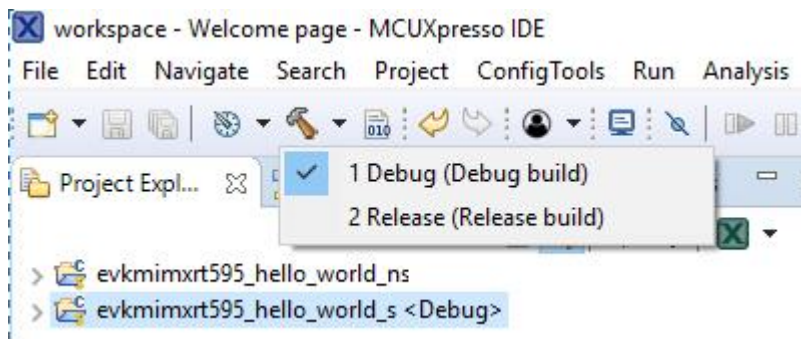


Build a TrustZone example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug TrustZone example applications. The TrustZone version of the hello_world example application targeted for the MIMXRT595-EVK hardware platform is used as an example, though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

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

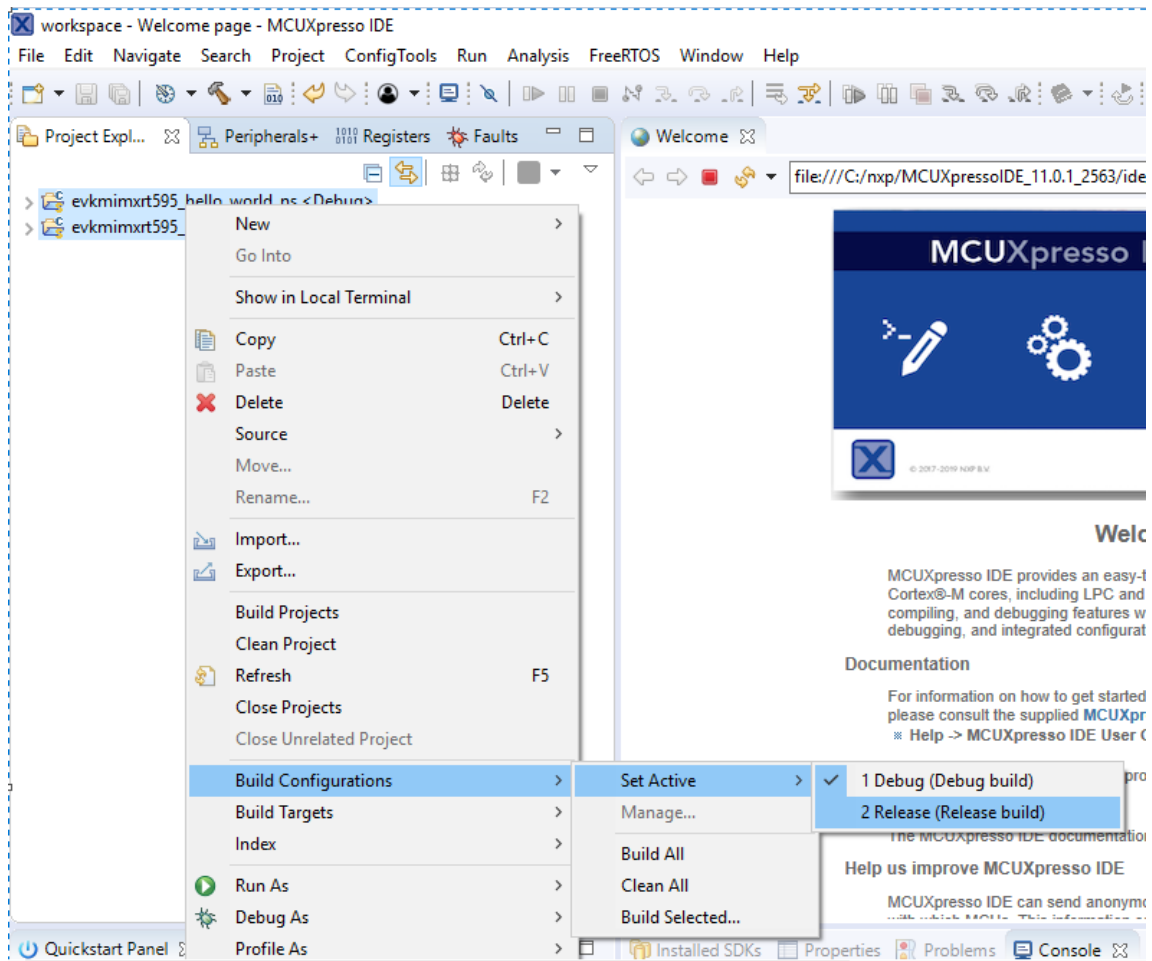


3. Now, two projects should be imported into the workspace. To start building the TrustZone application, highlight the `evkmimxrt595_hello_world_s` project (TrustZone master project) in the Project Explorer. Then, choose the appropriate build target, **Debug** or **Release**, by clicking the downward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



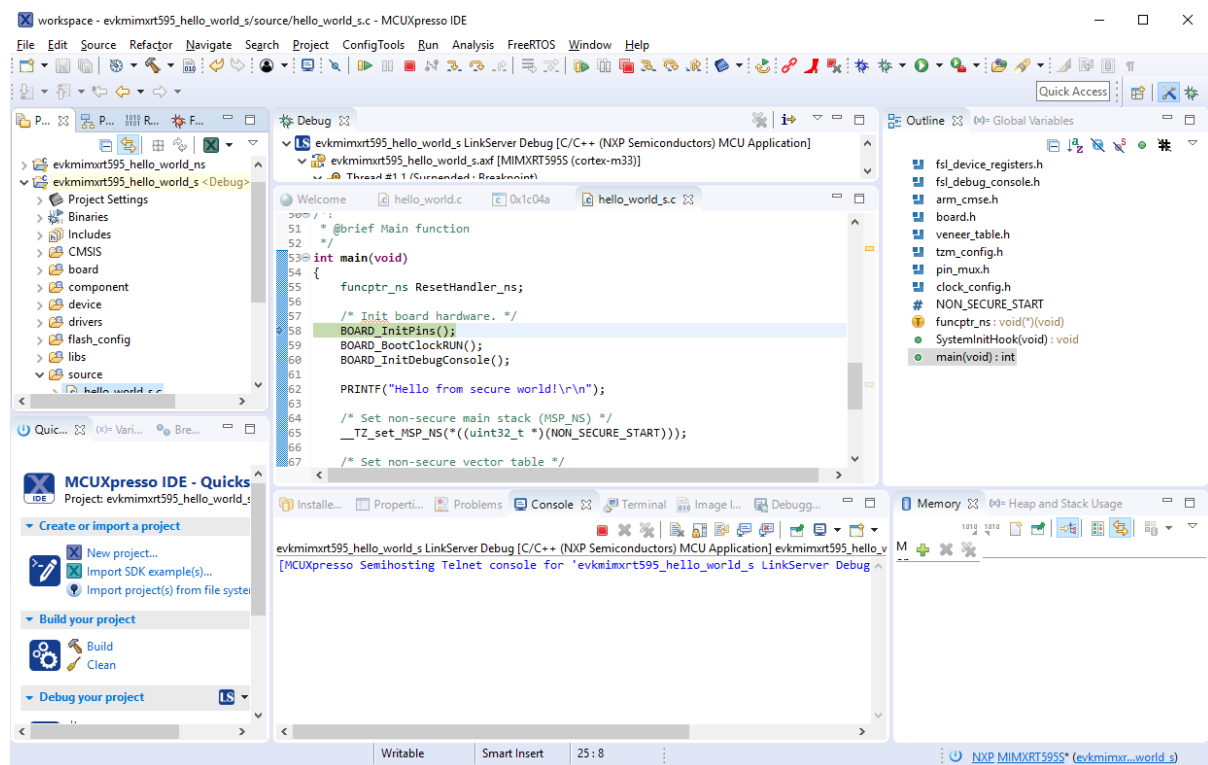
The project starts building after the build target is selected. It is requested to build the application for the secure project first, because the non-secure project must know the secure project since CMSE library when running the linker. It is not possible to finish the non-secure project linker when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

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



Run a TrustZone example application To download and run the application, perform all steps as described in **Run an example application**. These steps are common for single core, and TrustZone applications, ensuring `<board_name>_hello_world_s` is selected for debugging.

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



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

Run a demo application using IAR

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

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

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

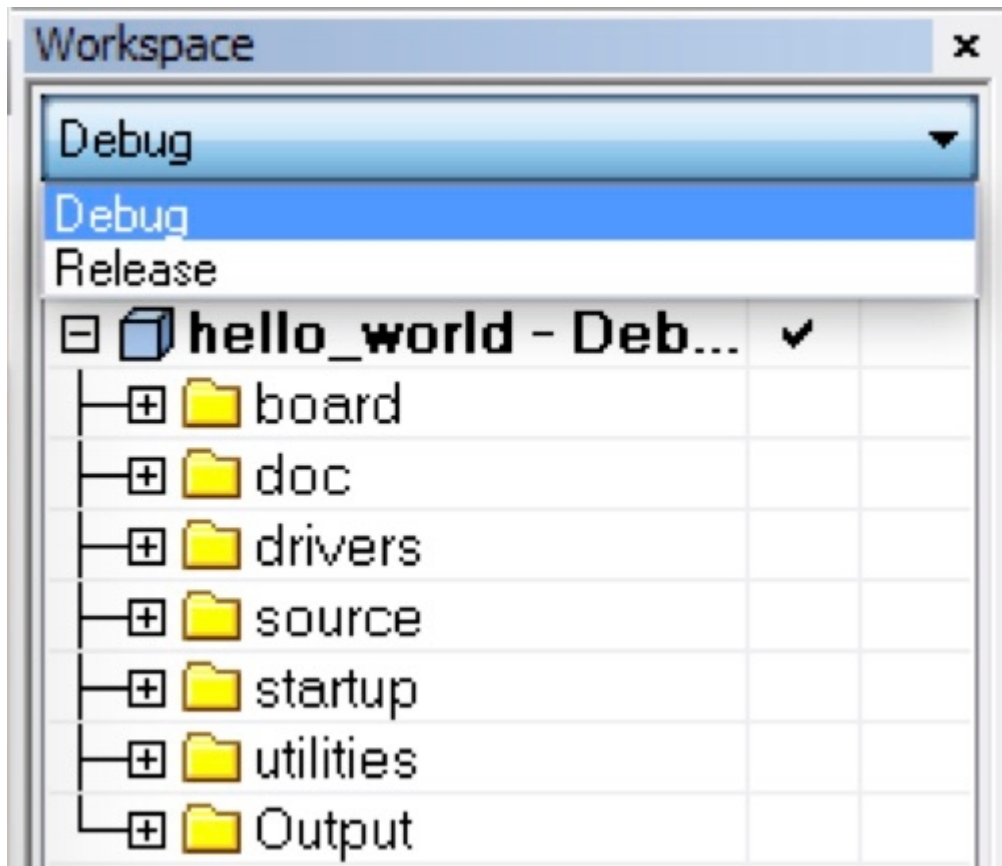
1. Open the desired demo application workspace. Most example application workspace files can be located using the following path:

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

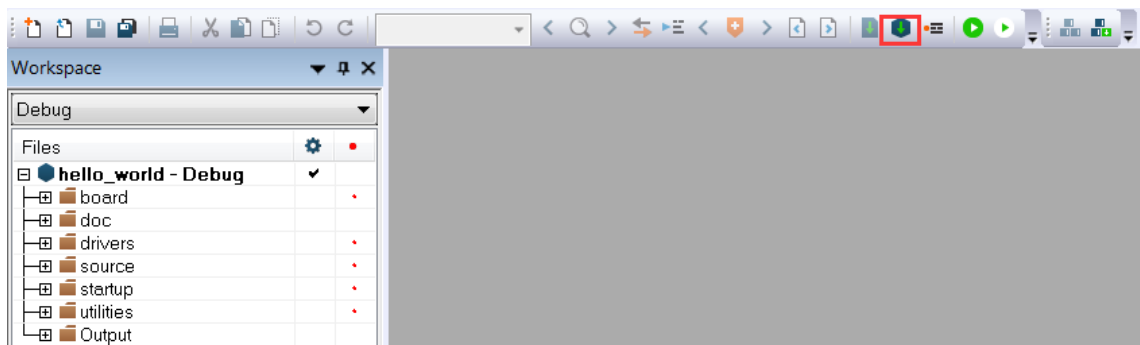
Other example applications may have additional folders in their path.

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

For this example, select **hello_world – debug**.



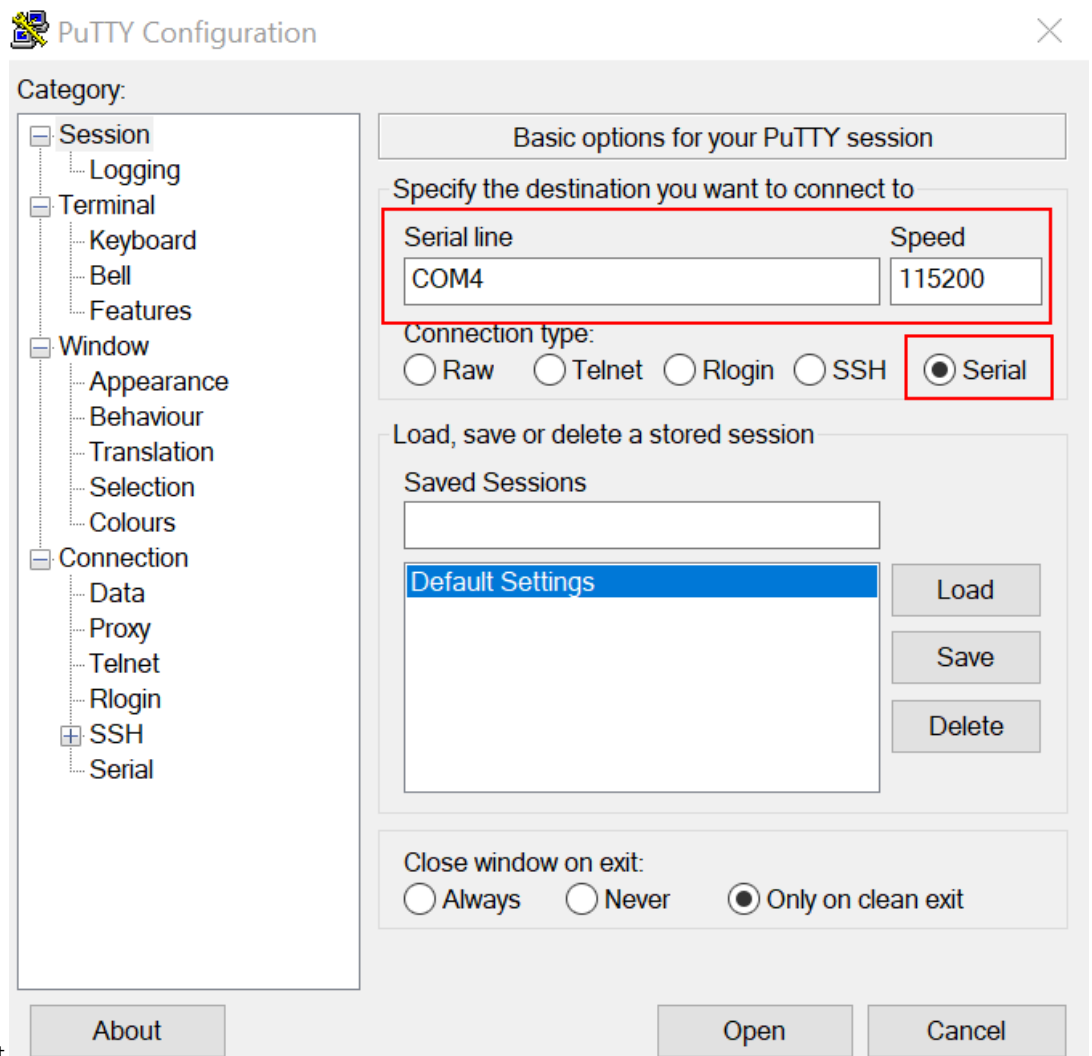
3. To build the demo application, click **Make**, highlighted in red in following figure.



4. The build completes without errors.

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

1. Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
2. Connect the development platform to your PC via USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug COM port (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the board.h file)
 2. No parity
 3. 8 data bits

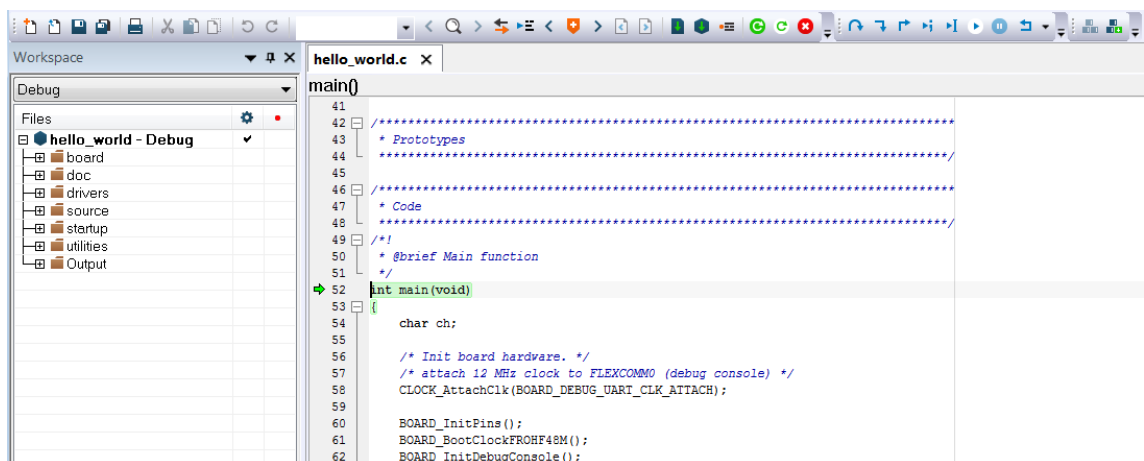


4. 1 stop bit

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



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



6. Run the code by clicking the **Go** button.

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



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

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

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

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/iar/hello_world_cm0plus.  
→ eww
```

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

Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm0plus) first, because the primary core application project (cm4) must know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

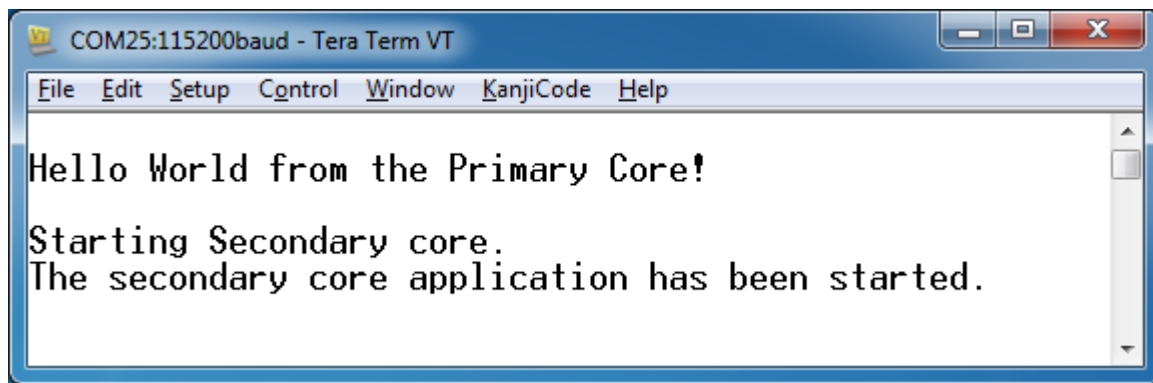
Run a multicore example application The primary core debugger handles flashing both primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 4 as described in **Run an example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

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

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



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



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

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

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

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

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

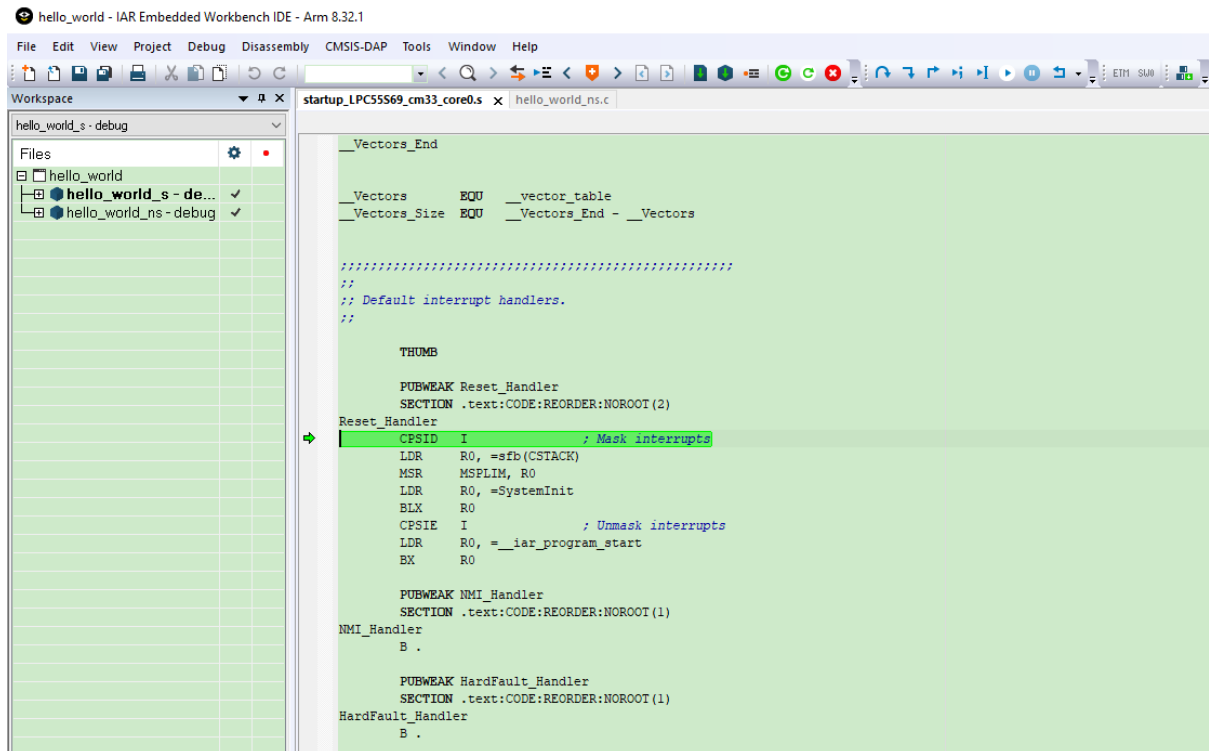
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_ns/iar/hello_world_  
↪ns.eww
```

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

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

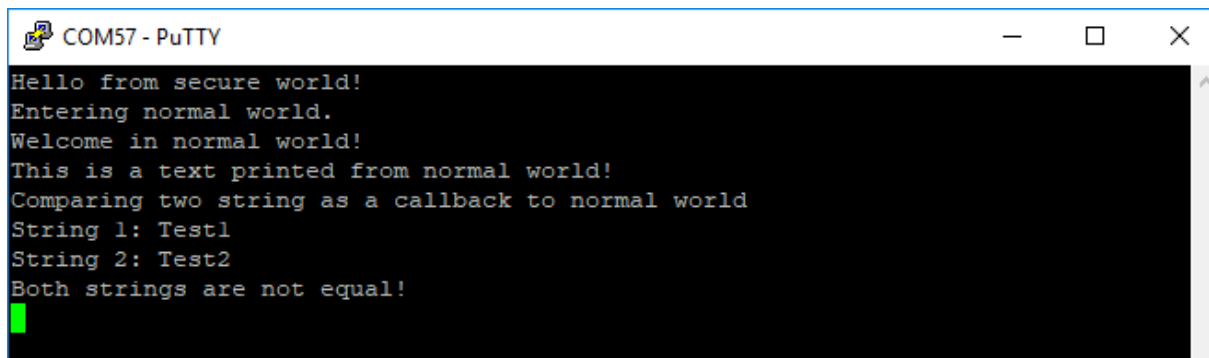
This project `hello_world.eww` contains both secure and non-secure projects in one workspace and it allows the user to easily transition from one project to another. Build both applications separately by clicking **Make**. It is requested to build the application for the secure project first, because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

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

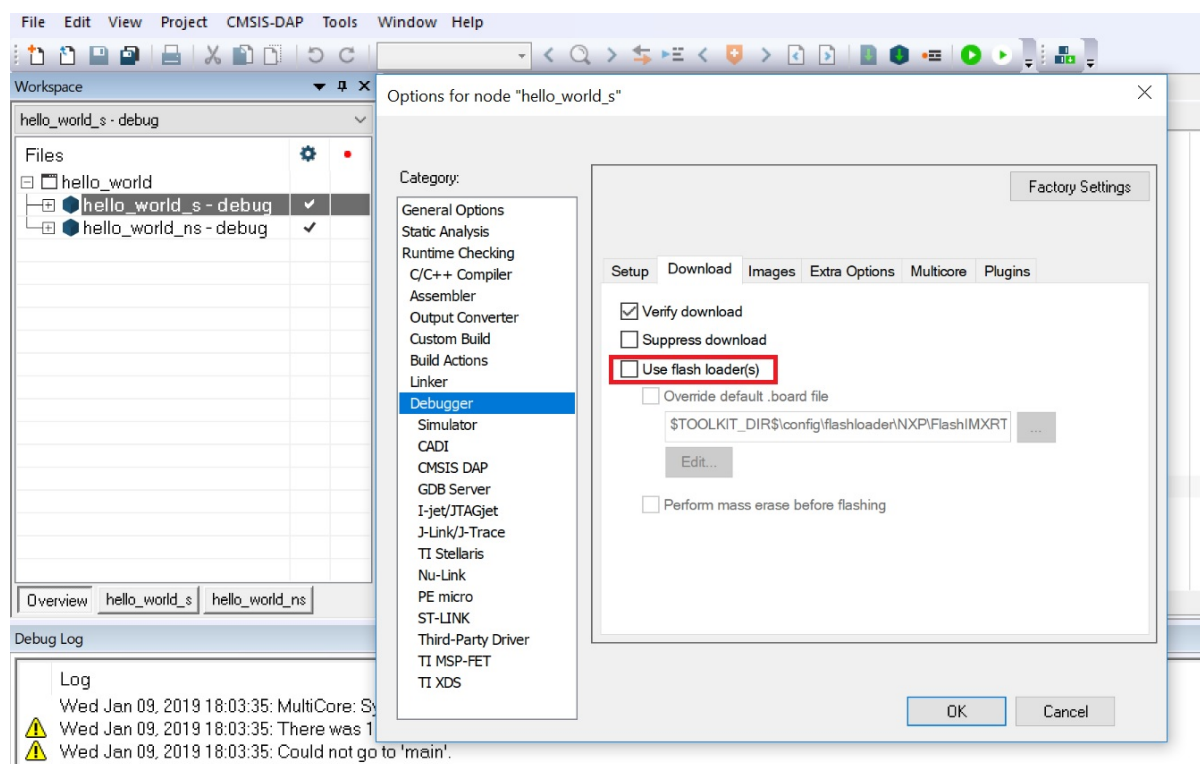


Run the code by clicking **Go** to start the application.

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



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

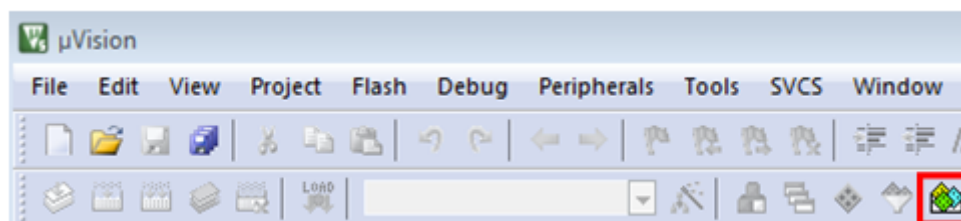


Run a demo using Keil MDK/μVision

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

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

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



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

Build an example application

1. Open the desired example application workspace in:

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

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

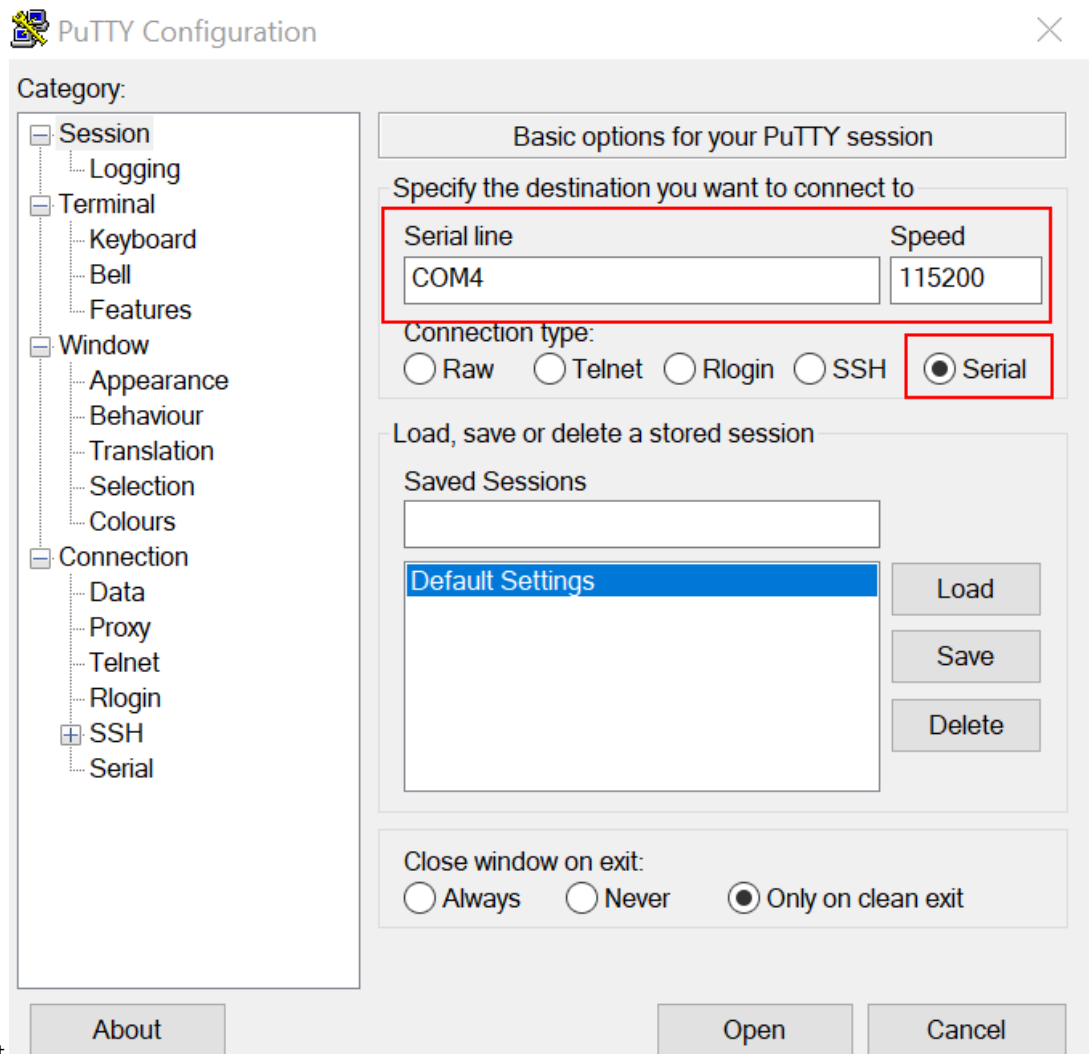
- To build the demo project, select **Rebuild**, highlighted in red.



- The build completes without errors.

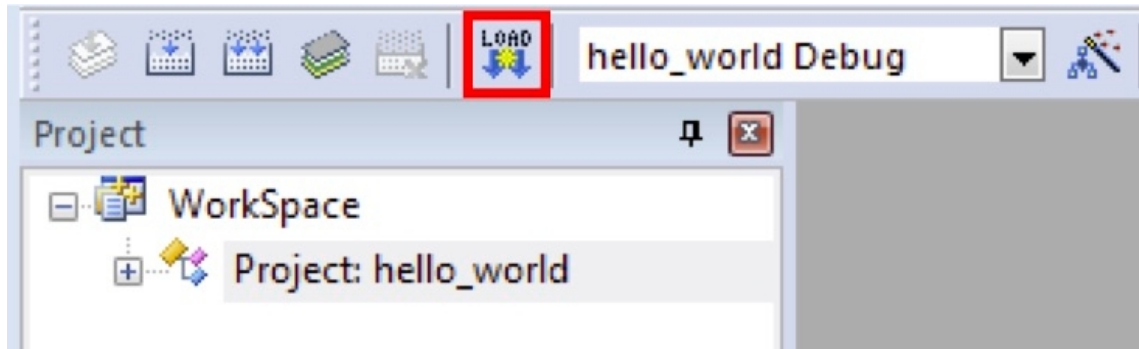
Run an example application To download and run the application, perform these steps:

- Ensure the host driver for the debugger firmware has been installed. See [On-board debugger](#).
- Connect the development platform to your PC via USB cable using USB connector.
- Open the terminal application on the PC, such as PuTTY or TeraTerm and connect to the debug serial port number (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:
 - 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the board.h file)
 - No parity
 - 8 data bits

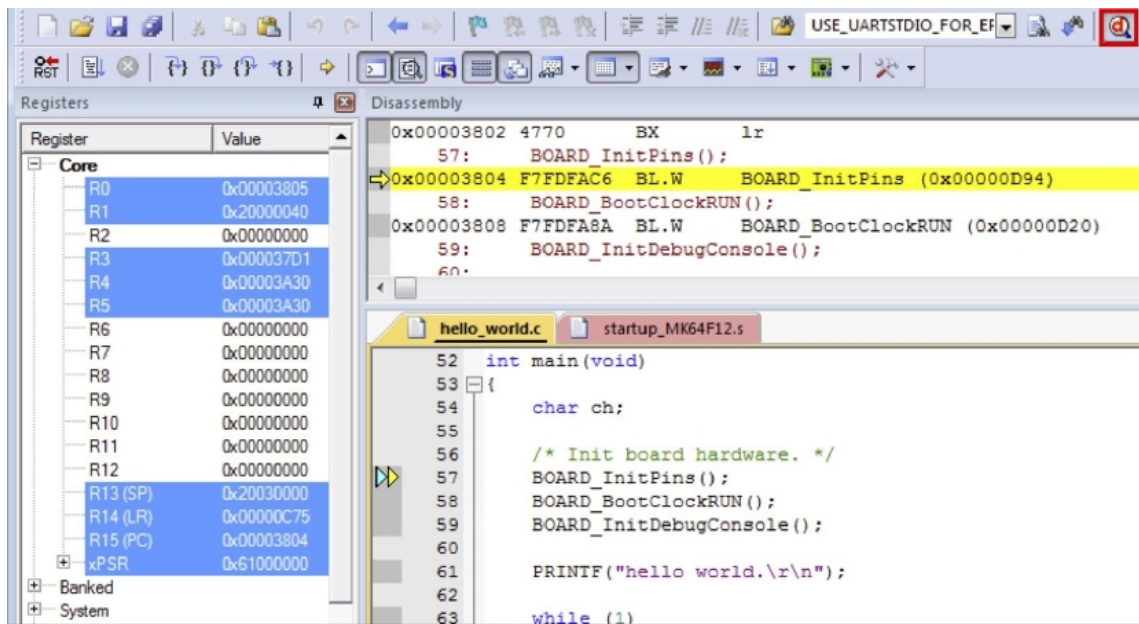


- 1 stop bit

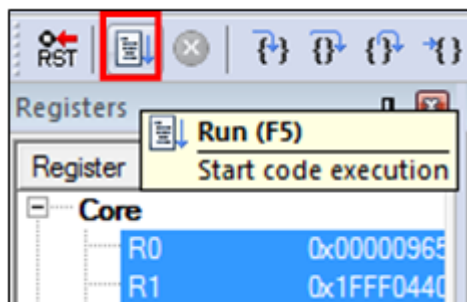
- In μ Vision, after the application is built, click the **Download** button to download the application to the target.



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



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



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



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

```
<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/mdk
```

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

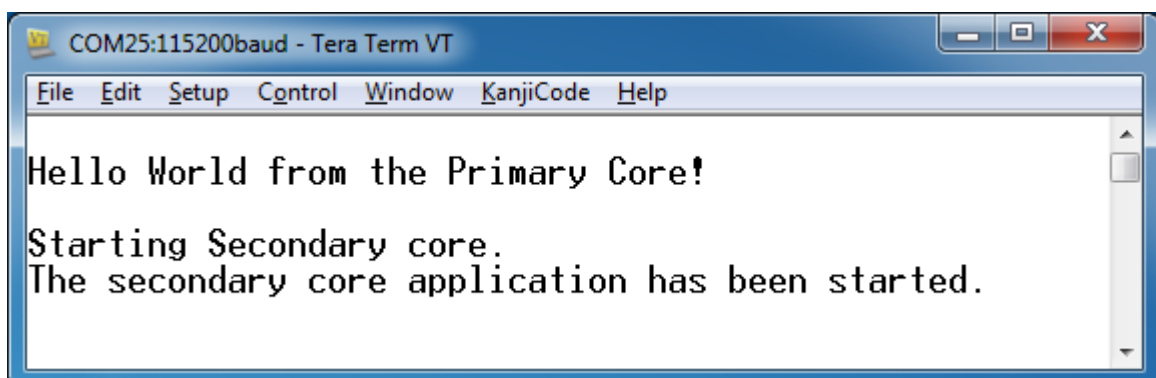
```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/mdk/hello_world_
→cm0plus.uvmpw
```

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

Build both applications separately by clicking the **Rebuild** button. Build the application for the auxiliary core (cm0plus) first because the primary core application project (cm4) must know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

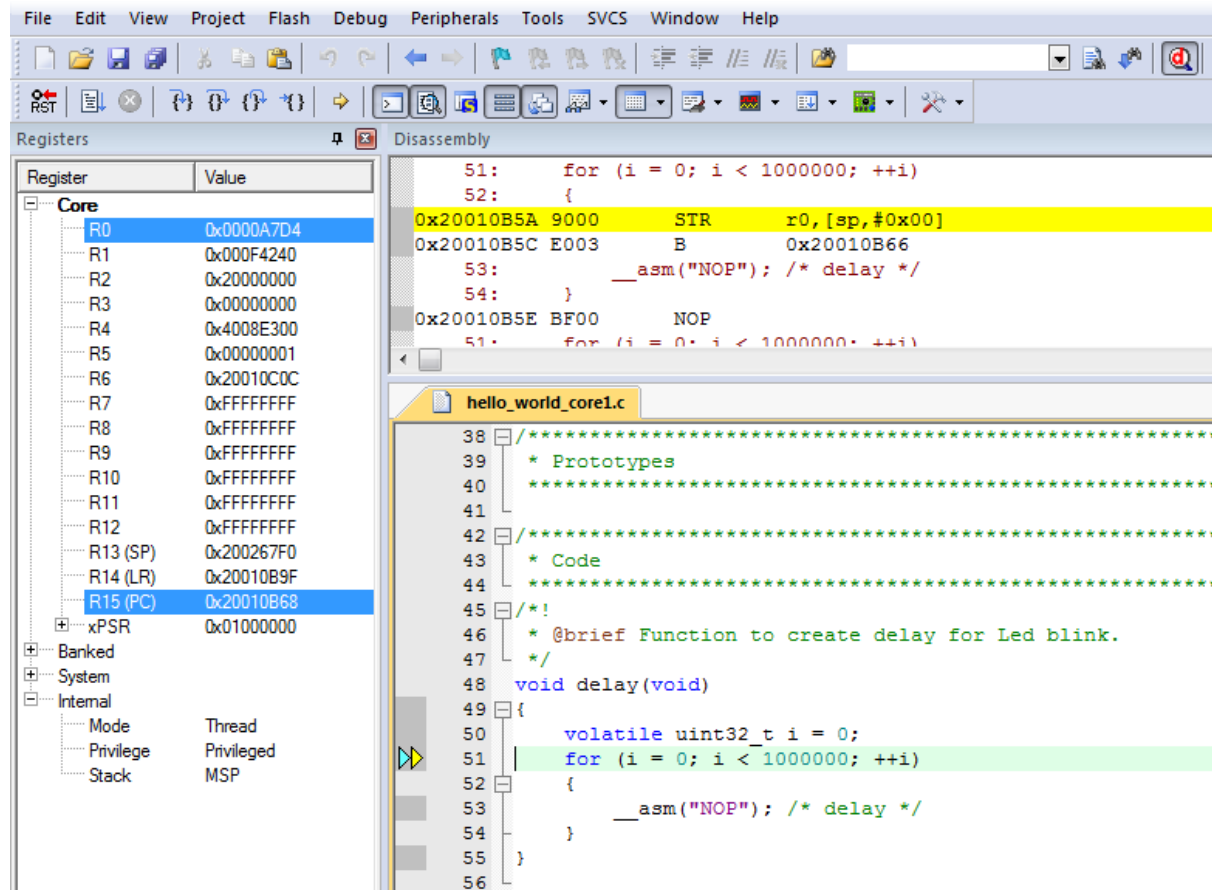
Run a multicore example application The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 5 as described in **Run an example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

Both the primary and the auxiliary image is loaded into the device flash memory. After clicking the “Run” button, the primary core application is executed. During the primary core code execution, the auxiliary core is released from the reset. The hello_world multicore application is now running and a banner is displayed on the terminal. If this does not appear, check your terminal settings and connections.



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

Attach the running application of the auxiliary core by opening the auxiliary core project in the second μ Vision instance and clicking the “Start/Stop Debug Session” button. After this, the second debug session is opened and the auxiliary core application can be debugged.



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

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

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

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

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

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

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



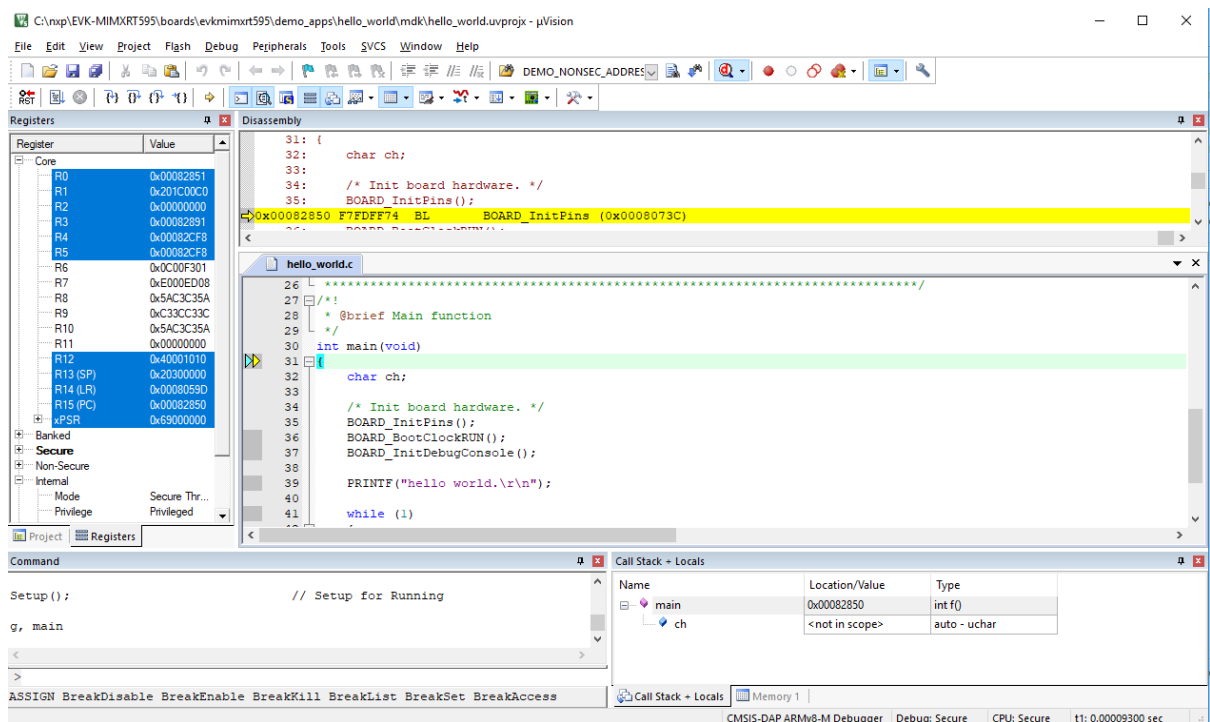
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/mdk/hello_world.  
→ uvmpw
```

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

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

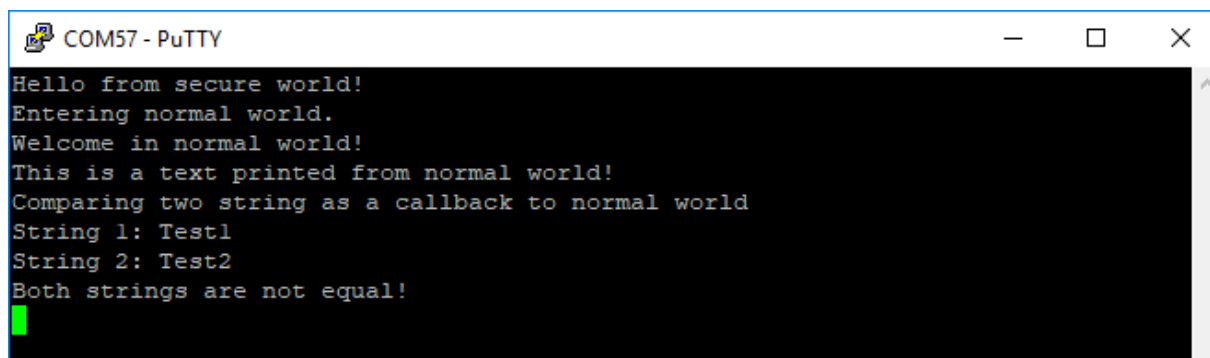
Run a TrustZone example application The secure project is configured to download both secure and non-secure output files so debugging can be fully managed from the secure project.

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



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

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



Run a demo using Arm GCC

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

Set up toolchain This section contains the steps to install the necessary components required to build and run an MCUXpresso SDK demo application with the Arm GCC toolchain, as supported by the MCUXpresso SDK. There are many ways to use Arm GCC tools, but this example focuses on a Windows operating system environment.

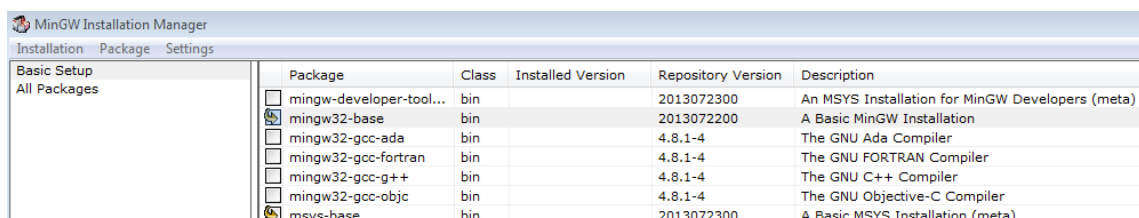
Install GCC Arm Embedded tool chain Download and run the installer from GNU Arm Embedded Toolchain. This is the actual toolset (in other words, compiler, linker, and so on). The GCC toolchain should correspond to the latest supported version, as described in **MCUXpresso SDK Release Notes**.

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

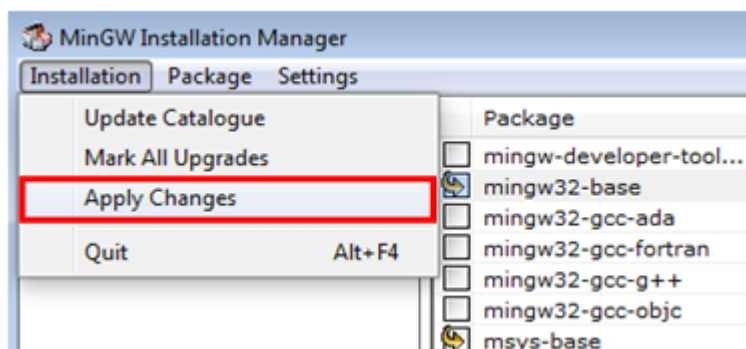
1. Download the latest MinGW mingw-get-setup installer from [MinGW](#).
2. Run the installer. The recommended installation path is `C:\MinGW`, however, you may install to any location.

Note: The installation path cannot contain any spaces.

3. Ensure that the **mingw32-base** and **msys-base** are selected under **Basic Setup**.



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

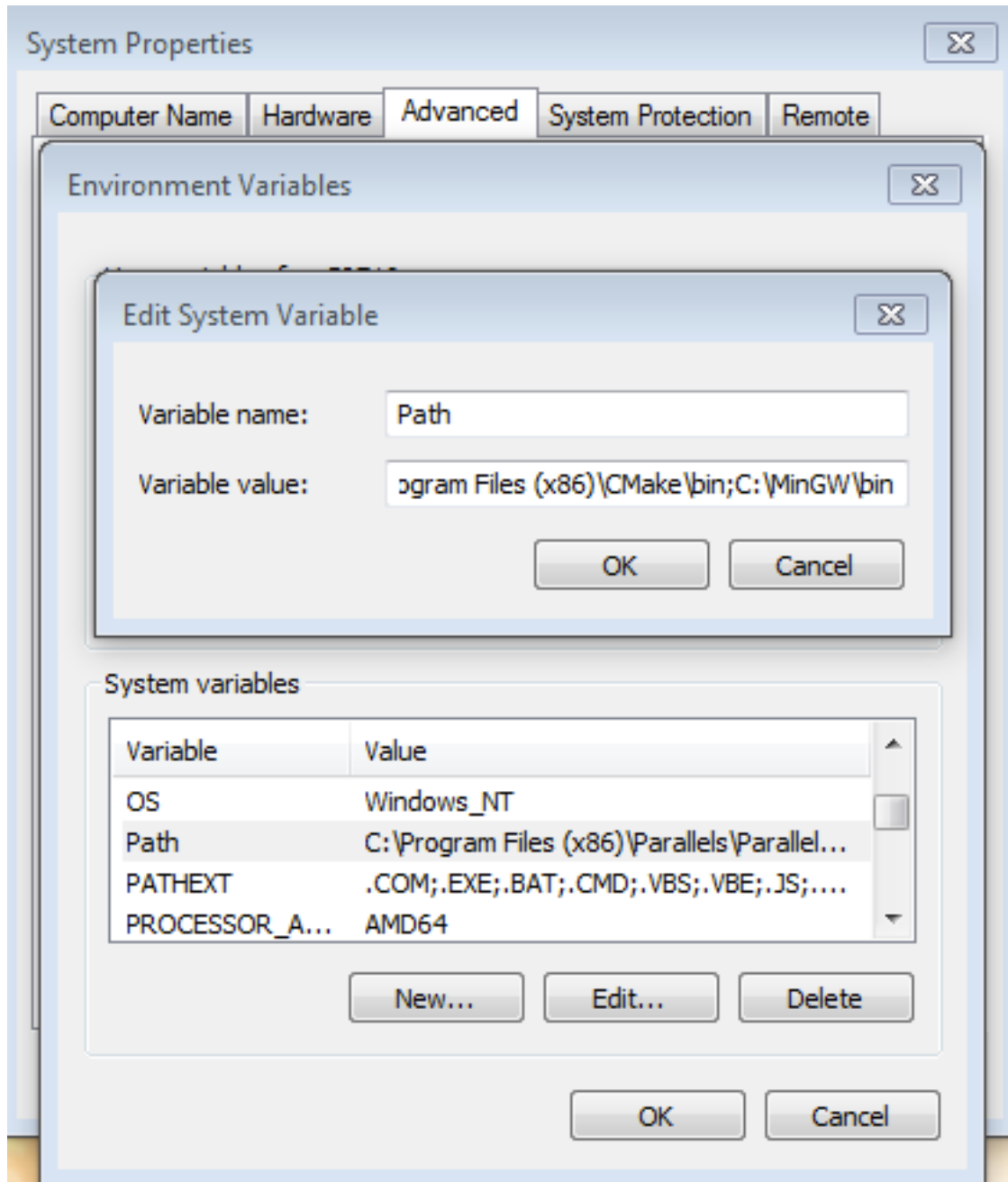


5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel->System and Security->System->Advanced System Settings** in the **Environment Variables...** section. The path is:


```
<mingw_install_dir>\bin
```

Assuming the default installation path, C:\MinGW, an example is shown below. If the path is not set correctly, the toolchain will not work.

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



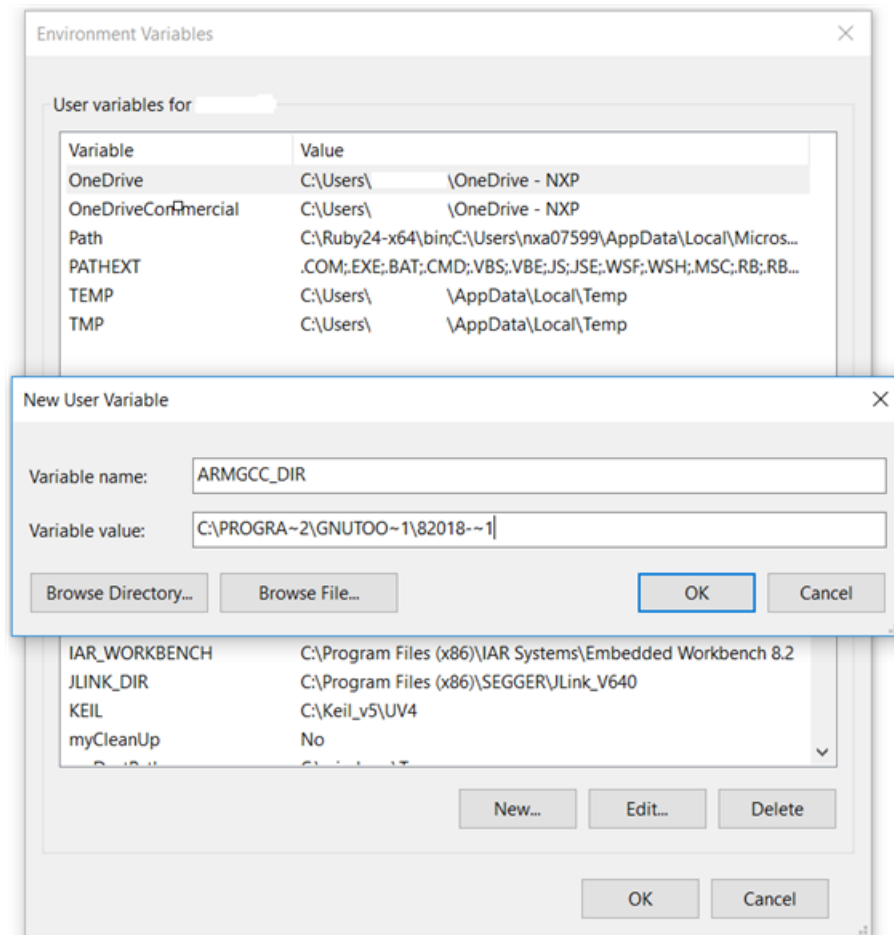
Add a new system environment variable for ARMGCC_DIR Create a new *system* environment variable and name it as ARMGCC_DIR. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

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

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

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

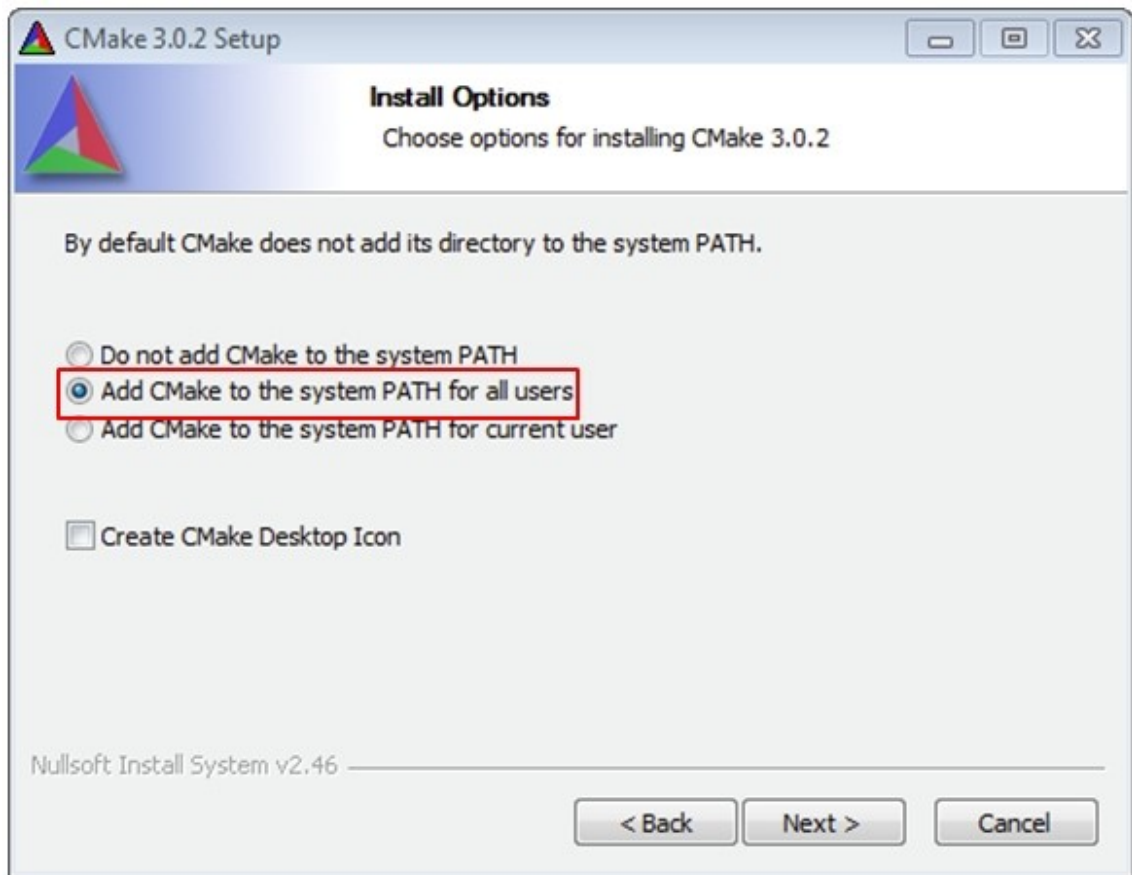
```
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>for %I in (.) do echo %~sI
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>echo C:\PROGRA~2\GNUTOO~1\82018~1
C:\PROGRA~2\GNUTOO~1\82018~1
```



Install CMake

Windows OS

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



3. Follow the remaining instructions of the installer.
4. You may need to reboot your system for the PATH changes to take effect.
5. Make sure `sh.exe` is not in the Environment Variable PATH. This is a limitation of mingw32-make.

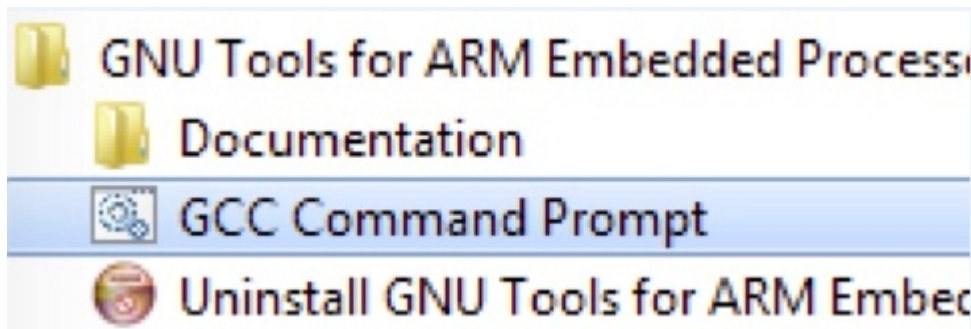
Linux OS It depends on the distributions of Linux Operation System. Here we use Ubuntu as an example.

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

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

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

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



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

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

For this example, the exact path is:

Note: To change directories, use the `cd` command.

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

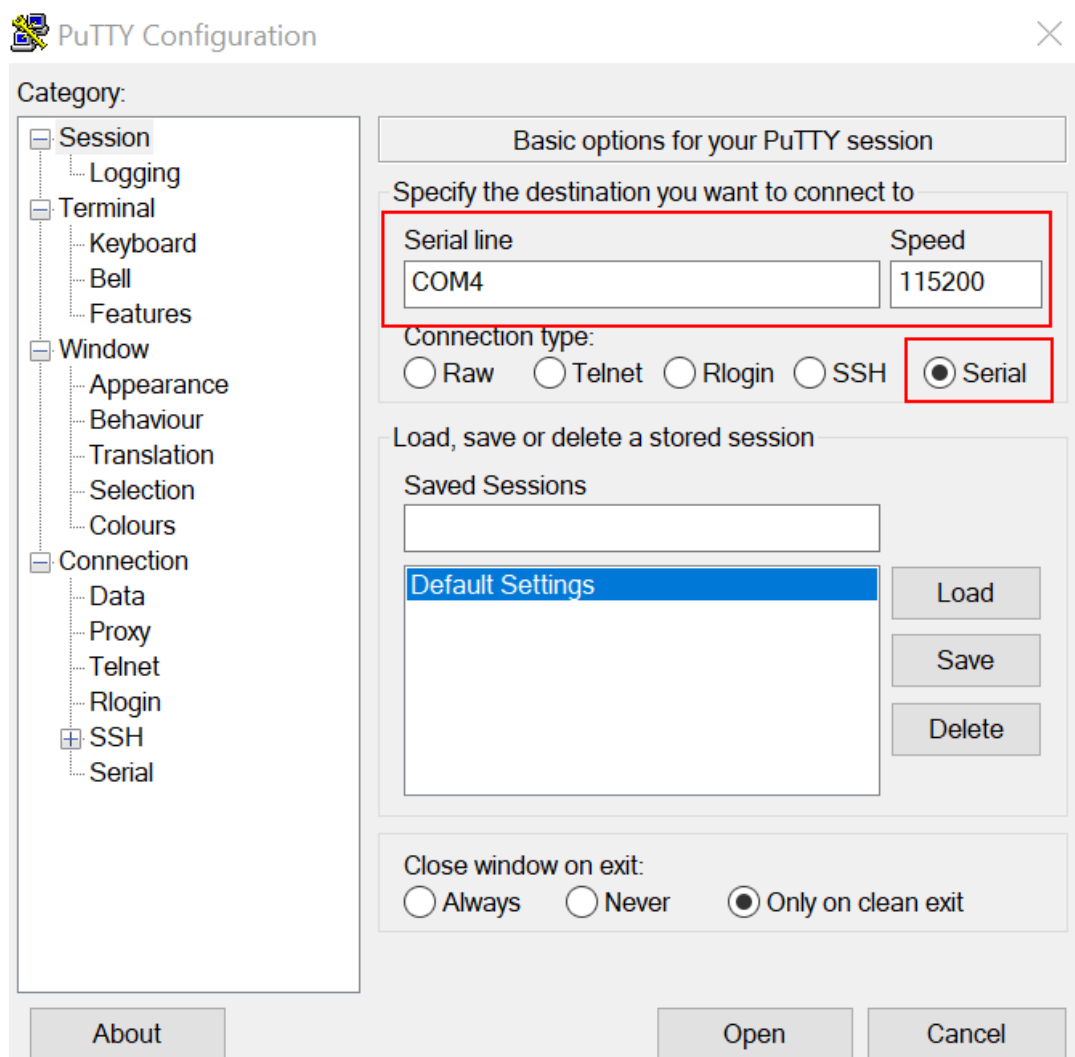
```
[ 84%] Building C object CMakeFiles/hello_world.elf.dir/C:/nxp/SDK_2.0_FRDM-K64F
/devices/MK64F12/drivers/fsl_smc.c.obj
[ 92%] Building C object CMakeFiles/hello_world.elf.dir/C:/nxp/SDK_2.0_FRDM-K64F
/devices/MK64F12/drivers/fsl_clock.c.obj
[100%] Linking C executable debug\hello_world.elf
[100%]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

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

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

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

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

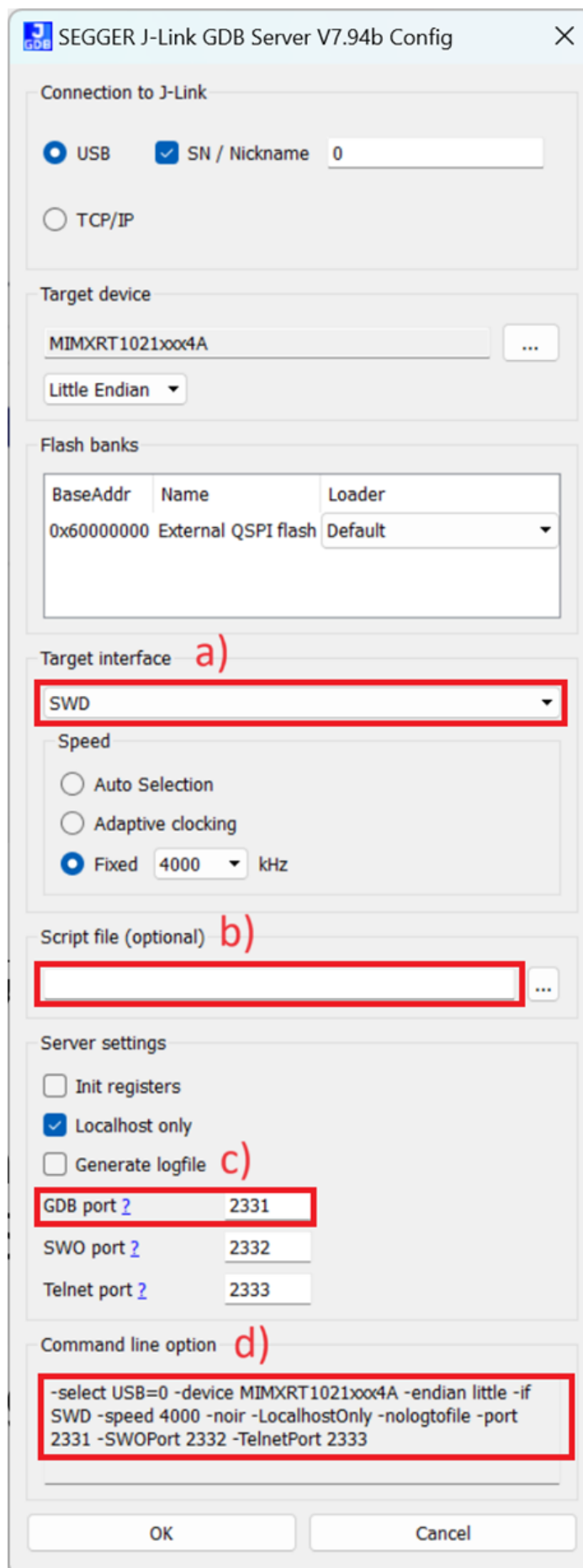


3. To launch the application, open the Windows **Start** menu and select **Programs > SEGGER > J-Link <version> J-Link GDB Server**.

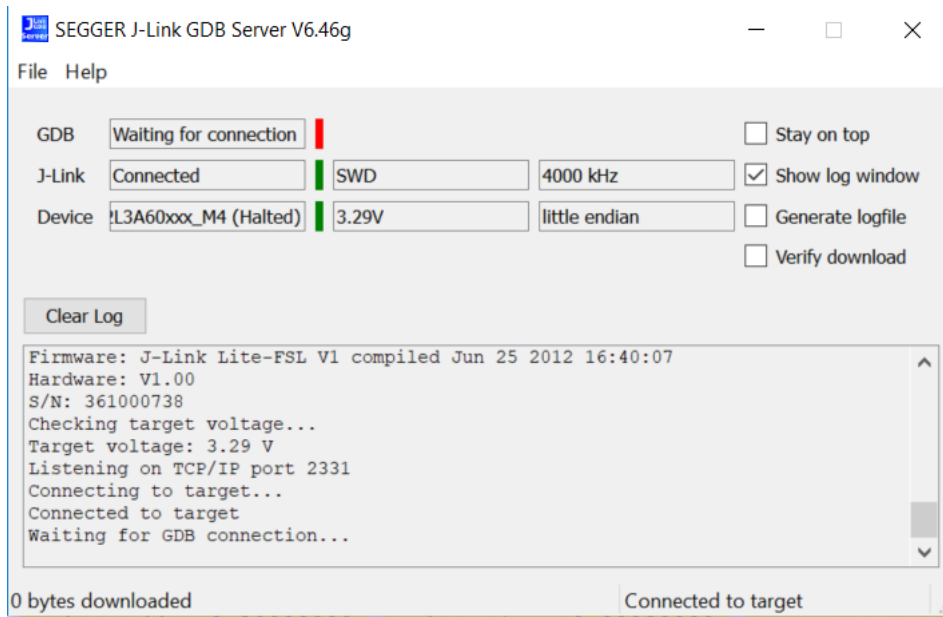
Note: It is assumed that the J-Link software is already installed.

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

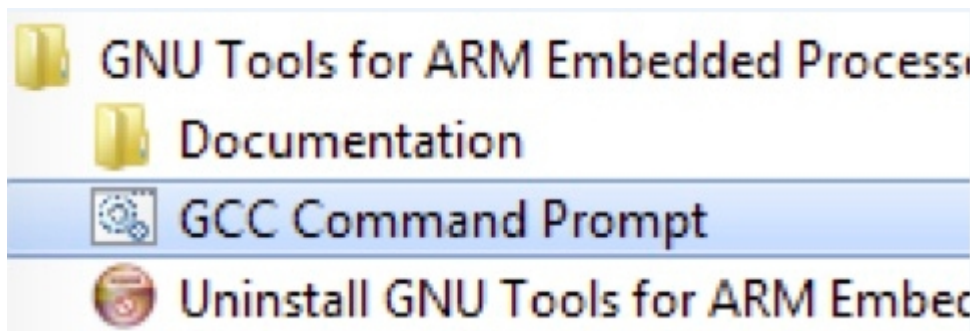
4. Make sure to check the following options.
 1. **Target interface:** The debug connection on board uses internal SWD signaling. In case of a wrong setting J-Link is unable to communicate with device under test.
 2. **Script file:** If required, a J-Link init script file can be used for board initialization.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



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



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

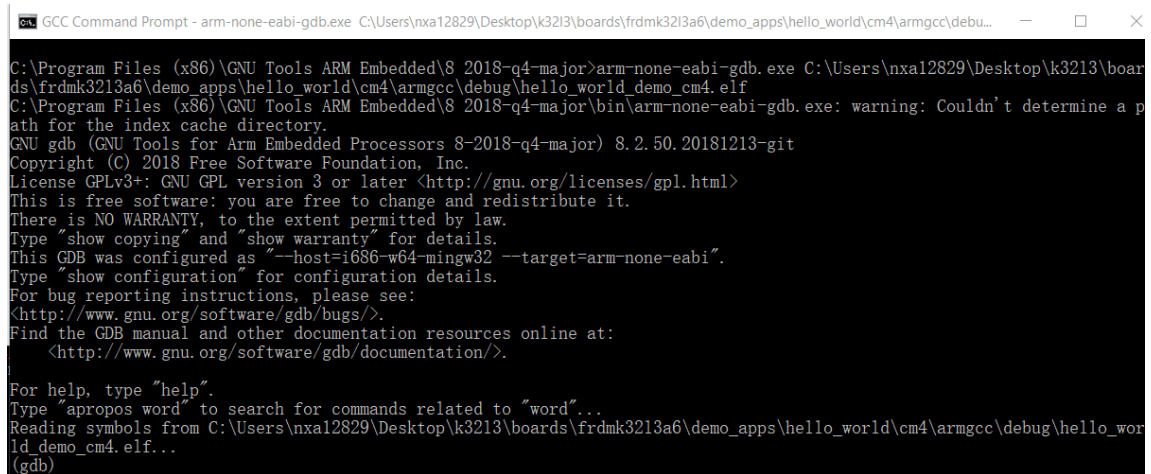


7. Change to the directory that contains the example application output. The output can be found in using one of these paths, depending on the build target selected:

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

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

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



```

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

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

```

9. Run these commands:

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

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

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



```

COM4 - PuTTY
hello world.

```

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

```
<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/armgcc
```

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

```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/armgcc/build_debug.bat
```

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


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

```

GCC Command Prompt - build_debug.bat

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

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

GCC Command Prompt - build_debug.bat

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

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

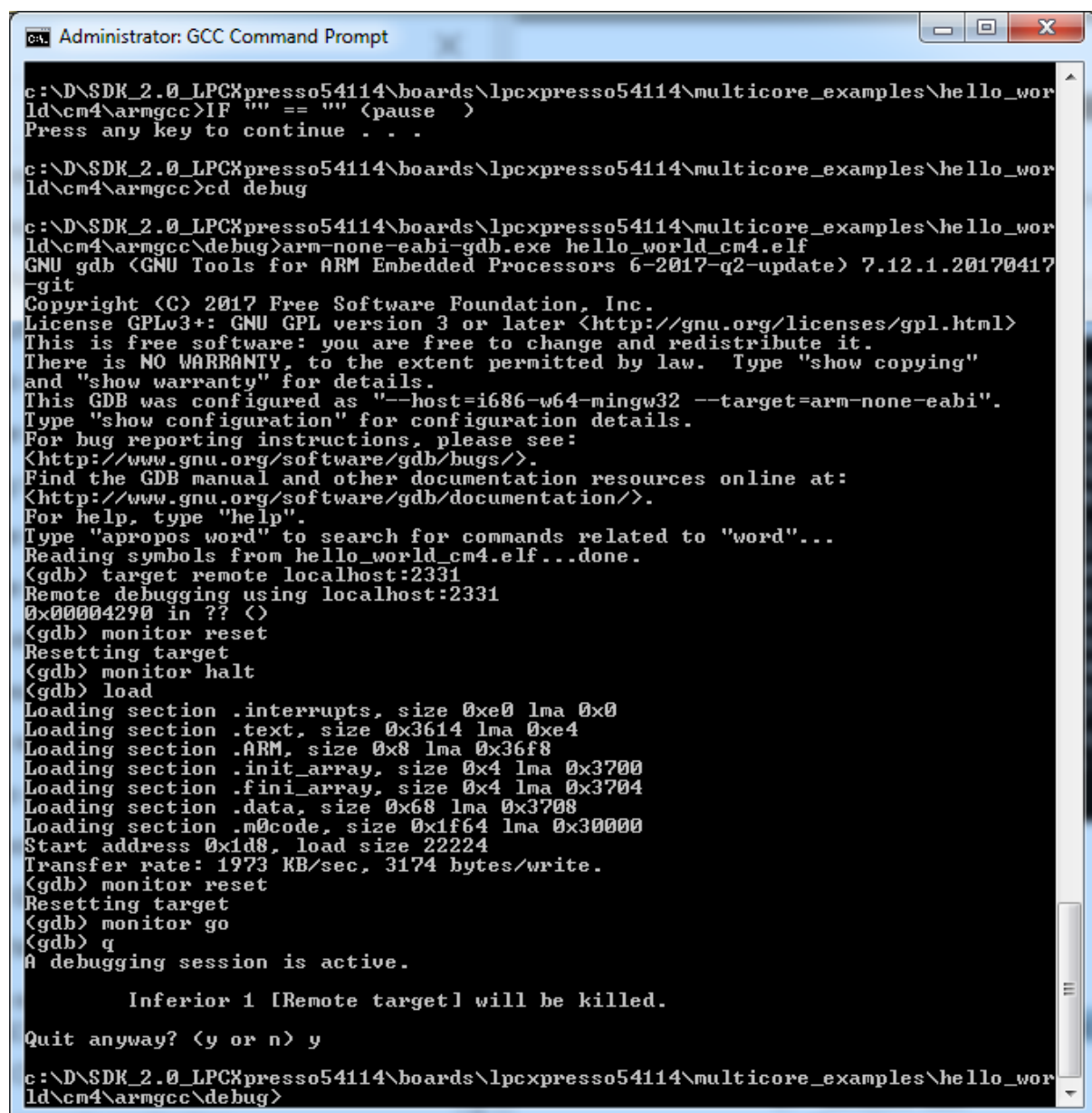
```

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

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

Both the primary and the auxiliary image is loaded into the SPI flash memory. After execution of the monitor go command, the primary core application is executed. During the primary core code execution, the auxiliary core code is reallocated from the flash memory to the RAM, and the auxiliary core is released from the reset. The hello_world multicore application is now running

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



```

Administrator: GCC Command Prompt

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

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

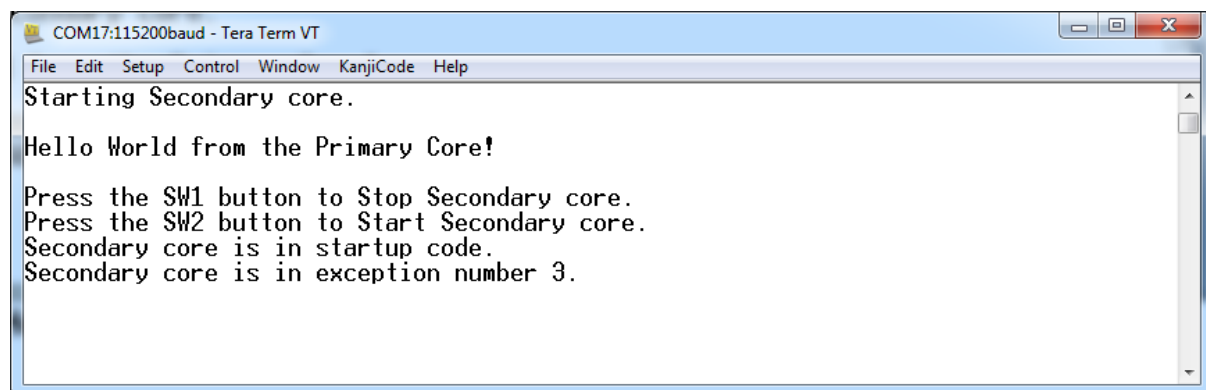
c:\D\SDK_2.0_LPCXpresso54114\boards\lpcxpresso54114\multicore_examples\hello_world_cm4\armgcc\debug>arm-none-eabi-gdb.exe hello_world_cm4.elf
GNU gdb (GNU Tools for ARM Embedded Processors 6-2017-q2-update) 7.12.1.20170417-git
Copyright (C) 2017 Free Software Foundation, Inc.
License GPLv3+: GNU GPL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

    Inferior 1 [Remote target] will be killed.

Quit anyway? (y or n) y

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

```



```

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

Hello World from the Primary Core!

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

```

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

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

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

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

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

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

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

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

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

```

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

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

```

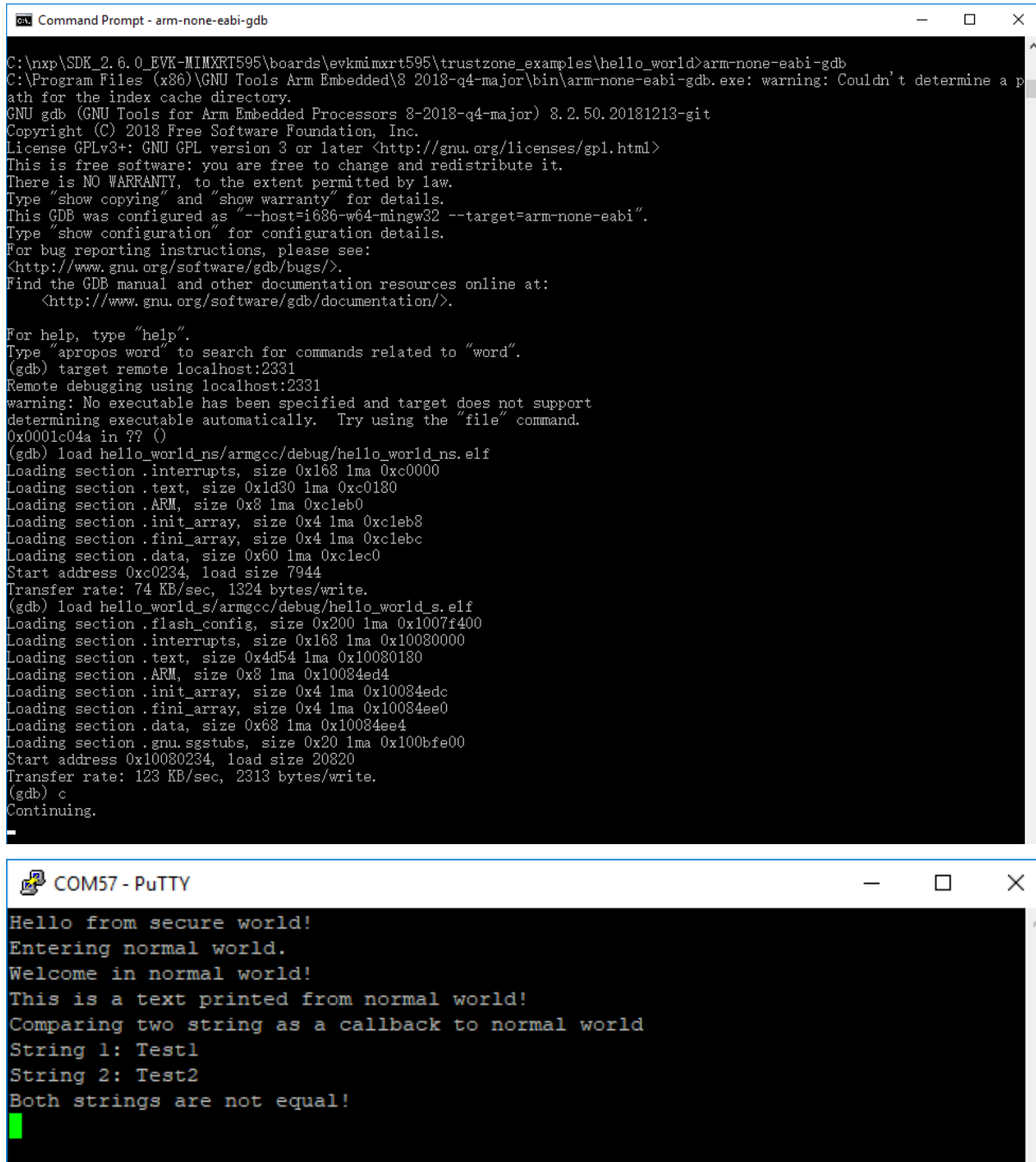
Run a TrustZone example application When running a TrustZone application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single core application, apply, as described in **Run an example application**.

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

Then, run these commands:

1. arm-none-eabi-gdb.exe
2. target remote localhost:2331
3. monitor reset
4. monitor halt
5. monitor exec SetFlashDLNoRMWThreshold = 0x20000
6. load <install_dir>/boards/evkmimxrt595/trustzone_examples/hello_world/hello_world_ns/armgcc/debug/hello_world_ns.elf
7. load <install_dir>/boards/evkmimxrt595/trustzone_examples/hello_world/hello_world_s/armgcc/debug/hello_world_s.elf
8. monitor reset

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



```

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

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

```

```

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

```

MCUXpresso Config Tools

MCUXpresso Config Tools can help configure the processor and generate initialization code for the on chip peripherals. The tools are able to modify any existing example project, or create a new configuration for the selected board or processor. The generated code is designed to be used with MCUXpresso SDK version 24.12.00 or later.

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

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

MCUXpresso Config Tools can be accessed in the following products:

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

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

How to determine COM port

This section describes the steps necessary to determine the debug COM port number of your NXP hardware development platform. All NXP boards ship with a factory programmed, onboard debug interface, whether it is based on MCU-Link or the legacy OpenSDA, LPC-Link2, P&E Micro OSJTAG interface. To determine what your specific board ships with, see [Default debug interfaces](#).

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

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

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

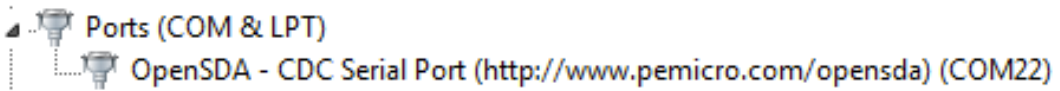
2. **Windows:** To determine the COM port open Device Manager in the Windows operating system. Click the **Start** menu and type **Device Manager** in the search bar.

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

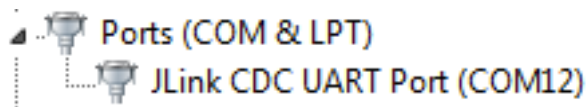
1. **CMSIS-DAP/mbd/DAPLink** interface:



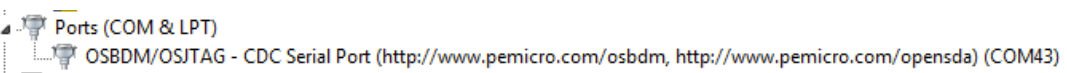
2. P&E Micro:



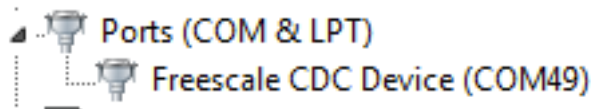
3. J-Link:



4. P&E Micro OSJTAG:



5. MRB-KW01:



On-board Debugger

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

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

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

The corresponding host driver must be installed before debugging.

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

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

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

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

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

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

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

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

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

The corresponding host driver must be installed before debugging.

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

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

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

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

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

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

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

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

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

The corresponding host driver must be installed before debugging.

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

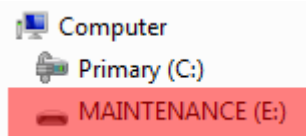
Updating OpenSDA firmware Any NXP hardware platform that comes with an OpenSDA-compatible debug interface has the ability to update the OpenSDA firmware. This typically means to switch from the default application (either CMSIS-DAP or P&E Micro) to a SEGGER J-Link. This section contains the steps to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

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

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

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

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



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

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

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

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

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

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

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

The host driver must be installed before debugging.

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

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

The host driver must be installed before debugging.

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

Default debug interfaces

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

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

continues on next page

Table 1 – continued from previous page

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

How to define IRQ handler in CPP files

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

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

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

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

1.3 Getting Started with MCUXpresso SDK GitHub

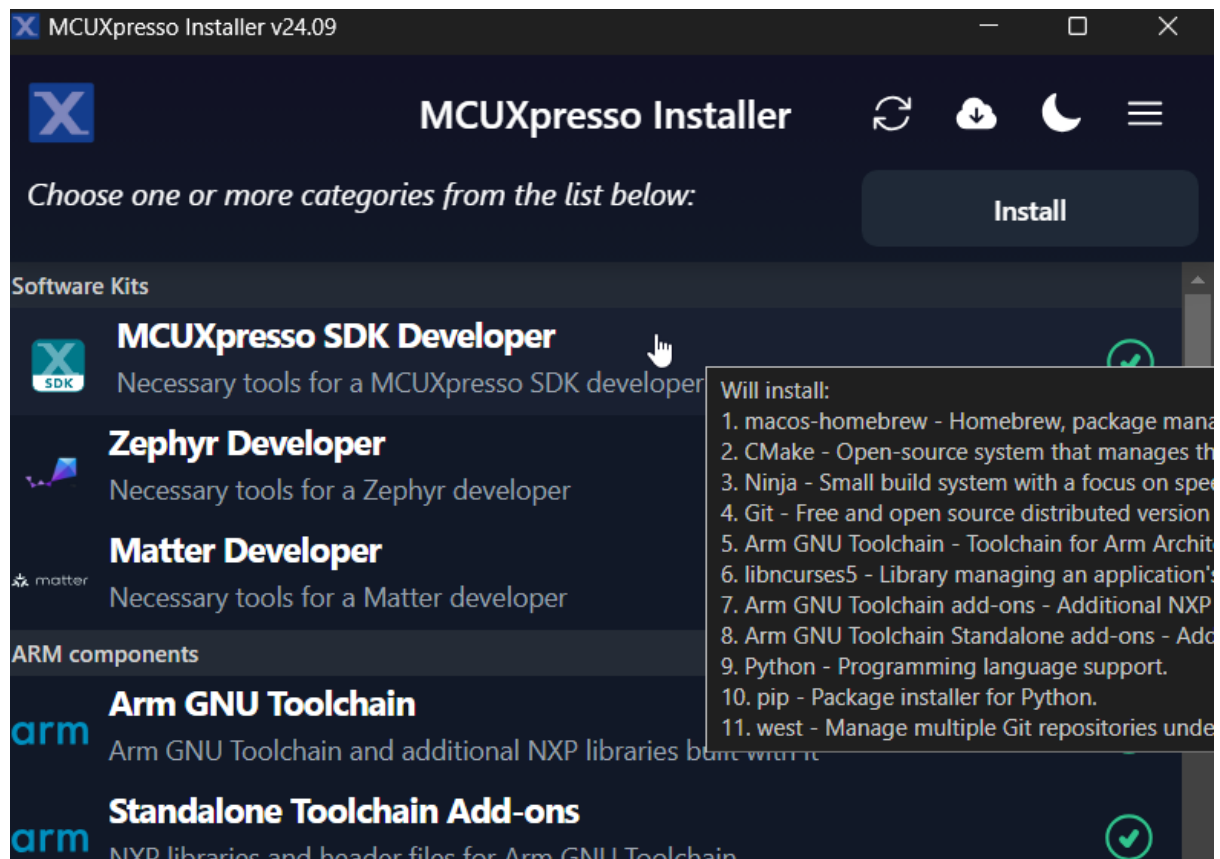
1.3.1 Getting Started with MCUXpresso SDK Repository

Installation

NOTE

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

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



Alternative: Manual Installation

Basic tools

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

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

Then configure your username and email using the commands:

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

Python Install python 3.10 or latest. Follow the [Python Download](#) guide.

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

West Please use the west version equal or greater than 1.2.0

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

Build And Configuration System

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

For Windows, you can directly use the .msi installer like [cmake-3.31.4-windows-x86_64.msi](#) to install.

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

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

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

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

For Linux, you can use your [system package manager](#) or you can directly download the [ninja binary](#) to work.

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

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

Please make sure [python](#) environment is setup ready then you can use the Kconfig.

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

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

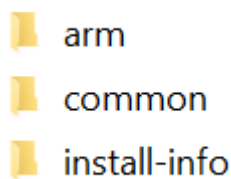
Toolchain MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

Toolchain	Download and Installation Guide	Note
Armgcc	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

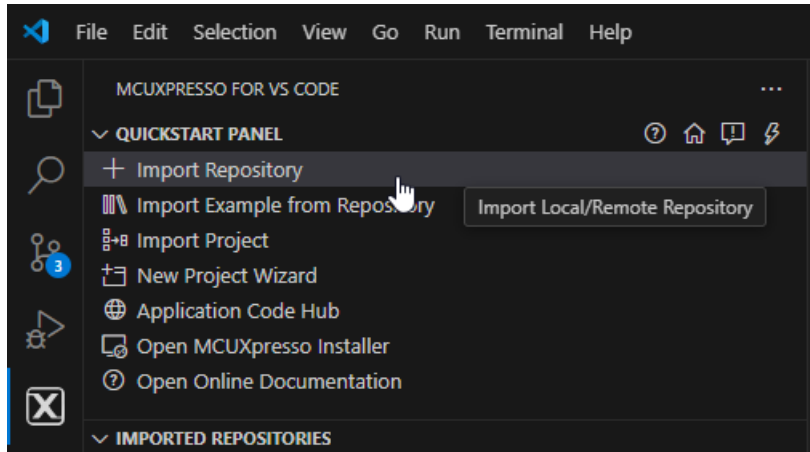
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the `hello_world` demo application as an example. However, these

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](#).

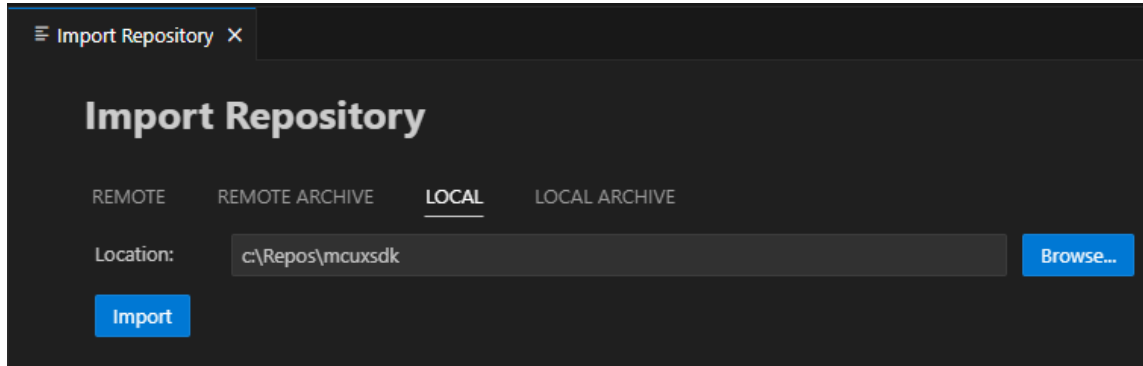
To build an example application:

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

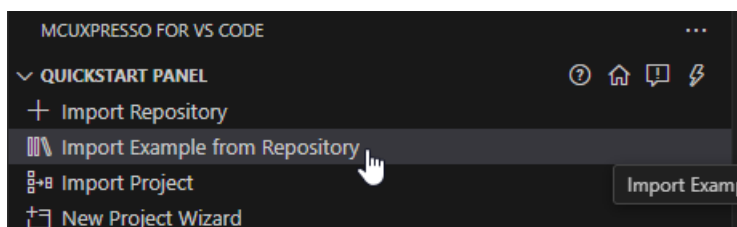


Note: You can import the SDK in several ways. Refer to [MCUXpresso for VS Code Wiki](#) for details.

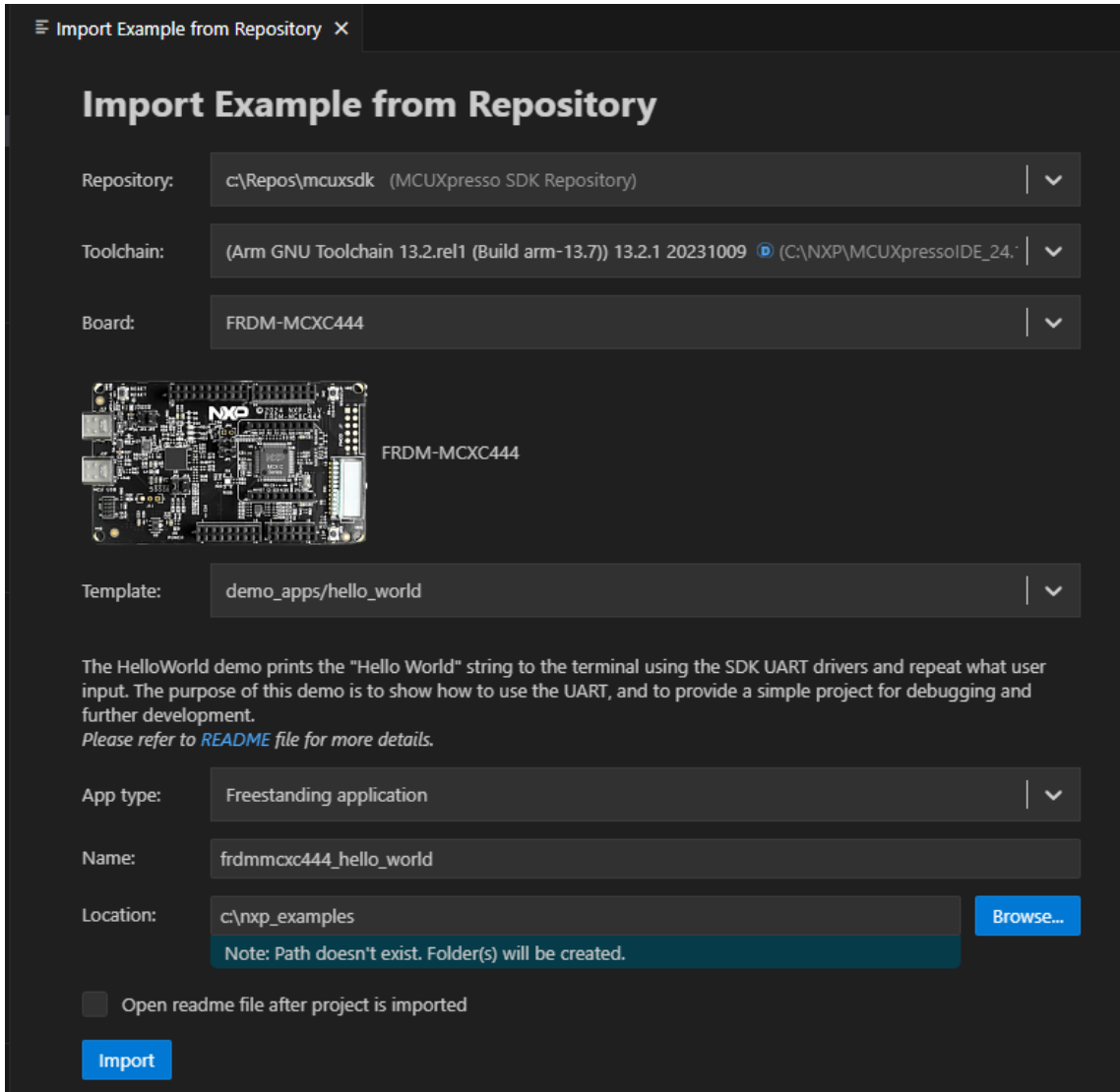
Select **Local** if you've already obtained the SDK as seen in [Get MCUXpresso SDK Repo](#). Select your location and click **Import**.



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...](#)

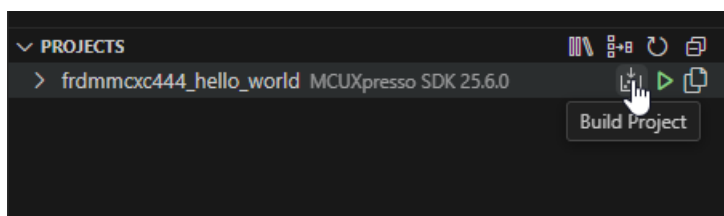
Note: Path doesn't exist. Folder(s) will be created.

☐ 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.

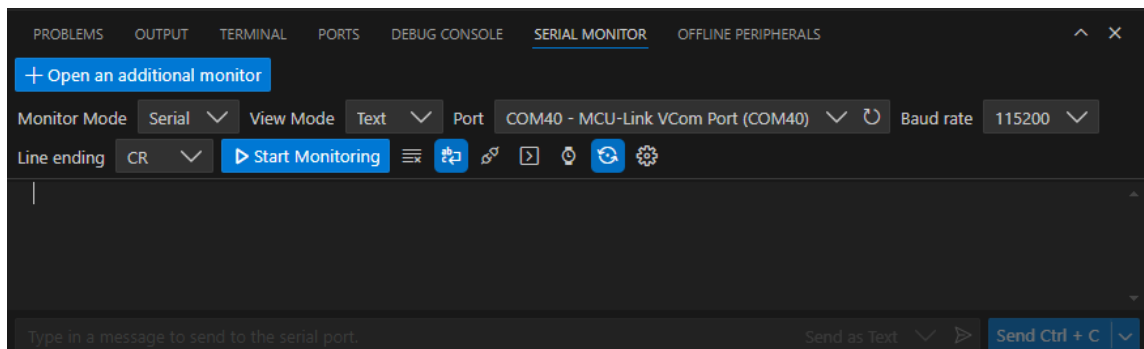
```

[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.

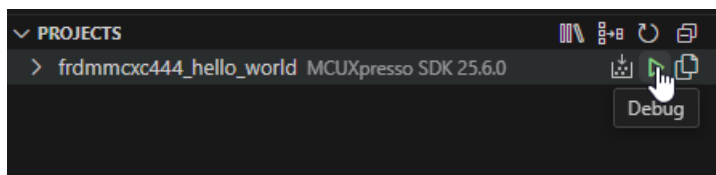
```

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

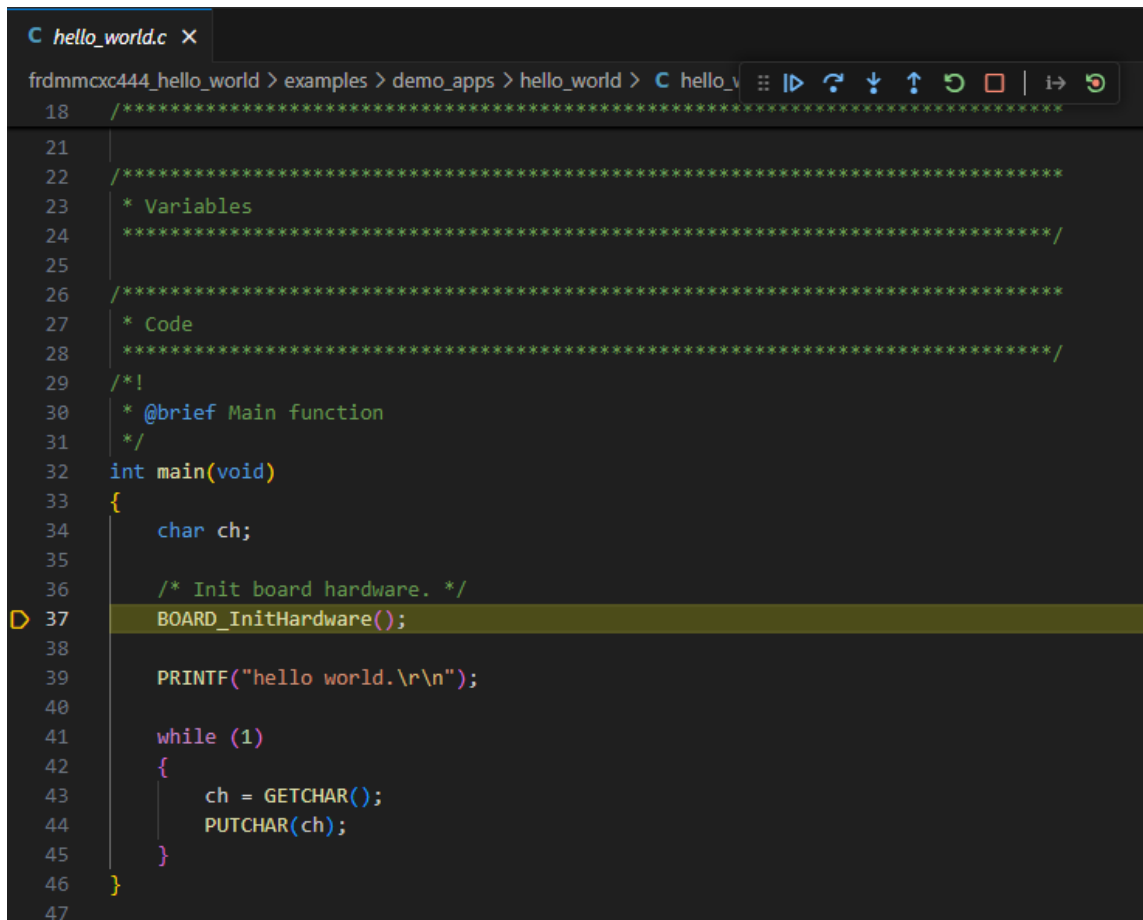
1. Open the **Serial Monitor** from the VS Code's integrated terminal. Select the VCom Port for your device and set the baud rate to 115200.



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.

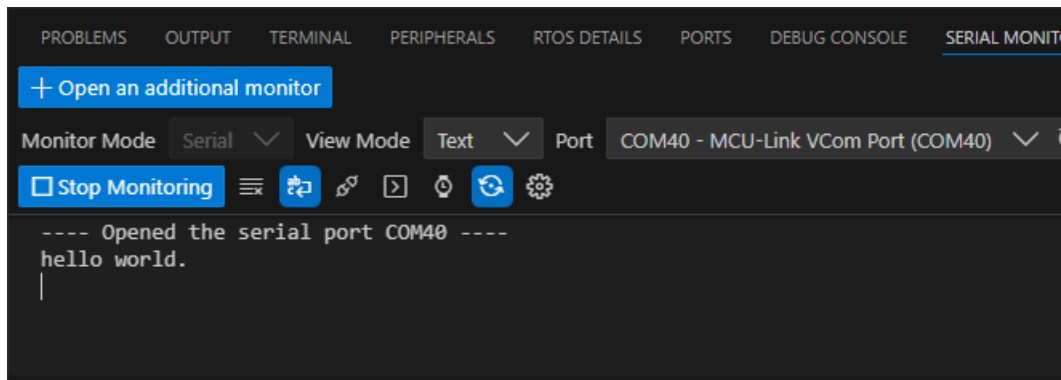


```

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)

(continued from previous page)

```

↪ evkbbmimxrt1060]
INFO: [ 4][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbbmimxrt1170 -Dcore_id=cm4]
INFO: [ 5][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbbmimxrt1170 -Dcore_id=cm7]
INFO: [ 6][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkcmimxrt1060]
INFO: [ 7][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkmcimx7ulp]
...

```

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

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

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

Here are some typical usages for generating a SDK example:

```

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

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

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

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

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

```

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

```

west build -b evkbbmimxrt1170 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 evkbbmimxrt1170 --sysbuild ./examples/multicore_examples/hello_world/primary -Dcore_
↪ id=cm7 --config flexspi_nor_debug --toolchain=armgcc -p always

```

For more details, please refer to System build.

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

1. Run cmake configuration

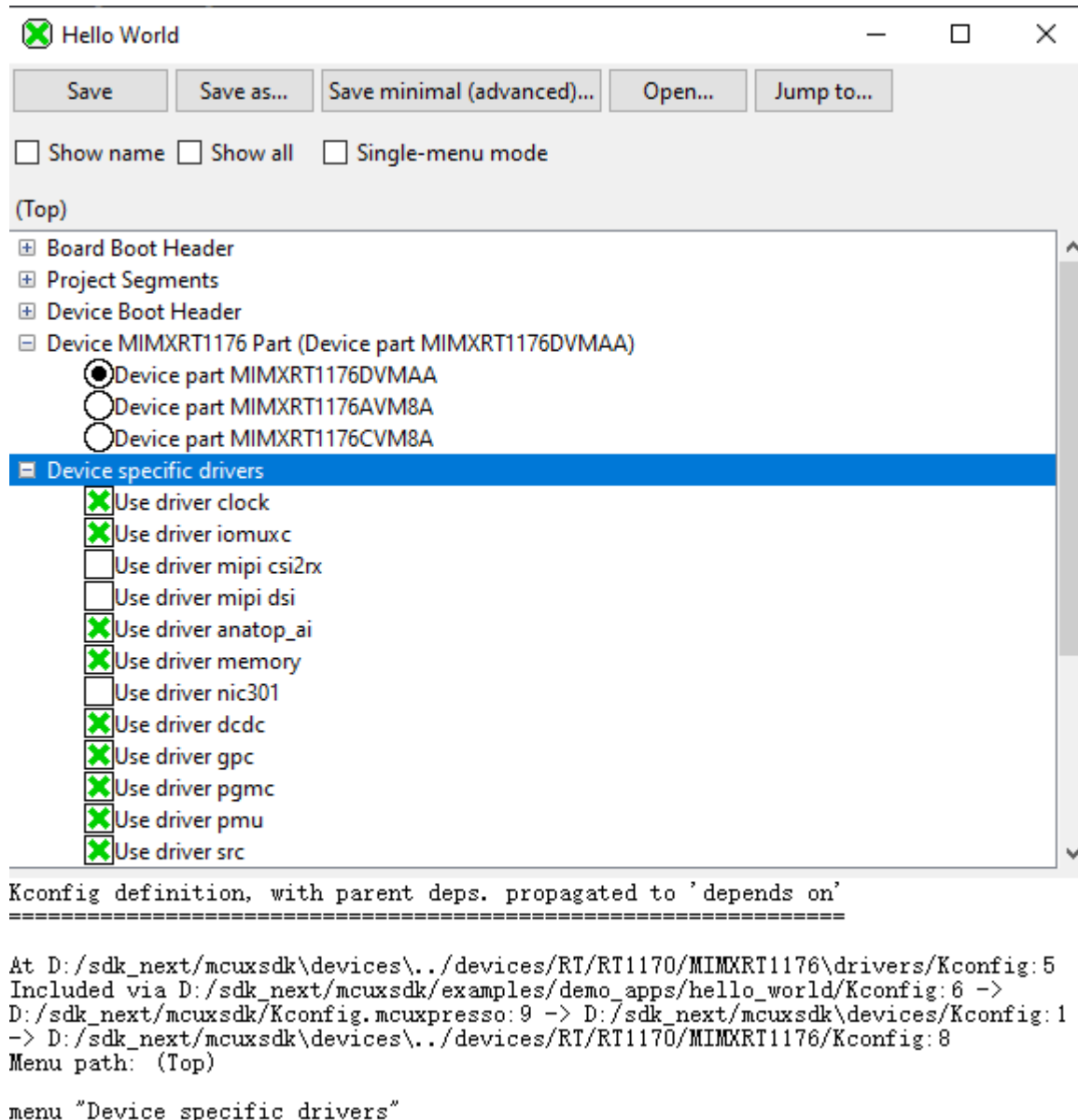
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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

2. Run guiconfig target

```
west build -t guiconfig
```

Then you will get the Kconfig GUI launched, like



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

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

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

```
west flash -r linkserver
```

Debug Start a gdb interface by following command:

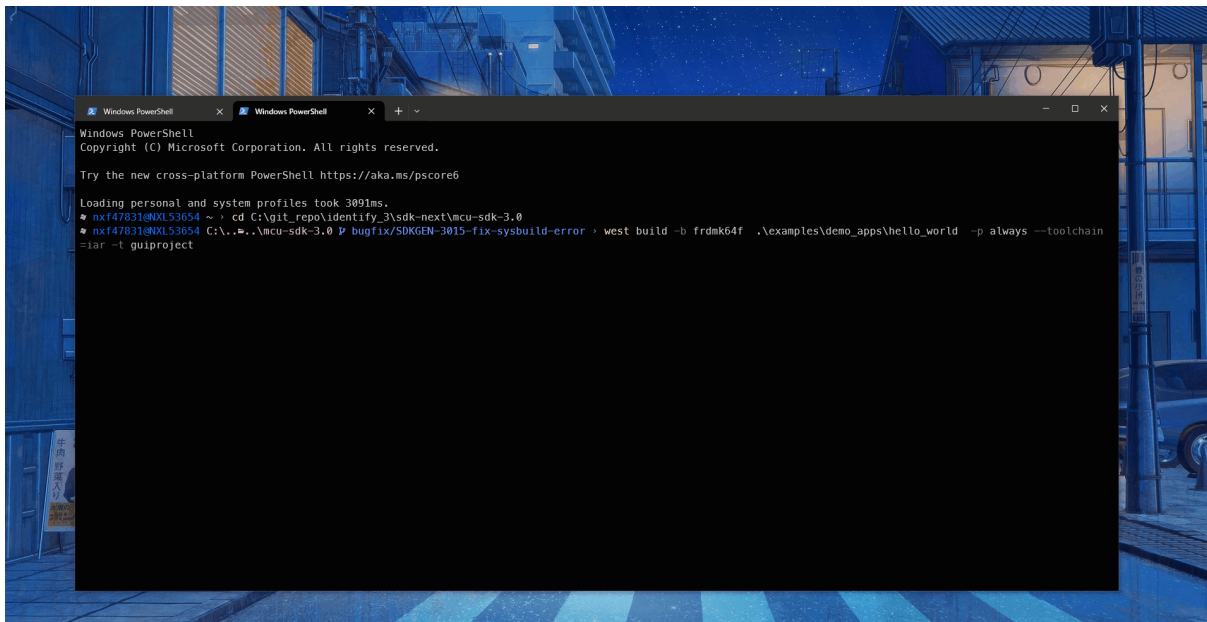
```
west debug -r linkserver
```

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

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

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

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



Note, please follow the [Installation](#) to setup the environment especially make sure that [ruby](#) has been installed.

1.4 Release Notes

1.4.1 MCUXpresso SDK Release Notes

Overview

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

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

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

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

MCUXpresso SDK

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

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

Development tools

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

- MCUXpresso IDE, Rev. 25.06.xx
- IAR Embedded Workbench for Arm, version is 9.60.4
- Keil MDK, version is 5.42
- MCUXpresso for VS Code v25.09
- GCC Arm Embedded Toolchain 14.2.x

Supported development systems

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

Development boards	MCU devices
FRDM-K32L3A6	K32L3A60VPJ1A

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.

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

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

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".

Multicore Multicore Software Development Kit

mbedTLS mbedtls SSL/TLS library v2.x

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.

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.

Build warning in freertos_tickless example

A build warning appears in the freertos_tickless example while working in the ArmGCC environment.

```
.. code-block:: none
  `c:\c\pkg\cmsis\core\include\core_cm0plus.h:854:52: warning: array subscript 14 is above array bounds
  ↳ of 'volatile uint32_t[8]' {aka 'volatile long unsigned int[8]'} [-Warray-bounds]`.
```

Example freertos_lpspi fail before the console output

The example freertos_lpspi fails before the message “LPSPI master transfer completed successfully.” appears in the console output.

Console output:

```
```
FreeRTOS LPSPI example start.
This example use one lpspi instance as master and another as slave on a single board.
Master and slave are both use interrupt way.
Please make sure you make the correct line connection. Basically, the connection is:
LPSPI_master -- LPSPI_slave
CLK -- CLK
PCS -- PCS
SOUT -- SIN
SIN -- SOUT ```
```

### The freertos\_tickless cm0plus example does not complete successfully

The example starts correctly but does not perform as expected (Ticks do not printed on the console).

Examples: freertos\_tickless

Affected toolchains: All

### The freertos\_lpuart example does not complete successfully

The example hangs after console output ‘FreeRTOS LPUART driver example’.

**Examples:** freertos\_lpuart

**Affected toolchains:** All

The example does not perform as expected (Ticks do not printed on the console or the application does not wake up from the sleep mode).

**Examples:** freertos\_tickless

**Affected toolchains:** All

## 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
- 

## CACHE LPCAC

#### [2.1.1]

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

#### [2.1.0]

- Bug Fixes
  - Deleted L1CACHE\_EnableCodeCacheWriteBuffer function because of no enable bit in register CPCR2.

#### [2.0.0]

- Initial version.
- 

## CACHE LPLMEM

#### [2.1.1]

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

#### [2.1.0]

- Bug Fixes
  - Deleted L1CACHE\_EnableCodeCacheWriteBuffer function because of no enable bit in register CPCR2.

#### [2.0.0]

- Initial version.
- 

### CAU3

#### [2.0.5]

- Improvements
  - Fix MISRA C-2012 issue.

#### [2.0.4]

- Improvements
  - Fix MISRA C-2012 issue.

#### [2.0.3]

- Improvements
  - Fix MISRA C-2012 issue.

#### [2.0.2]

- New Features
  - Added FSL\_CAU3\_USE\_HW\_SEMA compile time macro. When enabled, all CAU3 API functions lock hardware semaphore on function entry and release the hardware semaphore on function return.

#### [2.0.1]

- Improvements
  - Replaced static `cau3_make_mems_private()` with public `CAU3_MakeMemsPrivate()`.
  - Removed the `cau3_make_mems_private()` from `CAU3_Init` to allow loading multiple images.

#### [2.0.0]

- Initial version.
-

## CLOCK

### [2.2.1]

- Bug Fixes
  - Fixed MISRA C-2012 rule 10.1, rule 10.8, rule 14.4 and so on.

### [2.2.0]

- New features
  - Moved SDK\_DelayAtLeastUs function from clock driver to common driver.

### [2.1.0]

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

### [2.0.0]

- 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's 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

### [2.0.4]

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

**[2.0.3]**

- Bug fix:
  - Fix MISRA issues.

**[2.0.2]**

- Bug fix:
  - Fix MISRA issues.

**[2.0.1]**

- Bug fix:
  - DATA and DATALL macro definition moved from header file to source file.

**[2.0.0]**

- Initial version.
- 

**DAC****[2.1.2]**

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

**[2.1.1]**

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

**[2.1.0]**

- New Features
  - Added support for period trigger mode.
  - Added support for sync trigger between dac instances.
  - Added support for configuring DAC sync cycles.
  - Added support for internal reference current selection.
  - Enabled buffer mode manually for K4 series board.

**[2.0.2]**

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



### [2.0.1]

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

### [2.0.0]

- Initial version.
- 

## DMAMUX

### [2.1.3]

- Improvements
  - Wrap `DMAMUX_GetInstance` into `FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL` to avoid build issues.

### [2.1.2]

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

### [2.1.1]

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

### [2.1.0]

- Improvements
  - Modify the type of parameter source from `uint32_t` to `int32_t` in the `DMA-MUX_SetSource`.

### [2.0.5]

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

### [2.0.4]

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

**[2.0.3]**

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

**[2.0.2]**

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

**[2.0.1]**

- Bug Fixes
  - Fixed the build warning issue by changing the type of parameter source from uint8\_t to uint32\_t when setting DMA request source in DMAMUX\_SetSourceChange.

**[2.0.0]**

- Initial version.
- 

**EDMA****[2.4.5]**

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

**[2.4.4]**

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

**[2.4.3]**

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

#### [2.4.2]

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

#### [2.4.1]

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

#### [2.4.0]

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

#### [2.3.2]

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

#### [2.3.1]

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

#### [2.3.0]

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

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

#### [2.2.0]

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

#### [2.1.9]

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

#### [2.1.8]

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

#### [2.1.7]

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

#### [2.1.6]

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

#### [2.1.5]

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

#### [2.1.4]

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

#### [2.1.3]

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

#### [2.1.2]

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

#### [2.1.1]

- Improvements
  - Added documentation for eDMA data flow when scatter/gather is implemented for the EDMA\_HandleIRQ API.
  - Updated and corrected some related comments in the EDMA\_HandleIRQ API and edma\_handle\_t struct.

#### [2.1.0]

- Improvements
  - Changed the EDMA\_GetRemainingBytes API into EDMA\_GetRemainingMajorLoopCount due to eDMA IP limitation (see API comments/note for further details).

#### [2.0.5]

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

#### [2.0.4]

- Improvements
  - Added support for SoCs with multiple eDMA instances.
  - Added pubweak DriverIRQHandler for KL28T DMA1 and MCIMX7U5\_M4.

#### [2.0.3]

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

**[2.0.2]**

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

**[2.0.1]**

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

**[2.0.0]**

- Initial version.
- 

**EWM****[2.0.4]**

- Bug Fixes
  - Fixed CERT INT31-C violations.

**[2.0.3]**

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

**[2.0.2]**

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

**[2.0.1]**

- Bug Fixes
  - Fixed the hard fault in `EWM_Deinit`.

**[2.0.0]**

- Initial version.
- 

**FLASH****[3.3.0]**

- New Feature
  - Support for EEPROM Quick Write on devices with FTFC

### [3.2.0]

- New Feature
  - Basic support for FTFC

### [3.1.3]

- New Feature
  - Support 512KB flash for Kinetis E serials.

### [3.1.2]

- Bug Fixes — Remove redundant comments.

### [3.1.1]

- Bug Fixes — MISRA C-2012 issue fixed: rule 10.3

### [3.1.0]

- New Feature
  - Support erase flash asynchronously.

### [3.0.2]

- Bug Fixes — MISRA C-2012 issue fixed: rule 8.4, 17.7, 10.4, 16.1, 21.15, 11.3, 10.7 — building warning -Wnull-dereference on arm compiler v6

### [3.0.1]

- New Features
  - Added support FlexNVM alias for (kw37/38/39).

### [3.0.0]

- Improvements
  - Reorganized FTFx flash driver source file.
  - Extracted flash cache driver from FTFx driver.
  - Extracted flexnvm flash driver from FTFx driver.

### [2.3.1]

- Bug Fixes
  - Unified Flash IFR design from K3.
  - New encoding rule for K3 flash size.

**[2.3.0]**

- New Features
  - Added support for device with LP flash (K3S/G).
  - Added flash prefetch speculation APIs.
- Improvements
  - Refined flash\_cache\_clear function.
  - Reorganized the member of flash\_config\_t struct.

**[2.2.0]**

- New Features
  - Supported FTFL device in FLASH\_Swap API.
  - Supported various pflash start addresses.
  - Added support for KV58 in cache clear function.
  - Added support for device with secondary flash (KW40).
- Bug Fixes
  - Compiled execute-in-ram functions as PIC binary code for driver use.
  - Added missed flexram properties.
  - Fixed unaligned variable issue for execute-in-ram function code array.

**[2.1.0]**

- Improvements
  - Updated coding style to align with KSDK 2.0.
  - Different-alignment-size support for pflash and flexnvm.
  - Improved the implementation of execute-in-ram functions.

**[2.0.0]**

- Initial version
- 

**FLEXBUS****[2.1.1]**

- Bug Fixes
- MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.

**[2.1.0]**

- Bug Fixes
  - Added secondary wait states (SWS), which enabled flag into configuration structure, and updated FLEXBUS\_Init() function according to SWS.
  - Fixed MISRA issues regarding rule 10.1/10.4.



#### [2.0.2]

- Bug Fixes
  - Removed dissociated chip clearing operation while initializing the FLEXBUS module. Only the associated chip's register will be cleared.

#### [2.0.1]

- Bug Fixes
  - Corrected FLEXBUS\_Deinit() function to disable clock.

#### [2.0.0]

- Initial version.
- 

### FLEXIO

#### [2.3.0]

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

#### [2.2.3]

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

#### [2.2.2]

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

#### [2.2.1]

- Improvements
  - Added doxygen index parameter comment in FLEXIO\_SetClockMode.

#### [2.2.0]

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

#### [2.1.0]

- Improvements
  - Added API FLEXIO\_SetClockMode to set flexio channel counter and source clock.

**[2.0.4]**

- Bug Fixes
  - Fixed MISRA 8.4 issues.

**[2.0.3]**

- Bug Fixes
  - Fixed MISRA 10.4 issues.

**[2.0.2]**

- Improvements
  - Split FLEXIO component which combines all flexio/flexio\_uart/flexio\_i2c/flexio\_i2s drivers into several components: FlexIO component, flexio\_uart component, flexio\_i2c\_master component, and flexio\_i2s component.
- Bug Fixes
  - Fixed MISRA issues
    - \* Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.

**[2.0.1]**

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

**FLEXIO\_I2C****[2.6.2]**

- Improvements
  - Added timeout for while loop in FLEXIO\_I2C\_MasterTransferBlocking().
- Bug Fixes
  - Fixed build issues related to I2C\_RETRY\_TIMES.

**[2.6.1]**

- Bug Fixes
  - Fixed coverity issues

**[2.6.0]**

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

### [2.5.1]

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

### [2.5.0]

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

### [2.4.0]

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

### [2.3.0]

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

### [2.2.0]

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

**[2.1.7]**

- Bug Fixes
  - Fixed the issue that FLEXIO\_I2C\_MasterTransferBlocking did not wait for STOP bit sent.
  - Fixed COVERITY issue of useless call in FLEXIO\_I2C\_MasterTransferRunStateMachine.
  - Fixed the issue that I2C master did not check whether bus was busy before transfer.

**[2.1.6]**

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

**[2.1.5]**

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

**[2.1.4]**

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

**[2.1.3]**

- Improvements
  - Changed the prototype of FLEXIO\_I2C\_MasterInit to return kStatus\_Success if initialized successfully or to return kStatus\_InvalidArgument if “(srcClock\_Hz / masterConfig->baudRate\_Bps) / 2 - 1” exceeds 0xFFU.

**[2.1.2]**

- Bug Fixes
  - Fixed the FLEXIO I2C issue where the master could not receive data from I2C slave in high baudrate.
  - Fixed the FLEXIO I2C issue where the master could not receive NAK when master sent non-existent addr.
  - Fixed the FLEXIO I2C issue where the master could not get transfer count successfully.
  - Fixed the FLEXIO I2C issue where the master could not receive data successfully when sending data first.
  - Fixed the Dozen mode configuration error in FLEXIO\_I2C\_MasterInit API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.

- Fixed the issue that FLEXIO\_I2C\_MasterTransferBlocking API called FLEXIO\_I2C\_MasterTransferCreateHandle, which lead to the s\_flexioHandle/s\_flexioIsr/s\_flexioType variable being written. Then, if calling FLEXIO\_I2C\_MasterTransferBlocking API multiple times, the s\_flexioHandle/s\_flexioIsr/s\_flexioType variable would not be written any more due to it being out of range. This lead to the following situation: NonBlocking transfer APIs could not work due to the fail of register IRQ.

#### [2.1.1]

- Bug Fixes
  - Implemented the FLEXIO\_I2C\_MasterTransferBlocking API which is defined in header file but has no implementation in the C file.

#### [2.1.0]

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

### FLEXIO\_I2S

#### [2.2.2]

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

#### [2.2.1]

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

#### [2.2.0]

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

#### [2.1.6]

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

**[2.1.5]**

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

**[2.1.4]**

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

**[2.1.3]**

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

**[2.1.2]**

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

**[2.1.1]**

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

**[2.1.0]**

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

**FLEXIO\_I2S\_EDMA****[2.1.9]**

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

#### [2.1.8]

- Improvements
    - Applied EDMA ERRATA 51327.
- 

### FLEXIO\_SPI

#### [2.4.3]

- Improvements
  - Make SPI\_RETRY\_TIMES configurable by CONFIG\_SPI\_RETRY\_TIMES.

#### [2.4.2]

- Bug Fixes
  - Fixed FLEXIO\_SPI\_MasterTransferBlocking and FLEXIO\_SPI\_MasterTransferNonBlocking issue in CS continuous mode, the CS might not be continuous.

#### [2.4.1]

- Bug Fixes
  - Fixed coverity issues

#### [2.4.0]

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

#### [2.3.5]

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

#### [2.3.4]

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

#### [2.3.3]

- Bugfixes
  - Fixed cs-continuous mode.

#### [2.3.2]

- Improvements
  - Changed FLEXIO\_SPI\_DUMMYDATA to 0x00.

### [2.3.1]

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

### [2.3.0]

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

### [2.2.1]

- Bug Fixes
  - Fixed bug in FLEXIO\_SPI\_MasterTransferAbortEDMA that when aborting EDMA transfer EDMA\_AbortTransfer should be used rather than EDMA\_StopTransfer.

### [2.2.0]

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

### [2.1.3]

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

### [2.1.2]

- Bug Fixes
  - The following modification support FlexIO using multiple instances:
    - \* Removed FLEXIO\_Reset API in module Init APIs.



- \* Updated module Deinit APIs to reset the shifter/timer config instead of disabling module/clock.
- \* Updated module Enable APIs to only support enable operation.

#### [2.1.1]

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

#### [2.1.0]

- New Features
    - Added Transfer prefix in transactional APIs.
    - Added transferSize in handle structure to record the transfer size.
  - Bug Fixes
    - Fixed the error register address return for 16-bit data write in FLEXIO\_SPI\_GetTxDataRegisterAddress.
    - Provided independent IRQHandler/transfer APIs for Master and slave to fix the baudrate limit issue.
- 

## FLEXIO\_UART

#### [2.6.4]

- Improvements
  - Make UART\_RETRY\_TIMES configurable by CONFIG\_UART\_RETRY\_TIMES.

#### [2.6.3]

- Bug Fixes
  - Fixed coverity issues

#### [2.6.2]

- Bug Fixes
  - Fixed coverity issues

**[2.6.1]**

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

**[2.6.0]**

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

**[2.5.1]**

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

**[2.5.0]**

- Improvements
  - Added API FLEXIO\_UART\_FlushShifters to flush UART fifo.

**[2.4.0]**

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

**[2.3.0]**

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

**[2.2.0]**

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

#### [2.1.6]

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

#### [2.1.5]

- Improvements
  - Triggered user callback after all the data in ringbuffer were received in FLEXIO\_UART\_TransferReceiveNonBlocking.

#### [2.1.4]

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

#### [2.1.3]

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

#### [2.1.2]

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

#### [2.1.1]

- Bug Fixes
  - Changed the API name FLEXIO\_UART\_StopRingBuffer to FLEXIO\_UART\_TransferStopRingBuffer to align with the definition in C file.

**[2.1.0]**

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

**FLEXIO\_UART\_EDMA****[2.3.1]**

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

**[2.3.0]**

- Refer FLEXIO\_UART driver change log to 2.3.0
- 

**GPIO****[2.8.2]**

- Bug Fixes
  - Fixed COVERITY issue that GPIO\_GetInstance could return clock array overflow values due to GPIO base and clock being out of sync.

**[2.8.1]**

- Bug Fixes
  - Fixed CERT INT31-C issues.

**[2.8.0]**

- Improvements
  - Add API GPIO\_PortInit/GPIO\_PortDeinit to set GPIO clock enable and releasing GPIO reset.

**[2.8.0]**

- Improvements
  - Add API GPIO\_PortInit/GPIO\_PortDeinit to set GPIO clock enable and releasing GPIO reset.
  - Remove support for API GPIO\_GetPinsDMARequestFlags with GPIO\_ISFR\_COUNT <= 1.

### [2.7.3]

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

### [2.7.2]

- New Features
  - Support devices without PORT module.

### [2.7.1]

- Bug Fixes
  - Fixed MISRA C-2012 rule 10.4 issues in GPIO\_GpioGetInterruptChannelFlags() function and GPIO\_GpioClearInterruptChannelFlags() function.

### [2.7.0]

- New Features
  - Added API to support Interrupt select (IRQS) bitfield.

### [2.6.0]

- New Features
  - Added API to get GPIO version information.
  - Added API to control a pin for general purpose input.
  - Added some APIs to control pin in secure and privilege status.

### [2.5.3]

- Bug Fixes
  - Correct the feature macro typo: FSL\_FEATURE\_GPIO\_HAS\_NO\_INDEP\_OUTPUT\_CONTORL.

### [2.5.2]

- Improvements
  - Improved GPIO\_PortSet/GPIO\_PortClear/GPIO\_PortToggle functions to support devices without Set/Clear/Toggle registers.

### [2.5.1]

- Bug Fixes
  - Fixed wrong macro definition.
  - Fixed MISRA C-2012 rule issues in the FGPIO\_CheckAttributeBytes() function.
  - Defined the new macro to separate the scene when the width of registers is different.
  - Removed some redundant macros.
- New Features

- Added some APIs to get/clear the interrupt status flag when the port doesn't control pins' interrupt.

#### [2.4.1]

- Improvements
  - Improved GPIO\_CheckAttributeBytes() function to support 8 bits width GACR register.

#### [2.4.0]

- Improvements
  - API interface added:
    - \* New APIs were added to configure the GPIO interrupt clear settings.

#### [2.3.2]

- Bug Fixes
  - Fixed the issue for MISRA-2012 check.
    - \* Fixed rule 3.1, 10.1, 8.6, 10.6, and 10.3.

#### [2.3.1]

- Improvements
  - Removed deprecated APIs.

#### [2.3.0]

- New Features
  - Updated the driver code to adapt the case of interrupt configurations in GPIO module. New APIs were added to configure the GPIO interrupt settings if the module has this feature on it.

#### [2.2.1]

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

#### [2.1.1]

- Improvements
  - API interface changes:
    - \* Added an API for the check attribute bytes.

### [2.1.0]

- Improvements
    - API interface changes:
      - \* Added “pins” or “pin” to some APIs’ names.
      - \* Renamed “\_PinConfigure” to “GPIO\_PinInit”.
- 

## INTMUX

### [2.0.4]

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

### [2.0.3]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 17.7 and 18.1.

### [2.0.2]

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.

### [2.0.1]

- Improvements
  - Added weak function implementations of INTMUX1\_x\_DriverIRQHandler. x ranges from 0 to 7 to support 8 channels.

### [2.0.0]

- Initial version.
- 

## LLWU

### [2.0.5]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3.
  - Fixed the issue that function LLWU\_SetExternalWakeupPinMode() does not work on 32-bit width platforms.

**[2.0.4]**

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 10.6, 10.7, 11.3.
  - Fixed issue that LLWU\_ClearExternalWakeupPinFlag may clear other filter flags by mistake on platforms with 32-bit LLWU registers.

**[2.0.3]**

- Bug Fixes
  - Fixed MISRA-2012 rules.
    - \* Rule 16.4.

**[2.0.2]**

- Improvements
  - Corrected driver function LLWU\_SetResetPinMode parameter name.
- Bug Fixes
  - Fixed MISRA-2012 rules.
    - \* Rule 14.4, 10.8, 10.4, 10.3.

**[2.0.1]**

- Other Changes
  - Updates for KL8x.

**[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.
- 

**LPCMP****[2.3.2]**

- Improvements
  - Fixed LPCMP CERT-C issues.

**[2.3.1]**

- Improvements
  - Update LPCMP driver to be compatible with platforms that do not support LPCMP nano power mode selection.

### [2.3.0]

- New Feature
  - Added some new features for platforms which support
    - \* Plus input source selection.
    - \* Minus input source selection.
    - \* CMP to DAC link.
- Improvements
  - Removed some new features for platforms which doesn't support
    - \* Functional clock source selection.
    - \* DAC high power mode selection.
    - \* Round Robin clock source selection.
    - \* Round Robin trigger source selection.
    - \* Round Robin channel sample numbers setting.
    - \* Round Robin channel sample time threshold setting.
    - \* Round Robin internal trigger configuration.

### [2.2.0]

- Improvements
  - Change `FSL_FEATURE_LPCMP_HAS_NO_CCR0_CMP_STOP_EN` to `FSL_FEATURE_LPCMP_HAS_CCR0_CMP_STOP_EN`.

### [2.1.3]

- New Feature
  - Added new macro to handle the case where some instances do not have the CCR0 CMP\_STOP\_EN bit field.

### [2.1.2]

- New Feature
  - Add macros to be compatible with some platforms that do not have the CCR0 CMP\_STOP\_EN bitfield.

### [2.1.1]

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

### [2.1.0]

- New Features:
  - Supported round robin mode and window mode feature.

**[2.0.3]**

- Bug Fixes:
  - Fixed the violation of MISRA-2012 rule 17.7.

**[2.0.2]**

- Bug Fixes:
  - The current API LPCMP\_ClearStatusFlags has to check w1c bits.

**[2.0.1]**

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

**[2.0.0]**

- Initial version.
- 

**LPI2C****[2.6.2]**

- Improvements
  - Added timeout for while loop in LPI2C\_TransferStateMachineSendCommand().

**[2.6.1]**

- Bug Fixes
  - Fixed coverity issues.

**[2.6.0]**

- New Feature
  - Added common IRQ handler entry LPI2C\_DriverIRQHandler.

**[2.5.7]**

- Improvements
  - Added support for separated IRQ handlers.

**[2.5.6]**

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

#### [2.5.5]

- Bug Fixes
  - Fixed LPI2C\_SlaveInit() - allow to disable SDA/SCL glitch filter.

#### [2.5.4]

- Bug Fixes
  - Fixed LPI2C\_MasterTransferBlocking() - the return value was sometime affected by call of LPI2C\_MasterStop().

#### [2.5.3]

- Improvements
  - Added handler for LPI2C7 and LPI2C8.

#### [2.5.2]

- Bug Fixes
  - Fixed ERR051119 to ignore the nak flag when IGNACK=1 in LPI2C\_MasterCheckAndClearError.

#### [2.5.1]

- Bug Fixes
  - Added bus stop incase of bus stall in LPI2C\_MasterTransferBlocking.
- Improvements
  - Release peripheral from reset if necessary in init function.

#### [2.5.0]

- New Features
  - Added new function LPI2C\_SlaveEnableAckStall to enable or disable ACKSTALL.

#### [2.4.1]

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

#### [2.4.0]

- Improvements
  - Split some functions, fixed CCM problem in file fsl\_lpi2c.c.
- Bug Fixes
  - Fixed bug in LPI2C\_MasterInit that the MCFGR2's value set in LPI2C\_MasterSetBaudRate may be overwritten by mistake.

### [2.3.2]

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

### [2.3.1]

- Improvements
  - Updated LPI2C\_GetCyclesForWidth to add the parameter of minimum cycle, because for master SDA/SCL filter, master bus idle/pin low timeout and slave SDA/SCL filter configuration, 0 means disabling the feature and cannot be used.
- Bug Fixes
  - Fixed bug in LPI2C\_SlaveTransferHandleIRQ that when restart detect event happens the transfer structure should not be cleared.
  - Fixed bug in LPI2C\_RunTransferStateMachine, that when only slave address is transferred or there is still data remaining in tx FIFO the last byte's nack cannot be ignored.
  - Fixed bug in slave filter doze enable, that when FILTDZ is set it means disable rather than enable.
  - Fixed bug in the usage of LPI2C\_GetCyclesForWidth. First its return value cannot be used directly to configure the slave FILTSDA, FILTSCL, DATAVD or CLKHOLD, because the real cycle width for them should be FILTSDA+3, FILTSCL+3, FILTSCL+DATAVD+3 and CLKHOLD+3. Second when cycle period is not affected by the prescaler value, prescaler value should be passed as 0 rather than 1.
  - Fixed wrong default setting for LPI2C slave. If enabling the slave tx SCL stall, then the default clock hold time should be set to 250ns according to I2C spec for 100kHz standard mode baudrate.
  - Fixed bug that before pushing command to the tx FIFO the FIFO occupation should be checked first in case FIFO overflow.

### [2.3.0]

- New Features
  - Supported reading more than 256 bytes of data in one transfer as master.
  - Added API LPI2C\_GetInstance.
- Bug Fixes
  - Fixed bug in LPI2C\_MasterTransferAbortEDMA, LPI2C\_MasterTransferAbort and LPI2C\_MasterTransferHandleIRQ that before sending stop signal whether master is active and whether stop signal has been sent should be checked, to make sure no FIFO error or bus error will be caused.
  - Fixed bug in LPI2C master EDMA transactional layer that the bus error cannot be caught and returned by user callback, by monitoring bus error events in interrupt handler.
  - Fixed bug in LPI2C\_GetCyclesForWidth that the parameter used to calculate clock cycle should be  $2^{\text{prescaler}}$  rather than prescaler.
  - Fixed bug in LPI2C\_MasterInit that timeout value should be configured after baudrate, since the timeout calculation needs prescaler as parameter which is changed during baudrate configuration.



- Fixed bug in LPI2C\_MasterTransferHandleIRQ and LPI2C\_RunTransferStateMachine that when master writes with no stop signal, need to first make sure no data remains in the tx FIFO before finishes the transfer.

## [2.2.0]

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

## [2.1.12]

- Bug Fixes
  - Fixed MISRA advisory 15.5 issues.

## [2.1.11]

- Bug Fixes
  - Fixed the bug that, during master non-blocking transfer, after the last byte is sent/received, the kLPI2C\_MasterNackDetectFlag is expected, so master should not check and clear kLPI2C\_MasterNackDetectFlag when remainingBytes is zero, in case FIFO is emptied when stop command has not been sent yet.
  - Fixed the bug that, during non-blocking transfer slave may nack master while master is busy filling tx FIFO, and NDF may not be handled properly.

## [2.1.10]

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - \* Fixed rule 10.3, 14.4, 15.5.
  - Fixed unaligned access issue in LPI2C\_RunTransferStateMachine.
  - Fixed uninitialized variable issue in LPI2C\_MasterTransferHandleIRQ.
  - Used linked TCD to disable tx and enable rx in read operation to fix the issue that for platform sharing the same DMA request with tx and rx, during LPI2C read operation if interrupt with higher priority happened exactly after command was sent and before tx disabled, potentially both tx and rx could trigger dma and cause trouble.
  - Fixed MISRA issues.
    - \* Fixed rules 10.1, 10.3, 10.4, 11.6, 11.9, 14.4, 17.7.
  - Fixed the waitTimes variable not re-assignment issue for each byte read.
- New Features
  - Added the IRQHandler for LPI2C5 and LPI2C6 instances.
- Improvements
  - Updated the LPI2C\_WAIT\_TIMEOUT macro to unified name I2C\_RETRY\_TIMES.

**[2.1.9]**

- Bug Fixes
  - Fixed Coverity issue of unchecked return value in I2C\_RTOS\_Transfer.
  - Fixed Coverity issue of operands did not affect the result in LPI2C\_SlaveReceive and LPI2C\_SlaveSend.
  - Removed STOP signal wait when NAK detected.
  - Cleared slave repeat start flag before transmission started in LPI2C\_SlaveSend/LPI2C\_SlaveReceive. The issue was that LPI2C\_SlaveSend/LPI2C\_SlaveReceive did not handle with the reserved repeat start flag. This caused the next slave to send a break, and the master was always in the receive data status, but could not receive data.

**[2.1.8]**

- Bug Fixes
  - Fixed the transfer issue with LPI2C\_MasterTransferNonBlocking, kLPI2C\_TransferNoStopFlag, with the wait transfer done through callback in a way of not doing a blocking transfer.
  - Fixed the issue that STOP signal did not appear in the bus when NAK event occurred.

**[2.1.7]**

- Bug Fixes
  - Cleared the stopflag before transmission started in LPI2C\_SlaveSend/LPI2C\_SlaveReceive. The issue was that LPI2C\_SlaveSend/LPI2C\_SlaveReceive did not handle with the reserved stop flag and caused the next slave to send a break, and the master always stayed in the receive data status but could not receive data.

**[2.1.6]**

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

**[2.1.5]**

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

#### [2.1.4]

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

#### [2.1.3]

- Improvements
  - Added LPI2C\_WATI\_TIMEOUT macro to allow the user to specify the timeout times for waiting flags in functional API and blocking transfer API.
  - Added LPI2C\_MasterTransferBlocking API.

#### [2.1.2]

- Bug Fixes
  - In LPI2C\_SlaveTransferHandleIRQ, reset the slave status to idle when stop flag was detected.

#### [2.1.1]

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

#### [2.1.0]

- Improvements
  - API name changed:
    - \* LPI2C\_MasterTransferCreateHandle -> LPI2C\_MasterCreateHandle.
    - \* LPI2C\_MasterTransferGetCount -> LPI2C\_MasterGetTransferCount.
    - \* LPI2C\_MasterTransferAbort -> LPI2C\_MasterAbortTransfer.
    - \* LPI2C\_MasterTransferHandleIRQ -> LPI2C\_MasterHandleInterrupt.
    - \* LPI2C\_SlaveTransferCreateHandle -> LPI2C\_SlaveCreateHandle.
    - \* LPI2C\_SlaveTransferGetCount -> LPI2C\_SlaveGetTransferCount.
    - \* LPI2C\_SlaveTransferAbort -> LPI2C\_SlaveAbortTransfer.

\* LPI2C\_SlaveTransferHandleIRQ -> LPI2C\_SlaveHandleInterrupt.

#### [2.0.0]

- Initial version.
- 

### LPI2C\_EDMA

#### [2.4.4]

- Improvements
  - Added support for 2KB data transfer

#### [2.4.3]

- Improvements
  - Added support for separated IRQ handlers.

#### [2.4.2]

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

#### [2.4.1]

- Refer LPI2C driver change log 2.0.0 to 2.4.1
- 

### LPIT

#### [2.1.2]

- Bug Fixes
  - Fix CERT INT31-C issues.

#### [2.1.1]

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

#### [2.1.0]

- Improvements
  - Add new function LPIT\_SetTimerValue to set timeout period.

### [2.0.2]

- Improvements
  - Improved LPIT\_SetTimerPeriod implementation, configure timeout value with LPIT ticks minus 1 generate more correct interval.
  - Added timeout value configuration check for LPIT\_SetTimerPeriod, at least input 3 ticks for calling LPIT\_SetTimerPeriod.
- Bug Fixes
  - Fixed MISRA C-2012 rule 17.7 violations.

### [2.0.1]

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

### [2.0.0]

- Initial version.
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## LPSPi

### [2.7.3]

- Improvements
  - Added timeout for while loop in LPSPi\_MasterTransferWriteAllTxData().
  - Make SPI\_RETRY\_TIMES configurable by CONFIG\_SPI\_RETRY\_TIMES.

### [2.7.2]

- Bug Fixes
  - Fixed coverity issues.

### [2.7.1]

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

### [2.7.0]

- New Feature
  - Added common IRQ handler entry LPSPi\_DriverIRQHandler.

**[2.6.10]**

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

**[2.6.9]**

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

**[2.6.8]**

- Bug Fixes
  - Fixed build error when SPI\_RETRY\_TIMES is defined to non-zero value.

**[2.6.7]**

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

**[2.6.6]**

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

**[2.6.5]**

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

**[2.6.4]**

- Bug Fixes
  - Added `LPSPI6_DriverIRQHandler` for LPSPI6 instance.

**[2.6.3]**

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

**[2.6.2]**

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

### [2.6.1]

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

### [2.6.0]

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

### [2.5.3]

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

### [2.5.2]

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

### [2.5.1]

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

### [2.5.0]

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

### [2.4.7]

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

### [2.4.6]

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

### [2.4.5]

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

**[2.4.4]**

- Bug Fixes
  - Fixed LPSPI\_MasterGetDefaultConfig incorrect default inter-transfer delay calculation.

**[2.4.3]**

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

**[2.4.2]**

- Bug Fixes
  - Fixed bug that LPSPI\_MasterTransferBlocking will modify the parameter txbuff and rxbuff pointer.

**[2.4.1]**

- Bug Fixes
  - Fixed bug that LPSPI\_SlaveTransferNonBlocking can't detect RX error.

**[2.4.0]**

- Improvements
  - Split some functions, fixed CCM problem in file fsl\_lpspi.c.

**[2.3.1]**

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

**[2.3.0]**

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

**[2.2.1]**

- Bug Fixes
  - Fixed bug in LPSPI\_SetPCSContinuous when disabling PCS continuous mode.



## [2.2.0]

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

## [2.1.0]

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

## [2.0.5]

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

## [2.0.4]

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

## [2.0.3]

- Bug Fixes
  - Removed LPSPI\_Reset from LPSPI\_MasterInit and LPSPI\_SlaveInit, because this API may glitch the slave select line. If needed, call this function manually.

**[2.0.2]**

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

**[2.0.1]**

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

**[2.0.0]**

- Initial version.
- 

**LPSPI\_EDMA****[2.4.9]**

- Improvements
  - Removed unused code from LPSPI\_SeparateEdmaReadData().

**[2.4.8]**

- Improvements
  - Added timeout for while loop in EDMA\_LpspiMasterCallback() and EDMA\_LpspiSlaveCallback().

**[2.4.7]**

- Bug Fixes
  - Add macro LPSPI\_ALIGN\_TCD\_SIZE\_MASK to align an address to `edma_tcd_t` size.

**[2.4.6]**

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

#### [2.4.5]

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

#### [2.4.4]

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

#### [2.4.3]

- Improvements
  - Supported 32K bytes transmit in DMA, improve the max datasize in LP-SPI\_MasterTransferEDMALite.

#### [2.4.2]

- Improvements
  - Added callback status in EDMA\_LpspiMasterCallback and EDMA\_LpspiSlaveCallback to check transferDone.

#### [2.4.1]

- Improvements
  - Add the TXMSK wait after TCR setting.

#### [2.4.0]

- Improvements
    - Separated LPSPI\_MasterTransferEDMA functions to LP-SPI\_MasterTransferPrepareEDMA and LPSPI\_MasterTransferEDMALite to optimize the process of transfer.
- 

### LPTMR

#### [2.2.1]

- Bug Fixes
  - Fix CERT INT31-C issues.

#### [2.2.0]

- Improvements
  - Updated lptmr\_prescaler\_clock\_select\_t, only define the valid options.

**[2.1.1]**

- Improvements
  - Updated the characters from “PTMR” to “LPTMR” in “FSL\_FEATURE\_PTMR\_HAS\_NO\_PRESCALER\_CLOCK\_SOURCE\_1\_SUPPORT” feature definition.

**[2.1.0]**

- Improvements
  - Implement for some special devices’ not supporting for all clock sources.
- Bug Fixes
  - Fixed issue when accessing CMR register.

**[2.0.2]**

- Bug Fixes
  - Fixed MISRA-2012 issues.
    - \* Rule 10.1.

**[2.0.1]**

- Improvements
  - Updated the LPTMR driver to support 32-bit CNR and CMR registers in some devices.

**[2.0.0]**

- Initial version.
- 

**LPUART****[2.10.0]**

- New Feature
  - Added support to configure RTS watermark.

**[2.9.4]**

- Improvements
  - Merged duplicate code.

**[2.9.3]**

- Improvements
  - Added timeout for while loops in LPUART\_Deinit().

### [2.9.2]

- Bug Fixes
  - Fixed coverity issues.

### [2.9.1]

- Bug Fixes
  - Fixed coverity issues.

### [2.9.0]

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

### [2.8.3]

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

### [2.8.2]

- Bug Fix
  - Fixed the bug that LPUART\_TransferEnable16Bit controled by wrong feature macro.

### [2.8.1]

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

### [2.8.0]

- Improvements
  - Added support of DATA register for 9bit or 10bit data transmit in write and read API. Such as: LPUART\_WriteBlocking16bit, LPUART\_ReadBlocking16bit, LPUART\_TransferEnable16Bit, LPUART\_WriteNonBlocking16bit, LPUART\_ReadNonBlocking16bit.

### [2.7.7]

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

**[2.7.6]**

- Bug Fixes
  - Fixed LPUART\_EnableInterrupts and LPUART\_DisableInterrupts bug that blocks if the LPUART address doesn't support exclusive access.

**[2.7.5]**

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

**[2.7.4]**

- Improvements
  - Added support for atomic register accessing in LPUART\_EnableInterrupts and LPUART\_DisableInterrupts.

**[2.7.3]**

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 15.7.

**[2.7.2]**

- Bug Fix
  - Fixed the bug that the OSR calculation error when lpuart init and lpuart set baud rate.

**[2.7.1]**

- Improvements
  - Added support for LPUART\_BASE\_PTRS\_NS in security mode in file fsl\_lpuart.c.

**[2.7.0]**

- Improvements
  - Split some functions, fixed CCM problem in file fsl\_lpuart.c.

**[2.6.0]**

- Bug Fixes
  - Fixed bug that when there are multiple lpuart instance, unable to support different ISR.

**[2.5.3]**

- Bug Fixes
  - Fixed comments by replacing unused status flags kLPUART\_NoiseErrorInRxDataRegFlag and kLPUART\_ParityErrorInRxDataRegFlag with kLPUART\_NoiseErrorFlag and kLPUART\_ParityErrorFlag.

### [2.5.2]

- Bug Fixes
  - Fixed bug that when setting watermark for TX or RX FIFO, the value may exceed the maximum limit.
- Improvements
  - Added check in LPUART\_TransferDMAHandleIRQ and LPUART\_TransferEdmaHandleIRQ to ensure if user enables any interrupts other than transfer complete interrupt, the dma transfer is not terminated by mistake.

### [2.5.1]

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

### [2.5.0]

- Bug Fixes
  - Added missing interrupt enable masks kLPUART\_Match1InterruptEnable and kLPUART\_Match2InterruptEnable.
  - Fixed bug in LPUART\_EnableInterrupts, LPUART\_DisableInterrupts and LPUART\_GetEnabledInterrupts that the BAUD[LBKDIE] bit field should be soc specific.
  - Fixed bug in LPUART\_TransferHandleIRQ that idle line interrupt should be disabled when rx data size is zero.
  - Deleted unused status flags kLPUART\_NoiseErrorInRxDataRegFlag and kLPUART\_ParityErrorInRxDataRegFlag, since firstly their function are the same as kLPUART\_NoiseErrorFlag and kLPUART\_ParityErrorFlag, secondly to obtain them one data word must be read out thus interfering with the receiving process.
  - Fixed bug in LPUART\_GetStatusFlags that the STAT[LBKDIF], STAT[MA1F] and STAT[MA2F] should be soc specific.
  - Fixed bug in LPUART\_ClearStatusFlags that tx/rx FIFO is reset by mistake when clearing flags.
  - Fixed bug in LPUART\_TransferHandleIRQ that while clearing idle line flag the other bits should be masked in case other status bits be cleared by accident.
  - Fixed bug of race condition during LPUART transfer using transactional APIs, by disabling and re-enabling the global interrupt before and after critical operations on interrupt enable register.
  - Fixed DMA/eDMA transfer blocking issue by enabling tx idle interrupt after DMA/eDMA transmission finishes.
- New Features
  - Added APIs LPUART\_GetRxFifoCount/LPUART\_GetTxFifoCount to get rx/tx FIFO data count.
  - Added APIs LPUART\_SetRxFifoWatermark/LPUART\_SetTxFifoWatermark to set rx/tx FIFO water mark.

**[2.4.1]**

- Bug Fixes
  - Fixed MISRA advisory 17.7 issues.

**[2.4.0]**

- New Features
  - Added APIs to configure 9-bit data mode, set slave address and send address.

**[2.3.1]**

- Bug Fixes
  - Fixed MISRA advisory 15.5 issues.

**[2.3.0]**

- Improvements
  - Modified LPUART\_TransferHandleIRQ so that txState will be set to idle only when all data has been sent out to bus.
  - Modified LPUART\_TransferGetSendCount so that this API returns the real byte count that LPUART has sent out rather than the software buffer status.
  - Added timeout mechanism when waiting for certain states in transfer driver.

**[2.2.8]**

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - \* Fixed rule-10.3, rule-14.4, rule-15.5.
  - Eliminated Pa082 warnings by assigning volatile variables to local variables and using local variables instead.
  - Fixed MISRA issues.
    - \* Fixed rules 10.1, 10.3, 10.4, 10.8, 14.4, 11.6, 17.7.
- Improvements
  - Added check for kLPUART\_TransmissionCompleteFlag in LPUART\_WriteBlocking, LPUART\_TransferHandleIRQ, LPUART\_TransferSendDMACallback and LPUART\_SendEDMACallback to ensure all the data would be sent out to bus.
  - Rounded up the calculated sbr value in LPUART\_SetBaudRate and LPUART\_Init to achieve more accurate baudrate setting. Changed osr from uint32\_t to uint8\_t since osr's biggest value is 31.
  - Modified LPUART\_ReadBlocking so that if more than one receiver errors occur, all status flags will be cleared and the most severe error status will be returned.



#### [2.2.7]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - \* Fixed rule-12.1, rule-17.7, rule-14.4, rule-13.3, rule-14.4, rule-10.4, rule-10.8, rule-10.3, rule-10.7, rule-10.1, rule-11.6, rule-13.5, rule-11.3, rule-13.2, rule-8.3.

#### [2.2.6]

- Bug Fixes
  - Fixed the issue of register's being in repeated reading status while dealing with the IRQ routine.

#### [2.2.5]

- Bug Fixes
  - Do not set or clear the TIE/RIE bits when using LPUART\_EnableTxDMA and LPUART\_EnableRxDMA.

#### [2.2.4]

- Improvements
  - Added hardware flow control function support.
  - Added idle-line-detecting feature in LPUART\_TransferNonBlocking function. If an idle line is detected, a callback is triggered with status kStatus\_LPUART\_IdleLineDetected returned. This feature may be useful when the received Bytes is less than the expected received data size. Before triggering the callback, data in the FIFO (if has FIFO) is read out, and no interrupt will be disabled, except for that the receive data size reaches 0.
  - Enabled the RX FIFO watermark function. With the idle-line-detecting feature enabled, users can set the watermark value to whatever you want (should be less than the RX FIFO size). Data is received and a callback will be triggered when data receive ends.

#### [2.2.3]

- Improvements
  - Changed parameter type in LPUART\_RTOS\_Init struct from rtos\_lpuart\_config to lpuart\_rtos\_config\_t.
- Bug Fixes
  - Disabled LPUART receive interrupt instead of all NVICs when reading data from ring buffer. Otherwise when the ring buffer is used, receive nonblocking method will disable all NVICs to protect the ring buffer. This may has a negative effect on other IPs that are using the interrupt.

#### [2.2.2]

- Improvements
  - Added software reset feature support.
  - Added software reset API in LPUART\_Init.

**[2.2.1]**

- Improvements
  - Added separate RX/TX IRQ number support.

**[2.2.0]**

- Improvements
  - Added support of 7 data bits and MSB.

**[2.1.1]**

- Improvements
  - Removed unnecessary check of event flags and assert in LPUART\_RTOS\_Receive.
  - Added code to always wait for RX event flag in LPUART\_RTOS\_Receive.

**[2.1.0]**

- Improvements
    - Update transactional APIs.
- 

**LPUART\_EDMA****[2.4.0]**

- Refer LPUART driver change log 2.1.0 to 2.4.0
- 

**MMDVSQ****[2.0.4]**

- Improvements
  - Fixed CERT-C issues.

**[2.0.3]**

- Bug Fixes
  - MISRA C-2012 issue fixed: rule 10.3, 10.4, and 14.4.

**[2.0.2]**

- Bug fix:
  - Fixed MMDVSQ\_GetExecutionStatus function get execution status wrong.

#### [2.0.1]

- Other changes:
  - Changed name of MMDVSQ\_GetDivideRemainder and MMDVSQ\_GetDivideQuotient functions.

#### [2.0.0]

- Initial version.
- 

### MSCM

#### [2.0.0]

- Initial version.
- 

### MSMC

#### [2.1.2]

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

#### [2.1.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 10.1, 10.4, 10.8, 14.4.

#### [2.1.0]

- Added new APIs with FEATURE macros support: SMC\_GetStopEntryStatus()  
SMC\_ClearStopEntryStatus() SMC\_SetForceBootOptionConfig()  
SMC\_SRAMEnableLowPowerMode() SMC\_SRAMEnableDeepSleepMode()
- Updated APIs with FEATURE macros support: SMC\_SetPowerModeStop()  
SMC\_SetPowerModeVlpr() SMC\_SetPowerModeLls() SMC\_SetPowerModeVlls()  
SMC\_ConfigureResetPinFilter()

#### [2.0.0]

- Initial version.
-

## MU

### [2.3.0]

- New Features
  - Added MU\_BUSY\_POLL\_COUNT parameter to prevent infinite polling loops in MU operations.
  - Added timeout mechanism to all polling loops in MU driver code.
  - Added new function MU\_ReceiveMsgTimeout() to include timeout mechanism.
- Improvements
  - Updated function signatures to return status codes for better error handling:
    - \* Changed MU\_ResetBothSides to return status\_t instead of void
    - \* Updated MU\_SendMsg to return status\_t for timeout indication
    - \* Updated MU\_ReceiveMsg to use MU\_TIMEOUT\_VALUE (0xFFFFFFFF) as a special return value to indicate timeout
  - Enhanced documentation across all functions to clarify timeout behavior and return values.

### [2.2.0]

- New Features
  - Added API MU\_GetRxStatusFlags.

### [2.1.3]

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

### [2.1.2]

- Bug Fixes
  - Fixed issue that MU\_GetInstance() is defined but never used.

### [2.1.1]

- Bug Fixes
  - Fixed general interrupt comment typo.

### [2.1.0]

- Improvements
  - Added new enum mu\_msg\_reg\_index\_t.

### [2.0.7]

- Bug Fixes
  - Fixed MU\_GetInterruptsPending bug that can not get general interrupt status.

#### [2.0.6]

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

#### [2.0.5]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 14.4, 15.5.

#### [2.0.4]

- Improvements
  - Improved for the platforms which don't support reset assert interrupt and get the other core power mode.

#### [2.0.3]

- Bug fixes
  - MISRA C-2012 issue fixed.
    - \* Fixed rules, containing: rule-10.3, rule-14.4, rule-15.5.

#### [2.0.2]

- Improvements
  - Added support for MIMX8MQx.

#### [2.0.1]

- Improvements
  - Added support for MCIMX7Ux\_M4.

#### [2.0.0]

- Initial version.
- 

## PORT

#### [2.5.1]

- Bug Fixes
  - Fix CERT INT31-C issues.

#### [2.5.0]

- Bug Fixes
  - Correct the kPORT\_MuxAsGpio for some platforms.

**[2.4.1]**

- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules: 10.1, 10.8 and 14.4.

**[2.4.0]**

- New Features
  - Updated port\_pin\_config\_t to support input buffer and input invert.

**[2.3.0]**

- New Features
  - Added new APIs for Electrical Fast Transient(EFT) detect.
  - Added new API to configure port voltage range.

**[2.2.0]**

- New Features
  - Added new api PORT\_EnablePinDoubleDriveStrength.

**[2.1.1]**

- Bug Fixes
  - Fixed the violations of MISRA C-2012 rules: 10.1, 10.4–11.3–11.8, 14.4.

**[2.1.0]**

- New Features
  - Updated the driver code to adapt the case of the interrupt configurations in GPIO module. Will move the pin configuration APIs to GPIO module.

**[2.0.2]**

- Other Changes
  - Added feature guard macros in the driver.

**[2.0.1]**

- Other Changes
    - Added “const” in function parameter.
    - Updated some enumeration variables’ names.
-

## RTC

### [2.4.0]

- New features
  - Add support for RTC clock output.
  - Add support for RTC time seconds interrupt configuration.

### [2.3.3]

- Bug Fixes
  - Fix RTC\_GetDatetime function validating datetime issue.

### [2.3.2]

- Improvements
  - Handle errata 010716: Disable the counter before setting alarm register and then reen-able the counter.

### [2.3.1]

- Bug Fixes
  - Fixed CERT INT31-C violations.

### [2.3.0]

- Improvements
  - Added API RTC\_EnableLPOClock to set 1kHz LPO clock.
  - Added API RTC\_EnableCrystalClock to replace API RTC\_SetClockSource.

### [2.2.2]

- Improvements
  - Refine \_rtc\_interrupt\_enable order.

### [2.2.1]

- Bug Fixes
  - Fixed the issue of Pa082 warning.
  - Fixed the issue of bit field mask checking.
  - Fixed the issue of hard code in RTC\_Init.

### [2.2.0]

- Bug Fixes
  - Fixed MISRA C-2012 issue.
    - \* Fixed rule contain: rule-17.7, rule-14.4, rule-10.4, rule-10.7, rule-10.1, rule-10.3.
  - Fixed central repository code formatting issue.

- Improvements
  - Added an API for enabling wakeup pin.

#### [2.1.0]

- Improvements
  - Added feature macro check for many features.

#### [2.0.0]

- Initial version.
- 

### SAI

#### [2.4.9]

- Added Errata ERR051421 workaround.

#### [2.4.8]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

#### [2.4.7]

- Added conditional support for bit clock swap feature
- Added common IRQ handler entry SAI\_DriverIRQHandler.

#### [2.4.6]

- Bug Fixes
  - Fixed the IAR build warning.

#### [2.4.5]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

#### [2.4.4]

- Bug Fixes
  - Fixed enumeration sai\_fifo\_combine\_t - add RX configuration.

#### [2.4.3]

- Bug Fixes
  - Fixed enumeration sai\_fifo\_combine\_t value configuration issue.



#### [2.4.2]

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

#### [2.4.1]

- Bug Fixes
  - Fixed bitWidth incorrectly assigned issue.

#### [2.4.0]

- Improvements
  - Removed deprecated APIs.

#### [2.3.8]

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

#### [2.3.7]

- Improvements
  - Change feature “FSL\_FEATURE\_SAI\_FIFO\_COUNT” to “FSL\_FEATURE\_SAI\_HAS\_FIFO”.
  - Added feature “FSL\_FEATURE\_SAI\_FIFO\_COUNTn(x)” to align SAI fifo count function with IP in function

#### [2.3.6]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 5.6.

#### [2.3.5]

- Improvements
  - Make driver to be aarch64 compatible.

#### [2.3.4]

- Bug Fixes
  - Corrected the fifo combine feature macro used in driver.

#### [2.3.3]

- Bug Fixes
  - Added bit clock polarity configuration when sai act as slave.
  - Fixed out of bound access coverity issue.
  - Fixed violations of MISRA C-2012 rule 10.3, 10.4.

**[2.3.2]**

- Bug Fixes
  - Corrected the frame sync configuration when sai act as slave.

**[2.3.1]**

- Bug Fixes
  - Corrected the peripheral name in function SAI0\_DriverIRQHandler.
  - Fixed violations of MISRA C-2012 rule 17.7.

**[2.3.0]**

- Bug Fixes
  - Fixed the build error caused by the SOC has no fifo feature.

**[2.2.3]**

- Bug Fixes
  - Corrected the peripheral name in function SAI0\_DriverIRQHandler.

**[2.2.2]**

- Bug Fixes
  - Fixed the issue of MISRA 2004 rule 9.3.
  - Fixed sign-compare warning.
  - Fixed the PA082 build warning.
  - Fixed sign-compare warning.
  - Fixed violations of MISRA C-2012 rule 10.3,17.7,10.4,8.4,10.7,10.8,14.4,17.7,11.6,10.1,10.6,8.4,14.3,16.4,18.2.
  - Allow to reset Rx or Tx FIFO pointers only when Rx or Tx is disabled.
- Improvements
  - Added 24bit raw audio data width support in sai sdma driver.
  - Disabled the interrupt/DMA request in the SAI\_Init to avoid generates unexpected sai FIFO requests.

**[2.2.1]**

- Improvements
  - Added mclk post divider support in function SAI\_SetMasterClockDivider.
  - Removed useless configuration code in SAI\_RxSetSerialDataConfig.
- Bug Fixes
  - Fixed the SAI SDMA driver build issue caused by the wrong structure member name used in the function SAI\_TransferRxSetConfigSDMA/SAI\_TransferTxSetConfigSDMA.
  - Fixed BAD BIT SHIFT OPERATION issue caused by the FSL\_FEATURE\_SAI\_CHANNEL\_COUNTn.
  - Applied ERR05144: not set FCONT = 1 when TMR > 0, otherwise the TX may not work.

### [2.2.0]

- Improvements
  - Added new APIs for parameters collection and simplified user interfaces:
    - \* SAI\_Init
    - \* SAI\_SetMasterClockConfig
    - \* SAI\_TxSetBitClockRate
    - \* SAI\_TxSetSerialDataConfig
    - \* SAI\_TxSetFrameSyncConfig
    - \* SAI\_TxSetFifoConfig
    - \* SAI\_TxSetBitclockConfig
    - \* SAI\_TxSetConfig
    - \* SAI\_TxSetTransferConfig
    - \* SAI\_RxSetBitClockRate
    - \* SAI\_RxSetSerialDataConfig
    - \* SAI\_RxSetFrameSyncConfig
    - \* SAI\_RxSetFifoConfig
    - \* SAI\_RxSetBitclockConfig
    - \* SAI\_RXSetConfig
    - \* SAI\_RxSetTransferConfig
    - \* SAI\_GetClassicI2SConfig
    - \* SAI\_GetLeftJustifiedConfig
    - \* SAI\_GetRightJustifiedConfig
    - \* SAI\_GetTDMConfig

### [2.1.9]

- Improvements
  - Improved SAI driver comment for clock polarity.
  - Added enumeration for SAI for sample inputs on different edges.
  - Changed FSL\_FEATURE\_SAI\_CHANNEL\_COUNT to FSL\_FEATURE\_SAI\_CHANNEL\_COUNTn(base) for the difference between the different SAI instances.
- Added new APIs:
  - SAI\_TxSetBitClockDirection
  - SAI\_RxSetBitClockDirection
  - SAI\_RxSetFrameSyncDirection
  - SAI\_TxSetFrameSyncDirection

**[2.1.8]**

- Improvements
  - Added feature macro test for the sync mode2 and mode 3.
  - Added feature macro test for masterClockHz in sai\_transfer\_format\_t.

**[2.1.7]**

- Improvements
  - Added feature macro test for the mclkSource member in sai\_config\_t.
  - Changed “FSL\_FEATURE\_SAI5\_SAI6\_SHARE\_IRQ” to “FSL\_FEATURE\_SAI\_SAI5\_SAI6\_SHARE\_IRQ”.
  - Added #ifndef #endif check for SAI\_XFER\_QUEUE\_SIZE to allow redefinition.
- Bug Fixes
  - Fixed build error caused by feature macro test for mclkSource.

**[2.1.6]**

- Improvements
  - Added feature macro test for mclkSourceClockHz check.
  - Added bit clock source name for general devices.
- Bug Fixes
  - Fixed incorrect channel numbers setting while calling RX/TX set format together.

**[2.1.5]**

- Bug Fixes
  - Corrected SAI3 driver IRQ handler name.
  - Added I2S4/5/6 IRQ handler.
  - Added base in handler structure to support different instances sharing one IRQ number.
- New Features
  - Updated SAI driver for MCR bit MICS.
  - Added 192 KHZ/384 KHZ in the sample rate enumeration.
  - Added multi FIFO interrupt/SDMA transfer support for TX/RX.
  - Added an API to read/write multi FIFO data in a blocking method.
  - Added bclk bypass support when bclk is same with mclk.

**[2.1.4]**

- New Features
  - Added an API to enable/disable auto FIFO error recovery in platforms that support this feature.
  - Added an API to set data packing feature in platforms which support this feature.

### [2.1.3]

- New Features
  - Added feature to make I2S frame sync length configurable according to bitWidth.

### [2.1.2]

- Bug Fixes
  - Added 24-bit support for SAI eDMA transfer. All data shall be 32 bits for send/receive, as eDMA cannot directly handle 3-Byte transfer.

### [2.1.1]

- Improvements
  - Reduced code size while not using transactional API.

### [2.1.0]

- Improvements
  - API name changes:
    - \* SAI\_GetSendRemainingBytes -> SAI\_GetSentCount.
    - \* SAI\_GetReceiveRemainingBytes -> SAI\_GetReceivedCount.
    - \* All names of transactional APIs were added with “Transfer” prefix.
    - \* All transactional APIs use base and handle as input parameter.
    - \* Unified the parameter names.
- Bug Fixes
  - Fixed WLC bug while reading TCSR/RCSR registers.
  - Fixed MOE enable flow issue. Moved MOE enable after MICS settings in SAI\_TxInit/SAI\_RxInit.

### [2.0.0]

- Initial version.
- 

## SAI\_EDMA

### [2.7.3]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 12.4.

### [2.7.2]

- Improvements
  - Add macros `MCUX_SDK_SAI_EDMA_TX_ENABLE_INTERNAL` and `MCUX_SDK_SAI_EDMA_RX_ENABLE_INTERNAL` to let the user decide whether to enable SAI when calling `SAI_TransferSendEDMA/SAI_TransferReceiveEDMA`.

**[2.7.1]**

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

**[2.7.0]**

- Improvements
  - Updated api SAI\_TransferReceiveEDMA to support voice channel block interleave transfer.
  - Updated api SAI\_TransferSendEDMA to support voice channel block interleave transfer.
  - Added new api SAI\_TransferSetInterleaveType to support channel interleave type configurations.

**[2.6.0]**

- Improvements
  - Removed deprecated APIs.

**[2.5.1]**

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 20.7.

**[2.5.0]**

- Improvements
  - Added new api SAI\_TransferSendLoopEDMA/SAI\_TransferReceiveLoopEDMA to support loop transfer.
  - Added multi sai channel transfer support.

**[2.4.0]**

- Improvements
  - Added new api SAI\_TransferGetValidTransferSlotsEDMA which can be used to get valid transfer slot count in the sai edma transfer queue.
  - Deprecated the api SAI\_TransferRxSetFormatEDMA and SAI\_TransferTxSetFormatEDMA.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.3,10.4.

**[2.3.2]**

- Refer SAI driver change log 2.1.0 to 2.3.2
-

## SEMA42

### [2.1.1]

- Improvements
  - Updated SEMA42\_TryLock function to avoid unsigned integer operations wrap issue.

### [2.1.0]

- New Features
  - Added SEMA42\_BUSY\_POLL\_COUNT parameter to prevent infinite polling loops in SEMA42 operations.
  - Added timeout mechanism to all polling loops in SEMA42 driver code.
- Improvements
  - Updated SEMA42\_Lock function to return status\_t instead of void for better error handling.
  - Enhanced documentation to clarify timeout behavior and return values.

### [2.0.4]

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

### [2.0.3]

- Improvements
  - Changed to implement SEMA42\_Lock base on SEMA42\_TryLock.

### [2.0.2]

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

### [2.0.1]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 10.3, 10.4, 14.4, 18.1.

### [2.0.0]

- Initial version.
- 

## SIM

### [2.2.0]

- Improvements
  - Added API to trigger TRGMUX.

**[2.1.3]**

- Improvements
  - Updated function SIM\_GetUniqueId to support different register names.

**[2.1.2]**

- Bug Fixes
  - Fixed SIM\_GetUniqueId bug that could not get UIDH.

**[2.1.1]**

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

**[2.1.0]**

- Improvements
  - Added new APIs: SIM\_GetRfAddr() and SIM\_EnableSystickClock().

**[2.0.0]**

- Initial version.
- 

**SPM****[2.3.0]**

- Improvements
  - Added some missed APIs which are related to SPM features.

**[2.2.1]**

- Bug Fixes
  - Fixed MISRA C-2012 rule 10.3, rule 10.4 and so on.

**[2.2.0]**

- Bug Fix
  - Fix MDK 66-D warning (enumeration value out of int range) on kSPM\_DcdcStableOKFlag.
- Other Changes
  - Remove the support for K3S.
  - Change register and mask names to support K32-L3.
- Optimization
  - Convert SPM\_EnableVddxStepLock() and SPM\_SetLowPowerReqOutPinConfig() to inline functions.



#### [2.1.0]

- Bug Fix
  - Corrected spelling mistake of function name.

#### [2.0.0]

- Initial version.
- 

### TPM

#### [2.4.1]

- Improvements
  - Add Coverage Justification for uncovered code.

#### [2.4.0]

- New Feature
  - Added while loop timeout for MOD CnV CnSC and SC register write sequence.
  - Change the return type from void to status\_t for following API:
    - \* TPM\_DisableChannel
    - \* TPM\_EnableChannel
    - \* TPM\_SetupOutputCompare
    - \* TPM\_SetTimerPeriod
    - \* TPM\_StopTimer

#### [2.3.6]

- Bug Fixes
  - Fixed CERT INT30-C INT31-C issue for TPM\_SetupDualEdgeCapture.

#### [2.3.5]

- New Feature
  - Added IRQ handler entry for TPM2.

#### [2.3.4]

- New Feature
  - Added common IRQ handler entry TPM\_DriverIRQHandler.

#### [2.3.3]

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

### [2.3.2]

- Bug Fixes
  - Fixed ERR008085 TPM writing the TPMx\_MOD or TPMx\_CnV registers more than once may fail when the timer is disabled.

### [2.3.1]

- Bug Fixes
  - Fixed compilation error when macro FSL\_SDK\_DISABLE\_DRIVER\_CLOCK\_CONTROL is 1.

### [2.3.0]

- Improvements
  - Create callback feature for TPM match and timer overflow interrupts.

### [2.2.4]

- Improvements
  - Add feature macros(FSL\_FEATURE\_TPM\_HAS\_GLOBAL\_TIME\_BASE\_EN, FSL\_FEATURE\_TPM\_HAS\_GLOBAL\_TIME\_BASE\_SYNC).

### [2.2.3]

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

### [2.2.2]

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

### [2.2.1]

- Bug Fixes
  - Fixed CCM issue by splitting function from TPM\_SetupPwm() function to reduce function complexity.
  - Fixed violations of MISRA C-2012 rule 17.7.

### [2.2.0]

- Improvements
  - Added TPM\_SetChannelPolarity to support select channel input/output polarity.
  - Added TPM\_EnableChannelExtTrigger to support enable external trigger input to be used by channel.
  - Added TPM\_CalculateCounterClkDiv to help calculates the counter clock prescaler.
  - Added TPM\_GetChannelValue to support get TPM channel value.
  - Added new TPM configuration.

- \* syncGlobalTimeBase
  - \* extTriggerPolarity
  - \* chnlPolarity
- Added new PWM signal configuration.
  - \* secPauseLevel
- Bug Fixes
  - Fixed TPM\_SetupPwm can't configure 0% combined PWM issues.

#### [2.1.1]

- Improvements
  - Add feature macro for PWM pause level select feature.

#### [2.1.0]

- Improvements
  - Added TPM\_EnableChannel and TPM\_DisableChannel APIs.
  - Added new PWM signal configuration.
    - \* pauseLevel - Support select output level when counter first enabled or paused.
    - \* enableComplementary - Support enable/disable generate complementary PWM signal.
    - \* deadTimeValue - Support deadtime insertion for each pair of channels in combined PWM mode.
- Bug Fixes
  - Fixed issues about channel MSnB:MSnA and ELSnB:ELSnA bit fields and CnV register change request acknowledgement. Writes to these bits are ignored when the interval between successive writes is less than the TPM clock period.

#### [2.0.8]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.1, 10.4, 10.7 and 14.4.

#### [2.0.7]

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

#### [2.0.6]

- Bug Fixes
  - Fixed Out-of-bounds issue.

**[2.0.5]**

- Bug Fixes
  - Fixed MISRA-2012 rules.
    - \* Rule 10.6, 10.7

**[2.0.4]**

- Bug Fixes
  - Fixed ERR050050 in functions TPM\_SetupPwm/TPM\_UpdatePwmDutycycle. When TPM was configured in EPWM mode as PS = 0, the compare event was missed on the first reload/overflow after writing 1 to the CnV register.

**[2.0.3]**

- Bug Fixes
  - MISRA-2012 issue fixed.
    - \* Fixed rules: rule-12.1, rule-17.7, rule-16.3, rule-14.4, rule-1.3, rule-10.4, rule-10.3, rule-10.7, rule-10.1, rule-10.6, and rule-18.1.

**[2.0.2]**

- Bug Fixes
  - Fixed issues in functions TPM\_SetupPwm/TPM\_UpdateChnlEdgeLevelSelect/TPM\_SetupInputCapture/TPM\_SetupOutputCompare/TPM\_SetupDualEdgeCapture, wait acknowledgement when the channel is disabled.

**[2.0.1]**

- Bug Fixes
  - Fixed TPM\_UpdateChnlEdgeLevelSelect ACK wait issue.
  - Fixed the issue that TPM\_SetupDualEdgeCapture could not set FILTER register.
  - Fixed TPM\_UpdateChnlEdgeLevelSelect ACK wait issue.

**[2.0.0]**

- Initial version.
- 

**TRGMUX****[2.0.1]**

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

**[2.0.0]**

- Initial version.
-

## TRNG

### [2.0.19]

- New features:
  - Added support for MCXA and MCXL.

### [2.0.18]

- Bug fix:
  - TRNG health checks now done in software on RT5xx and RT6xx.

### [2.0.17]

- New features:
  - Add support for RT700.

### [2.0.16]

- Improvements:
  - Added support for Dual oscillator mode.

### [2.0.15]

- Other changes:
  - Changed TRNG\_USER\_CONFIG\_DEFAULT\_XXX values according to latest recommended by design team.

### [2.0.14]

- New features:
  - Add support for RW610 and RW612.

### [2.0.13]

- Bug fix:
  - After deepsleep it might return error, added clearing bits in TRNG\_GetRandomData() and generating new entropy.
  - Modified reloading entropy in TRNG\_GetRandomData(), for some data length it doesn't reloading entropy correctly.

### [2.0.12]

- Bug fix:
  - For KW34A4\_SERIES, KW35A4\_SERIES, KW36A4\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv8.

**[2.0.11]**

- Bug fix:
  - Add clearing pending errors in TRNG\_Init().

**[2.0.10]**

- Bug Fix:
  - Fixed doxygen issues.

**[2.0.9]**

- Bug Fix:
  - Fix HIS\_CCM metrics issues.

**[2.0.8]**

- Bug fix:
  - For K32L2A41A\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv4.

**[2.0.7]**

- Bug fix:
  - Fix MISRA 2004 issue rule 12.5.

**[2.0.6]**

- Bug fix:
  - For KW35Z4\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv8.

**[2.0.5]**

- Improvements:
  - For FRQMIN, FRQMAX and OSCDIV, add possibility to use device specific preprocessor macro to define default value in TRNG user configuration structure.

**[2.0.4]**

- Bug Fix:
  - Fix MISRA-2012 issues.
    - \* Rule 10.1, rule 10.3, rule 13.5, rule 16.1.

**[2.0.3]**

- Improvements:
  - update TRNG\_Init to restart new entropy generation.

### [2.0.2]

- Improvements:
  - fix MISRA issues
    - \* Rule 14.4.

### [2.0.1]

- New features:
  - Set default OSCDIV for Kinetis devices KL8x and KL28Z.
- Other changes:
  - Changed default OSCDIV for K81 to divide by 2.

### [2.0.0]

- Initial version.
- 

## TSTMR

### [2.1.0]

- New Features
  - Support configured clock frequency.
  - Add TSTMR\_Init and TSTMR\_init APIs.
- Improvements
  - Change TSTMR\_DelayUs from static inline function to normal function.

### [2.0.4]

- Bugfix
  - Fix MISRA C-2012 Rule 10.4 and 14.4 issues.

### [2.0.3]

- Bugfix
  - Fix CERT INT30-C that Unsigned integer operation TSTMR\_ReadTimeStamp(base) - startTime may wrap.

### [2.0.2]

- Improvements
  - Support 24MHz clock source.
- Bugfix
  - Fix MISRA C-2012 Rule 10.4 issue.
  - Read of TSTMR HIGH must follow TSTMR LOW atomically: require masking interrupt around 2 LSB / MSB accesses.

**[2.0.1]**

- Bugfix
  - Restrict to read with 32-bit accesses only.
  - Restrict that TSTMR LOW read occurs first, followed by the TSTMR HIGH read.

**[2.0.0]**

- Initial version.
- 

**USDHC****[2.8.6]**

- Bug Fixes
  - Invalidate cache after blocking read.

**[2.8.5]**

- Improvements
  - Enable the driver to be AARCH64 compatible.

**[2.8.4]**

- Improvements
  - Add feature macro FSL\_FEATURE\_USDHC\_HAS\_NO\_VS18.

**[2.8.3]**

- Improvements
  - Improved api USDHC\_EnableAutoTuningForCmdAndData to adapt to new bit field name for USDHC\_VEND\_SPEC2 register.

**[2.8.2]**

- Improvements
  - Added feature macro FSL\_FEATURE\_USDHC\_HAS\_NO\_VOLTAGE\_SELECT.

**[2.8.1]**

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.9.



#### [2.8.0]

- Improvements
  - Fixed the mmc boot transfer failed issue which is caused by the Dma complete interrupt not enabled.
  - Marked api USDHC\_AdjustDelayForManualTuning as deprecated and added new api USDHC\_SetTuningDelay/USDHC\_GetTuningDelayStatus.
  - Improved the manual tuning flow according to specification.
  - Added memory address conversion to support buffers which could only be accessed using alias address by non-core masters.
  - Fixed violations of MISRA C-2012 rule 10.4.

#### [2.7.0]

- Improvements
  - Added api USDHC\_TransferScatterGatherADMANonBlocking to support scatter gather transfer.
  - Added feature FSL\_FEATURE\_USDHC\_REGISTER\_HOST\_CTRL\_CAP\_HAS\_NO\_RETUNING\_TIME\_COUNTER for re-tuning time counter field in HOST\_CTRL\_CAP register.
- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 11.9, 10.1, 10.3, 10.4, 8.4.

#### [2.6.0]

- Improvements
  - Added api USDHC\_SetStandardTuningCounter to support adjust tuning counter of Standard tuning.

#### [2.5.1]

- Improvements
  - Used different status code for command and data interrupt callback.
  - Added cache line invalidate for receive buffer in driver IRQ handler to fix CM7 speculative access issue.

#### [2.5.0]

- Improvements
  - Added new api USDHC\_SetStrobeDllOverride for HS400 strobe dll override mode delay taps configurations.
  - Corrected the STROBE DLL configurations sequence.

#### [2.4.0]

- Improvements
  - Added feature macro for read/write burst length.
    - \* Disabled redundant interrupt per different transfer request.

- \* Disabled interrupt and reset command/data pointer in handle when transfer completes.

- Bug Fixes

- Fixed violations of MISRA C-2012 rule 11.9, 15.7, 4.7, 16.4, 10.1, 10.3, 10.4, 11.3, 14.4, 10.6, 17.7, 16.1, 16.3.
- Fixed PA082 build warning.
- Fixed logically dead code Coverity issue.

### [2.3.0]

- Improvements

- Added USDHC\_SetDataConfig API to support manual tuning.
- Removed the limitaion that source clock must be bigger than the target in function USDHC\_SetSdClock by using source clock frequency as target directly.
- Added peripheral reset in USDHC\_Init function.
- Added tuning reset support in function USDHC\_Reset function.

### [2.2.8]

- Bug Fixes

- Fixed out-of bounds write in function USDHC\_ReceiveCommandResponse.

### [2.2.7]

- Improvements

- Added API USDHC\_GetEnabledInterruptStatusFlags and used in USDHC\_TransferHandleIRQ.
- Removed useless member interruptFlags in usdhc\_handle\_t.

### [2.2.6]

- Improvements

- Added address align check for ADMA descriptor table address.
- Changed USDHC\_ADMA1\_DESCRIPTOR\_MAX\_LENGTH\_PER\_ENTRY to (65536-4096) to make sure the data address is 4KB align for a transfer which need more than one ADMA1 descriptor.

### [2.2.5]

- Bug Fixes

- Fixed MDK 66-D warning.

#### [2.2.4]

- Bug Fixes
  - Fixed issue that real clock frequency was mismatched with target clock frequency, which was caused by an incorrect prescaler calculation.
- New Features
  - Added control macro to enable/disable the CLOCK code in current driver.

#### [2.2.3]

- Bug Fixes
  - Fixed issue where AMDA did not disable with DMAEN clear.
- Improvements
  - Improved set clock function to check the output frequency range.
  - Dynamic set SDCLKFS during DDR enable or disable.

#### [2.2.2]

- Improvements
  - Improved read transfer cache maintain operation, combined clean, and invalidated them into one function.

#### [2.2.1]

- Bug Fixes
  - Disabled the invalidate cache operation for tuning.

#### [2.2.0]

- Improvements
  - Improved USDHC to support MMC boot feature.

#### [2.1.3]

- Bug Fixes
  - Fixed MISRA issue.

#### [2.1.2]

- Bug Fixes
  - Fixed Coverity issue.
  - Added base address and userData parameter for all callback functions.

**[2.1.1]**

- Improvements
  - Added cache maintain operation.
  - Added timeout status check for the DATA transfer which ignore error.
  - Added feature macro for SDR50/SDR104 mode.
  - Removed useless IRQ handler from different platforms.

**[2.1.0]**

- Improvements
  - Integrated tuning into transfer function.
  - Added strobe DLL feature.
  - Added enableAutoCommand23 in data structure.
  - Removed enable card clock function because the controller would handle the clock on/off.

**[2.0.0]**

- Initial version.
- 

**VREF****[2.1.3]**

- Improvements
  - Add timeout for APIs with dfmea issues.

**[2.1.2]**

- Bug Fixes
  - Fixed the violation of MISRA-2012 rule 10.3.
  - Fixed MISRA C-2012 rule 10.3, rule 10.4 violation.

**[2.1.1]**

- Bug Fixes
  - MISRA-2012 issue fixed.
    - \* Fixed rules containing: rule-10.4, rule-10.3, rule-10.1.

**[2.1.0]**

- Improvements
  - Added new functions to support L5K board: added VREF\_SetTrim2V1Val() and VREF\_GetTrim2V1Val() functions to supply 2V1 output mode.

#### [2.0.0]

- Initial version.
- 

### WDOG32

#### [2.2.1]

- Bug Fixes
  - Fix CERT INT31-C that the bool value shall be converted to unsigned int 0 or 1 then passed to registers.
  - Fix MISRA 2012 20.3 violation.

#### [2.2.0]

- Improvements
  - Added while loop timeout config value for WDOG32 reconfiguration and unlock sequence.
  - Change the return type of WDOG32\_Init, WDOG32\_Deinit and WDOG32\_Unlock from void to status\_t.

#### [2.1.0]

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

#### [2.0.4]

- Improvements
  - To ensure that the reconfiguration is inside 128 bus clocks unlock window, put all reconfiguration APIs in quick access code section.

#### [2.0.3]

- Bug Fixes
  - Fixed the noncompliance issue of the reference document.
    - \* Waited until for new configuration to take effect by checking the RCS bit field.
    - \* Waited until for registers to be unlocked by checking the ULK bit field.
- Improvements
  - Added 128 bus clocks delay ensures a smooth transition before restarting the counter with the new configuration when there is no RCS status bit.

**[2.0.2]**

- Bug Fixes
  - MISRA C-2012 issue fixed.
    - \* Fixed rules, containing: rule-10.3, rule-14.4, rule-15.5.
  - Fixed the issue of the inseparable process interrupted by other interrupt source.
    - \* WDOG32\_Refresh

**[2.0.1]**

- Bug Fixes
  - WDOG must be configured within its configuration time period.
    - \* Added WDOG32\_Init API to quick access section.
    - \* Defined register variable in WDOG32\_Init API.

**[2.0.0]**

- Initial version.
- 

**XRDC****[2.0.7]**

- Improvements
  - Handle errata ERR050593.

**[2.0.6]**

- Improvements
  - Supported platforms which don't have XRDC clock gate control.

**[2.0.5]**

- Bug Fixes
  - Fixed XRDC\_GetAndClearFirstSpecificDomainError potential array over index issue.

**[2.0.4]**

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 10.1, 10.3, 10.4, 10.6, 10.7, 10.8, 11.3, 12.2, 14.4, 17.7, 20.7.

**[2.0.3]**

- Improvements
  - Added necessary driver supports for K32H844P.
  - Added new APIs concerning new features of Exclusive Access Lock and programmable domain access flags configurations.

### [2.0.2]

- Bug Fixes
  - Fixed wrong assert of assignIndex input check in the xRDC driver.
- Improvements
  - Added master input CPU/non-CPU check in XRDC\_SetNonProcessorDomainAssignment and XRDC\_SetProcessorDomainAssignment API.
  - Added necessary assert checks for several config inputs.

### [2.0.1]

- Improvements
  - Changed reserved bit fields in the structs into unnamed-identifier bit fields.

### [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.

[K32L3A60](#)

## 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 Multicore

multicore

### 1.7.2 FreeMASTER

[freemaster](#)

### 1.7.3 FreeRTOS

[FreeRTOS](#)

### 1.7.4 File systemFatfs

fatfs

# Chapter 2

## K32L3A60

### 2.1 CACHE: LPCAC CACHE Memory Controller

`static inline void L1CACHE_EnableCodeCache(void)`

Enables the processor code bus cache.

`static inline void L1CACHE_DisableCodeCache(void)`

Disables the processor code bus cache.

`static inline void L1CACHE_InvalidateCodeCache(void)`

Invalidates the processor code bus cache.

`void L1CACHE_InvalidateICacheByRange(uint32_t address, uint32_t size_byte)`

Invalidates L1 instrument cache by range.

#### Parameters

- address – The start address of the memory to be invalidated.
- size\_byte – The memory size.

`static inline void L1CACHE_InvalidateDCacheByRange(uint32_t address, uint32_t size_byte)`

Invalidates L1 data cache by range.

#### Parameters

- address – The start address of the memory to be invalidated.
- size\_byte – The memory size.

`static inline void L1CACHE_CleanDCacheByRange(uint32_t address, uint32_t size_byte)`

Cleans L1 data cache by range.

The cache is write through mode, so there is nothing to do with the cache flush/clean operation.

#### Parameters

- address – The start address of the memory to be cleaned.
- size\_byte – The memory size.

`static inline void L1CACHE_CleanInvalidateDCacheByRange(uint32_t address, uint32_t size_byte)`

Cleans and Invalidates L1 data cache by range.

#### Parameters

- address – The start address of the memory to be clean and invalidated.



- `size_byte` – The memory size.

`static inline void ICACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)`

Invalidates instruction cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be invalidated.

`static inline void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)`

Invalidates data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be invalidated.

`static inline void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)`

Clean data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be cleaned.

`static inline void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)`

Cleans and Invalidates data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be Cleaned and Invalidated.

`FSL_CACHE_DRIVER_VERSION`

cache driver version 2.1.1.

## 2.2 CACHE: LPLMEM CACHE Memory Controller

`static inline void L1CACHE_EnableCodeCache(void)`

Enables the processor code bus cache.

`static inline void L1CACHE_DisableCodeCache(void)`

Disables the processor code bus cache.

`static inline void L1CACHE_InvalidateCodeCache(void)`

Invalidates the processor code bus cache.

`void L1CACHE_InvalidateICacheByRange(uint32_t address, uint32_t size_byte)`

Invalidates L1 instrument cache by range.

#### Parameters

- `address` – The start address of the memory to be invalidated.
- `size_byte` – The memory size.

`static inline void L1CACHE_InvalidateDCacheByRange(uint32_t address, uint32_t size_byte)`

Invalidates L1 data cache by range.

#### Parameters

- `address` – The start address of the memory to be invalidated.

- `size_byte` – The memory size.

```
static inline void L1CACHE_CleanDCacheByRange(uint32_t address, uint32_t size_byte)
```

Cleans L1 data cache by range.

The cache is write through mode, so there is nothing to do with the cache flush/clean operation.

#### Parameters

- `address` – The start address of the memory to be cleaned.
- `size_byte` – The memory size.

```
static inline void L1CACHE_CleanInvalidateDCacheByRange(uint32_t address, uint32_t
size_byte)
```

Cleans and Invalidates L1 data cache by range.

#### Parameters

- `address` – The start address of the memory to be clean and invalidated.
- `size_byte` – The memory size.

```
static inline void ICACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)
```

Invalidates instruction cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be invalidated.

```
static inline void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)
```

Invalidates data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be invalidated.

```
static inline void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)
```

Clean data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be cleaned.

```
static inline void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)
```

Cleans and Invalidates data cache by range.

#### Parameters

- `address` – The physical address.
- `size_byte` – size of the memory to be Cleaned and Invalidated.

FSL\_CACHE\_DRIVER\_VERSION

cache driver version 2.1.1.

## 2.3 CAU3

**FSL\_CAU3\_DRIVER\_VERSION**

CAU3 driver version. Version 2.0.5.

Current version: 2.0.5

Change log:

- Version 2.0.0
  - Initial version
- Version 2.0.1
  - Replace static `cau3_make_mems_private()` with public `CAU3_MakeMemsPrivate()`.
  - Remove the `cau3_make_mems_private()` from `CAU3_Init` to allow loading multiple images.
- Version 2.0.2
  - Add `FSL_CAU3_USE_HW_SEMA` compile time macro. When enabled, all CAU3 API functions lock hw semaphore on function entry and release the hw semaphore on function return.
- Version 2.0.3
  - Fix MISRA C-2012 issue.
- Version 2.0.4
  - Fix MISRA C-2012 issue.
- Version 2.0.5
  - Fix MISRA-C 2012 issue.

**enum \_cau3\_key\_slot**

Hardware semaphore usage by driver functions. This macro can be enabled for mutual exclusive calls to CAU3 APIs from multiple CPUs. Note this does not lock against calls from multiple threads on one CPU.

CAU3 key slot selection. Current CryptoCore firmware supports 4 key slots inside CryptoCore's Private DMEM.

*Values:*

enumerator `kCAU3_KeySlot0`

CAU3 key slot 0.

enumerator `kCAU3_KeySlotNone`

No key.

enumerator `kCAU3_KeySlot1`

CAU3 key slot 1.

enumerator `kCAU3_KeySlot2`

CAU3 key slot 2.

enumerator `kCAU3_KeySlot3`

CAU3 key slot 3.

**enum \_cau3\_task\_done**

CAU3 task done selection.

*Values:*

enumerator `kCAU3_TaskDoneNull`

enumerator kCAU3\_TaskDonePoll

Poll CAU3 status flag.

enumerator kCAU3\_TaskDoneIrq

Start operation and return. CAU3 asserts interrupt request when done.

enumerator kCAU3\_TaskDoneEvent

Call Wait-for-event opcode until CAU3 completes processing.

enumerator kCAU3\_TaskDoneDmaRequest

Start operation and return. CAU3 asserts DMA request when done.

typedef enum *cau3\_key\_slot* cau3\_key\_slot\_t

Hardware semaphore usage by driver functions. This macro can be enabled for mutual exclusive calls to CAU3 APIs from multiple CPUs. Note this does not lock against calls from multiple threads on one CPU.

CAU3 key slot selection. Current CryptoCore firmware supports 4 key slots inside CryptoCore's Private DMEM.

typedef enum *cau3\_task\_done* cau3\_task\_done\_t

CAU3 task done selection.

typedef struct *cau3\_handle* cau3\_handle\_t

Specify CAU3's key resource and signalling to be used for an operation.

void CAU3\_Init(CAU3\_Type \*base)

Enables clock for CAU3 and loads image to memory.

Enable CAU3 clock and loads image to CryptoCore.

#### Parameters

- base – CAU3 base address

*status\_t* CAU3\_ForceError(CAU3\_Type \*base, *cau3\_task\_done\_t* taskDone)

Execute a CAU3 null task to signal error termination.

Execute a null task to signal error termination. The CryptoCore task executes one instruction - a "stop with error".

#### Parameters

- base – CAU3 base address
- taskDone – indicates completion signal

#### Returns

status check from task completion

*status\_t* CAU3\_LoadSpecialKeyContext(CAU3\_Type \*base, *size\_t* keySize, *cau3\_key\_slot\_t* keySlot, *cau3\_task\_done\_t* taskDone)

Load special hardware "key context" into the CAU3's data memory.

Load the special hardware key context into the private DMEM. This only includes the complete 256-bit key which is then specified with a size of [8,16,24,32] bytes (for DES or AES-[128,256]). It also loads the default IV value specified in NIST/RFC2294 IV=0xa6a6a6a6a6a6a6a6. This operation typically loads keySlot 0, which, by convention, is used for the system key encryption key.

See the GENERAL COMMENTS for more information on the keyContext structure.

NOTE: This function also performs an AES key expansion if a keySize > 8 is specified.

#### Parameters

- base – CAU3 base address

- `keySize` – is the logical key size in bytes [8,16,24,32]
- `keySlot` – is the destination key slot number [0-3]
- `taskDone` – indicates completion signal.

**Returns**

status check from task completion

*status\_t* CAU3\_ClearKeyContext(CAU3\_Type \*base, *cau3\_key\_slot\_t* keySlot, *cau3\_task\_done\_t* taskDone)

Invalidate a 64-byte “key context” in the CAU3’s private data memory.

Clears the key context in the private DMEM. There is support for four “key slots” with slot 0 typically used for the system key encryption key.

**Parameters**

- `base` – CAU3 base address
- `keySlot` – is the key slot number [0-3] to invalidate
- `taskDone` – indicates completion signal \*

**Returns**

status check from task completion

*status\_t* CAU3\_LoadKeyInitVector(CAU3\_Type \*base, const uint8\_t \*iv, *cau3\_key\_slot\_t* keySlot, *cau3\_task\_done\_t* taskDone)

Load an initialization vector into a key context.

Loads a 16-byte initialization vector (iv) into the specified key slot. There is support for a maximum of 4 key slots. The function is used internally for loading AEAD\_CHACHA20\_POY1305 nonce. It can be also used for Alternative Initial Values for A[0] in RFC 3394.

**Parameters**

- `base` – CAU3 base address
- `iv` – The initialization vector, ALIGNED ON A 0-MOD-4 ADDRESS.
- `keySlot` – is the destination key context
- `taskDone` – indicates completion signal

**Returns**

status check from task completion

*status\_t* CAU3\_MakeMemsPrivate(CAU3\_Type \*base, *cau3\_task\_done\_t* taskDone)

Make the CAU3’s local memories private.

Modify the CAU3’s internal configuration so the local memories are private and only accessible to the CAU3. This operation is typically performed after the CAU\_InitializeInstMemory(), CAU\_InitializeDataMemory(), and CAU\_InitializeReadOnlyDataMemory() functions have been performed.

This configuration remains in effect until the next hardware reset.

**Parameters**

- `base` – CAU3 base address
- `taskDone` – indicates completion signal: CAU\_[POLL, IRQ, EVENT, DMAREQ]

**Return values**

status – check from task completion: CAU\_[OK, ERROR]

struct `_cau3_handle`

`#include <fsl_cau3.h>` Specify CAU3's key resource and signalling to be used for an operation.

### Public Members

`cau3_task_done_t` taskDone

Specify CAU3 task done signalling to Host CPU.

`cau3_key_slot_t` keySlot

For operations with key (such as AES encryption/decryption), specify CAU3 key slot.

## 2.4 CAU3 AES driver

`status_t` CAU3\_AES\_SetKey(CAU3\_Type \*base, `cau3_handle_t` \*handle, const uint8\_t \*key, size\_t keySize)

Load AES key into CAU3 key slot.

Load the key context into the private DMEM. This function also performs an AES key expansion. For CAU3 AES encryption/decryption/cmac, users only need to call one of CAU3\_AES\_SetKey and CAU3\_LoadSpecialKeyContext.

CAU3\_AES\_SetKey

### Parameters

- base – CAU3 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 or 32.

### Returns

status from set key operation

`status_t` CAU3\_AES\_Encrypt(CAU3\_Type \*base, `cau3_handle_t` \*handle, const uint8\_t plaintext[16], uint8\_t ciphertext[16])

Encrypts AES on one 128-bit block.

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

### Parameters

- base – CAU3 peripheral base address
- handle – Handle used for this request.
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text

### Returns

Status from encrypt operation

`status_t` CAU3\_AES\_Decrypt(CAU3\_Type \*base, `cau3_handle_t` \*handle, const uint8\_t ciphertext[16], uint8\_t plaintext[16])

Decrypts AES on one 128-bit block.

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

### Parameters

- base – CAU3 peripheral base address
- handle – Handle used for this request.
- ciphertext – Input plain text to encrypt
- plaintext – **[out]** Output cipher text

**Returns**

Status from decrypt operation

*status\_t* CAU3\_AES\_Cmac(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*message, size\_t size, uint8\_t \*mac)

Perform an AES-128 cipher-based authentication code (CMAC)

Performs an AES-128 cipher-based authentication code (CMAC) on a message. RFC 4493.

**Parameters**

- base – CAU3 peripheral base address
- handle – Handle used for this request.
- message – is source uint8\_t array of data bytes, any alignment
- size – Number of bytes in the message.
- mac – is the output 16 bytes MAC, must be a 0-mod-4 aligned address

**Returns**

status check from task completion

*status\_t* CAU3\_AES\_KeyExpansion(CAU3\_Type \*base, *cau3\_key\_slot\_t* keySlot, *cau3\_task\_done\_t* taskDone)

Perform an AES key expansion for specified key slot.

Performs an AES key expansion (aka schedule) on the specified key slot. It uses the keySize information in the context to determine whether the key expansion applies to a 128- or 256-bit AES key. This function is primarily intended to be called after key blob has been unwrapped by CAU3\_KeyBlobUnwrap to destination key slot, so that the unwrapped key can be used for AES encryption.

**Parameters**

- base – CAU3 base address
- keySlot – is the key context
- taskDone – indicates completion signal

**Returns**

status check from task completion

CAU3\_AES\_BLOCK\_SIZE

AES block size in bytes

## 2.5 CAU3 Blob driver

*status\_t* CAU3\_KeyBlobUnwrap(CAU3\_Type \*base, *cau3\_key\_slot\_t* keySlot, const uint8\_t \*keyBlob, uint32\_t numberOfBlocks, *cau3\_key\_slot\_t* dstContext)

Perform an RFC3394 key blob unwrap.

Perform an RFC3394 unwrap of an AES encrypted key blob. The unwrapped key blob is loaded into the specified key slot [1-3]. The initial special hardware KEK contained in key slot 0 is typically used for the unwrapping operation. The destination context number must

be different than the keySlot used for unwrapping. Implements the algorithm at RFC 3394 to AES key unwrap. The current implementation allows to unwrap up to 512 bits, with the restriction of nblocks=2 or =4 or n=8(means it unwraps only 128bits, 256bits or two 256 bits keys (512)). It is allowed input key of 128 and 256bits only (passed using the keyslot). The function also assumes the CAU3\_LoadSpecialKeyContext was called before. It returns error and clear the destination context in case parameters are not inside acceptable values. In case  $n > 4$  &  $n \neq 8$  it clears both destination contexts (the dstContext and the adjacent/next context) In case of  $n=8$ , the first unwrapped key will be stored in the dstContext slot, and the second key will be saved in the next context (E.g: if dstContext=1, then first key goes to slot 1 and second key to slot 2. If dstContext=3 then first key goes to slot 3 and second key goes to slot 1). Examples of n usage. E.g.:  $n = 2$  means a unwrapped key of 128 bits ( $2 * 64$ ) E.g.:  $n = 4$  means a unwrapped key of 256 bits ( $4 * 64$ ) E.g.:  $n = 8$  means two unwrapped keys of 256 bits ( $8 * 64$ )

The function is blocking, it uses the polling task done signaling.

#### Parameters

- base – CAU3 peripheral base address
- keySlot – is the key used to unwrap the key blob [0-3]
- keyBlob – 0-mod-4 aligned pointer is the RFC3394 wrapped key blob.
- numberOfBlocks – is the unwrapped keyBlob length as multiple of 64-bit blocks
- dstContext – is the destination key context for unwrapped blob [0-3]

#### Return values

status – check from task completion

## 2.6 CAU3 CHACHA20\_POLY1305 driver

*status\_t* CAU3\_CHACHA20\_POLY1305\_SetKey(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*key, size\_t keySize)

Load 256-bit key into CAU3 key context (in key slot).

Load the key context into the private DMEM for CHACHA20\_POLY1305 AEAD.

#### Parameters

- base – CAU3 peripheral base address.
- handle – Handle used for the request.
- key – 0-mod-4 aligned pointer to CHACHA20\_POLY1305 256-bit key.
- keySize – Size of the key in bytes. Shall be 32.

#### Returns

status from set key operation

*status\_t* CAU3\_CHACHA20\_POLY1305\_Encrypt(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*plaintext, uint8\_t \*ciphertext, size\_t size, const uint8\_t \*aad, size\_t aadLen, const uint8\_t \*nonce, uint8\_t \*tag)

Perform ChaCha-Poly encryption/authentication.

Perform ChaCha encryption over a message of “n” bytes, and authentication over the encrypted data plus an additional authenticated data, returning encrypted data + a message digest.

#### Parameters



- `base` – CAU3 peripheral base address
- `handle` – Handle used for this request. The `keySlot` member specifies key context with key and IV.
- `plaintext` – The `uint8_t` source message to be encrypted, any alignment
- `ciphertext` – **[out]** is a pointer to the output encrypted message, any alignment
- `size` – The length of the plaintext and ciphertext in bytes
- `aad` – A pointer to the additional authenticated data, any alignment
- `aadLen` – Length of additional authenticated data in bytes
- `nonce` – 0-mod-4 aligned pointer to CHACHA20\_POLY1305 96-bit nonce.
- `tag` – **[out]** A pointer to the 128-bit message digest output, any alignment

#### Returns

status check from task completion

```
status_t CAU3_CHACHA20_POLY1305_Decrypt(CAU3_Type *base, cau3_handle_t *handle,
 const uint8_t *ciphertext, uint8_t *plaintext,
 size_t size, const uint8_t *aad, size_t aadLen,
 const uint8_t *nonce, const uint8_t *tag)
```

Perform ChaCha-Poly decryption/authentication check.

Perform ChaCha decryption over a message of “n” bytes, and checks authentication over the encrypted data plus an additional authenticated data, returning decrypted data. IF the tag authentication fails, the task terminates with error and the output is forced to zero.

#### Parameters

- `base` – CAU3 peripheral base address
- `handle` – Handle used for this request. The `keySlot` member specifies key context with key and IV.
- `ciphertext` – The `uint8_t` source msg to be decrypted, any alignment
- `plaintext` – **[out]** A pointer to the output decrypted message, any alignment
- `size` – Length of the plaintext and ciphertext in bytes
- `aad` – A pointer to the additional authenticated data, any alignment
- `aadLen` – Length of additional authenticated data in bytes
- `nonce` – 0-mod-4 aligned pointer to CHACHA20\_POLY1305 96-bit nonce.
- `tag` – A pointer to the 128-bit msg digest input to be checked, any alignment

#### Returns

status check from task completion

## 2.7 CAU3 TDES driver

```
status_t CAU3_TDES_CheckParity(CAU3_Type *base, cau3_key_slot_t keySlot)
```

Perform a 3DES key parity check.

Performs a 3DES key parity check on three 8-byte keys. The function is blocking.

#### Parameters

- `base` – CAU3 peripheral base address

- `keySlot` – defines the key context to be used in the parity check

**Returns**

status check from task completion

`status_t` CAU3\_TDES\_SetKey(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*key, size\_t keySize)

Load DES key into CAU3 key slot.

Load the key context into the private DMEM.

**Parameters**

- `base` – CAU3 peripheral base address.
- `handle` – Handle used for the request.
- `key` – 0-mod-4 aligned pointer to 3DES key.
- `keySize` – 3DES key size in bytes. Shall equal 24.

**Returns**

status from set key operation

`status_t` CAU3\_TDES\_Encrypt(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*plaintext, uint8\_t \*ciphertext)

Perform a 3DES encryption.

Performs a 3DES “electronic code book” encryption on one 8-byte data block. The source plaintext and destination ciphertext can overlap in system memory. Supports both blocking and non-blocking task completion.

**Parameters**

- `base` – CAU3 peripheral base address.
- `handle` – Handle used for this request.
- `plaintext` – is source uint8\_t array of data bytes, any alignment
- `ciphertext` – is destination uint8\_t array of data byte, any alignment

**Returns**

status check from task completion

`status_t` CAU3\_TDES\_Decrypt(CAU3\_Type \*base, *cau3\_handle\_t* \*handle, const uint8\_t \*ciphertext, uint8\_t \*plaintext)

Perform a 3DES decryption.

Performs a 3DES “electronic code book” decryption on one 8-byte data block. The source ciphertext and destination plaintext can overlap in sysMemory. Supports both blocking and non-blocking task completion.

**Parameters**

- `base` – CAU3 peripheral base address.
- `handle` – Handle used for this request.
- `ciphertext` – is destination uint8\_t array of data byte, any alignment
- `plaintext` – is source uint8\_t array of data bytes, any alignment

**Returns**

status check from task completion

## 2.8 CAU3 HASH driver

enum `_cau3_hash_algo_t`

Supported cryptographic block cipher functions for HASH creation.

*Values:*

enumerator `kCAU3_Sha1`

`SHA_1`

enumerator `kCAU3_Sha256`

`SHA_256`

typedef enum `_cau3_hash_algo_t` `cau3_hash_algo_t`

Supported cryptographic block cipher functions for HASH creation.

typedef struct `_cau3_hash_ctx_t` `cau3_hash_ctx_t`

Storage type used to save hash context.

`status_t` `CAU3_HASH_Init(CAU3_Type *base, cau3_hash_ctx_t *ctx, cau3_hash_algo_t algo)`

Initialize HASH context.

This function initializes the HASH.

For blocking CAU3 HASH API, the HASH context contains all information required for context switch, such as running hash.

### Parameters

- `base` – CAU3 peripheral base address
- `ctx` – **[out]** Output hash context
- `algo` – Underlying algorithm to use for hash computation.

### Returns

Status of initialization

`status_t` `CAU3_HASH_Update(CAU3_Type *base, cau3_hash_ctx_t *ctx, const uint8_t *input, size_t inputSize)`

Add data to current HASH.

Add data to current HASH. This can be called repeatedly with an arbitrary amount of data to be hashed. The functions blocks. If it returns `kStatus_Success`, the running hash or mac has been updated (CAU3 has processed the input data), so the memory at input pointer can be released back to system. The context is updated with the running hash or mac and with all necessary information to support possible context switch.

### Parameters

- `base` – CAU3 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` `CAU3_HASH_Finish(CAU3_Type *base, cau3_hash_ctx_t *ctx, uint8_t *output, size_t *outputSize)`

Finalize hashing.

Outputs the final hash (computed by `CAU3_HASH_Update()`) and erases the context.

**Parameters**

- base – CAU3 peripheral base address
- ctx – **[inout]** Input hash context
- output – **[out]** Output hash data
- outputSize – **[out]** Output parameter storing the size of the output hash in bytes

**Returns**

Status of the hash finish operation

*status\_t* CAU3\_HASH(CAU3\_Type \*base, *cau3\_hash\_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 – CAU3 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.

CAU3\_SHA\_BLOCK\_SIZE

CAU3 HASH Context size.

internal buffer block size

CAU3\_HASH\_BLOCK\_SIZE

CAU3 hash block size

CAU3\_HASH\_CTX\_SIZE

CAU3 HASH Context size.

struct \_\_cau3\_hash\_ctx\_t

*#include <fsl\_cau3.h>* Storage type used to save hash context.

## 2.9 CAU3 PKHA driver

enum \_\_cau3\_pkha\_timing\_t

Use of timing equalized version of a PKHA function.

*Values:*

enumerator kCAU3\_PKHA\_NoTimingEqualized

Normal version of a PKHA operation

enumerator kCAU3\_PKHA\_TimingEqualized

Timing-equalized version of a PKHA operation

enum `_cau3_pkha_f2m_t`

Integer vs binary polynomial arithmetic selection.

*Values:*

enumerator `kCAU3_PKHA_IntegerArith`

Use integer arithmetic

enumerator `kCAU3_PKHA_F2mArith`

Use binary polynomial arithmetic

enum `_cau3_pkha_montgomery_form_t`

Montgomery or normal PKHA input format.

*Values:*

enumerator `kCAU3_PKHA_NormalValue`

PKHA number is normal integer

enumerator `kCAU3_PKHA_MontgomeryFormat`

PKHA number is in montgomery format

typedef struct `_cau3_pkha_ecc_point_t` `cau3_pkha_ecc_point_t`

PKHA ECC point structure

typedef enum `_cau3_pkha_timing_t` `cau3_pkha_timing_t`

Use of timing equalized version of a PKHA function.

typedef enum `_cau3_pkha_f2m_t` `cau3_pkha_f2m_t`

Integer vs binary polynomial arithmetic selection.

typedef enum `_cau3_pkha_montgomery_form_t` `cau3_pkha_montgomery_form_t`

Montgomery or normal PKHA input format.

int `CAU3_PKHA_CompareBigNum`(const uint8\_t \*a, size\_t sizeA, const uint8\_t \*b, size\_t sizeB)

`status_t` `CAU3_PKHA_NormalToMontgomery`(`CAU3_Type` \*base, const uint8\_t \*N, size\_t sizeN, uint8\_t \*A, size\_t \*sizeA, uint8\_t \*B, size\_t \*sizeB, uint8\_t \*R2, size\_t \*sizeR2, `cau3_pkha_timing_t` equalTime, `cau3_pkha_f2m_t` arithType)

Converts from integer to Montgomery format.

This function computes  $R2 \bmod N$  and optionally converts A or B into Montgomery format of A or B.

#### Parameters

- base – CAU3 peripheral base address
- N – modulus
- sizeN – size of N in bytes
- A – **[inout]** The first input in non-Montgomery format. Output Montgomery format of the first input.
- sizeA – **[inout]** pointer to size variable. On input it holds size of input A in bytes. On output it holds size of Montgomery format of A in bytes.
- B – **[inout]** Second input in non-Montgomery format. Output Montgomery format of the second input.
- sizeB – **[inout]** pointer to size variable. On input it holds size of input B in bytes. On output it holds size of Montgomery format of B in bytes.
- R2 – **[out]** Output Montgomery factor  $R2 \bmod N$ .

- sizeR2 – **[out]** pointer to size variable. On output it holds size of Montgomery factor  $R2 \bmod N$  in bytes.
- equalTime – Run the function time equalized or no timing equalization.
- arithType – Type of arithmetic to perform (integer or F2m)

**Returns**

Operation status.

```
status_t CAU3_PKHA_MontgomeryToNormal(CAU3_Type *base, const uint8_t *N, size_t sizeN,
 uint8_t *A, size_t *sizeA, uint8_t *B, size_t *sizeB,
 cau3_pkha_timing_t equalTime, cau3_pkha_f2m_t
 arithType)
```

Converts from Montgomery format to int.

This function converts Montgomery format of A or B into int A or B.

**Parameters**

- base – CAU3 peripheral base address
- N – modulus.
- sizeN – size of N modulus in bytes.
- A – **[inout]** Input first number in Montgomery format. Output is non-Montgomery format.
- sizeA – **[inout]** pointer to size variable. On input it holds size of the input A in bytes. On output it holds size of non-Montgomery A in bytes.
- B – **[inout]** Input first number in Montgomery format. Output is non-Montgomery format.
- sizeB – **[inout]** pointer to size variable. On input it holds size of the input B in bytes. On output it holds size of non-Montgomery B in bytes.
- equalTime – Run the function time equalized or no timing equalization.
- arithType – Type of arithmetic to perform (integer or F2m)

**Returns**

Operation status.

```
status_t CAU3_PKHA_ModAdd(CAU3_Type *base, const uint8_t *A, size_t sizeA, const uint8_t
 *B, size_t sizeB, const uint8_t *N, size_t sizeN, uint8_t *result,
 size_t *resultSize, cau3_pkha_f2m_t arithType)
```

Performs modular addition -  $(A + B) \bmod N$ .

This function performs modular addition of  $(A + B) \bmod N$ , with either integer or binary polynomial (F2m) inputs. In the F2m form, this function is equivalent to a bitwise XOR and it is functionally the same as subtraction.

**Parameters**

- base – CAU3 peripheral base address
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus.
- sizeN – Size of N in bytes.
- result – **[out]** Output array to store result of operation

- `resultSize` – **[out]** Output size of operation in bytes
- `arithType` – Type of arithmetic to perform (integer or F2m)

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_ModSub1(CAU3\_Type \*base, const uint8\_t \*A, size\_t sizeA, const uint8\_t \*B, size\_t sizeB, const uint8\_t \*N, size\_t sizeN, uint8\_t \*result, size\_t \*resultSize)

Performs modular subtraction -  $(A - B) \bmod N$ .

This function performs modular subtraction of  $(A - B) \bmod N$  with integer inputs.

**Parameters**

- `base` – CAU3 peripheral base address
- `A` – first addend (integer or binary polynomial)
- `sizeA` – Size of A in bytes
- `B` – second addend (integer or binary polynomial)
- `sizeB` – Size of B in bytes
- `N` – modulus
- `sizeN` – Size of N in bytes
- `result` – **[out]** Output array to store result of operation
- `resultSize` – **[out]** Output size of operation in bytes

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_ModSub2(CAU3\_Type \*base, const uint8\_t \*A, size\_t sizeA, const uint8\_t \*B, size\_t sizeB, const uint8\_t \*N, size\_t sizeN, uint8\_t \*result, size\_t \*resultSize)

Performs modular subtraction -  $(B - A) \bmod N$ .

This function performs modular subtraction of  $(B - A) \bmod N$ , with integer inputs.

**Parameters**

- `base` – CAU3 peripheral base address
- `A` – first addend (integer or binary polynomial)
- `sizeA` – Size of A in bytes
- `B` – second addend (integer or binary polynomial)
- `sizeB` – Size of B in bytes
- `N` – modulus
- `sizeN` – Size of N in bytes
- `result` – **[out]** Output array to store result of operation
- `resultSize` – **[out]** Output size of operation in bytes

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_ModMul(CAU3\_Type \*base, const uint8\_t \*A, size\_t sizeA, const uint8\_t \*B, size\_t sizeB, const uint8\_t \*N, size\_t sizeN, uint8\_t \*result, size\_t \*resultSize, *cau3\_pkha\_f2m\_t* arithType, *cau3\_pkha\_montgomery\_form\_t* montIn, *cau3\_pkha\_montgomery\_form\_t* montOut, *cau3\_pkha\_timing\_t* equalTime)

Performs modular multiplication -  $(A \times B) \bmod N$ .

This function performs modular multiplication with either integer or binary polynomial (F2m) inputs. It can optionally specify whether inputs and/or outputs will be in Montgomery form or not.

#### Parameters

- base – CAU3 peripheral base address
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- B – second addend (integer or binary polynomial)
- sizeB – Size of B in bytes
- N – modulus.
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)
- montIn – Format of inputs
- montOut – Format of output
- equalTime – Run the function time equalized or no timing equalization. This argument is ignored for F2m modular multiplication.

#### Returns

Operation status.

```
status_t CAU3_PKHA_ModExp(CAU3_Type *base, const uint8_t *A, size_t sizeA, const uint8_t *N, size_t sizeN, const uint8_t *E, size_t sizeE, uint8_t *result, size_t *resultSize, cau3_pkha_f2m_t arithType, cau3_pkha_montgomery_form_t montIn, cau3_pkha_timing_t equalTime)
```

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

This function performs modular exponentiation with either integer or binary polynomial (F2m) inputs.

#### Parameters

- base – CAU3 peripheral base address
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- E – exponent
- sizeE – Size of E in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- montIn – Format of A input (normal or Montgomery)
- arithType – Type of arithmetic to perform (integer or F2m)



- equalTime – Run the function time equalized or no timing equalization.

**Returns**

Operation status.

```
status_t CAU3_PKHA_ModSqrt(CAU3_Type *base, const uint8_t *A, size_t sizeA, const uint8_t
 *N, size_t sizeN, uint8_t *result, size_t *resultSize)
```

Performs Modular Square Root.

This function performs modular square root with integer inputs. The modular square root function computes output result B, such that  $(B \times B) \bmod N = \text{input } A$ . If no such B result exists, the result will be set to 0 and the PKHA “prime” flag will be set. Input values A and B are limited to a maximum size of 128 bytes. Note that two such square root values may exist. This algorithm will find either one of them, if any exist. The second possible square root (B') can be found by calculating  $B' = N - B$ .

**Parameters**

- base – CAU3 peripheral base address
- A – input value, for which a square root is to be calculated
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes

**Returns**

Operation status.

```
status_t CAU3_PKHA_ModRed(CAU3_Type *base, const uint8_t *A, size_t sizeA, const uint8_t
 *N, size_t sizeN, uint8_t *result, size_t *resultSize,
 cau3_pkha_f2m_t arithType)
```

Performs modular reduction -  $(A) \bmod N$ .

This function performs modular reduction with either integer or binary polynomial (F2m) inputs.

**Parameters**

- base – CAU3 peripheral base address
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

**Returns**

Operation status.

```
status_t CAU3_PKHA_ModInv(CAU3_Type *base, const uint8_t *A, size_t sizeA, const uint8_t
 *N, size_t sizeN, uint8_t *result, size_t *resultSize,
 cau3_pkha_f2m_t arithType)
```

Performs modular inversion -  $(A^{-1}) \bmod N$ .

This function performs modular inversion with either integer or binary polynomial (F2m) inputs.

#### Parameters

- base – CAU3 peripheral base address
- A – first addend (integer or binary polynomial)
- sizeA – Size of A in bytes
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

#### Returns

Operation status.

*status\_t* CAU3\_PKHA\_ModR2(CAU3\_Type \*base, const uint8\_t \*N, size\_t sizeN, uint8\_t \*result, size\_t \*resultSize, *cau3\_pkha\_f2m\_t* arithType)

Computes integer Montgomery factor  $R^2 \bmod N$ .

This function computes a constant to assist in converting operands into the Montgomery residue system representation.

#### Parameters

- base – CAU3 peripheral base address
- N – modulus
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

#### Returns

Operation status.

*status\_t* CAU3\_PKHA\_ModRR(CAU3\_Type \*base, const uint8\_t \*P, size\_t sizeP, size\_t sizeE, uint8\_t \*result, size\_t \*resultSize)

Performs Integer RERP mod P.

This function is used to compute a constant to assist in converting operands into the Montgomery residue system representation specifically for Chinese Remainder Theorem while performing RSA with a CRT implementation where a modulus  $E = P \times Q$ , and P and Q are prime numbers. Although labeled RERP mod P, this routine (function) can also compute RERQ mod Q.

#### Parameters

- base – CAU3 peripheral base address
- P – modulus P or Q of CRT, an odd integer
- sizeP – Size of P in bytes
- sizeE – Number of bytes of  $E = P \times Q$  (this size must be given, though content of E itself is not used).
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_ModGcd(CAU3\_Type \*base, const uint8\_t \*A, size\_t sizeA, const uint8\_t \*N, size\_t sizeN, uint8\_t \*result, size\_t \*resultSize, *cau3\_pkha\_f2m\_t* arithType)

Calculates the greatest common divisor - GCD (A, N).

This function calculates the greatest common divisor of two inputs with either integer or binary polynomial (F2m) inputs.

**Parameters**

- base – CAU3 peripheral base address
- A – first value (must be smaller than or equal to N)
- sizeA – Size of A in bytes
- N – second value (must be non-zero)
- sizeN – Size of N in bytes
- result – **[out]** Output array to store result of operation
- resultSize – **[out]** Output size of operation in bytes
- arithType – Type of arithmetic to perform (integer or F2m)

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_PrimalityTest(CAU3\_Type \*base, const uint8\_t \*A, size\_t sizeA, const uint8\_t \*B, size\_t sizeB, const uint8\_t \*N, size\_t sizeN, bool \*res)

Executes Miller-Rabin primality test.

This function calculates whether or not a candidate prime number is likely to be a prime.

**Parameters**

- base – CAU3 peripheral base address
- A – initial random seed
- sizeA – Size of A in bytes
- B – number of trial runs
- sizeB – Size of B in bytes
- N – candidate prime integer
- sizeN – Size of N in bytes
- res – **[out]** True if the value is likely prime or false otherwise

**Returns**

Operation status.

*status\_t* CAU3\_PKHA\_ECC\_PointAdd(CAU3\_Type \*base, const *cau3\_pkha\_ecc\_point\_t* \*A, const *cau3\_pkha\_ecc\_point\_t* \*B, const uint8\_t \*N, const uint8\_t \*R2modN, const uint8\_t \*aCurveParam, const uint8\_t \*bCurveParam, size\_t size, *cau3\_pkha\_f2m\_t* arithType, *cau3\_pkha\_ecc\_point\_t* \*result)

Adds elliptic curve points - A + B.

This function performs ECC point addition over a prime field (Fp) or binary field (F2m) using affine coordinates.

**Parameters**

- base – CAU3 peripheral base address
- A – Left-hand point
- B – Right-hand point
- N – Prime modulus of the field
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAU3\_PKHA\_ModR2() function).
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (constant)
- size – Size in bytes of curve points and parameters
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

### Returns

Operation status.

```
status_t CAU3_PKHA_ECC_PointDouble(CAU3_Type *base, const cau3_pkha_ecc_point_t *B,
 const uint8_t *N, const uint8_t *aCurveParam, const
 uint8_t *bCurveParam, size_t size, cau3_pkha_f2m_t
 arithType, cau3_pkha_ecc_point_t *result)
```

Doubles elliptic curve points - B + B.

This function performs ECC point doubling over a prime field (Fp) or binary field (F2m) using affine coordinates.

### Parameters

- base – CAU3 peripheral base address
- B – Point to double
- N – Prime modulus of the field
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (constant)
- size – Size in bytes of curve points and parameters
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

### Returns

Operation status.

```
status_t CAU3_PKHA_ECC_PointMul(CAU3_Type *base, const cau3_pkha_ecc_point_t *A, const
 uint8_t *E, size_t sizeE, const uint8_t *N, const uint8_t
 *R2modN, const uint8_t *aCurveParam, const uint8_t
 *bCurveParam, size_t size, cau3_pkha_timing_t
 equalTime, cau3_pkha_f2m_t arithType,
 cau3_pkha_ecc_point_t *result)
```

Multiplies an elliptic curve point by a scalar - E x (A0, A1).

This function performs ECC point multiplication to multiply an ECC point by a scalar integer multiplier over a prime field (Fp) or a binary field (F2m).

### Parameters

- base – CAU3 peripheral base address
- A – Point as multiplicand

- E – Scalar multiple
- sizeE – The size of E, in bytes
- N – Modulus, a prime number for the Fp field or Irreducible polynomial for F2m field.
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAU3\_PKHA\_ModR2() function).
- aCurveParam – A parameter from curve equation
- bCurveParam – B parameter from curve equation (C parameter for operation over F2m).
- size – Size in bytes of curve points and parameters
- equalTime – Run the function time equalized or no timing equalization.
- arithType – Type of arithmetic to perform (integer or F2m)
- result – **[out]** Result point

### Returns

Operation status.

```
status_t CAU3_PKHA_ECM_PointMul(CAU3_Type *base, const uint8_t *E, size_t sizeE, const
 uint8_t *inputCoordinate, const uint8_t *A24, const
 uint8_t *N, const uint8_t *R2modN, size_t size,
 cau3_pkha_timing_t equalTime, uint8_t
 *outputCoordinate)
```

Computes scalar multiplication of a point on an elliptic curve in Montgomery form.

This function computes the scalar multiplication of a point on an elliptic curve in Montgomery form. The input and output are just the x coordinates of the points. The points on a curve are defined by the equation  $E: B*y^2 = x^3 + A*x^2 + x \bmod p$ . This function computes a point multiplication on a Montgomery curve, using Montgomery values, by means of a Montgomery ladder. At the end of the ladder,  $P_2 = P_3 + P_1$ , where  $P_1$  is the input and  $P_3$  is the result.

### Parameters

- base – CAU3 peripheral base address
- E – Scalar multiplier, any integer
- sizeE – The size of E, in bytes
- inputCoordinate – Point as multiplicand, an input point's affine x coordinate
- A24 – elliptic curve a24 parameter, that is,  $(A+2)/4$
- N – Modulus, a prime number.
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAU3\_PKHA\_ModR2() function).
- size – Size in bytes of curve points and parameters
- equalTime – Run the function time equalized or no timing equalization.
- outputCoordinate – **[out]** Resulting point's x affine coordinate.

### Returns

Operation status.

```
status_t CAU3_PKHA_ECT_PointMul(CAU3_Type *base, const cau3_pkha_ecc_point_t *A, const
 uint8_t *E, size_t sizeE, const uint8_t *N, const uint8_t
 *R2modN, const uint8_t *aCurveParam, const uint8_t
 *dCurveParam, size_t size, cau3_pkha_timing_t
 equalTime, cau3_pkha_ecc_point_t *result)
```

Multiplies an Edwards-form elliptic curve point by a scalar -  $E \times (A_0, A_1)$ .

This function performs scalar multiplication of an Edwards-form elliptic curve point in affine coordinates. The points on a curve are defined by the equation  $E: a \cdot X^2 + d^2 = 1 + D^2 \cdot X^2 \cdot Y^2 \bmod N$

#### Parameters

- base – CAU3 peripheral base address
- A – Point as multiplicand
- E – Scalar multiple
- sizeE – The size of E, in bytes
- N – Modulus, a prime number for the Fp field.
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAU3\_PKHA\_ModR2() function).
- aCurveParam – A parameter from curve equation
- dCurveParam – D parameter from curve equation.
- size – Size in bytes of curve points and parameters
- equalTime – Run the function time equalized or no timing equalization.
- result – **[out]** Result point

#### Returns

Operation status.

```
status_t CAU3_PKHA_ECT_PointAdd(CAU3_Type *base, const cau3_pkha_ecc_point_t *A, const
 cau3_pkha_ecc_point_t *B, const uint8_t *N, const uint8_t
 *R2modN, const uint8_t *aCurveParam, const uint8_t
 *dCurveParam, size_t size, cau3_pkha_ecc_point_t
 *result)
```

Adds an Edwards-form elliptic curve points -  $A + B$ .

This function performs Edwards-form elliptic curve point addition over a prime field (Fp) using affine coordinates. The points on a curve are defined by the equation  $E: a \cdot X^2 + Y^2 = 1 + d^2 \cdot X^2 \cdot Y^2 \bmod N$

#### Parameters

- base – CAU3 peripheral base address
- A – Left-hand point
- B – Right-hand point
- N – Prime modulus of the field
- R2modN – NULL (the function computes R2modN internally) or pointer to pre-computed R2modN (obtained from CAU3\_PKHA\_ModR2() function).
- aCurveParam – A parameter from curve equation
- dCurveParam – D parameter from curve equation
- size – Size in bytes of curve points and parameters
- result – **[out]** Result point

#### Returns

Operation status.

```
struct __cau3_pkha_ecc_point_t
#include <fsl_cau3.h> PKHA ECC point structure
```

### Public Members

uint8\_t \*X  
X coordinate (affine)

uint8\_t \*Y  
Y coordinate (affine)

## 2.10 Clock Driver

enum \_clock\_name

Clock name used to get clock frequency.

These clocks source would be generated from SCG module.

*Values:*

enumerator kCLOCK\_CoreSysClk  
Core 0/1 clock.

enumerator kCLOCK\_SlowClk  
SLOW\_CLK with DIVSLOW.

enumerator kCLOCK\_PlatClk  
PLAT\_CLK.

enumerator kCLOCK\_SysClk  
SYS\_CLK.

enumerator kCLOCK\_BusClk  
BUS\_CLK with DIVBUS.

enumerator kCLOCK\_ExtClk  
One clock selection of CLKOUT from main clock after DIVCORE and DIVEXT divider.

enumerator kCLOCK\_ScgSysLpFllAsyncDiv1Clk  
LPFLL\_DIV1\_CLK.

enumerator kCLOCK\_ScgSysLpFllAsyncDiv2Clk  
LPFLL\_DIV1\_CLK.

enumerator kCLOCK\_ScgSysLpFllAsyncDiv3Clk  
LPFLL\_DIV1\_CLK.

enumerator kCLOCK\_ScgSircAsyncDiv1Clk  
SIRCDIV1\_CLK.

enumerator kCLOCK\_ScgSircAsyncDiv2Clk  
SIRCDIV2\_CLK.

enumerator kCLOCK\_ScgSircAsyncDiv3Clk  
SIRCDIV3\_CLK.

enumerator kCLOCK\_ScgFircAsyncDiv1Clk  
FIRCDIV1\_CLK.

enumerator kCLOCK\_ScgFircAsyncDiv2Clk  
FIRCDIV2\_CLK.

enumerator kCLOCK\_ScgFircAsyncDiv3Clk  
FIRCDIV3\_CLK.

enumerator kCLOCK\_ScgSircClk  
SCG SIRC clock.

enumerator kCLOCK\_ScgFircClk  
SCG FIRC clock.

enumerator kCLOCK\_RtcOscClk  
RTC OSC clock.

enumerator kCLOCK\_ScgLpFllClk  
SCG Low-power FLL clock. (LPFLL)

enumerator kCLOCK\_LpoClk  
LPO clock

enumerator kCLOCK\_Osc32kClk  
External OSC 32K clock (OSC32KCLK)

enum \_clock\_ip\_src

Clock source for peripherals that support various clock selections.

These options are for PCC->CLKCFG[PCS].

*Values:*

enumerator kCLOCK\_IpSrcNoneOrExt  
Clock is off or external clock is used.

enumerator kCLOCK\_IpSrcSircAsync  
Slow IRC async clock.

enumerator kCLOCK\_IpSrcFircAsync  
Fast IRC async clock.

enumerator kCLOCK\_IpSrcLpFllAsync  
System LPFLL async clock.

enum \_clock\_ip\_name

*Values:*

enumerator kCLOCK\_IpInvalid

enumerator kCLOCK\_Mscm

enumerator kCLOCK\_Syspm

enumerator kCLOCK\_Max0

enumerator kCLOCK\_Edma0

enumerator kCLOCK\_Flexbus

enumerator kCLOCK\_Xrdc0Mgr

enumerator kCLOCK\_Xrdc0Pac

enumerator kCLOCK\_Xrdc0Mrc

enumerator kCLOCK\_Sema420

enumerator kCLOCK\_Dmamux0

enumerator kCLOCK\_Ewm0

enumerator kCLOCK\_MuA



enumerator kCLOCK\_\_Crc0  
enumerator kCLOCK\_\_Lpit0  
enumerator kCLOCK\_\_Tpm0  
enumerator kCLOCK\_\_Tpm1  
enumerator kCLOCK\_\_Tpm2  
enumerator kCLOCK\_\_Emvsim0  
enumerator kCLOCK\_\_Flexio0  
enumerator kCLOCK\_\_Lpi2c0  
enumerator kCLOCK\_\_Lpi2c1  
enumerator kCLOCK\_\_Lpi2c2  
enumerator kCLOCK\_\_Sai0  
enumerator kCLOCK\_\_Sdhc0  
enumerator kCLOCK\_\_Lpspi0  
enumerator kCLOCK\_\_Lpspi1  
enumerator kCLOCK\_\_Lpspi2  
enumerator kCLOCK\_\_Lpuart0  
enumerator kCLOCK\_\_Lpuart1  
enumerator kCLOCK\_\_Lpuart2  
enumerator kCLOCK\_\_Usb0  
enumerator kCLOCK\_\_PortA  
enumerator kCLOCK\_\_PortB  
enumerator kCLOCK\_\_PortC  
enumerator kCLOCK\_\_PortD  
enumerator kCLOCK\_\_Lpadc0  
enumerator kCLOCK\_\_Dac0  
enumerator kCLOCK\_\_Vref  
enumerator kCLOCK\_\_Atx  
enumerator kCLOCK\_\_Trace  
enumerator kCLOCK\_\_Edma1  
enumerator kCLOCK\_\_GpioE  
enumerator kCLOCK\_\_Xrdc0PacB  
enumerator kCLOCK\_\_Xrdc0MrcB  
enumerator kCLOCK\_\_Sema421

enumerator kCLOCK\_Dmamux1

enumerator kCLOCK\_Intmux0

enumerator kCLOCK\_MuB

enumerator kCLOCK\_Cau3

enumerator kCLOCK\_Trng

enumerator kCLOCK\_Lpit1

enumerator kCLOCK\_Tpm3

enumerator kCLOCK\_Lpi2c3

enumerator kCLOCK\_Lpspi3

enumerator kCLOCK\_Lpuart3

enumerator kCLOCK\_PortE

enumerator kCLOCK\_Ext0

enumerator kCLOCK\_Ext1

enum \_clock\_usb\_src

USB clock source definition.

*Values:*

enumerator kCLOCK\_UsbSrcIrc48M

Use IRC48M.

enumerator kCLOCK\_UsbSrcUnused

Used when the function does not care the clock source.

SCG status return codes.

*Values:*

enumerator kStatus\_SCG\_Busy

Clock is busy.

enumerator kStatus\_SCG\_InvalidSrc

Invalid source.

enum \_scg\_sys\_clk

SCG system clock type.

*Values:*

enumerator kSCG\_SysClkSlow

System slow clock.

enumerator kSCG\_SysClkBus

Bus clock.

enumerator kSCG\_SysClkExt

External clock.

enumerator kSCG\_SysClkCore

Core clock.

enum \_scg\_sys\_clk\_src

SCG system clock source.

*Values:*

enumerator kSCG\_SysClkSrcSirc  
Slow IRC.

enumerator kSCG\_SysClkSrcFirc  
Fast IRC.

enumerator kSCG\_SysClkSrcRosc  
RTC OSC.

enumerator kSCG\_SysClkSrcLpFll  
Low power FLL.

enum \_scg\_sys\_clk\_div

SCG system clock divider value.

*Values:*

enumerator kSCG\_SysClkDivBy1  
Divided by 1.

enumerator kSCG\_SysClkDivBy2  
Divided by 2.

enumerator kSCG\_SysClkDivBy3  
Divided by 3.

enumerator kSCG\_SysClkDivBy4  
Divided by 4.

enumerator kSCG\_SysClkDivBy5  
Divided by 5.

enumerator kSCG\_SysClkDivBy6  
Divided by 6.

enumerator kSCG\_SysClkDivBy7  
Divided by 7.

enumerator kSCG\_SysClkDivBy8  
Divided by 8.

enumerator kSCG\_SysClkDivBy9  
Divided by 9.

enumerator kSCG\_SysClkDivBy10  
Divided by 10.

enumerator kSCG\_SysClkDivBy11  
Divided by 11.

enumerator kSCG\_SysClkDivBy12  
Divided by 12.

enumerator kSCG\_SysClkDivBy13  
Divided by 13.

enumerator kSCG\_SysClkDivBy14  
Divided by 14.

enumerator kSCG\_SysClkDivBy15  
Divided by 15.

enumerator kSCG\_SysClkDivBy16  
Divided by 16.

enum \_\_clock\_clkout\_src  
SCG clock out configuration (CLKOUTSEL).

*Values:*

enumerator kClockClkoutSelScgExt  
SCG external clock.

enumerator kClockClkoutSelSirc  
Slow IRC.

enumerator kClockClkoutSelFirc  
Fast IRC.

enumerator kClockClkoutSelScgRtcOsc  
SCG RTC OSC clock.

enumerator kClockClkoutSelLpFll  
Low power FLL.

enum \_\_scg\_async\_clk  
SCG asynchronous clock type.

*Values:*

enumerator kSCG\_AsyncDiv1Clk  
The async clock by DIV1, e.g. SOSCDIV1\_CLK, SIRCDIV1\_CLK.

enumerator kSCG\_AsyncDiv2Clk  
The async clock by DIV2, e.g. SOSCDIV2\_CLK, SIRCDIV2\_CLK.

enumerator kSCG\_AsyncDiv3Clk  
The async clock by DIV3, e.g. SOSCDIV3\_CLK, SIRCDIV3\_CLK.

enum scg\_async\_clk\_div  
SCG asynchronous clock divider value.

*Values:*

enumerator kSCG\_AsyncClkDisable  
Clock output is disabled.

enumerator kSCG\_AsyncClkDivBy1  
Divided by 1.

enumerator kSCG\_AsyncClkDivBy2  
Divided by 2.

enumerator kSCG\_AsyncClkDivBy4  
Divided by 4.

enumerator kSCG\_AsyncClkDivBy8  
Divided by 8.

enumerator kSCG\_AsyncClkDivBy16  
Divided by 16.

enumerator kSCG\_AsyncClkDivBy32

Divided by 32.

enumerator kSCG\_AsyncClkDivBy64

Divided by 64.

enum \_\_scg\_sirc\_range

SCG slow IRC clock frequency range.

*Values:*

enumerator kSCG\_SircRangeLow

Slow IRC low range clock (2 MHz, 4 MHz for i.MX 7 ULP).

enumerator kSCG\_SircRangeHigh

Slow IRC high range clock (8 MHz, 16 MHz for i.MX 7 ULP).

enum \_\_scg\_sirc\_enable\_mode

SIRC enable mode.

*Values:*

enumerator kSCG\_SircEnable

Enable SIRC clock.

enumerator kSCG\_SircEnableInStop

Enable SIRC in stop mode.

enumerator kSCG\_SircEnableInLowPower

Enable SIRC in low power mode.

enum \_\_scg\_firc\_trim\_mode

SCG fast IRC trim mode.

*Values:*

enumerator kSCG\_FircTrimNonUpdate

FIRC trim enable but not enable trim value update. In this mode, the trim value is fixed to the initialized value which is defined by trimCoar and trimFine in configure structure scg\_firc\_trim\_config\_t.

enumerator kSCG\_FircTrimUpdate

FIRC trim enable and trim value update enable. In this mode, the trim value is auto update.

enum \_\_scg\_firc\_trim\_div

SCG fast IRC trim predivided value for system OSC.

*Values:*

enumerator kSCG\_FircTrimDivBy1

Divided by 1.

enumerator kSCG\_FircTrimDivBy128

Divided by 128.

enumerator kSCG\_FircTrimDivBy256

Divided by 256.

enumerator kSCG\_FircTrimDivBy512

Divided by 512.

enumerator kSCG\_FircTrimDivBy1024

Divided by 1024.

enumerator kSCG\_FircTrimDivBy2048  
Divided by 2048.

enum \_scg\_firc\_trim\_src  
SCG fast IRC trim source.

*Values:*

enumerator kSCG\_FircTrimSrcSysOsc  
System OSC.

enumerator kSCG\_FircTrimSrcRtcOsc  
RTC OSC (32.768 kHz).

enum \_scg\_firc\_range  
SCG fast IRC clock frequency range.

*Values:*

enumerator kSCG\_FircRange48M  
Fast IRC is trimmed to 48 MHz.

enumerator kSCG\_FircRange52M  
Fast IRC is trimmed to 52 MHz.

enumerator kSCG\_FircRange56M  
Fast IRC is trimmed to 56 MHz.

enumerator kSCG\_FircRange60M  
Fast IRC is trimmed to 60 MHz.

enum \_scg\_firc\_enable\_mode  
FIRC enable mode.

*Values:*

enumerator kSCG\_FircEnable  
Enable FIRC clock.

enumerator kSCG\_FircEnableInStop  
Enable FIRC in stop mode.

enumerator kSCG\_FircEnableInLowPower  
Enable FIRC in low power mode.

enumerator kSCG\_FircDisableRegulator  
Disable regulator.

enum \_scg\_lpfll\_enable\_mode  
LPFLL enable mode.

*Values:*

enumerator kSCG\_LpFllEnable  
Enable LPFLL clock.

enum \_scg\_lpfll\_range  
SCG LPFLL clock frequency range.

*Values:*

enumerator kSCG\_LpFllRange48M  
LPFLL is trimmed to 48MHz.

enumerator kSCG\_LpFllRange72M

LPFLL is trimmed to 72MHz.

enumerator kSCG\_LpFllRange96M

LPFLL is trimmed to 96MHz.

enumerator kSCG\_LpFllRange120M

LPFLL is trimmed to 120MHz.

enum \_scg\_lpfl\_trim\_mode

SCG LPFLL trim mode.

*Values:*

enumerator kSCG\_LpFllTrimNonUpdate

LPFLL trim is enabled but the trim value update is not enabled. In this mode, the trim value is fixed to the initialized value, which is defined by the trimValue in the structure scg\_lpfl\_trim\_config\_t.

enumerator kSCG\_LpFllTrimUpdate

FIRC trim is enabled and trim value update is enabled. In this mode, the trim value is automatically updated.

enum \_scg\_lpfl\_trim\_src

SCG LPFLL trim source.

*Values:*

enumerator kSCG\_LpFllTrimSrcSirc

SIRC.

enumerator kSCG\_LpFllTrimSrcFirc

FIRC.

enumerator kSCG\_LpFllTrimSrcSysOsc

System OSC.

enumerator kSCG\_LpFllTrimSrcRtcOsc

RTC OSC (32.768 kHz).

enum \_scg\_lpfl\_lock\_mode

SCG LPFLL lock mode.

*Values:*

enumerator kSCG\_LpFllLock1Lsb

Lock with 1 LSB.

enumerator kSCG\_LpFllLock2Lsb

Lock with 2 LSB.

enum \_scg\_rosc\_monitor\_mode

SCG RTC OSC monitor mode.

*Values:*

enumerator kSCG\_rtcOscMonitorDisable

Monitor disable.

enumerator kSCG\_rtcOscMonitorInt

Interrupt when the RTC OSC error is detected.

enumerator kSCG\_rtcOscMonitorReset

Reset when the RTC OSC error is detected.

`typedef enum _clock_name clock_name_t`  
Clock name used to get clock frequency.  
These clocks source would be generated from SCG module.

`typedef enum _clock_ip_src clock_ip_src_t`  
Clock source for peripherals that support various clock selections.  
These options are for PCC->CLKCFG[PCS].

`typedef enum _clock_ip_name clock_ip_name_t`

`typedef enum _clock_usb_src clock_usb_src_t`  
USB clock source definition.

`typedef enum _scg_sys_clk scg_sys_clk_t`  
SCG system clock type.

`typedef enum _scg_sys_clk_src scg_sys_clk_src_t`  
SCG system clock source.

`typedef enum _scg_sys_clk_div scg_sys_clk_div_t`  
SCG system clock divider value.

`typedef struct _scg_sys_clk_config scg_sys_clk_config_t`  
SCG system clock configuration.

`typedef enum _clock_clkout_src clock_clkout_src_t`  
SCG clock out configuration (CLKOUTSEL).

`typedef enum _scg_async_clk scg_async_clk_t`  
SCG asynchronous clock type.

`typedef enum _scg_async_clk_div scg_async_clk_div_t`  
SCG asynchronous clock divider value.

`typedef enum _scg_sirc_range scg_sirc_range_t`  
SCG slow IRC clock frequency range.

`typedef struct _scg_sirc_config scg_sirc_config_t`  
SCG slow IRC clock configuration.

`typedef enum _scg_firc_trim_mode scg_firc_trim_mode_t`  
SCG fast IRC trim mode.

`typedef enum _scg_firc_trim_div scg_firc_trim_div_t`  
SCG fast IRC trim predivided value for system OSC.

`typedef enum _scg_firc_trim_src scg_firc_trim_src_t`  
SCG fast IRC trim source.

`typedef struct _scg_firc_trim_config scg_firc_trim_config_t`  
SCG fast IRC clock trim configuration.

`typedef enum _scg_firc_range scg_firc_range_t`  
SCG fast IRC clock frequency range.

`typedef struct _scg_firc_config_t scg_firc_config_t`  
SCG fast IRC clock configuration.

`typedef enum _scg_lpfl_range scg_lpfl_range_t`  
SCG LPFLL clock frequency range.



typedef enum *\_scg\_lpfl\_trim\_mode* scg\_lpfl\_trim\_mode\_t  
SCG LPFLL trim mode.

typedef enum *\_scg\_lpfl\_trim\_src* scg\_lpfl\_trim\_src\_t  
SCG LPFLL trim source.

typedef enum *\_scg\_lpfl\_lock\_mode* scg\_lpfl\_lock\_mode\_t  
SCG LPFLL lock mode.

typedef struct *\_scg\_lpfl\_trim\_config* scg\_lpfl\_trim\_config\_t  
SCG LPFLL clock trim configuration.

typedef struct *\_scg\_lpfl\_config* scg\_lpfl\_config\_t  
SCG low power FLL configuration.

typedef enum *\_scg\_rosc\_monitor\_mode* scg\_rosc\_monitor\_mode\_t  
SCG RTC OSC monitor mode.

typedef struct *\_scg\_rosc\_config* scg\_rosc\_config\_t  
SCG RTC OSC configuration.

volatile uint32\_t g\_xtal0Freq  
External XTAL0 (OSC0/SYSOSC) clock frequency.

The XTAL0/EXTAL0 (OSC0/SYSOSC) clock frequency in Hz. When the clock is set up, use the function `CLOCK_SetXtal0Freq` to set the value in the clock driver. For example, if XTAL0 is 8 MHz:

```
CLOCK_InitSysOsc(...);
CLOCK_SetXtal0Freq(8000000);
```

This is important for the multicore platforms where only one core needs to set up the OSC0/SYSOSC using `CLOCK_InitSysOsc`. All other cores need to call the `CLOCK_SetXtal0Freq` to get a valid clock frequency.

volatile uint32\_t g\_xtal32Freq  
External XTAL32/EXTAL32 clock frequency.

The XTAL32/EXTAL32 clock frequency in Hz. When the clock is set up, use the function `CLOCK_SetXtal32Freq` to set the value in the clock driver.

This is important for the multicore platforms where only one core needs to set up the clock. All other cores need to call the `CLOCK_SetXtal32Freq` to get a valid clock frequency.

static inline void `CLOCK_EnableClock(clock_ip_name_t name)`  
Enable the clock for specific IP.

#### Parameters

- `name` – Which clock to enable, see enumeration `clock_ip_name_t`.

static inline void `CLOCK_DisableClock(clock_ip_name_t name)`  
Disable the clock for specific IP.

#### Parameters

- `name` – Which clock to disable, see enumeration `clock_ip_name_t`.

static inline bool `CLOCK_IsEnabledByOtherCore(clock_ip_name_t name)`  
Check whether the clock is already enabled and configured by any other core.

#### Parameters

- `name` – Which peripheral to check, see enumeration `clock_ip_name_t`.

**Returns**

True if clock is already enabled, otherwise false.

```
static inline void CLOCK_SetIpSrc(clock_ip_name_t name, clock_ip_src_t src)
```

Set the clock source for specific IP module.

Set the clock source for specific IP, not all modules need to set the clock source, should only use this function for the modules need source setting.

**Parameters**

- *name* – Which peripheral to check, see enumeration *clock\_ip\_name\_t*.
- *src* – Clock source to set.

```
static inline void CLOCK_SetIpSrcDiv(clock_ip_name_t name, clock_ip_src_t src, uint8_t
divValue, uint8_t fracValue)
```

Set the clock source and divider for specific IP module.

Set the clock source and divider for specific IP, not all modules need to set the clock source and divider, should only use this function for the modules need source and divider setting.

Divider output clock = Divider input clock x [(fracValue+1)/(divValue+1)].

**Parameters**

- *name* – Which peripheral to check, see enumeration *clock\_ip\_name\_t*.
- *src* – Clock source to set.
- *divValue* – The divider value.
- *fracValue* – The fraction multiply value.

```
uint32_t CLOCK_GetFreq(clock_name_t clockName)
```

Gets the clock frequency for a specific clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in *clock\_name\_t*.

**Parameters**

- *clockName* – Clock names defined in *clock\_name\_t*

**Returns**

Clock frequency value in hertz

```
uint32_t CLOCK_GetCoreSysClkFreq(void)
```

Get the core clock or system clock frequency.

**Returns**

Clock frequency in Hz.

```
uint32_t CLOCK_GetPlatClkFreq(void)
```

Get the platform clock frequency.

**Returns**

Clock frequency in Hz.

```
uint32_t CLOCK_GetBusClkFreq(void)
```

Get the bus clock frequency.

**Returns**

Clock frequency in Hz.

```
uint32_t CLOCK_GetFlashClkFreq(void)
```

Get the flash clock frequency.

**Returns**

Clock frequency in Hz.

uint32\_t CLOCK\_GetOsc32kClkFreq(void)

Get the OSC 32K clock frequency (OSC32KCLK).

**Returns**

Clock frequency in Hz.

uint32\_t CLOCK\_GetExtClkFreq(void)

Get the external clock frequency (EXTCLK).

**Returns**

Clock frequency in Hz.

static inline uint32\_t CLOCK\_GetLpoClkFreq(void)

Get the LPO clock frequency.

**Returns**

Clock frequency in Hz.

uint32\_t CLOCK\_GetIpFreq(*clock\_ip\_name\_t* name)

Gets the functional clock frequency for a specific IP module.

This function gets the IP module's functional clock frequency based on PCC registers. It is only used for the IP modules which could select clock source by PCC[PCS].

**Parameters**

- name – Which peripheral to get, see enumeration clock\_ip\_name\_t.

**Returns**

Clock frequency value in Hz

static inline void CLOCK\_EnableRtcOsc(bool enable)

Enable the RTC Oscillator.

This function enables the Oscillator for RTC external crystal.

**Parameters**

- enable – Enable the Oscillator or not.

bool CLOCK\_EnableUsbfs0Clock(*clock\_usb\_src\_t* src, uint32\_t freq)

Enable USB FS clock.

**Parameters**

- src – USB FS clock source.
- freq – The frequency specified by src.

**Return values**

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB FS clock.

static inline void CLOCK\_DisableUsbfs0Clock(void)

Disable USB FS clock.

Disable USB FS clock.

FSL\_CLOCK\_DRIVER\_VERSION

CLOCK driver version 2.2.1.

SDK\_DEVICE\_MAXIMUM\_CPU\_CLOCK\_FREQUENCY

MAX\_CLOCKS

Clock ip name array for MAX.

EDMA\_CLOCKS

Clock ip name array for EDMA.

FLEXBUS\_CLOCKS

Clock ip name array for FLEXBUS.

FSL\_CLOCK\_XRDC\_GATE\_COUNT

XRDC clock gate number.

XRDC\_CLOCKS

Clock ip name array for XRDC.

SEMA42\_CLOCKS

Clock ip name array for SEMA42.

DMAMUX\_CLOCKS

Clock ip name array for DMAMUX.

MU\_CLOCKS

Clock ip name array for MU.

CRC\_CLOCKS

Clock ip name array for CRC.

LPIT\_CLOCKS

Clock ip name array for LPIT.

TPM\_CLOCKS

Clock ip name array for TPM.

TRNG\_CLOCKS

Clock ip name array for TRNG.

EMVSIM\_CLOCKS

Clock ip name array for SMVSIM.

EWM\_CLOCKS

Clock ip name array for EWM.

FLEXIO\_CLOCKS

Clock ip name array for FLEXIO.

LPI2C\_CLOCKS

Clock ip name array for LPI2C0.

SAI\_CLOCKS

Clock ip name array for SAI.

USDHC\_CLOCKS

Clock ip name array for SDHC.

LPSPi\_CLOCKS

Clock ip name array for LPSPi.

LPUART\_CLOCKS

Clock ip name array for LPUART.

USB\_CLOCKS

Clock ip name array for USB.

PORT\_CLOCKS

Clock ip name array for PORT.

LPADC\_CLOCKS

Clock ip name array for LPADC.

LPDAC\_CLOCKS

Clock ip name array for DAC.

INTMUX\_CLOCKS

Clock ip name array for INTMUX.

EXT\_CLOCKS

Clock ip name array for EXT.

VREF\_CLOCKS

Clock ip name array for VREF.

FGPIO\_CLOCKS

Clock ip name array for FGPIO.

kCLOCK\_FlashClk

LPO\_CLK\_FREQ

MAKE\_PCC\_REGADDR(base, offset)

Peripheral clock name definition used for clock gate, clock source and clock divider setting. It is defined as the corresponding register address.

uint32\_t CLOCK\_GetSysClkFreq(*scg\_sys\_clk\_t* type)

Gets the SCG system clock frequency.

This function gets the SCG system clock frequency. These clocks are used for core, platform, external, and bus clock domains.

#### Parameters

- type – Which type of clock to get, core clock or slow clock.

#### Returns

Clock frequency.

static inline void CLOCK\_SetVlprModeSysClkConfig(const *scg\_sys\_clk\_config\_t* \*config)

Sets the system clock configuration for VLPR mode.

This function sets the system clock configuration for VLPR mode.

#### Parameters

- config – Pointer to the configuration.

static inline void CLOCK\_SetRunModeSysClkConfig(const *scg\_sys\_clk\_config\_t* \*config)

Sets the system clock configuration for RUN mode.

This function sets the system clock configuration for RUN mode.

#### Parameters

- config – Pointer to the configuration.

static inline void CLOCK\_SetHsruntimeModeSysClkConfig(const *scg\_sys\_clk\_config\_t* \*config)

Sets the system clock configuration for HSRUN mode.

This function sets the system clock configuration for HSRUN mode.

#### Parameters

- config – Pointer to the configuration.

static inline void CLOCK\_GetCurSysClkConfig(*scg\_sys\_clk\_config\_t* \*config)

Gets the system clock configuration in the current power mode.

This function gets the system configuration in the current power mode.

#### Parameters

- config – Pointer to the configuration.

static inline void CLOCK\_SetClkOutSel(*clock\_clkout\_src\_t* setting)

Sets the clock out selection.

This function sets the clock out selection (CLKOUTSEL).

#### Parameters

- setting – The selection to set.

#### Returns

The current clock out selection.

*status\_t* CLOCK\_InitSirc(const *scg\_sirc\_config\_t* \*config)

Initializes the SCG slow IRC clock.

This function enables the SCG slow IRC clock according to the configuration.

---

**Note:** This function can't detect whether the system OSC has been enabled and used by an IP.

---

#### Parameters

- config – Pointer to the configuration structure.

#### Return values

- kStatus\_Success – SIRC is initialized.
- kStatus\_SCG\_Busy – SIRC has been enabled and is used by system clock.
- kStatus\_ReadOnly – SIRC control register is locked.

*status\_t* CLOCK\_DeinitSirc(void)

De-initializes the SCG slow IRC.

This function disables the SCG slow IRC.

---

**Note:** This function can't detect whether the SIRC is used by an IP.

---

#### Return values

- kStatus\_Success – SIRC is deinitialized.
- kStatus\_SCG\_Busy – SIRC is used by system clock.
- kStatus\_ReadOnly – SIRC control register is locked.

static inline void CLOCK\_SetSircAsyncClkDiv(*scg\_async\_clk\_t* asyncClk, *scg\_async\_clk\_div\_t* divider)

Set the asynchronous clock divider.

---

**Note:** There might be glitch when changing the asynchronous divider, so make sure the asynchronous clock is not used while changing divider.

---

**Parameters**

- `asyncClk` – Which asynchronous clock to configure.
- `divider` – The divider value to set.

`uint32_t` `CLOCK_GetSircFreq(void)`

Gets the SCG SIRC clock frequency.

**Returns**

Clock frequency; If the clock is invalid, returns 0.

`uint32_t` `CLOCK_GetSircAsyncFreq(scg_async_clk_t type)`

Gets the SCG asynchronous clock frequency from the SIRC.

**Parameters**

- `type` – The asynchronous clock type.

**Returns**

Clock frequency; If the clock is invalid, returns 0.

`static inline bool` `CLOCK_IsSircValid(void)`

Checks whether the SIRC clock is valid.

**Returns**

True if clock is valid, false if not.

`status_t` `CLOCK_InitFirc(const scg_firc_config_t *config)`

Initializes the SCG fast IRC clock.

This function enables the SCG fast IRC clock according to the configuration.

---

**Note:** This function can't detect whether the FIRC has been enabled and used by an IP.

---

**Parameters**

- `config` – Pointer to the configuration structure.

**Return values**

- `kStatus_Success` – FIRC is initialized.
- `kStatus_SCG_Busy` – FIRC has been enabled and is used by the system clock.
- `kStatus_ReadOnly` – FIRC control register is locked.

`status_t` `CLOCK_DeinitFirc(void)`

De-initializes the SCG fast IRC.

This function disables the SCG fast IRC.

---

**Note:** This function can't detect whether the FIRC is used by an IP.

---

**Return values**

- `kStatus_Success` – FIRC is deinitialized.
- `kStatus_SCG_Busy` – FIRC is used by the system clock.
- `kStatus_ReadOnly` – FIRC control register is locked.

```
static inline void CLOCK_SetFircAsyncClkDiv(scg_async_clk_t asyncClk, scg_async_clk_div_t divider)
```

Set the asynchronous clock divider.

---

**Note:** There might be glitch when changing the asynchronous divider, so make sure the asynchronous clock is not used while changing divider.

---

#### Parameters

- *asyncClk* – Which asynchronous clock to configure.
- *divider* – The divider value to set.

```
uint32_t CLOCK_GetFircFreq(void)
```

Gets the SCG FIRC clock frequency.

#### Returns

Clock frequency; If the clock is invalid, returns 0.

```
uint32_t CLOCK_GetFircAsyncFreq(scg_async_clk_t type)
```

Gets the SCG asynchronous clock frequency from the FIRC.

#### Parameters

- *type* – The asynchronous clock type.

#### Returns

Clock frequency; If the clock is invalid, returns 0.

```
static inline bool CLOCK_IsFircErr(void)
```

Checks whether the FIRC clock error occurs.

#### Returns

True if the error occurs, false if not.

```
static inline void CLOCK_ClearFircErr(void)
```

Clears the FIRC clock error.

```
static inline bool CLOCK_IsFircValid(void)
```

Checks whether the FIRC clock is valid.

#### Returns

True if clock is valid, false if not.

```
uint32_t CLOCK_GetRtcOscFreq(void)
```

Gets the SCG RTC OSC clock frequency.

#### Returns

Clock frequency; If the clock is invalid, returns 0.

```
static inline bool CLOCK_IsRtcOscErr(void)
```

Checks whether the RTC OSC clock error occurs.

#### Returns

True if error occurs, false if not.

```
static inline void CLOCK_ClearRtcOscErr(void)
```

Clears the RTC OSC clock error.

```
static inline void CLOCK_SetRtcOscMonitorMode(scg_rosc_monitor_mode_t mode)
```

Sets the RTC OSC monitor mode.

This function sets the RTC OSC monitor mode. The mode can be disabled. It can generate an interrupt when the error is disabled, or reset when the error is detected.



**Parameters**

- mode – Monitor mode to set.

static inline bool CLOCK\_IsRtcOscValid(void)

Checks whether the RTC OSC clock is valid.

**Returns**

True if the clock is valid, false if not.

status\_t CLOCK\_InitLpFll(const scg\_lpfl\_config\_t \*config)

Initializes the SCG LPFLL clock.

This function enables the SCG LPFLL clock according to the configuration.

---

**Note:** This function can't detect whether the LPFLL has been enabled and used by an IP.

---

**Parameters**

- config – Pointer to the configuration structure.

**Return values**

- kStatus\_Success – LPFLL is initialized.
- kStatus\_SCG\_Busy – LPFLL has been enabled and is used by the system clock.
- kStatus\_ReadOnly – LPFLL control register is locked.

status\_t CLOCK\_DeinitLpFll(void)

De-initializes the SCG LPFLL.

This function disables the SCG LPFLL.

---

**Note:** This function can't detect whether the LPFLL is used by an IP.

---

**Return values**

- kStatus\_Success – LPFLL is deinitialized.
- kStatus\_SCG\_Busy – LPFLL is used by the system clock.
- kStatus\_ReadOnly – LPFLL control register is locked.

static inline void CLOCK\_SetLpFllAsyncClkDiv(scg\_async\_clk\_t asyncClk, scg\_async\_clk\_div\_t divider)

Set the asynchronous clock divider.

---

**Note:** There might be glitch when changing the asynchronous divider, so make sure the asynchronous clock is not used while changing divider.

---

**Parameters**

- asyncClk – Which asynchronous clock to configure.
- divider – The divider value to set.

uint32\_t CLOCK\_GetLpFllFreq(void)

Gets the SCG LPFLL clock frequency.

**Returns**

Clock frequency in Hz; If the clock is invalid, returns 0.

uint32\_t CLOCK\_GetLpFllAsyncFreq(*scg\_async\_clk\_t* type)

Gets the SCG asynchronous clock frequency from the LPFLL.

**Parameters**

- type – The asynchronous clock type.

**Returns**

Clock frequency in Hz; If the clock is invalid, returns 0.

static inline bool CLOCK\_IsLpFllValid(void)

Checks whether the LPFLL clock is valid.

**Returns**

True if the clock is valid, false if not.

static inline void CLOCK\_SetXtal0Freq(uint32\_t freq)

Sets the XTAL0 frequency based on board settings.

**Parameters**

- freq – The XTAL0/EXTAL0 input clock frequency in Hz.

static inline void CLOCK\_SetXtal32Freq(uint32\_t freq)

Sets the XTAL32 frequency based on board settings.

**Parameters**

- freq – The XTAL32/EXTAL32 input clock frequency in Hz.

uint32\_t divSlow

Slow clock divider, see *scg\_sys\_clk\_div\_t*.

uint32\_t divBus

Bus clock divider, see *scg\_sys\_clk\_div\_t*.

uint32\_t divExt

External clock divider, see *scg\_sys\_clk\_div\_t*.

uint32\_t \_\_pad0\_\_

Reserved.

uint32\_t divCore

Core clock divider, see *scg\_sys\_clk\_div\_t*.

uint32\_t \_\_pad1\_\_

Reserved.

uint32\_t src

System clock source, see *scg\_sys\_clk\_src\_t*.

uint32\_t \_\_pad2\_\_

reserved.

uint32\_t enableMode

Enable mode, OR'ed value of *\_scg\_sirc\_enable\_mode*.

*scg\_async\_clk\_div\_t* div1

SIRCDIV1 value.

*scg\_async\_clk\_div\_t* div2

SIRCDIV2 value.

*scg\_async\_clk\_div\_t* div3  
SIRCDIV3 value.

*scg\_sirc\_range\_t* range  
Slow IRC frequency range.

*scg\_firc\_trim\_mode\_t* trimMode  
FIRC trim mode.

*scg\_firc\_trim\_src\_t* trimSrc  
Trim source.

uint8\_t trimCoar  
Trim coarse value; Irrelevant if trimMode is kSCG\_FircTrimUpdate.

uint8\_t trimFine  
Trim fine value; Irrelevant if trimMode is kSCG\_FircTrimUpdate.

uint32\_t enableMode  
Enable mode, OR'ed value of *\_scg\_firc\_enable\_mode*.

*scg\_async\_clk\_div\_t* div1  
FIRCDIV1 value.

*scg\_async\_clk\_div\_t* div2  
FIRCDIV2 value.

*scg\_async\_clk\_div\_t* div3  
FIRCDIV3 value.

*scg\_firc\_range\_t* range  
Fast IRC frequency range.

const *scg\_firc\_trim\_config\_t* \*trimConfig  
Pointer to the FIRC trim configuration; set NULL to disable trim.

*scg\_lpfl\_trim\_mode\_t* trimMode  
Trim mode.

*scg\_lpfl\_lock\_mode\_t* lockMode  
Lock mode; Irrelevant if the trimMode is kSCG\_LpFlTrimNonUpdate.

*scg\_lpfl\_trim\_src\_t* trimSrc  
Trim source.

uint8\_t trimDiv  
Trim predivideds value, which can be 0 ~ 31. [ Trim source frequency / (trimDiv + 1) ] must be 2 MHz or 32768 Hz.

uint8\_t trimValue  
Trim value; Irrelevant if trimMode is the kSCG\_LpFlTrimUpdate.

uint8\_t enableMode  
Enable mode, OR'ed value of *\_scg\_lpfl\_enable\_mode*

*scg\_async\_clk\_div\_t* div1  
LPFLLDIV1 value.

*scg\_async\_clk\_div\_t* div2  
LPFLLDIV2 value.

*scg\_async\_clk\_div\_t* div3  
LPFLLDIV3 value.

*scg\_lpfl\_range\_t* range

LPFLL frequency range.

const *scg\_lpfl\_trim\_config\_t* \*trimConfig

Trim configuration; set NULL to disable trim.

*scg\_rosc\_monitor\_mode\_t* monitorMode

Clock monitor mode selected.

FSL\_SDK\_DISABLE\_DRIVER\_CLOCK\_CONTROL

Configure whether driver controls clock.

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

---

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

---

struct *\_scg\_sys\_clk\_config*

#include <fsl\_clock.h> SCG system clock configuration.

struct *\_scg\_sirc\_config*

#include <fsl\_clock.h> SCG slow IRC clock configuration.

struct *\_scg\_firc\_trim\_config*

#include <fsl\_clock.h> SCG fast IRC clock trim configuration.

struct *\_scg\_firc\_config\_t*

#include <fsl\_clock.h> SCG fast IRC clock configuration.

struct *\_scg\_lpfl\_trim\_config*

#include <fsl\_clock.h> SCG LPFLL clock trim configuration.

struct *\_scg\_lpfl\_config*

#include <fsl\_clock.h> SCG low power FLL configuration.

struct *\_scg\_rosc\_config*

#include <fsl\_clock.h> SCG RTC OSC configuration.

## 2.11 CRC: Cyclic Redundancy Check Driver

FSL\_CRC\_DRIVER\_VERSION

CRC driver version. Version 2.0.4.

Current version: 2.0.4

Change log:

- Version 2.0.4
  - Release peripheral from reset if necessary in init function.
- Version 2.0.3
  - Fix MISRA issues
- Version 2.0.2
  - Fix MISRA issues

- Version 2.0.1
  - move DATA and DATALL macro definition from header file to source file

enum `_crc_bits`

CRC bit width.

*Values:*

enumerator `kCrcBits16`

Generate 16-bit CRC code

enumerator `kCrcBits32`

Generate 32-bit CRC code

enum `_crc_result`

CRC result type.

*Values:*

enumerator `kCrcFinalChecksum`

CRC data register read value is the final checksum. Reflect out and final xor protocol features are applied.

enumerator `kCrcIntermediateChecksum`

CRC data register read value is intermediate checksum (raw value). Reflect out and final xor protocol feature are not applied. Intermediate checksum can be used as a seed for `CRC_Init()` to continue adding data to this checksum.

typedef enum `_crc_bits` `crc_bits_t`

CRC bit width.

typedef enum `_crc_result` `crc_result_t`

CRC result type.

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 function enables the clock gate in the SIM module for the CRC peripheral. It also configures the CRC module and starts a 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 function disables the clock gate in the SIM module for the CRC peripheral.

#### Parameters

- `base` – CRC peripheral address.

void `CRC_GetDefaultConfig(crc_config_t *config)`

Loads default values to the CRC protocol configuration structure.

Loads default values to the CRC protocol configuration structure. The default values are as follows.

```

config->polynomial = 0x1021;
config->seed = 0xFFFF;
config->reflectIn = false;
config->reflectOut = false;
config->complementChecksum = false;
config->crcBits = kCrcBits16;
config->crcResult = kCrcFinalChecksum;

```

### Parameters

- 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 the CRC data register. The configured type of transpose is applied.

### Parameters

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

uint32\_t CRC\_Get32bitResult(CRC\_Type \*base)

Reads the 32-bit checksum from the CRC module.

Reads the CRC data register (either an intermediate or the final checksum). The configured type of transpose and complement is applied.

### Parameters

- base – CRC peripheral address.

### Returns

An intermediate or the final 32-bit checksum, after configured transpose and complement operations.

uint16\_t CRC\_Get16bitResult(CRC\_Type \*base)

Reads a 16-bit checksum from the CRC module.

Reads the CRC data register (either an intermediate or the final checksum). The configured type of transpose and complement is applied.

### Parameters

- base – CRC peripheral address.

### Returns

An intermediate or the final 16-bit checksum, after configured transpose and complement operations.

CRC\_DRIVER\_USE\_CRC16\_CCIT\_FALSE\_AS\_DEFAULT

Default configuration structure filled by CRC\_GetDefaultConfig(). Use CRC16-CCIT-FALSE as default.

struct \_crc\_config

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

This structure holds the configuration for the CRC protocol.

### Public Members

uint32\_t polynomial

CRC Polynomial, MSBit first. Example polynomial: 0x1021 = 1\_0000\_0010\_0001 =  $x^{12}+x^5+1$

uint32\_t seed

Starting checksum value

bool reflectIn

Reflect bits on input.

bool reflectOut

Reflect bits on output.

bool complementChecksum

True if the result shall be complement of the actual checksum.

crc\_bits\_t crcBits

Selects 16- or 32- bit CRC protocol.

crc\_result\_t crcResult

Selects final or intermediate checksum return from CRC\_Get16bitResult() or CRC\_Get32bitResult()

## 2.12 DAC: Digital-to-Analog Converter Driver

void DAC\_Init(LPDAC\_Type \*base, const dac\_config\_t \*config)

Initialize the DAC module with common configuration.

The clock will be enabled in this function.

### Parameters

- base – DAC peripheral base address.
- config – Pointer to configuration structure.

void DAC\_GetDefaultConfig(dac\_config\_t \*config)

Get the default settings for initialization's configuration.

This function initializes the user configuration structure to a default value. The default values are:

```
config->fifoWatermarkLevel = 0U;
config->fifoTriggerMode = kDAC_FIFOTriggerByHardwareMode;
config->fifoWorkMode = kDAC_FIFODisabled;
config->enableLowPowerMode = false;
config->referenceVoltageSource = kDAC_ReferenceVoltageSourceAlt1;
```

### Parameters

- config – Pointer to configuration structure.

void DAC\_Deinit(LPDAC\_Type \*base)

De-initialize the DAC module.

The clock will be disabled in this function.

### Parameters

- base – DAC peripheral base address.

static inline void DAC\_SetReset(LPDAC\_Type \*base, uint32\_t mask)

Assert the reset control to part hardware.

This function is to assert the reset control to part hardware. Responding part hardware would remain reset until cleared by software.

**Parameters**

- base – DAC peripheral base address.
- mask – The reset control mask, see to `_dac_reset_control_t`.

static inline void DAC\_ClearReset(LPDAC\_Type \*base, uint32\_t mask)

Clear the reset control to part hardware.

This function is to clear the reset control to part hardware. Responding part hardware would work after the reset control is cleared by software.

**Parameters**

- base – DAC peripheral base address.
- mask – The reset control mask, see to `_dac_reset_control_t`.

static inline void DAC\_Enable(LPDAC\_Type \*base, bool enable)

Enable the DAC hardware system or not.

This function is to start the Programmable Reference Generator operation or not.

**Parameters**

- base – DAC peripheral base address.
- enable – Assertion of indicated event.

static inline void DAC\_EnableInterrupts(LPDAC\_Type \*base, uint32\_t mask)

Enable the interrupts.

**Parameters**

- base – DAC peripheral base address.
- mask – Mask value of indicated interrupt events. See to `_dac_interrupt_enable`.

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

Disable the interrupts.

**Parameters**

- base – DAC peripheral base address.
- mask – Mask value of indicated interrupt events. See to `_dac_interrupt_enable`.

static inline void DAC\_EnableDMA(LPDAC\_Type \*base, uint32\_t mask, bool enable)

Enable the DMA switchers or not.

**Parameters**

- base – DAC peripheral base address.
- mask – Mask value of indicated DMA request. See to `_dac_dma_enable`.
- enable – Enable the DMA or not.

static inline uint32\_t DAC\_GetStatusFlags(LPDAC\_Type \*base)

Get status flags of DAC module.

**Parameters**



- base – DAC peripheral base address.

**Returns**

Mask value of status flags. See to `_dac_status_flags`.

static inline void DAC\_ClearStatusFlags(LPDAC\_Type \*base, uint32\_t flags)

Clear status flags of DAC module.

**Parameters**

- base – DAC peripheral base address.
- flags – Mask value of status flags to be cleared. See to `_dac_status_flags`.

static inline void DAC\_SetData(LPDAC\_Type \*base, uint32\_t value)

Set data into the entry of FIFO buffer.

**Parameters**

- base – DAC peripheral base address.
- value – Setting value into FIFO buffer.

static inline uint32\_t DAC\_GetFIFOWritePointer(LPDAC\_Type \*base)

Get the value of the FIFO write pointer.

**Parameters**

- base – DAC peripheral base address.

**Returns**

Current value of the FIFO write pointer.

static inline uint32\_t DAC\_GetFIFOReadPointer(LPDAC\_Type \*base)

Get the value of the FIFO read pointer.

**Parameters**

- base – DAC peripheral base address.

**Returns**

Current value of the FIFO read pointer.

static inline void DAC\_DoSoftwareTriggerFIFO(LPDAC\_Type \*base)

Do software trigger to FIFO when in software mode.

**Parameters**

- base – DAC peripheral base address.

FSL\_DAC\_DRIVER\_VERSION

DAC driver version 2.1.2.

DAC reset control.

*Values:*

enumerator kDAC\_ResetFIFO

Resets the FIFO pointers and flags.

enumerator kDAC\_ResetLogic

Resets all DAC registers and internal logic.

DAC interrupts.

*Values:*

enumerator kDAC\_FIFOFullInterruptEnable

FIFO full interrupt enable.

enumerator kDAC\_FIFOEmptyInterruptEnable

FIFO empty interrupt enable.

enumerator kDAC\_FIFOWatermarkInterruptEnable

FIFO watermark interrupt enable.

enumerator kDAC\_SwingBackInterruptEnable

Swing back one cycle complete interrupt enable.

enumerator kDAC\_FIFOOverflowInterruptEnable

FIFO overflow interrupt enable.

enumerator kDAC\_FIFOUnderflowInterruptEnable

FIFO underflow interrupt enable.

DAC DMA switchers.

*Values:*

enumerator kDAC\_FIFOEmptyDMAEnable

FIFO empty DMA enable.

enumerator kDAC\_FIFOWatermarkDMAEnable

FIFO watermark DMA enable.

DAC status flags.

*Values:*

enumerator kDAC\_FIFOUnderflowFlag

This flag means that there is a new trigger after the buffer is empty. The FIFO read pointer will not increase in this case and the data sent to DAC analog conversion will not changed. This flag is cleared by writing a 1 to it.

enumerator kDAC\_FIFOOverflowFlag

This flag indicates that data is intended to write into FIFO after the buffer is full. The writer pointer will not increase in this case. The extra data will not be written into the FIFO. This flag is cleared by writing a 1 to it.

enumerator kDAC\_FIFOSwingBackFlag

This flag indicates that the DAC has completed one period of conversion in swing back mode. It means that the read pointer has increased to the top (write pointer) once and then decreased to zero once. For example, after three data is written to FIFO, the writer pointer is now 3. Then, if continually triggered, the read pointer will swing like: 0-1-2-1-0-1-2-, and so on. After the fourth trigger, the flag is set. This flag is cleared by writing a 1 to it.

enumerator kDAC\_FIFOWatermarkFlag

This field is set if the remaining data in FIFO is less than or equal to the setting value of watermark. By writing data into FIFO by DMA or CPU, this flag is cleared automatically when the data in FIFO is more than the setting value of watermark.

enumerator kDAC\_FIFOEmptyFlag

FIFO empty flag.

enumerator kDAC\_FIFOFullFlag

FIFO full flag.

enum `_dac_fifo_trigger_mode`

DAC FIFO trigger mode.

*Values:*

enumerator `kDAC_FIFOTriggerByHardwareMode`

Buffer would be triggered by hardware.

enumerator `kDAC_FIFOTriggerBySoftwareMode`

Buffer would be triggered by software.

enum `_dac_fifo_work_mode`

DAC FIFO work mode.

*Values:*

enumerator `kDAC_FIFODisabled`

FIFO mode is disabled and buffer mode is enabled. Any data written to DATA[DATA] goes to buffer then goes to conversion.

enumerator `kDAC_FIFOWorkAsNormalMode`

FIFO mode is enabled. Data will be first read from FIFO to buffer then goes to conversion.

enumerator `kDAC_FIFOWorkAsSwingMode`

In swing mode, the read pointer swings between the writer pointer and zero. That is, the trigger increases the read pointer till reach the writer pointer and decreases the read pointer till zero, and so on. The FIFO empty/full/watermark flag will not update during swing back mode.

enum `_dac_reference_voltage_source`

DAC reference voltage source.

*Values:*

enumerator `kDAC_ReferenceVoltageSourceAlt1`

The DAC selects VREFH\_INT as the reference voltage.

enumerator `kDAC_ReferenceVoltageSourceAlt2`

The DAC selects VREFH\_EXT as the reference voltage.

typedef enum `_dac_fifo_trigger_mode` `dac_fifo_trigger_mode_t`

DAC FIFO trigger mode.

typedef enum `_dac_fifo_work_mode` `dac_fifo_work_mode_t`

DAC FIFO work mode.

typedef enum `_dac_reference_voltage_source` `dac_reference_voltage_source_t`

DAC reference voltage source.

typedef struct `_dac_config` `dac_config_t`

DAC configuration structure.

struct `_dac_config`

*#include <fsl\_dac.h>* DAC configuration structure.

### Public Members

uint32\_t `fifoWatermarkLevel`

FIFO's watermark, the max value can be the hardware FIFO size.

*dac\_fifo\_trigger\_mode\_t* fifoTriggerMode

Select the trigger mode for FIFO.

*dac\_fifo\_work\_mode\_t* fifoWorkMode

Select the work mode for FIFO.

bool enableLowPowerMode

Enable the low power mode.

*dac\_reference\_voltage\_source\_t* referenceVoltageSource

Select the reference voltage source.

## 2.13 DMAMUX: Direct Memory Access Multiplexer Driver

void DMAMUX\_Init(DMAMUX\_Type \*base)

Initializes the DMAMUX peripheral.

This function ungates the DMAMUX clock.

### Parameters

- base – DMAMUX peripheral base address.

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

Deinitializes the DMAMUX peripheral.

This function gates the DMAMUX clock.

### Parameters

- base – DMAMUX peripheral base address.

static inline void DMAMUX\_EnableChannel(DMAMUX\_Type \*base, uint32\_t channel)

Enables the DMAMUX channel.

This function enables the DMAMUX channel.

### Parameters

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

static inline void DMAMUX\_DisableChannel(DMAMUX\_Type \*base, uint32\_t channel)

Disables the DMAMUX channel.

This function disables the DMAMUX channel.

---

**Note:** The user must disable the DMAMUX channel before configuring it.

---

### Parameters

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

static inline void DMAMUX\_SetSource(DMAMUX\_Type \*base, uint32\_t channel, int32\_t source)

Configures the DMAMUX channel source.

### Parameters

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

- `source` – Channel source, which is used to trigger the DMA transfer. User need to use the `dma_request_source_t` type as the input parameter.

`static inline void DMAMUX_EnablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)`

Enables the DMAMUX period trigger.

This function enables the DMAMUX period trigger feature.

#### Parameters

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

`static inline void DMAMUX_DisablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)`

Disables the DMAMUX period trigger.

This function disables the DMAMUX period trigger.

#### Parameters

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

`static inline void DMAMUX_EnableAlwaysOn(DMAMUX_Type *base, uint32_t channel, bool enable)`

Enables the DMA channel to be always ON.

This function enables the DMAMUX channel always ON feature.

#### Parameters

- `base` – DMAMUX peripheral base address.
- `channel` – DMAMUX channel number.
- `enable` – Switcher of the always ON feature. “true” means enabled, “false” means disabled.

`FSL_DMAMUX_DRIVER_VERSION`

DMAMUX driver version 2.1.1.

## 2.14 eDMA: Enhanced Direct Memory Access (eDMA) Controller Driver

`void EDMA_Init(DMA_Type *base, const edma_config_t *config)`

Initializes the eDMA peripheral.

This function ungates the eDMA clock and configures the eDMA peripheral according to the configuration structure. All emda enabled request will be cleared in this function.

---

**Note:** This function enables the minor loop map feature.

---

#### Parameters

- `base` – eDMA peripheral base address.
- `config` – A pointer to the configuration structure, see “`edma_config_t`”.

`void EDMA_Deinit(DMA_Type *base)`

Deinitializes the eDMA peripheral.

This function gates the eDMA clock.

#### Parameters

- `base` – eDMA peripheral base address.

`void EDMA_InstallTCD(DMA_Type *base, uint32_t channel, edma_tcd_t *tcd)`

Push content of TCD structure into hardware TCD register.

#### Parameters

- `base` – EDMA peripheral base address.
- `channel` – EDMA channel number.
- `tcd` – Point to TCD structure.

`void EDMA_GetDefaultConfig(edma_config_t *config)`

Gets the eDMA default configuration structure.

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
config.enableContinuousLinkMode = false;
config.enableHaltOnError = true;
config.enableRoundRobinArbitration = false;
config.enableDebugMode = false;
```

#### Parameters

- `config` – A pointer to the eDMA configuration structure.

`static inline void EDMA_EnableContinuousChannelLinkMode(DMA_Type *base, bool enable)`

Enable/Disable continuous channel link mode.

---

**Note:** Do not use continuous link mode with a channel linking to itself if there is only one minor loop iteration per service request, for example, if the channel's NBYTES value is the same as either the source or destination size. The same data transfer profile can be achieved by simply increasing the NBYTES value, which provides more efficient, faster processing.

---

#### Parameters

- `base` – EDMA peripheral base address.
- `enable` – true is enable, false is disable.

`static inline void EDMA_EnableMinorLoopMapping(DMA_Type *base, bool enable)`

Enable/Disable minor loop mapping.

The `TCDn.word2` is redefined to include individual enable fields, an offset field, and the NBYTES field.

#### Parameters

- `base` – EDMA peripheral base address.
- `enable` – true is enable, false is disable.

void EDMA\_ResetChannel(DMA\_Type \*base, uint32\_t channel)

Sets all TCD registers to default values.

This function sets TCD registers for this channel to default values.

---

**Note:** This function must not be called while the channel transfer is ongoing or it causes unpredictable results.

---

---

**Note:** This function enables the auto stop request feature.

---

### Parameters

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

void EDMA\_SetTransferConfig(DMA\_Type \*base, uint32\_t channel, const *edma\_transfer\_config\_t* \*config, *edma\_tcd\_t* \*nextTcd)

Configures the eDMA transfer attribute.

This function configures the transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the TCD address. Example:

```
edma_transfer_t config;
edma_tcd_t tcd;
config.srcAddr = ..;
config.destAddr = ..;
...
EDMA_SetTransferConfig(DMA0, channel, &config, &stcd);
```

---

**Note:** If nextTcd is not NULL, it means scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the EDMA\_ResetChannel.

---

### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- config – Pointer to eDMA transfer configuration structure.
- nextTcd – Point to TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

void EDMA\_SetMinorOffsetConfig(DMA\_Type \*base, uint32\_t channel, const *edma\_minor\_offset\_config\_t* \*config)

Configures the eDMA minor offset feature.

The minor offset means that the signed-extended value is added to the source address or destination address after each minor loop.

### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- config – A pointer to the minor offset configuration structure.

```
void EDMA_SetChannelPreemptionConfig(DMA_Type *base, uint32_t channel, const
 edma_channel_preemption_config_t *config)
```

Configures the eDMA channel preemption feature.

This function configures the channel preemption attribute and the priority of the channel.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number
- config – A pointer to the channel preemption configuration structure.

```
void EDMA_SetChannelLink(DMA_Type *base, uint32_t channel, edma_channel_link_type_t
 linkType, uint32_t linkedChannel)
```

Sets the channel link for the eDMA transfer.

This function configures either the minor link or the major link mode. The minor link means that the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

---

**Note:** Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

---

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- linkType – A channel link type, which can be one of the following:
  - kEDMA\_LinkNone
  - kEDMA\_MinorLink
  - kEDMA\_MajorLink
- linkedChannel – The linked channel number.

```
void EDMA_SetBandWidth(DMA_Type *base, uint32_t channel, edma_bandwidth_t bandWidth)
```

Sets the bandwidth for the eDMA transfer.

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- bandWidth – A bandwidth setting, which can be one of the following:
  - kEDMABandwidthStallNone
  - kEDMABandwidthStall4Cycle
  - kEDMABandwidthStall8Cycle

```
void EDMA_SetModulo(DMA_Type *base, uint32_t channel, edma_modulo_t srcModulo,
 edma_modulo_t destModulo)
```



Sets the source modulo and the destination modulo for the eDMA transfer.

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- srcModulo – A source modulo value.
- destModulo – A destination modulo value.

```
static inline void EDMA_EnableAsyncRequest(DMA_Type *base, uint32_t channel, bool enable)
```

Enables an async request for the eDMA transfer.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- enable – The command to enable (true) or disable (false).

```
static inline void EDMA_EnableAutoStopRequest(DMA_Type *base, uint32_t channel, bool enable)
```

Enables an auto stop request for the eDMA transfer.

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- enable – The command to enable (true) or disable (false).

```
void EDMA_EnableChannelInterrupts(DMA_Type *base, uint32_t channel, uint32_t mask)
```

Enables the interrupt source for the eDMA transfer.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- mask – The mask of interrupt source to be set. Users need to use the defined `edma_interrupt_enable_t` type.

```
void EDMA_DisableChannelInterrupts(DMA_Type *base, uint32_t channel, uint32_t mask)
```

Disables the interrupt source for the eDMA transfer.

#### Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- mask – The mask of the interrupt source to be set. Use the defined `edma_interrupt_enable_t` type.

```
void EDMA_SetMajorOffsetConfig(DMA_Type *base, uint32_t channel, int32_t sourceOffset,
 int32_t destOffset)
```

Configures the eDMA channel TCD major offset feature.

Adjustment value added to the source address at the completion of the major iteration count

#### Parameters

- `base` – eDMA peripheral base address.
- `channel` – edma channel number.
- `sourceOffset` – source address offset will be applied to source address after major loop done.
- `destOffset` – destination address offset will be applied to source address after major loop done.

```
void EDMA_TcdReset(edma_tcd_t *tcd)
```

Sets all fields to default values for the TCD structure.

This function sets all fields for this TCD structure to default value.

---

**Note:** This function enables the auto stop request feature.

---

#### Parameters

- `tcd` – Pointer to the TCD structure.

```
void EDMA_TcdSetTransferConfig(edma_tcd_t *tcd, const edma_transfer_config_t *config,
 edma_tcd_t *nextTcd)
```

Configures the eDMA TCD transfer attribute.

The TCD is a transfer control descriptor. The content of the TCD is the same as the hardware TCD registers. The TCD is used in the scatter-gather mode. This function configures the TCD transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the next TCD address. Example:

```
edma_transfer_t config = {
 ...
}
edma_tcd_t tcd __aligned(32);
edma_tcd_t nextTcd __aligned(32);
EDMA_TcdSetTransferConfig(&tcd, &config, &nextTcd);
```

---

**Note:** TCD address should be 32 bytes aligned or it causes an eDMA error.

---

---

**Note:** If the `nextTcd` is not NULL, the scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the `EDMA_TcdReset`.

---

#### Parameters

- `tcd` – Pointer to the TCD structure.
- `config` – Pointer to eDMA transfer configuration structure.
- `nextTcd` – Pointer to the next TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

```
void EDMA__TcdSetMinorOffsetConfig(edma_tcd_t *tcd, const edma_minor_offset_config_t
 *config)
```

Configures the eDMA TCD minor offset feature.

A minor offset is a signed-extended value added to the source address or a destination address after each minor loop.

#### Parameters

- tcd – A point to the TCD structure.
- config – A pointer to the minor offset configuration structure.

```
void EDMA__TcdSetChannelLink(edma_tcd_t *tcd, edma_channel_link_type_t linkType, uint32_t
 linkedChannel)
```

Sets the channel link for the eDMA TCD.

This function configures either a minor link or a major link. The minor link means the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

---

**Note:** Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

---

#### Parameters

- tcd – Point to the TCD structure.
- linkType – Channel link type, it can be one of:
  - kEDMA\_LinkNone
  - kEDMA\_MinorLink
  - kEDMA\_MajorLink
- linkedChannel – The linked channel number.

```
static inline void EDMA__TcdSetBandWidth(edma_tcd_t *tcd, edma_bandwidth_t bandWidth)
```

Sets the bandwidth for the eDMA TCD.

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

#### Parameters

- tcd – A pointer to the TCD structure.
- bandWidth – A bandwidth setting, which can be one of the following:
  - kEDMABandwidthStallNone
  - kEDMABandwidthStall4Cycle
  - kEDMABandwidthStall8Cycle

```
void EDMA__TcdSetModulo(edma_tcd_t *tcd, edma_modulo_t srcModulo, edma_modulo_t
 destModulo)
```

Sets the source modulo and the destination modulo for the eDMA TCD.

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

#### Parameters

- `tcd` – A pointer to the TCD structure.
- `srcModulo` – A source modulo value.
- `destModulo` – A destination modulo value.

`static inline void EDMA__TcdEnableAutoStopRequest(edma_tcd_t *tcd, bool enable)`

Sets the auto stop request for the eDMA TCD.

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

#### Parameters

- `tcd` – A pointer to the TCD structure.
- `enable` – The command to enable (true) or disable (false).

`void EDMA__TcdEnableInterrupts(edma_tcd_t *tcd, uint32_t mask)`

Enables the interrupt source for the eDMA TCD.

#### Parameters

- `tcd` – Point to the TCD structure.
- `mask` – The mask of interrupt source to be set. Users need to use the defined `edma_interrupt_enable_t` type.

`void EDMA__TcdDisableInterrupts(edma_tcd_t *tcd, uint32_t mask)`

Disables the interrupt source for the eDMA TCD.

#### Parameters

- `tcd` – Point to the TCD structure.
- `mask` – The mask of interrupt source to be set. Users need to use the defined `edma_interrupt_enable_t` type.

`void EDMA__TcdSetMajorOffsetConfig(edma_tcd_t *tcd, int32_t sourceOffset, int32_t destOffset)`

Configures the eDMA TCD major offset feature.

Adjustment value added to the source address at the completion of the major iteration count

#### Parameters

- `tcd` – A point to the TCD structure.
- `sourceOffset` – source address offset will be applied to source address after major loop done.
- `destOffset` – destination address offset will be applied to source address after major loop done.

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

Enables the eDMA hardware channel request.

This function enables the hardware channel request.

#### Parameters

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

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

Disables the eDMA hardware channel request.

This function disables the hardware channel request.

#### Parameters

- `base` – eDMA peripheral base address.

- channel – eDMA channel number.

static inline void EDMA\_TriggerChannelStart(DMA\_Type \*base, uint32\_t channel)

Starts the eDMA transfer by using the software trigger.

This function starts a minor loop transfer.

#### Parameters

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

uint32\_t EDMA\_GetRemainingMajorLoopCount(DMA\_Type \*base, uint32\_t channel)

Gets the remaining major loop count from the eDMA current channel TCD.

This function checks the TCD (Task Control Descriptor) status for a specified eDMA channel and returns the number of major loop count that has not finished.

---

**Note:** 1. This function can only be used to get unfinished major loop count of transfer without the next TCD, or it might be inaccurate.

- a. The unfinished/remaining transfer bytes cannot be obtained directly from registers while the channel is running. Because to calculate the remaining bytes, the initial NBYTES configured in DMA\_TCDn\_NBYTES\_MLNO register is needed while the eDMA IP does not support getting it while a channel is active. In another word, the NBYTES value reading is always the actual (decrementing) NBYTES value the dma\_engine is working with while a channel is running. Consequently, to get the remaining transfer bytes, a software-saved initial value of NBYTES (for example copied before enabling the channel) is needed. The formula to calculate it is shown below:  $\text{RemainingBytes} = \text{RemainingMajorLoopCount} * \text{NBYTES}(\text{initially configured})$
- 

#### Parameters

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

#### Returns

Major loop count which has not been transferred yet for the current TCD.

static inline uint32\_t EDMA\_GetErrorStatusFlags(DMA\_Type \*base)

Gets the eDMA channel error status flags.

#### Parameters

- base – eDMA peripheral base address.

#### Returns

The mask of error status flags. Users need to use the `_edma_error_status_flags` type to decode the return variables.

uint32\_t EDMA\_GetChannelStatusFlags(DMA\_Type \*base, uint32\_t channel)

Gets the eDMA channel status flags.

#### Parameters

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

#### Returns

The mask of channel status flags. Users need to use the `_edma_channel_status_flags` type to decode the return variables.

`void EDMA__ClearChannelStatusFlags(DMA_Type *base, uint32_t channel, uint32_t mask)`

Clears the eDMA channel status flags.

**Parameters**

- `base` – eDMA peripheral base address.
- `channel` – eDMA channel number.
- `mask` – The mask of channel status to be cleared. Users need to use the defined `_edma_channel_status_flags` type.

`void EDMA__CreateHandle(edma_handle_t *handle, DMA_Type *base, uint32_t channel)`

Creates the eDMA handle.

This function is called if using the transactional API for eDMA. This function initializes the internal state of the eDMA handle.

**Parameters**

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

`void EDMA__InstallTCDMemory(edma_handle_t *handle, edma_tcd_t *tcdPool, uint32_t tcdSize)`

Installs the TCDs memory pool into the eDMA handle.

This function is called after the `EDMA_CreateHandle` to use scatter/gather feature. This function shall only be used while users need to use scatter gather mode. Scatter gather mode enables EDMA to load a new transfer control block (tcd) in hardware, and automatically reconfigure that DMA channel for a new transfer. Users need to prepare tcd memory and also configure tcds using interface `EDMA_SubmitTransfer`.

**Parameters**

- `handle` – eDMA handle pointer.
- `tcdPool` – A memory pool to store TCDs. It must be 32 bytes aligned.
- `tcdSize` – The number of TCD slots.

`void EDMA__SetCallback(edma_handle_t *handle, edma_callback callback, void *userData)`

Installs a callback function for the eDMA transfer.

This callback is called in the eDMA IRQ handler. Use the callback to do something after the current major loop transfer completes. This function will be called every time one tcd finished transfer.

**Parameters**

- `handle` – eDMA handle pointer.
- `callback` – eDMA callback function pointer.
- `userData` – A parameter for the callback function.

`void EDMA__PrepareTransferConfig(edma_transfer_config_t *config, void *srcAddr, uint32_t srcWidth, int16_t srcOffset, void *destAddr, uint32_t destWidth, int16_t destOffset, uint32_t bytesEachRequest, uint32_t transferBytes)`

Prepares the eDMA transfer structure configurations.

This function prepares the transfer configuration structure according to the user input.

---

**Note:** The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

---

### Parameters

- `config` – The user configuration structure of type `edma_transfer_t`.
- `srcAddr` – eDMA transfer source address.
- `srcWidth` – eDMA transfer source address width(bytes).
- `srcOffset` – source address offset.
- `destAddr` – eDMA transfer destination address.
- `destWidth` – eDMA transfer destination address width(bytes).
- `destOffset` – destination address offset.
- `bytesEachRequest` – eDMA transfer bytes per channel request.
- `transferBytes` – eDMA transfer bytes to be transferred.

```
void EDMA__PrepareTransfer(edma_transfer_config_t *config, void *srcAddr, uint32_t srcWidth,
 void *destAddr, uint32_t destWidth, uint32_t bytesEachRequest,
 uint32_t transferBytes, edma_transfer_type_t transferType)
```

Prepares the eDMA transfer structure.

This function prepares the transfer configuration structure according to the user input.

---

**Note:** The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

---

### Parameters

- `config` – The user configuration structure of type `edma_transfer_t`.
- `srcAddr` – eDMA transfer source address.
- `srcWidth` – eDMA transfer source address width(bytes).
- `destAddr` – eDMA transfer destination address.
- `destWidth` – eDMA transfer destination address width(bytes).
- `bytesEachRequest` – eDMA transfer bytes per channel request.
- `transferBytes` – eDMA transfer bytes to be transferred.
- `transferType` – eDMA transfer type.

```
status_t EDMA__SubmitTransfer(edma_handle_t *handle, const edma_transfer_config_t *config)
```

Submits the eDMA transfer request.

This function submits the eDMA transfer request according to the transfer configuration structure. In scatter gather mode, call this function will add a configured tcd to the circular list of tcd pool. The tcd pools is setup by call function `EDMA_InstallTCDMemory` before.

### Parameters

- `handle` – eDMA handle pointer.
- `config` – Pointer to eDMA transfer configuration structure.

### Return values

- `kStatus_EDMA_Success` – It means submit transfer request succeed.
- `kStatus_EDMA_QueueFull` – It means TCD queue is full. Submit transfer request is not allowed.
- `kStatus_EDMA_Busy` – It means the given channel is busy, need to submit request later.

`void EDMA_StartTransfer(edma_handle_t *handle)`

eDMA starts transfer.

This function enables the channel request. Users can call this function after submitting the transfer request or before submitting the transfer request.

#### Parameters

- `handle` – eDMA handle pointer.

`void EDMA_StopTransfer(edma_handle_t *handle)`

eDMA stops transfer.

This function disables the channel request to pause the transfer. Users can call `EDMA_StartTransfer()` again to resume the transfer.

#### Parameters

- `handle` – eDMA handle pointer.

`void EDMA_AbortTransfer(edma_handle_t *handle)`

eDMA aborts transfer.

This function disables the channel request and clear transfer status bits. Users can submit another transfer after calling this API.

#### Parameters

- `handle` – DMA handle pointer.

`static inline uint32_t EDMA_GetUnusedTCDNumber(edma_handle_t *handle)`

Get unused TCD slot number.

This function gets current tcd index which is run. If the TCD pool pointer is NULL, it will return 0.

#### Parameters

- `handle` – DMA handle pointer.

#### Returns

The unused tcd slot number.

`static inline uint32_t EDMA_GetNextTCDAddress(edma_handle_t *handle)`

Get the next tcd address.

This function gets the next tcd address. If this is last TCD, return 0.

#### Parameters

- `handle` – DMA handle pointer.

#### Returns

The next TCD address.

`void EDMA_HandleIRQ(edma_handle_t *handle)`

eDMA IRQ handler for the current major loop transfer completion.

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



Note: For the case using TCD queue, when the major iteration count is exhausted, additional operations are performed. These include the final address adjustments and reloading of the BITER field into the CITER. Assertion of an optional interrupt request also occurs at this time, as does a possible fetch of a new TCD from memory using the scatter/gather address pointer included in the descriptor (if scatter/gather is enabled).

For instance, when the time interrupt of TCD[0] happens, the TCD[1] has already been loaded into the eDMA engine. As sga and sga\_index are calculated based on the DLAST\_SGA bitfield lies in the TCD\_CSR register, the sga\_index in this case should be 2 (DLAST\_SGA of TCD[1] stores the address of TCD[2]). Thus, the “tcdUsed” updated should be (tcdUsed - 2U) which indicates the number of TCDs can be loaded in the memory pool (because TCD[0] and TCD[1] have been loaded into the eDMA engine at this point already.).

For the last two continuous ISRs in a scatter/gather process, they both load the last TCD (The last ISR does not load a new TCD) from the memory pool to the eDMA engine when major loop completes. Therefore, ensure that the header and tcdUsed updated are identical for them. tcdUsed are both 0 in this case as no TCD to be loaded.

See the “eDMA basic data flow” in the eDMA Functional description section of the Reference Manual for further details.

### Parameters

- handle – eDMA handle pointer.

FSL\_EDMA\_DRIVER\_VERSION

eDMA driver version

Version 2.4.5.

enum \_edma\_transfer\_size

eDMA transfer configuration

*Values:*

enumerator kEDMA\_TransferSize1Bytes

Source/Destination data transfer size is 1 byte every time

enumerator kEDMA\_TransferSize2Bytes

Source/Destination data transfer size is 2 bytes every time

enumerator kEDMA\_TransferSize4Bytes

Source/Destination data transfer size is 4 bytes every time

enumerator kEDMA\_TransferSize8Bytes

Source/Destination data transfer size is 8 bytes every time

enumerator kEDMA\_TransferSize16Bytes

Source/Destination data transfer size is 16 bytes every time

enumerator kEDMA\_TransferSize32Bytes

Source/Destination data transfer size is 32 bytes every time

enum \_edma\_modulo

eDMA modulo configuration

*Values:*

enumerator kEDMA\_ModuloDisable

Disable modulo

enumerator kEDMA\_Modulo2bytes

Circular buffer size is 2 bytes.

enumerator kEDMA\_Modulo4bytes  
Circular buffer size is 4 bytes.

enumerator kEDMA\_Modulo8bytes  
Circular buffer size is 8 bytes.

enumerator kEDMA\_Modulo16bytes  
Circular buffer size is 16 bytes.

enumerator kEDMA\_Modulo32bytes  
Circular buffer size is 32 bytes.

enumerator kEDMA\_Modulo64bytes  
Circular buffer size is 64 bytes.

enumerator kEDMA\_Modulo128bytes  
Circular buffer size is 128 bytes.

enumerator kEDMA\_Modulo256bytes  
Circular buffer size is 256 bytes.

enumerator kEDMA\_Modulo512bytes  
Circular buffer size is 512 bytes.

enumerator kEDMA\_Modulo1Kbytes  
Circular buffer size is 1 K bytes.

enumerator kEDMA\_Modulo2Kbytes  
Circular buffer size is 2 K bytes.

enumerator kEDMA\_Modulo4Kbytes  
Circular buffer size is 4 K bytes.

enumerator kEDMA\_Modulo8Kbytes  
Circular buffer size is 8 K bytes.

enumerator kEDMA\_Modulo16Kbytes  
Circular buffer size is 16 K bytes.

enumerator kEDMA\_Modulo32Kbytes  
Circular buffer size is 32 K bytes.

enumerator kEDMA\_Modulo64Kbytes  
Circular buffer size is 64 K bytes.

enumerator kEDMA\_Modulo128Kbytes  
Circular buffer size is 128 K bytes.

enumerator kEDMA\_Modulo256Kbytes  
Circular buffer size is 256 K bytes.

enumerator kEDMA\_Modulo512Kbytes  
Circular buffer size is 512 K bytes.

enumerator kEDMA\_Modulo1Mbytes  
Circular buffer size is 1 M bytes.

enumerator kEDMA\_Modulo2Mbytes  
Circular buffer size is 2 M bytes.

enumerator kEDMA\_Modulo4Mbytes  
Circular buffer size is 4 M bytes.

enumerator kEDMA\_Modulo8Mbytes

Circular buffer size is 8 M bytes.

enumerator kEDMA\_Modulo16Mbytes

Circular buffer size is 16 M bytes.

enumerator kEDMA\_Modulo32Mbytes

Circular buffer size is 32 M bytes.

enumerator kEDMA\_Modulo64Mbytes

Circular buffer size is 64 M bytes.

enumerator kEDMA\_Modulo128Mbytes

Circular buffer size is 128 M bytes.

enumerator kEDMA\_Modulo256Mbytes

Circular buffer size is 256 M bytes.

enumerator kEDMA\_Modulo512Mbytes

Circular buffer size is 512 M bytes.

enumerator kEDMA\_Modulo1Gbytes

Circular buffer size is 1 G bytes.

enumerator kEDMA\_Modulo2Gbytes

Circular buffer size is 2 G bytes.

enum \_edma\_bandwidth

Bandwidth control.

*Values:*

enumerator kEDMA\_BandwidthStallNone

No eDMA engine stalls.

enumerator kEDMA\_BandwidthStall4Cycle

eDMA engine stalls for 4 cycles after each read/write.

enumerator kEDMA\_BandwidthStall8Cycle

eDMA engine stalls for 8 cycles after each read/write.

enum \_edma\_channel\_link\_type

Channel link type.

*Values:*

enumerator kEDMA\_LinkNone

No channel link

enumerator kEDMA\_MinorLink

Channel link after each minor loop

enumerator kEDMA\_MajorLink

Channel link while major loop count exhausted

\_edma\_channel\_status\_flags eDMA channel status flags.

*Values:*

enumerator kEDMA\_DoneFlag

DONE flag, set while transfer finished, CITER value exhausted

enumerator kEDMA\_ErrorFlag

eDMA error flag, an error occurred in a transfer

enumerator kEDMA\_InterruptFlag

eDMA interrupt flag, set while an interrupt occurred of this channel

\_edma\_error\_status\_flags eDMA channel error status flags.

*Values:*

enumerator kEDMA\_DestinationBusErrorFlag

Bus error on destination address

enumerator kEDMA\_SourceBusErrorFlag

Bus error on the source address

enumerator kEDMA\_ScatterGatherErrorFlag

Error on the Scatter/Gather address, not 32byte aligned.

enumerator kEDMA\_NbytesErrorFlag

NBYTES/CITER configuration error

enumerator kEDMA\_DestinationOffsetErrorFlag

Destination offset not aligned with destination size

enumerator kEDMA\_DestinationAddressErrorFlag

Destination address not aligned with destination size

enumerator kEDMA\_SourceOffsetErrorFlag

Source offset not aligned with source size

enumerator kEDMA\_SourceAddressErrorFlag

Source address not aligned with source size

enumerator kEDMA\_ErrorChannelFlag

Error channel number of the cancelled channel number

enumerator kEDMA\_ChannelPriorityErrorFlag

Channel priority is not unique.

enumerator kEDMA\_TransferCanceledFlag

Transfer cancelled

enumerator kEDMA\_ValidFlag

No error occurred, this bit is 0. Otherwise, it is 1.

enum \_edma\_interrupt\_enable

eDMA interrupt source

*Values:*

enumerator kEDMA\_ErrorInterruptEnable

Enable interrupt while channel error occurs.

enumerator kEDMA\_MajorInterruptEnable

Enable interrupt while major count exhausted.

enumerator kEDMA\_HalfInterruptEnable

Enable interrupt while major count to half value.

enum \_edma\_transfer\_type

eDMA transfer type

*Values:*

enumerator kEDMA\_MemoryToMemory

Transfer from memory to memory

enumerator kEDMA\_PeripheralToMemory

Transfer from peripheral to memory

enumerator kEDMA\_MemoryToPeripheral

Transfer from memory to peripheral

enumerator kEDMA\_PeripheralToPeripheral

Transfer from Peripheral to peripheral

\_edma\_transfer\_status eDMA transfer status

*Values:*

enumerator kStatus\_EDMA\_QueueFull

TCD queue is full.

enumerator kStatus\_EDMA\_Busy

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

typedef enum \_edma\_transfer\_size edma\_transfer\_size\_t

eDMA transfer configuration

typedef enum \_edma\_modulo edma\_modulo\_t

eDMA modulo configuration

typedef enum \_edma\_bandwidth edma\_bandwidth\_t

Bandwidth control.

typedef enum \_edma\_channel\_link\_type edma\_channel\_link\_type\_t

Channel link type.

typedef enum \_edma\_interrupt\_enable edma\_interrupt\_enable\_t

eDMA interrupt source

typedef enum \_edma\_transfer\_type edma\_transfer\_type\_t

eDMA transfer type

typedef struct \_edma\_config edma\_config\_t

eDMA global configuration structure.

typedef struct \_edma\_transfer\_config edma\_transfer\_config\_t

eDMA transfer configuration

This structure configures the source/destination transfer attribute.

typedef struct \_edma\_channel\_Preemption\_config edma\_channel\_Preemption\_config\_t

eDMA channel priority configuration

typedef struct \_edma\_minor\_offset\_config edma\_minor\_offset\_config\_t

eDMA minor offset configuration

typedef struct \_edma\_tcd edma\_tcd\_t

eDMA TCD.

This structure is same as TCD register which is described in reference manual, and is used to configure the scatter/gather feature as a next hardware TCD.

```
typedef void (*edma_callback)(struct _edma_handle *handle, void *userData, bool transferDone,
uint32_t tcds)
```

Define callback function for eDMA.

This callback function is called in the EDMA interrupt handle. In normal mode, run into callback function means the transfer users need is done. In scatter gather mode, run into callback function means a transfer control block (tcd) is finished. Not all transfer finished, users can get the finished tcd numbers using interface EDMA\_GetUnusedTCDNumber.

**Param handle**

EDMA handle pointer, users shall not touch the values inside.

**Param userData**

The callback user parameter pointer. Users can use this parameter to involve things users need to change in EDMA callback function.

**Param transferDone**

If the current loaded transfer done. In normal mode it means if all transfer done. In scatter gather mode, this parameter shows is the current transfer block in EDMA register is done. As the load of core is different, it will be different if the new tcd loaded into EDMA registers while this callback called. If true, it always means new tcd still not loaded into registers, while false means new tcd already loaded into registers.

**Param tcds**

How many tcds are done from the last callback. This parameter only used in scatter gather mode. It tells user how many tcds are finished between the last callback and this.

```
typedef struct _edma_handle edma_handle_t
```

eDMA transfer handle structure

```
DMA_DCHPRI_INDEX(channel)
```

Compute the offset unit from DCHPRI3.

```
struct _edma_config
```

*#include <fsl\_edma.h>* eDMA global configuration structure.

## Public Members

**bool enableContinuousLinkMode**

Enable (true) continuous link mode. Upon minor loop completion, the channel activates again if that channel has a minor loop channel link enabled and the link channel is itself.

**bool enableHaltOnError**

Enable (true) transfer halt on error. Any error causes the HALT bit to set. Subsequently, all service requests are ignored until the HALT bit is cleared.

**bool enableRoundRobinArbitration**

Enable (true) round robin channel arbitration method or fixed priority arbitration is used for channel selection

**bool enableDebugMode**

Enable(true) eDMA debug mode. When in debug mode, the eDMA stalls the start of a new channel. Executing channels are allowed to complete.

```
struct _edma_transfer_config
```

*#include <fsl\_edma.h>* eDMA transfer configuration

This structure configures the source/destination transfer attribute.

**Public Members**

uint32\_t srcAddr

Source data address.

uint32\_t destAddr

Destination data address.

edma\_transfer\_size\_t srcTransferSize

Source data transfer size.

edma\_transfer\_size\_t destTransferSize

Destination data transfer size.

int16\_t srcOffset

Sign-extended offset applied to the current source address to form the next-state value as each source read is completed.

int16\_t destOffset

Sign-extended offset applied to the current destination address to form the next-state value as each destination write is completed.

uint32\_t minorLoopBytes

Bytes to transfer in a minor loop

uint32\_t majorLoopCounts

Major loop iteration count.

struct \_edma\_channel\_Preemption\_config

*#include <fsl\_edma.h>* eDMA channel priority configuration

**Public Members**

bool enableChannelPreemption

If true: a channel can be suspended by other channel with higher priority

bool enablePreemptAbility

If true: a channel can suspend other channel with low priority

uint8\_t channelPriority

Channel priority

struct \_edma\_minor\_offset\_config

*#include <fsl\_edma.h>* eDMA minor offset configuration

**Public Members**

bool enableSrcMinorOffset

Enable(true) or Disable(false) source minor loop offset.

bool enableDestMinorOffset

Enable(true) or Disable(false) destination minor loop offset.

uint32\_t minorOffset

Offset for a minor loop mapping.

struct \_edma\_tcd

*#include <fsl\_edma.h>* eDMA TCD.

This structure is same as TCD register which is described in reference manual, and is used to configure the scatter/gather feature as a next hardware TCD.

### Public Members

\_\_IO uint32\_t SADDR  
SADDR register, used to save source address

\_\_IO uint16\_t SOFF  
SOFF register, save offset bytes every transfer

\_\_IO uint16\_t ATTR  
ATTR register, source/destination transfer size and modulo

\_\_IO uint32\_t NBYTES  
Nbytes register, minor loop length in bytes

\_\_IO uint32\_t SLAST  
SLAST register

\_\_IO uint32\_t DADDR  
DADDR register, used for destination address

\_\_IO uint16\_t DOFF  
DOFF register, used for destination offset

\_\_IO uint16\_t CITER  
CITER register, current minor loop numbers, for unfinished minor loop.

\_\_IO uint32\_t DLAST\_SGA  
DLASTSGA register, next tcd address used in scatter-gather mode

\_\_IO uint16\_t CSR  
CSR register, for TCD control status

\_\_IO uint16\_t BITER  
BITER register, begin minor loop count.

struct \_\_edma\_handle  
#include <fsl\_edma.h> eDMA transfer handle structure

### Public Members

*edma\_callback* callback  
Callback function for major count exhausted.

void \*userData  
Callback function parameter.

DMA\_Type \*base  
eDMA peripheral base address.

*edma\_tcd\_t* \*tcdPool  
Pointer to memory stored TCDs.

uint8\_t channel  
eDMA channel number.

volatile int8\_t header  
The first TCD index. Should point to the next TCD to be loaded into the eDMA engine.

volatile int8\_t tail  
The last TCD index. Should point to the next TCD to be stored into the memory pool.



volatile int8\_t tcdUsed

The number of used TCD slots. Should reflect the number of TCDs can be used/loaded in the memory.

volatile int8\_t tcdSize

The total number of TCD slots in the queue.

uint8\_t flags

The status of the current channel.

## 2.15 EWM: External Watchdog Monitor Driver

void EWM\_Init(EWM\_Type \*base, const ewm\_config\_t \*config)

Initializes the EWM peripheral.

This function is used to initialize the EWM. After calling, the EWM runs immediately according to the configuration. Note that, except for the interrupt enable control bit, other control bits and registers are write once after a CPU reset. Modifying them more than once generates a bus transfer error.

This is an example.

```
ewm_config_t config;
EWM_GetDefaultConfig(&config);
config.compareHighValue = 0xAAU;
EWM_Init(ewm_base,&config);
```

### Parameters

- base – EWM peripheral base address
- config – The configuration of the EWM

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

Deinitializes the EWM peripheral.

This function is used to shut down the EWM.

### Parameters

- base – EWM peripheral base address

void EWM\_GetDefaultConfig(ewm\_config\_t \*config)

Initializes the EWM configuration structure.

This function initializes the EWM configuration structure to default values. The default values are as follows.

```
ewmConfig->enableEwm = true;
ewmConfig->enableEwmInput = false;
ewmConfig->setInputAssertLogic = false;
ewmConfig->enableInterrupt = false;
ewmConfig->ewm_lpo_clock_source_t = kEWM_LpoClockSource0;
ewmConfig->prescaler = 0;
ewmConfig->compareLowValue = 0;
ewmConfig->compareHighValue = 0xFEU;
```

### See also:

ewm\_config\_t

**Parameters**

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

`static inline void EWM_EnableInterrupts(EWM_Type *base, uint32_t mask)`

Enables the EWM interrupt.

This function enables the EWM interrupt.

**Parameters**

- `base` – EWM peripheral base address
- `mask` – The interrupts to enable The parameter can be combination of the following source if defined
  - `kEWM_InterruptEnable`

`static inline void EWM_DisableInterrupts(EWM_Type *base, uint32_t mask)`

Disables the EWM interrupt.

This function enables the EWM interrupt.

**Parameters**

- `base` – EWM peripheral base address
- `mask` – The interrupts to disable The parameter can be combination of the following source if defined
  - `kEWM_InterruptEnable`

`static inline uint32_t EWM_GetStatusFlags(EWM_Type *base)`

Gets all status flags.

This function gets all status flags.

This is an example for getting the running flag.

```
uint32_t status;
status = EWM_GetStatusFlags(ewm_base) & kEWM_RunningFlag;
```

**See also:**

`_ewm_status_flags_t`

- True: a related status flag has been set.
- False: a related status flag is not set.

**Parameters**

- `base` – EWM peripheral base address

**Returns**

State of the status flag: asserted (true) or not-asserted (false).

`void EWM_Refresh(EWM_Type *base)`

Services the EWM.

This function resets the EWM counter to zero.

**Parameters**

- `base` – EWM peripheral base address

FSL\_EWM\_DRIVER\_VERSION

EWM driver version 2.0.4.

enum `_ewm_lpo_clock_source`

Describes EWM clock source.

*Values:*

enumerator `kEWM_LpoClockSource0`

EWM clock sourced from `lpo_clk[0]`

enumerator `kEWM_LpoClockSource1`

EWM clock sourced from `lpo_clk[1]`

enumerator `kEWM_LpoClockSource2`

EWM clock sourced from `lpo_clk[2]`

enumerator `kEWM_LpoClockSource3`

EWM clock sourced from `lpo_clk[3]`

enum `_ewm_interrupt_enable_t`

EWM interrupt configuration structure with default settings all disabled.

This structure contains the settings for all of EWM interrupt configurations.

*Values:*

enumerator `kEWM_InterruptEnable`

Enable the EWM to generate an interrupt

enum `_ewm_status_flags_t`

EWM status flags.

This structure contains the constants for the EWM status flags for use in the EWM functions.

*Values:*

enumerator `kEWM_RunningFlag`

Running flag, set when EWM is enabled

typedef enum `_ewm_lpo_clock_source` `ewm_lpo_clock_source_t`

Describes EWM clock source.

typedef struct `_ewm_config` `ewm_config_t`

Data structure for EWM configuration.

This structure is used to configure the EWM.

struct `_ewm_config`

*#include <fsl\_ewm.h>* Data structure for EWM configuration.

This structure is used to configure the EWM.

## Public Members

bool `enableEwm`

Enable EWM module

bool `enableEwmInput`

Enable EWM\_in input

bool `setInputAssertLogic`

EWM\_in signal assertion state

bool `enableInterrupt`

Enable EWM interrupt

*ewm\_lpo\_clock\_source\_t* clockSource

Clock source select

uint8\_t prescaler

Clock prescaler value

uint8\_t compareLowValue

Compare low-register value

uint8\_t compareHighValue

Compare high-register value

## 2.16 FGPIO Driver

void FGPIO\_PortInit(FGPIO\_Type \*base)

Initializes the FGPIO peripheral.

This function ungates the FGPIO clock.

### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)

void FGPIO\_PinInit(FGPIO\_Type \*base, uint32\_t pin, const *gpio\_pin\_config\_t* \*config)

Initializes a FGPIO pin used by the board.

To initialize the FGPIO driver, define a pin configuration, as either input or output, in the user file. Then, call the FGPIO\_PinInit() function.

This is an example to define an input pin or an 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 – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO port pin number
- config – FGPIO pin configuration pointer

static inline void FGPIO\_PinWrite(FGPIO\_Type \*base, uint32\_t pin, uint8\_t output)

Sets the output level of the multiple FGPIO pins to the logic 1 or 0.

### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO pin number

- output – FGPIOpin output logic level.
  - 0: corresponding pin output low-logic level.
  - 1: corresponding pin output high-logic level.

static inline void FGPIO\_PortSet(FGPIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple FGPIO pins to the logic 1.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline void FGPIO\_PortClear(FGPIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple FGPIO pins to the logic 0.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline void FGPIO\_PortToggle(FGPIO\_Type \*base, uint32\_t mask)

Reverses the current output logic of the multiple FGPIO pins.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline uint32\_t FGPIO\_PinRead(FGPIO\_Type \*base, uint32\_t pin)

Reads the current input value of the FGPIO port.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO pin number

#### Return values

FGPIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

uint32\_t FGPIO\_PortGetInterruptFlags(FGPIO\_Type \*base)

Reads the FGPIO port interrupt status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains set until a logic one is written to that flag. If configured for a level-sensitive interrupt that remains asserted, the flag is set again immediately.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)

#### Return values

The – current FGPIO port interrupt status flags, for example, 0x00010001 means the pin 0 and 17 have the interrupt.

```
void FGPIO_PortClearInterruptFlags(FGPIO_Type *base, uint32_t mask)
```

Clears the multiple FGPIO pin interrupt status flag.

#### Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

## 2.17 C90TFS Flash Driver

## 2.18 FlexBus: External Bus Interface Driver

```
void FLEXBUS_Init(FB_Type *base, const flexbus_config_t *config)
```

Initializes and configures the FlexBus module.

This function enables the clock gate for FlexBus module. Only chip 0 is validated and set to known values. Other chips are disabled. Note that in this function, certain parameters, depending on external memories, must be set before using the FLEXBUS\_Init() function. This example shows how to set up the `uart_state_t` and the `flexbus_config_t` parameters and how to call the FLEXBUS\_Init function by passing in these parameters.

```
flexbus_config_t flexbusConfig;
FLEXBUS_GetDefaultConfig(&flexbusConfig);
flexbusConfig.waitStates = 2U;
flexbusConfig.chipBaseAddress = 0x60000000U;
flexbusConfig.chipBaseAddressMask = 7U;
FLEXBUS_Init(FB, &flexbusConfig);
```

#### Parameters

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

```
void FLEXBUS_Deinit(FB_Type *base)
```

De-initializes a FlexBus instance.

This function disables the clock gate of the FlexBus module clock.

#### Parameters

- base – FlexBus peripheral address.

```
void FLEXBUS_GetDefaultConfig(flexbus_config_t *config)
```

Initializes the FlexBus configuration structure.

This function initializes the FlexBus configuration structure to default value. The default values are.

```
fbConfig->chip = 0;
fbConfig->writeProtect = 0;
fbConfig->burstWrite = 0;
fbConfig->burstRead = 0;
fbConfig->byteEnableMode = 0;
fbConfig->autoAcknowledge = true;
fbConfig->extendTransferAddress = 0;
fbConfig->secondaryWaitStates = 0;
fbConfig->byteLaneShift = kFLEXBUS_NotShifted;
```

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```
fbConfig->writeAddressHold = kFLEXBUS_Hold1Cycle;
fbConfig->readAddressHold = kFLEXBUS_Hold1Or0Cycles;
fbConfig->addressSetup = kFLEXBUS_FirstRisingEdge;
fbConfig->portSize = kFLEXBUS_1Byte;
fbConfig->group1MultiplexControl = kFLEXBUS_MultiplexGroup1_FB_ALE;
fbConfig->group2MultiplexControl = kFLEXBUS_MultiplexGroup2_FB_CS4 ;
fbConfig->group3MultiplexControl = kFLEXBUS_MultiplexGroup3_FB_CS5;
fbConfig->group4MultiplexControl = kFLEXBUS_MultiplexGroup4_FB_TBST;
fbConfig->group5MultiplexControl = kFLEXBUS_MultiplexGroup5_FB_TA;
```

**See also:**

FLEXBUS\_Init

**Parameters**

- config – Pointer to the initialization structure.

FSL\_FLEXBUS\_DRIVER\_VERSION

Version 2.1.1.

enum \_flexbus\_port\_size

Defines port size for FlexBus peripheral.

*Values:*

enumerator kFLEXBUS\_4Bytes

32-bit port size

enumerator kFLEXBUS\_1Byte

8-bit port size

enumerator kFLEXBUS\_2Bytes

16-bit port size

enum \_flexbus\_write\_address\_hold

Defines number of cycles to hold address and attributes for FlexBus peripheral.

*Values:*

enumerator kFLEXBUS\_Hold1Cycle

Hold address and attributes one cycles after FB\_CS<sub>n</sub> negates on writes

enumerator kFLEXBUS\_Hold2Cycles

Hold address and attributes two cycles after FB\_CS<sub>n</sub> negates on writes

enumerator kFLEXBUS\_Hold3Cycles

Hold address and attributes three cycles after FB\_CS<sub>n</sub> negates on writes

enumerator kFLEXBUS\_Hold4Cycles

Hold address and attributes four cycles after FB\_CS<sub>n</sub> negates on writes

enum \_flexbus\_read\_address\_hold

Defines number of cycles to hold address and attributes for FlexBus peripheral.

*Values:*

enumerator kFLEXBUS\_Hold1Or0Cycles

Hold address and attributes 1 or 0 cycles on reads

enumerator kFLEXBUS\_Hold2Or1Cycles

Hold address and attributes 2 or 1 cycles on reads

enumerator kFLEXBUS\_Hold3Or2Cycle

Hold address and attributes 3 or 2 cycles on reads

enumerator kFLEXBUS\_Hold4Or3Cycle

Hold address and attributes 4 or 3 cycles on reads

enum \_flexbus\_address\_setup

Address setup for FlexBus peripheral.

*Values:*

enumerator kFLEXBUS\_FirstRisingEdge

Assert FB\_CS<sub>n</sub> on first rising clock edge after address is asserted

enumerator kFLEXBUS\_SecondRisingEdge

Assert FB\_CS<sub>n</sub> on second rising clock edge after address is asserted

enumerator kFLEXBUS\_ThirdRisingEdge

Assert FB\_CS<sub>n</sub> on third rising clock edge after address is asserted

enumerator kFLEXBUS\_FourthRisingEdge

Assert FB\_CS<sub>n</sub> on fourth rising clock edge after address is asserted

enum \_flexbus\_bytelane\_shift

Defines byte-lane shift for FlexBus peripheral.

*Values:*

enumerator kFLEXBUS\_NotShifted

Not shifted. Data is left-justified on FB\_AD

enumerator kFLEXBUS\_Shifted

Shifted. Data is right justified on FB\_AD

enum \_flexbus\_multiplex\_group1\_signal

Defines multiplex group1 valid signals.

*Values:*

enumerator kFLEXBUS\_MultiplexGroup1\_FB\_ALE

FB\_ALE

enumerator kFLEXBUS\_MultiplexGroup1\_FB\_CS1

FB\_CS1

enumerator kFLEXBUS\_MultiplexGroup1\_FB\_TS

FB\_TS

enum \_flexbus\_multiplex\_group2\_signal

Defines multiplex group2 valid signals.

*Values:*

enumerator kFLEXBUS\_MultiplexGroup2\_FB\_CS4

FB\_CS4

enumerator kFLEXBUS\_MultiplexGroup2\_FB\_TSIZ0

FB\_TSIZ0

enumerator kFLEXBUS\_MultiplexGroup2\_FB\_BE\_31\_24

FB\_BE\_31\_24



enum *\_flexbus\_multiplex\_group3\_signal*

Defines multiplex group3 valid signals.

*Values:*

enumerator kFLEXBUS\_MultiplexGroup3\_FB\_CS5  
FB\_CS5

enumerator kFLEXBUS\_MultiplexGroup3\_FB\_TSIZ1  
FB\_TSIZ1

enumerator kFLEXBUS\_MultiplexGroup3\_FB\_BE\_23\_16  
FB\_BE\_23\_16

enum *\_flexbus\_multiplex\_group4\_signal*

Defines multiplex group4 valid signals.

*Values:*

enumerator kFLEXBUS\_MultiplexGroup4\_FB\_TBST  
FB\_TBST

enumerator kFLEXBUS\_MultiplexGroup4\_FB\_CS2  
FB\_CS2

enumerator kFLEXBUS\_MultiplexGroup4\_FB\_BE\_15\_8  
FB\_BE\_15\_8

enum *\_flexbus\_multiplex\_group5\_signal*

Defines multiplex group5 valid signals.

*Values:*

enumerator kFLEXBUS\_MultiplexGroup5\_FB\_TA  
FB\_TA

enumerator kFLEXBUS\_MultiplexGroup5\_FB\_CS3  
FB\_CS3

enumerator kFLEXBUS\_MultiplexGroup5\_FB\_BE\_7\_0  
FB\_BE\_7\_0

typedef enum *\_flexbus\_port\_size* flexbus\_port\_size\_t

Defines port size for FlexBus peripheral.

typedef enum *\_flexbus\_write\_address\_hold* flexbus\_write\_address\_hold\_t

Defines number of cycles to hold address and attributes for FlexBus peripheral.

typedef enum *\_flexbus\_read\_address\_hold* flexbus\_read\_address\_hold\_t

Defines number of cycles to hold address and attributes for FlexBus peripheral.

typedef enum *\_flexbus\_address\_setup* flexbus\_address\_setup\_t

Address setup for FlexBus peripheral.

typedef enum *\_flexbus\_bytelane\_shift* flexbus\_bytelane\_shift\_t

Defines byte-lane shift for FlexBus peripheral.

typedef enum *\_flexbus\_multiplex\_group1\_signal* flexbus\_multiplex\_group1\_t

Defines multiplex group1 valid signals.

typedef enum *\_flexbus\_multiplex\_group2\_signal* flexbus\_multiplex\_group2\_t

Defines multiplex group2 valid signals.

`typedef enum _flexbus_multiplex_group3_signal flexbus__multiplex_group3_t`

Defines multiplex group3 valid signals.

`typedef enum _flexbus_multiplex_group4_signal flexbus__multiplex_group4_t`

Defines multiplex group4 valid signals.

`typedef enum _flexbus_multiplex_group5_signal flexbus__multiplex_group5_t`

Defines multiplex group5 valid signals.

`typedef struct _flexbus_config flexbus__config_t`

Configuration structure that the user needs to set.

`struct _flexbus_config`

`#include <fsl_flexbus.h>` Configuration structure that the user needs to set.

### Public Members

`uint8_t chip`

Chip FlexBus for validation

`uint8_t waitStates`

Value of wait states

`uint8_t secondaryWaitStates`

Value of secondary wait states

`uint32_t chipBaseAddress`

Chip base address for using FlexBus

`uint32_t chipBaseAddressMask`

Chip base address mask

`bool writeProtect`

Write protected

`bool burstWrite`

Burst-Write enable

`bool burstRead`

Burst-Read enable

`bool byteEnableMode`

Byte-enable mode support

`bool autoAcknowledge`

Auto acknowledge setting

`bool extendTransferAddress`

Extend transfer start/extend address latch enable

`bool secondaryWaitStatesEnable`

Enable secondary wait states

`flexbus_port_size_t portSize`

Port size of transfer

`flexbus_bytelane_shift_t byteLaneShift`

Byte-lane shift enable

`flexbus_write_address_hold_t writeAddressHold`

Write address hold or deselect option

*flexbus\_read\_address\_hold\_t* readAddressHold

Read address hold or deselect option

*flexbus\_address\_setup\_t* addressSetup

Address setup setting

*flexbus\_multiplex\_group1\_t* group1MultiplexControl

FlexBus Signal Group 1 Multiplex control

*flexbus\_multiplex\_group2\_t* group2MultiplexControl

FlexBus Signal Group 2 Multiplex control

*flexbus\_multiplex\_group3\_t* group3MultiplexControl

FlexBus Signal Group 3 Multiplex control

*flexbus\_multiplex\_group4\_t* group4MultiplexControl

FlexBus Signal Group 4 Multiplex control

*flexbus\_multiplex\_group5\_t* group5MultiplexControl

FlexBus Signal Group 5 Multiplex control

## 2.19 FlexIO: FlexIO Driver

## 2.20 FlexIO Driver

void FLEXIO\_GetDefaultConfig(*flexio\_config\_t* \*userConfig)

Gets the default configuration to configure the FlexIO module. The configuration can be used directly to call the FLEXIO\_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

### Parameters

- userConfig – pointer to flexio\_config\_t structure

void FLEXIO\_Init(FLEXIO\_Type \*base, const *flexio\_config\_t* \*userConfig)

Configures the FlexIO with a FlexIO configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO\_GetDefaultConfig().

Example

```
flexio_config_t config = {
 .enableFlexio = true,
 .enableInDoze = false,
 .enableInDebug = true,
 .enableFastAccess = false
};
FLEXIO_Configure(base, &config);
```

### Parameters

- base – FlexIO peripheral base address
- userConfig – pointer to flexio\_config\_t structure

`void FLEXIO__Deinit(FLEXIO_Type *base)`

Gates the FlexIO clock. Call this API to stop the FlexIO clock.

---

**Note:** After calling this API, call the FLEXIO\_Init to use the FlexIO module.

---

#### Parameters

- base – FlexIO peripheral base address

`uint32_t FLEXIO__GetInstance(FLEXIO_Type *base)`

Get instance number for FLEXIO module.

#### Parameters

- base – FLEXIO peripheral base address.

`void FLEXIO__Reset(FLEXIO_Type *base)`

Resets the FlexIO module.

#### Parameters

- base – FlexIO peripheral base address

`static inline void FLEXIO__Enable(FLEXIO_Type *base, bool enable)`

Enables the FlexIO module operation.

#### Parameters

- base – FlexIO peripheral base address
- enable – true to enable, false to disable.

`static inline uint32_t FLEXIO__ReadPinInput(FLEXIO_Type *base)`

Reads the input data on each of the FlexIO pins.

#### Parameters

- base – FlexIO peripheral base address

#### Returns

FlexIO pin input data

`static inline uint8_t FLEXIO__GetShifterState(FLEXIO_Type *base)`

Gets the current state pointer for state mode use.

#### Parameters

- base – FlexIO peripheral base address

#### Returns

current State pointer

`void FLEXIO__SetShifterConfig(FLEXIO_Type *base, uint8_t index, const flexio_shifter_config_t *shifterConfig)`

Configures the shifter with the shifter configuration. The configuration structure covers both the SHIFTCTL and SHIFTCFG registers. To configure the shifter to the proper mode, select which timer controls the shifter to shift, whether to generate start bit/stop bit, and the polarity of start bit and stop bit.

#### Example

```
flexio_shifter_config_t config = {
 .timerSelect = 0,
 .timerPolarity = kFLEXIO_ShifterTimerPolarityOnPositive,
 .pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
```

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```
.pinPolarity = kFLEXIO_PinActiveLow,
.shifterMode = kFLEXIO_ShifterModeTransmit,
.inputSource = kFLEXIO_ShifterInputFromPin,
.shifterStop = kFLEXIO_ShifterStopBitHigh,
.shifterStart = kFLEXIO_ShifterStartBitLow
};
FLEXIO_SetShifterConfig(base, &config);
```

### Parameters

- base – FlexIO peripheral base address
- index – Shifter index
- shifterConfig – Pointer to flexio\_shifter\_config\_t structure

```
void FLEXIO_SetTimerConfig(FLEXIO_Type *base, uint8_t index, const flexio_timer_config_t
 *timerConfig)
```

Configures the timer with the timer configuration. The configuration structure covers both the TIMCTL and TIMCFG registers. To configure the timer to the proper mode, select trigger source for timer and the timer pin output and the timing for timer.

### Example

```
flexio_timer_config_t config = {
.triggerSelect = FLEXIO_TIMER_TRIGGER_SEL_SHIFThnSTAT(0),
.triggerPolarity = kFLEXIO_TimerTriggerPolarityActiveLow,
.triggerSource = kFLEXIO_TimerTriggerSourceInternal,
.pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
.pinSelect = 0,
.pinPolarity = kFLEXIO_PinActiveHigh,
.timerMode = kFLEXIO_TimerModeDual8BitBaudBit,
.timerOutput = kFLEXIO_TimerOutputZeroNotAffectedByReset,
.timerDecrement = kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput,
.timerReset = kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput,
.timerDisable = kFLEXIO_TimerDisableOnTimerCompare,
.timerEnable = kFLEXIO_TimerEnableOnTriggerHigh,
.timerStop = kFLEXIO_TimerStopBitEnableOnTimerDisable,
.timerStart = kFLEXIO_TimerStartBitEnabled
};
FLEXIO_SetTimerConfig(base, &config);
```

### Parameters

- base – FlexIO peripheral base address
- index – Timer index
- timerConfig – Pointer to the flexio\_timer\_config\_t structure

```
static inline void FLEXIO_SetClockMode(FLEXIO_Type *base, uint8_t index,
 flexio_timer_decrement_source_t clocksource)
```

This function set the value of the prescaler on flexio channels.

### Parameters

- base – Pointer to the FlexIO simulated peripheral type.
- index – Timer index
- clocksource – Set clock value

static inline void FLEXIO\_EnableShifterStatusInterrupts(FLEXIO\_Type \*base, uint32\_t mask)

Enables the shifter status interrupt. The interrupt generates when the corresponding SSF is set.

---

**Note:** For multiple shifter status interrupt enable, for example, two shifter status enable, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by  $(1 \ll \text{shifter index})$

static inline void FLEXIO\_DisableShifterStatusInterrupts(FLEXIO\_Type \*base, uint32\_t mask)

Disables the shifter status interrupt. The interrupt won't generate when the corresponding SSF is set.

---

**Note:** For multiple shifter status interrupt enable, for example, two shifter status enable, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by  $(1 \ll \text{shifter index})$

static inline void FLEXIO\_EnableShifterErrorInterrupts(FLEXIO\_Type \*base, uint32\_t mask)

Enables the shifter error interrupt. The interrupt generates when the corresponding SEF is set.

---

**Note:** For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by  $(1 \ll \text{shifter index})$

static inline void FLEXIO\_DisableShifterErrorInterrupts(FLEXIO\_Type \*base, uint32\_t mask)

Disables the shifter error interrupt. The interrupt won't generate when the corresponding SEF is set.

---

**Note:** For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by  $(1 \ll \text{shifter index})$

```
static inline void FLEXIO_EnableTimerStatusInterrupts(FLEXIO_Type *base, uint32_t mask)
```

Enables the timer status interrupt. The interrupt generates when the corresponding SSF is set.

---

**Note:** For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using  $((1 \ll \text{timer index0}) | (1 \ll \text{timer index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by  $(1 \ll \text{timer index})$

```
static inline void FLEXIO_DisableTimerStatusInterrupts(FLEXIO_Type *base, uint32_t mask)
```

Disables the timer status interrupt. The interrupt won't generate when the corresponding SSF is set.

---

**Note:** For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using  $((1 \ll \text{timer index0}) | (1 \ll \text{timer index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by  $(1 \ll \text{timer index})$

```
static inline uint32_t FLEXIO_GetShifterStatusFlags(FLEXIO_Type *base)
```

Gets the shifter status flags.

#### Parameters

- base – FlexIO peripheral base address

#### Returns

Shifter status flags

```
static inline void FLEXIO_ClearShifterStatusFlags(FLEXIO_Type *base, uint32_t mask)
```

Clears the shifter status flags.

---

**Note:** For clearing multiple shifter status flags, for example, two shifter status flags, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by  $(1 \ll \text{shifter index})$

```
static inline uint32_t FLEXIO_GetShifterErrorFlags(FLEXIO_Type *base)
```

Gets the shifter error flags.

#### Parameters

- base – FlexIO peripheral base address

#### Returns

Shifter error flags

static inline void FLEXIO\_ClearShifterErrorFlags(FLEXIO\_Type \*base, uint32\_t mask)  
Clears the shifter error flags.

---

**Note:** For clearing multiple shifter error flags, for example, two shifter error flags, can calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by  $(1 \ll \text{shifter index})$

static inline uint32\_t FLEXIO\_GetTimerStatusFlags(FLEXIO\_Type \*base)  
Gets the timer status flags.

#### Parameters

- base – FlexIO peripheral base address

#### Returns

Timer status flags

static inline void FLEXIO\_ClearTimerStatusFlags(FLEXIO\_Type \*base, uint32\_t mask)  
Clears the timer status flags.

---

**Note:** For clearing multiple timer status flags, for example, two timer status flags, can calculate the mask by using  $((1 \ll \text{timer index0}) | (1 \ll \text{timer index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The timer status mask which can be calculated by  $(1 \ll \text{timer index})$

static inline void FLEXIO\_EnableShifterStatusDMA(FLEXIO\_Type \*base, uint32\_t mask, bool enable)

Enables/disables the shifter status DMA. The DMA request generates when the corresponding SSF is set.

---

**Note:** For multiple shifter status DMA enables, for example, calculate the mask by using  $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

---

#### Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by  $(1 \ll \text{shifter index})$
- enable – True to enable, false to disable.

uint32\_t FLEXIO\_GetShifterBufferAddress(FLEXIO\_Type \*base, flexio\_shifter\_buffer\_type\_t type, uint8\_t index)

Gets the shifter buffer address for the DMA transfer usage.

#### Parameters

- base – FlexIO peripheral base address
- type – Shifter type of flexio\_shifter\_buffer\_type\_t



- index – Shifter index

**Returns**

Corresponding shifter buffer index

*status\_t* FLEXIO\_RegisterHandleIRQ(void \*base, void \*handle, *flexio\_isr\_t* isr)

Registers the handle and the interrupt handler for the FlexIO-simulated peripheral.

**Parameters**

- base – Pointer to the FlexIO simulated peripheral type.
- handle – Pointer to the handler for FlexIO simulated peripheral.
- isr – FlexIO simulated peripheral interrupt handler.

**Return values**

- kStatus\_Success – Successfully create the handle.
- kStatus\_OutOfRange – The FlexIO type/handle/ISR table out of range.

*status\_t* FLEXIO\_UnregisterHandleIRQ(void \*base)

Unregisters the handle and the interrupt handler for the FlexIO-simulated peripheral.

**Parameters**

- base – Pointer to the FlexIO simulated peripheral type.

**Return values**

- kStatus\_Success – Successfully create the handle.
- kStatus\_OutOfRange – The FlexIO type/handle/ISR table out of range.

static inline void FLEXIO\_ClearPortOutput(FLEXIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple FLEXIO pins to the logic 0.

**Parameters**

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO\_SetPortOutput(FLEXIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple FLEXIO pins to the logic 1.

**Parameters**

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO\_TogglePortOutput(FLEXIO\_Type \*base, uint32\_t mask)

Reverses the current output logic of the multiple FLEXIO pins.

**Parameters**

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

static inline void FLEXIO\_PinWrite(FLEXIO\_Type \*base, uint32\_t pin, uint8\_t output)

Sets the output level of the FLEXIO pins to the logic 1 or 0.

**Parameters**

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.
- output – FLEXIO pin output logic level.

- 0: corresponding pin output low-logic level.
- 1: corresponding pin output high-logic level.

static inline void FLEXIO\_EnablePinOutput(FLEXIO\_Type \*base, uint32\_t pin)

Enables the FLEXIO output pin function.

**Parameters**

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

static inline uint32\_t FLEXIO\_PinRead(FLEXIO\_Type \*base, uint32\_t pin)

Reads the current input value of the FLEXIO pin.

**Parameters**

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

**Return values**

FLEXIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

static inline uint32\_t FLEXIO\_GetPinStatus(FLEXIO\_Type \*base, uint32\_t pin)

Gets the FLEXIO input pin status.

**Parameters**

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.

**Return values**

FLEXIO – port input status

- 0: corresponding pin input capture no status.
- 1: corresponding pin input capture rising or falling edge.

static inline void FLEXIO\_SetPinLevel(FLEXIO\_Type \*base, uint8\_t pin, bool level)

Sets the FLEXIO output pin level.

**Parameters**

- base – FlexIO peripheral base address
- pin – FlexIO pin number.
- level – FlexIO output pin level to set, can be either 0 or 1.

static inline bool FLEXIO\_GetPinOverride(const FLEXIO\_Type \*const base, uint8\_t pin)

Gets the enabled status of a FLEXIO output pin.

**Parameters**

- base – FlexIO peripheral base address
- pin – FlexIO pin number.

**Return values**

FlexIO – port enabled status

- 0: corresponding output pin is in disabled state.
- 1: corresponding output pin is in enabled state.

static inline void FLEXIO\_ConfigPinOverride(FLEXIO\_Type \*base, uint8\_t pin, bool enabled)

Enables or disables a FLEXIO output pin.

**Parameters**

- base – FlexIO peripheral base address
- pin – Flexio pin number.
- enabled – Enable or disable the FlexIO pin.

static inline void FLEXIO\_ClearPortStatus(FLEXIO\_Type \*base, uint32\_t mask)

Clears the multiple FLEXIO input pins status.

**Parameters**

- base – FlexIO peripheral base address
- mask – FLEXIO pin number mask

FSL\_FLEXIO\_DRIVER\_VERSION

FlexIO driver version.

enum \_flexio\_timer\_trigger\_polarity

Define time of timer trigger polarity.

*Values:*

enumerator kFLEXIO\_TimerTriggerPolarityActiveHigh  
Active high.

enumerator kFLEXIO\_TimerTriggerPolarityActiveLow  
Active low.

enum \_flexio\_timer\_trigger\_source

Define type of timer trigger source.

*Values:*

enumerator kFLEXIO\_TimerTriggerSourceExternal  
External trigger selected.

enumerator kFLEXIO\_TimerTriggerSourceInternal  
Internal trigger selected.

enum \_flexio\_pin\_config

Define type of timer/shifter pin configuration.

*Values:*

enumerator kFLEXIO\_PinConfigOutputDisabled  
Pin output disabled.

enumerator kFLEXIO\_PinConfigOpenDrainOrBidirection  
Pin open drain or bidirectional output enable.

enumerator kFLEXIO\_PinConfigBidirectionOutputData  
Pin bidirectional output data.

enumerator kFLEXIO\_PinConfigOutput  
Pin output.

enum \_flexio\_pin\_polarity

Definition of pin polarity.

*Values:*

enumerator kFLEXIO\_\_PinActiveHigh  
Active high.

enumerator kFLEXIO\_\_PinActiveLow  
Active low.

enum \_\_flexio\_timer\_mode  
Define type of timer work mode.

*Values:*

enumerator kFLEXIO\_\_TimerModeDisabled  
Timer Disabled.

enumerator kFLEXIO\_\_TimerModeDual8BitBaudBit  
Dual 8-bit counters baud/bit mode.

enumerator kFLEXIO\_\_TimerModeDual8BitPWM  
Dual 8-bit counters PWM mode.

enumerator kFLEXIO\_\_TimerModeSingle16Bit  
Single 16-bit counter mode.

enumerator kFLEXIO\_\_TimerModeDual8BitPWMLow  
Dual 8-bit counters PWM Low mode.

enum \_\_flexio\_timer\_output  
Define type of timer initial output or timer reset condition.

*Values:*

enumerator kFLEXIO\_\_TimerOutputOneNotAffectedByReset  
Logic one when enabled and is not affected by timer reset.

enumerator kFLEXIO\_\_TimerOutputZeroNotAffectedByReset  
Logic zero when enabled and is not affected by timer reset.

enumerator kFLEXIO\_\_TimerOutputOneAffectedByReset  
Logic one when enabled and on timer reset.

enumerator kFLEXIO\_\_TimerOutputZeroAffectedByReset  
Logic zero when enabled and on timer reset.

enum \_\_flexio\_timer\_decrement\_source  
Define type of timer decrement.

*Values:*

enumerator kFLEXIO\_\_TimerDecSrcOnFlexIOClockShiftTimerOutput  
Decrement counter on FlexIO clock, Shift clock equals Timer output.

enumerator kFLEXIO\_\_TimerDecSrcOnTriggerInputShiftTimerOutput  
Decrement counter on Trigger input (both edges), Shift clock equals Timer output.

enumerator kFLEXIO\_\_TimerDecSrcOnPinInputShiftPinInput  
Decrement counter on Pin input (both edges), Shift clock equals Pin input.

enumerator kFLEXIO\_\_TimerDecSrcOnTriggerInputShiftTriggerInput  
Decrement counter on Trigger input (both edges), Shift clock equals Trigger input.

enum \_\_flexio\_timer\_reset\_condition  
Define type of timer reset condition.

*Values:*

enumerator kFLEXIO\_\_TimerResetNever

Timer never reset.

enumerator kFLEXIO\_\_TimerResetOnTimerPinEqualToTimerOutput

Timer reset on Timer Pin equal to Timer Output.

enumerator kFLEXIO\_\_TimerResetOnTimerTriggerEqualToTimerOutput

Timer reset on Timer Trigger equal to Timer Output.

enumerator kFLEXIO\_\_TimerResetOnTimerPinRisingEdge

Timer reset on Timer Pin rising edge.

enumerator kFLEXIO\_\_TimerResetOnTimerTriggerRisingEdge

Timer reset on Trigger rising edge.

enumerator kFLEXIO\_\_TimerResetOnTimerTriggerBothEdge

Timer reset on Trigger rising or falling edge.

enum \_flexio\_timer\_disable\_condition

Define type of timer disable condition.

*Values:*

enumerator kFLEXIO\_\_TimerDisableNever

Timer never disabled.

enumerator kFLEXIO\_\_TimerDisableOnPreTimerDisable

Timer disabled on Timer N-1 disable.

enumerator kFLEXIO\_\_TimerDisableOnTimerCompare

Timer disabled on Timer compare.

enumerator kFLEXIO\_\_TimerDisableOnTimerCompareTriggerLow

Timer disabled on Timer compare and Trigger Low.

enumerator kFLEXIO\_\_TimerDisableOnPinBothEdge

Timer disabled on Pin rising or falling edge.

enumerator kFLEXIO\_\_TimerDisableOnPinBothEdgeTriggerHigh

Timer disabled on Pin rising or falling edge provided Trigger is high.

enumerator kFLEXIO\_\_TimerDisableOnTriggerFallingEdge

Timer disabled on Trigger falling edge.

enum \_flexio\_timer\_enable\_condition

Define type of timer enable condition.

*Values:*

enumerator kFLEXIO\_\_TimerEnabledAlways

Timer always enabled.

enumerator kFLEXIO\_\_TimerEnableOnPrevTimerEnable

Timer enabled on Timer N-1 enable.

enumerator kFLEXIO\_\_TimerEnableOnTriggerHigh

Timer enabled on Trigger high.

enumerator kFLEXIO\_\_TimerEnableOnTriggerHighPinHigh

Timer enabled on Trigger high and Pin high.

enumerator kFLEXIO\_\_TimerEnableOnPinRisingEdge

Timer enabled on Pin rising edge.

enumerator kFLEXIO\_\_TimerEnableOnPinRisingEdgeTriggerHigh  
Timer enabled on Pin rising edge and Trigger high.

enumerator kFLEXIO\_\_TimerEnableOnTriggerRisingEdge  
Timer enabled on Trigger rising edge.

enumerator kFLEXIO\_\_TimerEnableOnTriggerBothEdge  
Timer enabled on Trigger rising or falling edge.

enum \_flexio\_timer\_stop\_bit\_condition  
Define type of timer stop bit generate condition.

*Values:*

enumerator kFLEXIO\_\_TimerStopBitDisabled  
Stop bit disabled.

enumerator kFLEXIO\_\_TimerStopBitEnableOnTimerCompare  
Stop bit is enabled on timer compare.

enumerator kFLEXIO\_\_TimerStopBitEnableOnTimerDisable  
Stop bit is enabled on timer disable.

enumerator kFLEXIO\_\_TimerStopBitEnableOnTimerCompareDisable  
Stop bit is enabled on timer compare and timer disable.

enum \_flexio\_timer\_start\_bit\_condition  
Define type of timer start bit generate condition.

*Values:*

enumerator kFLEXIO\_\_TimerStartBitDisabled  
Start bit disabled.

enumerator kFLEXIO\_\_TimerStartBitEnabled  
Start bit enabled.

enum \_flexio\_timer\_output\_state  
FlexIO as PWM channel output state.

*Values:*

enumerator kFLEXIO\_\_PwmLow  
The output state of PWM channel is low

enumerator kFLEXIO\_\_PwmHigh  
The output state of PWM channel is high

enum \_flexio\_shifter\_timer\_polarity  
Define type of timer polarity for shifter control.

*Values:*

enumerator kFLEXIO\_\_ShifterTimerPolarityOnPositive  
Shift on positive edge of shift clock.

enumerator kFLEXIO\_\_ShifterTimerPolarityOnNegative  
Shift on negative edge of shift clock.

enum \_flexio\_shifter\_mode  
Define type of shifter working mode.

*Values:*

enumerator kFLEXIO\_\_ShifterDisabled

Shifter is disabled.

enumerator kFLEXIO\_\_ShifterModeReceive

Receive mode.

enumerator kFLEXIO\_\_ShifterModeTransmit

Transmit mode.

enumerator kFLEXIO\_\_ShifterModeMatchStore

Match store mode.

enumerator kFLEXIO\_\_ShifterModeMatchContinuous

Match continuous mode.

enumerator kFLEXIO\_\_ShifterModeState

SHIFTBUF contents are used for storing programmable state attributes.

enumerator kFLEXIO\_\_ShifterModeLogic

SHIFTBUF contents are used for implementing programmable logic look up table.

enum \_flexio\_shifter\_input\_source

Define type of shifter input source.

*Values:*

enumerator kFLEXIO\_\_ShifterInputFromPin

Shifter input from pin.

enumerator kFLEXIO\_\_ShifterInputFromNextShifterOutput

Shifter input from Shifter N+1.

enum \_flexio\_shifter\_stop\_bit

Define of STOP bit configuration.

*Values:*

enumerator kFLEXIO\_\_ShifterStopBitDisable

Disable shifter stop bit.

enumerator kFLEXIO\_\_ShifterStopBitLow

Set shifter stop bit to logic low level.

enumerator kFLEXIO\_\_ShifterStopBitHigh

Set shifter stop bit to logic high level.

enum \_flexio\_shifter\_start\_bit

Define type of START bit configuration.

*Values:*

enumerator kFLEXIO\_\_ShifterStartBitDisabledLoadDataOnEnable

Disable shifter start bit, transmitter loads data on enable.

enumerator kFLEXIO\_\_ShifterStartBitDisabledLoadDataOnShift

Disable shifter start bit, transmitter loads data on first shift.

enumerator kFLEXIO\_\_ShifterStartBitLow

Set shifter start bit to logic low level.

enumerator kFLEXIO\_\_ShifterStartBitHigh

Set shifter start bit to logic high level.

enum *\_flexio\_shifter\_buffer\_type*

Define FlexIO shifter buffer type.

*Values:*

enumerator *kFLEXIO\_\_ShifterBuffer*

Shifter Buffer N Register.

enumerator *kFLEXIO\_\_ShifterBufferBitSwapped*

Shifter Buffer N Bit Byte Swapped Register.

enumerator *kFLEXIO\_\_ShifterBufferByteSwapped*

Shifter Buffer N Byte Swapped Register.

enumerator *kFLEXIO\_\_ShifterBufferBitByteSwapped*

Shifter Buffer N Bit Swapped Register.

enumerator *kFLEXIO\_\_ShifterBufferNibbleByteSwapped*

Shifter Buffer N Nibble Byte Swapped Register.

enumerator *kFLEXIO\_\_ShifterBufferHalfWordSwapped*

Shifter Buffer N Half Word Swapped Register.

enumerator *kFLEXIO\_\_ShifterBufferNibbleSwapped*

Shifter Buffer N Nibble Swapped Register.

enum *\_flexio\_gpio\_direction*

FLEXIO gpio direction definition.

*Values:*

enumerator *kFLEXIO\_\_DigitalInput*

Set current pin as digital input

enumerator *kFLEXIO\_\_DigitalOutput*

Set current pin as digital output

enum *\_flexio\_pin\_input\_config*

FLEXIO gpio input config.

*Values:*

enumerator *kFLEXIO\_\_InputInterruptDisabled*

Interrupt request is disabled.

enumerator *kFLEXIO\_\_InputInterruptEnable*

Interrupt request is enable.

enumerator *kFLEXIO\_\_FlagRisingEdgeEnable*

Input pin flag on rising edge.

enumerator *kFLEXIO\_\_FlagFallingEdgeEnable*

Input pin flag on falling edge.

typedef enum *\_flexio\_timer\_trigger\_polarity* *flexio\_timer\_trigger\_polarity\_t*

Define time of timer trigger polarity.

typedef enum *\_flexio\_timer\_trigger\_source* *flexio\_timer\_trigger\_source\_t*

Define type of timer trigger source.

typedef enum *\_flexio\_pin\_config* *flexio\_pin\_config\_t*

Define type of timer/shifter pin configuration.



typedef enum *\_flexio\_pin\_polarity* flexio\_pin\_polarity\_t

Definition of pin polarity.

typedef enum *\_flexio\_timer\_mode* flexio\_timer\_mode\_t

Define type of timer work mode.

typedef enum *\_flexio\_timer\_output* flexio\_timer\_output\_t

Define type of timer initial output or timer reset condition.

typedef enum *\_flexio\_timer\_decrement\_source* flexio\_timer\_decrement\_source\_t

Define type of timer decrement.

typedef enum *\_flexio\_timer\_reset\_condition* flexio\_timer\_reset\_condition\_t

Define type of timer reset condition.

typedef enum *\_flexio\_timer\_disable\_condition* flexio\_timer\_disable\_condition\_t

Define type of timer disable condition.

typedef enum *\_flexio\_timer\_enable\_condition* flexio\_timer\_enable\_condition\_t

Define type of timer enable condition.

typedef enum *\_flexio\_timer\_stop\_bit\_condition* flexio\_timer\_stop\_bit\_condition\_t

Define type of timer stop bit generate condition.

typedef enum *\_flexio\_timer\_start\_bit\_condition* flexio\_timer\_start\_bit\_condition\_t

Define type of timer start bit generate condition.

typedef enum *\_flexio\_timer\_output\_state* flexio\_timer\_output\_state\_t

FlexIO as PWM channel output state.

typedef enum *\_flexio\_shifter\_timer\_polarity* flexio\_shifter\_timer\_polarity\_t

Define type of timer polarity for shifter control.

typedef enum *\_flexio\_shifter\_mode* flexio\_shifter\_mode\_t

Define type of shifter working mode.

typedef enum *\_flexio\_shifter\_input\_source* flexio\_shifter\_input\_source\_t

Define type of shifter input source.

typedef enum *\_flexio\_shifter\_stop\_bit* flexio\_shifter\_stop\_bit\_t

Define of STOP bit configuration.

typedef enum *\_flexio\_shifter\_start\_bit* flexio\_shifter\_start\_bit\_t

Define type of START bit configuration.

typedef enum *\_flexio\_shifter\_buffer\_type* flexio\_shifter\_buffer\_type\_t

Define FlexIO shifter buffer type.

typedef struct *\_flexio\_config* flexio\_config\_t

Define FlexIO user configuration structure.

typedef struct *\_flexio\_timer\_config* flexio\_timer\_config\_t

Define FlexIO timer configuration structure.

typedef struct *\_flexio\_shifter\_config* flexio\_shifter\_config\_t

Define FlexIO shifter configuration structure.

typedef enum *\_flexio\_gpio\_direction* flexio\_gpio\_direction\_t

FLEXIO gpio direction definition.

typedef enum *\_flexio\_pin\_input\_config* flexio\_pin\_input\_config\_t

FLEXIO gpio input config.

```
typedef struct flexio_gpio_config flexio_gpio_config_t
```

The FLEXIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, use inputConfig param. If configured as an output pin, use outputLogic.

```
typedef void (*flexio_isr_t)(void *base, void *handle)
```

typedef for FlexIO simulated driver interrupt handler.

```
FLEXIO_Type *const s_flexioBases[]
```

Pointers to flexio bases for each instance.

```
const clock_ip_name_t s_flexioClocks[]
```

Pointers to flexio clocks for each instance.

```
void FLEXIO_SetPinConfig(FLEXIO_Type *base, uint32_t pin, flexio_gpio_config_t *config)
```

Configure a FLEXIO pin used by the board.

To Config the FLEXIO PIN, define a pin configuration, as either input or output, in the user file. Then, call the FLEXIO\_SetPinConfig() function.

This is an example to define an input pin or an output pin configuration.

```
Define a digital input pin configuration,
flexio_gpio_config_t config =
{
 kFLEXIO_DigitalInput,
 0U,
 kFLEXIO_FlagRisingEdgeEnable | kFLEXIO_InputInterruptEnable,
}
Define a digital output pin configuration,
flexio_gpio_config_t config =
{
 kFLEXIO_DigitalOutput,
 0U,
 0U
}
```

### Parameters

- base – FlexIO peripheral base address
- pin – FLEXIO pin number.
- config – FLEXIO pin configuration pointer.

```
FLEXIO_TIMER_TRIGGER_SEL_PININPUT(x)
```

Calculate FlexIO timer trigger.

```
FLEXIO_TIMER_TRIGGER_SEL_SHIFTnSTAT(x)
```

```
FLEXIO_TIMER_TRIGGER_SEL_TIMn(x)
```

```
struct flexio_config_
```

#include <fsl\_flexio.h> Define FlexIO user configuration structure.

### Public Members

```
bool enableFlexio
```

Enable/disable FlexIO module

bool enableInDoze

Enable/disable FlexIO operation in doze mode

bool enableInDebug

Enable/disable FlexIO operation in debug mode

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

struct `_flexio_timer_config`

*#include <fsl\_flexio.h>* Define FlexIO timer configuration structure.

### Public Members

uint32\_t triggerSelect

The internal trigger selection number using MACROs.

*flexio\_timer\_trigger\_polarity\_t* triggerPolarity

Trigger Polarity.

*flexio\_timer\_trigger\_source\_t* triggerSource

Trigger Source, internal (see 'trgsel') or external.

*flexio\_pin\_config\_t* pinConfig

Timer Pin Configuration.

uint32\_t pinSelect

Timer Pin number Select.

*flexio\_pin\_polarity\_t* pinPolarity

Timer Pin Polarity.

*flexio\_timer\_mode\_t* timerMode

Timer work Mode.

*flexio\_timer\_output\_t* timerOutput

Configures the initial state of the Timer Output and whether it is affected by the Timer reset.

*flexio\_timer\_decrement\_source\_t* timerDecrement

Configures the source of the Timer decrement and the source of the Shift clock.

*flexio\_timer\_reset\_condition\_t* timerReset

Configures the condition that causes the timer counter (and optionally the timer output) to be reset.

*flexio\_timer\_disable\_condition\_t* timerDisable

Configures the condition that causes the Timer to be disabled and stop decrementing.

*flexio\_timer\_enable\_condition\_t* timerEnable

Configures the condition that causes the Timer to be enabled and start decrementing.

*flexio\_timer\_stop\_bit\_condition\_t* timerStop

Timer STOP Bit generation.

*flexio\_timer\_start\_bit\_condition\_t* timerStart

Timer STRAT Bit generation.

uint32\_t timerCompare

Value for Timer Compare N Register.

struct `_flexio_shifter_config`

`#include <fsl_flexio.h>` Define FlexIO shifter configuration structure.

### Public Members

uint32\_t timerSelect

Selects which Timer is used for controlling the logic/shift register and generating the Shift clock.

*flexio\_shifter\_timer\_polarity\_t* timerPolarity

Timer Polarity.

*flexio\_pin\_config\_t* pinConfig

Shifter Pin Configuration.

uint32\_t pinSelect

Shifter Pin number Select.

*flexio\_pin\_polarity\_t* pinPolarity

Shifter Pin Polarity.

*flexio\_shifter\_mode\_t* shifterMode

Configures the mode of the Shifter.

uint32\_t parallelWidth

Configures the parallel width when using parallel mode.

*flexio\_shifter\_input\_source\_t* inputSource

Selects the input source for the shifter.

*flexio\_shifter\_stop\_bit\_t* shifterStop

Shifter STOP bit.

*flexio\_shifter\_start\_bit\_t* shifterStart

Shifter START bit.

struct `_flexio_gpio_config`

`#include <fsl_flexio.h>` The FLEXIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, use inputConfig param. If configured as an output pin, use outputLogic.

### Public Members

*flexio\_gpio\_direction\_t* pinDirection

FLEXIO pin direction, input or output

uint8\_t outputLogic

Set a default output logic, which has no use in input

uint8\_t inputConfig

Set an input config

## 2.21 FlexIO eDMA I2S Driver

```
void FLEXIO_I2S_TransferTxCreateHandleEDMA(FLEXIO_I2S_Type *base,
 flexio_i2s_edma_handle_t *handle,
 flexio_i2s_edma_callback_t callback, void
 *userData, edma_handle_t *dmaHandle)
```

Initializes the FlexIO I2S eDMA handle.

This function initializes the FlexIO I2S master DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer.
- callback – FlexIO I2S eDMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

```
void FLEXIO_I2S_TransferRxCreateHandleEDMA(FLEXIO_I2S_Type *base,
 flexio_i2s_edma_handle_t *handle,
 flexio_i2s_edma_callback_t callback, void
 *userData, edma_handle_t *dmaHandle)
```

Initializes the FlexIO I2S Rx eDMA handle.

This function initializes the FlexIO I2S slave DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer.
- callback – FlexIO I2S eDMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

```
void FLEXIO_I2S_TransferSetFormatEDMA(FLEXIO_I2S_Type *base, flexio_i2s_edma_handle_t
 *handle, flexio_i2s_format_t *format, uint32_t
 srcClock_Hz)
```

Configures the FlexIO I2S Tx audio format.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred. This function also sets the eDMA parameter according to format.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S eDMA handle pointer
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock\_Hz – FlexIO I2S clock source frequency in Hz, it should be 0 while in slave mode.

```
status_t FLEXIO_I2S_TransferSendEDMA(FLEXIO_I2S_Type *base, flexio_i2s_edma_handle_t
 *handle, flexio_i2s_transfer_t *xfer)
```

Performs a non-blocking FlexIO I2S transfer using DMA.

---

**Note:** This interface returned immediately after transfer initiates. Users should call FLEXIO\_I2S\_GetTransferStatus to poll the transfer status and check whether the FlexIO I2S transfer is finished.

---

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- xfer – Pointer to DMA transfer structure.

#### Return values

- kStatus\_Success – Start a FlexIO I2S eDMA send successfully.
- kStatus\_InvalidArgument – The input arguments is invalid.
- kStatus\_TxBusy – FlexIO I2S is busy sending data.

```
status_t FLEXIO_I2S_TransferReceiveEDMA(FLEXIO_I2S_Type *base, flexio_i2s_edma_handle_t
 *handle, flexio_i2s_transfer_t *xfer)
```

Performs a non-blocking FlexIO I2S receive using eDMA.

---

**Note:** This interface returned immediately after transfer initiates. Users should call FLEXIO\_I2S\_GetReceiveRemainingBytes to poll the transfer status and check whether the FlexIO I2S transfer is finished.

---

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- xfer – Pointer to DMA transfer structure.

#### Return values

- kStatus\_Success – Start a FlexIO I2S eDMA receive successfully.
- kStatus\_InvalidArgument – The input arguments is invalid.
- kStatus\_RxBusy – FlexIO I2S is busy receiving data.

```
void FLEXIO_I2S_TransferAbortSendEDMA(FLEXIO_I2S_Type *base, flexio_i2s_edma_handle_t
 *handle)
```

Aborts a FlexIO I2S transfer using eDMA.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.

```
void FLEXIO_I2S_TransferAbortReceiveEDMA(FLEXIO_I2S_Type *base,
 flexio_i2s_edma_handle_t *handle)
```

Aborts a FlexIO I2S receive using eDMA.

#### Parameters

- base – FlexIO I2S peripheral base address.

- handle – FlexIO I2S DMA handle pointer.

*status\_t* FLEXIO\_I2S\_TransferGetSendCountEDMA(*FLEXIO\_I2S\_Type* \*base,  
flexio\_i2s\_edma\_handle\_t \*handle, size\_t  
\*count)

Gets the remaining bytes to be sent.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes sent.

#### Return values

- kStatus\_Success – Succeed get the transfer count.
- kStatus\_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

*status\_t* FLEXIO\_I2S\_TransferGetReceiveCountEDMA(*FLEXIO\_I2S\_Type* \*base,  
flexio\_i2s\_edma\_handle\_t \*handle, size\_t  
\*count)

Get the remaining bytes to be received.

#### Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes received.

#### Return values

- kStatus\_Success – Succeed get the transfer count.
- kStatus\_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

FSL\_FLEXIO\_I2S\_EDMA\_DRIVER\_VERSION

FlexIO I2S EDMA driver version 2.1.9.

typedef struct flexio\_i2s\_edma\_handle flexio\_i2s\_edma\_handle\_t

typedef void (\*flexio\_i2s\_edma\_callback\_t)(*FLEXIO\_I2S\_Type* \*base, flexio\_i2s\_edma\_handle\_t  
\*handle, *status\_t* status, void \*userData)

FlexIO I2S eDMA transfer callback function for finish and error.

struct flexio\_i2s\_edma\_handle

#include <fsl\_flexio\_i2s\_edma.h> FlexIO I2S DMA transfer handle, users should not touch the  
content of the handle.

#### Public Members

edma\_handle\_t \*dmaHandle

DMA handler for FlexIO I2S send

uint8\_t bytesPerFrame

Bytes in a frame

uint8\_t nbytes

eDMA minor byte transfer count initially configured.

`uint32_t state`  
Internal state for FlexIO I2S eDMA transfer

`flexio_i2s_edma_callback_t callback`  
Callback for users while transfer finish or error occurred

`void *userData`  
User callback parameter

`edma_tcd_t tcd[(4U) + 1U]`  
TCD pool for eDMA transfer.

`flexio_i2s_transfer_t queue[(4U)]`  
Transfer queue storing queued transfer.

`size_t transferSize[(4U)]`  
Data bytes need to transfer

`volatile uint8_t queueUser`  
Index for user to queue transfer.

`volatile uint8_t queueDriver`  
Index for driver to get the transfer data and size

## 2.22 FlexIO eDMA SPI Driver

`status_t FLEXIO_SPI_MasterTransferCreateHandleEDMA(FLEXIO_SPI_Type *base,`  
`flexio_spi_master_edma_handle_t`  
`*handle,`  
`flexio_spi_master_edma_transfer_callback_t`  
`callback, void *userData,`  
`edma_handle_t *txHandle,`  
`edma_handle_t *rxHandle)`

Initializes the FlexIO SPI master eDMA handle.

This function initializes the FlexIO SPI master eDMA handle which can be used for other FlexIO SPI master transactional APIs. For a specified FlexIO SPI instance, call this API once to get the initialized handle.

### Parameters

- `base` – Pointer to `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to `flexio_spi_master_edma_handle_t` structure to store the transfer state.
- `callback` – SPI callback, NULL means no callback.
- `userData` – callback function parameter.
- `txHandle` – User requested eDMA handle for FlexIO SPI RX eDMA transfer.
- `rxHandle` – User requested eDMA handle for FlexIO SPI TX eDMA transfer.

### Return values

- `kStatus_Success` – Successfully create the handle.
- `kStatus_OutOfRange` – The FlexIO SPI eDMA type/handle table out of range.



```
status_t FLEXIO_SPI_MasterTransferEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_master_edma_handle_t *handle,
 flexio_spi_transfer_t *xfer)
```

Performs a non-blocking FlexIO SPI transfer using eDMA.

---

**Note:** This interface returns immediately after transfer initiates. Call FLEXIO\_SPI\_MasterGetTransferCountEDMA to poll the transfer status and check whether the FlexIO SPI transfer is finished.

---

#### Parameters

- base – Pointer to FLEXIO\_SPI\_Type structure.
- handle – Pointer to flexio\_spi\_master\_edma\_handle\_t structure to store the transfer state.
- xfer – Pointer to FlexIO SPI transfer structure.

#### Return values

- kStatus\_Success – Successfully start a transfer.
- kStatus\_InvalidArgument – Input argument is invalid.
- kStatus\_FLEXIO\_SPI\_Busy – FlexIO SPI is not idle, is running another transfer.

```
void FLEXIO_SPI_MasterTransferAbortEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_master_edma_handle_t *handle)
```

Aborts a FlexIO SPI transfer using eDMA.

#### Parameters

- base – Pointer to FLEXIO\_SPI\_Type structure.
- handle – FlexIO SPI eDMA handle pointer.

```
status_t FLEXIO_SPI_MasterTransferGetCountEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_master_edma_handle_t *handle,
 size_t *count)
```

Gets the number of bytes transferred so far using FlexIO SPI master eDMA.

#### Parameters

- base – Pointer to FLEXIO\_SPI\_Type structure.
- handle – FlexIO SPI eDMA handle pointer.
- count – Number of bytes transferred so far by the non-blocking transaction.

```
static inline void FLEXIO_SPI_SlaveTransferCreateHandleEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_slave_edma_handle_t
 *handle,
 flexio_spi_slave_edma_transfer_callback_t
 callback, void *userData,
 edma_handle_t *txHandle,
 edma_handle_t *rxHandle)
```

Initializes the FlexIO SPI slave eDMA handle.

This function initializes the FlexIO SPI slave eDMA handle.

#### Parameters

- base – Pointer to FLEXIO\_SPI\_Type structure.

- `handle` – Pointer to `flexio_spi_slave_edma_handle_t` structure to store the transfer state.
- `callback` – SPI callback, NULL means no callback.
- `userData` – callback function parameter.
- `txHandle` – User requested eDMA handle for FlexIO SPI TX eDMA transfer.
- `rxHandle` – User requested eDMA handle for FlexIO SPI RX eDMA transfer.

```
status_t FLEXIO_SPI_SlaveTransferEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_slave_edma_handle_t *handle,
 flexio_spi_transfer_t *xfer)
```

Performs a non-blocking FlexIO SPI transfer using eDMA.

---

**Note:** This interface returns immediately after transfer initiates. Call `FLEXIO_SPI_SlaveGetTransferCountEDMA` to poll the transfer status and check whether the FlexIO SPI transfer is finished.

---

#### Parameters

- `base` – Pointer to `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to `flexio_spi_slave_edma_handle_t` structure to store the transfer state.
- `xfer` – Pointer to FlexIO SPI transfer structure.

#### Return values

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_FLEXIO_SPI_Busy` – FlexIO SPI is not idle, is running another transfer.

```
static inline void FLEXIO_SPI_SlaveTransferAbortEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_slave_edma_handle_t
 *handle)
```

Aborts a FlexIO SPI transfer using eDMA.

#### Parameters

- `base` – Pointer to `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to `flexio_spi_slave_edma_handle_t` structure to store the transfer state.

```
static inline status_t FLEXIO_SPI_SlaveTransferGetCountEDMA(FLEXIO_SPI_Type *base,
 flexio_spi_slave_edma_handle_t
 *handle, size_t *count)
```

Gets the number of bytes transferred so far using FlexIO SPI slave eDMA.

#### Parameters

- `base` – Pointer to `FLEXIO_SPI_Type` structure.
- `handle` – FlexIO SPI eDMA handle pointer.
- `count` – Number of bytes transferred so far by the non-blocking transaction.

```
FSL_FLEXIO_SPI_EDMA_DRIVER_VERSION
```

FlexIO SPI EDMA driver version.

```
typedef struct flexio_spi_master_edma_handle flexio_spi_master_edma_handle_t
 typedef for flexio_spi_master_edma_handle_t in advance.
```

```
typedef flexio_spi_master_edma_handle_t flexio_spi_slave_edma_handle_t
 Slave handle is the same with master handle.
```

```
typedef void (*flexio_spi_master_edma_transfer_callback_t)(FLEXIO_SPI_Type *base,
flexio_spi_master_edma_handle_t *handle, status_t status, void *userData)
```

FlexIO SPI master callback for finished transmit.

```
typedef void (*flexio_spi_slave_edma_transfer_callback_t)(FLEXIO_SPI_Type *base,
flexio_spi_slave_edma_handle_t *handle, status_t status, void *userData)
```

FlexIO SPI slave callback for finished transmit.

```
struct flexio_spi_master_edma_handle
 #include <fsl_flexio_spi_edma.h> FlexIO SPI eDMA transfer handle, users should not touch
 the content of the handle.
```

### Public Members

*size\_t* transferSize

Total bytes to be transferred.

*uint8\_t* nbytes

eDMA minor byte transfer count initially configured.

*bool* txInProgress

Send transfer in progress

*bool* rxInProgress

Receive transfer in progress

*edma\_handle\_t* \*txHandle

DMA handler for SPI send

*edma\_handle\_t* \*rxHandle

DMA handler for SPI receive

*flexio\_spi\_master\_edma\_transfer\_callback\_t* callback

Callback for SPI DMA transfer

*void* \*userData

User Data for SPI DMA callback

## 2.23 FlexIO eDMA UART Driver

```
status_t FLEXIO_UART_TransferCreateHandleEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle,
 flexio_uart_edma_transfer_callback_t
 callback, void *userData, edma_handle_t
 *txEdmaHandle, edma_handle_t
 *rxEdmaHandle)
```

Initializes the UART handle which is used in transactional functions.

### Parameters

- base – Pointer to *FLEXIO\_UART\_Type*.
- handle – Pointer to *flexio\_uart\_edma\_handle\_t* structure.

- callback – The callback function.
- userData – The parameter of the callback function.
- rxEdmaHandle – User requested DMA handle for RX DMA transfer.
- txEdmaHandle – User requested DMA handle for TX DMA transfer.

**Return values**

- kStatus\_Success – Successfully create the handle.
- kStatus\_OutOfRange – The FlexIO SPI eDMA type/handle table out of range.

```
status_t FLEXIO_UART_TransferSendEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle,
 flexio_uart_transfer_t *xfer)
```

Sends data using eDMA.

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent out, the send callback function is called.

**Parameters**

- base – Pointer to FLEXIO\_UART\_Type
- handle – UART handle pointer.
- xfer – UART eDMA transfer structure, see flexio\_uart\_transfer\_t.

**Return values**

- kStatus\_Success – if succeed, others failed.
- kStatus\_FLEXIO\_UART\_TxBusy – Previous transfer on going.

```
status_t FLEXIO_UART_TransferReceiveEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle,
 flexio_uart_transfer_t *xfer)
```

Receives data using eDMA.

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

**Parameters**

- base – Pointer to FLEXIO\_UART\_Type
- handle – Pointer to flexio\_uart\_edma\_handle\_t structure
- xfer – UART eDMA transfer structure, see flexio\_uart\_transfer\_t.

**Return values**

- kStatus\_Success – if succeed, others failed.
- kStatus\_UART\_RxBusy – Previous transfer on going.

```
void FLEXIO_UART_TransferAbortSendEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle)
```

Aborts the sent data which using eDMA.

This function aborts sent data which using eDMA.

**Parameters**

- base – Pointer to FLEXIO\_UART\_Type
- handle – Pointer to flexio\_uart\_edma\_handle\_t structure

```
void FLEXIO_UART_TransferAbortReceiveEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle)
```

Aborts the receive data which using eDMA.

This function aborts the receive data which using eDMA.

#### Parameters

- base – Pointer to *FLEXIO\_UART\_Type*
- handle – Pointer to *flexio\_uart\_edma\_handle\_t* structure

```
status_t FLEXIO_UART_TransferGetSendCountEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle,
 size_t *count)
```

Gets the number of bytes sent out.

This function gets the number of bytes sent out.

#### Parameters

- base – Pointer to *FLEXIO\_UART\_Type*
- handle – Pointer to *flexio\_uart\_edma\_handle\_t* structure
- count – Number of bytes sent so far by the non-blocking transaction.

#### Return values

- *kStatus\_NoTransferInProgress* – transfer has finished or no transfer in progress.
- *kStatus\_Success* – Successfully return the count.

```
status_t FLEXIO_UART_TransferGetReceiveCountEDMA(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle,
 size_t *count)
```

Gets the number of bytes received.

This function gets the number of bytes received.

#### Parameters

- base – Pointer to *FLEXIO\_UART\_Type*
- handle – Pointer to *flexio\_uart\_edma\_handle\_t* structure
- count – Number of bytes received so far by the non-blocking transaction.

#### Return values

- *kStatus\_NoTransferInProgress* – transfer has finished or no transfer in progress.
- *kStatus\_Success* – Successfully return the count.

```
FSL_FLEXIO_UART_EDMA_DRIVER_VERSION
```

FlexIO UART EDMA driver version.

```
typedef struct flexio_uart_edma_handle flexio_uart_edma_handle_t
```

```
typedef void (*flexio_uart_edma_transfer_callback_t)(FLEXIO_UART_Type *base,
 flexio_uart_edma_handle_t *handle, status_t status, void *userData)
```

UART transfer callback function.

```
struct flexio_uart_edma_handle
```

```
#include <fsl_flexio_uart_edma.h> UART eDMA handle.
```

## Public Members

*flexio\_uart\_edma\_transfer\_callback\_t* callback

Callback function.

*void \*userData*

UART callback function parameter.

*size\_t txDataSizeAll*

Total bytes to be sent.

*size\_t rxDataSizeAll*

Total bytes to be received.

*edma\_handle\_t \*txEdmaHandle*

The eDMA TX channel used.

*edma\_handle\_t \*rxEdmaHandle*

The eDMA RX channel used.

*uint8\_t nbytes*

eDMA minor byte transfer count initially configured.

*volatile uint8\_t txState*

TX transfer state.

*volatile uint8\_t rxState*

RX transfer state

## 2.24 FlexIO I2C Master Driver

*status\_t* FLEXIO\_I2C\_CheckForBusyBus(*FLEXIO\_I2C\_Type \*base*)

Make sure the bus isn't already pulled down.

Check the FLEXIO pin status to see whether either of SDA and SCL pin is pulled down.

### Parameters

- *base* – Pointer to *FLEXIO\_I2C\_Type* structure..

### Return values

- *kStatus\_Success* –
- *kStatus\_FLEXIO\_I2C\_Busy* –

*status\_t* FLEXIO\_I2C\_MasterInit(*FLEXIO\_I2C\_Type \*base*, *flexio\_i2c\_master\_config\_t \*masterConfig*, *uint32\_t srcClock\_Hz*)

Ungates the FlexIO clock, resets the FlexIO module, and configures the FlexIO I2C hardware configuration.

### Example

```

FLEXIO_I2C_Type base = {
 .flexioBase = FLEXIO,
 .SDAPinIndex = 0,
 .SCLPinIndex = 1,
 .shifterIndex = {0,1},
 .timerIndex = {0,1}
};
flexio_i2c_master_config_t config = {
 .enableInDoze = false,

```

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```
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 100000
};
FLEXIO_I2C_MasterInit(base, &config, srcClock_Hz);
```

### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.
- masterConfig – Pointer to flexio\_i2c\_master\_config\_t structure.
- srcClock\_Hz – FlexIO source clock in Hz.

### Return values

- kStatus\_Success – Initialization successful
- kStatus\_InvalidArgument – The source clock exceed upper range limitation

void FLEXIO\_I2C\_MasterDeinit(*FLEXIO\_I2C\_Type* \*base)

De-initializes the FlexIO I2C master peripheral. Calling this API Resets the FlexIO I2C master shifer and timer config, module can't work unless the FLEXIO\_I2C\_MasterInit is called.

### Parameters

- base – pointer to FLEXIO\_I2C\_Type structure.

void FLEXIO\_I2C\_MasterGetDefaultConfig(*flexio\_i2c\_master\_config\_t* \*masterConfig)

Gets the default configuration to configure the FlexIO module. The configuration can be used directly for calling the FLEXIO\_I2C\_MasterInit().

Example:

```
flexio_i2c_master_config_t config;
FLEXIO_I2C_MasterGetDefaultConfig(&config);
```

### Parameters

- masterConfig – Pointer to flexio\_i2c\_master\_config\_t structure.

static inline void FLEXIO\_I2C\_MasterEnable(*FLEXIO\_I2C\_Type* \*base, bool enable)

Enables/disables the FlexIO module operation.

### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.
- enable – Pass true to enable module, false does not have any effect.

uint32\_t FLEXIO\_I2C\_MasterGetStatusFlags(*FLEXIO\_I2C\_Type* \*base)

Gets the FlexIO I2C master status flags.

### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure

### Returns

Status flag, use status flag to AND `_flexio_i2c_master_status_flags` can get the related status.

void FLEXIO\_I2C\_MasterClearStatusFlags(*FLEXIO\_I2C\_Type* \*base, uint32\_t mask)

Clears the FlexIO I2C master status flags.

### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.

- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO\_I2C\_RxFullFlag
  - kFLEXIO\_I2C\_ReceiveNakFlag

void FLEXIO\_I2C\_MasterEnableInterrupts(*FLEXIO\_I2C\_Type* \*base, uint32\_t mask)

Enables the FlexIO i2c master interrupt requests.

#### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.
- mask – Interrupt source. Currently only one interrupt request source:
  - kFLEXIO\_I2C\_TransferCompleteInterruptEnable

void FLEXIO\_I2C\_MasterDisableInterrupts(*FLEXIO\_I2C\_Type* \*base, uint32\_t mask)

Disables the FlexIO I2C master interrupt requests.

#### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.
- mask – Interrupt source.

void FLEXIO\_I2C\_MasterSetBaudRate(*FLEXIO\_I2C\_Type* \*base, uint32\_t baudRate\_Bps, uint32\_t srcClock\_Hz)

Sets the FlexIO I2C master transfer baudrate.

#### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure
- baudRate\_Bps – the baud rate value in HZ
- srcClock\_Hz – source clock in HZ

void FLEXIO\_I2C\_MasterStart(*FLEXIO\_I2C\_Type* \*base, uint8\_t address, *flexio\_i2c\_direction\_t* direction)

Sends START + 7-bit address to the bus.

---

**Note:** This API should be called when the transfer configuration is ready to send a START signal and 7-bit address to the bus. This is a non-blocking API, which returns directly after the address is put into the data register but the address transfer is not finished on the bus. Ensure that the kFLEXIO\_I2C\_RxFullFlag status is asserted before calling this API.

---

#### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.
- address – 7-bit address.
- direction – transfer direction. This parameter is one of the values in *flexio\_i2c\_direction\_t*:
  - kFLEXIO\_I2C\_Write: Transmit
  - kFLEXIO\_I2C\_Read: Receive

void FLEXIO\_I2C\_MasterStop(*FLEXIO\_I2C\_Type* \*base)

Sends the stop signal on the bus.

#### Parameters

- base – Pointer to FLEXIO\_I2C\_Type structure.



void FLEXIO\_I2C\_MasterRepeatedStart(*FLEXIO\_I2C\_Type* \*base)

Sends the repeated start signal on the bus.

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.

void FLEXIO\_I2C\_MasterAbortStop(*FLEXIO\_I2C\_Type* \*base)

Sends the stop signal when transfer is still on-going.

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.

void FLEXIO\_I2C\_MasterEnableAck(*FLEXIO\_I2C\_Type* \*base, bool enable)

Configures the sent ACK/NAK for the following byte.

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.
- enable – True to configure send ACK, false configure to send NAK.

*status\_t* FLEXIO\_I2C\_MasterSetTransferCount(*FLEXIO\_I2C\_Type* \*base, uint16\_t count)

Sets the number of bytes to be transferred from a start signal to a stop signal.

---

**Note:** Call this API before a transfer begins because the timer generates a number of clocks according to the number of bytes that need to be transferred.

---

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.
- count – Number of bytes need to be transferred from a start signal to a re-start/stop signal

**Return values**

- kStatus\_Success – Successfully configured the count.
- kStatus\_InvalidArgument – Input argument is invalid.

static inline void FLEXIO\_I2C\_MasterWriteByte(*FLEXIO\_I2C\_Type* \*base, uint32\_t data)

Writes one byte of data to the I2C bus.

---

**Note:** This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

---

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.
- data – a byte of data.

static inline uint8\_t FLEXIO\_I2C\_MasterReadByte(*FLEXIO\_I2C\_Type* \*base)

Reads one byte of data from the I2C bus.

---

**Note:** This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the data is ready in the register.

---

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.

**Returns**

data byte read.

*status\_t* FLEXIO\_I2C\_MasterWriteBlocking(*FLEXIO\_I2C\_Type* \*base, const uint8\_t \*txBuff, uint8\_t txSize)

Sends a buffer of data in bytes.

---

**Note:** This function blocks via polling until all bytes have been sent.

---

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.
- txBuff – The data bytes to send.
- txSize – The number of data bytes to send.

**Return values**

- kStatus\_Success – Successfully write data.
- kStatus\_FLEXIO\_I2C\_Nak – Receive NAK during writing data.
- kStatus\_FLEXIO\_I2C\_Timeout – Timeout polling status flags.

*status\_t* FLEXIO\_I2C\_MasterReadBlocking(*FLEXIO\_I2C\_Type* \*base, uint8\_t \*rxBuff, uint8\_t rxSize)

Receives a buffer of bytes.

---

**Note:** This function blocks via polling until all bytes have been received.

---

**Parameters**

- base – Pointer to FLEXIO\_I2C\_Type structure.
- rxBuff – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

**Return values**

- kStatus\_Success – Successfully read data.
- kStatus\_FLEXIO\_I2C\_Timeout – Timeout polling status flags.

*status\_t* FLEXIO\_I2C\_MasterTransferBlocking(*FLEXIO\_I2C\_Type* \*base, *flexio\_i2c\_master\_transfer\_t* \*xfer)

Performs a master polling transfer on the I2C bus.

---

**Note:** The API does not return until the transfer succeeds or fails due to receiving NAK.

---

**Parameters**

- base – pointer to FLEXIO\_I2C\_Type structure.
- xfer – pointer to flexio\_i2c\_master\_transfer\_t structure.

**Returns**

status of status\_t.

```
status_t FLEXIO_I2C_MasterTransferCreateHandle(FLEXIO_I2C_Type *base,
 flexio_i2c_master_handle_t *handle,
 flexio_i2c_master_transfer_callback_t
 callback, void *userData)
```

Initializes the I2C handle which is used in transactional functions.

#### Parameters

- base – Pointer to *FLEXIO\_I2C\_Type* structure.
- handle – Pointer to *flexio\_i2c\_master\_handle\_t* structure to store the transfer state.
- callback – Pointer to user callback function.
- userData – User param passed to the callback function.

#### Return values

- *kStatus\_Success* – Successfully create the handle.
- *kStatus\_OutOfRange* – The FlexIO type/handle/isr table out of range.

```
status_t FLEXIO_I2C_MasterTransferNonBlocking(FLEXIO_I2C_Type *base,
 flexio_i2c_master_handle_t *handle,
 flexio_i2c_master_transfer_t *xfer)
```

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

---

**Note:** The API returns immediately after the transfer initiates. Call *FLEXIO\_I2C\_MasterTransferGetCount* to poll the transfer status to check whether the transfer is finished. If the return status is not *kStatus\_FLEXIO\_I2C\_Busy*, the transfer is finished.

---

#### Parameters

- base – Pointer to *FLEXIO\_I2C\_Type* structure
- handle – Pointer to *flexio\_i2c\_master\_handle\_t* structure which stores the transfer state
- xfer – pointer to *flexio\_i2c\_master\_transfer\_t* structure

#### Return values

- *kStatus\_Success* – Successfully start a transfer.
- *kStatus\_FLEXIO\_I2C\_Busy* – FlexIO I2C is not idle, is running another transfer.

```
status_t FLEXIO_I2C_MasterTransferGetCount(FLEXIO_I2C_Type *base,
 flexio_i2c_master_handle_t *handle, size_t
 *count)
```

Gets the master transfer status during a interrupt non-blocking transfer.

#### Parameters

- base – Pointer to *FLEXIO\_I2C\_Type* structure.
- handle – Pointer to *flexio\_i2c\_master\_handle\_t* structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

#### Return values

- *kStatus\_InvalidArgument* – count is Invalid.

- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.
- `kStatus_Success` – Successfully return the count.

`void FLEXIO_I2C_MasterTransferAbort(FLEXIO_I2C_Type *base, flexio_i2c_master_handle_t *handle)`

Aborts an interrupt non-blocking transfer early.

---

**Note:** This API can be called at any time when an interrupt non-blocking transfer initiates to abort the transfer early.

---

#### Parameters

- `base` – Pointer to `FLEXIO_I2C_Type` structure
- `handle` – Pointer to `flexio_i2c_master_handle_t` structure which stores the transfer state

`void FLEXIO_I2C_MasterTransferHandleIRQ(void *i2cType, void *i2cHandle)`

Master interrupt handler.

#### Parameters

- `i2cType` – Pointer to `FLEXIO_I2C_Type` structure
- `i2cHandle` – Pointer to `flexio_i2c_master_transfer_t` structure

`FSL_FLEXIO_I2C_MASTER_DRIVER_VERSION`

FlexIO I2C transfer status.

*Values:*

enumerator `kStatus_FLEXIO_I2C_Busy`  
I2C is busy doing transfer.

enumerator `kStatus_FLEXIO_I2C_Idle`  
I2C is busy doing transfer.

enumerator `kStatus_FLEXIO_I2C_Nak`  
NAK received during transfer.

enumerator `kStatus_FLEXIO_I2C_Timeout`  
Timeout polling status flags.

enum `_flexio_i2c_master_interrupt`

Define FlexIO I2C master interrupt mask.

*Values:*

enumerator `kFLEXIO_I2C_TxEmptyInterruptEnable`  
Tx buffer empty interrupt enable.

enumerator `kFLEXIO_I2C_RxFullInterruptEnable`  
Rx buffer full interrupt enable.

enum `_flexio_i2c_master_status_flags`

Define FlexIO I2C master status mask.

*Values:*

enumerator kFLEXIO\_I2C\_TxEmptyFlag  
Tx shifter empty flag.

enumerator kFLEXIO\_I2C\_RxFullFlag  
Rx shifter full/Transfer complete flag.

enumerator kFLEXIO\_I2C\_ReceiveNakFlag  
Receive NAK flag.

enum \_flexio\_i2c\_direction  
Direction of master transfer.  
*Values:*

enumerator kFLEXIO\_I2C\_Write  
Master send to slave.

enumerator kFLEXIO\_I2C\_Read  
Master receive from slave.

typedef enum *flexio\_i2c\_direction* flexio\_i2c\_direction\_t  
Direction of master transfer.

typedef struct *flexio\_i2c\_type* FLEXIO\_I2C\_Type  
Define FlexIO I2C master access structure typedef.

typedef struct *flexio\_i2c\_master\_config* flexio\_i2c\_master\_config\_t  
Define FlexIO I2C master user configuration structure.

typedef struct *flexio\_i2c\_master\_transfer* flexio\_i2c\_master\_transfer\_t  
Define FlexIO I2C master transfer structure.

typedef struct *flexio\_i2c\_master\_handle* flexio\_i2c\_master\_handle\_t  
FlexIO I2C master handle typedef.

typedef void (\*flexio\_i2c\_master\_transfer\_callback\_t)(FLEXIO\_I2C\_Type \*base,  
*flexio\_i2c\_master\_handle\_t* \*handle, *status\_t* status, void \*userData)  
FlexIO I2C master transfer callback typedef.

I2C\_RETRY\_TIMES  
Retry times for waiting flag.

struct \_flexio\_i2c\_type  
*#include <fsl\_flexio\_i2c\_master.h>* Define FlexIO I2C master access structure typedef.

### Public Members

FLEXIO\_Type \*flexioBase  
FlexIO base pointer.

uint8\_t SDAPinIndex  
Pin select for I2C SDA.

uint8\_t SCLPinIndex  
Pin select for I2C SCL.

uint8\_t shifterIndex[2]  
Shifter index used in FlexIO I2C.

uint8\_t timerIndex[3]  
Timer index used in FlexIO I2C.

uint32\_t baudrate

Master transfer baudrate, used to calculate delay time.

struct \_flexio\_i2c\_master\_config

*#include <fsl\_flexio\_i2c\_master.h>* Define FlexIO I2C master user configuration structure.

### Public Members

bool enableMaster

Enables the FlexIO I2C peripheral at initialization time.

bool enableInDoze

Enable/disable FlexIO operation in doze mode.

bool enableInDebug

Enable/disable FlexIO operation in debug mode.

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32\_t baudRate\_Bps

Baud rate in Bps.

struct \_flexio\_i2c\_master\_transfer

*#include <fsl\_flexio\_i2c\_master.h>* Define FlexIO I2C master transfer structure.

### Public Members

uint32\_t flags

Transfer flag which controls the transfer, reserved for FlexIO I2C.

uint8\_t slaveAddress

7-bit slave address.

*flexio\_i2c\_direction\_t* direction

Transfer direction, read or write.

uint32\_t subaddress

Sub address. Transferred MSB first.

uint8\_t subaddressSize

Size of sub address.

uint8\_t volatile \*data

Transfer buffer.

volatile size\_t dataSize

Transfer size.

struct \_flexio\_i2c\_master\_handle

*#include <fsl\_flexio\_i2c\_master.h>* Define FlexIO I2C master handle structure.

### Public Members

*flexio\_i2c\_master\_transfer\_t* transfer

FlexIO I2C master transfer copy.

size\_t transferSize

Total bytes to be transferred.

uint8\_t state

Transfer state maintained during transfer.

*flexio\_i2c\_master\_transfer\_callback\_t* completionCallback

Callback function called at transfer event. Callback function called at transfer event.

void \*userData

Callback parameter passed to callback function.

bool needRestart

Whether master needs to send re-start signal.

## 2.25 FlexIO I2S Driver

void FLEXIO\_I2S\_Init(*FLEXIO\_I2S\_Type* \*base, const *flexio\_i2s\_config\_t* \*config)

Initializes the FlexIO I2S.

This API configures FlexIO pins and shifter to I2S and configures the FlexIO I2S with a configuration structure. The configuration structure can be filled by the user, or be set with default values by FLEXIO\_I2S\_GetDefaultConfig().

---

**Note:** This API should be called at the beginning of the application to use the FlexIO I2S driver. Otherwise, any access to the FlexIO I2S module can cause hard fault because the clock is not enabled.

---

### Parameters

- base – FlexIO I2S base pointer
- config – FlexIO I2S configure structure.

void FLEXIO\_I2S\_GetDefaultConfig(*flexio\_i2s\_config\_t* \*config)

Sets the FlexIO I2S configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in FLEXIO\_I2S\_Init(). Users may use the initialized structure unchanged in FLEXIO\_I2S\_Init() or modify some fields of the structure before calling FLEXIO\_I2S\_Init().

### Parameters

- config – pointer to master configuration structure

void FLEXIO\_I2S\_Deinit(*FLEXIO\_I2S\_Type* \*base)

De-initializes the FlexIO I2S.

Calling this API resets the FlexIO I2S shifter and timer config. After calling this API, call the FLEXIO\_I2S\_Init to use the FlexIO I2S module.

### Parameters

- base – FlexIO I2S base pointer

static inline void FLEXIO\_I2S\_Enable(*FLEXIO\_I2S\_Type* \*base, bool enable)

Enables/disables the FlexIO I2S module operation.

### Parameters

- base – Pointer to FLEXIO\_I2S\_Type

- enable – True to enable, false dose not have any effect.

uint32\_t FLEXIO\_I2S\_GetStatusFlags(*FLEXIO\_I2S\_Type* \*base)

Gets the FlexIO I2S status flags.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure

#### Returns

Status flag, which are ORed by the enumerators in the `_flexio_i2s_status_flags`.

void FLEXIO\_I2S\_EnableInterrupts(*FLEXIO\_I2S\_Type* \*base, uint32\_t mask)

Enables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure
- mask – interrupt source

void FLEXIO\_I2S\_DisableInterrupts(*FLEXIO\_I2S\_Type* \*base, uint32\_t mask)

Disables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

#### Parameters

- base – pointer to FLEXIO\_I2S\_Type structure
- mask – interrupt source

static inline void FLEXIO\_I2S\_TxEnableDMA(*FLEXIO\_I2S\_Type* \*base, bool enable)

Enables/disables the FlexIO I2S Tx DMA requests.

#### Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline void FLEXIO\_I2S\_RxEnableDMA(*FLEXIO\_I2S\_Type* \*base, bool enable)

Enables/disables the FlexIO I2S Rx DMA requests.

#### Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline uint32\_t FLEXIO\_I2S\_TxGetDataRegisterAddress(*FLEXIO\_I2S\_Type* \*base)

Gets the FlexIO I2S send data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure

#### Returns

FlexIO i2s send data register address.

static inline uint32\_t FLEXIO\_I2S\_RxGetDataRegisterAddress(*FLEXIO\_I2S\_Type* \*base)

Gets the FlexIO I2S receive data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure



**Returns**

FlexIO I2S receive data register address.

```
void FLEXIO_I2S_MasterSetFormat(FLEXIO_I2S_Type *base, flexio_i2s_format_t *format,
 uint32_t srcClock_Hz)
```

Configures the FlexIO I2S audio format in master mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

**Parameters**

- base – Pointer to *FLEXIO\_I2S\_Type* structure
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock\_Hz – I2S master clock source frequency in Hz.

```
void FLEXIO_I2S_SlaveSetFormat(FLEXIO_I2S_Type *base, flexio_i2s_format_t *format)
```

Configures the FlexIO I2S audio format in slave mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

**Parameters**

- base – Pointer to *FLEXIO\_I2S\_Type* structure
- format – Pointer to FlexIO I2S audio data format structure.

```
status_t FLEXIO_I2S_WriteBlocking(FLEXIO_I2S_Type *base, uint8_t bitWidth, uint8_t *txData,
 size_t size)
```

Sends data using a blocking method.

---

**Note:** This function blocks via polling until data is ready to be sent.

---

**Parameters**

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- txData – Pointer to the data to be written.
- size – Bytes to be written.

**Return values**

- kStatus\_Success – Successfully write data.
- kStatus\_FLEXIO\_I2C\_Timeout – Timeout polling status flags.

```
static inline void FLEXIO_I2S_WriteData(FLEXIO_I2S_Type *base, uint8_t bitWidth, uint32_t
 data)
```

Writes data into a data register.

**Parameters**

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- data – Data to be written.

*status\_t* FLEXIO\_I2S\_ReadBlocking(*FLEXIO\_I2S\_Type* \*base, uint8\_t bitWidth, uint8\_t \*rxData, size\_t size)

Receives a piece of data using a blocking method.

---

**Note:** This function blocks via polling until data is ready to be sent.

---

#### Parameters

- base – FlexIO I2S base pointer
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- rxData – Pointer to the data to be read.
- size – Bytes to be read.

#### Return values

- kStatus\_Success – Successfully read data.
- kStatus\_FLEXIO\_I2C\_Timeout – Timeout polling status flags.

static inline uint32\_t FLEXIO\_I2S\_ReadData(*FLEXIO\_I2S\_Type* \*base)

Reads a data from the data register.

#### Parameters

- base – FlexIO I2S base pointer

#### Returns

Data read from data register.

void FLEXIO\_I2S\_TransferTxCreateHandle(*FLEXIO\_I2S\_Type* \*base, *flexio\_i2s\_handle\_t* \*handle, *flexio\_i2s\_callback\_t* callback, void \*userData)

Initializes the FlexIO I2S handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure
- handle – Pointer to flexio\_i2s\_handle\_t structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

void FLEXIO\_I2S\_TransferSetFormat(*FLEXIO\_I2S\_Type* \*base, *flexio\_i2s\_handle\_t* \*handle, *flexio\_i2s\_format\_t* \*format, uint32\_t srcClock\_Hz)

Configures the FlexIO I2S audio format.

Audio format can be changed at run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

#### Parameters

- base – Pointer to FLEXIO\_I2S\_Type structure.
- handle – FlexIO I2S handle pointer.
- format – Pointer to audio data format structure.
- srcClock\_Hz – FlexIO I2S bit clock source frequency in Hz. This parameter should be 0 while in slave mode.

```
void FLEXIO_I2S_TransferRxCreateHandle(FLEXIO_I2S_Type *base, flexio_i2s_handle_t *handle,
 flexio_i2s_callback_t callback, void *userData)
```

Initializes the FlexIO I2S receive handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

#### Parameters

- base – Pointer to *FLEXIO\_I2S\_Type* structure.
- handle – Pointer to *flexio\_i2s\_handle\_t* structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

```
status_t FLEXIO_I2S_TransferSendNonBlocking(FLEXIO_I2S_Type *base, flexio_i2s_handle_t
 *handle, flexio_i2s_transfer_t *xfer)
```

Performs an interrupt non-blocking send transfer on FlexIO I2S.

---

**Note:** The API returns immediately after transfer initiates. Call *FLEXIO\_I2S\_GetRemainingBytes* to poll the transfer status and check whether the transfer is finished. If the return status is 0, the transfer is finished.

---

#### Parameters

- base – Pointer to *FLEXIO\_I2S\_Type* structure.
- handle – Pointer to *flexio\_i2s\_handle\_t* structure which stores the transfer state
- xfer – Pointer to *flexio\_i2s\_transfer\_t* structure

#### Return values

- *kStatus\_Success* – Successfully start the data transmission.
- *kStatus\_FLEXIO\_I2S\_TxBusy* – Previous transmission still not finished, data not all written to TX register yet.
- *kStatus\_InvalidArgument* – The input parameter is invalid.

```
status_t FLEXIO_I2S_TransferReceiveNonBlocking(FLEXIO_I2S_Type *base, flexio_i2s_handle_t
 *handle, flexio_i2s_transfer_t *xfer)
```

Performs an interrupt non-blocking receive transfer on FlexIO I2S.

---

**Note:** The API returns immediately after transfer initiates. Call *FLEXIO\_I2S\_GetRemainingBytes* to poll the transfer status to check whether the transfer is finished. If the return status is 0, the transfer is finished.

---

#### Parameters

- base – Pointer to *FLEXIO\_I2S\_Type* structure.
- handle – Pointer to *flexio\_i2s\_handle\_t* structure which stores the transfer state
- xfer – Pointer to *flexio\_i2s\_transfer\_t* structure

#### Return values

- *kStatus\_Success* – Successfully start the data receive.

- `kStatus_FLEXIO_I2S_RxBusy` – Previous receive still not finished.
- `kStatus_InvalidArgument` – The input parameter is invalid.

`void FLEXIO_I2S_TransferAbortSend(FLEXIO_I2S_Type *base, flexio_i2s_handle_t *handle)`  
Aborts the current send.

---

**Note:** This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

---

#### Parameters

- `base` – Pointer to `FLEXIO_I2S_Type` structure.
- `handle` – Pointer to `flexio_i2s_handle_t` structure which stores the transfer state

`void FLEXIO_I2S_TransferAbortReceive(FLEXIO_I2S_Type *base, flexio_i2s_handle_t *handle)`  
Aborts the current receive.

---

**Note:** This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

---

#### Parameters

- `base` – Pointer to `FLEXIO_I2S_Type` structure.
- `handle` – Pointer to `flexio_i2s_handle_t` structure which stores the transfer state

`status_t FLEXIO_I2S_TransferGetSendCount(FLEXIO_I2S_Type *base, flexio_i2s_handle_t *handle, size_t *count)`

Gets the remaining bytes to be sent.

#### Parameters

- `base` – Pointer to `FLEXIO_I2S_Type` structure.
- `handle` – Pointer to `flexio_i2s_handle_t` structure which stores the transfer state
- `count` – Bytes sent.

#### Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.

`status_t FLEXIO_I2S_TransferGetReceiveCount(FLEXIO_I2S_Type *base, flexio_i2s_handle_t *handle, size_t *count)`

Gets the remaining bytes to be received.

#### Parameters

- `base` – Pointer to `FLEXIO_I2S_Type` structure.
- `handle` – Pointer to `flexio_i2s_handle_t` structure which stores the transfer state
- `count` – Bytes recieved.

#### Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.

**Returns**

count Bytes received.

`void FLEXIO_I2S_TransferTxHandleIRQ(void *i2sBase, void *i2sHandle)`

Tx interrupt handler.

**Parameters**

- `i2sBase` – Pointer to `FLEXIO_I2S_Type` structure.
- `i2sHandle` – Pointer to `flexio_i2s_handle_t` structure

`void FLEXIO_I2S_TransferRxHandleIRQ(void *i2sBase, void *i2sHandle)`

Rx interrupt handler.

**Parameters**

- `i2sBase` – Pointer to `FLEXIO_I2S_Type` structure.
- `i2sHandle` – Pointer to `flexio_i2s_handle_t` structure.

`FSL_FLEXIO_I2S_DRIVER_VERSION`

FlexIO I2S driver version 2.2.2.

FlexIO I2S transfer status.

*Values:*

enumerator `kStatus_FLEXIO_I2S_Idle`

FlexIO I2S is in idle state

enumerator `kStatus_FLEXIO_I2S_TxBusy`

FlexIO I2S Tx is busy

enumerator `kStatus_FLEXIO_I2S_RxBusy`

FlexIO I2S Rx is busy

enumerator `kStatus_FLEXIO_I2S_Error`

FlexIO I2S error occurred

enumerator `kStatus_FLEXIO_I2S_QueueFull`

FlexIO I2S transfer queue is full.

enumerator `kStatus_FLEXIO_I2S_Timeout`

FlexIO I2S timeout polling status flags.

enum `_flexio_i2s_master_slave`

Master or slave mode.

*Values:*

enumerator `kFLEXIO_I2S_Master`

Master mode

enumerator `kFLEXIO_I2S_Slave`

Slave mode

`_flexio_i2s_interrupt_enable` Define FlexIO FlexIO I2S interrupt mask.

*Values:*

enumerator kFLEXIO\_I2S\_TxDataRegEmptyInterruptEnable  
Transmit buffer empty interrupt enable.

enumerator kFLEXIO\_I2S\_RxDataRegFullInterruptEnable  
Receive buffer full interrupt enable.

\_flexio\_i2s\_status\_flags Define FlexIO FlexIO I2S status mask.

*Values:*

enumerator kFLEXIO\_I2S\_TxDataRegEmptyFlag  
Transmit buffer empty flag.

enumerator kFLEXIO\_I2S\_RxDataRegFullFlag  
Receive buffer full flag.

enum \_flexio\_i2s\_sample\_rate  
Audio sample rate.

*Values:*

enumerator kFLEXIO\_I2S\_SampleRate8KHz  
Sample rate 8000Hz

enumerator kFLEXIO\_I2S\_SampleRate11025Hz  
Sample rate 11025Hz

enumerator kFLEXIO\_I2S\_SampleRate12KHz  
Sample rate 12000Hz

enumerator kFLEXIO\_I2S\_SampleRate16KHz  
Sample rate 16000Hz

enumerator kFLEXIO\_I2S\_SampleRate22050Hz  
Sample rate 22050Hz

enumerator kFLEXIO\_I2S\_SampleRate24KHz  
Sample rate 24000Hz

enumerator kFLEXIO\_I2S\_SampleRate32KHz  
Sample rate 32000Hz

enumerator kFLEXIO\_I2S\_SampleRate44100Hz  
Sample rate 44100Hz

enumerator kFLEXIO\_I2S\_SampleRate48KHz  
Sample rate 48000Hz

enumerator kFLEXIO\_I2S\_SampleRate96KHz  
Sample rate 96000Hz

enum \_flexio\_i2s\_word\_width  
Audio word width.

*Values:*

enumerator kFLEXIO\_I2S\_WordWidth8bits  
Audio data width 8 bits

enumerator kFLEXIO\_I2S\_WordWidth16bits  
Audio data width 16 bits

enumerator `kFLEXIO_I2S_WordWidth24bits`  
Audio data width 24 bits

enumerator `kFLEXIO_I2S_WordWidth32bits`  
Audio data width 32 bits

typedef struct *flexio\_i2s\_type* FLEXIO\_I2S\_Type  
Define FlexIO I2S access structure typedef.

typedef enum *flexio\_i2s\_master\_slave* flexio\_i2s\_master\_slave\_t  
Master or slave mode.

typedef struct *flexio\_i2s\_config* flexio\_i2s\_config\_t  
FlexIO I2S configure structure.

typedef struct *flexio\_i2s\_format* flexio\_i2s\_format\_t  
FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

typedef enum *flexio\_i2s\_sample\_rate* flexio\_i2s\_sample\_rate\_t  
Audio sample rate.

typedef enum *flexio\_i2s\_word\_width* flexio\_i2s\_word\_width\_t  
Audio word width.

typedef struct *flexio\_i2s\_transfer* flexio\_i2s\_transfer\_t  
Define FlexIO I2S transfer structure.

typedef struct *flexio\_i2s\_handle* flexio\_i2s\_handle\_t

typedef void (\*flexio\_i2s\_callback\_t)(FLEXIO\_I2S\_Type \*base, flexio\_i2s\_handle\_t \*handle, status\_t status, void \*userData)  
FlexIO I2S xfer callback prototype.

I2S\_RETRY\_TIMES  
Retry times for waiting flag.

FLEXIO\_I2S\_XFER\_QUEUE\_SIZE  
FlexIO I2S transfer queue size, user can refine it according to use case.

struct *flexio\_i2s\_type*  
*#include <fsl\_flexio\_i2s.h>* Define FlexIO I2S access structure typedef.

### Public Members

FLEXIO\_Type \*flexioBase  
FlexIO base pointer

uint8\_t txPinIndex  
Tx data pin index in FlexIO pins

uint8\_t rxPinIndex  
Rx data pin index

uint8\_t bclkPinIndex  
Bit clock pin index

uint8\_t fsPinIndex  
Frame sync pin index

uint8\_t txShifterIndex  
Tx data shifter index

uint8\_t rxShifterIndex  
    Rx data shifter index

uint8\_t bclkTimerIndex  
    Bit clock timer index

uint8\_t fsTimerIndex  
    Frame sync timer index

struct \_\_flexio\_i2s\_config  
    #include <fsl\_flexio\_i2s.h> FlexIO I2S configure structure.

### Public Members

bool enableI2S  
    Enable FlexIO I2S

flexio\_i2s\_master\_slave\_t masterSlave  
    Master or slave

flexio\_pin\_polarity\_t txPinPolarity  
    Tx data pin polarity, active high or low

flexio\_pin\_polarity\_t rxPinPolarity  
    Rx data pin polarity

flexio\_pin\_polarity\_t bclkPinPolarity  
    Bit clock pin polarity

flexio\_pin\_polarity\_t fsPinPolarity  
    Frame sync pin polarity

flexio\_shifter\_timer\_polarity\_t txTimerPolarity  
    Tx data valid on bclk rising or falling edge

flexio\_shifter\_timer\_polarity\_t rxTimerPolarity  
    Rx data valid on bclk rising or falling edge

struct \_\_flexio\_i2s\_format  
    #include <fsl\_flexio\_i2s.h> FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

### Public Members

uint8\_t bitWidth  
    Bit width of audio data, always 8/16/24/32 bits

uint32\_t sampleRate\_Hz  
    Sample rate of the audio data

struct \_\_flexio\_i2s\_transfer  
    #include <fsl\_flexio\_i2s.h> Define FlexIO I2S transfer structure.

### Public Members

uint8\_t \*data  
    Data buffer start pointer



size\_t dataSize

Bytes to be transferred.

struct flexio\_i2s\_handle

#include <fsl\_flexio\_i2s.h> Define FlexIO I2S handle structure.

### Public Members

uint32\_t state

Internal state

flexio\_i2s\_callback\_t callback

Callback function called at transfer event

void \*userData

Callback parameter passed to callback function

uint8\_t bitWidth

Bit width for transfer, 8/16/24/32bits

flexio\_i2s\_transfer\_t queue[(4U)]

Transfer queue storing queued transfer

size\_t transferSize[(4U)]

Data bytes need to transfer

volatile uint8\_t queueUser

Index for user to queue transfer

volatile uint8\_t queueDriver

Index for driver to get the transfer data and size

## 2.26 FlexIO SPI Driver

```
void FLEXIO_SPI_MasterInit(FLEXIO_SPI_Type *base, flexio_spi_master_config_t
 *masterConfig, uint32_t srcClock_Hz)
```

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI master hardware, and configures the FlexIO SPI with FlexIO SPI master configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO\_SPI\_MasterGetDefaultConfig().

### Example

```
FLEXIO_SPI_Type spiDev = {
 .flexioBase = FLEXIO,
 .SDOPinIndex = 0,
 .SDIPinIndex = 1,
 .SCKPinIndex = 2,
 .CSnPinIndex = 3,
 .shifterIndex = {0,1},
 .timerIndex = {0,1}
};
flexio_spi_master_config_t config = {
 .enableMaster = true,
 .enableInDoze = false,
 .enableInDebug = true,
```

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(continued from previous page)

```
.enableFastAccess = false,
.baudRate_Bps = 500000,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_MasterInit(&spiDev, &config, srcClock_Hz);
```

**Note:** 1.FlexIO SPI master only support CPOL = 0, which means clock inactive low. 2.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI master communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by  $2*2=4$ . If FlexIO SPI master communicates with FlexIO SPI slave, the maximum baud rate is FlexIO clock frequency divided by  $(1.5+2.5)*2=8$ .

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type structure.
- masterConfig – Pointer to the flexio\_spi\_master\_config\_t structure.
- srcClock\_Hz – FlexIO source clock in Hz.

void FLEXIO\_SPI\_MasterDeinit(*FLEXIO\_SPI\_Type* \*base)

Resets the FlexIO SPI timer and shifter config.

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type.

void FLEXIO\_SPI\_MasterGetDefaultConfig(*flexio\_spi\_master\_config\_t* \*masterConfig)

Gets the default configuration to configure the FlexIO SPI master. The configuration can be used directly by calling the FLEXIO\_SPI\_MasterConfigure(). Example:

```
flexio_spi_master_config_t masterConfig;
FLEXIO_SPI_MasterGetDefaultConfig(&masterConfig);
```

### Parameters

- masterConfig – Pointer to the flexio\_spi\_master\_config\_t structure.

void FLEXIO\_SPI\_SlaveInit(*FLEXIO\_SPI\_Type* \*base, *flexio\_spi\_slave\_config\_t* \*slaveConfig)

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI slave hardware configuration, and configures the FlexIO SPI with FlexIO SPI slave configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO\_SPI\_SlaveGetDefaultConfig().

**Note:** 1.Only one timer is needed in the FlexIO SPI slave. As a result, the second timer index is ignored. 2.FlexIO SPI slave only support CPOL = 0, which means clock inactive low. 3.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI slave communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by  $3*2=6$ . If FlexIO SPI slave communicates with FlexIO SPI master, the maximum baud rate is FlexIO clock frequency divided by  $(1.5+2.5)*2=8$ . Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
```

(continues on next page)

(continued from previous page)

```
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0}
};
flexio_spi_slave_config_t config = {
.enableSlave = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_SlaveInit(&spiDev, &config);
```

---

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type structure.
- slaveConfig – Pointer to the flexio\_spi\_slave\_config\_t structure.

void FLEXIO\_SPI\_SlaveDeinit(*FLEXIO\_SPI\_Type* \*base)

Gates the FlexIO clock.

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type.

void FLEXIO\_SPI\_SlaveGetDefaultConfig(*flexio\_spi\_slave\_config\_t* \*slaveConfig)

Gets the default configuration to configure the FlexIO SPI slave. The configuration can be used directly for calling the FLEXIO\_SPI\_SlaveConfigure(). Example:

```
flexio_spi_slave_config_t slaveConfig;
FLEXIO_SPI_SlaveGetDefaultConfig(&slaveConfig);
```

### Parameters

- slaveConfig – Pointer to the flexio\_spi\_slave\_config\_t structure.

uint32\_t FLEXIO\_SPI\_GetStatusFlags(*FLEXIO\_SPI\_Type* \*base)

Gets FlexIO SPI status flags.

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type structure.

### Returns

status flag; Use the status flag to AND the following flag mask and get the status.

- kFLEXIO\_SPI\_TxEmptyFlag
- kFLEXIO\_SPI\_RxEmptyFlag

void FLEXIO\_SPI\_ClearStatusFlags(*FLEXIO\_SPI\_Type* \*base, uint32\_t mask)

Clears FlexIO SPI status flags.

### Parameters

- base – Pointer to the FLEXIO\_SPI\_Type structure.

- **mask** – status flag The parameter can be any combination of the following values:
  - kFLEXIO\_SPI\_TxEmptyFlag
  - kFLEXIO\_SPI\_RxEmptyFlag

void FLEXIO\_SPI\_EnableInterrupts(*FLEXIO\_SPI\_Type* \*base, uint32\_t mask)

Enables the FlexIO SPI interrupt.

This function enables the FlexIO SPI interrupt.

#### Parameters

- **base** – Pointer to the FLEXIO\_SPI\_Type structure.
- **mask** – interrupt source. The parameter can be any combination of the following values:
  - kFLEXIO\_SPI\_RxFullInterruptEnable
  - kFLEXIO\_SPI\_TxEmptyInterruptEnable

void FLEXIO\_SPI\_DisableInterrupts(*FLEXIO\_SPI\_Type* \*base, uint32\_t mask)

Disables the FlexIO SPI interrupt.

This function disables the FlexIO SPI interrupt.

#### Parameters

- **base** – Pointer to the FLEXIO\_SPI\_Type structure.
- **mask** – interrupt source The parameter can be any combination of the following values:
  - kFLEXIO\_SPI\_RxFullInterruptEnable
  - kFLEXIO\_SPI\_TxEmptyInterruptEnable

void FLEXIO\_SPI\_EnableDMA(*FLEXIO\_SPI\_Type* \*base, uint32\_t mask, bool enable)

Enables/disables the FlexIO SPI transmit DMA. This function enables/disables the FlexIO SPI Tx DMA, which means that asserting the kFLEXIO\_SPI\_TxEmptyFlag does/doesn't trigger the DMA request.

#### Parameters

- **base** – Pointer to the FLEXIO\_SPI\_Type structure.
- **mask** – SPI DMA source.
- **enable** – True means enable DMA, false means disable DMA.

static inline uint32\_t FLEXIO\_SPI\_GetTxDataRegisterAddress(*FLEXIO\_SPI\_Type* \*base,  
*flexio\_spi\_shift\_direction\_t*  
direction)

Gets the FlexIO SPI transmit data register address for MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

#### Parameters

- **base** – Pointer to the FLEXIO\_SPI\_Type structure.
- **direction** – Shift direction of MSB first or LSB first.

#### Returns

FlexIO SPI transmit data register address.

```
static inline uint32_t FLEXIO_SPI_GetRxDataRegisterAddress(FLEXIO_SPI_Type *base,
 flexio_spi_shift_direction_t
 direction)
```

Gets the FlexIO SPI receive data register address for the MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- direction – Shift direction of MSB first or LSB first.

#### Returns

FlexIO SPI receive data register address.

```
static inline void FLEXIO_SPI_Enable(FLEXIO_SPI_Type *base, bool enable)
```

Enables/disables the FlexIO SPI module operation.

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type*.
- enable – True to enable, false does not have any effect.

```
void FLEXIO_SPI_MasterSetBaudRate(FLEXIO_SPI_Type *base, uint32_t baudRate_Bps,
 uint32_t srcClockHz)
```

Sets baud rate for the FlexIO SPI transfer, which is only used for the master.

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- baudRate\_Bps – Baud Rate needed in Hz.
- srcClockHz – SPI source clock frequency in Hz.

```
static inline void FLEXIO_SPI_WriteData(FLEXIO_SPI_Type *base, flexio_spi_shift_direction_t
 direction, uint32_t data)
```

Writes one byte of data, which is sent using the MSB method.

---

**Note:** This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

---

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- direction – Shift direction of MSB first or LSB first.
- data – 8/16/32 bit data.

```
static inline uint32_t FLEXIO_SPI_ReadData(FLEXIO_SPI_Type *base,
 flexio_spi_shift_direction_t direction)
```

Reads 8 bit/16 bit data.

---

**Note:** This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

---

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.

- direction – Shift direction of MSB first or LSB first.

**Returns**

8 bit/16 bit data received.

*status\_t* FLEXIO\_SPI\_WriteBlocking(*FLEXIO\_SPI\_Type* \*base, *flexio\_spi\_shift\_direction\_t* direction, const uint8\_t \*buffer, size\_t size)

Sends a buffer of data bytes.

---

**Note:** This function blocks using the polling method until all bytes have been sent.

---

**Parameters**

- base – Pointer to the FLEXIO\_SPI\_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The data bytes to send.
- size – The number of data bytes to send.

**Return values**

- kStatus\_Success – Successfully create the handle.
- kStatus\_FLEXIO\_SPI\_Timeout – The transfer timed out and was aborted.

*status\_t* FLEXIO\_SPI\_ReadBlocking(*FLEXIO\_SPI\_Type* \*base, *flexio\_spi\_shift\_direction\_t* direction, uint8\_t \*buffer, size\_t size)

Receives a buffer of bytes.

---

**Note:** This function blocks using the polling method until all bytes have been received.

---

**Parameters**

- base – Pointer to the FLEXIO\_SPI\_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The buffer to store the received bytes.
- size – The number of data bytes to be received.

**Return values**

- kStatus\_Success – Successfully create the handle.
- kStatus\_FLEXIO\_SPI\_Timeout – The transfer timed out and was aborted.

*status\_t* FLEXIO\_SPI\_MasterTransferBlocking(*FLEXIO\_SPI\_Type* \*base, *flexio\_spi\_transfer\_t* \*xfer)

Receives a buffer of bytes.

---

**Note:** This function blocks via polling until all bytes have been received.

---

**Parameters**

- base – pointer to FLEXIO\_SPI\_Type structure
- xfer – FlexIO SPI transfer structure, see flexio\_spi\_transfer\_t.

**Return values**

- kStatus\_Success – Successfully create the handle.

- `kStatus_FLEXIO_SPI_Timeout` – The transfer timed out and was aborted.

`void FLEXIO_SPI_FlushShifters(FLEXIO_SPI_Type *base)`

Flush tx/rx shifters.

#### Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.

`status_t FLEXIO_SPI_MasterTransferCreateHandle(FLEXIO_SPI_Type *base,  
flexio_spi_master_handle_t *handle,  
flexio_spi_master_transfer_callback_t  
callback, void *userData)`

Initializes the FlexIO SPI Master handle, which is used in transactional functions.

#### Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.
- `callback` – The callback function.
- `userData` – The parameter of the callback function.

#### Return values

- `kStatus_Success` – Successfully create the handle.
- `kStatus_OutOfRange` – The FlexIO type/handle/ISR table out of range.

`status_t FLEXIO_SPI_MasterTransferNonBlocking(FLEXIO_SPI_Type *base,  
flexio_spi_master_handle_t *handle,  
flexio_spi_transfer_t *xfer)`

Master transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

#### Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.
- `xfer` – FlexIO SPI transfer structure. See `flexio_spi_transfer_t`.

#### Return values

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_FLEXIO_SPI_Busy` – SPI is not idle, is running another transfer.

`void FLEXIO_SPI_MasterTransferAbort(FLEXIO_SPI_Type *base, flexio_spi_master_handle_t  
*handle)`

Aborts the master data transfer, which used IRQ.

#### Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.

```
status_t FLEXIO_SPI_MasterTransferGetCount(FLEXIO_SPI_Type *base,
 flexio_spi_master_handle_t *handle, size_t
 *count)
```

Gets the data transfer status which used IRQ.

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- handle – Pointer to the *flexio\_spi\_master\_handle\_t* structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

#### Return values

- *kStatus\_InvalidArgument* – count is Invalid.
- *kStatus\_Success* – Successfully return the count.

```
void FLEXIO_SPI_MasterTransferHandleIRQ(void *spiType, void *spiHandle)
```

FlexIO SPI master IRQ handler function.

#### Parameters

- spiType – Pointer to the *FLEXIO\_SPI\_Type* structure.
- spiHandle – Pointer to the *flexio\_spi\_master\_handle\_t* structure to store the transfer state.

```
status_t FLEXIO_SPI_SlaveTransferCreateHandle(FLEXIO_SPI_Type *base,
 flexio_spi_slave_handle_t *handle,
 flexio_spi_slave_transfer_callback_t callback,
 void *userData)
```

Initializes the FlexIO SPI Slave handle, which is used in transactional functions.

#### Parameters

- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- handle – Pointer to the *flexio\_spi\_slave\_handle\_t* structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

#### Return values

- *kStatus\_Success* – Successfully create the handle.
- *kStatus\_OutOfRange* – The FlexIO type/handle/ISR table out of range.

```
status_t FLEXIO_SPI_SlaveTransferNonBlocking(FLEXIO_SPI_Type *base,
 flexio_spi_slave_handle_t *handle,
 flexio_spi_transfer_t *xfer)
```

Slave transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

#### Parameters

- handle – Pointer to the *flexio\_spi\_slave\_handle\_t* structure to store the transfer state.
- base – Pointer to the *FLEXIO\_SPI\_Type* structure.
- xfer – FlexIO SPI transfer structure. See *flexio\_spi\_transfer\_t*.



**Return values**

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_FLEXIO_SPI_Busy` – SPI is not idle; it is running another transfer.

```
static inline void FLEXIO_SPI_SlaveTransferAbort(FLEXIO_SPI_Type *base,
 flexio_spi_slave_handle_t *handle)
```

Aborts the slave data transfer which used IRQ, share same API with master.

**Parameters**

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.

```
static inline status_t FLEXIO_SPI_SlaveTransferGetCount(FLEXIO_SPI_Type *base,
 flexio_spi_slave_handle_t *handle,
 size_t *count)
```

Gets the data transfer status which used IRQ, share same API with master.

**Parameters**

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.
- `count` – Number of bytes transferred so far by the non-blocking transaction.

**Return values**

- `kStatus_InvalidArgument` – count is Invalid.
- `kStatus_Success` – Successfully return the count.

```
void FLEXIO_SPI_SlaveTransferHandleIRQ(void *spiType, void *spiHandle)
```

FlexIO SPI slave IRQ handler function.

**Parameters**

- `spiType` – Pointer to the `FLEXIO_SPI_Type` structure.
- `spiHandle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.

```
FSL_FLEXIO_SPI_DRIVER_VERSION
```

FlexIO SPI driver version.

Error codes for the FlexIO SPI driver.

*Values:*

```
enumerator kStatus_FLEXIO_SPI_Busy
```

FlexIO SPI is busy.

```
enumerator kStatus_FLEXIO_SPI_Idle
```

SPI is idle

```
enumerator kStatus_FLEXIO_SPI_Error
```

FlexIO SPI error.

```
enumerator kStatus_FLEXIO_SPI_Timeout
```

FlexIO SPI timeout polling status flags.

enum \_flexio\_spi\_clock\_phase

FlexIO SPI clock phase configuration.

*Values:*

enumerator kFLEXIO\_SPI\_ClockPhaseFirstEdge

First edge on SPCK occurs at the middle of the first cycle of a data transfer.

enumerator kFLEXIO\_SPI\_ClockPhaseSecondEdge

First edge on SPCK occurs at the start of the first cycle of a data transfer.

enum \_flexio\_spi\_shift\_direction

FlexIO SPI data shifter direction options.

*Values:*

enumerator kFLEXIO\_SPI\_MsbFirst

Data transfers start with most significant bit.

enumerator kFLEXIO\_SPI\_LsbFirst

Data transfers start with least significant bit.

enum \_flexio\_spi\_data\_bitcount\_mode

FlexIO SPI data length mode options.

*Values:*

enumerator kFLEXIO\_SPI\_8BitMode

8-bit data transmission mode.

enumerator kFLEXIO\_SPI\_16BitMode

16-bit data transmission mode.

enumerator kFLEXIO\_SPI\_32BitMode

32-bit data transmission mode.

enum \_flexio\_spi\_interrupt\_enable

Define FlexIO SPI interrupt mask.

*Values:*

enumerator kFLEXIO\_SPI\_TxEmptyInterruptEnable

Transmit buffer empty interrupt enable.

enumerator kFLEXIO\_SPI\_RxFullInterruptEnable

Receive buffer full interrupt enable.

enum \_flexio\_spi\_status\_flags

Define FlexIO SPI status mask.

*Values:*

enumerator kFLEXIO\_SPI\_TxBufferEmptyFlag

Transmit buffer empty flag.

enumerator kFLEXIO\_SPI\_RxBufferFullFlag

Receive buffer full flag.

enum \_flexio\_spi\_dma\_enable

Define FlexIO SPI DMA mask.

*Values:*

enumerator kFLEXIO\_SPI\_TxDmaEnable

Tx DMA request source

enumerator kFLEXIO\_SPI\_RxDmaEnable

Rx DMA request source

enumerator kFLEXIO\_SPI\_DmaAllEnable

All DMA request source

enum \_flexio\_spi\_transfer\_flags

Define FlexIO SPI transfer flags.

---

**Note:** Use kFLEXIO\_SPI\_csContinuous and one of the other flags to OR together to form the transfer flag.

---

*Values:*

enumerator kFLEXIO\_SPI\_8bitMsb

FlexIO SPI 8-bit MSB first

enumerator kFLEXIO\_SPI\_8bitLsb

FlexIO SPI 8-bit LSB first

enumerator kFLEXIO\_SPI\_16bitMsb

FlexIO SPI 16-bit MSB first

enumerator kFLEXIO\_SPI\_16bitLsb

FlexIO SPI 16-bit LSB first

enumerator kFLEXIO\_SPI\_32bitMsb

FlexIO SPI 32-bit MSB first

enumerator kFLEXIO\_SPI\_32bitLsb

FlexIO SPI 32-bit LSB first

enumerator kFLEXIO\_SPI\_csContinuous

Enable the CS signal continuous mode

typedef enum \_flexio\_spi\_clock\_phase flexio\_spi\_clock\_phase\_t

FlexIO SPI clock phase configuration.

typedef enum \_flexio\_spi\_shift\_direction flexio\_spi\_shift\_direction\_t

FlexIO SPI data shifter direction options.

typedef enum \_flexio\_spi\_data\_bitcount\_mode flexio\_spi\_data\_bitcount\_mode\_t

FlexIO SPI data length mode options.

typedef struct \_flexio\_spi\_type FLEXIO\_SPI\_Type

Define FlexIO SPI access structure typedef.

typedef struct \_flexio\_spi\_master\_config flexio\_spi\_master\_config\_t

Define FlexIO SPI master configuration structure.

typedef struct \_flexio\_spi\_slave\_config flexio\_spi\_slave\_config\_t

Define FlexIO SPI slave configuration structure.

typedef struct \_flexio\_spi\_transfer flexio\_spi\_transfer\_t

Define FlexIO SPI transfer structure.

typedef struct \_flexio\_spi\_master\_handle flexio\_spi\_master\_handle\_t

typedef for flexio\_spi\_master\_handle\_t in advance.

typedef flexio\_spi\_master\_handle\_t flexio\_spi\_slave\_handle\_t

Slave handle is the same with master handle.

```
typedef void (*flexio_spi_master_transfer_callback_t)(FLEXIO_SPI_Type *base,
flexio_spi_master_handle_t *handle, status_t status, void *userData)
```

FlexIO SPI master callback for finished transmit.

```
typedef void (*flexio_spi_slave_transfer_callback_t)(FLEXIO_SPI_Type *base,
flexio_spi_slave_handle_t *handle, status_t status, void *userData)
```

FlexIO SPI slave callback for finished transmit.

```
FLEXIO_SPI_DUMMYDATA
```

FlexIO SPI dummy transfer data, the data is sent while txData is NULL.

```
SPI_RETRY_TIMES
```

Retry times for waiting flag.

```
FLEXIO_SPI_XFER_DATA_FORMAT(flag)
```

Get the transfer data format of width and bit order.

```
struct _flexio_spi_type
```

*#include <fsl\_flexio\_spi.h>* Define FlexIO SPI access structure typedef.

### Public Members

```
FLEXIO_Type *flexioBase
```

FlexIO base pointer.

```
uint8_t SDOPinIndex
```

Pin select for data output. To set SDO pin in Hi-Z state, user needs to mux the pin as GPIO input and disable all pull up/down in application.

```
uint8_t SDIPinIndex
```

Pin select for data input.

```
uint8_t SCKPinIndex
```

Pin select for clock.

```
uint8_t CSnPinIndex
```

Pin select for enable.

```
uint8_t shifterIndex[2]
```

Shifter index used in FlexIO SPI.

```
uint8_t timerIndex[2]
```

Timer index used in FlexIO SPI.

```
struct _flexio_spi_master_config
```

*#include <fsl\_flexio\_spi.h>* Define FlexIO SPI master configuration structure.

### Public Members

```
bool enableMaster
```

Enable/disable FlexIO SPI master after configuration.

```
bool enableInDoze
```

Enable/disable FlexIO operation in doze mode.

```
bool enableInDebug
```

Enable/disable FlexIO operation in debug mode.

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32\_t baudRate\_Bps

Baud rate in Bps.

*flexio\_spi\_clock\_phase\_t* phase

Clock phase.

*flexio\_spi\_data\_bitcount\_mode\_t* dataMode

8bit or 16bit mode.

struct *\_flexio\_spi\_slave\_config*

*#include <fsl\_flexio\_spi.h>* Define FlexIO SPI slave configuration structure.

### Public Members

bool enableSlave

Enable/disable FlexIO SPI slave after configuration.

bool enableInDoze

Enable/disable FlexIO operation in doze mode.

bool enableInDebug

Enable/disable FlexIO operation in debug mode.

bool enableFastAccess

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

*flexio\_spi\_clock\_phase\_t* phase

Clock phase.

*flexio\_spi\_data\_bitcount\_mode\_t* dataMode

8bit or 16bit mode.

struct *\_flexio\_spi\_transfer*

*#include <fsl\_flexio\_spi.h>* Define FlexIO SPI transfer structure.

### Public Members

const uint8\_t \*txData

Send buffer.

uint8\_t \*rxData

Receive buffer.

size\_t dataSize

Transfer bytes.

uint8\_t flags

FlexIO SPI control flag, MSB first or LSB first.

struct *\_flexio\_spi\_master\_handle*

*#include <fsl\_flexio\_spi.h>* Define FlexIO SPI handle structure.

**Public Members**

`const uint8_t *txData`  
Transfer buffer.

`uint8_t *rxData`  
Receive buffer.

`size_t transferSize`  
Total bytes to be transferred.

`volatile size_t txRemainingBytes`  
Send data remaining in bytes.

`volatile size_t rxRemainingBytes`  
Receive data remaining in bytes.

`volatile uint32_t state`  
FlexIO SPI internal state.

`uint8_t bytePerFrame`  
SPI mode, 2bytes or 1byte in a frame

`flexio_spi_shift_direction_t direction`  
Shift direction.

`flexio_spi_master_transfer_callback_t callback`  
FlexIO SPI callback.

`void *userData`  
Callback parameter.

`bool isCsContinuous`  
Is current transfer using CS continuous mode.

`uint32_t timer1Cfg`  
TIMER1 TIMCFG regiser value backup.

## 2.27 FlexIO UART Driver

`status_t FLEXIO_UART_Init(FLEXIO_UART_Type *base, const flexio_uart_config_t *userConfig, uint32_t srcClock_Hz)`

Ungates the FlexIO clock, resets the FlexIO module, configures FlexIO UART hardware, and configures the FlexIO UART with FlexIO UART configuration. The configuration structure can be filled by the user or be set with default values by `FLEXIO_UART_GetDefaultConfig()`.

**Example**

```
FLEXIO_UART_Type base = {
 .flexioBase = FLEXIO,
 .TxPinIndex = 0,
 .RxPinIndex = 1,
 .shifterIndex = {0,1},
 .timerIndex = {0,1}
};
flexio_uart_config_t config = {
 .enableInDoze = false,
 .enableInDebug = true,
 .enableFastAccess = false,
 .baudRate_Bps = 115200U,
```

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```
.bitCountPerChar = 8
};
FLEXIO_UART_Init(base, &config, srcClock_Hz);
```

**Parameters**

- base – Pointer to the FLEXIO\_UART\_Type structure.
- userConfig – Pointer to the flexio\_uart\_config\_t structure.
- srcClock\_Hz – FlexIO source clock in Hz.

**Return values**

- kStatus\_Success – Configuration success.
- kStatus\_FLEXIO\_UART\_BaudrateNotSupport – Baudrate is not supported for current clock source frequency.

```
void FLEXIO_UART_Deinit(FLEXIO_UART_Type *base)
```

Resets the FlexIO UART shifter and timer config.

---

**Note:** After calling this API, call the FLEXIO\_UART\_Init to use the FlexIO UART module.

---

**Parameters**

- base – Pointer to FLEXIO\_UART\_Type structure

```
void FLEXIO_UART_GetDefaultConfig(flexio_uart_config_t *userConfig)
```

Gets the default configuration to configure the FlexIO UART. The configuration can be used directly for calling the FLEXIO\_UART\_Init(). Example:

```
flexio_uart_config_t config;
FLEXIO_UART_GetDefaultConfig(&userConfig);
```

**Parameters**

- userConfig – Pointer to the flexio\_uart\_config\_t structure.

```
uint32_t FLEXIO_UART_GetStatusFlags(FLEXIO_UART_Type *base)
```

Gets the FlexIO UART status flags.

**Parameters**

- base – Pointer to the FLEXIO\_UART\_Type structure.

**Returns**

FlexIO UART status flags.

```
void FLEXIO_UART_ClearStatusFlags(FLEXIO_UART_Type *base, uint32_t mask)
```

Gets the FlexIO UART status flags.

**Parameters**

- base – Pointer to the FLEXIO\_UART\_Type structure.
- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO\_UART\_TxDataRegEmptyFlag
  - kFLEXIO\_UART\_RxEmptyFlag

– kFLEXIO\_UART\_RxOverRunFlag

void FLEXIO\_UART\_EnableInterrupts(*FLEXIO\_UART\_Type* \*base, uint32\_t mask)

Enables the FlexIO UART interrupt.

This function enables the FlexIO UART interrupt.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- mask – Interrupt source.

void FLEXIO\_UART\_DisableInterrupts(*FLEXIO\_UART\_Type* \*base, uint32\_t mask)

Disables the FlexIO UART interrupt.

This function disables the FlexIO UART interrupt.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- mask – Interrupt source.

static inline uint32\_t FLEXIO\_UART\_GetTxDataRegisterAddress(*FLEXIO\_UART\_Type* \*base)

Gets the FlexIO UART transmit data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.

#### Returns

FlexIO UART transmit data register address.

static inline uint32\_t FLEXIO\_UART\_GetRxDataRegisterAddress(*FLEXIO\_UART\_Type* \*base)

Gets the FlexIO UART receive data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.

#### Returns

FlexIO UART receive data register address.

static inline void FLEXIO\_UART\_EnableTxDMA(*FLEXIO\_UART\_Type* \*base, bool enable)

Enables/disables the FlexIO UART transmit DMA. This function enables/disables the FlexIO UART Tx DMA, which means asserting the kFLEXIO\_UART\_TxDataRegEmptyFlag does/doesn't trigger the DMA request.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- enable – True to enable, false to disable.

static inline void FLEXIO\_UART\_EnableRxDMA(*FLEXIO\_UART\_Type* \*base, bool enable)

Enables/disables the FlexIO UART receive DMA. This function enables/disables the FlexIO UART Rx DMA, which means asserting kFLEXIO\_UART\_RxDataRegFullFlag does/doesn't trigger the DMA request.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- enable – True to enable, false to disable.



```
static inline void FLEXIO_UART_Enable(FLEXIO_UART_Type *base, bool enable)
```

Enables/disables the FlexIO UART module operation.

#### Parameters

- base – Pointer to the *FLEXIO\_UART\_Type*.
- enable – True to enable, false does not have any effect.

```
static inline void FLEXIO_UART_WriteByte(FLEXIO_UART_Type *base, const uint8_t *buffer)
```

Writes one byte of data.

---

**Note:** This is a non-blocking API, which returns directly after the data is put into the data register. Ensure that the TxEmptyFlag is asserted before calling this API.

---

#### Parameters

- base – Pointer to the *FLEXIO\_UART\_Type* structure.
- buffer – The data bytes to send.

```
static inline void FLEXIO_UART_ReadByte(FLEXIO_UART_Type *base, uint8_t *buffer)
```

Reads one byte of data.

---

**Note:** This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

---

#### Parameters

- base – Pointer to the *FLEXIO\_UART\_Type* structure.
- buffer – The buffer to store the received bytes.

```
status_t FLEXIO_UART_WriteBlocking(FLEXIO_UART_Type *base, const uint8_t *txData, size_t txSize)
```

Sends a buffer of data bytes.

---

**Note:** This function blocks using the polling method until all bytes have been sent.

---

#### Parameters

- base – Pointer to the *FLEXIO\_UART\_Type* structure.
- txData – The data bytes to send.
- txSize – The number of data bytes to send.

#### Return values

- kStatus\_FLEXIO\_UART\_Timeout – Transmission timed out and was aborted.
- kStatus\_Success – Successfully wrote all data.

```
status_t FLEXIO_UART_ReadBlocking(FLEXIO_UART_Type *base, uint8_t *rxData, size_t rxSize)
```

Receives a buffer of bytes.

---

**Note:** This function blocks using the polling method until all bytes have been received.

---

### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- rxData – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

### Return values

- kStatus\_FLEXIO\_UART\_Timeout – Transmission timed out and was aborted.
- kStatus\_Success – Successfully received all data.

*status\_t* FLEXIO\_UART\_TransferCreateHandle(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle, *flexio\_uart\_transfer\_callback\_t* callback, void \*userData)

Initializes the UART handle.

This function initializes the FlexIO UART handle, which can be used for other FlexIO UART transactional APIs. Call this API once to get the initialized handle.

The UART driver supports the “background” receiving, which means that users can set up a RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn’t call the FLEXIO\_UART\_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as ringBuffer.

### Parameters

- base – to FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

### Return values

- kStatus\_Success – Successfully create the handle.
- kStatus\_OutOfRange – The FlexIO type/handle/ISR table out of range.

void FLEXIO\_UART\_TransferStartRingBuffer(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle, uint8\_t \*ringBuffer, size\_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn’t call the UART\_ReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly.

---

**Note:** When using the RX ring buffer, one byte is reserved for internal use. In other words, if ringBufferSize is 32, only 31 bytes are used for saving data.

---

### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.

- ringBuffer – Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
- ringBufferSize – Size of the ring buffer.

void FLEXIO\_UART\_TransferStopRingBuffer(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.

*status\_t* FLEXIO\_UART\_TransferSendNonBlocking(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle, *flexio\_uart\_transfer\_t* \*xfer)

Transmits a buffer of data using the interrupt method.

This function sends data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data to be written to the TX register. When all data is written to the TX register in ISR, the FlexIO UART driver calls the callback function and passes the kStatus\_FLEXIO\_UART\_TxIdle as status parameter.

---

**Note:** The kStatus\_FLEXIO\_UART\_TxIdle is passed to the upper layer when all data is written to the TX register. However, it does not ensure that all data is sent out.

---

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.
- xfer – FlexIO UART transfer structure. See flexio\_uart\_transfer\_t.

#### Return values

- kStatus\_Success – Successfully starts the data transmission.
- kStatus\_UART\_TxBusy – Previous transmission still not finished, data not written to the TX register.

void FLEXIO\_UART\_TransferAbortSend(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt-driven data sending. Get the remainBytes to find out how many bytes are still not sent out.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.

*status\_t* FLEXIO\_UART\_TransferGetSendCount(*FLEXIO\_UART\_Type* \*base, *flexio\_uart\_handle\_t* \*handle, *size\_t* \*count)

Gets the number of bytes sent.

This function gets the number of bytes sent driven by interrupt.

**Parameters**

- `base` – Pointer to the `FLEXIO_UART_Type` structure.
- `handle` – Pointer to the `flexio_uart_handle_t` structure to store the transfer state.
- `count` – Number of bytes sent so far by the non-blocking transaction.

**Return values**

- `kStatus_NoTransferInProgress` – transfer has finished or no transfer in progress.
- `kStatus_Success` – Successfully return the count.

```
status_t FLEXIO_UART_TransferReceiveNonBlocking(FLEXIO_UART_Type *base,
 flexio_uart_handle_t *handle,
 flexio_uart_transfer_t *xfer, size_t
 *receivedBytes)
```

Receives a buffer of data using the interrupt method.

This function receives data using the interrupt method. This is a non-blocking function, which returns without waiting for all data to be received. If the RX ring buffer is used and not empty, the data in ring buffer is copied and the parameter `receivedBytes` shows how many bytes are copied from the ring buffer. After copying, if the data in ring buffer is not enough to read, the receive request is saved by the UART driver. When new data arrives, the receive request is serviced first. When all data is received, the UART driver notifies the upper layer through a callback function and passes the status parameter `kStatus_UART_RxIdle`. For example, if the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer, the 5 bytes are copied to `xfer->data`. This function returns with the parameter `receivedBytes` set to 5. For the last 5 bytes, newly arrived data is saved from the `xfer->data[5]`. When 5 bytes are received, the UART driver notifies upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to `xfer->data`. When all data is received, the upper layer is notified.

**Parameters**

- `base` – Pointer to the `FLEXIO_UART_Type` structure.
- `handle` – Pointer to the `flexio_uart_handle_t` structure to store the transfer state.
- `xfer` – UART transfer structure. See `flexio_uart_transfer_t`.
- `receivedBytes` – Bytes received from the ring buffer directly.

**Return values**

- `kStatus_Success` – Successfully queue the transfer into the transmit queue.
- `kStatus_FLEXIO_UART_RxBusy` – Previous receive request is not finished.

```
void FLEXIO_UART_TransferAbortReceive(FLEXIO_UART_Type *base, flexio_uart_handle_t
 *handle)
```

Aborts the receive data which was using IRQ.

This function aborts the receive data which was using IRQ.

**Parameters**

- `base` – Pointer to the `FLEXIO_UART_Type` structure.
- `handle` – Pointer to the `flexio_uart_handle_t` structure to store the transfer state.

*status\_t* FLEXIO\_UART\_TransferGetReceiveCount(*FLEXIO\_UART\_Type* \*base,  
flexio\_uart\_handle\_t \*handle, size\_t \*count)

Gets the number of bytes received.

This function gets the number of bytes received driven by interrupt.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.
- handle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.
- count – Number of bytes received so far by the non-blocking transaction.

#### Return values

- kStatus\_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus\_Success – Successfully return the count.

void FLEXIO\_UART\_TransferHandleIRQ(void \*uartType, void \*uartHandle)

FlexIO UART IRQ handler function.

This function processes the FlexIO UART transmit and receives the IRQ request.

#### Parameters

- uartType – Pointer to the FLEXIO\_UART\_Type structure.
- uartHandle – Pointer to the flexio\_uart\_handle\_t structure to store the transfer state.

void FLEXIO\_UART\_FlushShifters(*FLEXIO\_UART\_Type* \*base)

Flush tx/rx shifters.

#### Parameters

- base – Pointer to the FLEXIO\_UART\_Type structure.

FSL\_FLEXIO\_UART\_DRIVER\_VERSION

FlexIO UART driver version.

Error codes for the UART driver.

*Values:*

enumerator kStatus\_FLEXIO\_UART\_TxBusy

Transmitter is busy.

enumerator kStatus\_FLEXIO\_UART\_RxBusy

Receiver is busy.

enumerator kStatus\_FLEXIO\_UART\_TxIdle

UART transmitter is idle.

enumerator kStatus\_FLEXIO\_UART\_RxIdle

UART receiver is idle.

enumerator kStatus\_FLEXIO\_UART\_ERROR

ERROR happens on UART.

enumerator kStatus\_FLEXIO\_UART\_RxRingBufferOverrun

UART RX software ring buffer overrun.

enumerator kStatus\_FLEXIO\_UART\_RxHardwareOverrun  
UART RX receiver overrun.

enumerator kStatus\_FLEXIO\_UART\_Timeout  
UART times out.

enumerator kStatus\_FLEXIO\_UART\_BaudrateNotSupport  
Baudrate is not supported in current clock source

enum \_flexio\_uart\_bit\_count\_per\_char  
FlexIO UART bit count per char.

*Values:*

enumerator kFLEXIO\_UART\_7BitsPerChar  
7-bit data characters

enumerator kFLEXIO\_UART\_8BitsPerChar  
8-bit data characters

enumerator kFLEXIO\_UART\_9BitsPerChar  
9-bit data characters

enum \_flexio\_uart\_interrupt\_enable  
Define FlexIO UART interrupt mask.

*Values:*

enumerator kFLEXIO\_UART\_TxDataRegEmptyInterruptEnable  
Transmit buffer empty interrupt enable.

enumerator kFLEXIO\_UART\_RxDataRegFullInterruptEnable  
Receive buffer full interrupt enable.

enum \_flexio\_uart\_status\_flags  
Define FlexIO UART status mask.

*Values:*

enumerator kFLEXIO\_UART\_TxDataRegEmptyFlag  
Transmit buffer empty flag.

enumerator kFLEXIO\_UART\_RxDataRegFullFlag  
Receive buffer full flag.

enumerator kFLEXIO\_UART\_RxOverRunFlag  
Receive buffer over run flag.

typedef enum \_flexio\_uart\_bit\_count\_per\_char flexio\_uart\_bit\_count\_per\_char\_t  
FlexIO UART bit count per char.

typedef struct \_flexio\_uart\_type FLEXIO\_UART\_Type  
Define FlexIO UART access structure typedef.

typedef struct \_flexio\_uart\_config flexio\_uart\_config\_t  
Define FlexIO UART user configuration structure.

typedef struct \_flexio\_uart\_transfer flexio\_uart\_transfer\_t  
Define FlexIO UART transfer structure.

typedef struct \_flexio\_uart\_handle flexio\_uart\_handle\_t

```
typedef void (*flexio_uart_transfer_callback_t)(FLEXIO_UART_Type *base, flexio_uart_handle_t *handle, status_t status, void *userData)
```

FlexIO UART transfer callback function.

```
UART_RETRY_TIMES
```

Retry times for waiting flag.

```
struct _flexio_uart_type
```

*#include <fsl\_flexio\_uart.h>* Define FlexIO UART access structure typedef.

### Public Members

```
FLEXIO_Type *flexioBase
```

FlexIO base pointer.

```
uint8_t TxPinIndex
```

Pin select for UART\_Tx.

```
uint8_t RxPinIndex
```

Pin select for UART\_Rx.

```
uint8_t shifterIndex[2]
```

Shifter index used in FlexIO UART.

```
uint8_t timerIndex[2]
```

Timer index used in FlexIO UART.

```
struct _flexio_uart_config
```

*#include <fsl\_flexio\_uart.h>* Define FlexIO UART user configuration structure.

### Public Members

```
bool enableUart
```

Enable/disable FlexIO UART TX & RX.

```
bool enableInDoze
```

Enable/disable FlexIO operation in doze mode

```
bool enableInDebug
```

Enable/disable FlexIO operation in debug mode

```
bool enableFastAccess
```

Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

```
uint32_t baudRate_Bps
```

Baud rate in Bps.

```
flexio_uart_bit_count_per_char_t bitCountPerChar
```

number of bits, 7/8/9 -bit

```
struct _flexio_uart_transfer
```

*#include <fsl\_flexio\_uart.h>* Define FlexIO UART transfer structure.

### Public Members

```
size_t dataSize
```

Transfer size

struct `_flexio_uart_handle`

*#include <fsl\_flexio\_uart.h>* Define FLEXIO UART handle structure.

### Public Members

const uint8\_t \*volatile txData

Address of remaining data to send.

volatile size\_t txDataSize

Size of the remaining data to send.

uint8\_t \*volatile rxData

Address of remaining data to receive.

volatile size\_t rxDataSize

Size of the remaining data to receive.

size\_t txDataSizeAll

Total bytes to be sent.

size\_t rxDataSizeAll

Total bytes to be received.

uint8\_t \*rxRingBuffer

Start address of the receiver ring buffer.

size\_t rxRingBufferSize

Size of the ring buffer.

volatile uint16\_t rxRingBufferHead

Index for the driver to store received data into ring buffer.

volatile uint16\_t rxRingBufferTail

Index for the user to get data from the ring buffer.

*flexio\_uart\_transfer\_callback\_t* callback

Callback function.

void \*userData

UART callback function parameter.

volatile uint8\_t txState

TX transfer state.

volatile uint8\_t rxState

RX transfer state

union `__unnamed64__`

### 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.



## 2.28 ftfx adapter

## 2.29 Ftfx CACHE Driver

enum \_ftfx\_cache\_ram\_func\_constants

Constants for execute-in-RAM flash function.

*Values:*

enumerator kFTFx\_CACHE\_RamFuncMaxSizeInWords

The maximum size of execute-in-RAM function.

typedef struct \_flash\_prefetch\_speculation\_status ftfx\_prefetch\_speculation\_status\_t

FTFx prefetch speculation status.

typedef struct \_ftfx\_cache\_config ftfx\_cache\_config\_t

FTFx cache 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 FTFx\_CACHE\_Init(ftfx\_cache\_config\_t \*config)

Initializes the global FTFx cache structure members.

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

### Parameters

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

### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

status\_t FTFx\_CACHE\_ClearCachePrefetchSpeculation(ftfx\_cache\_config\_t \*config, bool isPreProcess)

Process the cache/prefetch/speculation to the flash.

### Parameters

- config – A pointer to the storage for the driver runtime state.
- isPreProcess – The possible option used to control flash cache/prefetch/speculation

### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – Invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

status\_t FTFx\_CACHE\_PflashSetPrefetchSpeculation(ftfx\_prefetch\_speculation\_status\_t \*speculationStatus)

Sets the PFlash prefetch speculation to the intended speculation status.

### Parameters

- speculationStatus – The expected protect status to set to the PFlash protection register. Each bit is

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidSpeculationOption` – An invalid speculation option argument is provided.

`status_t FTFx_CACHE_PflashGetPrefetchSpeculation(ftfx_prefetch_speculation_status_t *speculationStatus)`

Gets the PFlash prefetch speculation status.

**Parameters**

- `speculationStatus` – Speculation status returned by the PFlash IP.

**Return values**

`kStatus_FTFx_Success` – API was executed successfully.

`struct _flash_prefetch_speculation_status`

`#include <fsl_ftfx_cache.h>` FTFx prefetch speculation status.

**Public Members**

`bool instructionOff`

Instruction speculation.

`bool dataOff`

Data speculation.

`union function_bit_operation_ptr_t`

`#include <fsl_ftfx_cache.h>`

**Public Members**

`uint32_t commadAddr`

`void (*callFlashCommand)(volatile uint32_t *base, uint32_t bitMask, uint32_t bitShift, uint32_t bitValue)`

`struct _ftfx_cache_config`

`#include <fsl_ftfx_cache.h>` FTFx cache 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**

`uint8_t flashMemoryIndex`

0 - primary flash; 1 - secondary flash

`function_bit_operation_ptr_t bitOperFuncAddr`

An buffer point to the flash execute-in-RAM function.

## 2.30 ftfx controller

FTFx driver status codes.

*Values:*

enumerator kStatus\_FTFx\_Success

API is executed successfully

enumerator kStatus\_FTFx\_InvalidArgument

Invalid argument

enumerator kStatus\_FTFx\_SizeError

Error size

enumerator kStatus\_FTFx\_AlignmentError

Parameter is not aligned with the specified baseline

enumerator kStatus\_FTFx\_AddressError

Address is out of range

enumerator kStatus\_FTFx\_AccessError

Invalid instruction codes and out-of bound addresses

enumerator kStatus\_FTFx\_ProtectionViolation

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

enumerator kStatus\_FTFx\_CommandFailure

Run-time error during command execution.

enumerator kStatus\_FTFx\_UnknownProperty

Unknown property.

enumerator kStatus\_FTFx\_EraseKeyError

API erase key is invalid.

enumerator kStatus\_FTFx\_RegionExecuteOnly

The current region is execute-only.

enumerator kStatus\_FTFx\_ExecuteInRamFunctionNotReady

Execute-in-RAM function is not available.

enumerator kStatus\_FTFx\_PartitionStatusUpdateFailure

Failed to update partition status.

enumerator kStatus\_FTFx\_SetFlexramAsEepromError

Failed to set FlexRAM as EEPROM.

enumerator kStatus\_FTFx\_RecoverFlexramAsRamError

Failed to recover FlexRAM as RAM.

enumerator kStatus\_FTFx\_SetFlexramAsRamError

Failed to set FlexRAM as RAM.

enumerator kStatus\_FTFx\_RecoverFlexramAsEepromError

Failed to recover FlexRAM as EEPROM.

enumerator kStatus\_FTFx\_CommandNotSupported

Flash API is not supported.

enumerator kStatus\_FTFx\_SwapSystemNotInUninitialized

Swap system is not in an uninitialized state.

enumerator kStatus\_FTFx\_SwapIndicatorAddressError

The swap indicator address is invalid.

enumerator kStatus\_FTFx\_ReadOnlyProperty

The flash property is read-only.

enumerator kStatus\_FTFx\_InvalidPropertyValue

The flash property value is out of range.

enumerator kStatus\_FTFx\_InvalidSpeculationOption

The option of flash prefetch speculation is invalid.

enumerator kStatus\_FTFx\_CommandOperationInProgress

The option of flash command is processing.

enum \_ftfx\_driver\_api\_keys

Enumeration for FTFx 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 kFTFx\_ApiEraseKey

Key value used to validate all FTFx erase APIs.

void FTFx\_API\_Init(*ftfx\_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.

status\_t FTFx\_API\_UpdateFlexnvmPartitionStatus(*ftfx\_config\_t* \*config)

Updates FlexNVM memory partition status according to data flash 0 IFR.

This function updates FlexNVM memory partition status.

#### Parameters

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

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_PartitionStatusUpdateFailure – Failed to update the partition status.

status\_t FTFx\_CMD\_Erase(*ftfx\_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 does not need to be sector-aligned but must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words) to be erased. Must be word-aligned.
- `key` – The value used to validate all flash erase APIs.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – The parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – The address is out of range.
- `kStatus_FTFx_EraseKeyError` – The API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_EraseSectorNonBlocking(ftfx_config_t *config, uint32_t start, uint32_t key)`

Erases the flash sectors encompassed by parameters passed into function.

This function erases one flash sector size based on the start address.

**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 does not need to be sector-aligned but must be word-aligned.
- `key` – The value used to validate all flash erase APIs.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – The parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – The address is out of range.
- `kStatus_FTFx_EraseKeyError` – The API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.

`status_t FTFx_CMD_EraseAll(ftfx_config_t *config, uint32_t key)`

Erases entire flash.

**Parameters**

- `config` – Pointer to the storage for the driver runtime state.
- `key` – A value used to validate all flash erase APIs.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_PartitionStatusUpdateFailure` – Failed to update the partition status.

`status_t FTFx_CMD_EraseAllUnsecure(ftfx_config_t *config, uint32_t key)`

Erases the entire flash, including protected sectors.

#### Parameters

- `config` – Pointer to the storage for the driver runtime state.
- `key` – A value used to validate all flash erase APIs.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_PartitionStatusUpdateFailure` – Failed to update the partition status.

`status_t FTFx_CMD_EraseAllExecuteOnlySegments(ftfx_config_t *config, uint32_t key)`

Erases all program flash execute-only segments defined by the FXACC registers.

#### Parameters

- `config` – Pointer to the storage for the driver runtime state.
- `key` – A value used to validate all flash erase APIs.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.

- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_Program(ftfx_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 word-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 word-aligned.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_ProgramOnce(ftfx_config_t *config, uint32_t index, const uint8_t *src, uint32_t lengthInBytes)`

Programs Program Once Field through parameters.

This function programs the Program Once Field with the desired data for a given flash area as determined by the index and length.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `index` – The index indicating which area of the Program Once Field to be programmed.
- `src` – A pointer to the source buffer of data that is to be programmed into the Program Once Field.

- `lengthInBytes` – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_ProgramSection(ftfx_config_t *config, uint32_t start, const uint8_t *src, uint32_t lengthInBytes)`

Programs flash with data at locations passed in through parameters via the Program Section command.

This function programs the flash memory with the desired 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 programmed. Must be word-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 word-aligned.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_SetFlexramAsRamError` – Failed to set flexram as RAM.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_RecoverFlexramAsEepromError` – Failed to recover FlexRAM as EEPROM.



```
status_t FTFx_CMD_ProgramPartition(ftfx_config_t *config, ftfx_partition_flexram_load_opt_t
 option, uint32_t eepromDataSizeCode, uint32_t
 flexnvmPartitionCode, uint8_t CSEcKeySize, uint8_t CFE)
```

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM.

#### Parameters

- config – Pointer to storage for the driver runtime state.
- option – The option used to set FlexRAM load behavior during reset.
- eepromDataSizeCode – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- flexnvmPartitionCode – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – Invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during command execution.

```
status_t FTFx_CMD_ReadOnce(ftfx_config_t *config, uint32_t index, uint8_t *dst, uint32_t
 lengthInBytes)
```

Reads the Program Once Field through parameters.

This function reads the read once feild with given index and length.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating the area of program once field to be read.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.

- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_ReadResource(ftfx_config_t *config, uint32_t start, uint8_t *dst, uint32_t lengthInBytes, ftfx_read_resource_opt_t option)`

Reads the resource with data at locations passed in through parameters.

This function reads the flash memory with the desired location 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 programmed. Must be word-aligned.
- `dst` – A pointer to the destination buffer of data that is used to store data to be read.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- `option` – The resource option which indicates which area should be read back.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_VerifyErase(ftfx_config_t *config, uint32_t start, uint32_t lengthInBytes, ftfx_margin_value_t margin)`

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 does not need to be sector-aligned but must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.

- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_VerifyEraseAll(ftfx_config_t *config, ftfx_margin_value_t margin)`

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_VerifyEraseAllExecuteOnlySegments(ftfx_config_t *config,  
ftfx_margin_value_t margin)`

Verifies whether the program flash execute-only segments have been erased to the specified read margin level.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.

- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_VerifyProgram(ftfx_config_t *config, uint32_t start, uint32_t lengthInBytes, const uint8_t *expectedData, ftfx_margin_value_t margin, 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. Must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `expectedData` – A pointer to the expected data that is to be verified against.
- `margin` – Read margin choice.
- `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_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_REG_GetSecurityState(ftfx_config_t *config, ftfx_security_state_t *state)`

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

#### Parameters

- `config` – A pointer to storage for the driver runtime state.
- `state` – A pointer to the value returned for the current security status code:

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.

`status_t FTFx_CMD_SecurityBypass(ftfx_config_t *config, const uint8_t *backdoorKey)`

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `backdoorKey` – A pointer to the user buffer containing the backdoor key.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_SetFlexramFunction(ftfx_config_t *config, ftfx_flexram_func_opt_t option)`

Sets the FlexRAM function command.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `option` – The option used to set the work mode of FlexRAM.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FTFx_CMD_SwapControl(ftfx_config_t *config, uint32_t address, ftfx_swap_control_opt_t option, ftfx_swap_state_config_t *returnInfo)`

Configures the Swap function or checks the swap state of the Flash module.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `address` – Address used to configure the flash Swap function.

- option – The possible option used to configure Flash Swap function or check the flash Swap status
- returnInfo – A pointer to the data which is used to return the information of flash Swap.

**Return values**

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus\_FTFx\_SwapIndicatorAddressError – Swap indicator address is invalid.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during the command execution.

enum \_ftfx\_partition\_flexram\_load\_option

Enumeration for the FlexRAM load during reset option.

*Values:*

enumerator kFTFx\_PartitionFlexramLoadOptLoadedWithValidEepromData  
FlexRAM is loaded with valid EEPROM data during reset sequence.

enumerator kFTFx\_PartitionFlexramLoadOptNotLoaded  
FlexRAM is not loaded during reset sequence.

enum \_ftfx\_read\_resource\_opt

Enumeration for the two possible options of flash read resource command.

*Values:*

enumerator kFTFx\_ResourceOptionFlashIfc  
Select code for Program flash 0 IFR, Program flash swap 0 IFR, Data flash 0 IFR

enumerator kFTFx\_ResourceOptionVersionId  
Select code for the version ID

enum \_ftfx\_margin\_value

Enumeration for supported FTFx margin levels.

*Values:*

enumerator kFTFx\_MarginValueNormal  
Use the 'normal' read level for 1s.

enumerator kFTFx\_MarginValueUser  
Apply the 'User' margin to the normal read-1 level.

enumerator kFTFx\_MarginValueFactory  
Apply the 'Factory' margin to the normal read-1 level.

enumerator kFTFx\_MarginValueInvalid

Not real margin level, Used to determine the range of valid margin level.

enum \_ftfx\_security\_state

Enumeration for the three possible FTFx security states.

*Values:*

enumerator kFTFx\_SecurityStateNotSecure

Flash is not secure.

enumerator kFTFx\_SecurityStateBackdoorEnabled

Flash backdoor is enabled.

enumerator kFTFx\_SecurityStateBackdoorDisabled

Flash backdoor is disabled.

enum \_ftfx\_flexram\_function\_option

Enumeration for the two possilbe options of set FlexRAM function command.

*Values:*

enumerator kFTFx\_FlexramFuncOptAvailableAsRam

An option used to make FlexRAM available as RAM

enumerator kFTFx\_FlexramFuncOptEepromQuickWriteRecovery

An option used to complete interrupted EEPROM quick write process

enumerator kFTFx\_FlexramFuncOptEepromQuickWriteStatus

An option used to make EEPROM quick write status query

enumerator kFTFx\_FlexramFuncOptAvailableForEepromQuickWrite

An option used to make FlexRAM available for EEPROM in Quick Write mode

enumerator kFTFx\_FlexramFuncOptAvailableForEeprom

An option used to make FlexRAM available for EEPROM

enum \_flash\_acceleration\_ram\_property

Enumeration for acceleration ram property.

*Values:*

enumerator kFLASH\_AccelerationRamSize

enum \_ftfx\_swap\_control\_option

Enumeration for the possible options of Swap control commands.

*Values:*

enumerator kFTFx\_SwapControlOptionIntializeSystem

An option used to initialize the Swap system

enumerator kFTFx\_SwapControlOptionSetInUpdateState

An option used to set the Swap in an update state

enumerator kFTFx\_SwapControlOptionSetInCompleteState

An option used to set the Swap in a complete state

enumerator kFTFx\_SwapControlOptionReportStatus

An option used to report the Swap status

enumerator kFTFx\_SwapControlOptionDisableSystem

An option used to disable the Swap status

enum `_ftfx_swap_state`

Enumeration for the possible flash Swap status.

*Values:*

enumerator `kFTFx_SwapStateUninitialized`

Flash Swap system is in an uninitialized state.

enumerator `kFTFx_SwapStateReady`

Flash Swap system is in a ready state.

enumerator `kFTFx_SwapStateUpdate`

Flash Swap system is in an update state.

enumerator `kFTFx_SwapStateUpdateErased`

Flash Swap system is in an updateErased state.

enumerator `kFTFx_SwapStateComplete`

Flash Swap system is in a complete state.

enumerator `kFTFx_SwapStateDisabled`

Flash Swap system is in a disabled state.

enum `_ftfx_swap_block_status`

Enumeration for the possible flash Swap block status.

*Values:*

enumerator `kFTFx_SwapBlockStatusLowerHalfProgramBlocksAtZero`

Swap block status is that lower half program block at zero.

enumerator `kFTFx_SwapBlockStatusUpperHalfProgramBlocksAtZero`

Swap block status is that upper half program block at zero.

enum `_ftfx_memory_type`

Enumeration for FTFx memory type.

*Values:*

enumerator `kFTFx_MemTypePflash`

enumerator `kFTFx_MemTypeFlexnvm`

typedef enum `_ftfx_partition_flexram_load_option` `ftfx_partition_flexram_load_opt_t`

Enumeration for the FlexRAM load during reset option.

typedef enum `_ftfx_read_resource_opt` `ftfx_read_resource_opt_t`

Enumeration for the two possible options of flash read resource command.

typedef enum `_ftfx_margin_value` `ftfx_margin_value_t`

Enumeration for supported FTFx margin levels.

typedef enum `_ftfx_security_state` `ftfx_security_state_t`

Enumeration for the three possible FTFx security states.

typedef enum `_ftfx_flexram_function_option` `ftfx_flexram_func_opt_t`

Enumeration for the two possible options of set FlexRAM function command.

typedef enum `_ftfx_swap_control_option` `ftfx_swap_control_opt_t`

Enumeration for the possible options of Swap control commands.

typedef enum `_ftfx_swap_state` `ftfx_swap_state_t`

Enumeration for the possible flash Swap status.



```
typedef enum _ftfx_swap_block_status ftfx_swap_block_status_t
```

Enumeration for the possible flash Swap block status.

```
typedef struct _ftfx_swap_state_config ftfx_swap_state_config_t
```

Flash Swap information.

```
typedef struct _ftfx_special_mem ftfx_spec_mem_t
```

ftfx special memory access information.

```
typedef struct _ftfx_mem_descriptor ftfx_mem_desc_t
```

Flash memory descriptor.

```
typedef struct _ftfx_ops_config ftfx_ops_config_t
```

Active FTFx information for the current operation.

```
typedef struct _ftfx_ifr_descriptor ftfx_ifr_desc_t
```

Flash IFR memory descriptor.

```
typedef struct _ftfx_config ftfx_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.

```
struct _ftfx_swap_state_config
```

*#include <fsl\_ftfx\_controller.h>* Flash Swap information.

### Public Members

*ftfx\_swap\_state\_t* flashSwapState

The current Swap system status.

*ftfx\_swap\_block\_status\_t* currentSwapBlockStatus

The current Swap block status.

*ftfx\_swap\_block\_status\_t* nextSwapBlockStatus

The next Swap block status.

```
struct _ftfx_special_mem
```

*#include <fsl\_ftfx\_controller.h>* ftfx special memory access information.

### Public Members

uint32\_t base

Base address of flash special memory.

uint32\_t size

size of flash special memory.

uint32\_t count

flash special memory count.

```
struct _ftfx_mem_descriptor
```

*#include <fsl\_ftfx\_controller.h>* Flash memory descriptor.

### Public Members

uint32\_t blockSize

A base address of the flash block

uint32\_t aliasBlockSize

A base address of the alias flash block

uint32\_t totalSize

The size of the flash block.

uint32\_t sectorSize

The size in bytes of a sector of flash.

uint32\_t blockCount

A number of flash blocks.

struct \_ftfx\_ops\_config

#include <fsl\_ftfx\_controller.h> Active FTFx information for the current operation.

### Public Members

uint32\_t convertedAddress

A converted address for the current flash type.

struct \_ftfx\_ifr\_descriptor

#include <fsl\_ftfx\_controller.h> Flash IFR memory descriptor.

union function\_ptr\_t

#include <fsl\_ftfx\_controller.h>

### Public Members

uint32\_t commandAddr

void (\*callFlashCommand)(volatile uint8\_t \*FTMRx\_fstat)

struct \_ftfx\_config

#include <fsl\_ftfx\_controller.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 flexramBlockSize

The base address of the FlexRAM/acceleration RAM

uint32\_t flexramTotalSize

The size of the FlexRAM/acceleration RAM

uint16\_t eepromTotalSize

The size of EEPROM area which was partitioned from FlexRAM

function\_ptr\_t runCmdFuncAddr

An buffer point to the flash execute-in-RAM function.

struct \_\_unnamed11\_\_

**Public Members**

uint8\_t type

Type of flash block.

uint8\_t index

Index of flash block.

struct feature

struct addrAligment

struct feature

struct resRange

**Public Members**

uint8\_t versionIdStart

Version ID start address

uint32\_t pflashIfrStart

Program Flash 0 IFR start address

uint32\_t dflashIfrStart

Data Flash 0 IFR start address

uint32\_t pflashSwapIfrStart

Program Flash Swap IFR start address

struct idxInfo

## 2.31 ftfx feature

FTFX\_DRIVER\_IS\_FLASH\_RESIDENT

Flash driver location.

Used for the flash resident application.

FTFX\_DRIVER\_IS\_EXPORTED

Flash Driver Export option.

Used for the MCUXpresso SDK application.

FTFX\_FLASH1\_HAS\_PROT\_CONTROL

Indicates whether the secondary flash has its own protection register in flash module.

FTFX\_FLASH1\_HAS\_XACC\_CONTROL

Indicates whether the secondary flash has its own Execute-Only access register in flash module.

FTFX\_DRIVER\_HAS\_FLASH1\_SUPPORT

Indicates whether the secondary flash is supported in the Flash driver.

FTFX\_FLASH\_COUNT

FTFX\_FLASH1\_IS\_INDEPENDENT\_BLOCK

## 2.32 Ftftx FLASH Driver

*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\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_PartitionStatusUpdateFailure – Failed to update the partition status.

*status\_t* FLASH\_Erase(*flash\_config\_t* \*config, uint32\_t start, uint32\_t lengthInBytes, uint32\_t key)

Erases the Dflash 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 does not need to be sector-aligned but must be word-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words) to be erased. Must be word-aligned.
- key – The value used to validate all flash erase APIs.

### Return values

- kStatus\_FTFx\_Success – API was executed successfully; the appropriate number of flash sectors based on the desired start address and length were erased successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus\_FTFx\_AddressError – The address is out of range.
- kStatus\_FTFx\_EraseKeyError – The API erase key is invalid.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during the command execution.

*status\_t* FLASH\_EraseSectorNonBlocking(*flash\_config\_t* \*config, uint32\_t start, uint32\_t key)

Erases the Dflash sectors encompassed by parameters passed into function.

This function erases one flash sector size based on the start address, and it is executed asynchronously.

NOTE: This function can only erase one flash sector at a time, and the other commands can be executed after the previous command has been completed.

#### 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 does not need to be sector-aligned but must be word-aligned.
- key – The value used to validate all flash erase APIs.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus\_FTFx\_AddressError – The address is out of range.
- kStatus\_FTFx\_EraseKeyError – The API erase key is invalid.

*status\_t* FLASH\_EraseAll(*flash\_config\_t* \*config, uint32\_t key)

Erases entire flexnvm.

#### Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully; the all pflash and flexnvm were erased successfully, the swap and eeprom have been reset to unconfigured state.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_EraseKeyError – API erase key is invalid.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during command execution.
- kStatus\_FTFx\_PartitionStatusUpdateFailure – Failed to update the partition status.

*status\_t* FLASH\_EraseAllUnsecure(*flash\_config\_t* \*config, uint32\_t key)

Erases the entire flexnvm, including protected sectors.

#### Parameters

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

- `key` – A value used to validate all flash erase APIs.

### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the protected sectors of flash were reset to unprotected status.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_PartitionStatusUpdateFailure` – Failed to update the partition status.

`status_t FLASH_Program(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.

### 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 word-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 word-aligned.

### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the desired data were programmed successfully into flash based on desired start address and length.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

*status\_t* FLASH\_ProgramOnce(*flash\_config\_t* \*config, uint32\_t index, uint8\_t \*src, uint32\_t lengthInBytes)

Program the Program-Once-Field through parameters.

This function Program the Program-once-field with given index and length.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating the area of program once field to be read.
- src – A pointer to the source buffer of data that is used to store data to be write.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully; The index indicating the area of program once field was programmed successfully.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during the command execution.

*status\_t* FLASH\_ProgramSection(*flash\_config\_t* \*config, uint32\_t start, uint8\_t \*src, uint32\_t lengthInBytes)

Programs flash with data at locations passed in through parameters via the Program Section command.

This function programs the flash memory with the desired 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 programmed. Must be word-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 word-aligned.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully; the desired data have been programmed successfully into flash based on start address and length.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus\_FTFx\_AddressError – Address is out of range.

- `kStatus_FTFx_SetFlexramAsRamError` – Failed to set flexram as RAM.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_RecoverFlexramAsEepromError` – Failed to recover FlexRAM as EEPROM.

`status_t` FLASH\_ReadResource(*flash\_config\_t* \*config, uint32\_t start, uint8\_t \*dst, uint32\_t lengthInBytes, *ftfx\_read\_resource\_opt\_t* option)

Reads the resource with data at locations passed in through parameters.

This function reads the flash memory with the desired location 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 programmed. Must be word-aligned.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- option – The resource option which indicates which area should be read back.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the data have been read successfully from program flash IFR, data flash IFR space, and the Version ID field.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t` FLASH\_ReadOnce(*flash\_config\_t* \*config, uint32\_t index, uint8\_t \*dst, uint32\_t lengthInBytes)

Reads the Program Once Field through parameters.

This function reads the read once field with given index and length.



**Parameters**

- `config` – A pointer to the storage for the driver runtime state.
- `index` – The index indicating the area of program once field to be read.
- `dst` – A pointer to the destination buffer of data that is used to store data to be read.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the data have been successfully read from Program flash0 IFR map and Program Once field based on index and length.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t` FLASH\_VerifyErase(*flash\_config\_t* \*`config`, `uint32_t` `start`, `uint32_t` `lengthInBytes`, *ftfx\_margin\_value\_t* `margin`)

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 does not need to be sector-aligned but must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `margin` – Read margin choice.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the specified FLASH region has been erased.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.

- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLASH_VerifyEraseAll(flash_config_t *config, ftfx_margin_value_t margin)`

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; all program flash and flexnvm were in erased state.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

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

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

This function verifies the data programmed 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. Must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `expectedData` – A pointer to the expected data that is to be verified against.
- `margin` – Read margin choice.
- `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_FTFx_Success` – API was executed successfully; the desired data have been successfully programed into specified FLASH region.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.

- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t` FLASH\_GetSecurityState(*flash\_config\_t* \*config, *ftfx\_security\_state\_t* \*state)

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

#### Parameters

- config – A pointer to storage for the driver runtime state.
- state – A pointer to the value returned for the current security status code:

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the security state of flash was stored to state.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.

`status_t` FLASH\_SecurityBypass(*flash\_config\_t* \*config, `const uint8_t` \*backdoorKey)

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- backdoorKey – A pointer to the user buffer containing the backdoor key.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t` FLASH\_SetFlexramFunction(*flash\_config\_t* \*config, *ftfx\_flexram\_func\_opt\_t* option)

Sets the FlexRAM function command.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- option – The option used to set the work mode of FlexRAM.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the FlexRAM has been successfully configured as RAM or EEPROM.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLASH_Swap(flash_config_t *config, uint32_t address, bool isSetEnable)`

Swaps the lower half flash with the higher half flash.

**Parameters**

- `config` – A pointer to the storage for the driver runtime state.
- `address` – Address used to configure the flash swap function
- `isSetEnable` – The possible option used to configure the Flash Swap function or check the flash Swap status.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the lower half flash and higher half flash have been swapped.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_SwapIndicatorAddressError` – Swap indicator address is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_SwapSystemNotInUninitialized` – Swap system is not in an uninitialized state.

`status_t FLASH_IsProtected(flash_config_t *config, uint32_t start, uint32_t lengthInBytes, flash_prot_state_t *protection_state)`

Returns the protection state of the desired flash area via the pointer passed into the function.

This function retrieves the current flash protect status 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 checked. Must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words) to be checked. Must be word-aligned.
- `protection_state` – A pointer to the value returned for the current protection status code for the desired flash area.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the protection state of specified FLASH region was stored to `protection_state`.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – The address is out of range.

`status_t` FLASH\_IsExecuteOnly(*flash\_config\_t* \*config, uint32\_t start, uint32\_t lengthInBytes, *flash\_xacc\_state\_t* \*access\_state)

Returns the access state of the desired flash area via the pointer passed into the function.

This function retrieves the current flash access status 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 checked. Must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be checked. Must be word-aligned.
- `access_state` – A pointer to the value returned for the current access status code for the desired flash area.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the executeOnly state of specified FLASH region was stored to `access_state`.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – The parameter is not aligned to the specified baseline.
- `kStatus_FTFx_AddressError` – The address is out of range.

`status_t` FLASH\_PflashSetProtection(*flash\_config\_t* \*config, *pflash\_prot\_status\_t* \*protectStatus)

Sets the PFlash Protection to the intended protection status.

#### Parameters

- `config` – A pointer to storage for the driver runtime state.
- `protectStatus` – The expected protect status to set to the PFlash protection register. Each bit is corresponding to protection of 1/32(64) of the total PFlash. The least significant bit is corresponding to the lowest address area of PFlash. The most significant bit is corresponding to the highest address area of PFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the specified FLASH region is protected.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.

`status_t` FLASH\_PflashGetProtection(*flash\_config\_t* \*config, *pflash\_prot\_status\_t* \*protectStatus)

Gets the PFlash protection status.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – Protect status returned by the PFlash IP. Each bit is corresponding to the protection of 1/32(64) of the total PFlash. The least significant bit corresponds to the lowest address area of the PFlash. The most significant bit corresponds to the highest address area of PFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the Protection state was stored to protectStatus;
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.

`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_FTFx_Success` – API was executed successfully; the flash property was stored to value.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_UnknownProperty` – An unknown property tag.

`status_t` FLASH\_GetCommandState(*void*)

Get previous command status.

This function is used to obtain the execution status of the previous command.

#### Return values

- `kStatus_FTFx_Success` – The previous command is executed successfully.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.

- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`FSL_FLASH_DRIVER_VERSION`

Flash driver version for SDK.

Version 3.3.0.

`FSL_FLASH_DRIVER_VERSION_ROM`

Flash driver version for ROM.

Version 3.0.0.

`enum _flash_protection_state`

Enumeration for the three possible flash protection levels.

*Values:*

`enumerator kFLASH_ProtectionStateUnprotected`

Flash region is not protected.

`enumerator kFLASH_ProtectionStateProtected`

Flash region is protected.

`enumerator kFLASH_ProtectionStateMixed`

Flash is mixed with protected and unprotected region.

`enum _flash_execute_only_access_state`

Enumeration for the three possible flash execute access levels.

*Values:*

`enumerator kFLASH_AccessStateUnLimited`

Flash region is unlimited.

`enumerator kFLASH_AccessStateExecuteOnly`

Flash region is execute only.

`enumerator kFLASH_AccessStateMixed`

Flash is mixed with unlimited and execute only region.

`enum _flash_property_tag`

Enumeration for various flash properties.

*Values:*

`enumerator kFLASH_PropertyPflash0SectorSize`

Pflash sector size property.

`enumerator kFLASH_PropertyPflash0TotalSize`

Pflash total size property.

`enumerator kFLASH_PropertyPflash0BlockSize`

Pflash block size property.

`enumerator kFLASH_PropertyPflash0BlockCount`

Pflash block count property.

`enumerator kFLASH_PropertyPflash0BlockBaseAddr`

Pflash block base address property.

`enumerator kFLASH_PropertyPflash0FacSupport`

Pflash fac support property.

enumerator kFLASH\_PropertyPflash0AccessSegmentSize  
Pflash access segment size property.

enumerator kFLASH\_PropertyPflash0AccessSegmentCount  
Pflash access segment count property.

enumerator kFLASH\_PropertyPflash1SectorSize  
Pflash sector size property.

enumerator kFLASH\_PropertyPflash1TotalSize  
Pflash total size property.

enumerator kFLASH\_PropertyPflash1BlockSize  
Pflash block size property.

enumerator kFLASH\_PropertyPflash1BlockCount  
Pflash block count property.

enumerator kFLASH\_PropertyPflash1BlockBaseAddr  
Pflash block base address property.

enumerator kFLASH\_PropertyPflash1FacSupport  
Pflash fac support property.

enumerator kFLASH\_PropertyPflash1AccessSegmentSize  
Pflash access segment size property.

enumerator kFLASH\_PropertyPflash1AccessSegmentCount  
Pflash access segment count property.

enumerator kFLASH\_PropertyFlexRamBlockBaseAddr  
FlexRam block base address property.

enumerator kFLASH\_PropertyFlexRamTotalSize  
FlexRam total size property.

typedef enum *\_flash\_protection\_state* flash\_prot\_state\_t  
Enumeration for the three possible flash protection levels.

typedef union *\_pflash\_protection\_status* pflash\_prot\_status\_t  
PFlash protection status.

typedef enum *\_flash\_execute\_only\_access\_state* flash\_xacc\_state\_t  
Enumeration for the three possible flash execute access levels.

typedef enum *\_flash\_property\_tag* flash\_property\_tag\_t  
Enumeration for various flash properties.

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.

kStatus\_FLASH\_Success

kFLASH\_ApiEraseKey

union *\_pflash\_protection\_status*  
*#include <fsl\_ftfx\_flash.h>* PFlash protection status.



### Public Members

```
uint32_t protl
 PROT[31:0] .

uint32_t proth
 PROT[63:32].

uint8_t protsl
 PROTS[7:0] .

uint8_t protsh
 PROTS[15:8] .

uint8_t reserved[2]
```

struct `_flash_config`

*#include <fsl\_ftfx\_flash.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.

## 2.33 Ftftx FLEXNVM Driver

*status\_t* FLEXNVM\_Init(*flexnvm\_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\_FTFx\_Success* – API was executed successfully.
- *kStatus\_FTFx\_InvalidArgument* – An invalid argument is provided.
- *kStatus\_FTFx\_ExecuteInRamFunctionNotReady* – Execute-in-RAM function is not available.
- *kStatus\_FTFx\_PartitionStatusUpdateFailure* – Failed to update the partition status.

*status\_t* FLEXNVM\_DflashErase(*flexnvm\_config\_t* \*config, uint32\_t start, uint32\_t lengthInBytes, uint32\_t key)

Erases the Dflash 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 does not need to be sector-aligned but must be word-aligned.
- *lengthInBytes* – The length, given in bytes (not words or long-words) to be erased. Must be word-aligned.
- *key* – The value used to validate all flash erase APIs.

### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the appropriate number of data flash sectors based on the desired start address and length were erased successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – The parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – The address is out of range.
- `kStatus_FTFx_EraseKeyError` – The API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLEXNVM_EraseAll(flexnvm_config_t *config, uint32_t key)`

Erases entire flexnvm.

#### Parameters

- `config` – Pointer to the storage for the driver runtime state.
- `key` – A value used to validate all flash erase APIs.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the entire flexnvm has been erased successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_PartitionStatusUpdateFailure` – Failed to update the partition status.

`status_t FLEXNVM_EraseAllUnsecure(flexnvm_config_t *config, uint32_t key)`

Erases the entire flexnvm, including protected sectors.

#### Parameters

- `config` – Pointer to the storage for the driver runtime state.
- `key` – A value used to validate all flash erase APIs.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the flexnvm is not in security state.

- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_EraseKeyError` – API erase key is invalid.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_PartitionStatusUpdateFailure` – Failed to update the partition status.

`status_t FLEXNVM_DflashProgram(flexnvm_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.

#### 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 word-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 word-aligned.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the desired data have been successfully programmed into specified data flash region.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLEXNVM_DflashProgramSection(flexnvm_config_t *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)`

Programs flash with data at locations passed in through parameters via the Program Section command.

This function programs the flash memory with the desired 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 programmed. Must be word-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 word-aligned.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the desired data have been successfully programmed into specified data flash area.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_SetFlexramAsRamError` – Failed to set flexram as RAM.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.
- `kStatus_FTFx_RecoverFlexramAsEepromError` – Failed to recover FlexRAM as EEPROM.

`status_t FLEXNVM_ProgramPartition(flexnvm_config_t *config,  
                                           ftfx_partition_flexram_load_opt_t option, uint32_t  
                                           eepromDataSizeCode, uint32_t flexnvmPartitionCode)`

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM.

**Parameters**

- `config` – Pointer to storage for the driver runtime state.
- `option` – The option used to set FlexRAM load behavior during reset.
- `eepromDataSizeCode` – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- `flexnvmPartitionCode` – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully; the FlexNVM block for use as data flash, EEPROM backup, or a combination of both have been Prepared.
- `kStatus_FTFx_InvalidArgument` – Invalid argument is provided.

- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.

`status_t FLEXNVM_ProgramPartition_CSE(flexnvm_config_t *config,  
ftfx_partition_flexram_load_opt_t option, uint32_t  
eepromDataSizeCode, uint32_t  
flexnvmPartitionCode, uint8_t CSEcKeySize, uint8_t  
SFE)`

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM. This is the CSE enabled version for IP's like FTFC.

#### Parameters

- `config` – Pointer to storage for the driver runtime state.
- `option` – The option used to set FlexRAM load behavior during reset.
- `eepromDataSizeCode` – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- `flexnvmPartitionCode` – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.
- `CSEcKeySize` – CSEc/SHE key size, see RM for details and possible values
- `SFE` – Security Flag Extension (SFE), see RM for details and possible values

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the FlexNVM block for use as data flash, EEPROM backup, or a combination of both have been Prepared.
- `kStatus_FTFx_InvalidArgument` – Invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.

`status_t FLEXNVM_ReadResource(flexnvm_config_t *config, uint32_t start, uint8_t *dst, uint32_t  
lengthInBytes, ftfx_read_resource_opt_t option)`

Reads the resource with data at locations passed in through parameters.

This function reads the flash memory with the desired location 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 programmed. Must be word-aligned.
- `dst` – A pointer to the destination buffer of data that is used to store data to be read.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- `option` – The resource option which indicates which area should be read back.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the data have been read successfully from program flash IFR, data flash IFR space, and the Version ID field
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with the specified baseline.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLEXNVM_DflashVerifyErase(flexnvm_config_t *config, uint32_t start, uint32_t lengthInBytes, ftfx_margin_value_t margin)`

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 does not need to be sector-aligned but must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the specified data flash region is in erased state.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.

- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLEXNVM_VerifyEraseAll(flexnvm_config_t *config, ftfx_margin_value_t margin)`

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `margin` – Read margin choice.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the entire flexnvm region is in erased state.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t FLEXNVM_DflashVerifyProgram(flexnvm_config_t *config, uint32_t start, uint32_t lengthInBytes, const uint8_t *expectedData, ftfx_margin_value_t margin, uint32_t *failedAddress, uint32_t *failedData)`

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

This function verifies the data programmed 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. Must be word-aligned.
- `lengthInBytes` – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- `expectedData` – A pointer to the expected data that is to be verified against.
- `margin` – Read margin choice.
- `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_FTFx_Success` – API was executed successfully; the desired data have been programmed successfully into specified data flash region.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AlignmentError` – Parameter is not aligned with specified baseline.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.

`status_t` FLEXNVM\_GetSecurityState(*flexnvm\_config\_t* \*config, *ftfx\_security\_state\_t* \*state)

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

#### Parameters

- `config` – A pointer to storage for the driver runtime state.
- `state` – A pointer to the value returned for the current security status code:

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the security state of flexnvm was stored to state.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.

`status_t` FLEXNVM\_SecurityBypass(*flexnvm\_config\_t* \*config, `const uint8_t` \*backdoorKey)

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

#### Parameters

- `config` – A pointer to the storage for the driver runtime state.
- `backdoorKey` – A pointer to the user buffer containing the backdoor key.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_ExecuteInRamFunctionNotReady` – Execute-in-RAM function is not available.
- `kStatus_FTFx_AccessError` – Invalid instruction codes and out-of bounds addresses.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_CommandFailure` – Run-time error during the command execution.



*status\_t* FLEXNVM\_SetFlexramFunction(*flexnvm\_config\_t* \*config, *ftfx\_flexram\_func\_opt\_t* option)

Sets the FlexRAM function command.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- option – The option used to set the work mode of FlexRAM.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully; the FlexRAM has been successfully configured as RAM or EEPROM
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus\_FTFx\_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus\_FTFx\_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus\_FTFx\_CommandFailure – Run-time error during the command execution.

*status\_t* FLEXNVM\_DflashSetProtection(*flexnvm\_config\_t* \*config, *uint8\_t* protectStatus)

Sets the DFlash protection to the intended protection status.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – The expected protect status to set to the DFlash protection register. Each bit corresponds to the protection of the 1/8 of the total DFlash. The least significant bit corresponds to the lowest address area of the DFlash. The most significant bit corresponds to the highest address area of the DFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

#### Return values

- kStatus\_FTFx\_Success – API was executed successfully; the specified DFlash region is protected.
- kStatus\_FTFx\_InvalidArgument – An invalid argument is provided.
- kStatus\_FTFx\_CommandNotSupported – Flash API is not supported.
- kStatus\_FTFx\_CommandFailure – Run-time error during command execution.

*status\_t* FLEXNVM\_DflashGetProtection(*flexnvm\_config\_t* \*config, *uint8\_t* \*protectStatus)

Gets the DFlash protection status.

#### Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – DFlash Protect status returned by the PFlash IP. Each bit corresponds to the protection of the 1/8 of the total DFlash. The least significant bit corresponds to the lowest address area of the DFlash. The most significant bit corresponds to the highest address area of the DFlash, and so on. There are two possible cases as below: 0: this area is protected. 1: this area is unprotected.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_CommandNotSupported` – Flash API is not supported.

`status_t` FLEXNVM\_EepromSetProtection(*flexnvm\_config\_t* \*config, uint8\_t protectStatus)

Sets the EEPROM protection to the intended protection status.

**Parameters**

- config – A pointer to the storage for the driver runtime state.
- protectStatus – The expected protect status to set to the EEPROM protection register. Each bit corresponds to the protection of the 1/8 of the total EEPROM. The least significant bit corresponds to the lowest address area of the EEPROM. The most significant bit corresponds to the highest address area of EEPROM, and so on. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_CommandNotSupported` – Flash API is not supported.
- `kStatus_FTFx_CommandFailure` – Run-time error during command execution.

`status_t` FLEXNVM\_EepromGetProtection(*flexnvm\_config\_t* \*config, uint8\_t \*protectStatus)

Gets the EEPROM protection status.

**Parameters**

- config – A pointer to the storage for the driver runtime state.
- protectStatus – DFlash Protect status returned by the PFlash IP. Each bit corresponds to the protection of the 1/8 of the total EEPROM. The least significant bit corresponds to the lowest address area of the EEPROM. The most significant bit corresponds to the highest address area of the EEPROM. There are two possible cases as below: 0: this area is protected. 1: this area is unprotected.

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_CommandNotSupported` – Flash API is not supported.

`status_t` FLEXNVM\_GetProperty(*flexnvm\_config\_t* \*config, *flexnvm\_property\_tag\_t* whichProperty, uint32\_t \*value)

Returns the desired flexnvm property.

**Parameters**

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

**Return values**

- `kStatus_FTFx_Success` – API was executed successfully.

- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_UnknownProperty` – An unknown property tag.

`enum _flexnvm_property_tag`

Enumeration for various flexnvm properties.

*Values:*

enumerator `kFLEXNVM_PropertyDflashSectorSize`  
Dflash sector size property.

enumerator `kFLEXNVM_PropertyDflashTotalSize`  
Dflash total size property.

enumerator `kFLEXNVM_PropertyDflashBlockSize`  
Dflash block size property.

enumerator `kFLEXNVM_PropertyDflashBlockCount`  
Dflash block count property.

enumerator `kFLEXNVM_PropertyDflashBlockBaseAddr`  
Dflash block base address property.

enumerator `kFLEXNVM_PropertyAliasDflashBlockBaseAddr`  
Dflash block base address Alias property.

enumerator `kFLEXNVM_PropertyFlexRamBlockBaseAddr`  
FlexRam block base address property.

enumerator `kFLEXNVM_PropertyFlexRamTotalSize`  
FlexRam total size property.

enumerator `kFLEXNVM_PropertyEepromTotalSize`  
EEPROM total size property.

`typedef enum _flexnvm_property_tag flexnvm_property_tag_t`

Enumeration for various flexnvm properties.

`typedef struct _flexnvm_config flexnvm_config_t`

Flexnvm driver state information.

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

`status_t FLEXNVM_EepromWrite(flexnvm_config_t *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)`

Programs the EEPROM with data at locations passed in through parameters.

This function programs the emulated EEPROM with the desired 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 programmed. Must be word-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 word-aligned.

#### Return values

- `kStatus_FTFx_Success` – API was executed successfully; the desires data have been successfully programed into specified eeprom region.
- `kStatus_FTFx_InvalidArgument` – An invalid argument is provided.
- `kStatus_FTFx_AddressError` – Address is out of range.
- `kStatus_FTFx_SetFlexramAsEepromError` – Failed to set flexram as eeprom.
- `kStatus_FTFx_ProtectionViolation` – The program/erase operation is requested to execute on protected areas.
- `kStatus_FTFx_RecoverFlexramAsRamError` – Failed to recover the FlexRAM as RAM.

`struct __flexnvm_config`

*#include <fsl\_ftfx\_flexnvm.h>* Flexnvm driver state information.

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

## 2.34 ftfx utilities

`ALIGN_DOWN(x, a)`

Alignment(down) utility.

`ALIGN_UP(x, a)`

Alignment(up) utility.

`MAKE_VERSION(major, minor, bugfix)`

Constructs the version number for drivers.

`MAKE_STATUS(group, code)`

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

`FOUR_CHAR_CODE(a, b, c, d)`

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

`B1P4(b)`

bytes2word utility.

`B1P3(b)`

`B1P2(b)`

`B1P1(b)`

`B2P3(b)`

`B2P2(b)`

`B2P1(b)`

`B3P2(b)`

`B3P1(b)`

`BYTE2WORD_1_3(x, y)`

`BYTE2WORD_2_2(x, y)`

`BYTE2WORD_3_1(x, y)`

BYTE2WORD\_1\_1\_2(x, y, z)

BYTE2WORD\_1\_2\_1(x, y, z)

BYTE2WORD\_2\_1\_1(x, y, z)

BYTE2WORD\_1\_1\_1\_1(x, y, z, w)

## 2.35 GPIO: General-Purpose Input/Output Driver

FSL\_GPIO\_DRIVER\_VERSION

GPIO driver version.

enum \_gpio\_pin\_direction

GPIO direction definition.

*Values:*

enumerator kGPIO\_DigitalInput

Set current pin as digital input

enumerator kGPIO\_DigitalOutput

Set current pin as digital output

enum \_gpio\_checker\_attribute

GPIO checker attribute.

*Values:*

enumerator kGPIO\_UsernonsecureRWUsersecureRWPrivilegedsecureRW

User nonsecure:Read+Write; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureRUsersecureRWPrivilegedsecureRW

User nonsecure:Read; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureNUsersecureRWPrivilegedsecureRW

User nonsecure:None; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureRUsersecureRPrivilegedsecureRW

User nonsecure:Read; User Secure:Read; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureNUsersecureRPrivilegedsecureRW

User nonsecure:None; User Secure:Read; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureNUsersecureNPrivilegedsecureRW

User nonsecure:None; User Secure:None; Privileged Secure:Read+Write

enumerator kGPIO\_UsernonsecureNUsersecureNPrivilegedsecureR

User nonsecure:None; User Secure:None; Privileged Secure:Read

enumerator kGPIO\_UsernonsecureNUsersecureNPrivilegedsecureN

User nonsecure:None; User Secure:None; Privileged Secure:None

enumerator kGPIO\_IgnoreAttributeCheck

Ignores the attribute check

typedef enum \_gpio\_pin\_direction gpio\_pin\_direction\_t

GPIO direction definition.

typedef enum \_gpio\_checker\_attribute gpio\_checker\_attribute\_t

GPIO checker attribute.

```
typedef struct _gpio_pin_config gpio_pin_config_t
```

The GPIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, leave the outputConfig unused. Note that in some use cases, the corresponding port property should be configured in advance with the `PORT_SetPinConfig()`.

```
GPIO_FIT_REG(value)
```

```
struct _gpio_pin_config
```

`#include <fsl_gpio.h>` The GPIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, leave the outputConfig unused. Note that in some use cases, the corresponding port property should be configured in advance with the `PORT_SetPinConfig()`.

### Public Members

`gpio_pin_direction_t` pinDirection

GPIO direction, input or output

`uint8_t` outputLogic

Set a default output logic, which has no use in input

## 2.36 GPIO Driver

```
void GPIO_PortInit(GPIO_Type *base)
```

Initializes the GPIO peripheral.

This function ungates the GPIO clock.

### Parameters

- base – GPIO peripheral base pointer.

```
void GPIO_PortDeinit(GPIO_Type *base)
```

Denitalizes the GPIO peripheral.

### Parameters

- base – GPIO peripheral base pointer.

```
void GPIO_PinInit(GPIO_Type *base, 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, as either input or output, in the user file. Then, call the `GPIO_PinInit()` function.

This is an example to define an input pin or an 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 (GPIOA, GPIOB, GPIOC, and so on.)
- pin – GPIO port pin number
- config – GPIO pin configuration pointer

static inline void GPIO\_PinWrite(GPIO\_Type \*base, uint32\_t pin, uint8\_t output)

Sets the output level of the multiple GPIO pins to the logic 1 or 0.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- 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 void GPIO\_PortSet(GPIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple GPIO pins to the logic 1.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO\_PortClear(GPIO\_Type \*base, uint32\_t mask)

Sets the output level of the multiple GPIO pins to the logic 0.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO\_PortToggle(GPIO\_Type \*base, uint32\_t mask)

Reverses the current output logic of the multiple GPIO pins.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline uint32\_t GPIO\_PinRead(GPIO\_Type \*base, uint32\_t pin)

Reads the current input value of the GPIO port.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- pin – GPIO pin number

**Return values**

GPIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

uint32\_t GPIO\_PortGetInterruptFlags(GPIO\_Type \*base)

Reads the GPIO port interrupt status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains

set until a logic one is written to that flag. If configured for a level sensitive interrupt that remains asserted, the flag is set again immediately.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)

**Return values**

The – current GPIO port interrupt status flag, for example, 0x00010001 means the pin 0 and 17 have the interrupt.

```
void GPIO_PortClearInterruptFlags(GPIO_Type *base, uint32_t mask)
```

Clears multiple GPIO pin interrupt status flags.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
void GPIO_CheckAttributeBytes(GPIO_Type *base, gpio_checker_attribute_t attribute)
```

brief The GPIO module supports a device-specific number of data ports, organized as 32-bit words/8-bit Bytes. Each 32-bit/8-bit data port includes a GACR register, which defines the byte-level attributes required for a successful access to the GPIO programming model. If the GPIO module's GACR register organized as 32-bit words, the attribute controls for the 4 data bytes in the GACR follow a standard little endian data convention.

**Parameters**

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- attribute – GPIO checker attribute

## 2.37 INTMUX: Interrupt Multiplexer Driver

```
void INTMUX_Init(INTMUX_Type *base)
```

Initializes the INTMUX module.

This function enables the clock gate for the specified INTMUX. It then resets all channels, so that no interrupt sources are routed and the logic mode is set to default of kINTMUX\_ChannelLogicOR. Finally, the NVIC vectors for all the INTMUX output channels are enabled.

**Parameters**

- base – INTMUX peripheral base address.

```
void INTMUX_Deinit(INTMUX_Type *base)
```

Deinitializes an INTMUX instance for operation.

The clock gate for the specified INTMUX is disabled and the NVIC vectors for all channels are disabled.

**Parameters**

- base – INTMUX peripheral base address.

```
static inline void INTMUX_ResetChannel(INTMUX_Type *base, uint32_t channel)
```

Resets an INTMUX channel.

Sets all register values in the specified channel to their reset value. This function disables all interrupt sources for the channel.

**Parameters**

- base – INTMUX peripheral base address.



- `channel` – The INTMUX channel number.

```
static inline void INTMUX_SetChannelMode(INTMUX_Type *base, uint32_t channel,
 intmux_channel_logic_mode_t logic)
```

Sets the logic mode for an INTMUX channel.

INTMUX channels can be configured to use one of the two logic modes that control how pending interrupt sources on the channel trigger the output interrupt.

- `kINTMUX_ChannelLogicOR` means any source pending triggers the output interrupt.
- `kINTMUX_ChannelLogicAND` means all selected sources on the channel must be pending before the channel output interrupt triggers.

#### Parameters

- `base` – INTMUX peripheral base address.
- `channel` – The INTMUX channel number.
- `logic` – The INTMUX channel logic mode.

```
static inline void INTMUX_EnableInterrupt(INTMUX_Type *base, uint32_t channel, IRQn_Type
 irq)
```

Enables an interrupt source on an INTMUX channel.

#### Parameters

- `base` – INTMUX peripheral base address.
- `channel` – Index of the INTMUX channel on which the specified interrupt is enabled.
- `irq` – Interrupt to route to the specified INTMUX channel. The interrupt must be an INTMUX source.

```
static inline void INTMUX_DisableInterrupt(INTMUX_Type *base, uint32_t channel, IRQn_Type
 irq)
```

Disables an interrupt source on an INTMUX channel.

#### Parameters

- `base` – INTMUX peripheral base address.
- `channel` – Index of the INTMUX channel on which the specified interrupt is disabled.
- `irq` – Interrupt number. The interrupt must be an INTMUX source.

```
static inline uint32_t INTMUX_GetChannelPendingSources(INTMUX_Type *base, uint32_t
 channel)
```

Gets INTMUX pending interrupt sources for a specific channel.

#### Parameters

- `base` – INTMUX peripheral base address.
- `channel` – The INTMUX channel number.

#### Returns

The mask of pending interrupt bits. Bit[n] set means INTMUX source n is pending.

FSL\_INTMUX\_DRIVER\_VERSION

```
enum _intmux_channel_logic_mode
 INTMUX channel logic mode.
```

*Values:*

enumerator kINTMUX\_ChannelLogicOR  
Logic OR all enabled interrupt inputs

enumerator kINTMUX\_ChannelLogicAND  
Logic AND all enabled interrupt inputs

typedef enum *\_intmux\_channel\_logic\_mode* intmux\_channel\_logic\_mode\_t  
INTMUX channel logic mode.

## 2.38 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 USB CDC.

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 I2C status codes.

enumerator kStatusGroup\_LPSCI

Group number for LPSCI status codes.

enumerator kStatusGroup\_LPUART

Group number for LPUART status codes.

enumerator kStatusGroup\_SPI

Group number for SPI status code.

enumerator kStatusGroup\_XRDC

Group number for XRDC status code.

enumerator kStatusGroup\_SEMA42

Group number for SEMA42 status code.

enumerator kStatusGroup\_SDHC

Group number for SDHC status code

enumerator kStatusGroup\_SDMMC

Group number for SDMMC status code

enumerator kStatusGroup\_SAI

Group number for SAI status code

enumerator kStatusGroup\_MCG

Group number for MCG status codes.

enumerator kStatusGroup\_\_SCG  
Group number for SCG status codes.

enumerator kStatusGroup\_\_SDSPI  
Group number for SDSPIC status codes.

enumerator kStatusGroup\_\_FLEXIO\_I2S  
Group number for FLEXIO I2S status codes

enumerator kStatusGroup\_\_FLEXIO\_MCULCD  
Group number for FLEXIO LCD status codes

enumerator kStatusGroup\_\_FLASHIAP  
Group number for FLASHIAP status codes

enumerator kStatusGroup\_\_FLEXCOMM\_I2C  
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup\_\_I2S  
Group number for I2S status codes

enumerator kStatusGroup\_\_IUART  
Group number for IUART status codes

enumerator kStatusGroup\_\_CSI  
Group number for CSI status codes

enumerator kStatusGroup\_\_MIPI\_DSI  
Group number for MIPI DSI status codes

enumerator kStatusGroup\_\_SDRAMC  
Group number for SDRAMC status codes.

enumerator kStatusGroup\_\_POWER  
Group number for POWER status codes.

enumerator kStatusGroup\_\_ENET  
Group number for ENET status codes.

enumerator kStatusGroup\_\_PHY  
Group number for PHY status codes.

enumerator kStatusGroup\_\_TRGMUX  
Group number for TRGMUX status codes.

enumerator kStatusGroup\_\_SMARTCARD  
Group number for SMARTCARD status codes.

enumerator kStatusGroup\_\_LMEM  
Group number for LMEM status codes.

enumerator kStatusGroup\_\_QSPI  
Group number for QSPI status codes.

enumerator kStatusGroup\_\_DMA  
Group number for DMA status codes.

enumerator kStatusGroup\_\_EDMA  
Group number for EDMA status codes.

enumerator kStatusGroup\_\_DMAMGR  
Group number for DMAMGR status codes.

enumerator kStatusGroup\_FLEXCAN  
Group number for FlexCAN status codes.

enumerator kStatusGroup\_LTC  
Group number for LTC status codes.

enumerator kStatusGroup\_FLEXIO\_CAMERA  
Group number for FLEXIO CAMERA status codes.

enumerator kStatusGroup\_LPC\_SPI  
Group number for LPC\_SPI status codes.

enumerator kStatusGroup\_LPC\_USART  
Group number for LPC\_USART status codes.

enumerator kStatusGroup\_DMIC  
Group number for DMIC status codes.

enumerator kStatusGroup\_SDIF  
Group number for SDIF status codes.

enumerator kStatusGroup\_SPIFI  
Group number for SPIFI status codes.

enumerator kStatusGroup\_OTP  
Group number for OTP status codes.

enumerator kStatusGroup\_MCAN  
Group number for MCAN status codes.

enumerator kStatusGroup\_CAAM  
Group number for CAAM status codes.

enumerator kStatusGroup\_ECSPI  
Group number for ECSPI status codes.

enumerator kStatusGroup\_USDHC  
Group number for USDHC status codes.

enumerator kStatusGroup\_LPC\_I2C  
Group number for LPC\_I2C status codes.

enumerator kStatusGroup\_DCP  
Group number for DCP status codes.

enumerator kStatusGroup\_MSCAN  
Group number for MSCAN status codes.

enumerator kStatusGroup\_ESAI  
Group number for ESAI status codes.

enumerator kStatusGroup\_FLEXSPI  
Group number for FLEXSPI status codes.

enumerator kStatusGroup\_MMDC  
Group number for MMDC status codes.

enumerator kStatusGroup\_PDM  
Group number for MIC status codes.

enumerator kStatusGroup\_SDMA  
Group number for SDMA status codes.

enumerator kStatusGroup\_ICS  
Group number for ICS status codes.

enumerator kStatusGroup\_SPDIF  
Group number for SPDIF status codes.

enumerator kStatusGroup\_LPC\_MINISPI  
Group number for LPC\_MINISPI status codes.

enumerator kStatusGroup\_HASHCRYPT  
Group number for Hashcrypt status codes

enumerator kStatusGroup\_LPC\_SPI\_SSP  
Group number for LPC\_SPI\_SSP status codes.

enumerator kStatusGroup\_I3C  
Group number for I3C status codes

enumerator kStatusGroup\_LPC\_I2C\_1  
Group number for LPC\_I2C\_1 status codes.

enumerator kStatusGroup\_NOTIFIER  
Group number for NOTIFIER status codes.

enumerator kStatusGroup\_DebugConsole  
Group number for debug console status codes.

enumerator kStatusGroup\_SEMC  
Group number for SEMC status codes.

enumerator kStatusGroup\_ApplicationRangeStart  
Starting number for application groups.

enumerator kStatusGroup\_IAP  
Group number for IAP status codes

enumerator kStatusGroup\_SFA  
Group number for SFA status codes

enumerator kStatusGroup\_SPC  
Group number for SPC status codes.

enumerator kStatusGroup\_PUF  
Group number for PUF status codes.

enumerator kStatusGroup\_TOUCH\_PANEL  
Group number for touch panel status codes

enumerator kStatusGroup\_VBAT  
Group number for VBAT status codes

enumerator kStatusGroup\_XSPI  
Group number for XSPI status codes

enumerator kStatusGroup\_PNGDEC  
Group number for PNGDEC status codes

enumerator kStatusGroup\_JPEGDEC  
Group number for JPEGDEC status codes

enumerator kStatusGroup\_AUDMIX  
Group number for AUDMIX status codes

enumerator `kStatusGroup_HAL_GPIO`  
Group number for HAL GPIO status codes.

enumerator `kStatusGroup_HAL_UART`  
Group number for HAL UART status codes.

enumerator `kStatusGroup_HAL_TIMER`  
Group number for HAL TIMER status codes.

enumerator `kStatusGroup_HAL_SPI`  
Group number for HAL SPI status codes.

enumerator `kStatusGroup_HAL_I2C`  
Group number for HAL I2C status codes.

enumerator `kStatusGroup_HAL_FLASH`  
Group number for HAL FLASH status codes.

enumerator `kStatusGroup_HAL_PWM`  
Group number for HAL PWM status codes.

enumerator `kStatusGroup_HAL_RNG`  
Group number for HAL RNG status codes.

enumerator `kStatusGroup_HAL_I2S`  
Group number for HAL I2S status codes.

enumerator `kStatusGroup_HAL_ADC_SENSOR`  
Group number for HAL ADC SENSOR status codes.

enumerator `kStatusGroup_TIMERMANAGER`  
Group number for TiMER MANAGER status codes.

enumerator `kStatusGroup_SERIALMANAGER`  
Group number for SERIAL MANAGER status codes.

enumerator `kStatusGroup_LED`  
Group number for LED status codes.

enumerator `kStatusGroup_BUTTON`  
Group number for BUTTON status codes.

enumerator `kStatusGroup_EXTERN_EEPROM`  
Group number for EXTERN EEPROM status codes.

enumerator `kStatusGroup_SHELL`  
Group number for SHELL status codes.

enumerator `kStatusGroup_MEM_MANAGER`  
Group number for MEM MANAGER status codes.

enumerator `kStatusGroup_LIST`  
Group number for List status codes.

enumerator `kStatusGroup_OSA`  
Group number for OSA status codes.

enumerator `kStatusGroup_COMMON_TASK`  
Group number for Common task status codes.

enumerator `kStatusGroup_MSG`  
Group number for messaging status codes.



enumerator kStatusGroup\_SDK\_OCOTP  
Group number for OCOTP status codes.

enumerator kStatusGroup\_SDK\_FLEXSPINOR  
Group number for FLEXSPINOR status codes.

enumerator kStatusGroup\_CODEEC  
Group number for codec status codes.

enumerator kStatusGroup\_ASRC  
Group number for codec status ASRC.

enumerator kStatusGroup\_OTFAD  
Group number for codec status codes.

enumerator kStatusGroup\_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\_QUEUE DSPI  
Group number for QSPI status codes.

enumerator kStatusGroup\_POWER\_MANAGER  
Group number for POWER\_MANAGER status codes.

enumerator kStatusGroup\_IPED  
Group number for IPED status codes.

enumerator kStatusGroup\_ELS\_PKC  
Group number for ELS PKC status codes.

enumerator kStatusGroup\_CSS\_PKC  
Group number for CSS PKC status codes.

enumerator kStatusGroup\_HOSTIF  
Group number for HOSTIF status codes.

enumerator kStatusGroup\_CLIF  
Group number for CLIF status codes.

enumerator kStatusGroup\_BMA  
Group number for BMA status codes.

enumerator kStatusGroup\_NETC  
Group number for NETC status codes.

enumerator kStatusGroup\_ELE

Group number for ELE status codes.

enumerator kStatusGroup\_GLIKEY

Group number for GLIKEY status codes.

enumerator kStatusGroup\_AON\_POWER

Group number for AON\_POWER status codes.

enumerator kStatusGroup\_AON\_COMMON

Group number for AON\_COMMON status codes.

enumerator kStatusGroup\_ENDAT3

Group number for ENDAT3 status codes.

enumerator kStatusGroup\_HIPERFACE

Group number for HIPERFACE status codes.

enumerator kStatusGroup\_NPX

Group number for NPX status codes.

enumerator kStatusGroup\_ELA\_CSEC

Group number for ELA\_CSEC status codes.

enumerator kStatusGroup\_FLEXIO\_T\_FORMAT

Group number for T-format status codes.

enumerator kStatusGroup\_FLEXIO\_A\_FORMAT

Group number for A-format status codes.

Generic status return codes.

*Values:*

enumerator kStatus\_Success

Generic status for Success.

enumerator kStatus\_Fail

Generic status for Fail.

enumerator kStatus\_ReadOnly

Generic status for read only failure.

enumerator kStatus\_OutOfRange

Generic status for out of range access.

enumerator kStatus\_InvalidArgument

Generic status for invalid argument check.

enumerator kStatus\_Timeout

Generic status for timeout.

enumerator kStatus\_NoTransferInProgress

Generic status for no transfer in progress.

enumerator kStatus\_Busy

Generic status for module is busy.

enumerator kStatus\_NoData

Generic status for no data is found for the operation.

`typedef int32_t status_t`

Type used for all status and error return values.

`void *SDK_Malloc(size_t size, size_t alignbytes)`

Allocate memory with given alignment and aligned size.

This is provided to support the dynamically allocated memory used in cache-able region.

#### Parameters

- `size` – The length required to malloc.
- `alignbytes` – The alignment size.

#### Return values

The – allocated memory.

`void SDK_Free(void *ptr)`

Free memory.

#### Parameters

- `ptr` – The memory to be release.

`void SDK_DelayAtLeastUs(uint32_t delayTime_us, uint32_t coreClock_Hz)`

Delay at least for some time. Please note that, this API uses while loop for delay, different run-time environments make the time not precise, if precise delay count was needed, please implement a new delay function with hardware timer.

#### Parameters

- `delayTime_us` – Delay time in unit of microsecond.
- `coreClock_Hz` – Core clock frequency with Hz.

`static inline status_t EnableIRQ(IRQn_Type interrupt)`

Enable specific interrupt.

Enable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only enables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

#### Parameters

- `interrupt` – The IRQ number.

#### Return values

- `kStatus_Success` – Interrupt enabled successfully
- `kStatus_Fail` – Failed to enable the interrupt

`static inline status_t DisableIRQ(IRQn_Type interrupt)`

Disable specific interrupt.

Disable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only disables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

#### Parameters

- `interrupt` – The IRQ number.

**Return values**

- `kStatus_Success` – Interrupt disabled successfully
- `kStatus_Fail` – Failed to disable the interrupt

static inline *status\_t* EnableIRQWithPriority(IRQn\_Type interrupt, uint8\_t priNum)

Enable the IRQ, and also set the interrupt priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

**Parameters**

- `interrupt` – The IRQ to Enable.
- `priNum` – Priority number set to interrupt controller register.

**Return values**

- `kStatus_Success` – Interrupt priority set successfully
- `kStatus_Fail` – Failed to set the interrupt priority.

static inline *status\_t* IRQ\_SetPriority(IRQn\_Type interrupt, uint8\_t priNum)

Set the IRQ priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

**Parameters**

- `interrupt` – The IRQ to set.
- `priNum` – Priority number set to interrupt controller register.

**Return values**

- `kStatus_Success` – Interrupt priority set successfully
- `kStatus_Fail` – Failed to set the interrupt priority.

static inline *status\_t* IRQ\_ClearPendingIRQ(IRQn\_Type interrupt)

Clear the pending IRQ flag.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro `FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS`.

**Parameters**

- `interrupt` – The flag which IRQ to clear.

**Return values**

- `kStatus_Success` – Interrupt priority set successfully

- `kStatus_Fail` – Failed to set the interrupt priority.

`static inline uint32_t DisableGlobalIRQ(void)`

Disable the global IRQ.

Disable the global interrupt and return the current primask register. User is required to provided the primask register for the `EnableGlobalIRQ()`.

#### Returns

Current primask value.

`static inline void EnableGlobalIRQ(uint32_t primask)`

Enable the global IRQ.

Set the primask register with the provided primask value but not just enable the primask. The idea is for the convenience of integration of RTOS. some RTOS get its own management mechanism of primask. User is required to use the `EnableGlobalIRQ()` and `DisableGlobalIRQ()` in pair.

#### Parameters

- `primask` – value of primask register to be restored. The primask value is supposed to be provided by the `DisableGlobalIRQ()`.

`static inline bool _SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t newValue)`

`static inline uint32_t _SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)`

`FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ`

Macro to use the default weak IRQ handler in drivers.

`MAKE_STATUS(group, code)`

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

`MAKE_VERSION(major, minor, bugfix)`

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms(such as Cortex M) and 16-bit platforms(such as DSC).

|          |               |               |         |  |
|----------|---------------|---------------|---------|--|
| Unused   | Major Version | Minor Version | Bug Fix |  |
| 31 25 24 | 17 16         | 9 8           | 0       |  |

`ARRAY_SIZE(x)`

Computes the number of elements in an array.

`UINT64_H(X)`

Macro to get upper 32 bits of a 64-bit value

`UINT64_L(X)`

Macro to get lower 32 bits of a 64-bit value

`SUPPRESS_FALL_THROUGH_WARNING()`

For switch case code block, if case section ends without “break;” statement, there wil be fallthrough warning with compiler flag `-Wextra` or `-Wimplicit-fallthrough=n` when using `armgcc`. To suppress this warning, “`SUPPRESS_FALL_THROUGH_WARNING()`,” need to be added at the end of each case section which misses “break;”statement.

`MSDK_REG_SECURE_ADDR(x)`

Convert the register address to the one used in secure mode.

`MSDK_REG_NONSECURE_ADDR(x)`

Convert the register address to the one used in non-secure mode.

MSDK\_INVALID\_IRQ\_HANDLER  
Invalid IRQ handler address.

## 2.39 Lin\_lpuart\_driver

FSL\_LIN\_LPUART\_DRIVER\_VERSION  
LIN LPUART driver version.

enum \_lin\_lpuart\_stop\_bit\_count

*Values:*

enumerator kLPUART\_OneStopBit

One stop bit

enumerator kLPUART\_TwoStopBit

Two stop bits

enum \_lin\_lpuart\_flags

*Values:*

enumerator kLPUART\_TxDataRegEmptyFlag

Transmit data register empty flag, sets when transmit buffer is empty

enumerator kLPUART\_TransmissionCompleteFlag

Transmission complete flag, sets when transmission activity complete

enumerator kLPUART\_RxDataRegFullFlag

Receive data register full flag, sets when the receive data buffer is full

enumerator kLPUART\_IdleLineFlag

Idle line detect flag, sets when idle line detected

enumerator kLPUART\_RxOverrunFlag

Receive Overrun, sets when new data is received before data is read from receive register

enumerator kLPUART\_NoiseErrorFlag

Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets

enumerator kLPUART\_FramingErrorFlag

Frame error flag, sets if logic 0 was detected where stop bit expected

enumerator kLPUART\_ParityErrorFlag

If parity enabled, sets upon parity error detection

enumerator kLPUART\_LinBreakFlag

LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled

enumerator kLPUART\_RxActiveEdgeFlag

Receive pin active edge interrupt flag, sets when active edge detected

enumerator kLPUART\_RxActiveFlag

Receiver Active Flag (RAF), sets at beginning of valid start bit

enumerator kLPUART\_DataMatch1Flag

The next character to be read from LPUART\_DATA matches MA1

enumerator kLPUART\_DataMatch2Flag

The next character to be read from LPUART\_DATA matches MA2

enumerator kLPUART\_NoiseErrorInRxDataRegFlag

NOISY bit, sets if noise detected in current data word

enumerator kLPUART\_ParityErrorInRxDataRegFlag

PARITY bit, sets if noise detected in current data word

enumerator kLPUART\_TxFifoEmptyFlag

TXEMPT bit, sets if transmit buffer is empty

enumerator kLPUART\_RxFifoEmptyFlag

RXEMPT bit, sets if receive buffer is empty

enumerator kLPUART\_TxFifoOverflowFlag

TXOF bit, sets if transmit buffer overflow occurred

enumerator kLPUART\_RxFifoUnderflowFlag

RXUF bit, sets if receive buffer underflow occurred

enum \_lin\_lpuart\_interrupt\_enable

*Values:*

enumerator kLPUART\_LinBreakInterruptEnable

LIN break detect.

enumerator kLPUART\_RxActiveEdgeInterruptEnable

Receive Active Edge.

enumerator kLPUART\_TxDataRegEmptyInterruptEnable

Transmit data register empty.

enumerator kLPUART\_TransmissionCompleteInterruptEnable

Transmission complete.

enumerator kLPUART\_RxDataRegFullInterruptEnable

Receiver data register full.

enumerator kLPUART\_IdleLineInterruptEnable

Idle line.

enumerator kLPUART\_RxOverrunInterruptEnable

Receiver Overrun.

enumerator kLPUART\_NoiseErrorInterruptEnable

Noise error flag.

enumerator kLPUART\_FramingErrorInterruptEnable

Framing error flag.

enumerator kLPUART\_ParityErrorInterruptEnable

Parity error flag.

enumerator kLPUART\_TxFifoOverflowInterruptEnable

Transmit FIFO Overflow.

enumerator kLPUART\_RxFifoUnderflowInterruptEnable

Receive FIFO Underflow.

enum \_lin\_lpuart\_status

*Values:*

```
enumerator kStatus_LPUART_TxBusy
 TX busy
enumerator kStatus_LPUART_RxBusy
 RX busy
enumerator kStatus_LPUART_TxIdle
 LPUART transmitter is idle.
enumerator kStatus_LPUART_RxIdle
 LPUART receiver is idle.
enumerator kStatus_LPUART_TxWatermarkTooLarge
 TX FIFO watermark too large
enumerator kStatus_LPUART_RxWatermarkTooLarge
 RX FIFO watermark too large
enumerator kStatus_LPUART_FlagCannotClearManually
 Some flag can't manually clear
enumerator kStatus_LPUART_Error
 Error happens on LPUART.
enumerator kStatus_LPUART_RxRingBufferOverflow
 LPUART RX software ring buffer overrun.
enumerator kStatus_LPUART_RxHardwareOverflow
 LPUART RX receiver overrun.
enumerator kStatus_LPUART_NoiseError
 LPUART noise error.
enumerator kStatus_LPUART_FramingError
 LPUART framing error.
enumerator kStatus_LPUART_ParityError
 LPUART parity error.
enum lin_lpuart_bit_count_per_char_t
 Values:
 enumerator LPUART_8_BITS_PER_CHAR
 8-bit data characters
 enumerator LPUART_9_BITS_PER_CHAR
 9-bit data characters
 enumerator LPUART_10_BITS_PER_CHAR
 10-bit data characters
typedef enum lin_lpuart_stop_bit_count lin_lpuart_stop_bit_count_t
static inline bool LIN_LPUART_GetRxDataPolarity(const LPUART_Type *base)
static inline void LIN_LPUART_SetRxDataPolarity(LPUART_Type *base, bool polarity)
static inline void LIN_LPUART_WriteByte(LPUART_Type *base, uint8_t data)
static inline void LIN_LPUART_ReadByte(const LPUART_Type *base, uint8_t *readData)
```



```
status_t LIN_LPUART_CalculateBaudRate(LPUART_Type *base, uint32_t baudRate_Bps,
 uint32_t srcClock_Hz, uint32_t *osr, uint16_t *sbr)
```

Calculates the best osr and sbr value for configured baudrate.

#### Parameters

- base – LPUART peripheral base address
- baudRate\_Bps – user configuration structure of type #lin\_user\_config\_t
- srcClock\_Hz – pointer to the LIN\_LPUART driver state structure
- osr – pointer to osr value
- sbr – pointer to sbr value

#### Returns

An error code or lin\_status\_t

```
void LIN_LPUART_SetBaudRate(LPUART_Type *base, uint32_t *osr, uint16_t *sbr)
```

Configure baudrate according to osr and sbr value.

#### Parameters

- base – LPUART peripheral base address
- osr – pointer to osr value
- sbr – pointer to sbr value

```
lin_status_t LIN_LPUART_Init(LPUART_Type *base, lin_user_config_t *linUserConfig,
 lin_state_t *linCurrentState, uint32_t linSourceClockFreq)
```

Initializes an LIN\_LPUART instance for LIN Network.

The caller provides memory for the driver state structures during initialization. The user must select the LIN\_LPUART clock source in the application to initialize the LIN\_LPUART. This function initializes a LPUART instance for operation. This function will initialize the run-time state structure to keep track of the on-going transfers, initialize the module to user defined settings and default settings, set break field length to be 13 bit times minimum, enable the break detect interrupt, Rx complete interrupt, frame error detect interrupt, and enable the LPUART module transmitter and receiver

#### Parameters

- base – LPUART peripheral base address
- linUserConfig – user configuration structure of type #lin\_user\_config\_t
- linCurrentState – pointer to the LIN\_LPUART driver state structure

#### Returns

An error code or lin\_status\_t

```
lin_status_t LIN_LPUART_Deinit(LPUART_Type *base)
```

Shuts down the LIN\_LPUART by disabling interrupts and transmitter/receiver.

#### Parameters

- base – LPUART peripheral base address

#### Returns

An error code or lin\_status\_t

```
lin_status_t LIN_LPUART_SendFrameDataBlocking(LPUART_Type *base, const uint8_t *txBuff,
 uint8_t txSize, uint32_t timeoutMSec)
```

Sends Frame data out through the LIN\_LPUART module using blocking method. This function will calculate the checksum byte and send it with the frame data. Blocking means that the function does not return until the transmission is complete.

**Parameters**

- base – LPUART peripheral base address
- txBuff – source buffer containing 8-bit data chars to send
- txSize – the number of bytes to send
- timeoutMSec – timeout value in milli seconds

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_SendFrameData(LPUART_Type *base, const uint8_t *txBuff, uint8_t txSize)`

Sends frame data out through the LIN\_LPUART module using non-blocking method. This enables an a-sync method for transmitting data. Non-blocking means that the function returns immediately. The application has to get the transmit status to know when the transmit is complete. This function will calculate the checksum byte and send it with the frame data.

**Parameters**

- base – LPUART peripheral base address
- txBuff – source buffer containing 8-bit data chars to send
- txSize – the number of bytes to send

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_GetTransmitStatus(LPUART_Type *base, uint8_t *bytesRemaining)`

Get status of an on-going non-blocking transmission While sending frame data using non-blocking method, users can use this function to get status of that transmission. This function return `LIN_TX_BUSY` while sending, or `LIN_TIMEOUT` if timeout has occurred, or return `LIN_SUCCESS` when the transmission is complete. The `bytesRemaining` shows number of bytes that still needed to transmit.

**Parameters**

- base – LPUART peripheral base address
- bytesRemaining – Number of bytes still needed to transmit

**Returns**

`lin_status_t LIN_TX_BUSY`, `LIN_SUCCESS` or `LIN_TIMEOUT`

`lin_status_t LIN_LPUART_RecvFrmDataBlocking(LPUART_Type *base, uint8_t *rxBuff, uint8_t rxSize, uint32_t timeoutMSec)`

Receives frame data through the LIN\_LPUART module using blocking method. This function will check the checksum byte. If the checksum is correct, it will receive the frame data. Blocking means that the function does not return until the reception is complete.

**Parameters**

- base – LPUART peripheral base address
- rxBuff – buffer containing 8-bit received data
- rxSize – the number of bytes to receive
- timeoutMSec – timeout value in milli seconds

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_RecvFrmData(LPUART_Type *base, uint8_t *rxBuff, uint8_t rxSize)`

Receives frame data through the LIN\_LPUART module using non-blocking method. This function will check the checksum byte. If the checksum is correct, it will receive it with the frame data. Non-blocking means that the function returns immediately. The application has to get the receive status to know when the reception is complete.

**Parameters**

- `base` – LPUART peripheral base address
- `rxBuff` – buffer containing 8-bit received data
- `rxSize` – the number of bytes to receive

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_AbortTransferData(LPUART_Type *base)`

Aborts an on-going non-blocking transmission/reception. While performing a non-blocking transferring data, users can call this function to terminate immediately the transferring.

**Parameters**

- `base` – LPUART peripheral base address

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_GetReceiveStatus(LPUART_Type *base, uint8_t *bytesRemaining)`

Get status of an on-going non-blocking reception While receiving frame data using non-blocking method, users can use this function to get status of that receiving. This function return the current event ID, `LIN_RX_BUSY` while receiving and return `LIN_SUCCESS`, or timeout (`LIN_TIMEOUT`) when the reception is complete. The `bytesRemaining` shows number of bytes that still needed to receive.

**Parameters**

- `base` – LPUART peripheral base address
- `bytesRemaining` – Number of bytes still needed to receive

**Returns**

`lin_status_t` `LIN_RX_BUSY`, `LIN_TIMEOUT` or `LIN_SUCCESS`

`lin_status_t LIN_LPUART_GoToSleepMode(LPUART_Type *base)`

This function puts current node to sleep mode This function changes current node state to `LIN_NODE_STATE_SLEEP_MODE`.

**Parameters**

- `base` – LPUART peripheral base address

**Returns**

An error code or `lin_status_t`

`lin_status_t LIN_LPUART_GotoIdleState(LPUART_Type *base)`

Puts current LIN node to Idle state This function changes current node state to `LIN_NODE_STATE_IDLE`.

**Parameters**

- `base` – LPUART peripheral base address

**Returns**

An error code or `lin_status_t`

lin\_status\_t LIN\_LPUART\_SendWakeupSignal(LPUART\_Type \*base)

Sends a wakeup signal through the LIN\_LPUART interface.

**Parameters**

- base – LPUART peripheral base address

**Returns**

An error code or lin\_status\_t

lin\_status\_t LIN\_LPUART\_MasterSendHeader(LPUART\_Type \*base, uint8\_t id)

Sends frame header out through the LIN\_LPUART module using a non-blocking method. This function sends LIN Break field, sync field then the ID with correct parity.

**Parameters**

- base – LPUART peripheral base address
- id – Frame Identifier

**Returns**

An error code or lin\_status\_t

lin\_status\_t LIN\_LPUART\_EnableIRQ(LPUART\_Type \*base)

Enables LIN\_LPUART hardware interrupts.

**Parameters**

- base – LPUART peripheral base address

**Returns**

An error code or lin\_status\_t

lin\_status\_t LIN\_LPUART\_DisableIRQ(LPUART\_Type \*base)

Disables LIN\_LPUART hardware interrupts.

**Parameters**

- base – LPUART peripheral base address

**Returns**

An error code or lin\_status\_t

lin\_status\_t LIN\_LPUART\_AutoBaudCapture(uint32\_t instance)

This function capture bits time to detect break char, calculate baudrate from sync bits and enable transceiver if autobaud successful. This function should only be used in Slave. The timer should be in mode input capture of both rising and falling edges. The timer input capture pin should be externally connected to RXD pin.

**Parameters**

- instance – LPUART instance

**Returns**

lin\_status\_t

void LIN\_LPUART\_IRQHandler(LPUART\_Type \*base)

LIN\_LPUART RX TX interrupt handler.

**Parameters**

- base – LPUART peripheral base address

**Returns**

void

LIN\_LPUART\_TRANSMISSION\_COMPLETE\_TIMEOUT

Max loops to wait for LPUART transmission complete.

When de-initializing the LIN LPUART module, the program shall wait for the previous transmission to complete. This parameter defines how many loops to check completion before return error. If defined as 0, driver will wait forever until completion.

AUTOBAUD\_BAUDRATE\_TOLERANCE

BIT\_RATE\_TOLERANCE\_UNSYNC

BIT\_DURATION\_MAX\_19200

BIT\_DURATION\_MIN\_19200

BIT\_DURATION\_MAX\_14400

BIT\_DURATION\_MIN\_14400

BIT\_DURATION\_MAX\_9600

BIT\_DURATION\_MIN\_9600

BIT\_DURATION\_MAX\_4800

BIT\_DURATION\_MIN\_4800

BIT\_DURATION\_MAX\_2400

BIT\_DURATION\_MIN\_2400

TWO\_BIT\_DURATION\_MAX\_19200

TWO\_BIT\_DURATION\_MIN\_19200

TWO\_BIT\_DURATION\_MAX\_14400

TWO\_BIT\_DURATION\_MIN\_14400

TWO\_BIT\_DURATION\_MAX\_9600

TWO\_BIT\_DURATION\_MIN\_9600

TWO\_BIT\_DURATION\_MAX\_4800

TWO\_BIT\_DURATION\_MIN\_4800

TWO\_BIT\_DURATION\_MAX\_2400

TWO\_BIT\_DURATION\_MIN\_2400

AUTOBAUD\_BREAK\_TIME\_MIN

## 2.40 LLWU: Low-Leakage Wakeup Unit Driver

static inline void LLWU\_GetVersionId(LLWU\_Type \*base, *llwu\_version\_id\_t* \*versionId)

Gets the LLWU version ID.

This function gets the LLWU version ID, including the major version number, the minor version number, and the feature specification number.

### Parameters

- base – LLWU peripheral base address.

- `versionId` – A pointer to the version ID structure.

`static inline void LLWU_GetParam(LLWU_Type *base, llwu_param_t *param)`

Gets the LLWU parameter.

This function gets the LLWU parameter, including a wakeup pin number, a module number, a DMA number, and a pin filter number.

#### Parameters

- `base` – LLWU peripheral base address.
- `param` – A pointer to the LLWU parameter structure.

`void LLWU_SetExternalWakeupPinMode(LLWU_Type *base, uint32_t pinIndex, llwu_external_pin_mode_t pinMode)`

Sets the external input pin source mode.

This function sets the external input pin source mode that is used as a wake up source.

#### Parameters

- `base` – LLWU peripheral base address.
- `pinIndex` – A pin index to be enabled as an external wakeup source starting from 1.
- `pinMode` – A pin configuration mode defined in the `llwu_external_pin_modes_t`.

`bool LLWU_GetExternalWakeupPinFlag(LLWU_Type *base, uint32_t pinIndex)`

Gets the external wakeup source flag.

This function checks the external pin flag to detect whether the MCU is woken up by the specific pin.

#### Parameters

- `base` – LLWU peripheral base address.
- `pinIndex` – A pin index, which starts from 1.

#### Returns

True if the specific pin is a wakeup source.

`void LLWU_ClearExternalWakeupPinFlag(LLWU_Type *base, uint32_t pinIndex)`

Clears the external wakeup source flag.

This function clears the external wakeup source flag for a specific pin.

#### Parameters

- `base` – LLWU peripheral base address.
- `pinIndex` – A pin index, which starts from 1.

`static inline void LLWU_EnableInternalModuleInterruptWakup(LLWU_Type *base, uint32_t moduleIndex, bool enable)`

Enables/disables the internal module source.

This function enables/disables the internal module source mode that is used as a wake up source.

#### Parameters

- `base` – LLWU peripheral base address.
- `moduleIndex` – A module index to be enabled as an internal wakeup source starting from 1.
- `enable` – An enable or a disable setting

```
static inline void LLWU_EnableInternalModuleDmaRequestWakeup(LLWU_Type *base, uint32_t
 moduleIndex, bool enable)
```

Enables/disables the internal module DMA wakeup source.

This function enables/disables the internal DMA that is used as a wake up source.

#### Parameters

- base – LLWU peripheral base address.
- moduleIndex – An internal module index which is used as a DMA request source, starting from 1.
- enable – Enable or disable the DMA request source

```
void LLWU_SetPinFilterMode(LLWU_Type *base, uint32_t filterIndex,
 llwu_external_pin_filter_mode_t filterMode)
```

Sets the pin filter configuration.

This function sets the pin filter configuration.

#### Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index used to enable/disable the digital filter, starting from 1.
- filterMode – A filter mode configuration

```
bool LLWU_GetPinFilterFlag(LLWU_Type *base, uint32_t filterIndex)
```

Gets the pin filter configuration.

This function gets the pin filter flag.

#### Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index, which starts from 1.

#### Returns

True if the flag is a source of the existing low-leakage power mode.

```
void LLWU_ClearPinFilterFlag(LLWU_Type *base, uint32_t filterIndex)
```

Clears the pin filter configuration.

This function clears the pin filter flag.

#### Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index to clear the flag, starting from 1.

```
void LLWU_SetResetPinMode(LLWU_Type *base, bool pinEnable, bool pinFilterEnable)
```

Sets the reset pin mode.

This function determines how the reset pin is used as a low leakage mode exit source.

#### Parameters

- base – LLWU peripheral base address.
- pinEnable – Enable reset the pin filter
- pinFilterEnable – Specify whether the pin filter is enabled in Low-Leakage power mode.

```
FSL_LLWU_DRIVER_VERSION
```

LLWU driver version.

enum `_llwu_external_pin_mode`

External input pin control modes.

*Values:*

enumerator `kLLWU_ExternalPinDisable`

Pin disabled as a wakeup input.

enumerator `kLLWU_ExternalPinRisingEdge`

Pin enabled with the rising edge detection.

enumerator `kLLWU_ExternalPinFallingEdge`

Pin enabled with the falling edge detection.

enumerator `kLLWU_ExternalPinAnyEdge`

Pin enabled with any change detection.

enum `_llwu_pin_filter_mode`

Digital filter control modes.

*Values:*

enumerator `kLLWU_PinFilterDisable`

Filter disabled.

enumerator `kLLWU_PinFilterRisingEdge`

Filter positive edge detection.

enumerator `kLLWU_PinFilterFallingEdge`

Filter negative edge detection.

enumerator `kLLWU_PinFilterAnyEdge`

Filter any edge detection.

typedef enum `_llwu_external_pin_mode` `llwu_external_pin_mode_t`

External input pin control modes.

typedef enum `_llwu_pin_filter_mode` `llwu_pin_filter_mode_t`

Digital filter control modes.

typedef struct `_llwu_version_id` `llwu_version_id_t`

IP version ID definition.

typedef struct `_llwu_param` `llwu_param_t`

IP parameter definition.

typedef struct `_llwu_external_pin_filter_mode` `llwu_external_pin_filter_mode_t`

An external input pin filter control structure.

`LLWU_REG_VAL(x)`

struct `_llwu_version_id`

*#include <fsl\_llwu.h>* IP version ID definition.

### Public Members

uint16\_t feature

A feature specification number.

uint8\_t minor

The minor version number.



uint8\_t major

The major version number.

struct \_llwu\_param

*#include <fsl\_llwu.h>* IP parameter definition.

### Public Members

uint8\_t filters

A number of the pin filter.

uint8\_t dmas

A number of the wakeup DMA.

uint8\_t modules

A number of the wakeup module.

uint8\_t pins

A number of the wake up pin.

struct \_llwu\_external\_pin\_filter\_mode

*#include <fsl\_llwu.h>* An external input pin filter control structure.

### Public Members

uint32\_t pinIndex

A pin number

*llwu\_pin\_filter\_mode\_t* filterMode

Filter mode

## 2.41 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 `TPRCTRL` 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;
```

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```

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_PrepareAutoCalibration(ADC_Type *base)
```

Prepare auto calibration, LPADC\_FinishAutoCalibration has to be called before using the LPADC. LPADC\_DoAutoCalibration has been split in two API to avoid to be stuck too long in the function.

#### Parameters

- base – LPADC peripheral base address.



*status\_t* LPADC\_FinishAutoCalibration(ADC\_Type \*base)

Finish auto calibration start with LPADC\_PrepareAutoCalibration.

---

**Note:** This feature is used for LPADC with CTRL[CALOFSMODE].

---

#### Parameters

- base – LPADC peripheral base address.

#### Return values

- kStatus\_Success – Successfully configured.
- kStatus\_Timeout – Timeout occurs while waiting completion.

void LPADC\_GetCalibrationValue(ADC\_Type \*base, *lpadc\_calibration\_value\_t* \*ptrCalibrationValue)

Get calibration value into the memory which is defined by invoker.

---

**Note:** Please note the ADC will be disabled temporary.

---

---

**Note:** This function should be used after finish calibration.

---

#### Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to *lpadc\_calibration\_value\_t* structure, this memory block should be always powered on even in low power modes.

*status\_t* LPADC\_SetCalibrationValue(ADC\_Type \*base, const *lpadc\_calibration\_value\_t* \*ptrCalibrationValue)

Set calibration value into ADC calibration registers.

---

**Note:** Please note the ADC will be disabled temporary.

---

#### Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to *lpadc\_calibration\_value\_t* structure which contains ADC's calibration value.

#### Return values

- kStatus\_Success – Successfully configured.
- kStatus\_Timeout – Timeout occurs while waiting completion.

FSL\_LPADC\_DRIVER\_VERSION

LPADC driver version 2.9.3.

struct *lpadc\_config\_t*

*#include <fsl\_lpadc.h>* LPADC global configuration.

This structure would used to keep the settings for initialization.

## Public Members

**bool** enableInternalClock

Enables the internally generated clock source. The clock source is used in clock selection logic at the chip level and is optionally used for the ADC clock source.

**bool** enableVref1LowVoltage

If voltage reference option1 input is below 1.8V, it should be “true”. If voltage reference option1 input is above 1.8V, it should be “false”.

**bool** enableInDozeMode

Control system transition to Stop and Wait power modes while ADC is converting. When enabled in Doze mode, immediate entries to Wait or Stop are allowed. When disabled, the ADC will wait for the current averaging iteration/FIFO storage to complete before acknowledging stop or wait mode entry.

*lpadc\_conversion\_average\_mode\_t* conversionAverageMode

Auto-Calibration Averages.

**bool** enableAnalogPreliminary

ADC analog circuits are pre-enabled and ready to execute conversions without startup delays(at the cost of higher DC current consumption).

**uint32\_t** powerUpDelay

When the analog circuits are not pre-enabled, the ADC analog circuits are only powered while the ADC is active and there is a counted delay defined by this field after an initial trigger transitions the ADC from its Idle state to allow time for the analog circuits to stabilize. The startup delay count of (powerUpDelay \* 4) ADCK cycles must result in a longer delay than the analog startup time.

*lpadc\_reference\_voltage\_source\_t* referenceVoltageSource

Selects the voltage reference high used for conversions.

*lpadc\_power\_level\_mode\_t* powerLevelMode

Power Configuration Selection.

*lpadc\_trigger\_priority\_policy\_t* triggerPriorityPolicy

Control how higher priority triggers are handled, see to *lpadc\_trigger\_priority\_policy\_t*.

**bool** enableConvPause

Enables the ADC pausing function. When enabled, a programmable delay is inserted during command execution sequencing between LOOP iterations, between commands in a sequence, and between conversions when command is executing in “Compare Until True” configuration.

**uint32\_t** convPauseDelay

Controls the duration of pausing during command execution sequencing. The pause delay is a count of (convPauseDelay\*4) ADCK cycles. Only available when ADC pausing function is enabled. The available value range is in 9-bit.

**uint32\_t** FIFOWatermark

FIFOWatermark is a programmable threshold setting. When the number of datawords stored in the ADC Result FIFO is greater than the value in this field, the ready flag would be asserted to indicate stored data has reached the programmable threshold.

**struct** lpadc\_conv\_command\_config\_t

*#include <fsl\_lpadc.h>* Define structure to keep the configuration for conversion command.

## Public Members

*lpadc\_sample\_scale\_mode\_t* sampleScaleMode

Sample scale mode.

*lpadc\_sample\_scale\_mode\_t* channelBScaleMode

Alternate 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.

## 2.42 LPCMP: Low Power Analog Comparator Driver

void LPCMP\_Init(LPCMP\_Type \*base, const *lpcmp\_config\_t* \*config)

Initialize the LPCMP.

This function initializes the LPCMP module. The operations included are:

- Enabling the clock for LPCMP module.
- Configuring the comparator.
- Enabling the LPCMP module. Note: For some devices, multiple LPCMP instance share the same clock gate. In this case, to enable the clock for any instance enables all the LPCMPs. Check the chip reference manual for the clock assignment of the LPCMP.

### Parameters

- base – LPCMP peripheral base address.
- config – Pointer to “lpcmp\_config\_t” structure.

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

De-initializes the LPCMP module.

This function de-initializes the LPCMP module. The operations included are:

- Disabling the LPCMP module.
- Disabling the clock for LPCMP module.

This function disables the clock for the LPCMP. Note: For some devices, multiple LPCMP instance shares the same clock gate. In this case, before disabling the clock for the LPCMP, ensure that all the LPCMP instances are not used.

#### Parameters

- base – LPCMP peripheral base address.

void LPCMP\_GetDefaultConfig(*lpcmp\_config\_t* \*config)

Gets an available pre-defined settings for the comparator's configuration.

This function initializes the comparator configuration structure to these default values:

```
config->enableStopMode = false;
config->enableOutputPin = false;
config->enableCmpToDacLink = false;
config->useUnfilteredOutput = false;
config->enableInvertOutput = false;
config->hysteresisMode = kLPCMP_HysteresisLevel0;
config->powerMode = kLPCMP_LowSpeedPowerMode;
config->functionalSourceClock = kLPCMP_FunctionalClockSource0;
config->plusInputSrc = kLPCMP_PlusInputSrcMux;
config->minusInputSrc = kLPCMP_MinusInputSrcMux;
```

#### Parameters

- config – Pointer to “lpcmp\_config\_t” structure.

static inline void LPCMP\_Enable(LPCMP\_Type \*base, bool enable)

Enable/Disable LPCMP module.

#### Parameters

- base – LPCMP peripheral base address.
- enable – “true” means enable the module, and “false” means disable the module.

void LPCMP\_SetInputChannels(LPCMP\_Type \*base, uint32\_t positiveChannel, uint32\_t negativeChannel)

Select the input channels for LPCMP. This function determines which input is selected for the negative and positive mux.

#### Parameters

- base – LPCMP peripheral base address.
- positiveChannel – Positive side input channel number. Available range is 0-7.
- negativeChannel – Negative side input channel number. Available range is 0-7.

static inline void LPCMP\_EnableDMA(LPCMP\_Type \*base, bool enable)

Enables/disables the DMA request for rising/falling events. Normally, the LPCMP generates a CPU interrupt if there is a rising/falling event. When DMA support is enabled and the rising/falling interrupt is enabled, the rising/falling event forces a DMA transfer request rather than a CPU interrupt instead.

**Parameters**

- base – LPCMP peripheral base address.
- enable – “true” means enable DMA support, and “false” means disable DMA support.

void LPCMP\_SetFilterConfig(LPCMP\_Type \*base, const *lpcmp\_filter\_config\_t* \*config)

Configures the filter.

**Parameters**

- base – LPCMP peripheral base address.
- config – Pointer to “lpcmp\_filter\_config\_t” structure.

void LPCMP\_SetDACConfig(LPCMP\_Type \*base, const *lpcmp\_dac\_config\_t* \*config)

Configure the internal DAC module.

**Parameters**

- base – LPCMP peripheral base address.
- config – Pointer to “lpcmp\_dac\_config\_t” structure. If config is “NULL”, disable internal DAC.

static inline void LPCMP\_EnableInterrupts(LPCMP\_Type \*base, uint32\_t mask)

Enable the interrupts.

**Parameters**

- base – LPCMP peripheral base address.
- mask – Mask value for interrupts. See “\_lpcmp\_interrupt\_enable”.

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

Disable the interrupts.

**Parameters**

- base – LPCMP peripheral base address.
- mask – Mask value for interrupts. See “\_lpcmp\_interrupt\_enable”.

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

Get the LPCMP status flags.

**Parameters**

- base – LPCMP peripheral base address.

**Returns**

Mask value for the asserted flags. See “\_lpcmp\_status\_flags”.

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

Clear the LPCMP status flags.

**Parameters**

- base – LPCMP peripheral base address.
- mask – Mask value for the flags. See “\_lpcmp\_status\_flags”.

static inline void LPCMP\_EnableWindowMode(LPCMP\_Type \*base, bool enable)

Enable/Disable window mode. When any windowed mode is active, COUTA is clocked by the bus clock whenever WINDOW = 1. The last latched value is held when WINDOW = 0. The optionally inverted comparator output COUT\_RAW is sampled on every bus clock when WINDOW=1 to generate COUTA.

**Parameters**

- base – LPCMP peripheral base address.
- enable – “true” means enable window mode, and “false” means disable window mode.

```
void LPCMP_SetWindowControl(LPCMP_Type *base, const lpcmp_window_control_config_t
 *config)
```

Configure the window control, users can use this API to implement operations on the window, such as inverting the window signal, setting the window closing event(only valid in windowing mode), and setting the COUTA signal after the window is closed(only valid in windowing mode).

#### Parameters

- base – LPCMP peripheral base address.
- config – Pointer “*lpcmp\_window\_control\_config\_t*” structure.

```
void LPCMP_SetRoundRobinConfig(LPCMP_Type *base, const lpcmp_roundrobin_config_t
 *config)
```

Configure the roundrobin mode.

#### Parameters

- base – LPCMP peripheral base address.
- config – Pointer “*lpcmp\_roundrobin\_config\_t*” structure.

```
static inline void LPCMP_EnableRoundRobinMode(LPCMP_Type *base, bool enable)
Enable/Disable roundrobin mode.
```

#### Parameters

- base – LPCMP peripheral base address.
- enable – “true” means enable roundrobin mode, and “false” means disable roundrobin mode.

```
void LPCMP_SetRoundRobinInternalTimer(LPCMP_Type *base, uint32_t value)
```

brief Configure the roundrobin internal timer reload value.

param base LPCMP peripheral base address. param value RoundRobin internal timer reload value, allowed range:0x0UL-0xFFFFFFFFUL.

```
static inline void LPCMP_EnableRoundRobinInternalTimer(LPCMP_Type *base, bool enable)
Enable/Disable roundrobin internal timer; note that this function is only valid when using
the internal trigger source.
```

#### Parameters

- base – LPCMP peripheral base address.
- enable – “true” means enable roundrobin internal timer, and “false” means disable roundrobin internal timer.

```
static inline void LPCMP_SetPreSetValue(LPCMP_Type *base, uint8_t mask)
```

Set preset value for all channels, users can set all channels’ preset vaule through this API, for example, if the mask set to 0x03U means channel0 and channel2’s preset value set to 1U and other channels’ preset value set to 0U.

#### Parameters

- base – LPCMP peripheral base address.
- mask – Mask of channel index.

static inline uint8\_t LPCMP\_GetComparisonResult(LPCMP\_Type \*base)

Get comparison results for all channels, users can get all channels' comparison results through this API.

**Parameters**

- base – LPCMP peripheral base address.

**Returns**

return All channels' comparison result.

static inline void LPCMP\_ClearInputChangedFlags(LPCMP\_Type \*base, uint8\_t mask)

Clear input changed flags for single channel or multiple channels, users can clear input changed flag of a single channel or multiple channels through this API, for example, if the mask set to 0x03U means clear channel0 and channel2's input changed flags.

**Parameters**

- base – LPCMP peripheral base address.
- mask – Mask of channel index.

static inline uint8\_t LPCMP\_GetInputChangedFlags(LPCMP\_Type \*base)

Get input changed flags for all channels, Users can get all channels' input changed flags through this API.

**Parameters**

- base – LPCMP peripheral base address.

**Returns**

return All channels' changed flag.

FSL\_LPCMP\_DRIVER\_VERSION

LPCMP driver version 2.3.2.

enum \_lpcmp\_status\_flags

LPCMP status falgs mask.

*Values:*

enumerator kLPCMP\_OutputRisingEventFlag

Rising-edge on the comparison output has occurred.

enumerator kLPCMP\_OutputFallingEventFlag

Falling-edge on the comparison output has occurred.

enumerator kLPCMP\_OutputRoundRobinEventFlag

Detects when any channel's last comparison result is different from the pre-set value in trigger mode.

enumerator kLPCMP\_OutputAssertEventFlag

Return the current value of the analog comparator output. The flag does not support W1C.

enum \_lpcmp\_interrupt\_enable

LPCMP interrupt enable/disable mask.

*Values:*

enumerator kLPCMP\_OutputRisingInterruptEnable

Comparator interrupt enable rising.

enumerator kLPCMP\_OutputFallingInterruptEnable

Comparator interrupt enable falling.



enumerator kLPCMP\_RoundRobinInterruptEnable

Comparator round robin mode interrupt occurred when the comparison result changes for a given channel.

enum \_\_lpcmp\_hysteresis\_mode

LPCMP hysteresis mode. See chip data sheet to get the actual hysteresis value with each level.

*Values:*

enumerator kLPCMP\_HysteresisLevel0

The hard block output has level 0 hysteresis internally.

enumerator kLPCMP\_HysteresisLevel1

The hard block output has level 1 hysteresis internally.

enumerator kLPCMP\_HysteresisLevel2

The hard block output has level 2 hysteresis internally.

enumerator kLPCMP\_HysteresisLevel3

The hard block output has level 3 hysteresis internally.

enum \_\_lpcmp\_power\_mode

LPCMP nano mode.

*Values:*

enumerator kLPCMP\_LowSpeedPowerMode

Low speed comparison mode is selected.

enumerator kLPCMP\_HighSpeedPowerMode

High speed comparison mode is selected.

enumerator kLPCMP\_NanoPowerMode

Nano power comparator is enabled.

enum \_\_lpcmp\_dac\_reference\_voltage\_source

Internal DAC reference voltage source.

*Values:*

enumerator kLPCMP\_VrefSourceVin1

vrefh\_int is selected as resistor ladder network supply reference Vin.

enumerator kLPCMP\_VrefSourceVin2

vrefh\_ext is selected as resistor ladder network supply reference Vin.

enum \_\_lpcmp\_functional\_source\_clock

LPCMP functional mode clock source selection.

**Note:** In different devices, the functional mode clock source selection is different, please refer to specific device Reference Manual for details.

*Values:*

enumerator kLPCMP\_FunctionalClockSource0

Select functional mode clock source0.

enumerator kLPCMP\_FunctionalClockSource1

Select functional mode clock source1.

enumerator kLPCMP\_FunctionalClockSource2

Select functional mode clock source2.

enumerator kLPCMP\_FunctionalClockSource3

Select functional mode clock source3.

enum \_lpcmp\_couta\_signal

Set the COUTA signal value when the window is closed.

*Values:*

enumerator kLPCMP\_COUTASignalNoSet

NO set the COUTA signal value when the window is closed.

enumerator kLPCMP\_COUTASignalLow

Set COUTA signal low(0) when the window is closed.

enumerator kLPCMP\_COUTASignalHigh

Set COUTA signal high(1) when the window is closed.

enum \_lpcmp\_close\_window\_event

Set COUT event, which can close the active window in window mode.

*Values:*

enumerator kLPCMP\_CloseWindowEventNoSet

No Set COUT event, which can close the active window in window mode.

enumerator kLPCMP\_CloseWindowEventRisingEdge

Set rising edge COUT signal as COUT event.

enumerator kLPCMP\_CloseWindowEventFallingEdge

Set falling edge COUT signal as COUT event.

enumerator kLPCMP\_CloseWindowEventBothEdge

Set both rising and falling edge COUT signal as COUT event.

enum \_lpcmp\_roundrobin\_fixedmuxport

LPCMP round robin mode fixed mux port.

*Values:*

enumerator kLPCMP\_FixedPlusMuxPort

Fixed plus mux port.

enumerator kLPCMP\_FixedMinusMuxPort

Fixed minus mux port.

enum \_lpcmp\_roundrobin\_clock\_source

LPCMP round robin mode clock source selection.

Note: In different devices, the round robin mode clock source selection is different, please refer to the specific device Reference Manual for details.

*Values:*

enumerator kLPCMP\_RoundRobinClockSource0

Select roundrobin mode clock source0.

enumerator kLPCMP\_RoundRobinClockSource1

Select roundrobin mode clock source1.

enumerator kLPCMP\_RoundRobinClockSource2

Select roundrobin mode clock source2.

enumerator kLPCMP\_RoundRobinClockSource3

Select roundrobin mode clock source3.

enum `_lpcmp_roundrobin_trigger_source`

LPCMP round robin mode trigger source.

*Values:*

enumerator `kLPCMP_TriggerSourceExternally`

Select external trigger source.

enumerator `kLPCMP_TriggerSourceInternally`

Select internal trigger source.

typedef enum `_lpcmp_hysteresis_mode` `lpcmp_hysteresis_mode_t`

LPCMP hysteresis mode. See chip data sheet to get the actual hysteresis value with each level.

typedef enum `_lpcmp_power_mode` `lpcmp_power_mode_t`

LPCMP nano mode.

typedef enum `_lpcmp_dac_reference_voltage_source` `lpcmp_dac_reference_voltage_source_t`

Internal DAC reference voltage source.

typedef enum `_lpcmp_functional_source_clock` `lpcmp_functional_source_clock_t`

LPCMP functional mode clock source selection.

Note: In different devices, the functional mode clock source selection is different, please refer to specific device Reference Manual for details.

typedef enum `_lpcmp_couta_signal` `lpcmp_couta_signal_t`

Set the COUTA signal value when the window is closed.

typedef enum `_lpcmp_close_window_event` `lpcmp_close_window_event_t`

Set COUT event, which can close the active window in window mode.

typedef enum `_lpcmp_roundrobin_fixedmuxport` `lpcmp_roundrobin_fixedmuxport_t`

LPCMP round robin mode fixed mux port.

typedef enum `_lpcmp_roundrobin_clock_source` `lpcmp_roundrobin_clock_source_t`

LPCMP round robin mode clock source selection.

Note: In different devices, the round robin mode clock source selection is different, please refer to the specific device Reference Manual for details.

typedef enum `_lpcmp_roundrobin_trigger_source` `lpcmp_roundrobin_trigger_source_t`

LPCMP round robin mode trigger source.

typedef struct `_lpcmp_filter_config` `lpcmp_filter_config_t`

Configure the filter.

typedef struct `_lpcmp_dac_config` `lpcmp_dac_config_t`

configure the internal DAC.

typedef struct `_lpcmp_config` `lpcmp_config_t`

Configures the comparator.

typedef struct `_lpcmp_window_control_config` `lpcmp_window_control_config_t`

Configure the window mode control.

typedef struct `_lpcmp_roundrobin_config` `lpcmp_roundrobin_config_t`

Configure the round robin mode.

`LPCMP_CCR1_COUTA_CFG_MASK`

`LPCMP_CCR1_COUTA_CFG_SHIFT`

LPCMP\_CCR1\_COUTA\_CFG(**x**)

LPCMP\_CCR1\_EVT\_SEL\_CFG\_MASK

LPCMP\_CCR1\_EVT\_SEL\_CFG\_SHIFT

LPCMP\_CCR1\_EVT\_SEL\_CFG(**x**)

struct `_lpcmp_filter_config`

*#include <fsl\_lpcmp.h>* Configure the filter.

### Public Members

bool enableSample

Decide whether to use the external SAMPLE as a sampling clock input.

uint8\_t filterSampleCount

Filter Sample Count. Available range is 1-7; 0 disables the filter.

uint8\_t filterSamplePeriod

Filter Sample Period. The divider to the bus clock. Available range is 0-255. The sampling clock must be at least 4 times slower than the system clock to the comparator. So if enableSample is “false”, filterSamplePeriod should be set greater than 4.

struct `_lpcmp_dac_config`

*#include <fsl\_lpcmp.h>* configure the internal DAC.

### Public Members

bool enableLowPowerMode

Decide whether to enable DAC low power mode.

*lpcmp\_dac\_reference\_voltage\_source\_t* referenceVoltageSource

Internal DAC supply voltage reference source.

uint8\_t DACValue

Value for the DAC Output Voltage. Different devices has different available range, for specific values, please refer to the reference manual.

struct `_lpcmp_config`

*#include <fsl\_lpcmp.h>* Configures the comparator.

### Public Members

bool enableStopMode

Decide whether to enable the comparator when in STOP modes.

bool enableOutputPin

Decide whether to enable the comparator is available in selected pin.

bool useUnfilteredOutput

Decide whether to use unfiltered output.

bool enableInvertOutput

Decide whether to inverts the comparator output.

*lpcmp\_hysteresis\_mode\_t* hysteresisMode

LPCMP hysteresis mode.

*lpcmp\_power\_mode\_t* powerMode

LPCMP power mode.

*lpcmp\_functional\_source\_clock\_t* functionalSourceClock

Select LPCMP functional mode clock source.

struct *\_lpcmp\_window\_control\_config*

*#include <fsl\_lpcmp.h>* Configure the window mode control.

### Public Members

bool enableInvertWindowSignal

True: enable invert window signal, False: disable invert window signal.

*lpcmp\_couta\_signal\_t* COUTASignal

Decide whether to define the COUTA signal value when the window is closed.

*lpcmp\_close\_window\_event\_t* closeWindowEvent

Decide whether to select COUT event signal edge defines a COUT event to close window.

struct *\_lpcmp\_roundrobin\_config*

*#include <fsl\_lpcmp.h>* Configure the round robin mode.

### Public Members

uint8\_t initDelayModules

Comparator and DAC initialization delay modulus, See Reference Manual and DataSheet for specific value.

uint8\_t sampleClockNumbers

Specify the number of the round robin clock cycles(0~3) to wait after scanning the active channel before sampling the channel's comparison result.

uint8\_t channelSampleNumbers

Specify the number of samples for one channel, note that channelSampleNumbers must not smaller than sampleTimeThreshhold.

uint8\_t sampleTimeThreshhold

Specify that for one channel, when (sampleTimeThreshhold + 1) sample results are "1",the final result is "1", otherwise the final result is "0", note that the sampleTimeThreshhold must not be larger than channelSampleNumbers.

*lpcmp\_roundrobin\_clock\_source\_t* roundrobinClockSource

Decide which clock source to choose in round robin mode.

*lpcmp\_roundrobin\_trigger\_source\_t* roundrobinTriggerSource

Decide which trigger source to choose in round robin mode.

*lpcmp\_roundrobin\_fixedmuxport\_t* fixedMuxPort

Decide which mux port to choose as fixed channel in round robin mode.

uint8\_t fixedChannel

Indicate which channel of the fixed mux port is used in round robin mode.

uint8\_t checkerChannelMask

Indicate which channel of the non-fixed mux port to check its voltage value in round robin mode, for example, if checkerChannelMask set to 0x11U means select channel 0 and channel 4 as checker channel.

## 2.43 LPI2C: Low Power Inter-Integrated Circuit Driver

`void LPI2C_DriverIRQHandler(uint32_t instance)`

LPI2C driver IRQ handler common entry.

This function provides the common IRQ request entry for LPI2C.

### Parameters

- `instance` – LPI2C instance.

`FSL_LPI2C_DRIVER_VERSION`

LPI2C driver version.

LPI2C status return codes.

*Values:*

enumerator `kStatus_LPI2C_Busy`

The master is already performing a transfer.

enumerator `kStatus_LPI2C_Idle`

The slave driver is idle.

enumerator `kStatus_LPI2C_Nak`

The slave device sent a NAK in response to a byte.

enumerator `kStatus_LPI2C_FifoError`

FIFO under run or overrun.

enumerator `kStatus_LPI2C_BitError`

Transferred bit was not seen on the bus.

enumerator `kStatus_LPI2C_ArbitrationLost`

Arbitration lost error.

enumerator `kStatus_LPI2C_PinLowTimeout`

SCL or SDA were held low longer than the timeout.

enumerator `kStatus_LPI2C_NoTransferInProgress`

Attempt to abort a transfer when one is not in progress.

enumerator `kStatus_LPI2C_DmaRequestFail`

DMA request failed.

enumerator `kStatus_LPI2C_Timeout`

Timeout polling status flags.

`IRQn_Type const kLpi2cIrqs[]`

Array to map LPI2C instance number to IRQ number, used internally for LPI2C master interrupt and EDMA transactional APIs.

`lpi2c_master_isr_t s_lpi2cMasterIsr`

Pointer to master IRQ handler for each instance, used internally for LPI2C master interrupt and EDMA transactional APIs.

`void *s_lpi2cMasterHandle[]`

Pointers to master handles for each instance, used internally for LPI2C master interrupt and EDMA transactional APIs.

uint32\_t LPI2C\_GetInstance(LPI2C\_Type \*base)

Returns an instance number given a base address.

If an invalid base address is passed, debug builds will assert. Release builds will just return instance number 0.

#### Parameters

- base – The LPI2C peripheral base address.

#### Returns

LPI2C instance number starting from 0.

I2C\_RETRY\_TIMES

Retry times for waiting flag.

## 2.44 LPI2C Master Driver

void LPI2C\_MasterGetDefaultConfig(*lpi2c\_master\_config\_t* \*masterConfig)

Provides a default configuration for the LPI2C master peripheral.

This function provides the following default configuration for the LPI2C master peripheral:

```
masterConfig->enableMaster = true;
masterConfig->debugEnable = false;
masterConfig->ignoreAck = false;
masterConfig->pinConfig = kLPI2C_2PinOpenDrain;
masterConfig->baudRate_Hz = 100000U;
masterConfig->busIdleTimeout_ns = 0;
masterConfig->pinLowTimeout_ns = 0;
masterConfig->sdaGlitchFilterWidth_ns = 0;
masterConfig->sclGlitchFilterWidth_ns = 0;
masterConfig->hostRequest.enable = false;
masterConfig->hostRequest.source = kLPI2C_HostRequestExternalPin;
masterConfig->hostRequest.polarity = kLPI2C_HostRequestPinActiveHigh;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with LPI2C\_MasterInit().

#### Parameters

- masterConfig – **[out]** User provided configuration structure for default values. Refer to *lpi2c\_master\_config\_t*.

void LPI2C\_MasterInit(LPI2C\_Type \*base, const *lpi2c\_master\_config\_t* \*masterConfig, uint32\_t sourceClock\_Hz)

Initializes the LPI2C master peripheral.

This function enables the peripheral clock and initializes the LPI2C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

#### Parameters

- base – The LPI2C peripheral base address.
- masterConfig – User provided peripheral configuration. Use LPI2C\_MasterGetDefaultConfig() to get a set of defaults that you can override.
- sourceClock\_Hz – Frequency in Hertz of the LPI2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

`void LPI2C_MasterDeinit(LPI2C_Type *base)`

Deinitializes the LPI2C master peripheral.

This function disables the LPI2C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

**Parameters**

- `base` – The LPI2C peripheral base address.

`void LPI2C_MasterConfigureDataMatch(LPI2C_Type *base, const lpi2c_data_match_config_t *matchConfig)`

Configures LPI2C master data match feature.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `matchConfig` – Settings for the data match feature.

`status_t LPI2C_MasterCheckAndClearError(LPI2C_Type *base, uint32_t status)`

Convert provided flags to status code, and clear any errors if present.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `status` – Current status flags value that will be checked.

**Return values**

- `kStatus_Success` –
- `kStatus_LPI2C_PinLowTimeout` –
- `kStatus_LPI2C_ArbitrationLost` –
- `kStatus_LPI2C_Nak` –
- `kStatus_LPI2C_FifoError` –

`status_t LPI2C_CheckForBusyBus(LPI2C_Type *base)`

Make sure the bus isn't already busy.

A busy bus is allowed if we are the one driving it.

**Parameters**

- `base` – The LPI2C peripheral base address.

**Return values**

- `kStatus_Success` –
- `kStatus_LPI2C_Busy` –

`static inline void LPI2C_MasterReset(LPI2C_Type *base)`

Performs a software reset.

Restores the LPI2C master peripheral to reset conditions.

**Parameters**

- `base` – The LPI2C peripheral base address.

`static inline void LPI2C_MasterEnable(LPI2C_Type *base, bool enable)`

Enables or disables the LPI2C module as master.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `enable` – Pass true to enable or false to disable the specified LPI2C as master.



```
static inline uint32_t LPI2C_MasterGetStatusFlags(LPI2C_Type *base)
```

Gets the LPI2C master status flags.

A bit mask with the state of all LPI2C master status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_lpi2c_master_flags`

**Parameters**

- `base` – The LPI2C peripheral base address.

**Returns**

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void LPI2C_MasterClearStatusFlags(LPI2C_Type *base, uint32_t statusMask)
```

Clears the LPI2C master status flag state.

The following status register flags can be cleared:

- `kLPI2C_MasterEndOfPacketFlag`
- `kLPI2C_MasterStopDetectFlag`
- `kLPI2C_MasterNackDetectFlag`
- `kLPI2C_MasterArbitrationLostFlag`
- `kLPI2C_MasterFifoErrFlag`
- `kLPI2C_MasterPinLowTimeoutFlag`
- `kLPI2C_MasterDataMatchFlag`

Attempts to clear other flags has no effect.

**See also:**

`_lpi2c_master_flags`.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_lpi2c_master_flags` enumerators OR'd together. You may pass the result of a previous call to `LPI2C_MasterGetStatusFlags()`.

```
static inline void LPI2C_MasterEnableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Enables the LPI2C master interrupt requests.

All flags except `kLPI2C_MasterBusyFlag` and `kLPI2C_MasterBusBusyFlag` can be enabled as interrupts.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_lpi2c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline void LPI2C_MasterDisableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Disables the LPI2C master interrupt requests.

All flags except `kLPI2C_MasterBusyFlag` and `kLPI2C_MasterBusBusyFlag` can be enabled as interrupts.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to disable. See `_lpi2c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline uint32_t LPI2C_MasterGetEnabledInterrupts(LPI2C_Type *base)
```

Returns the set of currently enabled LPI2C master interrupt requests.

#### Parameters

- `base` – The LPI2C peripheral base address.

#### Returns

A bitmask composed of `_lpi2c_master_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
static inline void LPI2C_MasterEnableDMA(LPI2C_Type *base, bool enableTx, bool enableRx)
```

Enables or disables LPI2C master DMA requests.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `enableTx` – Enable flag for transmit DMA request. Pass true for enable, false for disable.
- `enableRx` – Enable flag for receive DMA request. Pass true for enable, false for disable.

```
static inline uint32_t LPI2C_MasterGetTxFifoAddress(LPI2C_Type *base)
```

Gets LPI2C master transmit data register address for DMA transfer.

#### Parameters

- `base` – The LPI2C peripheral base address.

#### Returns

The LPI2C Master Transmit Data Register address.

```
static inline uint32_t LPI2C_MasterGetRxFifoAddress(LPI2C_Type *base)
```

Gets LPI2C master receive data register address for DMA transfer.

#### Parameters

- `base` – The LPI2C peripheral base address.

#### Returns

The LPI2C Master Receive Data Register address.

```
static inline void LPI2C_MasterSetWatermarks(LPI2C_Type *base, size_t txWords, size_t rxWords)
```

Sets the watermarks for LPI2C master FIFOs.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `txWords` – Transmit FIFO watermark value in words. The `kLPI2C_MasterTxReadyFlag` flag is set whenever the number of words in the transmit FIFO is equal or less than `txWords`. Writing a value equal or greater than the FIFO size is truncated.

- `rxWords` – Receive FIFO watermark value in words. The `kLPI2C_MasterRxReadyFlag` flag is set whenever the number of words in the receive FIFO is greater than `rxWords`. Writing a value equal or greater than the FIFO size is truncated.

```
static inline void LPI2C_MasterGetFifoCounts(LPI2C_Type *base, size_t *rxCount, size_t *txCount)
```

Gets the current number of words in the LPI2C master FIFOs.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `txCount` – **[out]** Pointer through which the current number of words in the transmit FIFO is returned. Pass NULL if this value is not required.
- `rxCount` – **[out]** Pointer through which the current number of words in the receive FIFO is returned. Pass NULL if this value is not required.

```
void LPI2C_MasterSetBaudRate(LPI2C_Type *base, uint32_t sourceClock_Hz, uint32_t baudRate_Hz)
```

Sets the I2C bus frequency for master transactions.

The LPI2C master is automatically disabled and re-enabled as necessary to configure the baud rate. Do not call this function during a transfer, or the transfer is aborted.

---

**Note:** Please note that the second parameter is the clock frequency of LPI2C module, the third parameter means user configured bus baudrate, this implementation is different from other I2C drivers which use baudrate configuration as second parameter and source clock frequency as third parameter.

---

#### Parameters

- `base` – The LPI2C peripheral base address.
- `sourceClock_Hz` – LPI2C functional clock frequency in Hertz.
- `baudRate_Hz` – Requested bus frequency in Hertz.

```
static inline bool LPI2C_MasterGetBusIdleState(LPI2C_Type *base)
```

Returns whether the bus is idle.

Requires the master mode to be enabled.

#### Parameters

- `base` – The LPI2C peripheral base address.

#### Return values

- `true` – Bus is busy.
- `false` – Bus is idle.

```
status_t LPI2C_MasterStart(LPI2C_Type *base, uint8_t address, lpi2c_direction_t dir)
```

Sends a START signal and slave address on the I2C bus.

This function is used to initiate a new master mode transfer. First, the bus state is checked to ensure that another master is not occupying the bus. Then a START signal is transmitted, followed by the 7-bit address specified in the *address* parameter. Note that this function does not actually wait until the START and address are successfully sent on the bus before returning.

#### Parameters

- `base` – The LPI2C peripheral base address.

- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kLPI2C_Read` or `kLPI2C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

#### Return values

- `kStatus_Success` – START signal and address were successfully enqueued in the transmit FIFO.
- `kStatus_LPI2C_Busy` – Another master is currently utilizing the bus.

```
static inline status_t LPI2C_MasterRepeatedStart(LPI2C_Type *base, uint8_t address,
 lpi2c_direction_t dir)
```

Sends a repeated START signal and slave address on the I2C bus.

This function is used to send a Repeated START signal when a transfer is already in progress. Like `LPI2C_MasterStart()`, it also sends the specified 7-bit address.

---

**Note:** This function exists primarily to maintain compatible APIs between LPI2C and I2C drivers, as well as to better document the intent of code that uses these APIs.

---

#### Parameters

- `base` – The LPI2C peripheral base address.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kLPI2C_Read` or `kLPI2C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

#### Return values

- `kStatus_Success` – Repeated START signal and address were successfully enqueued in the transmit FIFO.
- `kStatus_LPI2C_Busy` – Another master is currently utilizing the bus.

```
status_t LPI2C_MasterSend(LPI2C_Type *base, void *txBuff, size_t txSize)
```

Performs a polling send transfer on the I2C bus.

Sends up to `txSize` number of bytes to the previously addressed slave device. The slave may reply with a NAK to any byte in order to terminate the transfer early. If this happens, this function returns `kStatus_LPI2C_Nak`.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

#### Return values

- `kStatus_Success` – Data was sent successfully.
- `kStatus_LPI2C_Busy` – Another master is currently utilizing the bus.
- `kStatus_LPI2C_Nak` – The slave device sent a NAK in response to a byte.
- `kStatus_LPI2C_FifoError` – FIFO under run or over run.
- `kStatus_LPI2C_ArbitrationLost` – Arbitration lost error.
- `kStatus_LPI2C_PinLowTimeout` – SCL or SDA were held low longer than the timeout.

*status\_t* LPI2C\_MasterReceive(LPI2C\_Type \*base, void \*rxBuff, size\_t rxSize)

Performs a polling receive transfer on the I2C bus.

#### Parameters

- base – The LPI2C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.

#### Return values

- kStatus\_Success – Data was received successfully.
- kStatus\_LPI2C\_Busy – Another master is currently utilizing the bus.
- kStatus\_LPI2C\_Nak – The slave device sent a NAK in response to a byte.
- kStatus\_LPI2C\_FifoError – FIFO under run or overrun.
- kStatus\_LPI2C\_ArbitrationLost – Arbitration lost error.
- kStatus\_LPI2C\_PinLowTimeout – SCL or SDA were held low longer than the timeout.

*status\_t* LPI2C\_MasterStop(LPI2C\_Type \*base)

Sends a STOP signal on the I2C bus.

This function does not return until the STOP signal is seen on the bus, or an error occurs.

#### Parameters

- base – The LPI2C peripheral base address.

#### Return values

- kStatus\_Success – The STOP signal was successfully sent on the bus and the transaction terminated.
- kStatus\_LPI2C\_Busy – Another master is currently utilizing the bus.
- kStatus\_LPI2C\_Nak – The slave device sent a NAK in response to a byte.
- kStatus\_LPI2C\_FifoError – FIFO under run or overrun.
- kStatus\_LPI2C\_ArbitrationLost – Arbitration lost error.
- kStatus\_LPI2C\_PinLowTimeout – SCL or SDA were held low longer than the timeout.

*status\_t* LPI2C\_MasterTransferBlocking(LPI2C\_Type \*base, *lpi2c\_master\_transfer\_t* \*transfer)

Performs a master polling transfer on the I2C bus.

---

**Note:** The API does not return until the transfer succeeds or fails due to error happens during transfer.

---

#### Parameters

- base – The LPI2C peripheral base address.
- transfer – Pointer to the transfer structure.

#### Return values

- kStatus\_Success – Data was received successfully.
- kStatus\_LPI2C\_Busy – Another master is currently utilizing the bus.
- kStatus\_LPI2C\_Nak – The slave device sent a NAK in response to a byte.

- kStatus\_LPI2C\_FifoError – FIFO under run or overrun.
- kStatus\_LPI2C\_ArbitrationLost – Arbitration lost error.
- kStatus\_LPI2C\_PinLowTimeout – SCL or SDA were held low longer than the timeout.

```
void LPI2C_MasterTransferCreateHandle(LPI2C_Type *base, lpi2c_master_handle_t *handle,
 lpi2c_master_transfer_callback_t callback, void
 *userData)
```

Creates a new handle for the LPI2C master non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C\_MasterTransferAbort() API shall be called.

---

**Note:** The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

---

#### Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C master driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

```
status_t LPI2C_MasterTransferNonBlocking(LPI2C_Type *base, lpi2c_master_handle_t *handle,
 lpi2c_master_transfer_t *transfer)
```

Performs a non-blocking transaction on the I2C bus.

#### Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- transfer – The pointer to the transfer descriptor.

#### Return values

- kStatus\_Success – The transaction was started successfully.
- kStatus\_LPI2C\_Busy – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

```
status_t LPI2C_MasterTransferGetCount(LPI2C_Type *base, lpi2c_master_handle_t *handle,
 size_t *count)
```

Returns number of bytes transferred so far.

#### Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- count – **[out]** Number of bytes transferred so far by the non-blocking transaction.

#### Return values

- kStatus\_Success –
- kStatus\_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void LPI2C\_MasterTransferAbort(LPI2C\_Type \*base, *lpi2c\_master\_handle\_t* \*handle)

Terminates a non-blocking LPI2C master transmission early.

---

**Note:** It is not safe to call this function from an IRQ handler that has a higher priority than the LPI2C peripheral's IRQ priority.

---

#### Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.

void LPI2C\_MasterTransferHandleIRQ(LPI2C\_Type \*base, void \*lpi2cMasterHandle)

Reusable routine to handle master interrupts.

---

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

---

#### Parameters

- base – The LPI2C peripheral base address.
- lpi2cMasterHandle – Pointer to the LPI2C master driver handle.

enum *\_lpi2c\_master\_flags*

LPI2C master peripheral flags.

The following status register flags can be cleared:

- kLPI2C\_MasterEndOfPacketFlag
- kLPI2C\_MasterStopDetectFlag
- kLPI2C\_MasterNackDetectFlag
- kLPI2C\_MasterArbitrationLostFlag
- kLPI2C\_MasterFifoErrFlag
- kLPI2C\_MasterPinLowTimeoutFlag
- kLPI2C\_MasterDataMatchFlag

All flags except kLPI2C\_MasterBusyFlag and kLPI2C\_MasterBusBusyFlag can be enabled as interrupts.

---

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

---

*Values:*

enumerator kLPI2C\_MasterTxReadyFlag

Transmit data flag

enumerator kLPI2C\_MasterRxReadyFlag

Receive data flag

enumerator kLPI2C\_MasterEndOfPacketFlag

End Packet flag

enumerator kLPI2C\_MasterStopDetectFlag

Stop detect flag

enumerator kLPI2C\_MasterNackDetectFlag  
NACK detect flag

enumerator kLPI2C\_MasterArbitrationLostFlag  
Arbitration lost flag

enumerator kLPI2C\_MasterFifoErrFlag  
FIFO error flag

enumerator kLPI2C\_MasterPinLowTimeoutFlag  
Pin low timeout flag

enumerator kLPI2C\_MasterDataMatchFlag  
Data match flag

enumerator kLPI2C\_MasterBusyFlag  
Master busy flag

enumerator kLPI2C\_MasterBusBusyFlag  
Bus busy flag

enumerator kLPI2C\_MasterClearFlags  
All flags which are cleared by the driver upon starting a transfer.

enumerator kLPI2C\_MasterIrqFlags  
IRQ sources enabled by the non-blocking transactional API.

enumerator kLPI2C\_MasterErrorFlags  
Errors to check for.

enum \_lpi2c\_direction  
Direction of master and slave transfers.  
*Values:*

enumerator kLPI2C\_Write  
Master transmit.

enumerator kLPI2C\_Read  
Master receive.

enum \_lpi2c\_master\_pin\_config  
LPI2C pin configuration.  
*Values:*

enumerator kLPI2C\_2PinOpenDrain  
LPI2C Configured for 2-pin open drain mode

enumerator kLPI2C\_2PinOutputOnly  
LPI2C Configured for 2-pin output only mode (ultra-fast mode)

enumerator kLPI2C\_2PinPushPull  
LPI2C Configured for 2-pin push-pull mode

enumerator kLPI2C\_4PinPushPull  
LPI2C Configured for 4-pin push-pull mode

enumerator kLPI2C\_2PinOpenDrainWithSeparateSlave  
LPI2C Configured for 2-pin open drain mode with separate LPI2C slave

enumerator kLPI2C\_2PinOutputOnlyWithSeparateSlave  
LPI2C Configured for 2-pin output only mode(ultra-fast mode) with separate LPI2C slave



enumerator kLPI2C\_2PinPushPullWithSeparateSlave  
LPI2C Configured for 2-pin push-pull mode with separate LPI2C slave

enumerator kLPI2C\_4PinPushPullWithInvertedOutput  
LPI2C Configured for 4-pin push-pull mode(inverted outputs)

enum \_lpi2c\_host\_request\_source  
LPI2C master host request selection.

*Values:*

enumerator kLPI2C\_HostRequestExternalPin  
Select the LPI2C\_HREQ pin as the host request input

enumerator kLPI2C\_HostRequestInputTrigger  
Select the input trigger as the host request input

enum \_lpi2c\_host\_request\_polarity  
LPI2C master host request pin polarity configuration.

*Values:*

enumerator kLPI2C\_HostRequestPinActiveLow  
Configure the LPI2C\_HREQ pin active low

enumerator kLPI2C\_HostRequestPinActiveHigh  
Configure the LPI2C\_HREQ pin active high

enum \_lpi2c\_data\_match\_config\_mode  
LPI2C master data match configuration modes.

*Values:*

enumerator kLPI2C\_MatchDisabled  
LPI2C Match Disabled

enumerator kLPI2C\_1stWordEqualsM0OrM1  
LPI2C Match Enabled and 1st data word equals MATCH0 OR MATCH1

enumerator kLPI2C\_AnyWordEqualsM0OrM1  
LPI2C Match Enabled and any data word equals MATCH0 OR MATCH1

enumerator kLPI2C\_1stWordEqualsM0And2ndWordEqualsM1  
LPI2C Match Enabled and 1st data word equals MATCH0, 2nd data equals MATCH1

enumerator kLPI2C\_AnyWordEqualsM0AndNextWordEqualsM1  
LPI2C Match Enabled and any data word equals MATCH0, next data equals MATCH1

enumerator kLPI2C\_1stWordAndM1EqualsM0AndM1  
LPI2C Match Enabled and 1st data word and MATCH0 equals MATCH0 and MATCH1

enumerator kLPI2C\_AnyWordAndM1EqualsM0AndM1  
LPI2C Match Enabled and any data word and MATCH0 equals MATCH0 and MATCH1

enum \_lpi2c\_master\_transfer\_flags  
Transfer option flags.

---

**Note:** These enumerations are intended to be OR'd together to form a bit mask of options for the `_lpi2c_master_transfer::flags` field.

---

*Values:*

enumerator `kLPI2C_TransferDefaultFlag`

Transfer starts with a start signal, stops with a stop signal.

enumerator `kLPI2C_TransferNoStartFlag`

Don't send a start condition, address, and sub address

enumerator `kLPI2C_TransferRepeatedStartFlag`

Send a repeated start condition

enumerator `kLPI2C_TransferNoStopFlag`

Don't send a stop condition.

typedef enum `_lpi2c_direction` `lpi2c_direction_t`

Direction of master and slave transfers.

typedef enum `_lpi2c_master_pin_config` `lpi2c_master_pin_config_t`

LPI2C pin configuration.

typedef enum `_lpi2c_host_request_source` `lpi2c_host_request_source_t`

LPI2C master host request selection.

typedef enum `_lpi2c_host_request_polarity` `lpi2c_host_request_polarity_t`

LPI2C master host request pin polarity configuration.

typedef struct `_lpi2c_master_config` `lpi2c_master_config_t`

Structure with settings to initialize the LPI2C master module.

This structure holds configuration settings for the LPI2C peripheral. To initialize this structure to reasonable defaults, call the `LPI2C_MasterGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum `_lpi2c_data_match_config_mode` `lpi2c_data_match_config_mode_t`

LPI2C master data match configuration modes.

typedef struct `_lpi2c_match_config` `lpi2c_data_match_config_t`

LPI2C master data match configuration structure.

typedef struct `_lpi2c_master_transfer` `lpi2c_master_transfer_t`

LPI2C master descriptor of the transfer.

typedef struct `_lpi2c_master_handle` `lpi2c_master_handle_t`

LPI2C master handle of the transfer.

typedef void (\*`lpi2c_master_transfer_callback_t`)(`LPI2C_Type` \*`base`, `lpi2c_master_handle_t` \*`handle`, `status_t` `completionStatus`, void \*`userData`)

Master completion callback function pointer type.

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to `LPI2C_MasterTransferCreateHandle()`.

**Param base**

The LPI2C peripheral base address.

**Param handle**

Pointer to the LPI2C master driver handle.

**Param completionStatus**

Either `kStatus_Success` or an error code describing how the transfer completed.

**Param userData**

Arbitrary pointer-sized value passed from the application.

```
typedef void (*lpi2c_master_isr_t)(LPI2C_Type *base, void *handle)
```

Typedef for master interrupt handler, used internally for LPI2C master interrupt and EDMA transactional APIs.

```
struct __lpi2c_master_config
```

*#include <fsl\_lpi2c.h>* Structure with settings to initialize the LPI2C master module.

This structure holds configuration settings for the LPI2C peripheral. To initialize this structure to reasonable defaults, call the LPI2C\_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

### Public Members

bool enableMaster

Whether to enable master mode.

bool enableDoze

Whether master is enabled in doze mode.

bool debugEnable

Enable transfers to continue when halted in debug mode.

bool ignoreAck

Whether to ignore ACK/NACK.

*lpi2c\_master\_pin\_config\_t* pinConfig

The pin configuration option.

uint32\_t baudRate\_Hz

Desired baud rate in Hertz.

uint32\_t busIdleTimeout\_ns

Bus idle timeout in nanoseconds. Set to 0 to disable.

uint32\_t pinLowTimeout\_ns

Pin low timeout in nanoseconds. Set to 0 to disable.

uint8\_t sdaGlitchFilterWidth\_ns

Width in nanoseconds of glitch filter on SDA pin. Set to 0 to disable.

uint8\_t sclGlitchFilterWidth\_ns

Width in nanoseconds of glitch filter on SCL pin. Set to 0 to disable.

struct *lpi2c\_master\_config* hostRequest

Host request options.

```
struct __lpi2c_match_config
```

*#include <fsl\_lpi2c.h>* LPI2C master data match configuration structure.

### Public Members

*lpi2c\_data\_match\_config\_mode\_t* matchMode

Data match configuration setting.

bool rxDataMatchOnly

When set to true, received data is ignored until a successful match.

uint32\_t match0

Match value 0.

uint32\_t match1

Match value 1.

struct \_lpi2c\_master\_transfer

*#include <fsl\_lpi2c.h>* Non-blocking transfer descriptor structure.

This structure is used to pass transaction parameters to the LPI2C\_MasterTransferNonBlocking() API.

### Public Members

uint32\_t flags

Bit mask of options for the transfer. See enumeration \_lpi2c\_master\_transfer\_flags for available options. Set to 0 or kLPI2C\_TransferDefaultFlag for normal transfers.

uint16\_t slaveAddress

The 7-bit slave address.

*lpi2c\_direction\_t* direction

Either kLPI2C\_Read or kLPI2C\_Write.

uint32\_t subaddress

Sub address. Transferred MSB first.

size\_t subaddressSize

Length of sub address to send in bytes. Maximum size is 4 bytes.

void \*data

Pointer to data to transfer.

size\_t dataSize

Number of bytes to transfer.

struct \_lpi2c\_master\_handle

*#include <fsl\_lpi2c.h>* Driver handle for master non-blocking APIs.

---

**Note:** The contents of this structure are private and subject to change.

---

### Public Members

uint8\_t state

Transfer state machine current state.

uint16\_t remainingBytes

Remaining byte count in current state.

uint8\_t \*buf

Buffer pointer for current state.

uint16\_t commandBuffer[6]

LPI2C command sequence. When all 6 command words are used: Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word]

*lpi2c\_master\_transfer\_t* transfer

Copy of the current transfer info.

*lpi2c\_master\_transfer\_callback\_t* completionCallback

Callback function pointer.

void \*userData

Application data passed to callback.

struct hostRequest

### Public Members

bool enable

Enable host request.

lpi2c\_host\_request\_source\_t source

Host request source.

lpi2c\_host\_request\_polarity\_t polarity

Host request pin polarity.

## 2.45 LPI2C Master DMA Driver

```
void LPI2C_MasterCreateEDMAHandle(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle,
 edma_handle_t *rxDmaHandle, edma_handle_t
 *txDmaHandle, lpi2c_master_edma_transfer_callback_t
 callback, void *userData)
```

Create a new handle for the LPI2C master DMA APIs.

The creation of a handle is for use with the DMA APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C\_MasterTransferAbortEDMA() API shall be called.

For devices where the LPI2C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

### Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C master driver handle.
- rxDmaHandle – Handle for the eDMA receive channel. Created by the user prior to calling this function.
- txDmaHandle – Handle for the eDMA transmit channel. Created by the user prior to calling this function.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

```
status_t LPI2C_MasterTransferEDMA(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle,
 lpi2c_master_transfer_t *transfer)
```

Performs a non-blocking DMA-based transaction on the I2C bus.

The callback specified when the *handle* was created is invoked when the transaction has completed.

### Parameters

- base – The LPI2C peripheral base address.
- handle – Pointer to the LPI2C master driver handle.
- transfer – The pointer to the transfer descriptor.

### Return values

- `kStatus_Success` – The transaction was started successfully.
- `kStatus_LPI2C_Busy` – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

`status_t LPI2C_MasterTransferGetCountEDMA(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, size_t *count)`

Returns number of bytes transferred so far.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to the LPI2C master driver handle.
- `count` – **[out]** Number of bytes transferred so far by the non-blocking transaction.

#### Return values

- `kStatus_Success` –
- `kStatus_NoTransferInProgress` – There is not a DMA transaction currently in progress.

`status_t LPI2C_MasterTransferAbortEDMA(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle)`

Terminates a non-blocking LPI2C master transmission early.

---

**Note:** It is not safe to call this function from an IRQ handler that has a higher priority than the eDMA peripheral's IRQ priority.

---

#### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to the LPI2C master driver handle.

#### Return values

- `kStatus_Success` – A transaction was successfully aborted.
- `kStatus_LPI2C_Idle` – There is not a DMA transaction currently in progress.

`typedef struct _lpi2c_master_edma_handle lpi2c_master_edma_handle_t`

LPI2C master EDMA handle of the transfer.

`typedef void (*lpi2c_master_edma_transfer_callback_t)(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, status_t completionStatus, void *userData)`

Master DMA completion callback function pointer type.

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to `LPI2C_MasterCreateEDMAHandle()`.

#### Param base

The LPI2C peripheral base address.

#### Param handle

Handle associated with the completed transfer.

#### Param completionStatus

Either `kStatus_Success` or an error code describing how the transfer completed.

**Param userData**

Arbitrary pointer-sized value passed from the application.

struct `_lpi2c_master_edma_handle`

*#include <fsl\_lpi2c\_edma.h>* Driver handle for master DMA APIs.

---

**Note:** The contents of this structure are private and subject to change.

---

**Public Members**

`LPI2C_Type *base`

LPI2C base pointer.

`bool isBusy`

Transfer state machine current state.

`uint8_t nbytes`

eDMA minor byte transfer count initially configured.

`uint16_t commandBuffer[20]`

LPI2C command sequence. When all 10 command words are used:  
Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word] +  
receive&Size[4 words]

`lpi2c_master_transfer_t transfer`

Copy of the current transfer info.

`lpi2c_master_edma_transfer_callback_t completionCallback`

Callback function pointer.

`void *userData`

Application data passed to callback.

`edma_handle_t *rx`

Handle for receive DMA channel.

`edma_handle_t *tx`

Handle for transmit DMA channel.

`edma_tcd_t tcds[3]`

Software TCD. Three are allocated to provide enough room to align to 32-bytes.

## 2.46 LPI2C Slave Driver

`void LPI2C_SlaveGetDefaultConfig(lpi2c_slave_config_t *slaveConfig)`

Provides a default configuration for the LPI2C slave peripheral.

This function provides the following default configuration for the LPI2C slave peripheral:

```
slaveConfig->enableSlave = true;
slaveConfig->address0 = 0U;
slaveConfig->address1 = 0U;
slaveConfig->addressMatchMode = kLPI2C_MatchAddress0;
slaveConfig->filterDozeEnable = true;
slaveConfig->filterEnable = true;
slaveConfig->enableGeneralCall = false;
slaveConfig->sclStall.enableAck = false;
```

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```

slaveConfig->sclStall.enableTx = true;
slaveConfig->sclStall.enableRx = true;
slaveConfig->sclStall.enableAddress = true;
slaveConfig->ignoreAck = false;
slaveConfig->enableReceivedAddressRead = false;
slaveConfig->sdaGlitchFilterWidth_ns = 0;
slaveConfig->sclGlitchFilterWidth_ns = 0;
slaveConfig->dataValidDelay_ns = 0;
slaveConfig->clockHoldTime_ns = 0;

```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with `LPI2C_SlaveInit()`. Be sure to override at least the *address0* member of the configuration structure with the desired slave address.

### Parameters

- `slaveConfig` – **[out]** User provided configuration structure that is set to default values. Refer to `lpi2c_slave_config_t`.

```
void LPI2C__SlaveInit(LPI2C_Type *base, const lpi2c_slave_config_t *slaveConfig, uint32_t
 sourceClock_Hz)
```

Initializes the LPI2C slave peripheral.

This function enables the peripheral clock and initializes the LPI2C slave peripheral as described by the user provided configuration.

### Parameters

- `base` – The LPI2C peripheral base address.
- `slaveConfig` – User provided peripheral configuration. Use `LPI2C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the LPI2C functional clock. Used to calculate the filter widths, data valid delay, and clock hold time.

```
void LPI2C__SlaveDeinit(LPI2C_Type *base)
```

Deinitializes the LPI2C slave peripheral.

This function disables the LPI2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

### Parameters

- `base` – The LPI2C peripheral base address.

```
static inline void LPI2C__SlaveReset(LPI2C_Type *base)
```

Performs a software reset of the LPI2C slave peripheral.

### Parameters

- `base` – The LPI2C peripheral base address.

```
static inline void LPI2C__SlaveEnable(LPI2C_Type *base, bool enable)
```

Enables or disables the LPI2C module as slave.

### Parameters

- `base` – The LPI2C peripheral base address.
- `enable` – Pass true to enable or false to disable the specified LPI2C as slave.



```
static inline uint32_t LPI2C_SlaveGetStatusFlags(LPI2C_Type *base)
```

Gets the LPI2C slave status flags.

A bit mask with the state of all LPI2C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

**See also:**

`_lpi2c_slave_flags`

**Parameters**

- `base` – The LPI2C peripheral base address.

**Returns**

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void LPI2C_SlaveClearStatusFlags(LPI2C_Type *base, uint32_t statusMask)
```

Clears the LPI2C status flag state.

The following status register flags can be cleared:

- `kLPI2C_SlaveRepeatedStartDetectFlag`
- `kLPI2C_SlaveStopDetectFlag`
- `kLPI2C_SlaveBitErrFlag`
- `kLPI2C_SlaveFifoErrFlag`

Attempts to clear other flags has no effect.

**See also:**

`_lpi2c_slave_flags`.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_lpi2c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `LPI2C_SlaveGetStatusFlags()`.

```
static inline void LPI2C_SlaveEnableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Enables the LPI2C slave interrupt requests.

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

**Parameters**

- `base` – The LPI2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_lpi2c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline void LPI2C_SlaveDisableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Disables the LPI2C slave interrupt requests.

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

**Parameters**

- base – The LPI2C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_lpi2c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline uint32_t LPI2C_SlaveGetEnabledInterrupts(LPI2C_Type *base)
```

Returns the set of currently enabled LPI2C slave interrupt requests.

**Parameters**

- base – The LPI2C peripheral base address.

**Returns**

A bitmask composed of `_lpi2c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
static inline void LPI2C_SlaveEnableDMA(LPI2C_Type *base, bool enableAddressValid, bool enableRx, bool enableTx)
```

Enables or disables the LPI2C slave peripheral DMA requests.

**Parameters**

- base – The LPI2C peripheral base address.
- enableAddressValid – Enable flag for the address valid DMA request. Pass true for enable, false for disable. The address valid DMA request is shared with the receive data DMA request.
- enableRx – Enable flag for the receive data DMA request. Pass true for enable, false for disable.
- enableTx – Enable flag for the transmit data DMA request. Pass true for enable, false for disable.

```
static inline bool LPI2C_SlaveGetBusIdleState(LPI2C_Type *base)
```

Returns whether the bus is idle.

Requires the slave mode to be enabled.

**Parameters**

- base – The LPI2C peripheral base address.

**Return values**

- true – Bus is busy.
- false – Bus is idle.

```
static inline void LPI2C_SlaveTransmitAck(LPI2C_Type *base, bool ackOrNack)
```

Transmits either an ACK or NAK on the I2C bus in response to a byte from the master.

Use this function to send an ACK or NAK when the `kLPI2C_SlaveTransmitAckFlag` is asserted. This only happens if you enable the `sclStall.enableAck` field of the `lpi2c_slave_config_t` configuration structure used to initialize the slave peripheral.

**Parameters**

- base – The LPI2C peripheral base address.
- ackOrNack – Pass true for an ACK or false for a NAK.

```
static inline void LPI2C_SlaveEnableAckStall(LPI2C_Type *base, bool enable)
```

Enables or disables ACKSTALL.

When enables ACKSTALL, software can transmit either an ACK or NAK on the I2C bus in response to a byte from the master.

**Parameters**

- base – The LPI2C peripheral base address.
- enable – True will enable ACKSTALL, false will disable ACKSTALL.

static inline uint32\_t LPI2C\_SlaveGetReceivedAddress(LPI2C\_Type \*base)

Returns the slave address sent by the I2C master.

This function should only be called if the kLPI2C\_SlaveAddressValidFlag is asserted.

**Parameters**

- base – The LPI2C peripheral base address.

**Returns**

The 8-bit address matched by the LPI2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

status\_t LPI2C\_SlaveSend(LPI2C\_Type \*base, void \*txBuff, size\_t txSize, size\_t \*actualTxSize)

Performs a polling send transfer on the I2C bus.

**Parameters**

- base – The LPI2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- actualTxSize – **[out]**

**Returns**

Error or success status returned by API.

status\_t LPI2C\_SlaveReceive(LPI2C\_Type \*base, void \*rxBuff, size\_t rxSize, size\_t \*actualRxSize)

Performs a polling receive transfer on the I2C bus.

**Parameters**

- base – The LPI2C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.
- actualRxSize – **[out]**

**Returns**

Error or success status returned by API.

void LPI2C\_SlaveTransferCreateHandle(LPI2C\_Type \*base, lpi2c\_slave\_handle\_t \*handle, lpi2c\_slave\_transfer\_callback\_t callback, void \*userData)

Creates a new handle for the LPI2C slave non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C\_SlaveTransferAbort() API shall be called.

---

**Note:** The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

---

**Parameters**

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C slave driver handle.

- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

`status_t` LPI2C\_SlaveTransferNonBlocking(LPI2C\_Type \*base, *lpi2c\_slave\_handle\_t* \*handle, uint32\_t eventMask)

Starts accepting slave transfers.

Call this API after calling `I2C_SlaveInit()` and `LPI2C_SlaveTransferCreateHandle()` to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to `LPI2C_SlaveTransferCreateHandle()`. The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of `lpi2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `kLPI2C_SlaveTransmitEvent` and `kLPI2C_SlaveReceiveEvent` events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the `kLPI2C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to `lpi2c_slave_handle_t` structure which stores the transfer state.
- `eventMask` – Bit mask formed by OR'ing together `lpi2c_slave_transfer_event_t` enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and `kLPI2C_SlaveAllEvents` to enable all events.

#### Return values

- `kStatus__Success` – Slave transfers were successfully started.
- `kStatus_LPI2C_Busy` – Slave transfers have already been started on this handle.

`status_t` LPI2C\_SlaveTransferGetCount(LPI2C\_Type \*base, *lpi2c\_slave\_handle\_t* \*handle, size\_t \*count)

Gets the slave transfer status during a non-blocking transfer.

#### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to `i2c_slave_handle_t` structure.
- `count` – **[out]** Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

#### Return values

- `kStatus__Success` –
- `kStatus_NoTransferInProgress` –

`void` LPI2C\_SlaveTransferAbort(LPI2C\_Type \*base, *lpi2c\_slave\_handle\_t* \*handle)

Aborts the slave non-blocking transfers.

---

**Note:** This API could be called at any time to stop slave for handling the bus events.

---

#### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to `lpi2c_slave_handle_t` structure which stores the transfer state.

`void LPI2C_SlaveTransferHandleIRQ(LPI2C_Type *base, lpi2c_slave_handle_t *handle)`

Reusable routine to handle slave interrupts.

---

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

---

### Parameters

- `base` – The LPI2C peripheral base address.
- `handle` – Pointer to `lpi2c_slave_handle_t` structure which stores the transfer state.

`enum _lpi2c_slave_flags`

LPI2C slave peripheral flags.

The following status register flags can be cleared:

- `kLPI2C_SlaveRepeatedStartDetectFlag`
- `kLPI2C_SlaveStopDetectFlag`
- `kLPI2C_SlaveBitErrFlag`
- `kLPI2C_SlaveFifoErrFlag`

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

---

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

---

### Values:

enumerator `kLPI2C_SlaveTxReadyFlag`

Transmit data flag

enumerator `kLPI2C_SlaveRxReadyFlag`

Receive data flag

enumerator `kLPI2C_SlaveAddressValidFlag`

Address valid flag

enumerator `kLPI2C_SlaveTransmitAckFlag`

Transmit ACK flag

enumerator `kLPI2C_SlaveRepeatedStartDetectFlag`

Repeated start detect flag

enumerator `kLPI2C_SlaveStopDetectFlag`

Stop detect flag

enumerator `kLPI2C_SlaveBitErrFlag`

Bit error flag

enumerator `kLPI2C_SlaveFifoErrFlag`

FIFO error flag

enumerator kLPI2C\_SlaveAddressMatch0Flag  
Address match 0 flag

enumerator kLPI2C\_SlaveAddressMatch1Flag  
Address match 1 flag

enumerator kLPI2C\_SlaveGeneralCallFlag  
General call flag

enumerator kLPI2C\_SlaveBusyFlag  
Master busy flag

enumerator kLPI2C\_SlaveBusBusyFlag  
Bus busy flag

enumerator kLPI2C\_SlaveClearFlags  
All flags which are cleared by the driver upon starting a transfer.

enumerator kLPI2C\_SlaveIrqFlags  
IRQ sources enabled by the non-blocking transactional API.

enumerator kLPI2C\_SlaveErrorFlags  
Errors to check for.

enum \_lpi2c\_slave\_address\_match  
LPI2C slave address match options.

*Values:*

enumerator kLPI2C\_MatchAddress0  
Match only address 0.

enumerator kLPI2C\_MatchAddress0OrAddress1  
Match either address 0 or address 1.

enumerator kLPI2C\_MatchAddress0ThroughAddress1  
Match a range of slave addresses from address 0 through address 1.

enum \_lpi2c\_slave\_transfer\_event

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C\_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

---

**Note:** These enumerations are meant to be OR'd together to form a bit mask of events.

---

*Values:*

enumerator kLPI2C\_SlaveAddressMatchEvent  
Received the slave address after a start or repeated start.

enumerator kLPI2C\_SlaveTransmitEvent  
Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kLPI2C\_SlaveReceiveEvent  
Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kLPI2C\_SlaveTransmitAckEvent  
Callback needs to either transmit an ACK or NACK.

enumerator kLPI2C\_SlaveRepeatedStartEvent

A repeated start was detected.

enumerator kLPI2C\_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator kLPI2C\_SlaveAllEvents

Bit mask of all available events.

typedef enum *\_lpi2c\_slave\_address\_match* lpi2c\_slave\_address\_match\_t

LPI2C slave address match options.

typedef struct *\_lpi2c\_slave\_config* lpi2c\_slave\_config\_t

Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C\_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum *\_lpi2c\_slave\_transfer\_event* lpi2c\_slave\_transfer\_event\_t

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C\_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

---

**Note:** These enumerations are meant to be OR'd together to form a bit mask of events.

---

typedef struct *\_lpi2c\_slave\_transfer* lpi2c\_slave\_transfer\_t

LPI2C slave transfer structure.

typedef struct *\_lpi2c\_slave\_handle* lpi2c\_slave\_handle\_t

LPI2C slave handle structure.

typedef void (\*lpi2c\_slave\_transfer\_callback\_t)(LPI2C\_Type \*base, *lpi2c\_slave\_transfer\_t* \*transfer, void \*userData)

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the LPI2C\_SlaveSetCallback() function after you have created a handle.

**Param base**

Base address for the LPI2C instance on which the event occurred.

**Param transfer**

Pointer to transfer descriptor containing values passed to and/or from the callback.

**Param userData**

Arbitrary pointer-sized value passed from the application.

struct *\_lpi2c\_slave\_config*

*#include <fsl\_lpi2c.h>* Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C\_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

### Public Members

`bool enableSlave`  
Enable slave mode.

`uint8_t address0`  
Slave's 7-bit address.

`uint8_t address1`  
Alternate slave 7-bit address.

`lpi2c_slave_address_match_t addressMatchMode`  
Address matching options.

`bool filterDozeEnable`  
Enable digital glitch filter in doze mode.

`bool filterEnable`  
Enable digital glitch filter.

`bool enableGeneralCall`  
Enable general call address matching.

`struct _lpi2c_slave_config sclStall`  
SCL stall enable options.

`bool ignoreAck`  
Continue transfers after a NACK is detected.

`bool enableReceivedAddressRead`  
Enable reading the address received address as the first byte of data.

`uint32_t sdaGlitchFilterWidth_ns`  
Width in nanoseconds of the digital filter on the SDA signal. Set to 0 to disable.

`uint32_t sclGlitchFilterWidth_ns`  
Width in nanoseconds of the digital filter on the SCL signal. Set to 0 to disable.

`uint32_t dataValidDelay_ns`  
Width in nanoseconds of the data valid delay.

`uint32_t clockHoldTime_ns`  
Width in nanoseconds of the clock hold time.

`struct _lpi2c_slave_transfer`  
*#include <fsl\_lpi2c.h>* LPI2C slave transfer structure.

### Public Members

`lpi2c_slave_transfer_event_t event`  
Reason the callback is being invoked.

`uint8_t receivedAddress`  
Matching address send by master.

`uint8_t *data`  
Transfer buffer

`size_t dataSize`  
Transfer size



*status\_t* completionStatus

Success or error code describing how the transfer completed. Only applies for kLPI2C\_SlaveCompletionEvent.

*size\_t* transferredCount

Number of bytes actually transferred since start or last repeated start.

struct *\_lpi2c\_slave\_handle*

*#include <fsl\_lpi2c.h>* LPI2C slave handle structure.

---

**Note:** The contents of this structure are private and subject to change.

---

### Public Members

*lpi2c\_slave\_transfer\_t* transfer

LPI2C slave transfer copy.

bool isBusy

Whether transfer is busy.

bool wasTransmit

Whether the last transfer was a transmit.

uint32\_t eventMask

Mask of enabled events.

uint32\_t transferredCount

Count of bytes transferred.

*lpi2c\_slave\_transfer\_callback\_t* callback

Callback function called at transfer event.

void \*userData

Callback parameter passed to callback.

struct sclStall

### Public Members

bool enableAck

Enables SCL clock stretching during slave-transmit address byte(s) and slave-receiver address and data byte(s) to allow software to write the Transmit ACK Register before the ACK or NACK is transmitted. Clock stretching occurs when transmitting the 9th bit. When enableAckSCLStall is enabled, there is no need to set either enableRxDataSCLStall or enableAddressSCLStall.

bool enableTx

Enables SCL clock stretching when the transmit data flag is set during a slave-transmit transfer.

bool enableRx

Enables SCL clock stretching when receive data flag is set during a slave-receive transfer.

bool enableAddress

Enables SCL clock stretching when the address valid flag is asserted.

## 2.47 LPIT: Low-Power Interrupt Timer

enum `_lpit_chnl`

List of LPIT channels.

---

**Note:** Actual number of available channels is SoC-dependent

---

*Values:*

enumerator `kLPIT_Chnl_0`  
LPIT channel number 0

enumerator `kLPIT_Chnl_1`  
LPIT channel number 1

enumerator `kLPIT_Chnl_2`  
LPIT channel number 2

enumerator `kLPIT_Chnl_3`  
LPIT channel number 3

enum `_lpit_timer_modes`

Mode options available for the LPIT timer.

*Values:*

enumerator `kLPIT_PeriodicCounter`  
Use the all 32-bits, counter loads and decrements to zero

enumerator `kLPIT_DualPeriodicCounter`  
Counter loads, lower 16-bits decrement to zero, then upper 16-bits decrement

enumerator `kLPIT_TriggerAccumulator`  
Counter loads on first trigger and decrements on each trigger

enumerator `kLPIT_InputCapture`  
Counter loads with 0xFFFFFFFF, decrements to zero. It stores the inverse of the current value when a input trigger is detected

enum `_lpit_trigger_select`

Trigger options available.

This is used for both internal and external trigger sources. The actual trigger options available is SoC-specific, user should refer to the reference manual.

*Values:*

enumerator `kLPIT_Trigger_TimerChn0`  
Channel 0 is selected as a trigger source

enumerator `kLPIT_Trigger_TimerChn1`  
Channel 1 is selected as a trigger source

enumerator `kLPIT_Trigger_TimerChn2`  
Channel 2 is selected as a trigger source

enumerator `kLPIT_Trigger_TimerChn3`  
Channel 3 is selected as a trigger source

enumerator `kLPIT_Trigger_TimerChn4`  
Channel 4 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn5

Channel 5 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn6

Channel 6 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn7

Channel 7 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn8

Channel 8 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn9

Channel 9 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn10

Channel 10 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn11

Channel 11 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn12

Channel 12 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn13

Channel 13 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn14

Channel 14 is selected as a trigger source

enumerator kLPIT\_Trigger\_TimerChn15

Channel 15 is selected as a trigger source

enum \_lpit\_trigger\_source

Trigger source options available.

*Values:*

enumerator kLPIT\_TriggerSource\_External

Use external trigger input

enumerator kLPIT\_TriggerSource\_Internal

Use internal trigger

enum \_lpit\_interrupt\_enable

List of LPIT interrupts.

---

**Note:** Number of timer channels are SoC-specific. See the SoC Reference Manual.

---

*Values:*

enumerator kLPIT\_Channel0TimerInterruptEnable

Channel 0 Timer interrupt

enumerator kLPIT\_Channel1TimerInterruptEnable

Channel 1 Timer interrupt

enumerator kLPIT\_Channel2TimerInterruptEnable

Channel 2 Timer interrupt

enumerator kLPIT\_Channel3TimerInterruptEnable

Channel 3 Timer interrupt

enum *\_lpit\_status\_flags*

List of LPIT status flags.

---

**Note:** Number of timer channels are SoC-specific. See the SoC Reference Manual.

---

*Values:*

enumerator *kLPIT\_Channel0TimerFlag*

Channel 0 Timer interrupt flag

enumerator *kLPIT\_Channel1TimerFlag*

Channel 1 Timer interrupt flag

enumerator *kLPIT\_Channel2TimerFlag*

Channel 2 Timer interrupt flag

enumerator *kLPIT\_Channel3TimerFlag*

Channel 3 Timer interrupt flag

typedef enum *\_lpit\_chnl* *lpit\_chnl\_t*

List of LPIT channels.

---

**Note:** Actual number of available channels is SoC-dependent

---

typedef enum *\_lpit\_timer\_modes* *lpit\_timer\_modes\_t*

Mode options available for the LPIT timer.

typedef enum *\_lpit\_trigger\_select* *lpit\_trigger\_select\_t*

Trigger options available.

This is used for both internal and external trigger sources. The actual trigger options available is SoC-specific, user should refer to the reference manual.

typedef enum *\_lpit\_trigger\_source* *lpit\_trigger\_source\_t*

Trigger source options available.

typedef enum *\_lpit\_interrupt\_enable* *lpit\_interrupt\_enable\_t*

List of LPIT interrupts.

---

**Note:** Number of timer channels are SoC-specific. See the SoC Reference Manual.

---

typedef enum *\_lpit\_status\_flags* *lpit\_status\_flags\_t*

List of LPIT status flags.

---

**Note:** Number of timer channels are SoC-specific. See the SoC Reference Manual.

---

typedef struct *\_lpit\_chnl\_params* *lpit\_chnl\_params\_t*

Structure to configure the channel timer.

typedef struct *\_lpit\_config* *lpit\_config\_t*

LPIT configuration structure.

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

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

FSL\_LPIT\_DRIVER\_VERSION

Version 2.1.2

LPIT\_RESET\_STATE\_DELAY

Delay used in LPIT\_Reset.

The macro value should be larger than  $4 * \text{core clock} / \text{LPIT peripheral clock}$ .

void LPIT\_Init(LPIT\_Type \*base, const *lpit\_config\_t* \*config)

Ungates the LPIT clock and configures the peripheral for a basic operation.

This function issues a software reset to reset all channels and registers except the Module Control register.

---

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

---

#### Parameters

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

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

Disables the module and gates the LPIT clock.

#### Parameters

- base – LPIT peripheral base address.

void LPIT\_GetDefaultConfig(*lpit\_config\_t* \*config)

Fills in the LPIT configuration structure with default settings.

The default values are:

```
config->enableRunInDebug = false;
config->enableRunInDoze = false;
```

#### Parameters

- config – Pointer to the user configuration structure.

*status\_t* LPIT\_SetupChannel(LPIT\_Type \*base, *lpit\_chnl\_t* channel, const *lpit\_chnl\_params\_t* \*chnlSetup)

Sets up an LPIT channel based on the user's preference.

This function sets up the operation mode to one of the options available in the enumeration *lpit\_timer\_modes\_t*. It sets the trigger source as either internal or external, trigger selection and the timers behaviour when a timeout occurs. It also chains the timer if a prior timer if requested by the user.

#### Parameters

- base – LPIT peripheral base address.
- channel – Channel that is being configured.
- chnlSetup – Configuration parameters.

static inline void LPIT\_EnableInterrupts(LPIT\_Type \*base, uint32\_t mask)

Enables the selected PIT interrupts.

#### Parameters

- base – LPIT peripheral base address.

- `mask` – The interrupts to enable. This is a logical OR of members of the enumeration `lpit_interrupt_enable_t`

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

Disables the selected PIT interrupts.

#### Parameters

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

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

Gets the enabled LPIT interrupts.

#### Parameters

- `base` – LPIT peripheral base address.

#### Returns

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

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

Gets the LPIT status flags.

#### Parameters

- `base` – LPIT peripheral base address.

#### Returns

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

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

Clears the LPIT status flags.

#### Parameters

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

static inline void LPIT\_SetTimerPeriod(LPIT\_Type \*base, *lpit\_chnl\_t* channel, uint32\_t ticks)

Sets the timer period in units of count.

Timers begin counting down from the value set by this function until it reaches 0, at which point it generates an interrupt and loads this register value again. Writing a new value to this register does not restart the timer. Instead, the value is loaded after the timer expires.

---

**Note:** User can call the utility macros provided in `fsl_common.h` to convert to ticks.

---

#### Parameters

- `base` – LPIT peripheral base address.
- `channel` – Timer channel number.
- `ticks` – Timer period in units of ticks.

static inline void LPIT\_SetTimerValue(LPIT\_Type \*base, *lpit\_chnl\_t* channel, uint32\_t ticks)

Sets the timer period in units of count.

In the Dual 16-bit Periodic Counter mode, the counter will load and then the lower 16-bits will decrement down to zero, which will assert the output pre-trigger. The upper 16-bits will

then decrement down to zero, which will negate the output pre-trigger and set the timer interrupt flag.

---

**Note:** Set TVAL register to 0 or 1 is invalid in compare mode.

---

#### Parameters

- `base` – LPIT peripheral base address.
- `channel` – Timer channel number.
- `ticks` – Timer period in units of ticks.

static inline uint32\_t LPIT\_GetCurrentTimerCount(LPIT\_Type \*base, *lpit\_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 microseconds or milliseconds.

---

#### Parameters

- `base` – LPIT peripheral base address.
- `channel` – Timer channel number.

#### Returns

Current timer counting value in ticks.

static inline void LPIT\_StartTimer(LPIT\_Type \*base, *lpit\_chnl\_t* channel)

Starts the timer counting.

After calling this function, timers load the period value and count down to 0. When the timer reaches 0, it generates a trigger pulse and sets the timeout interrupt flag.

#### Parameters

- `base` – LPIT peripheral base address.
- `channel` – Timer channel number.

static inline void LPIT\_StopTimer(LPIT\_Type \*base, *lpit\_chnl\_t* channel)

Stops the timer counting.

#### Parameters

- `base` – LPIT peripheral base address.
- `channel` – Timer channel number.

static void LPIT\_ResetStateDelay(void)

Short wait for LPIT state reset.

After clear or set `LPIT_EN`, there should be delay longer than 4 LPIT functional clock.

#### Parameters

- `count` – Delay count.

static inline void LPIT\_Reset(LPIT\_Type \*base)

Performs a software reset on the LPIT module.

This resets all channels and registers except the Module Control Register.

#### Parameters

- base – LPIT peripheral base address.

struct `_lpit_chnl_params`

*#include <fsl\_lpit.h>* Structure to configure the channel timer.

### Public Members

bool chainChannel

true: Timer chained to previous timer; false: Timer not chained

*lpit\_timer\_modes\_t* timerMode

Timers mode of operation.

*lpit\_trigger\_select\_t* triggerSelect

Trigger selection for the timer

*lpit\_trigger\_source\_t* triggerSource

Decides if we use external or internal trigger.

bool enableReloadOnTrigger

true: Timer reloads when a trigger is detected; false: No effect

bool enableStopOnTimeout

true: Timer will stop after timeout; false: does not stop after timeout

bool enableStartOnTrigger

true: Timer starts when a trigger is detected; false: decrement immediately

struct `_lpit_config`

*#include <fsl\_lpit.h>* LPIT configuration structure.

This structure holds the configuration settings for the LPIT peripheral. To initialize this structure to reasonable defaults, call the `LPIT_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 enableRunInDebug

true: Timers run in debug mode; false: Timers stop in debug mode

bool enableRunInDoze

true: Timers run in doze mode; false: Timers stop in doze mode

## 2.48 LPSPI: Low Power Serial Peripheral Interface

### 2.49 LPSPI Peripheral driver

void `LPSPI_MasterInit(LPSPI_Type *base, const lpspi_master_config_t *masterConfig, uint32_t srcClock_Hz)`

Initializes the LPSPI master.

#### Parameters

- base – LPSPI peripheral address.
- masterConfig – Pointer to structure `lpspi_master_config_t`.



- srcClock\_Hz – Module source input clock in Hertz

void LPSPI\_MasterGetDefaultConfig(*lpspi\_master\_config\_t* \*masterConfig)

Sets the *lpspi\_master\_config\_t* structure to default values.

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

```
lpspi_master_config_t masterConfig;
LPSPI_MasterGetDefaultConfig(&masterConfig);
```

#### Parameters

- masterConfig – pointer to *lpspi\_master\_config\_t* structure

void LPSPI\_SlaveInit(LPSPI\_Type \*base, const *lpspi\_slave\_config\_t* \*slaveConfig)

LPSPI slave configuration.

#### Parameters

- base – LPSPI peripheral address.
- slaveConfig – Pointer to a structure *lpspi\_slave\_config\_t*.

void LPSPI\_SlaveGetDefaultConfig(*lpspi\_slave\_config\_t* \*slaveConfig)

Sets the *lpspi\_slave\_config\_t* structure to default values.

This API initializes the configuration structure for LPSPI\_SlaveInit(). The initialized structure can remain unchanged in LPSPI\_SlaveInit() or can be modified before calling the LPSPI\_SlaveInit(). Example:

```
lpspi_slave_config_t slaveConfig;
LPSPI_SlaveGetDefaultConfig(&slaveConfig);
```

#### Parameters

- slaveConfig – pointer to *lpspi\_slave\_config\_t* structure.

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

De-initializes the LPSPI peripheral. Call this API to disable the LPSPI clock.

#### Parameters

- base – LPSPI peripheral address.

void LPSPI\_Reset(LPSPI\_Type \*base)

Restores the LPSPI peripheral to reset state. Note that this function sets all registers to reset state. As a result, the LPSPI module can't work after calling this API.

#### Parameters

- base – LPSPI peripheral address.

uint32\_t LPSPI\_GetInstance(LPSPI\_Type \*base)

Get the LPSPI instance from peripheral base address.

#### Parameters

- base – LPSPI peripheral base address.

#### Returns

LPSPI instance.

static inline void LPSPI\_Enable(LPSPI\_Type \*base, bool enable)  
 Enables the LPSPI peripheral and sets the MCR MDIS to 0.

**Parameters**

- base – LPSPI peripheral address.
- enable – Pass true to enable module, false to disable module.

static inline uint32\_t LPSPI\_GetStatusFlags(LPSPI\_Type \*base)  
 Gets the LPSPI status flag state.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The LPSPI status(in SR register).

static inline uint8\_t LPSPI\_GetTxFifoSize(LPSPI\_Type \*base)  
 Gets the LPSPI Tx FIFO size.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The LPSPI Tx FIFO size.

static inline uint8\_t LPSPI\_GetRxFifoSize(LPSPI\_Type \*base)  
 Gets the LPSPI Rx FIFO size.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The LPSPI Rx FIFO size.

static inline uint32\_t LPSPI\_GetTxFifoCount(LPSPI\_Type \*base)  
 Gets the LPSPI Tx FIFO count.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The number of words in the transmit FIFO.

static inline uint32\_t LPSPI\_GetRxFifoCount(LPSPI\_Type \*base)  
 Gets the LPSPI Rx FIFO count.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The number of words in the receive FIFO.

static inline void LPSPI\_ClearStatusFlags(LPSPI\_Type \*base, uint32\_t statusFlags)  
 Clears the LPSPI status flag.

This function clears the desired status bit by using a write-1-to-clear. The user passes in the base and the desired status flag bit to clear. The list of status flags is defined in the `_lpspi_flags`. Example usage:

```
LPSPI_ClearStatusFlags(base, kLPSPI_TxDataRequestFlag|kLPSPI_RxDataReadyFlag);
```

**Parameters**

- base – LPSPI peripheral address.
- statusFlags – The status flag used from type `_lpspi_flags`.

static inline uint32\_t LPSPI\_GetTcr(LPSPI\_Type \*base)

static inline void LPSPI\_EnableInterrupts(LPSPI\_Type \*base, uint32\_t mask)

Enables the LPSPI interrupts.

This function configures the various interrupt masks of the LPSPI. The parameters are base and an interrupt mask. Note that, for Tx fill and Rx FIFO drain requests, enabling the interrupt request disables the DMA request.

```
LPSPI_EnableInterrupts(base, kLPSPI_TxInterruptEnable | kLPSPI_RxInterruptEnable);
```

#### Parameters

- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum `_lpspi_interrupt_enable`.

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

Disables the LPSPI interrupts.

```
LPSPI_DisableInterrupts(base, kLPSPI_TxInterruptEnable | kLPSPI_RxInterruptEnable);
```

#### Parameters

- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum `_lpspi_interrupt_enable`.

static inline void LPSPI\_EnableDMA(LPSPI\_Type \*base, uint32\_t mask)

Enables the LPSPI DMA request.

This function configures the Rx and Tx DMA mask of the LPSPI. The parameters are base and a DMA mask.

```
LPSPI_EnableDMA(base, kLPSPI_TxDmaEnable | kLPSPI_RxDmaEnable);
```

#### Parameters

- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum `_lpspi_dma_enable`.

static inline void LPSPI\_DisableDMA(LPSPI\_Type \*base, uint32\_t mask)

Disables the LPSPI DMA request.

This function configures the Rx and Tx DMA mask of the LPSPI. The parameters are base and a DMA mask.

```
SPI_DisableDMA(base, kLPSPI_TxDmaEnable | kLPSPI_RxDmaEnable);
```

#### Parameters

- base – LPSPI peripheral address.
- mask – The interrupt mask; Use the enum `_lpspi_dma_enable`.

static inline uint32\_t LPSPI\_GetTxRegisterAddress(LPSPI\_Type \*base)

Gets the LPSPI Transmit Data Register address for a DMA operation.

This function gets the LPSPI Transmit Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The LPSPI Transmit Data Register address.

```
static inline uint32_t LPSPI_GetRxRegisterAddress(LPSPI_Type *base)
```

Gets the LPSPI Receive Data Register address for a DMA operation.

This function gets the LPSPI Receive Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

**Parameters**

- base – LPSPI peripheral address.

**Returns**

The LPSPI Receive Data Register address.

```
bool LPSPI_CheckTransferArgument(LPSPI_Type *base, lpspi_transfer_t *transfer, bool isEdma)
```

Check the argument for transfer .

**Parameters**

- base – LPSPI peripheral address.
- transfer – the transfer struct to be used.
- isEdma – True to check for EDMA transfer, false to check interrupt non-blocking transfer

**Returns**

Return true for right and false for wrong.

```
static inline void LPSPI_SetMasterSlaveMode(LPSPI_Type *base, lpspi_master_slave_mode_t mode)
```

Configures the LPSPI for either master or slave.

Note that the CFGR1 should only be written when the LPSPI is disabled (LPSPIx\_CR\_MEN = 0).

**Parameters**

- base – LPSPI peripheral address.
- mode – Mode setting (master or slave) of type lpspi\_master\_slave\_mode\_t.

```
static inline void LPSPI_SelectTransferPCS(LPSPI_Type *base, lpspi_which_pcs_t select)
```

Configures the peripheral chip select used for the transfer.

**Parameters**

- base – LPSPI peripheral address.
- select – LPSPI Peripheral Chip Select (PCS) configuration.

```
static inline void LPSPI_SetPCSContinuous(LPSPI_Type *base, bool IsContinuous)
```

Set the PCS signal to continuous or uncontinuous mode.

---

**Note:** In master mode, continuous transfer will keep the PCS asserted at the end of the frame size, until a command word is received that starts a new frame. So PCS must be set back to uncontinuous when transfer finishes. In slave mode, when continuous transfer is enabled, the LPSPI will only transmit the first frame size bits, after that the LPSPI will transmit received data back (assuming a 32-bit shift register).

---

**Parameters**

- base – LPSPI peripheral address.
- IsContinuous – True to set the transfer PCS to continuous mode, false to set to uncontinuous mode.

static inline bool LPSPI\_IsMaster(LPSPI\_Type \*base)

Returns whether the LPSPI module is in master mode.

#### Parameters

- base – LPSPI peripheral address.

#### Returns

Returns true if the module is in master mode or false if the module is in slave mode.

static inline void LPSPI\_FlushFifo(LPSPI\_Type \*base, bool flushTxFifo, bool flushRxFifo)

Flushes the LPSPI FIFOs.

#### Parameters

- base – LPSPI peripheral address.
- flushTxFifo – Flushes (true) the Tx FIFO, else do not flush (false) the Tx FIFO.
- flushRxFifo – Flushes (true) the Rx FIFO, else do not flush (false) the Rx FIFO.

static inline void LPSPI\_SetFifoWatermarks(LPSPI\_Type \*base, uint32\_t txWater, uint32\_t rxWater)

Sets the transmit and receive FIFO watermark values.

This function allows the user to set the receive and transmit FIFO watermarks. The function does not compare the watermark settings to the FIFO size. The FIFO watermark should not be equal to or greater than the FIFO size. It is up to the higher level driver to make this check.

#### Parameters

- base – LPSPI peripheral address.
- txWater – The TX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.
- rxWater – The RX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.

static inline void LPSPI\_SetAllPcsPolarity(LPSPI\_Type \*base, uint32\_t mask)

Configures all LPSPI peripheral chip select polarities simultaneously.

Note that the CFGR1 should only be written when the LPSPI is disabled (LPSPIx\_CR\_MEN = 0).

This is an example: PCS0 and PCS1 set to active low and other PCSs set to active high. Note that the number of PCS is device-specific.

```
LPSPI_SetAllPcsPolarity(base, kLPSPI_Pcs0ActiveLow | kLPSPI_Pcs1ActiveLow);
```

#### Parameters

- base – LPSPI peripheral address.
- mask – The PCS polarity mask; Use the enum `_lpspi_pcs_polarity`.

static inline void LPSPI\_SetFrameSize(LPSPI\_Type \*base, uint32\_t frameSize)

Configures the frame size.

The minimum frame size is 8-bits and the maximum frame size is 4096-bits. If the frame size is less than or equal to 32-bits, the word size and frame size are identical. If the frame

size is greater than 32-bits, the word size is 32-bits for each word except the last (the last word contains the remainder bits if the frame size is not divisible by 32). The minimum word size is 2-bits. A frame size of 33-bits (or similar) is not supported.

Note 1: The transmit command register should be initialized before enabling the LPSPI in slave mode, although the command register does not update until after the LPSPI is enabled. After it is enabled, the transmit command register should only be changed if the LPSPI is idle.

Note 2: The transmit and command FIFO is a combined FIFO that includes both transmit data and command words. That means the TCR register should be written to when the Tx FIFO is not full.

#### Parameters

- base – LPSPI peripheral address.
- frameSize – The frame size in number of bits.

```
uint32_t LPSPI_MasterSetBaudRate(LPSPI_Type *base, uint32_t baudRate_Bps, uint32_t
 srcClock_Hz, uint32_t *tcrPrescaleValue)
```

Sets the LPSPI baud rate in bits per second.

This function takes in the desired bitsPerSec (baud rate) and calculates the nearest possible baud rate without exceeding the desired baud rate and returns the calculated baud rate in bits-per-second. It requires the caller to provide the frequency of the module source clock (in Hertz). Note that the baud rate does not go into effect until the Transmit Control Register (TCR) is programmed with the prescale value. Hence, this function returns the prescale tcrPrescaleValue parameter for later programming in the TCR. The higher level peripheral driver should alert the user of an out of range baud rate input.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

#### Parameters

- base – LPSPI peripheral address.
- baudRate\_Bps – The desired baud rate in bits per second.
- srcClock\_Hz – Module source input clock in Hertz.
- tcrPrescaleValue – The TCR prescale value needed to program the TCR.

#### Returns

The actual calculated baud rate. This function may also return a “0” if the LPSPI is not configured for master mode or if the LPSPI module is not disabled.

```
void LPSPI_MasterSetDelayScaler(LPSPI_Type *base, uint32_t scaler, lpspi_delay_type_t
 whichDelay)
```

Manually configures a specific LPSPI delay parameter (module must be disabled to change the delay values).

This function configures the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type *lpspi\_delay\_type\_t*.

The user passes the desired delay along with the delay value. This allows the user to directly set the delay values if they have pre-calculated them or if they simply wish to manually increment the value.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

#### Parameters

- base – LPSPI peripheral address.

- `scaler` – The 8-bit delay value 0x00 to 0xFF (255).
- `whichDelay` – The desired delay to configure, must be of type `lpspi_delay_type_t`.

```
uint32_t LPSPI_MasterSetDelayTimes(LPSPI_Type *base, uint32_t delayTimeInNanoSec,
 lpspi_delay_type_t whichDelay, uint32_t srcClock_Hz)
```

Calculates the delay based on the desired delay input in nanoseconds (module must be disabled to change the delay values).

This function calculates the values for the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type `lpspi_delay_type_t`.

The user passes the desired delay and the desired delay value in nano-seconds. The function calculates the value needed for the desired delay parameter and returns the actual calculated delay because an exact delay match may not be possible. In this case, the closest match is calculated without going below the desired delay value input. It is possible to input a very large delay value that exceeds the capability of the part, in which case the maximum supported delay is returned. It is up to the higher level peripheral driver to alert the user of an out of range delay input.

Note that the LPSPi module must be configured for master mode before configuring this. And note that the `delayTime = LPSPI_clockSource / (PRESCALE * Delay_scaler)`.

#### Parameters

- `base` – LPSPi peripheral address.
- `delayTimeInNanoSec` – The desired delay value in nano-seconds.
- `whichDelay` – The desired delay to configuration, which must be of type `lpspi_delay_type_t`.
- `srcClock_Hz` – Module source input clock in Hertz.

#### Returns

actual Calculated delay value in nano-seconds.

```
static inline void LPSPI_WriteData(LPSPI_Type *base, uint32_t data)
```

Writes data into the transmit data buffer.

This function writes data passed in by the user to the Transmit Data Register (TDR). The user can pass up to 32-bits of data to load into the TDR. If the frame size exceeds 32-bits, the user has to manage sending the data one 32-bit word at a time. Any writes to the TDR result in an immediate push to the transmit FIFO. This function can be used for either master or slave modes.

#### Parameters

- `base` – LPSPi peripheral address.
- `data` – The data word to be sent.

```
static inline uint32_t LPSPI_ReadData(LPSPI_Type *base)
```

Reads data from the data buffer.

This function reads the data from the Receive Data Register (RDR). This function can be used for either master or slave mode.

#### Parameters

- `base` – LPSPi peripheral address.

#### Returns

The data read from the data buffer.

```
void LPSPI_SetDummyData(LPSPI_Type *base, uint8_t dummyData)
```

Set up the dummy data.

#### Parameters

- *base* – LPSPI peripheral address.
- *dummyData* – Data to be transferred when tx buffer is NULL. Note: This API has no effect when LPSPI in slave interrupt mode, because driver will set the TXMSK bit to 1 if txData is NULL, no data is loaded from transmit FIFO and output pin is tristated.

```
void LPSPI_MasterTransferCreateHandle(LPSPI_Type *base, lpspi_master_handle_t *handle,
 lpspi_master_transfer_callback_t callback, void
 *userData)
```

Initializes the LPSPI master handle.

This function initializes the LPSPI handle, which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

#### Parameters

- *base* – LPSPI peripheral address.
- *handle* – LPSPI handle pointer to *lpspi\_master\_handle\_t*.
- *callback* – DSPI callback.
- *userData* – callback function parameter.

```
status_t LPSPI_MasterTransferBlocking(LPSPI_Type *base, lpspi_transfer_t *transfer)
```

LPSPI master transfer data using a polling method.

This function transfers data using a polling method. This is a blocking function, which does not return until all transfers have been completed.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

#### Parameters

- *base* – LPSPI peripheral address.
- *transfer* – pointer to *lpspi\_transfer\_t* structure.

#### Returns

status of *status\_t*.

```
status_t LPSPI_MasterTransferNonBlocking(LPSPI_Type *base, lpspi_master_handle_t *handle,
 lpspi_transfer_t *transfer)
```

LPSPI master transfer data using an interrupt method.

This function transfers data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

#### Parameters

- *base* – LPSPI peripheral address.
- *handle* – pointer to *lpspi\_master\_handle\_t* structure which stores the transfer state.



- transfer – pointer to `lpspi_transfer_t` structure.

**Returns**

status of `status_t`.

`status_t` LPSPI\_MasterTransferGetCount(LPSPI\_Type \*base, *lpspi\_master\_handle\_t* \*handle, size\_t \*count)

Gets the master transfer remaining bytes.

This function gets the master transfer remaining bytes.

**Parameters**

- base – LPSPI peripheral address.
- handle – pointer to `lpspi_master_handle_t` structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

**Returns**

status of `status_t`.

void LPSPI\_MasterTransferAbort(LPSPI\_Type \*base, *lpspi\_master\_handle\_t* \*handle)

LPSPI master abort transfer which uses an interrupt method.

This function aborts a transfer which uses an interrupt method.

**Parameters**

- base – LPSPI peripheral address.
- handle – pointer to `lpspi_master_handle_t` structure which stores the transfer state.

void LPSPI\_MasterTransferHandleIRQ(LPSPI\_Type \*base, *lpspi\_master\_handle\_t* \*handle)

LPSPI Master IRQ handler function.

This function processes the LPSPI transmit and receive IRQ.

**Parameters**

- base – LPSPI peripheral address.
- handle – pointer to `lpspi_master_handle_t` structure which stores the transfer state.

void LPSPI\_SlaveTransferCreateHandle(LPSPI\_Type \*base, *lpspi\_slave\_handle\_t* \*handle, *lpspi\_slave\_transfer\_callback\_t* callback, void \*userData)

Initializes the LPSPI slave handle.

This function initializes the LPSPI handle, which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

**Parameters**

- base – LPSPI peripheral address.
- handle – LPSPI handle pointer to `lpspi_slave_handle_t`.
- callback – DSPI callback.
- userData – callback function parameter.

`status_t` LPSPI\_SlaveTransferNonBlocking(LPSPI\_Type \*base, *lpspi\_slave\_handle\_t* \*handle, *lpspi\_transfer\_t* \*transfer)

LPSPI slave transfer data using an interrupt method.

This function transfer data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

#### Parameters

- base – LPSPi peripheral address.
- handle – pointer to `lpspi_slave_handle_t` structure which stores the transfer state.
- transfer – pointer to `lpspi_transfer_t` structure.

#### Returns

status of `status_t`.

`status_t` LPSPi\_SlaveTransferGetCount(LPSPi\_Type \*base, *lpspi\_slave\_handle\_t* \*handle, size\_t \*count)

Gets the slave transfer remaining bytes.

This function gets the slave transfer remaining bytes.

#### Parameters

- base – LPSPi peripheral address.
- handle – pointer to `lpspi_slave_handle_t` structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

#### Returns

status of `status_t`.

void LPSPi\_SlaveTransferAbort(LPSPi\_Type \*base, *lpspi\_slave\_handle\_t* \*handle)

LPSPi slave aborts a transfer which uses an interrupt method.

This function aborts a transfer which uses an interrupt method.

#### Parameters

- base – LPSPi peripheral address.
- handle – pointer to `lpspi_slave_handle_t` structure which stores the transfer state.

void LPSPi\_SlaveTransferHandleIRQ(LPSPi\_Type \*base, *lpspi\_slave\_handle\_t* \*handle)

LPSPi Slave IRQ handler function.

This function processes the LPSPi transmit and receives an IRQ.

#### Parameters

- base – LPSPi peripheral address.
- handle – pointer to `lpspi_slave_handle_t` structure which stores the transfer state.

bool LPSPi\_WaitTxFifoEmpty(LPSPi\_Type \*base)

Wait for tx FIFO to be empty.

This function wait the tx fifo empty

#### Parameters

- base – LPSPi peripheral address.

#### Returns

true for the tx FIFO is ready, false is not.

void LPSPI\_DriverIRQHandler(uint32\_t instance)

LPSPI driver IRQ handler common entry.

This function provides the common IRQ request entry for LPSPI.

#### Parameters

- instance – LPSPI instance.

FSL\_LPSPI\_DRIVER\_VERSION

LPSPI driver version.

Status for the LPSPI driver.

*Values:*

enumerator kStatus\_LPSPI\_Busy

LPSPI transfer is busy.

enumerator kStatus\_LPSPI\_Error

LPSPI driver error.

enumerator kStatus\_LPSPI\_Idle

LPSPI is idle.

enumerator kStatus\_LPSPI\_OutOfRange

LPSPI transfer out Of range.

enumerator kStatus\_LPSPI\_Timeout

LPSPI timeout polling status flags.

enum \_lpspi\_flags

LPSPI status flags in SPIx\_SR register.

*Values:*

enumerator kLPSPI\_TxDataRequestFlag

Transmit data flag

enumerator kLPSPI\_RxDataReadyFlag

Receive data flag

enumerator kLPSPI\_WordCompleteFlag

Word Complete flag

enumerator kLPSPI\_FrameCompleteFlag

Frame Complete flag

enumerator kLPSPI\_TransferCompleteFlag

Transfer Complete flag

enumerator kLPSPI\_TransmitErrorFlag

Transmit Error flag (FIFO underrun)

enumerator kLPSPI\_ReceiveErrorFlag

Receive Error flag (FIFO overrun)

enumerator kLPSPI\_DataMatchFlag

Data Match flag

enumerator kLPSPI\_ModuleBusyFlag

Module Busy flag

enumerator kLPSPi\_AllStatusFlag

Used for clearing all w1c status flags

enum \_lpspi\_interrupt\_enable

LPSPi interrupt source.

*Values:*

enumerator kLPSPi\_TxInterruptEnable

Transmit data interrupt enable

enumerator kLPSPi\_RxInterruptEnable

Receive data interrupt enable

enumerator kLPSPi\_WordCompleteInterruptEnable

Word complete interrupt enable

enumerator kLPSPi\_FrameCompleteInterruptEnable

Frame complete interrupt enable

enumerator kLPSPi\_TransferCompleteInterruptEnable

Transfer complete interrupt enable

enumerator kLPSPi\_TransmitErrorInterruptEnable

Transmit error interrupt enable(FIFO underrun)

enumerator kLPSPi\_ReceiveErrorInterruptEnable

Receive Error interrupt enable (FIFO overrun)

enumerator kLPSPi\_DataMatchInterruptEnable

Data Match interrupt enable

enumerator kLPSPi\_AllInterruptEnable

All above interrupts enable.

enum \_lpspi\_dma\_enable

LPSPi DMA source.

*Values:*

enumerator kLPSPi\_TxDmaEnable

Transmit data DMA enable

enumerator kLPSPi\_RxDmaEnable

Receive data DMA enable

enum \_lpspi\_master\_slave\_mode

LPSPi master or slave mode configuration.

*Values:*

enumerator kLPSPi\_Master

LPSPi peripheral operates in master mode.

enumerator kLPSPi\_Slave

LPSPi peripheral operates in slave mode.

enum \_lpspi\_which\_pcs\_config

LPSPi Peripheral Chip Select (PCS) configuration (which PCS to configure).

*Values:*

enumerator kLPSPi\_Pcs0

PCS[0]

enumerator kLPSPI\_Pcs1  
PCS[1]

enumerator kLPSPI\_Pcs2  
PCS[2]

enumerator kLPSPI\_Pcs3  
PCS[3]

enum \_\_lpspi\_pcs\_polarity\_config  
LPSPI Peripheral Chip Select (PCS) Polarity configuration.  
*Values:*

enumerator kLPSPI\_PcsActiveHigh  
PCS Active High (idles low)

enumerator kLPSPI\_PcsActiveLow  
PCS Active Low (idles high)

enum \_\_lpspi\_pcs\_polarity  
LPSPI Peripheral Chip Select (PCS) Polarity.  
*Values:*

enumerator kLPSPI\_Pcs0ActiveLow  
Pcs0 Active Low (idles high).

enumerator kLPSPI\_Pcs1ActiveLow  
Pcs1 Active Low (idles high).

enumerator kLPSPI\_Pcs2ActiveLow  
Pcs2 Active Low (idles high).

enumerator kLPSPI\_Pcs3ActiveLow  
Pcs3 Active Low (idles high).

enumerator kLPSPI\_PcsAllActiveLow  
Pcs0 to Pcs5 Active Low (idles high).

enum \_\_lpspi\_clock\_polarity  
LPSPI clock polarity configuration.  
*Values:*

enumerator kLPSPI\_ClockPolarityActiveHigh  
CPOL=0. Active-high LPSPI clock (idles low)

enumerator kLPSPI\_ClockPolarityActiveLow  
CPOL=1. Active-low LPSPI clock (idles high)

enum \_\_lpspi\_clock\_phase  
LPSPI clock phase configuration.  
*Values:*

enumerator kLPSPI\_ClockPhaseFirstEdge  
CPHA=0. Data is captured on the leading edge of the SCK and changed on the following edge.

enumerator kLPSPI\_ClockPhaseSecondEdge  
CPHA=1. Data is changed on the leading edge of the SCK and captured on the following edge.

enum \_lpspi\_shift\_direction

LPSPi data shifter direction options.

*Values:*

enumerator kLPSPi\_MsbFirst

Data transfers start with most significant bit.

enumerator kLPSPi\_LsbFirst

Data transfers start with least significant bit.

enum \_lpspi\_host\_request\_select

LPSPi Host Request select configuration.

*Values:*

enumerator kLPSPi\_HostReqExtPin

Host Request is an ext pin.

enumerator kLPSPi\_HostReqInternalTrigger

Host Request is an internal trigger.

enum \_lpspi\_match\_config

LPSPi Match configuration options.

*Values:*

enumerator kLPSPi\_MatchDisabled

LPSPi Match Disabled.

enumerator kLPSPi\_1stWordEqualsM0orM1

LPSPi Match Enabled.

enumerator kLPSPi\_AnyWordEqualsM0orM1

LPSPi Match Enabled.

enumerator kLPSPi\_1stWordEqualsM0and2ndWordEqualsM1

LPSPi Match Enabled.

enumerator kLPSPi\_AnyWordEqualsM0andNxtWordEqualsM1

LPSPi Match Enabled.

enumerator kLPSPi\_1stWordAndM1EqualsM0andM1

LPSPi Match Enabled.

enumerator kLPSPi\_AnyWordAndM1EqualsM0andM1

LPSPi Match Enabled.

enum \_lpspi\_pin\_config

LPSPi pin (SDO and SDI) configuration.

*Values:*

enumerator kLPSPi\_SdiInSdoOut

LPSPi SDI input, SDO output.

enumerator kLPSPi\_SdiInSdiOut

LPSPi SDI input, SDI output.

enumerator kLPSPi\_SdoInSdoOut

LPSPi SDO input, SDO output.

enumerator kLPSPi\_SdoInSdiOut

LPSPi SDO input, SDI output.

enum \_lpspi\_data\_out\_config

LPSPi data output configuration.

*Values:*

enumerator kLpspiDataOutRetained

Data out retains last value when chip select is de-asserted

enumerator kLpspiDataOutTristate

Data out is tristated when chip select is de-asserted

enum \_lpspi\_transfer\_width

LPSPi transfer width configuration.

*Values:*

enumerator kLPSPi\_SingleBitXfer

1-bit shift at a time, data out on SDO, in on SDI (normal mode)

enumerator kLPSPi\_TwoBitXfer

2-bits shift out on SDO/SDI and in on SDO/SDI

enumerator kLPSPi\_FourBitXfer

4-bits shift out on SDO/SDI/PCS[3:2] and in on SDO/SDI/PCS[3:2]

enum \_lpspi\_delay\_type

LPSPi delay type selection.

*Values:*

enumerator kLPSPi\_PcsToSck

PCS-to-SCK delay.

enumerator kLPSPi\_LastSckToPcs

Last SCK edge to PCS delay.

enumerator kLPSPi\_BetweenTransfer

Delay between transfers.

enum \_lpspi\_transfer\_config\_flag\_for\_master

Use this enumeration for LPSPi master transfer configFlags.

*Values:*

enumerator kLPSPi\_MasterPcs0

LPSPi master PCS shift macro , internal used. LPSPi master transfer use PCS0 signal

enumerator kLPSPi\_MasterPcs1

LPSPi master PCS shift macro , internal used. LPSPi master transfer use PCS1 signal

enumerator kLPSPi\_MasterPcs2

LPSPi master PCS shift macro , internal used. LPSPi master transfer use PCS2 signal

enumerator kLPSPi\_MasterPcs3

LPSPi master PCS shift macro , internal used. LPSPi master transfer use PCS3 signal

enumerator kLPSPi\_MasterPcsContinuous

Is PCS signal continuous

enumerator kLPSPi\_MasterByteSwap

Is master swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set lpspi\_shift\_direction\_t to MSB).

- i. If you set bitPerFrame = 8 , no matter the kLPSPi\_MasterByteSwapyou flag is used or not, the waveform is 1 2 3 4 5 6 7 8.

- ii. If you set bitPerFrame = 16 : (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the kLPSPi\_MasterByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPi\_MasterByteSwap flag.
- iii. If you set bitPerFrame = 32 : (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the kLPSPi\_MasterByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPi\_MasterByteSwap flag.

enum \_lpspi\_transfer\_config\_flag\_for\_slave

Use this enumeration for LPSPi slave transfer configFlags.

*Values:*

enumerator kLPSPi\_SlavePcs0

LPSPi slave PCS shift macro , internal used. LPSPi slave transfer use PCS0 signal

enumerator kLPSPi\_SlavePcs1

LPSPi slave PCS shift macro , internal used. LPSPi slave transfer use PCS1 signal

enumerator kLPSPi\_SlavePcs2

LPSPi slave PCS shift macro , internal used. LPSPi slave transfer use PCS2 signal

enumerator kLPSPi\_SlavePcs3

LPSPi slave PCS shift macro , internal used. LPSPi slave transfer use PCS3 signal

enumerator kLPSPi\_SlaveByteSwap

Is slave swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set lpspi\_shift\_direction\_t to MSB).

- i. If you set bitPerFrame = 8 , no matter the kLPSPi\_SlaveByteSwap flag is used or not, the waveform is 1 2 3 4 5 6 7 8.
- ii. If you set bitPerFrame = 16 : (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the kLPSPi\_SlaveByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPi\_SlaveByteSwap flag.
- iii. If you set bitPerFrame = 32 : (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the kLPSPi\_SlaveByteSwap flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the kLPSPi\_SlaveByteSwap flag.

enum \_lpspi\_transfer\_state

LPSPi transfer state, which is used for LPSPi transactional API state machine.

*Values:*

enumerator kLPSPi\_Idle

Nothing in the transmitter/receiver.

enumerator kLPSPi\_Busy

Transfer queue is not finished.

enumerator kLPSPi\_Error

Transfer error.

typedef enum \_lpspi\_master\_slave\_mode lpspi\_master\_slave\_mode\_t

LPSPi master or slave mode configuration.

typedef enum \_lpspi\_which\_pcs\_config lpspi\_which\_pcs\_t

LPSPi Peripheral Chip Select (PCS) configuration (which PCS to configure).

typedef enum \_lpspi\_pcs\_polarity\_config lpspi\_pcs\_polarity\_config\_t

LPSPi Peripheral Chip Select (PCS) Polarity configuration.



typedef enum *\_lpspi\_clock\_polarity* lpspi\_clock\_polarity\_t

LPSPI clock polarity configuration.

typedef enum *\_lpspi\_clock\_phase* lpspi\_clock\_phase\_t

LPSPI clock phase configuration.

typedef enum *\_lpspi\_shift\_direction* lpspi\_shift\_direction\_t

LPSPI data shifter direction options.

typedef enum *\_lpspi\_host\_request\_select* lpspi\_host\_request\_select\_t

LPSPI Host Request select configuration.

typedef enum *\_lpspi\_match\_config* lpspi\_match\_config\_t

LPSPI Match configuration options.

typedef enum *\_lpspi\_pin\_config* lpspi\_pin\_config\_t

LPSPI pin (SDO and SDI) configuration.

typedef enum *\_lpspi\_data\_out\_config* lpspi\_data\_out\_config\_t

LPSPI data output configuration.

typedef enum *\_lpspi\_transfer\_width* lpspi\_transfer\_width\_t

LPSPI transfer width configuration.

typedef enum *\_lpspi\_delay\_type* lpspi\_delay\_type\_t

LPSPI delay type selection.

typedef struct *\_lpspi\_master\_config* lpspi\_master\_config\_t

LPSPI master configuration structure.

typedef struct *\_lpspi\_slave\_config* lpspi\_slave\_config\_t

LPSPI slave configuration structure.

typedef struct *\_lpspi\_master\_handle* lpspi\_master\_handle\_t

Forward declaration of the *\_lpspi\_master\_handle* typedefs.

typedef struct *\_lpspi\_slave\_handle* lpspi\_slave\_handle\_t

Forward declaration of the *\_lpspi\_slave\_handle* typedefs.

typedef void (\*lpspi\_master\_transfer\_callback\_t)(LPSPI\_Type \*base, *lpspi\_master\_handle\_t* \*handle, *status\_t* status, void \*userData)

Master completion callback function pointer type.

**Param base**

LPSPI peripheral address.

**Param handle**

Pointer to the handle for the LPSPI master.

**Param status**

Success or error code describing whether the transfer is completed.

**Param userData**

Arbitrary pointer-dataSized value passed from the application.

typedef void (\*lpspi\_slave\_transfer\_callback\_t)(LPSPI\_Type \*base, *lpspi\_slave\_handle\_t* \*handle, *status\_t* status, void \*userData)

Slave completion callback function pointer type.

**Param base**

LPSPI peripheral address.

**Param handle**

Pointer to the handle for the LPSPI slave.

**Param status**

Success or error code describing whether the transfer is completed.

**Param userData**

Arbitrary pointer-dataSized value passed from the application.

```
typedef struct _lpspi_transfer lpspi_transfer_t
```

LPSPI master/slave transfer structure.

```
volatile uint8_t g_lpspiDummyData[]
```

Global variable for dummy data value setting.

```
LPSPI_DUMMY_DATA
```

LPSPI dummy data if no Tx data.

Dummy data used for tx if there is not txData.

```
SPI_RETRY_TIMES
```

Retry times for waiting flag.

```
LPSPI_MASTER_PCS_SHIFT
```

LPSPI master PCS shift macro , internal used.

```
LPSPI_MASTER_PCS_MASK
```

LPSPI master PCS shift macro , internal used.

```
LPSPI_SLAVE_PCS_SHIFT
```

LPSPI slave PCS shift macro , internal used.

```
LPSPI_SLAVE_PCS_MASK
```

LPSPI slave PCS shift macro , internal used.

```
struct _lpspi_master_config
```

*#include <fsl\_lpspi.h>* LPSPI master configuration structure.

**Public Members**

```
uint32_t baudRate
```

Baud Rate for LPSPI.

```
uint32_t bitsPerFrame
```

Bits per frame, minimum 8, maximum 4096.

```
lpspi_clock_polarity_t cpol
```

Clock polarity.

```
lpspi_clock_phase_t cpha
```

Clock phase.

```
lpspi_shift_direction_t direction
```

MSB or LSB data shift direction.

```
uint32_t pcsToSckDelayInNanoSec
```

PCS to SCK delay time in nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

```
uint32_t lastSckToPcsDelayInNanoSec
```

Last SCK to PCS delay time in nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

uint32\_t betweenTransferDelayInNanoSec

After the SCK delay time with nanoseconds, setting to 0 sets the minimum delay. It sets the boundary value if out of range.

lpspi\_which\_pcs\_t whichPcs

Desired Peripheral Chip Select (PCS).

lpspi\_pcs\_polarity\_config\_t pcsActiveHighOrLow

Desired PCS active high or low

lpspi\_pin\_config\_t pinCfg

Configures which pins are used for input and output data during single bit transfers.

lpspi\_data\_out\_config\_t dataOutConfig

Configures if the output data is tristated between accesses (LPSPi\_PCS is negated).

bool enableInputDelay

Enable master to sample the input data on a delayed SCK. This can help improve slave setup time. Refer to device data sheet for specific time length.

struct \_\_lpspi\_slave\_config

#include <fsl\_lpspi.h> LPSPi slave configuration structure.

### Public Members

uint32\_t bitsPerFrame

Bits per frame, minimum 8, maximum 4096.

lpspi\_clock\_polarity\_t cpol

Clock polarity.

lpspi\_clock\_phase\_t cpha

Clock phase.

lpspi\_shift\_direction\_t direction

MSB or LSB data shift direction.

lpspi\_which\_pcs\_t whichPcs

Desired Peripheral Chip Select (pcs)

lpspi\_pcs\_polarity\_config\_t pcsActiveHighOrLow

Desired PCS active high or low

lpspi\_pin\_config\_t pinCfg

Configures which pins are used for input and output data during single bit transfers.

lpspi\_data\_out\_config\_t dataOutConfig

Configures if the output data is tristated between accesses (LPSPi\_PCS is negated).

struct \_\_lpspi\_transfer

#include <fsl\_lpspi.h> LPSPi master/slave transfer structure.

### Public Members

const uint8\_t \*txData

Send buffer.

uint8\_t \*rxData

Receive buffer.

volatile size\_t dataSize

Transfer bytes.

uint32\_t configFlags

Transfer transfer configuration flags. Set from `_lpspi_transfer_config_flag_for_master` if the transfer is used for master or `_lpspi_transfer_config_flag_for_slave` enumeration if the transfer is used for slave.

struct `_lpspi_master_handle`

*#include <fsl\_lpspi.h>* LPSPi master transfer handle structure used for transactional API.

### Public Members

volatile bool isPcsContinuous

Is PCS continuous in transfer.

volatile bool writeTcrInIsr

A flag that whether should write TCR in ISR.

volatile bool isByteSwap

A flag that whether should byte swap.

volatile bool isTxMask

A flag that whether TCR[TXMSK] is set.

volatile uint16\_t bytesPerFrame

Number of bytes in each frame

volatile uint16\_t frameSize

Backup of TCR[FRAMESZ]

volatile uint8\_t fifoSize

FIFO dataSize.

volatile uint8\_t rxWatermark

Rx watermark.

volatile uint8\_t bytesEachWrite

Bytes for each write TDR.

volatile uint8\_t bytesEachRead

Bytes for each read RDR.

const uint8\_t \*volatile txData

Send buffer.

uint8\_t \*volatile rxData

Receive buffer.

volatile size\_t txRemainingByteCount

Number of bytes remaining to send.

volatile size\_t rxRemainingByteCount

Number of bytes remaining to receive.

volatile uint32\_t writeRegRemainingTimes

Write TDR register remaining times.

volatile uint32\_t readRegRemainingTimes

Read RDR register remaining times.

uint32\_t totalByteCount

Number of transfer bytes

uint32\_t txBuffIfNull

Used if the txData is NULL.

volatile uint8\_t state

LPSPi transfer state , \_lpspi\_transfer\_state.

*lpspi\_master\_transfer\_callback\_t* callback

Completion callback.

void \*userData

Callback user data.

struct \_lpspi\_slave\_handle

*#include <fsl\_lpspi.h>* LPSPi slave transfer handle structure used for transactional API.

### Public Members

volatile bool isByteSwap

A flag that whether should byte swap.

volatile uint8\_t fifoSize

FIFO dataSize.

volatile uint8\_t rxWatermark

Rx watermark.

volatile uint8\_t bytesEachWrite

Bytes for each write TDR.

volatile uint8\_t bytesEachRead

Bytes for each read RDR.

const uint8\_t \*volatile txData

Send buffer.

uint8\_t \*volatile rxData

Receive buffer.

volatile size\_t txRemainingByteCount

Number of bytes remaining to send.

volatile size\_t rxRemainingByteCount

Number of bytes remaining to receive.

volatile uint32\_t writeRegRemainingTimes

Write TDR register remaining times.

volatile uint32\_t readRegRemainingTimes

Read RDR register remaining times.

uint32\_t totalByteCount

Number of transfer bytes

volatile uint8\_t state

LPSPi transfer state , \_lpspi\_transfer\_state.

volatile uint32\_t errorCount

Error count for slave transfer.

*lpspi\_slave\_transfer\_callback\_t* callback

Completion callback.

void \*userData

Callback user data.

## 2.50 LPSPI eDMA Driver

FSL\_LPSPI\_EDMA\_DRIVER\_VERSION

LPSPI EDMA driver version.

DMA\_MAX\_TRANSFER\_COUNT

DMA max transfer size.

typedef struct *lpspi\_master\_edma\_handle* lpspi\_master\_edma\_handle\_t

Forward declaration of the *lpspi\_master\_edma\_handle* typedefs.

typedef struct *lpspi\_slave\_edma\_handle* lpspi\_slave\_edma\_handle\_t

Forward declaration of the *lpspi\_slave\_edma\_handle* typedefs.

typedef void (\*lpspi\_master\_edma\_transfer\_callback\_t)(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, *status\_t* status, void \*userData)

Completion callback function pointer type.

### Param base

LPSPI peripheral base address.

### Param handle

Pointer to the handle for the LPSPI master.

### Param status

Success or error code describing whether the transfer completed.

### Param userData

Arbitrary pointer-dataSized value passed from the application.

typedef void (\*lpspi\_slave\_edma\_transfer\_callback\_t)(LPSPI\_Type \*base, *lpspi\_slave\_edma\_handle\_t* \*handle, *status\_t* status, void \*userData)

Completion callback function pointer type.

### Param base

LPSPI peripheral base address.

### Param handle

Pointer to the handle for the LPSPI slave.

### Param status

Success or error code describing whether the transfer completed.

### Param userData

Arbitrary pointer-dataSized value passed from the application.

void LPSPI\_MasterTransferCreateHandleEDMA(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, *lpspi\_master\_edma\_transfer\_callback\_t* callback, void \*userData, *edma\_handle\_t* \*edmaRxRegToRxDataHandle, *edma\_handle\_t* \*edmaTxDataToTxRegHandle)

Initializes the LPSPI master eDMA handle.

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that the LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx are the same source) DMA request source. (1) For a separated DMA request source, enable and set the Rx DMAMUX source for `edmaRxRegToRxDataHandle` and Tx DMAMUX source for `edmaTxDataToTxRegHandle`. (2) For a shared DMA request source, enable and set the Rx/Tx DMAMUX source for `edmaRxRegToRxDataHandle`.

#### Parameters

- `base` – LPSPI peripheral base address.
- `handle` – LPSPI handle pointer to `lpspi_master_edma_handle_t`.
- `callback` – LPSPI callback.
- `userData` – callback function parameter.
- `edmaRxRegToRxDataHandle` – `edmaRxRegToRxDataHandle` pointer to `edma_handle_t`.
- `edmaTxDataToTxRegHandle` – `edmaTxDataToTxRegHandle` pointer to `edma_handle_t`.

*status\_t* LPSPI\_MasterTransferEDMA(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, *lpspi\_transfer\_t* \*transfer)

LPSPI master transfer data using eDMA.

This function transfers data using eDMA. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of `bytesPerFrame` if `bytesPerFrame` is less than or equal to 4. For `bytesPerFrame` greater than 4: The transfer data size should be equal to `bytesPerFrame` if the `bytesPerFrame` is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of `bytesPerFrame`.

#### Parameters

- `base` – LPSPI peripheral base address.
- `handle` – pointer to `lpspi_master_edma_handle_t` structure which stores the transfer state.
- `transfer` – pointer to `lpspi_transfer_t` structure.

#### Returns

status of `status_t`.

*status\_t* LPSPI\_MasterTransferPrepareEDMALite(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, `uint32_t` configFlags)

LPSPI master config transfer parameter while using eDMA.

This function is preparing to transfer data using eDMA, work with `LPSPI_MasterTransferEDMALite`.

#### Parameters

- `base` – LPSPI peripheral base address.
- `handle` – pointer to `lpspi_master_edma_handle_t` structure which stores the transfer state.
- `configFlags` – transfer configuration flags. `_lpspi_transfer_config_flag_for_master`.

#### Return values

- `kStatus_Success` – Execution successfully.
- `kStatus_LPSPI_Busy` – The LPSPI device is busy.

**Returns**

Indicates whether LPSPI master transfer was successful or not.

*status\_t* LPSPI\_MasterTransferEDMALite(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, *lpspi\_transfer\_t* \*transfer)

LPSPI master transfer data using eDMA without configs.

This function transfers data using eDMA. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: This API is only for transfer through DMA without configuration. Before calling this API, you must call LPSPI\_MasterTransferPrepareEDMALite to configure it once. The transfer data size should be an integer multiple of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

**Parameters**

- base – LPSPI peripheral base address.
- handle – pointer to *lpspi\_master\_edma\_handle\_t* structure which stores the transfer state.
- transfer – pointer to *lpspi\_transfer\_t* structure, config field is not used.

**Return values**

- kStatus\_Success – Execution successfully.
- kStatus\_LPSPI\_Busy – The LPSPI device is busy.
- kStatus\_InvalidArgument – The transfer structure is invalid.

**Returns**

Indicates whether LPSPI master transfer was successful or not.

void LPSPI\_MasterTransferAbortEDMA(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle)

LPSPI master aborts a transfer which is using eDMA.

This function aborts a transfer which is using eDMA.

**Parameters**

- base – LPSPI peripheral base address.
- handle – pointer to *lpspi\_master\_edma\_handle\_t* structure which stores the transfer state.

*status\_t* LPSPI\_MasterTransferGetCountEDMA(LPSPI\_Type \*base, *lpspi\_master\_edma\_handle\_t* \*handle, *size\_t* \*count)

Gets the master eDMA transfer remaining bytes.

This function gets the master eDMA transfer remaining bytes.

**Parameters**

- base – LPSPI peripheral base address.
- handle – pointer to *lpspi\_master\_edma\_handle\_t* structure which stores the transfer state.
- count – Number of bytes transferred so far by the EDMA transaction.

**Returns**

status of *status\_t*.



```
void LPSPI_SlaveTransferCreateHandleEDMA(LPSPI_Type *base, lpspi_slave_edma_handle_t
 *handle, lpspi_slave_edma_transfer_callback_t
 callback, void *userData, edma_handle_t
 *edmaRxRegToRxDataHandle, edma_handle_t
 *edmaTxDataToTxRegHandle)
```

Initializes the LPSPI slave eDMA handle.

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx as the same source) DMA request source.

(1) For a separated DMA request source, enable and set the Rx DMAMUX source for edmaRxRegToRxDataHandle and Tx DMAMUX source for edmaTxDataToTxRegHandle. (2) For a shared DMA request source, enable and set the Rx/Rx DMAMUX source for edmaRxRegToRxDataHandle .

#### Parameters

- base – LPSPI peripheral base address.
- handle – LPSPI handle pointer to *lpspi\_slave\_edma\_handle\_t*.
- callback – LPSPI callback.
- userData – callback function parameter.
- edmaRxRegToRxDataHandle – edmaRxRegToRxDataHandle pointer to *edma\_handle\_t*.
- edmaTxDataToTxRegHandle – edmaTxDataToTxRegHandle pointer to *edma\_handle\_t*.

```
status_t LPSPI_SlaveTransferEDMA(LPSPI_Type *base, lpspi_slave_edma_handle_t *handle,
 lpspi_transfer_t *transfer)
```

LPSPI slave transfers data using eDMA.

This function transfers data using eDMA. This is a non-blocking function, which return right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

#### Parameters

- base – LPSPI peripheral base address.
- handle – pointer to *lpspi\_slave\_edma\_handle\_t* structure which stores the transfer state.
- transfer – pointer to *lpspi\_transfer\_t* structure.

#### Returns

status of *status\_t*.

```
void LPSPI_SlaveTransferAbortEDMA(LPSPI_Type *base, lpspi_slave_edma_handle_t *handle)
```

LPSPI slave aborts a transfer which is using eDMA.

This function aborts a transfer which is using eDMA.

#### Parameters

- base – LPSPI peripheral base address.

- `handle` – pointer to `lpspi_slave_edma_handle_t` structure which stores the transfer state.

`status_t` LPSPI\_SlaveTransferGetCountEDMA(LPSPI\_Type \*base, *lpspi\_slave\_edma\_handle\_t* \*handle, `size_t` \*count)

Gets the slave eDMA transfer remaining bytes.

This function gets the slave eDMA transfer remaining bytes.

#### Parameters

- `base` – LPSPI peripheral base address.
- `handle` – pointer to `lpspi_slave_edma_handle_t` structure which stores the transfer state.
- `count` – Number of bytes transferred so far by the eDMA transaction.

#### Returns

status of `status_t`.

`struct _lpspi_master_edma_handle`

*#include <fsl\_lpspi\_edma.h>* LPSPI master eDMA transfer handle structure used for transactional API.

#### Public Members

`volatile bool` `isPcsContinuous`

Is PCS continuous in transfer.

`volatile bool` `isByteSwap`

A flag that whether should byte swap.

`volatile uint8_t` `fifoSize`

FIFO dataSize.

`volatile uint8_t` `rxWatermark`

Rx watermark.

`volatile uint8_t` `bytesEachWrite`

Bytes for each write TDR.

`volatile uint8_t` `bytesEachRead`

Bytes for each read RDR.

`volatile uint8_t` `bytesLastRead`

Bytes for last read RDR.

`volatile bool` `isThereExtraRxBytes`

Is there extra RX byte.

`const uint8_t *volatile` `txData`

Send buffer.

`uint8_t *volatile` `rxData`

Receive buffer.

`volatile size_t` `txRemainingByteCount`

Number of bytes remaining to send.

`volatile size_t` `rxRemainingByteCount`

Number of bytes remaining to receive.

`volatile uint32_t writeRegRemainingTimes`  
Write TDR register remaining times.

`volatile uint32_t readRegRemainingTimes`  
Read RDR register remaining times.

`uint32_t totalByteCount`  
Number of transfer bytes

`edma_tcd_t *lastTimeTCD`  
Pointer to the lastTime TCD

`bool isMultiDMATransmit`  
Is there multi DMA transmit

`volatile uint8_t dmaTransmitTime`  
DMA Transfer times.

`uint32_t lastTimeDataBytes`  
DMA transmit last Time data Bytes

`uint32_t dataBytesEveryTime`  
Bytes in a time for DMA transfer, default is DMA\_MAX\_TRANSFER\_COUNT

`edma_transfer_config_t transferConfigRx`  
Config of DMA rx channel.

`edma_transfer_config_t transferConfigTx`  
Config of DMA tx channel.

`uint32_t txBuffIfNull`  
Used if there is not txData for DMA purpose.

`uint32_t rxBuffIfNull`  
Used if there is not rxData for DMA purpose.

`uint32_t transmitCommand`  
Used to write TCR for DMA purpose.

`volatile uint8_t state`  
LPSPI transfer state , `_lpspi_transfer_state`.

`uint8_t nbytes`  
eDMA minor byte transfer count initially configured.

`lpspi_master_edma_transfer_callback_t callback`  
Completion callback.

`void *userData`  
Callback user data.

`edma_handle_t *edmaRxRegToRxDataHandle`  
edma\_handle\_t handle point used for RxReg to RxData buff

`edma_handle_t *edmaTxDataToTxRegHandle`  
edma\_handle\_t handle point used for TxData to TxReg buff

`edma_tcd_t lpspiSoftwareTCD[3]`  
SoftwareTCD, internal used

`struct _lpspi_slave_edma_handle`  
`#include <fsl_lpspi_edma.h>` LPSPI slave eDMA transfer handle structure used for transactional API.

## Public Members

volatile bool isByteSwap

A flag that whether should byte swap.

volatile uint8\_t fifoSize

FIFO dataSize.

volatile uint8\_t rxWatermark

Rx watermark.

volatile uint8\_t bytesEachWrite

Bytes for each write TDR.

volatile uint8\_t bytesEachRead

Bytes for each read RDR.

volatile uint8\_t bytesLastRead

Bytes for last read RDR.

volatile bool isThereExtraRxBytes

Is there extra RX byte.

uint8\_t nbytes

eDMA minor byte transfer count initially configured.

const uint8\_t \*volatile txData

Send buffer.

uint8\_t \*volatile rxData

Receive buffer.

volatile size\_t txRemainingByteCount

Number of bytes remaining to send.

volatile size\_t rxRemainingByteCount

Number of bytes remaining to receive.

volatile uint32\_t writeRegRemainingTimes

Write TDR register remaining times.

volatile uint32\_t readRegRemainingTimes

Read RDR register remaining times.

uint32\_t totalByteCount

Number of transfer bytes

uint32\_t txBuffIfNull

Used if there is not txData for DMA purpose.

uint32\_t rxBuffIfNull

Used if there is not rxData for DMA purpose.

volatile uint8\_t state

LPSPi transfer state.

uint32\_t errorCount

Error count for slave transfer.

*lpspi\_slave\_edma\_transfer\_callback\_t* callback

Completion callback.

`void *userData`

Callback user data.

`edma_handle_t *edmaRxRegToRxDataHandle`

`edma_handle_t` handle point used for RxReg to RxData buff

`edma_handle_t *edmaTxDataToTxRegHandle`

`edma_handle_t` handle point used for TxData to TxReg

`edma_tcd_t` `lpspiSoftwareTCD[2]`

SoftwareTCD, internal used

## 2.51 LPTMR: Low-Power Timer

`void LPTMR_Init(LPTMR_Type *base, const lptmr_config_t *config)`

Ungates the LPTMR clock and configures the peripheral for a basic operation.

---

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

---

### Parameters

- `base` – LPTMR peripheral base address
- `config` – A pointer to the LPTMR configuration structure.

`void LPTMR_Deinit(LPTMR_Type *base)`

Gates the LPTMR clock.

### Parameters

- `base` – LPTMR peripheral base address

`void LPTMR_GetDefaultConfig(lptmr_config_t *config)`

Fills in the LPTMR configuration structure with default settings.

The default values are as follows.

```
config->timerMode = kLPTMR_TimerModeTimeCounter;
config->pinSelect = kLPTMR_PinSelectInput_0;
config->pinPolarity = kLPTMR_PinPolarityActiveHigh;
config->enableFreeRunning = false;
config->bypassPrescaler = true;
config->prescalerClockSource = kLPTMR_PrescalerClock_1;
config->value = kLPTMR_Prescale_Glitch_0;
```

### Parameters

- `config` – A pointer to the LPTMR configuration structure.

`static inline void LPTMR_EnableInterrupts(LPTMR_Type *base, uint32_t mask)`

Enables the selected LPTMR interrupts.

### Parameters

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

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

Disables the selected LPTMR interrupts.

**Parameters**

- base – LPTMR peripheral base address
- mask – The interrupts to disable. This is a logical OR of members of the enumeration `lptmr_interrupt_enable_t`.

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

Gets the enabled LPTMR interrupts.

**Parameters**

- base – LPTMR peripheral base address

**Returns**

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

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

Gets the LPTMR status flags.

**Parameters**

- base – LPTMR peripheral base address

**Returns**

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

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

Clears the LPTMR status flags.

**Parameters**

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

static inline void LPTMR\_SetTimerPeriod(LPTMR\_Type \*base, uint32\_t ticks)

Sets the timer period in units of count.

Timers counts from 0 until it equals the count value set here. The count value is written to the CMR register.

---

**Note:**

- a. The TCF flag is set with the CNR equals the count provided here and then increments.
  - b. Call the utility macros provided in the `fsl_common.h` to convert to ticks.
- 

**Parameters**

- base – LPTMR peripheral base address
- ticks – A timer period in units of ticks

static inline uint32\_t LPTMR\_GetCurrentTimerCount(LPTMR\_Type \*base)

Reads the current timer counting value.

This function returns the real-time timer counting value in a range from 0 to a timer period.

---

**Note:** Call the utility macros provided in the `fsl_common.h` to convert ticks to usec or msec.

---

**Parameters**

- base – LPTMR peripheral base address

**Returns**

The current counter value in ticks

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

Starts the timer.

After calling this function, the timer counts up to the CMR register value. Each time the timer reaches the CMR value and then increments, it generates a trigger pulse and sets the timeout interrupt flag. An interrupt is also triggered if the timer interrupt is enabled.

**Parameters**

- base – LPTMR peripheral base address

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

Stops the timer.

This function stops the timer and resets the timer's counter register.

**Parameters**

- base – LPTMR peripheral base address

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Driver Version

enum \_lptmr\_pin\_select

LPTMR pin selection used in pulse counter mode.

*Values:*

enumerator kLPTMR\_PinSelectInput\_0

Pulse counter input 0 is selected

enumerator kLPTMR\_PinSelectInput\_1

Pulse counter input 1 is selected

enumerator kLPTMR\_PinSelectInput\_2

Pulse counter input 2 is selected

enumerator kLPTMR\_PinSelectInput\_3

Pulse counter input 3 is selected

enum \_lptmr\_pin\_polarity

LPTMR pin polarity used in pulse counter mode.

*Values:*

enumerator kLPTMR\_PinPolarityActiveHigh

Pulse Counter input source is active-high

enumerator kLPTMR\_PinPolarityActiveLow

Pulse Counter input source is active-low

enum \_lptmr\_timer\_mode

LPTMR timer mode selection.

*Values:*

enumerator kLPTMR\_TimerModeTimeCounter

Time Counter mode

enumerator kLPTMR\_TimerModePulseCounter  
Pulse Counter mode

enum \_lptmr\_prescaler\_glitch\_value  
LPTMR prescaler/glitch filter values.

*Values:*

enumerator kLPTMR\_Prescale\_Glitch\_0  
Prescaler divide 2, glitch filter does not support this setting

enumerator kLPTMR\_Prescale\_Glitch\_1  
Prescaler divide 4, glitch filter 2

enumerator kLPTMR\_Prescale\_Glitch\_2  
Prescaler divide 8, glitch filter 4

enumerator kLPTMR\_Prescale\_Glitch\_3  
Prescaler divide 16, glitch filter 8

enumerator kLPTMR\_Prescale\_Glitch\_4  
Prescaler divide 32, glitch filter 16

enumerator kLPTMR\_Prescale\_Glitch\_5  
Prescaler divide 64, glitch filter 32

enumerator kLPTMR\_Prescale\_Glitch\_6  
Prescaler divide 128, glitch filter 64

enumerator kLPTMR\_Prescale\_Glitch\_7  
Prescaler divide 256, glitch filter 128

enumerator kLPTMR\_Prescale\_Glitch\_8  
Prescaler divide 512, glitch filter 256

enumerator kLPTMR\_Prescale\_Glitch\_9  
Prescaler divide 1024, glitch filter 512

enumerator kLPTMR\_Prescale\_Glitch\_10  
Prescaler divide 2048 glitch filter 1024

enumerator kLPTMR\_Prescale\_Glitch\_11  
Prescaler divide 4096, glitch filter 2048

enumerator kLPTMR\_Prescale\_Glitch\_12  
Prescaler divide 8192, glitch filter 4096

enumerator kLPTMR\_Prescale\_Glitch\_13  
Prescaler divide 16384, glitch filter 8192

enumerator kLPTMR\_Prescale\_Glitch\_14  
Prescaler divide 32768, glitch filter 16384

enumerator kLPTMR\_Prescale\_Glitch\_15  
Prescaler divide 65536, glitch filter 32768

enum \_lptmr\_prescaler\_clock\_select  
LPTMR prescaler/glitch filter clock select.

---

**Note:** Clock connections are SoC-specific

---

*Values:*



enum `_lptmr_interrupt_enable`

List of the LPTMR interrupts.

*Values:*

enumerator `kLPTMR_TimerInterruptEnable`

Timer interrupt enable

enum `_lptmr_status_flags`

List of the LPTMR status flags.

*Values:*

enumerator `kLPTMR_TimerCompareFlag`

Timer compare flag

typedef enum `_lptmr_pin_select` `lptmr_pin_select_t`

LPTMR pin selection used in pulse counter mode.

typedef enum `_lptmr_pin_polarity` `lptmr_pin_polarity_t`

LPTMR pin polarity used in pulse counter mode.

typedef enum `_lptmr_timer_mode` `lptmr_timer_mode_t`

LPTMR timer mode selection.

typedef enum `_lptmr_prescaler_glitch_value` `lptmr_prescaler_glitch_value_t`

LPTMR prescaler/glitch filter values.

typedef enum `_lptmr_prescaler_clock_select` `lptmr_prescaler_clock_select_t`

LPTMR prescaler/glitch filter clock select.

---

**Note:** Clock connections are SoC-specific

---

typedef enum `_lptmr_interrupt_enable` `lptmr_interrupt_enable_t`

List of the LPTMR interrupts.

typedef enum `_lptmr_status_flags` `lptmr_status_flags_t`

List of the LPTMR status flags.

typedef struct `_lptmr_config` `lptmr_config_t`

LPTMR config structure.

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

The configuration struct can be made constant so it resides in flash.

static inline void `LPTMR_EnableTimerDMA(LPTMR_Type *base, bool enable)`

Enable or disable timer DMA request.

#### Parameters

- `base` – base LPTMR peripheral base address
- `enable` – Switcher of timer DMA feature. “true” means to enable, “false” means to disable.

struct `_lptmr_config`

`#include <fsl_lptmr.h>` LPTMR config structure.

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

The configuration struct can be made constant so it resides in flash.

### Public Members

*lptmr\_timer\_mode\_t* timerMode

Time counter mode or pulse counter mode

*lptmr\_pin\_select\_t* pinSelect

LPTMR pulse input pin select; used only in pulse counter mode

*lptmr\_pin\_polarity\_t* pinPolarity

LPTMR pulse input pin polarity; used only in pulse counter mode

bool enableFreeRunning

True: enable free running, counter is reset on overflow False: counter is reset when the compare flag is set

bool bypassPrescaler

True: bypass prescaler; false: use clock from prescaler

*lptmr\_prescaler\_clock\_select\_t* prescalerClockSource

LPTMR clock source

*lptmr\_prescaler\_glitch\_value\_t* value

Prescaler or glitch filter value

## 2.52 LPUART: Low Power Universal Asynchronous Receiver/Transmitter Driver

### 2.53 LPUART Driver

static inline void LPUART\_SoftwareReset(LPUART\_Type \*base)

Resets the LPUART using software.

This function resets all internal logic and registers except the Global Register. Remains set until cleared by software.

#### Parameters

- base – LPUART peripheral base address.

*status\_t* LPUART\_Init(LPUART\_Type \*base, const *lpuart\_config\_t* \*config, uint32\_t srcClock\_Hz)

Initializes an LPUART instance with the user configuration structure and the peripheral clock.

This function configures the LPUART module with user-defined settings. Call the LPUART\_GetDefaultConfig() function to configure the configuration structure and get the default configuration. The example below shows how to use this API to configure the LPUART.

```
lpuart_config_t lpuartConfig;
lpuartConfig.baudRate_Bps = 115200U;
lpuartConfig.parityMode = kLPUART_ParityDisabled;
lpuartConfig.dataBitsCount = kLPUART_EightDataBits;
lpuartConfig.isMsb = false;
lpuartConfig.stopBitCount = kLPUART_OneStopBit;
lpuartConfig.txFifoWatermark = 0;
```

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```
lpuartConfig.rxFifoWatermark = 1;
LPUART_Init(LPUART1, &lpuartConfig, 20000000U);
```

**Parameters**

- base – LPUART peripheral base address.
- config – Pointer to a user-defined configuration structure.
- srcClock\_Hz – LPUART clock source frequency in HZ.

**Return values**

- kStatus\_LPUART\_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus\_Success – LPUART initialize succeed

*status\_t* LPUART\_Deinit(LPUART\_Type \*base)

Deinitializes a LPUART instance.

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

**Parameters**

- base – LPUART peripheral base address.

**Return values**

- kStatus\_Success – Deinit is success.
- kStatus\_LPUART\_Timeout – Timeout during deinit.

void LPUART\_GetDefaultConfig(*lpuart\_config\_t* \*config)

Gets the default configuration structure.

This function initializes the LPUART configuration structure to a default value. The default values are: lpuartConfig->baudRate\_Bps = 115200U; lpuartConfig->parityMode = kLPUART\_ParityDisabled; lpuartConfig->dataBitsCount = kLPUART\_EightDataBits; lpuartConfig->isMsb = false; lpuartConfig->stopBitCount = kLPUART\_OneStopBit; lpuartConfig->txFifoWatermark = 0; lpuartConfig->rxFifoWatermark = 1; lpuartConfig->rxIdleType = kLPUART\_IdleTypeStartBit; lpuartConfig->rxIdleConfig = kLPUART\_IdleCharacter1; lpuartConfig->enableTx = false; lpuartConfig->enableRx = false;

**Parameters**

- config – Pointer to a configuration structure.

*status\_t* LPUART\_SetBaudRate(LPUART\_Type \*base, uint32\_t baudRate\_Bps, uint32\_t srcClock\_Hz)

Sets the LPUART instance baudrate.

This function configures the LPUART module baudrate. This function is used to update the LPUART module baudrate after the LPUART module is initialized by the LPUART\_Init.

```
LPUART_SetBaudRate(LPUART1, 115200U, 20000000U);
```

**Parameters**

- base – LPUART peripheral base address.
- baudRate\_Bps – LPUART baudrate to be set.
- srcClock\_Hz – LPUART clock source frequency in HZ.

**Return values**

- kStatus\_LPUART\_BaudrateNotSupport – Baudrate is not supported in the current clock source.
- kStatus\_Success – Set baudrate succeeded.

void LPUART\_Enable9bitMode(LPUART\_Type \*base, bool enable)

Enable 9-bit data mode for LPUART.

This function set the 9-bit mode for LPUART module. The 9th bit is not used for parity thus can be modified by user.

#### Parameters

- base – LPUART peripheral base address.
- enable – true to enable, false to disable.

static inline void LPUART\_SetMatchAddress(LPUART\_Type \*base, uint16\_t address1, uint16\_t address2)

Set the LPUART address.

This function configures the address for LPUART module that works as slave in 9-bit data mode. One or two address fields can be configured. When the address field's match enable bit is set, the frame it receives with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer; otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

---

**Note:** Any LPUART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

---

#### Parameters

- base – LPUART peripheral base address.
- address1 – LPUART slave address1.
- address2 – LPUART slave address2.

static inline void LPUART\_EnableMatchAddress(LPUART\_Type \*base, bool match1, bool match2)

Enable the LPUART match address feature.

#### Parameters

- base – LPUART peripheral base address.
- match1 – true to enable match address1, false to disable.
- match2 – true to enable match address2, false to disable.

static inline void LPUART\_SetRxFifoWatermark(LPUART\_Type \*base, uint8\_t water)

Sets the rx FIFO watermark.

#### Parameters

- base – LPUART peripheral base address.
- water – Rx FIFO watermark.

static inline void LPUART\_SetTxFifoWatermark(LPUART\_Type \*base, uint8\_t water)

Sets the tx FIFO watermark.

#### Parameters

- base – LPUART peripheral base address.
- water – Tx FIFO watermark.

static inline void LPUART\_TransferEnable16Bit(*lpuart\_handle\_t* \*handle, bool enable)

Sets the LPUART using 16bit transmit, only for 9bit or 10bit mode.

This function Enable 16bit Data transmit in *lpuart\_handle\_t*.

#### Parameters

- handle – LPUART handle pointer.
- enable – true to enable, false to disable.

uint32\_t LPUART\_GetStatusFlags(LPUART\_Type \*base)

Gets LPUART status flags.

This function gets all LPUART status flags. The flags are returned as the logical OR value of the enumerators *\_lpuart\_flags*. To check for a specific status, compare the return value with enumerators in the *\_lpuart\_flags*. For example, to check whether the TX is empty:

```
if (kLPUART_TxDataRegEmptyFlag & LPUART_GetStatusFlags(LPUART1))
{
 ...
}
```

#### Parameters

- base – LPUART peripheral base address.

#### Returns

LPUART status flags which are Ored by the enumerators in the *\_lpuart\_flags*.

*status\_t* LPUART\_ClearStatusFlags(LPUART\_Type \*base, uint32\_t mask)

Clears status flags with a provided mask.

This function clears LPUART status flags with a provided mask. Automatically cleared flags can't be cleared by this function. Flags that can only cleared or set by hardware are: *kLPUART\_TxDataRegEmptyFlag*, *kLPUART\_TransmissionCompleteFlag*, *kLPUART\_RxDataRegFullFlag*, *kLPUART\_RxActiveFlag*, *kLPUART\_NoiseErrorFlag*, *kLPUART\_ParityErrorFlag*, *kLPUART\_TxFifoEmptyFlag*, *kLPUART\_RxFifoEmptyFlag* Note: This API should be called when the Tx/Rx is idle, otherwise it takes no effects.

#### Parameters

- base – LPUART peripheral base address.
- mask – the status flags to be cleared. The user can use the enumerators in the *\_lpuart\_status\_flag\_t* to do the OR operation and get the mask.

#### Return values

- *kStatus\_LPUART\_FlagCannotClearManually* – The flag can't be cleared by this function but it is cleared automatically by hardware.
- *kStatus\_Success* – Status in the mask are cleared.

#### Returns

0 succeed, others failed.

void LPUART\_EnableInterrupts(LPUART\_Type \*base, uint32\_t mask)

Enables LPUART interrupts according to a provided mask.

This function enables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See the *\_lpuart\_interrupt\_enable*. This examples shows how to enable TX empty interrupt and RX full interrupt:

```
LPUART_EnableInterrupts(LPUART1, kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↳ RxDataRegFullInterruptEnable);
```

### Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to enable. Logical OR of `_lpuart_interrupt_enable`.

```
void LPUART_DisableInterrupts(LPUART_Type *base, uint32_t mask)
```

Disables LPUART interrupts according to a provided mask.

This function disables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See `_lpuart_interrupt_enable`. This example shows how to disable the TX empty interrupt and RX full interrupt:

```
LPUART_DisableInterrupts(LPUART1, kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↳ RxDataRegFullInterruptEnable);
```

### Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to disable. Logical OR of `_lpuart_interrupt_enable`.

```
uint32_t LPUART_GetEnabledInterrupts(LPUART_Type *base)
```

Gets enabled LPUART interrupts.

This function gets the enabled LPUART interrupts. The enabled interrupts are returned as the logical OR value of the enumerators `_lpuart_interrupt_enable`. To check a specific interrupt enable status, compare the return value with enumerators in `_lpuart_interrupt_enable`. For example, to check whether the TX empty interrupt is enabled:

```
uint32_t enabledInterrupts = LPUART_GetEnabledInterrupts(LPUART1);

if (kLPUART_TxDataRegEmptyInterruptEnable & enabledInterrupts)
{
 ...
}
```

### Parameters

- base – LPUART peripheral base address.

### Returns

LPUART interrupt flags which are logical OR of the enumerators in `_lpuart_interrupt_enable`.

```
static inline uintptr_t LPUART_GetDataRegisterAddress(LPUART_Type *base)
```

Gets the LPUART data register address.

This function returns the LPUART data register address, which is mainly used by the DMA/eDMA.

### Parameters

- base – LPUART peripheral base address.

### Returns

LPUART data register addresses which are used both by the transmitter and receiver.

```
static inline void LPUART_EnableTxDMA(LPUART_Type *base, bool enable)
```

Enables or disables the LPUART transmitter DMA request.

This function enables or disables the transmit data register empty flag, STAT[TDRE], to generate DMA requests.

**Parameters**

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

```
static inline void LPUART_EnableRxDMA(LPUART_Type *base, bool enable)
```

Enables or disables the LPUART receiver DMA.

This function enables or disables the receiver data register full flag, STAT[RDRF], to generate DMA requests.

**Parameters**

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

```
uint32_t LPUART_GetInstance(LPUART_Type *base)
```

Get the LPUART instance from peripheral base address.

**Parameters**

- base – LPUART peripheral base address.

**Returns**

LPUART instance.

```
static inline void LPUART_EnableTx(LPUART_Type *base, bool enable)
```

Enables or disables the LPUART transmitter.

This function enables or disables the LPUART transmitter.

**Parameters**

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

```
static inline void LPUART_EnableRx(LPUART_Type *base, bool enable)
```

Enables or disables the LPUART receiver.

This function enables or disables the LPUART receiver.

**Parameters**

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

```
static inline void LPUART_WriteByte(LPUART_Type *base, uint8_t data)
```

Writes to the transmitter register.

This function writes data to the transmitter register directly. The upper layer must ensure that the TX register is empty or that the TX FIFO has room before calling this function.

**Parameters**

- base – LPUART peripheral base address.
- data – Data write to the TX register.

static inline uint8\_t LPUART\_ReadByte(LPUART\_Type \*base)

Reads the receiver register.

This function reads data from the receiver register directly. The upper layer must ensure that the receiver register is full or that the RX FIFO has data before calling this function.

**Parameters**

- base – LPUART peripheral base address.

**Returns**

Data read from data register.

static inline uint8\_t LPUART\_GetRxFifoCount(LPUART\_Type \*base)

Gets the rx FIFO data count.

**Parameters**

- base – LPUART peripheral base address.

**Returns**

rx FIFO data count.

static inline uint8\_t LPUART\_GetTxFifoCount(LPUART\_Type \*base)

Gets the tx FIFO data count.

**Parameters**

- base – LPUART peripheral base address.

**Returns**

tx FIFO data count.

void LPUART\_SendAddress(LPUART\_Type \*base, uint8\_t address)

Transmit an address frame in 9-bit data mode.

**Parameters**

- base – LPUART peripheral base address.
- address – LPUART slave address.

status\_t LPUART\_WriteBlocking(LPUART\_Type \*base, const uint8\_t \*data, size\_t length)

Writes to the transmitter register using a blocking method.

This function polls the transmitter register, first waits for the register to be empty or TX FIFO to have room, and writes data to the transmitter buffer, then waits for the data to be sent out to the bus.

**Parameters**

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

**Return values**

- kStatus\_LPUART\_Timeout – Transmission timed out and was aborted.
- kStatus\_Success – Successfully wrote all data.

status\_t LPUART\_WriteBlocking16bit(LPUART\_Type \*base, const uint16\_t \*data, size\_t length)

Writes to the transmitter register using a blocking method in 9bit or 10bit mode.

---

**Note:** This function only support 9bit or 10bit transfer. Please make sure only 10bit of data is valid and other bits are 0.

---



**Parameters**

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

**Return values**

- kStatus\_LPUART\_Timeout – Transmission timed out and was aborted.
- kStatus\_Success – Successfully wrote all data.

*status\_t* LPUART\_ReadBlocking(LPUART\_Type \*base, uint8\_t \*data, size\_t length)

Reads the receiver data register using a blocking method.

This function polls the receiver register, waits for the receiver register full or receiver FIFO has data, and reads data from the TX register.

**Parameters**

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

**Return values**

- kStatus\_LPUART\_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus\_LPUART\_NoiseError – Noise error happened while receiving data.
- kStatus\_LPUART\_FramingError – Framing error happened while receiving data.
- kStatus\_LPUART\_ParityError – Parity error happened while receiving data.
- kStatus\_LPUART\_Timeout – Transmission timed out and was aborted.
- kStatus\_Success – Successfully received all data.

*status\_t* LPUART\_ReadBlocking16bit(LPUART\_Type \*base, uint16\_t \*data, size\_t length)

Reads the receiver data register in 9bit or 10bit mode.

---

**Note:** This function only support 9bit or 10bit transfer.

---

**Parameters**

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data by 16bit, only 10bit is valid.
- length – Size of the buffer.

**Return values**

- kStatus\_LPUART\_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus\_LPUART\_NoiseError – Noise error happened while receiving data.
- kStatus\_LPUART\_FramingError – Framing error happened while receiving data.

- `kStatus_LPUART_ParityError` – Parity error happened while receiving data.
- `kStatus_LPUART_Timeout` – Transmission timed out and was aborted.
- `kStatus_Success` – Successfully received all data.

```
void LPUART__TransferCreateHandle(LPUART_Type *base, lpuart_handle_t *handle,
 lpuart_transfer_callback_t callback, void *userData)
```

Initializes the LPUART handle.

This function initializes the LPUART handle, which can be used for other LPUART transactional APIs. Usually, for a specified LPUART instance, call this API once to get the initialized handle.

The LPUART driver supports the “background” receiving, which means that user can set up an RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn’t call the `LPUART_TransferReceiveNonBlocking()` API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as `ringBuffer`.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.
- `callback` – Callback function.
- `userData` – User data.

```
status_t LPUART__TransferSendNonBlocking(LPUART_Type *base, lpuart_handle_t *handle,
 lpuart_transfer_t *xfer)
```

Transmits a buffer of data using the interrupt method.

This function send data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data written to the transmitter register. When all data is written to the TX register in the ISR, the LPUART driver calls the callback function and passes the `kStatus_LPUART_TxIdle` as status parameter.

---

**Note:** The `kStatus_LPUART_TxIdle` is passed to the upper layer when all data are written to the TX register. However, there is no check to ensure that all the data sent out. Before disabling the TX, check the `kLPUART_TransmissionCompleteFlag` to ensure that the transmit is finished.

---

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.
- `xfer` – LPUART transfer structure, see `lpuart_transfer_t`.

#### Return values

- `kStatus_Success` – Successfully start the data transmission.
- `kStatus_LPUART_TxBusy` – Previous transmission still not finished, data not all written to the TX register.
- `kStatus_InvalidArgument` – Invalid argument.

```
void LPUART__TransferStartRingBuffer(LPUART_Type *base, lpuart_handle_t *handle, uint8_t
 *ringBuffer, size_t ringBufferSize)
```

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn't call the `UART_TransferReceiveNonBlocking()` API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly.

---

**Note:** When using RX ring buffer, one byte is reserved for internal use. In other words, if `ringBufferSize` is 32, then only 31 bytes are used for saving data.

---

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.
- `ringBuffer` – Start address of ring buffer for background receiving. Pass `NULL` to disable the ring buffer.
- `ringBufferSize` – size of the ring buffer.

`void LPUART__TransferStopRingBuffer(LPUART_Type *base, lpuart_handle_t *handle)`

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.

`size_t LPUART__TransferGetRxRingBufferLength(LPUART_Type *base, lpuart_handle_t *handle)`

Get the length of received data in RX ring buffer.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.

#### Returns

Length of received data in RX ring buffer.

`void LPUART__TransferAbortSend(LPUART_Type *base, lpuart_handle_t *handle)`

Aborts the interrupt-driven data transmit.

This function aborts the interrupt driven data sending. The user can get the `remainBtyes` to find out how many bytes are not sent out.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.

`status_t LPUART__TransferGetSendCount(LPUART_Type *base, lpuart_handle_t *handle, uint32_t *count)`

Gets the number of bytes that have been sent out to bus.

This function gets the number of bytes that have been sent out to bus by an interrupt method.

#### Parameters

- `base` – LPUART peripheral base address.

- `handle` – LPUART handle pointer.
- `count` – Send bytes count.

#### Return values

- `kStatus_NoTransferInProgress` – No send in progress.
- `kStatus_InvalidArgument` – Parameter is invalid.
- `kStatus_Success` – Get successfully through the parameter `count`;

`status_t` LPUART\_TransferReceiveNonBlocking(LPUART\_Type \*base, *lpuart\_handle\_t* \*handle, *lpuart\_transfer\_t* \*xfer, `size_t` \*receivedBytes)

Receives a buffer of data using the interrupt method.

This function receives data using an interrupt method. This is a non-blocking function which returns without waiting to ensure that all data are received. If the RX ring buffer is used and not empty, the data in the ring buffer is copied and the parameter `receivedBytes` shows how many bytes are copied from the ring buffer. After copying, if the data in the ring buffer is not enough for read, the receive request is saved by the LPUART driver. When the new data arrives, the receive request is serviced first. When all data is received, the LPUART driver notifies the upper layer through a callback function and passes a status parameter `kStatus_UART_RxIdle`. For example, the upper layer needs 10 bytes but there are only 5 bytes in ring buffer. The 5 bytes are copied to `xfer->data`, which returns with the parameter `receivedBytes` set to 5. For the remaining 5 bytes, the newly arrived data is saved from `xfer->data[5]`. When 5 bytes are received, the LPUART driver notifies the upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to `xfer->data`. When all data is received, the upper layer is notified.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.
- `xfer` – LPUART transfer structure, see `uart_transfer_t`.
- `receivedBytes` – Bytes received from the ring buffer directly.

#### Return values

- `kStatus_Success` – Successfully queue the transfer into the transmit queue.
- `kStatus_LPUART_RxBusy` – Previous receive request is not finished.
- `kStatus_InvalidArgument` – Invalid argument.

`void` LPUART\_TransferAbortReceive(LPUART\_Type \*base, *lpuart\_handle\_t* \*handle)

Aborts the interrupt-driven data receiving.

This function aborts the interrupt-driven data receiving. The user can get the `remainBytes` to find out how many bytes not received yet.

#### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.

`status_t` LPUART\_TransferGetReceiveCount(LPUART\_Type \*base, *lpuart\_handle\_t* \*handle, `uint32_t` \*count)

Gets the number of bytes that have been received.

This function gets the number of bytes that have been received.

#### Parameters

- `base` – LPUART peripheral base address.

- handle – LPUART handle pointer.
- count – Receive bytes count.

**Return values**

- kStatus\_NoTransferInProgress – No receive in progress.
- kStatus\_InvalidArgument – Parameter is invalid.
- kStatus\_Success – Get successfully through the parameter count;

void LPUART\_TransferHandleIRQ(LPUART\_Type \*base, void \*irqHandle)  
LPUART IRQ handle function.

This function handles the LPUART transmit and receive IRQ request.

**Parameters**

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART\_TransferHandleErrorIRQ(LPUART\_Type \*base, void \*irqHandle)  
LPUART Error IRQ handle function.

This function handles the LPUART error IRQ request.

**Parameters**

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART\_DriverIRQHandler(uint32\_t instance)  
LPUART driver IRQ handler common entry.

This function provides the common IRQ request entry for LPUART.

**Parameters**

- instance – LPUART instance.

FSL\_LPUART\_DRIVER\_VERSION  
LPUART driver version.

Error codes for the LPUART driver.

*Values:*

enumerator kStatus\_LPUART\_TxBusy  
TX busy

enumerator kStatus\_LPUART\_RxBusy  
RX busy

enumerator kStatus\_LPUART\_TxIdle  
LPUART transmitter is idle.

enumerator kStatus\_LPUART\_RxIdle  
LPUART receiver is idle.

enumerator kStatus\_LPUART\_TxWatermarkTooLarge  
TX FIFO watermark too large

enumerator kStatus\_LPUART\_RxWatermarkTooLarge  
RX FIFO watermark too large

enumerator kStatus\_LPUART\_FlagCannotClearManually  
Some flag can't manually clear

enumerator kStatus\_LPUART\_Error  
Error happens on LPUART.

enumerator kStatus\_LPUART\_RxRingBufferOverrun  
LPUART RX software ring buffer overrun.

enumerator kStatus\_LPUART\_RxHardwareOverrun  
LPUART RX receiver overrun.

enumerator kStatus\_LPUART\_NoiseError  
LPUART noise error.

enumerator kStatus\_LPUART\_FramingError  
LPUART framing error.

enumerator kStatus\_LPUART\_ParityError  
LPUART parity error.

enumerator kStatus\_LPUART\_BaudrateNotSupport  
Baudrate is not support in current clock source

enumerator kStatus\_LPUART\_IdleLineDetected  
IDLE flag.

enumerator kStatus\_LPUART\_Timeout  
LPUART times out.

enum \_lpuart\_parity\_mode  
LPUART parity mode.

*Values:*

enumerator kLPUART\_ParityDisabled  
Parity disabled

enumerator kLPUART\_ParityEven  
Parity enabled, type even, bit setting: PE | PT = 10

enumerator kLPUART\_ParityOdd  
Parity enabled, type odd, bit setting: PE | PT = 11

enum \_lpuart\_data\_bits  
LPUART data bits count.

*Values:*

enumerator kLPUART\_EightDataBits  
Eight data bit

enumerator kLPUART\_SevenDataBits  
Seven data bit

enum \_lpuart\_stop\_bit\_count  
LPUART stop bit count.

*Values:*

enumerator kLPUART\_OneStopBit  
One stop bit

enumerator kLPUART\_TwoStopBit

Two stop bits

enum \_lpuart\_transmit\_cts\_source

LPUART transmit CTS source.

*Values:*

enumerator kLPUART\_CtsSourcePin

CTS resource is the LPUART\_CTS pin.

enumerator kLPUART\_CtsSourceMatchResult

CTS resource is the match result.

enum \_lpuart\_transmit\_cts\_config

LPUART transmit CTS configure.

*Values:*

enumerator kLPUART\_CtsSampleAtStart

CTS input is sampled at the start of each character.

enumerator kLPUART\_CtsSampleAtIdle

CTS input is sampled when the transmitter is idle

enum \_lpuart\_idle\_type\_select

LPUART idle flag type defines when the receiver starts counting.

*Values:*

enumerator kLPUART\_IdleTypeStartBit

Start counting after a valid start bit.

enumerator kLPUART\_IdleTypeStopBit

Start counting after a stop bit.

enum \_lpuart\_idle\_config

LPUART idle detected configuration. This structure defines the number of idle characters that must be received before the IDLE flag is set.

*Values:*

enumerator kLPUART\_IdleCharacter1

the number of idle characters.

enumerator kLPUART\_IdleCharacter2

the number of idle characters.

enumerator kLPUART\_IdleCharacter4

the number of idle characters.

enumerator kLPUART\_IdleCharacter8

the number of idle characters.

enumerator kLPUART\_IdleCharacter16

the number of idle characters.

enumerator kLPUART\_IdleCharacter32

the number of idle characters.

enumerator kLPUART\_IdleCharacter64

the number of idle characters.

enumerator kLPUART\_IdleCharacter128  
the number of idle characters.

enum \_lpuart\_interrupt\_enable

LPUART interrupt configuration structure, default settings all disabled.

This structure contains the settings for all LPUART interrupt configurations.

*Values:*

enumerator kLPUART\_LinBreakInterruptEnable  
LIN break detect. bit 7

enumerator kLPUART\_RxActiveEdgeInterruptEnable  
Receive Active Edge. bit 6

enumerator kLPUART\_TxDataRegEmptyInterruptEnable  
Transmit data register empty. bit 23

enumerator kLPUART\_TransmissionCompleteInterruptEnable  
Transmission complete. bit 22

enumerator kLPUART\_RxDataRegFullInterruptEnable  
Receiver data register full. bit 21

enumerator kLPUART\_IdleLineInterruptEnable  
Idle line. bit 20

enumerator kLPUART\_RxOverrunInterruptEnable  
Receiver Overrun. bit 27

enumerator kLPUART\_NoiseErrorInterruptEnable  
Noise error flag. bit 26

enumerator kLPUART\_FramingErrorInterruptEnable  
Framing error flag. bit 25

enumerator kLPUART\_ParityErrorInterruptEnable  
Parity error flag. bit 24

enumerator kLPUART\_Match1InterruptEnable  
Parity error flag. bit 15

enumerator kLPUART\_Match2InterruptEnable  
Parity error flag. bit 14

enumerator kLPUART\_TxFifoOverflowInterruptEnable  
Transmit FIFO Overflow. bit 9

enumerator kLPUART\_RxFifoUnderflowInterruptEnable  
Receive FIFO Underflow. bit 8

enumerator kLPUART\_AllInterruptEnable

enum \_lpuart\_flags

LPUART status flags.

This provides constants for the LPUART status flags for use in the LPUART functions.

*Values:*

enumerator kLPUART\_TxDataRegEmptyFlag  
Transmit data register empty flag, sets when transmit buffer is empty. bit 23



enumerator kLPUART\_TransmissionCompleteFlag

Transmission complete flag, sets when transmission activity complete. bit 22

enumerator kLPUART\_RxDataRegFullFlag

Receive data register full flag, sets when the receive data buffer is full. bit 21

enumerator kLPUART\_IdleLineFlag

Idle line detect flag, sets when idle line detected. bit 20

enumerator kLPUART\_RxOverrunFlag

Receive Overrun, sets when new data is received before data is read from receive register. bit 19

enumerator kLPUART\_NoiseErrorFlag

Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets. bit 18

enumerator kLPUART\_FramingErrorFlag

Frame error flag, sets if logic 0 was detected where stop bit expected. bit 17

enumerator kLPUART\_ParityErrorFlag

If parity enabled, sets upon parity error detection. bit 16

enumerator kLPUART\_LinBreakFlag

LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled. bit 31

enumerator kLPUART\_RxActiveEdgeFlag

Receive pin active edge interrupt flag, sets when active edge detected. bit 30

enumerator kLPUART\_RxActiveFlag

Receiver Active Flag (RAF), sets at beginning of valid start. bit 24

enumerator kLPUART\_DataMatch1Flag

The next character to be read from LPUART\_DATA matches MA1. bit 15

enumerator kLPUART\_DataMatch2Flag

The next character to be read from LPUART\_DATA matches MA2. bit 14

enumerator kLPUART\_TxFifoEmptyFlag

TXEMPT bit, sets if transmit buffer is empty. bit 7

enumerator kLPUART\_RxFifoEmptyFlag

RXEMPT bit, sets if receive buffer is empty. bit 6

enumerator kLPUART\_TxFifoOverflowFlag

TXOF bit, sets if transmit buffer overflow occurred. bit 1

enumerator kLPUART\_RxFifoUnderflowFlag

RXUF bit, sets if receive buffer underflow occurred. bit 0

enumerator kLPUART\_AllClearFlags

enumerator kLPUART\_AllFlags

typedef enum *\_lpuart\_parity\_mode* lpuart\_parity\_mode\_t

LPUART parity mode.

typedef enum *\_lpuart\_data\_bits* lpuart\_data\_bits\_t

LPUART data bits count.

typedef enum *\_lpuart\_stop\_bit\_count* lpuart\_stop\_bit\_count\_t

LPUART stop bit count.

```
typedef enum _lpuart_transmit_cts_source lpuart_transmit_cts_source_t
 LPUART transmit CTS source.

typedef enum _lpuart_transmit_cts_config lpuart_transmit_cts_config_t
 LPUART transmit CTS configure.

typedef enum _lpuart_idle_type_select lpuart_idle_type_select_t
 LPUART idle flag type defines when the receiver starts counting.

typedef enum _lpuart_idle_config lpuart_idle_config_t
 LPUART idle detected configuration. This structure defines the number of idle characters
 that must be received before the IDLE flag is set.

typedef struct _lpuart_config lpuart_config_t
 LPUART configuration structure.

typedef struct _lpuart_transfer lpuart_transfer_t
 LPUART transfer structure.

typedef struct _lpuart_handle lpuart_handle_t

typedef void (*lpuart_transfer_callback_t)(LPUART_Type *base, lpuart_handle_t *handle,
status_t status, void *userData)
 LPUART transfer callback function.

typedef void (*lpuart_isr_t)(LPUART_Type *base, void *handle)

void *s_lpuartHandle[]

const IRQn_Type s_lpuartTxIRQ[]

lpuart_isr_t s_lpuartIsr[]

UART_RETRY_TIMES
 Retry times for waiting flag.

struct _lpuart_config
 #include <fsl_lpuart.h> LPUART configuration structure.
```

### Public Members

```
uint32_t baudRate_Bps
 LPUART baud rate

lpuart_parity_mode_t parityMode
 Parity mode, disabled (default), even, odd

lpuart_data_bits_t dataBitsCount
 Data bits count, eight (default), seven

bool isMsb
 Data bits order, LSB (default), MSB

lpuart_stop_bit_count_t stopBitCount
 Number of stop bits, 1 stop bit (default) or 2 stop bits

uint8_t txFifoWatermark
 TX FIFO watermark

uint8_t rxFifoWatermark
 RX FIFO watermark
```

`bool enableRxRTS`  
RX RTS enable

`bool enableTxCTS`  
TX CTS enable

`lpuart_transmit_cts_source_t txCtsSource`  
TX CTS source

`lpuart_transmit_cts_config_t txCtsConfig`  
TX CTS configure

`lpuart_idle_type_select_t rxIdleType`  
RX IDLE type.

`lpuart_idle_config_t rxIdleConfig`  
RX IDLE configuration.

`bool enableTx`  
Enable TX

`bool enableRx`  
Enable RX

`struct __lpuart__transfer`  
*#include <fsl\_lpuart.h>* LPUART transfer structure.

### Public Members

`size_t dataSize`  
The byte count to be transfer.

`struct __lpuart__handle`  
*#include <fsl\_lpuart.h>* LPUART handle structure.

### Public Members

`volatile size_t txDataSize`  
Size of the remaining data to send.

`size_t txDataSizeAll`  
Size of the data to send out.

`volatile size_t rxDataSize`  
Size of the remaining data to receive.

`size_t rxDataSizeAll`  
Size of the data to receive.

`size_t rxRingBufferSize`  
Size of the ring buffer.

`volatile uint16_t rxRingBufferHead`  
Index for the driver to store received data into ring buffer.

`volatile uint16_t rxRingBufferTail`  
Index for the user to get data from the ring buffer.

`lpuart_transfer_callback_t callback`  
Callback function.

`void *userData`  
LPUART callback function parameter.

`volatile uint8_t txState`  
TX transfer state.

`volatile uint8_t rxState`  
RX transfer state.

`bool isSevenDataBits`  
Seven data bits flag.

`bool is16bitData`  
16bit data bits flag, only used for 9bit or 10bit data

`union __unnamed23__`

### Public Members

`uint8_t *data`  
The buffer of data to be transfer.

`uint8_t *rxData`  
The buffer to receive data.

`uint16_t *rxData16`  
The buffer to receive data.

`const uint8_t *txData`  
The buffer of data to be sent.

`const uint16_t *txData16`  
The buffer of data to be sent.

`union __unnamed25__`

### Public Members

`const uint8_t *volatile txData`  
Address of remaining data to send.

`const uint16_t *volatile txData16`  
Address of remaining data to send.

`union __unnamed27__`

### Public Members

`uint8_t *volatile rxData`  
Address of remaining data to receive.

`uint16_t *volatile rxData16`  
Address of remaining data to receive.

`union __unnamed29__`

### Public Members

`uint8_t *rxRingBuffer`  
Start address of the receiver ring buffer.

`uint16_t *rxRingBuffer16`  
Start address of the receiver ring buffer.

## 2.54 LPUART eDMA Driver

```
void LPUART__TransferCreateHandleEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle,
 lpuart_edma_transfer_callback_t callback, void
 *userData, edma_handle_t *txEdmaHandle,
 edma_handle_t *rxEdmaHandle)
```

Initializes the LPUART handle which is used in transactional functions.

---

**Note:** This function disables all LPUART interrupts.

---

### Parameters

- `base` – LPUART peripheral base address.
- `handle` – Pointer to `lpuart_edma_handle_t` structure.
- `callback` – Callback function.
- `userData` – User data.
- `txEdmaHandle` – User requested DMA handle for TX DMA transfer.
- `rxEdmaHandle` – User requested DMA handle for RX DMA transfer.

```
status_t LPUART__SendEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle,
 lpuart_transfer_t *xfer)
```

Sends data using eDMA.

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent, the send callback function is called.

### Parameters

- `base` – LPUART peripheral base address.
- `handle` – LPUART handle pointer.
- `xfer` – LPUART eDMA transfer structure. See `lpuart_transfer_t`.

### Return values

- `kStatus_Success` – if succeed, others failed.
- `kStatus_LPUART_TxBusy` – Previous transfer on going.
- `kStatus_InvalidArgument` – Invalid argument.

```
status_t LPUART__ReceiveEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle,
 lpuart_transfer_t *xfer)
```

Receives data using eDMA.

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

### Parameters

- base – LPUART peripheral base address.
- handle – Pointer to `lpuart_edma_handle_t` structure.
- xfer – LPUART eDMA transfer structure, see `lpuart_transfer_t`.

**Return values**

- `kStatus__Success` – if succeed, others fail.
- `kStatus__LPUART_RxBusy` – Previous transfer ongoing.
- `kStatus__InvalidArgument` – Invalid argument.

`void LPUART__TransferAbortSendEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle)`  
Aborts the sent data using eDMA.

This function aborts the sent data using eDMA.

**Parameters**

- base – LPUART peripheral base address.
- handle – Pointer to `lpuart_edma_handle_t` structure.

`void LPUART__TransferAbortReceiveEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle)`  
Aborts the received data using eDMA.

This function aborts the received data using eDMA.

**Parameters**

- base – LPUART peripheral base address.
- handle – Pointer to `lpuart_edma_handle_t` structure.

`status_t LPUART__TransferGetSendCountEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle, uint32_t *count)`

Gets the number of bytes written to the LPUART TX register.

This function gets the number of bytes written to the LPUART TX register by DMA.

**Parameters**

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Send bytes count.

**Return values**

- `kStatus__NoTransferInProgress` – No send in progress.
- `kStatus__InvalidArgument` – Parameter is invalid.
- `kStatus__Success` – Get successfully through the parameter count;

`status_t LPUART__TransferGetReceiveCountEDMA(LPUART_Type *base, lpuart_edma_handle_t *handle, uint32_t *count)`

Gets the number of received bytes.

This function gets the number of received bytes.

**Parameters**

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Receive bytes count.

**Return values**

- `kStatus_NoTransferInProgress` – No receive in progress.
- `kStatus_InvalidArgument` – Parameter is invalid.
- `kStatus_Success` – Get successfully through the parameter count;

`void LPUART__TransferEdmaHandleIRQ(LPUART_Type *base, void *lpuartEdmaHandle)`  
LPUART eDMA IRQ handle function.

This function handles the LPUART tx complete IRQ request and invoke user callback. It is not set to static so that it can be used in user application.

---

**Note:** This function is used as default IRQ handler by double weak mechanism. If user's specific IRQ handler is implemented, make sure this function is invoked in the handler.

---

### Parameters

- `base` – LPUART peripheral base address.
- `lpuartEdmaHandle` – LPUART handle pointer.

`FSL_LPUART_EDMA_DRIVER_VERSION`

LPUART EDMA driver version.

`typedef struct _lpuart_edma_handle lpuart_edma_handle_t`

`typedef void (*lpuart_edma_transfer_callback_t)(LPUART_Type *base, lpuart_edma_handle_t *handle, status_t status, void *userData)`

LPUART transfer callback function.

`struct _lpuart_edma_handle`

`#include <fsl_lpuart_edma.h>` LPUART eDMA handle.

### Public Members

`lpuart_edma_transfer_callback_t` callback

Callback function.

`void *userData`

LPUART callback function parameter.

`size_t rxDataSizeAll`

Size of the data to receive.

`size_t txDataSizeAll`

Size of the data to send out.

`edma_handle_t *txEdmaHandle`

The eDMA TX channel used.

`edma_handle_t *rxEdmaHandle`

The eDMA RX channel used.

`uint8_t nbytes`

eDMA minor byte transfer count initially configured.

`volatile uint8_t txState`

TX transfer state.

`volatile uint8_t rxState`

RX transfer state

## 2.55 MMDVSQ: Memory-Mapped Divide and Square Root

```
int32_t MMDVSQ_GetDivideRemainder(MMDVSQ_Type *base, int32_t dividend, int32_t divisor,
 bool isUnsigned)
```

Performs the MMDVSQ division operation and returns the remainder.

### Parameters

- base – MMDVSQ peripheral address
- dividend – Dividend value
- divisor – Divisor value
- isUnsigned – Mode of unsigned divide
  - true unsigned divide
  - false signed divide

```
int32_t MMDVSQ_GetDivideQuotient(MMDVSQ_Type *base, int32_t dividend, int32_t divisor,
 bool isUnsigned)
```

Performs the MMDVSQ division operation and returns the quotient.

### Parameters

- base – MMDVSQ peripheral address
- dividend – Dividend value
- divisor – Divisor value
- isUnsigned – Mode of unsigned divide
  - true unsigned divide
  - false signed divide

```
uint16_t MMDVSQ_Sqrt(MMDVSQ_Type *base, uint32_t radicand)
```

Performs the MMDVSQ square root operation.

This function performs the MMDVSQ square root operation and returns the square root result of a given radicand value.

### Parameters

- base – MMDVSQ peripheral address
- radicand – Radicand value

```
static inline mmdvsq_execution_status_t MMDVSQ_GetExecutionStatus(MMDVSQ_Type *base)
```

Gets the MMDVSQ execution status.

This function checks the current MMDVSQ execution status of the combined CSR[BUSY, DIV, Sqrt] indicators.

### Parameters

- base – MMDVSQ peripheral address

### Returns

Current MMDVSQ execution status

```
static inline void MMDVSQ_SetFastStartConfig(MMDVSQ_Type *base,
 mmdvsq_fast_start_select_t mode)
```

Configures MMDVSQ fast start mode.

This function sets the MMDVSQ division fast start. The MMDVSQ supports two mechanisms for initiating a division operation. The default mechanism is a “fast start” where a write to



the DSOR register begins the division. Alternatively, the start mechanism can begin after a write to the CSR register with CSR[SRT] set.

#### Parameters

- base – MMDVSQ peripheral address
- mode – Mode of Divide-Fast-Start
  - kMmdvsqDivideFastStart = 0
  - kMmdvsqDivideNormalStart = 1

```
static inline void MMDVSQ_SetDivideByZeroConfig(MMDVSQ_Type *base, bool isDivByZero)
```

Configures the MMDVSQ divide-by-zero mode.

This function configures the MMDVSQ response to divide-by-zero calculations. If both CSR[DZ] and CSR[DZE] are set, then a subsequent read of the RES register is error-terminated to signal the processor of the attempted divide-by-zero. Otherwise, the register contents are returned.

#### Parameters

- base – MMDVSQ peripheral address
- isDivByZero – Mode of Divide-By-Zero
  - kMmdvsqDivideByZeroDis = 0
  - kMmdvsqDivideByZeroEn = 1

```
FSL_MMSVSQ_DRIVER_VERSION
```

Version 2.0.4.

```
enum _mmdvsq_execution_status
```

MMDVSQ execution status.

*Values:*

```
enumerator kMMDVSQ_IdleSquareRoot
```

MMDVSQ is idle; the last calculation was a square root

```
enumerator kMMDVSQ_IdleDivide
```

MMDVSQ is idle; the last calculation was division

```
enumerator kMMDVSQ_BusySquareRoot
```

MMDVSQ is busy processing a square root calculation

```
enumerator kMMDVSQ_BusyDivide
```

MMDVSQ is busy processing a division calculation

```
enum _mmdvsq_fast_start_select
```

MMDVSQ divide fast start select.

*Values:*

```
enumerator kMMDVSQ_EnableFastStart
```

Division operation is initiated by a write to the DSOR register

```
enumerator kMMDVSQ_DisableFastStart
```

Division operation is initiated by a write to CSR[SRT] = 1; normal start instead fast start

```
typedef enum _mmdvsq_execution_status mmdvsq_execution_status_t
```

MMDVSQ execution status.

```
typedef enum _mmdvsq_fast_start_select mmdvsq_fast_start_select_t
```

MMDVSQ divide fast start select.

## 2.56 MSCM: Miscellaneous System Control

FSL\_MSCM\_DRIVER\_VERSION

MSCM driver version 2.0.0.

```
typedef struct _mscm_uid mscm_uid_t
```

```
static inline void MSCM_GetUID(MSCM_Type *base, mscm_uid_t *uid)
```

Get MSCM UID.

### Parameters

- base – MSCM peripheral base address.
- uid – Pointer to an uid struct.

```
static inline void MSCM_SetSecureIrqParameter(MSCM_Type *base, const uint32_t parameter)
```

Set MSCM Secure Irq.

### Parameters

- base – MSCM peripheral base address.
- parameter – Value to be write to SECURE\_IRQ.

```
static inline uint32_t MSCM_GetSecureIrq(MSCM_Type *base)
```

Get MSCM Secure Irq.

### Parameters

- base – MSCM peripheral base address.

### Returns

MSCM Secure Irq.

FSL\_COMPONENT\_ID

```
struct _mscm_uid
```

```
#include <fsl_mscm.h>
```

## 2.57 MSMC: Multicore System Mode Controller

```
static inline void SMC_SetPowerModeProtection(SMC_Type *base, uint8_t allowedModes)
```

Configures all power mode protection settings.

This function configures the power mode protection settings for supported power modes in the specified chip family. The available power modes are defined in the `smc_power_mode_protection_t`. This should be done at an early system level initialization stage. See the reference manual for details. This register can only write once after the power reset.

The allowed modes are passed as bit map, for example, to allow LLS and VLLS, use `SMC_SetPowerModeProtection(kSMC_AllowPowerModeLls | kSMC_AllowPowerModeVlls)`. To allow all modes, use `SMC_SetPowerModeProtection(kSMC_AllowPowerModeAll)`.

### Parameters

- base – SMC peripheral base address.
- allowedModes – Bitmap of the allowed power modes.

static inline *smc\_power\_state\_t* SMC\_GetPowerModeState(SMC\_Type \*base)

Gets the current power mode status.

This function returns the current power mode stat. Once application switches the power mode, it should always check the stat to check whether it runs into the specified mode or not. An application should check this mode before switching to a different mode. The system requires that only certain modes can switch to other specific modes. See the reference manual for details and the *smc\_power\_state\_t* for information about the power stat.

#### Parameters

- base – SMC peripheral base address.

#### Returns

Current power mode status.

static inline void SMC\_PreEnterStopModes(void)

Prepare to enter stop modes.

This function should be called before entering STOP/VLPS/LLS/VLLS modes.

static inline void SMC\_PostExitStopModes(void)

Recovering after wake up from stop modes.

This function should be called after wake up from STOP/VLPS/LLS/VLLS modes. It is used together with SMC\_PreEnterStopModes.

static inline void SMC\_PreEnterWaitModes(void)

Prepare to enter wait modes.

This function should be called before entering WAIT/VLPW modes..

static inline void SMC\_PostExitWaitModes(void)

Recovering after wake up from stop modes.

This function should be called after wake up from WAIT/VLPW modes. It is used together with SMC\_PreEnterWaitModes.

*status\_t* SMC\_SetPowerModeRun(SMC\_Type \*base)

Configure the system to RUN power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeHsrn(SMC\_Type \*base)

Configure the system to HSRUN power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeWait(SMC\_Type \*base)

Configure the system to WAIT power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeStop(SMC\_Type \*base, *smc\_partial\_stop\_option\_t* option)

Configure the system to Stop power mode.

#### Parameters

- base – SMC peripheral base address.
- option – Partial Stop mode option.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeVlpr(SMC\_Type \*base)

Configure the system to VLPR power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeVlpw(SMC\_Type \*base)

Configure the system to VLPW power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeVlps(SMC\_Type \*base)

Configure the system to VLPS power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeLls(SMC\_Type \*base)

Configure the system to LLS power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeVlls0(SMC\_Type \*base)

Configure the system to VLLS0 power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

*status\_t* SMC\_SetPowerModeVlls2(SMC\_Type \*base)

Configure the system to VLLS2 power mode.

#### Parameters

- base – SMC peripheral base address.

#### Returns

SMC configuration error code.

```
static inline uint32_t SMC_GetPreviousResetSources(SMC_Type *base)
```

Gets the reset source status which caused a previous reset.

This function gets the current reset source status. Use source masks defined in the `smc_reset_source_t` to get the desired source status.

Example: To get all reset source statuses.

```
resetStatus = SMC_GetPreviousResetSources(SMC0) & kSMC_SourceAll;
```

Example: To test whether the MCU is reset using Watchdog.

```
uint32_t resetStatus;

resetStatus = SMC_GetPreviousResetSources(SMC0) & kSMC_SourceWdog;
```

Example: To test multiple reset sources.

```
uint32_t resetStatus;

resetStatus = SMC_GetPreviousResetSources(SMC0) & (kSMC_SourceWdog | kSMC_SourcePin);
```

### Parameters

- `base` – SMC peripheral base address.

### Returns

All reset source status bit map.

```
static inline uint32_t SMC_GetStickyResetSources(SMC_Type *base)
```

Gets the sticky reset source status.

This function gets the current reset source status that has not been cleared by software for some specific source.

Example: To get all reset source statuses.

```
uint32_t resetStatus;

resetStatus = SMC_GetStickyResetSources(SMC0) & kSMC_SourceAll;
```

Example, To test whether the MCU is reset using Watchdog.

```
uint32_t resetStatus;

resetStatus = SMC_GetStickyResetSources(SMC0) & kSMC_SourceWdog;
```

Example To test multiple reset sources.

```
uint32_t resetStatus;

resetStatus = SMC_GetStickyResetSources(SMC0) & (kSMC_SourceWdog | kSMC_SourcePin);
```

### Parameters

- `base` – SMC peripheral base address.

### Returns

All reset source status bit map.

```
static inline void SMC_ClearStickyResetSources(SMC_Type *base, uint32_t sourceMasks)
```

Clears the sticky reset source status.

This function clears the sticky system reset flags indicated by source masks.

Example: Clears multiple reset sources.

```
SMC_ClearStickyResetSources(SMC0, (kSMC_SourceWdog | kSMC_SourcePin));
```

### Parameters

- base – SMC peripheral base address.
- sourceMasks – reset source status bit map

**void SMC\_ConfigureResetPinFilter(SMC\_Type \*base, const *smc\_reset\_pin\_filter\_config\_t* \*config)**  
Configures the reset pin filter.

This function sets the reset pin filter including the enablement/disablement and filter width.

### Parameters

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

**static inline void SMC\_SetSystemResetInterruptConfig(SMC\_Type \*base, uint32\_t intMask)**  
Sets the system reset interrupt configuration.

For a graceful shut down, the MSMC supports delaying the assertion of the system reset for a period of time when the reset interrupt is generated. This function can be used to enable the interrupt. The interrupts are passed in as bit mask. See *smc\_interrupt\_enable\_t* for details. For example, to delay a reset after the WDOG timeout or PIN reset occurs, configure as follows: `SMC_SetSystemResetInterruptConfig(SMC0, (kSMC_IntWdog | kSMC_IntPin));`

### Parameters

- base – SMC peripheral base address.
- intMask – Bit mask of the system reset interrupts to enable. See *smc\_interrupt\_enable\_t* for details.

**static inline uint32\_t SMC\_GetResetInterruptSourcesStatus(SMC\_Type \*base)**  
Gets the source status of the system reset interrupt.

This function gets the source status of the reset interrupt. Use source masks defined in the *smc\_interrupt\_enable\_t* to get the desired source status.

Example: To get all reset interrupt source statuses.

```
uint32_t interruptStatus;

interruptStatus = SMC_GetResetInterruptSourcesStatus(SMC0) & kSMC_IntAll;
```

Example: To test whether the reset interrupt of Watchdog is pending.

```
uint32_t interruptStatus;

interruptStatus = SMC_GetResetInterruptSourcesStatus(SMC0) & kSMC_IntWdog;
```

Example: To test multiple reset interrupt sources.

```
uint32_t interruptStatus;

interruptStatus = SMC_GetResetInterruptSourcesStatus(SMC0) & (kSMC_IntWdog | kSMC_IntPin);
```

### Parameters

- base – SMC peripheral base address.

### Returns

All reset interrupt source status bit map.

```
static inline void SMC_ClearResetInterruptSourcesStatus(SMC_Type *base, uint32_t intMask)
```

Clears the source status of the system reset interrupt.

This function clears the source status of the reset interrupt. Use source masks defined in the `smc_interrupt_enable_t` to get the desired source status.

Example: To clear all reset interrupt source statuses.

```
uint32_t interruptStatus;

MMC_ClearResetInterruptSourcesStatus(SMC0, kSMC_IntAll);
```

Example, To clear the reset interrupt of Watchdog.

```
uint32_t interruptStatus;

SMC_ClearResetInterruptSourcesStatus(SMC0, kSMC_IntWdog);
```

Example, To clear multiple reset interrupt sources status.

```
uint32_t interruptStatus;

SMC_ClearResetInterruptSourcesStatus(SMC0, (kSMC_IntWdog | kSMC_IntPin));
```

#### Parameters

- `base` – SMC peripheral base address.
- `intMask` – All reset interrupt source status bit map to clear.

```
static inline void SMC_SetCoreSoftwareResetConfig(SMC_Type *base, uint32_t intMask)
```

Sets the core software reset feature configuration.

The MSMC supports delaying the assertion of the system reset for a period of time while a core software reset is generated. This allows software to recover without resetting the entire system. This function can be used to enable/disable the core software reset feature. The interrupts are passed in as bit mask. See `smc_interrupt_enable_t` for details. For example, to delay a system after the WDOG timeout or PIN core software reset occurs, configure as follows: `SMC_SetCoreSoftwareResetConfig(SMC0, (kSMC_IntWdog | kSMC_IntPin));`

#### Parameters

- `base` – SMC peripheral base address.
- `intMask` – Bit mask of the core software reset to enable. See `smc_interrupt_enable_t` for details.

```
static inline uint32_t SMC_GetBootOptionConfig(SMC_Type *base)
```

Gets the boot option configuration.

This function gets the boot option configuration of MSMC.

#### Parameters

- `base` – SMC peripheral base address.

#### Returns

The boot option configuration. 1 means boot option enabled. 0 means not.

```
FSL_MSMC_DRIVER_VERSION
```

MSMC driver version.

```
enum __smc_power_mode_protection
```

Power Modes Protection.

*Values:*

enumerator kSMC\_\_AllowPowerModeVlls  
Allow Very-Low-Leakage Stop Mode.

enumerator kSMC\_\_AllowPowerModeLls  
Allow Low-Leakage Stop Mode.

enumerator kSMC\_\_AllowPowerModeVlp  
Allow Very-Low-Power Mode.

enumerator kSMC\_\_AllowPowerModeHsrn  
Allow High Speed Run mode.

enumerator kSMC\_\_AllowPowerModeAll  
Allow all power mode.

enum \_\_smc\_\_power\_\_state  
Power Modes in PMSTAT.

*Values:*

enumerator kSMC\_\_PowerStateRun  
0000\_0001 - Current power mode is RUN

enumerator kSMC\_\_PowerStateStop  
0000\_0010 - Current power mode is any STOP mode

enumerator kSMC\_\_PowerStateVlpr  
0000\_0100 - Current power mode is VLPR

enumerator kSMC\_\_PowerStateHsrn  
1000\_0000 - Current power mode is HSRUN

enum \_\_smc\_\_power\_\_stop\_\_entry\_\_status  
Power Stop Entry Status in PMSTAT.

*Values:*

enumerator kSMC\_\_PowerStopEntryAlt0  
Indicates a Stop mode entry since this field was last cleared.

enumerator kSMC\_\_PowerStopEntryAlt1  
Indicates the system bus masters acknowledged the Stop mode entry.

enumerator kSMC\_\_PowerStopEntryAlt2  
Indicates the system clock peripherals acknowledged the Stop mode entry.

enumerator kSMC\_\_PowerStopEntryAlt3  
Indicates the bus clock peripherals acknowledged the Stop mode entry.

enumerator kSMC\_\_PowerStopEntryAlt4  
Indicates the slow clock peripherals acknowledged the Stop mode entry.

enumerator kSMC\_\_PowerStopEntryAlt5  
Indicates Stop mode entry completed.

enum \_\_smc\_\_run\_\_mode  
Run mode definition.

*Values:*

enumerator kSMC\_\_RunNormal  
normal RUN mode.



enumerator kSMC\_RunVlpr  
Very-Low-Power RUN mode.

enumerator kSMC\_Hsrun  
High Speed Run mode (HSRUN).

enum \_\_smc\_stop\_mode  
Stop mode definition.

*Values:*

enumerator kSMC\_StopNormal  
Normal STOP mode.

enumerator kSMC\_StopVlps  
Very-Low-Power STOP mode.

enumerator kSMC\_StopLls  
Low-Leakage Stop mode.

enumerator kSMC\_StopVlls2  
Very-Low-Leakage Stop mode, VLPS2/3.

enumerator kSMC\_StopVlls0  
Very-Low-Leakage Stop mode, VLPS0/1.

enum \_\_smc\_partial\_stop\_mode  
Partial STOP option.

*Values:*

enumerator kSMC\_PartialStop  
STOP - Normal Stop mode

enumerator kSMC\_PartialStop1  
Partial Stop with both system and bus clocks disabled

enumerator kSMC\_PartialStop2  
Partial Stop with system clock disabled and bus clock enabled

enumerator kSMC\_PartialStop3  
Partial Stop with system clock enabled and bus clock disabled

SMC configuration status.

*Values:*

enumerator kStatus\_SMC\_StopAbort  
Entering Stop mode is abort

enum \_\_smc\_reset\_source  
System Reset Source Name definitions.

*Values:*

enumerator kSMC\_SourceWakeup  
Very low-leakage wakeup reset

enumerator kSMC\_SourcePor  
Power on reset

enumerator kSMC\_SourceLvd  
Low-voltage detect reset

enumerator kSMC\_SourceHvd

High-voltage detect reset

enumerator kSMC\_SourceWarm

Warm reset. Warm Reset flag will assert if any of the system reset sources in this register assert (SRS[31:8])

enumerator kSMC\_SourceFatal

Fatal reset

enumerator kSMC\_SourceCore

Software reset that only reset the core, NOT a sticky system reset source.

enumerator kSMC\_SourcePin

RESET\_B pin reset.

enumerator kSMC\_SourceMdm

MDM reset.

enumerator kSMC\_SourceRstAck

Reset Controller timeout reset.

enumerator kSMC\_SourceStopAck

Stop timeout reset

enumerator kSMC\_SourceScg

SCG loss of lock or loss of clock

enumerator kSMC\_SourceWdog

Watchdog reset

enumerator kSMC\_SourceSoftware

Software reset

enumerator kSMC\_SourceLockup

Lockup reset. Core lockup or exception.

enumerator kSMC\_SourceJtag

JTAG system reset

enumerator kSMC\_SourceVbat

enumerator kSMC\_SourceSecVio

Security violation reset

enumerator kSMC\_SourceTamper

Tamper reset

enumerator kSMC\_SourceCore0

Core0 System Reset.

enumerator kSMC\_SourceCore1

Core1 System Reset.

enumerator kSMC\_SourceAll

enum \_\_smc\_interrupt\_enable

System reset interrupt enable bit definitions.

*Values:*

enumerator kSMC\_IntNone

No interrupt enabled.

enumerator kSMC\_IntPin  
Pin reset interrupt.

enumerator kSMC\_IntMdm  
MDM reset interrupt.

enumerator kSMC\_IntStopAck  
Stop timeout reset interrupt.

enumerator kSMC\_IntWdog  
Watchdog interrupt.

enumerator kSMC\_IntSoftware  
Software reset interrupts.

enumerator kSMC\_IntLockup  
Lock up interrupt.

enumerator kSMC\_IntVbat

enumerator kSMC\_IntCore0

enumerator kSMC\_IntCore1  
Core 0 interrupts.

enumerator kSMC\_IntAll  
Core 1 interrupts. All system reset interrupts.

typedef enum *\_smc\_power\_mode\_protection* smc\_power\_mode\_protection\_t  
Power Modes Protection.

typedef enum *\_smc\_power\_state* smc\_power\_state\_t  
Power Modes in PMSTAT.

typedef enum *\_smc\_power\_stop\_entry\_status* smc\_power\_stop\_entry\_status\_t  
Power Stop Entry Status in PMSTAT.

typedef enum *\_smc\_run\_mode* smc\_run\_mode\_t  
Run mode definition.

typedef enum *\_smc\_stop\_mode* smc\_stop\_mode\_t  
Stop mode definition.

typedef enum *\_smc\_partial\_stop\_mode* smc\_partial\_stop\_option\_t  
Partial STOP option.

typedef enum *\_smc\_reset\_source* smc\_reset\_source\_t  
System Reset Source Name definitions.

typedef enum *\_smc\_interrupt\_enable* smc\_interrupt\_enable\_t  
System reset interrupt enable bit definitions.

typedef struct *\_smc\_reset\_pin\_filter\_config* smc\_reset\_pin\_filter\_config\_t  
Reset pin filter configuration.

struct *\_smc\_reset\_pin\_filter\_config*  
*#include <fsl\_msmc.h>* Reset pin filter configuration.

**Public Members**

uint8\_t slowClockFilterCount

Reset pin bus clock filter width from 1 to 32 slow clock cycles.

bool enableFilter

Reset pin filter enable/disable.

## 2.58 MU: Messaging Unit

void MU\_Init(MU\_Type \*base)

Initializes the MU module.

This function enables the MU clock only.

**Parameters**

- base – MU peripheral base address.

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

De-initializes the MU module.

This function disables the MU clock only.

**Parameters**

- base – MU peripheral base address.

static inline void MU\_SendMsgNonBlocking(MU\_Type \*base, uint32\_t regIndex, uint32\_t msg)

Writes a message to the TX register.

This function writes a message to the specific TX register. It does not check whether the TX register is empty or not. The upper layer should make sure the TX register is empty before calling this function. This function can be used in ISR for better performance.

```
while (!(kMU_Tx0EmptyFlag & MU_GetStatusFlags(base))) { } Wait for TX0 register empty.
MU_SendMsgNonBlocking(base, kMU_MsgReg0, MSG_VAL); Write message to the TX0 register.
```

**Parameters**

- base – MU peripheral base address.
- regIndex – TX register index, see mu\_msg\_reg\_index\_t.
- msg – Message to send.

status\_t MU\_SendMsg(MU\_Type \*base, uint32\_t regIndex, uint32\_t msg)

Blocks to send a message.

This function waits until the TX register is empty and sends the message. If MU\_BUSY\_POLL\_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and returns kStatus\_Timeout.

**Parameters**

- base – MU peripheral base address.
- regIndex – MU message register, see mu\_msg\_reg\_index\_t.
- msg – Message to send.

**Return values**

- kStatus\_Success – Message sent successfully.

- `kStatus_Timeout` – Timeout occurred while waiting for TX register to be empty.

**Returns**

`status_t`

`static inline uint32_t MU_ReceiveMsgNonBlocking(MU_Type *base, uint32_t regIndex)`

Reads a message from the RX register.

This function reads a message from the specific RX register. It does not check whether the RX register is full or not. The upper layer should make sure the RX register is full before calling this function. This function can be used in ISR for better performance.

```
uint32_t msg;
while (!(kMU_Rx0FullFlag & MU_GetStatusFlags(base)))
{
} Wait for the RX0 register full.

msg = MU_ReceiveMsgNonBlocking(base, kMU_MsgReg0); Read message from RX0 register.
```

**Parameters**

- `base` – MU peripheral base address.
- `regIndex` – RX register index, see `mu_msg_reg_index_t`.

**Returns**

The received message.

`status_t MU_ReceiveMsgTimeout(MU_Type *base, uint32_t regIndex, uint32_t *readValue)`

Blocks to receive a message with timeout protection.

This function waits until the RX register is full and receives the message. If `MU_BUSY_POLL_COUNT` is defined and non-zero, the function will timeout after the specified number of polling iterations and return `kStatus_Timeout`.

This function provides the same blocking behavior as `MU_ReceiveMsg()` but with additional timeout protection to prevent system hangs if the other core becomes unresponsive or if hardware issues occur.

---

**Note:** Both `MU_ReceiveMsg()` and `MU_ReceiveMsgTimeout()` are blocking functions. The difference is that this function includes timeout protection while `MU_ReceiveMsg()` waits indefinitely.

---

**Parameters**

- `base` – MU peripheral base address.
- `regIndex` – RX register index, see `mu_msg_reg_index_t`.
- `readValue` – Pointer to store the received message.

**Return values**

- `kStatus_Success` – Message received successfully.
- `kStatus_InvalidArgument` – Invalid `readValue` pointer.
- `kStatus_Timeout` – Timeout occurred while waiting for RX register to be full.

**Returns**

`status_t`

uint32\_t MU\_ReceiveMsg(MU\_Type \*base, uint32\_t regIndex)

Blocks to receive a message (infinite wait, no timeout protection).

This function waits until the RX register is full and receives the message. This function will wait indefinitely until a message is received.

---

**Note:** Both MU\_ReceiveMsg() and MU\_ReceiveMsgTimeout() are blocking functions. The difference is that MU\_ReceiveMsgTimeout() includes timeout protection while this function waits indefinitely.

---

**Warning:** This function does not include timeout protection and may cause system hangs if the other core becomes unresponsive. For applications requiring timeout protection, use MU\_ReceiveMsgTimeout() instead.

### Parameters

- base – MU peripheral base address.
- regIndex – RX register index, see mu\_msg\_reg\_index\_t.

### Returns

The received message.

static inline void MU\_SetFlagsNonBlocking(MU\_Type \*base, uint32\_t flags)

Sets the 3-bit MU flags reflect on the other MU side.

This function sets the 3-bit MU flags directly. Every time the 3-bit MU flags are changed, the status flag kMU\_FlagsUpdatingFlag asserts indicating the 3-bit MU flags are updating to the other side. After the 3-bit MU flags are updated, the status flag kMU\_FlagsUpdatingFlag is cleared by hardware. During the flags updating period, the flags cannot be changed. The upper layer should make sure the status flag kMU\_FlagsUpdatingFlag is cleared before calling this function.

```
while (kMU_FlagsUpdatingFlag & MU_GetStatusFlags(base))
{
 } Wait for previous MU flags updating.
```

```
MU_SetFlagsNonBlocking(base, 0U); Set the mU flags.
```

### Parameters

- base – MU peripheral base address.
- flags – The 3-bit MU flags to set.

status\_t MU\_SetFlags(MU\_Type \*base, uint32\_t flags)

Blocks setting the 3-bit MU flags reflect on the other MU side.

This function blocks setting the 3-bit MU flags. Every time the 3-bit MU flags are changed, the status flag kMU\_FlagsUpdatingFlag asserts indicating the 3-bit MU flags are updating to the other side. After the 3-bit MU flags are updated, the status flag kMU\_FlagsUpdatingFlag is cleared by hardware. During the flags updating period, the flags cannot be changed. This function waits for the MU status flag kMU\_FlagsUpdatingFlag cleared and sets the 3-bit MU flags.

If MU\_BUSY\_POLL\_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus\_Timeout.

### Parameters

- base – MU peripheral base address.

- flags – The 3-bit MU flags to set.

**Return values**

- kStatus\_Success – Flags were set successfully.
- kStatus\_Timeout – Timeout occurred while waiting for flags to update.

**Returns**

status\_t

static inline uint32\_t MU\_GetFlags(MU\_Type \*base)

Gets the current value of the 3-bit MU flags set by the other side.

This function gets the current 3-bit MU flags on the current side.

**Parameters**

- base – MU peripheral base address.

**Returns**

flags Current value of the 3-bit flags.

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

Gets the MU status flags.

This function returns the bit mask of the MU status flags. See \_mu\_status\_flags.

```
uint32_t flags;
flags = MU_GetStatusFlags(base); Get all status flags.
if (kMU_Tx0EmptyFlag & flags)
{
 The TX0 register is empty. Message can be sent.
 MU_SendMsgNonBlocking(base, kMU_MsgReg0, MSG0_VAL);
}
if (kMU_Tx1EmptyFlag & flags)
{
 The TX1 register is empty. Message can be sent.
 MU_SendMsgNonBlocking(base, kMU_MsgReg1, MSG1_VAL);
}
```

**Parameters**

- base – MU peripheral base address.

**Returns**

Bit mask of the MU status flags, see \_mu\_status\_flags.

static inline uint32\_t MU\_GetRxStatusFlags(MU\_Type \*base)

Return the RX status flags.

This function return the RX status flags. Note: RFn bits of SR[27-24](mu status register) are mapped in reverse numerical order: RF0 -> SR[27] RF1 -> SR[26] RF2 -> SR[25] RF3 -> SR[24]

```
status_reg = MU_GetRxStatusFlags(base);
```

**Parameters**

- base – MU peripheral base address.

**Returns**

MU RX status

static inline uint32\_t MU\_GetInterruptsPending(MU\_Type \*base)

Gets the MU IRQ pending status of enabled interrupts.

This function returns the bit mask of the pending MU IRQs of enabled interrupts. Only these flags are checked. kMU\_Tx0EmptyFlag kMU\_Tx1EmptyFlag kMU\_Tx2EmptyFlag kMU\_Tx3EmptyFlag kMU\_Rx0FullFlag kMU\_Rx1FullFlag kMU\_Rx2FullFlag kMU\_Rx3FullFlag kMU\_GenInt0Flag kMU\_GenInt1Flag kMU\_GenInt2Flag kMU\_GenInt3Flag

### Parameters

- base – MU peripheral base address.

### Returns

Bit mask of the MU IRQs pending.

```
static inline void MU_ClearStatusFlags(MU_Type *base, uint32_t mask)
```

Clears the specific MU status flags.

This function clears the specific MU status flags. The flags to clear should be passed in as bit mask. See `_mu_status_flags`.

Clear general interrupt 0 and general interrupt 1 pending flags.  
 MU\_ClearStatusFlags(base, kMU\_GenInt0Flag | kMU\_GenInt1Flag);

### Parameters

- base – MU peripheral base address.
- mask – Bit mask of the MU status flags. See `_mu_status_flags`. The following flags are cleared by hardware, this function could not clear them.
  - kMU\_Tx0EmptyFlag
  - kMU\_Tx1EmptyFlag
  - kMU\_Tx2EmptyFlag
  - kMU\_Tx3EmptyFlag
  - kMU\_Rx0FullFlag
  - kMU\_Rx1FullFlag
  - kMU\_Rx2FullFlag
  - kMU\_Rx3FullFlag
  - kMU\_EventPendingFlag
  - kMU\_FlagsUpdatingFlag
  - kMU\_OtherSideInResetFlag

```
static inline void MU_EnableInterrupts(MU_Type *base, uint32_t mask)
```

Enables the specific MU interrupts.

This function enables the specific MU interrupts. The interrupts to enable should be passed in as bit mask. See `_mu_interrupt_enable`.

Enable general interrupt 0 and TX0 empty interrupt.  
 MU\_EnableInterrupts(base, kMU\_GenInt0InterruptEnable | kMU\_Tx0EmptyInterruptEnable);

### Parameters

- base – MU peripheral base address.
- mask – Bit mask of the MU interrupts. See `_mu_interrupt_enable`.



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

Disables the specific MU interrupts.

This function disables the specific MU interrupts. The interrupts to disable should be passed in as bit mask. See `_mu_interrupt_enable`.

```
Disable general interrupt 0 and TX0 empty interrupt.
MU_DisableInterrupts(base, kMU_GenInt0InterruptEnable | kMU_Tx0EmptyInterruptEnable);
```

### Parameters

- base – MU peripheral base address.
- mask – Bit mask of the MU interrupts. See `_mu_interrupt_enable`.

status\_t MU\_TriggerInterrupts(MU\_Type \*base, uint32\_t mask)

Triggers interrupts to the other core.

This function triggers the specific interrupts to the other core. The interrupts to trigger are passed in as bit mask. See `_mu_interrupt_trigger`. The MU should not trigger an interrupt to the other core when the previous interrupt has not been processed by the other core. This function checks whether the previous interrupts have been processed. If not, it returns an error.

```
if (kStatus_Success != MU_TriggerInterrupts(base, kMU_GenInt0InterruptTrigger | kMU_
↪ GenInt2InterruptTrigger))
{
 Previous general purpose interrupt 0 or general purpose interrupt 2
 has not been processed by the other core.
}
```

### Parameters

- base – MU peripheral base address.
- mask – Bit mask of the interrupts to trigger. See `_mu_interrupt_trigger`.

### Return values

- kStatus\_Success – Interrupts have been triggered successfully.
- kStatus\_Fail – Previous interrupts have not been accepted.

static inline void MU\_MaskHardwareReset(MU\_Type \*base, bool mask)

Mask hardware reset by the other core.

The other core could call `MU_HardwareResetOtherCore()` to reset current core. To mask the reset, call this function and pass in true.

### Parameters

- base – MU peripheral base address.
- mask – Pass true to mask the hardware reset, pass false to unmask it.

FSL\_MU\_DRIVER\_VERSION

MU driver version.

enum \_mu\_status\_flags

MU status flags.

*Values:*

enumerator kMU\_Tx0EmptyFlag  
TX0 empty.

enumerator kMU\_\_Tx1EmptyFlag  
TX1 empty.

enumerator kMU\_\_Tx2EmptyFlag  
TX2 empty.

enumerator kMU\_\_Tx3EmptyFlag  
TX3 empty.

enumerator kMU\_\_Rx0FullFlag  
RX0 full.

enumerator kMU\_\_Rx1FullFlag  
RX1 full.

enumerator kMU\_\_Rx2FullFlag  
RX2 full.

enumerator kMU\_\_Rx3FullFlag  
RX3 full.

enumerator kMU\_\_GenInt0Flag  
General purpose interrupt 0 pending.

enumerator kMU\_\_GenInt1Flag  
General purpose interrupt 1 pending.

enumerator kMU\_\_GenInt2Flag  
General purpose interrupt 2 pending.

enumerator kMU\_\_GenInt3Flag  
General purpose interrupt 3 pending.

enumerator kMU\_\_EventPendingFlag  
MU event pending.

enumerator kMU\_\_FlagsUpdatingFlag  
MU flags update is on-going.

enumerator kMU\_\_ResetAssertInterruptFlag  
The other core reset assert interrupt pending.

enumerator kMU\_\_ResetDeassertInterruptFlag  
The other core reset de-assert interrupt pending.

enumerator kMU\_\_OtherSideInResetFlag  
The other side is in reset.

enumerator kMU\_\_MuResetInterruptFlag  
The other side initializes MU reset.

enumerator kMU\_\_HardwareResetInterruptFlag  
Current side has been hardware reset by the other side.

enum \_\_mu\_interrupt\_enable  
MU interrupt source to enable.

*Values:*

enumerator kMU\_\_Tx0EmptyInterruptEnable  
TX0 empty.

enumerator kMU\_Tx1EmptyInterruptEnable  
TX1 empty.

enumerator kMU\_Tx2EmptyInterruptEnable  
TX2 empty.

enumerator kMU\_Tx3EmptyInterruptEnable  
TX3 empty.

enumerator kMU\_Rx0FullInterruptEnable  
RX0 full.

enumerator kMU\_Rx1FullInterruptEnable  
RX1 full.

enumerator kMU\_Rx2FullInterruptEnable  
RX2 full.

enumerator kMU\_Rx3FullInterruptEnable  
RX3 full.

enumerator kMU\_GenInt0InterruptEnable  
General purpose interrupt 0.

enumerator kMU\_GenInt1InterruptEnable  
General purpose interrupt 1.

enumerator kMU\_GenInt2InterruptEnable  
General purpose interrupt 2.

enumerator kMU\_GenInt3InterruptEnable  
General purpose interrupt 3.

enumerator kMU\_ResetAssertInterruptEnable  
The other core reset assert interrupt.

enumerator kMU\_ResetDeassertInterruptEnable  
The other core reset de-assert interrupt.

enumerator kMU\_MuResetInterruptEnable  
The other side initializes MU reset. The interrupt is ORed with the general purpose interrupt 3. The general purpose interrupt 3 is issued when the other side set the MU reset and this interrupt is enabled.

enumerator kMU\_HardwareResetInterruptEnable  
Current side has been hardware reset by the other side.

enum \_mu\_interrupt\_trigger  
MU interrupt that could be triggered to the other core.

*Values:*

enumerator kMU\_GenInt0InterruptTrigger  
General purpose interrupt 0.

enumerator kMU\_GenInt1InterruptTrigger  
General purpose interrupt 1.

enumerator kMU\_GenInt2InterruptTrigger  
General purpose interrupt 2.

enumerator kMU\_GenInt3InterruptTrigger  
General purpose interrupt 3.

enum `_mu_msg_reg_index`

MU message register.

*Values:*

enumerator `kMU_MsgReg0`

enumerator `kMU_MsgReg1`

enumerator `kMU_MsgReg2`

enumerator `kMU_MsgReg3`

typedef enum `_mu_msg_reg_index` `mu_msg_reg_index_t`

MU message register.

`MU_CR_NMI_MASK`

`MU_BUSY_POLL_COUNT`

Maximum polling iterations for MU waiting loops.

This parameter defines the maximum number of iterations for any polling loop in the MU code before timing out and returning an error.

It applies to all waiting loops in MU driver, such as waiting for TX register to be empty or waiting for RX register to be full.

This is a count of loop iterations, not a time-based value.

If defined as 0, polling loops will continue indefinitely until their exit condition is met, which could potentially cause the system to hang if a core becomes unresponsive.

`MU_GET_CORE_FLAG(flags)`

`MU_GET_STAT_FLAG(flags)`

`MU_GET_TX_FLAG(flags)`

`MU_GET_RX_FLAG(flags)`

`MU_GET_GI_FLAG(flags)`

## 2.59 PORT: Port Control and Interrupts

static inline void `PORT_SetPinConfig(PORT_Type *base, uint32_t pin, const port_pin_config_t *config)`

Sets the port PCR register.

This is an example to define an input pin or output pin PCR configuration.

```
// Define a digital input pin PCR configuration
port_pin_config_t config = {
 kPORT_PullUp,
 kPORT_FastSlewRate,
 kPORT_PassiveFilterDisable,
 kPORT_OpenDrainDisable,
 kPORT_LowDriveStrength,
 kPORT_MuxAsGpio,
 kPORT_UnLockRegister,
};
```

### Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.
- config – PORT PCR register configuration structure.

```
static inline void PORT_SetMultiplePinsConfig(PORT_Type *base, uint32_t mask, const
 port_pin_config_t *config)
```

Sets the port PCR register for multiple pins.

This is an example to define input pins or output pins PCR configuration.

```
Define a digital input pin PCR configuration
port_pin_config_t config = {
 kPORT_PullUp ,
 kPORT_PullEnable,
 kPORT_FastSlewRate,
 kPORT_PassiveFilterDisable,
 kPORT_OpenDrainDisable,
 kPORT_LowDriveStrength,
 kPORT_MuxAsGpio,
 kPORT_UnlockRegister,
};
```

### Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- config – PORT PCR register configuration structure.

```
static inline void PORT_SetMultipleInterruptPinsConfig(PORT_Type *base, uint32_t mask,
 port_interrupt_t config)
```

Sets the port interrupt configuration in PCR register for multiple pins.

### Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- config – PORT pin interrupt configuration.
  - kPORT\_InterruptOrDMADisabled: Interrupt/DMA request disabled.
  - kPORT\_DMARisingEdge : DMA request on rising edge(if the DMA requests exit).
  - kPORT\_DMAFallingEdge: DMA request on falling edge(if the DMA requests exit).
  - kPORT\_DMAEitherEdge : DMA request on either edge(if the DMA requests exit).
  - kPORT\_FlagRisingEdge : Flag sets on rising edge(if the Flag states exit).
  - kPORT\_FlagFallingEdge : Flag sets on falling edge(if the Flag states exit).
  - kPORT\_FlagEitherEdge : Flag sets on either edge(if the Flag states exit).
  - kPORT\_InterruptLogicZero : Interrupt when logic zero.
  - kPORT\_InterruptRisingEdge : Interrupt on rising edge.
  - kPORT\_InterruptFallingEdge: Interrupt on falling edge.
  - kPORT\_InterruptEitherEdge : Interrupt on either edge.
  - kPORT\_InterruptLogicOne : Interrupt when logic one.

- kPORT\_ActiveHighTriggerOutputEnable : Enable active high-trigger output (if the trigger states exit).
- kPORT\_ActiveLowTriggerOutputEnable : Enable active low-trigger output (if the trigger states exit)..

static inline void PORT\_SetPinMux(PORT\_Type \*base, uint32\_t pin, *port\_mux\_t* mux)

Configures the pin muxing.

---

**Note:** : This function is NOT recommended to use together with the PORT\_SetPinsConfig, because the PORT\_SetPinsConfig need to configure the pin mux anyway (Otherwise the pin mux is reset to zero : kPORT\_PinDisabledOrAnalog). This function is recommended to use to reset the pin mux

---

#### Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.
- mux – pin muxing slot selection.
  - kPORT\_PinDisabledOrAnalog: Pin disabled or work in analog function.
  - kPORT\_MuxAsGpio : Set as GPIO.
  - kPORT\_MuxAlt2 : chip-specific.
  - kPORT\_MuxAlt3 : chip-specific.
  - kPORT\_MuxAlt4 : chip-specific.
  - kPORT\_MuxAlt5 : chip-specific.
  - kPORT\_MuxAlt6 : chip-specific.
  - kPORT\_MuxAlt7 : chip-specific.

static inline void PORT\_EnablePinsDigitalFilter(PORT\_Type \*base, uint32\_t mask, bool enable)

Enables the digital filter in one port, each bit of the 32-bit register represents one pin.

#### Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- enable – PORT digital filter configuration.

static inline void PORT\_SetDigitalFilterConfig(PORT\_Type \*base, const  
*port\_digital\_filter\_config\_t* \*config)

Sets the digital filter in one port, each bit of the 32-bit register represents one pin.

#### Parameters

- base – PORT peripheral base pointer.
- config – PORT digital filter configuration structure.

static inline void PORT\_SetPinInterruptConfig(PORT\_Type \*base, uint32\_t pin, *port\_interrupt\_t*  
config)

Configures the port pin interrupt/DMA request.

#### Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.

- `config` – PORT pin interrupt configuration.
  - `kPORT_InterruptOrDMADisabled`: Interrupt/DMA request disabled.
  - `kPORT_DMARisingEdge` : DMA request on rising edge(if the DMA requests exit).
  - `kPORT_DMAFallingEdge`: DMA request on falling edge(if the DMA requests exit).
  - `kPORT_DMAEitherEdge` : DMA request on either edge(if the DMA requests exit).
  - `kPORT_FlagRisingEdge` : Flag sets on rising edge(if the Flag states exit).
  - `kPORT_FlagFallingEdge` : Flag sets on falling edge(if the Flag states exit).
  - `kPORT_FlagEitherEdge` : Flag sets on either edge(if the Flag states exit).
  - `kPORT_InterruptLogicZero` : Interrupt when logic zero.
  - `kPORT_InterruptRisingEdge` : Interrupt on rising edge.
  - `kPORT_InterruptFallingEdge`: Interrupt on falling edge.
  - `kPORT_InterruptEitherEdge` : Interrupt on either edge.
  - `kPORT_InterruptLogicOne` : Interrupt when logic one.
  - `kPORT_ActiveHighTriggerOutputEnable` : Enable active high-trigger output (if the trigger states exit).
  - `kPORT_ActiveLowTriggerOutputEnable` : Enable active low-trigger output (if the trigger states exit).

`static inline void PORT_SetPinDriveStrength(PORT_Type *base, uint32_t pin, uint8_t strength)`  
Configures the port pin drive strength.

#### Parameters

- `base` – PORT peripheral base pointer.
- `pin` – PORT pin number.
- `strength` – PORT pin drive strength
  - `kPORT_LowDriveStrength = 0U` - Low-drive strength is configured.
  - `kPORT_HighDriveStrength = 1U` - High-drive strength is configured.

`static inline uint32_t PORT_GetPinsInterruptFlags(PORT_Type *base)`  
Reads the whole port status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains set until a logic one is written to that flag. If configured for a level sensitive interrupt that remains asserted, the flag is set again immediately.

#### Parameters

- `base` – PORT peripheral base pointer.

#### Returns

Current port interrupt status flags, for example, `0x00010001` means the pin 0 and 16 have the interrupt.

`static inline void PORT_ClearPinsInterruptFlags(PORT_Type *base, uint32_t mask)`  
Clears the multiple pin interrupt status flag.

#### Parameters

- `base` – PORT peripheral base pointer.

- mask – PORT pin number macro.

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PORT driver version.

enum \_\_port\_pull

Internal resistor pull feature selection.

*Values:*

enumerator kPORT\_PullDisable

Internal pull-up/down resistor is disabled.

enumerator kPORT\_PullDown

Internal pull-down resistor is enabled.

enumerator kPORT\_PullUp

Internal pull-up resistor is enabled.

enum \_\_port\_slew\_rate

Slew rate selection.

*Values:*

enumerator kPORT\_FastSlewRate

Fast slew rate is configured.

enumerator kPORT\_SlowSlewRate

Slow slew rate is configured.

enum \_\_port\_open\_drain\_enable

Open Drain feature enable/disable.

*Values:*

enumerator kPORT\_OpenDrainDisable

Open drain output is disabled.

enumerator kPORT\_OpenDrainEnable

Open drain output is enabled.

enum \_\_port\_passive\_filter\_enable

Passive filter feature enable/disable.

*Values:*

enumerator kPORT\_PassiveFilterDisable

Passive input filter is disabled.

enumerator kPORT\_PassiveFilterEnable

Passive input filter is enabled.

enum \_\_port\_drive\_strength

Configures the drive strength.

*Values:*

enumerator kPORT\_LowDriveStrength

Low-drive strength is configured.

enumerator kPORT\_HighDriveStrength

High-drive strength is configured.



enum `_port_lock_register`

Unlock/lock the pin control register field[15:0].

*Values:*

enumerator `kPORT_UnlockRegister`

Pin Control Register fields [15:0] are not locked.

enumerator `kPORT_LockRegister`

Pin Control Register fields [15:0] are locked.

enum `_port_mux`

Pin mux selection.

*Values:*

enumerator `kPORT_PinDisabledOrAnalog`

Corresponding pin is disabled, but is used as an analog pin.

enumerator `kPORT_MuxAsGpio`

Corresponding pin is configured as GPIO.

enumerator `kPORT_MuxAlt0`

Chip-specific

enumerator `kPORT_MuxAlt1`

Chip-specific

enumerator `kPORT_MuxAlt2`

Chip-specific

enumerator `kPORT_MuxAlt3`

Chip-specific

enumerator `kPORT_MuxAlt4`

Chip-specific

enumerator `kPORT_MuxAlt5`

Chip-specific

enumerator `kPORT_MuxAlt6`

Chip-specific

enumerator `kPORT_MuxAlt7`

Chip-specific

enumerator `kPORT_MuxAlt8`

Chip-specific

enumerator `kPORT_MuxAlt9`

Chip-specific

enumerator `kPORT_MuxAlt10`

Chip-specific

enumerator `kPORT_MuxAlt11`

Chip-specific

enumerator `kPORT_MuxAlt12`

Chip-specific

enumerator `kPORT_MuxAlt13`

Chip-specific

enumerator kPORT\_MuxAlt14

Chip-specific

enumerator kPORT\_MuxAlt15

Chip-specific

enum \_\_port\_interrupt

Configures the interrupt generation condition.

*Values:*

enumerator kPORT\_InterruptOrDMADisabled

Interrupt/DMA request is disabled.

enumerator kPORT\_DMARisingEdge

DMA request on rising edge.

enumerator kPORT\_DMAFallingEdge

DMA request on falling edge.

enumerator kPORT\_DMAEitherEdge

DMA request on either edge.

enumerator kPORT\_FlagRisingEdge

Flag sets on rising edge.

enumerator kPORT\_FlagFallingEdge

Flag sets on falling edge.

enumerator kPORT\_FlagEitherEdge

Flag sets on either edge.

enumerator kPORT\_InterruptLogicZero

Interrupt when logic zero.

enumerator kPORT\_InterruptRisingEdge

Interrupt on rising edge.

enumerator kPORT\_InterruptFallingEdge

Interrupt on falling edge.

enumerator kPORT\_InterruptEitherEdge

Interrupt on either edge.

enumerator kPORT\_InterruptLogicOne

Interrupt when logic one.

enumerator kPORT\_ActiveHighTriggerOutputEnable

Enable active high-trigger output.

enumerator kPORT\_ActiveLowTriggerOutputEnable

Enable active low-trigger output.

enum \_\_port\_digital\_filter\_clock\_source

Digital filter clock source selection.

*Values:*

enumerator kPORT\_BusClock

Digital filters are clocked by the bus clock.

enumerator kPORT\_LpoClock

Digital filters are clocked by the 1 kHz LPO clock.

typedef enum *\_port\_mux* port\_\_mux\_t

Pin mux selection.

typedef enum *\_port\_interrupt* port\_\_interrupt\_t

Configures the interrupt generation condition.

typedef enum *\_port\_digital\_filter\_clock\_source* port\_\_digital\_filter\_clock\_source\_t

Digital filter clock source selection.

typedef struct *\_port\_digital\_filter\_config* port\_\_digital\_filter\_config\_t

PORT digital filter feature configuration definition.

typedef struct *\_port\_pin\_config* port\_\_pin\_config\_t

PORT pin configuration structure.

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struct \_\_port\_digital\_filter\_config

*#include <fsl\_port.h>* PORT digital filter feature configuration definition.

### Public Members

uint32\_t digitalFilterWidth

Set digital filter width

*port\_digital\_filter\_clock\_source\_t* clockSource

Set digital filter clockSource

struct \_\_port\_pin\_config

*#include <fsl\_port.h>* PORT pin configuration structure.

### Public Members

uint16\_t pullSelect

No-pull/pull-down/pull-up select

uint16\_t slewRate

Fast/slow slew rate Configure

uint16\_t passiveFilterEnable

Passive filter enable/disable

uint16\_t openDrainEnable

Open drain enable/disable

uint16\_t driveStrength

Fast/slow drive strength configure

uint16\_t lockRegister

Lock/unlock the PCR field[15:0]

## 2.60 RTC: Real Time Clock

`void RTC_Init(RTC_Type *base, const rtc_config_t *config)`

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

This function issues a software reset if the timer invalid flag is set.

---

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

---

#### Parameters

- `base` – RTC peripheral base address
- `config` – Pointer to the user's RTC configuration structure.

`static inline void RTC_Deinit(RTC_Type *base)`

Stops the timer and gate the RTC clock.

#### Parameters

- `base` – RTC peripheral base address

`void RTC_GetDefaultConfig(rtc_config_t *config)`

Fills in the RTC config struct with the default settings.

The default values are as follows.

```
config->clockOutput = false;
config->wakeupSelect = false;
config->updateMode = false;
config->supervisorAccess = false;
config->compensationInterval = 0;
config->compensationTime = 0;
```

#### Parameters

- `config` – Pointer to the user's RTC configuration structure.

`status_t RTC_SetDatetime(RTC_Type *base, const rtc_datetime_t *datetime)`

Sets the RTC date and time according to the given time structure.

The RTC counter must be stopped prior to calling this function because writes to the RTC seconds register fail if the RTC counter is running.

#### Parameters

- `base` – RTC peripheral base address
- `datetime` – Pointer to the structure where the date and time details are stored.

#### Returns

`kStatus_Success`: Success in setting the time and starting the RTC  
`kStatus_InvalidArgument`: Error because the datetime format is incorrect

`void RTC_GetDatetime(RTC_Type *base, rtc_datetime_t *datetime)`

Gets the RTC time and stores it in the given time structure.

#### Parameters

- `base` – RTC peripheral base address
- `datetime` – Pointer to the structure where the date and time details are stored.

*status\_t* RTC\_SetAlarm(RTC\_Type \*base, const *rtc\_datetime\_t* \*alarmTime)

Sets 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 the 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)

Returns the RTC alarm time.

#### Parameters

- base – RTC peripheral base address
- datetime – Pointer to the structure where the alarm date and time details are stored.

void RTC\_EnableInterrupts(RTC\_Type \*base, uint32\_t mask)

Enables the selected RTC interrupts.

#### 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*

void RTC\_DisableInterrupts(RTC\_Type \*base, uint32\_t mask)

Disables the selected RTC interrupts.

#### 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*

uint32\_t RTC\_GetEnabledInterrupts(RTC\_Type \*base)

Gets the enabled RTC interrupts.

#### Parameters

- base – RTC peripheral base address

#### Returns

The enabled interrupts. This is the logical OR of members of the enumeration *rtc\_interrupt\_enable\_t*

uint32\_t RTC\_GetStatusFlags(RTC\_Type \*base)

Gets 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*

`void RTC_ClearStatusFlags(RTC_Type *base, uint32_t mask)`

Clears 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_EnableLPOClock(RTC_Type *base, bool enable)`

Enable/Disable RTC 1kHz LPO clock.

---

**Note:** After setting this bit, RTC prescaler increments using the LPO 1kHz clock and not the RTC 32kHz crystal clock.

---

**Parameters**

- `base` – RTC peripheral base address
- `enable` – Enable/Disable RTC 1kHz LPO clock

`static inline void RTC_StartTimer(RTC_Type *base)`

Starts the RTC time counter.

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.

RTC's seconds register can be written to only when the timer is stopped.

**Parameters**

- `base` – RTC peripheral base address

`void RTC_GetMonotonicCounter(RTC_Type *base, uint64_t *counter)`

Reads the values of the Monotonic Counter High and Monotonic Counter Low and returns them as a single value.

**Parameters**

- `base` – RTC peripheral base address
- `counter` – Pointer to variable where the value is stored.

`void RTC_SetMonotonicCounter(RTC_Type *base, uint64_t counter)`

Writes values Monotonic Counter High and Monotonic Counter Low by decomposing the given single value. The Monotonic Overflow Flag in `RTC_SR` is cleared due to the API.

**Parameters**

- `base` – RTC peripheral base address
- `counter` – Counter value

`status_t RTC_IncrementMonotonicCounter(RTC_Type *base)`

Increments the Monotonic Counter by one.

Increments the Monotonic Counter (registers RTC\_MCLR and RTC\_MCHR accordingly) by setting the monotonic counter enable (MER[MCE]) and then writing to the RTC\_MCLR register. A write to the monotonic counter low that causes it to overflow also increments the monotonic counter high.

**Parameters**

- base – RTC peripheral base address

**Returns**

kStatus\_Success: success  
kStatus\_Fail: error occurred, either time invalid or monotonic overflow flag was found

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enum \_rtc\_interrupt\_enable

List of RTC interrupts.

*Values:*

enumerator kRTC\_TimeInvalidInterruptEnable

Time invalid interrupt.

enumerator kRTC\_TimeOverflowInterruptEnable

Time overflow interrupt.

enumerator kRTC\_AlarmInterruptEnable

Alarm interrupt.

enumerator kRTC\_MonotonicOverflowInterruptEnable

Monotonic Overflow Interrupt Enable

enumerator kRTC\_SecondsInterruptEnable

Seconds interrupt.

enumerator kRTC\_TestModeInterruptEnable

enumerator kRTC\_FlashSecurityInterruptEnable

enumerator kRTC\_TamperPinInterruptEnable

enumerator kRTC\_SecurityModuleInterruptEnable

enumerator kRTC\_LossOfClockInterruptEnable

enum \_rtc\_status\_flags

List of RTC flags.

*Values:*

enumerator kRTC\_TimeInvalidFlag

Time invalid flag

enumerator kRTC\_TimeOverflowFlag

Time overflow flag

enumerator kRTC\_AlarmFlag

Alarm flag

enumerator kRTC\_MonotonicOverflowFlag

Monotonic Overflow Flag

enumerator kRTC\_TamperInterruptDetectFlag

Tamper interrupt detect flag

enumerator kRTC\_TestModeFlag

enumerator kRTC\_FlashSecurityFlag

enumerator kRTC\_TamperPinFlag

enumerator kRTC\_SecurityTamperFlag

enumerator kRTC\_LossOfClockTamperFlag

enum \_rtc\_osc\_cap\_load

List of RTC Oscillator capacitor load settings.

*Values:*

enumerator kRTC\_Capacitor\_2p

2 pF capacitor load

enumerator kRTC\_Capacitor\_4p

4 pF capacitor load

enumerator kRTC\_Capacitor\_8p

8 pF capacitor load

enumerator kRTC\_Capacitor\_16p

16 pF capacitor load

enum \_rtc\_timer\_seconds\_interrupt\_frequency

List of RTC Timer Seconds Interrupt Frequencies.

*Values:*

enumerator kRTC\_TimerSecondsFrequency1Hz

Timer seconds frequency is 1Hz

enumerator kRTC\_TimerSecondsFrequency2Hz

Timer seconds frequency is 2Hz

enumerator kRTC\_TimerSecondsFrequency4Hz

Timer seconds frequency is 4Hz

enumerator kRTC\_TimerSecondsFrequency8Hz

Timer seconds frequency is 8Hz

enumerator kRTC\_TimerSecondsFrequency16Hz

Timer seconds frequency is 16Hz

enumerator kRTC\_TimerSecondsFrequency32Hz

Timer seconds frequency is 32Hz

enumerator kRTC\_TimerSecondsFrequency64Hz

Timer seconds frequency is 64Hz

enumerator kRTC\_TimerSecondsFrequency128Hz

Timer seconds frequency is 128Hz

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 enum \_rtc\_osc\_cap\_load rtc\_osc\_cap\_load\_t

List of RTC Oscillator capacitor load settings.



```
typedef enum _rtc_timer_seconds_interrupt_frequency rtc_timer_seconds_interrupt_frequency_t
```

List of RTC Timer Seconds Interrupt Frequencies.

```
typedef struct _rtc_datetime rtc_datetime_t
```

Structure is used to hold the date and time.

```
typedef struct _rtc_pin_config rtc_pin_config_t
```

RTC pin config structure.

```
typedef struct _rtc_config rtc_config_t
```

RTC config structure.

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

The config struct can be made const so it resides in flash

```
static inline uint32_t RTC_GetTamperTimeSeconds(RTC_Type *base)
```

Get the RTC tamper time seconds.

#### Parameters

- `base` – RTC peripheral base address

```
static inline void RTC_SetOscCapLoad(RTC_Type *base, uint32_t capLoad)
```

This function sets the specified capacitor configuration for the RTC oscillator.

#### Parameters

- `base` – RTC peripheral base address
- `capLoad` – Oscillator loads to enable. This is a logical OR of members of the enumeration `rtc_osc_cap_load_t`

```
static inline void RTC_Reset(RTC_Type *base)
```

Performs a software reset on the RTC module.

This resets all RTC registers except for the SWR bit and the `RTC_WAR` and `RTC_RAR` registers. The SWR bit is cleared by software explicitly clearing it.

#### Parameters

- `base` – RTC peripheral base address

```
static inline void RTC_EnableWakeUpPin(RTC_Type *base, bool enable)
```

Enables or disables the RTC Wakeup Pin Operation.

This function enable or disable RTC Wakeup Pin. The wakeup pin is optional and not available on all devices.

#### Parameters

- `base` – `RTC_Type` base pointer.
- `enable` – true to enable, false to disable.

```
static inline void RTC_EnableClockOutput(RTC_Type *base, bool enable)
```

Enables or disables the RTC 32 kHz clock output.

This function enables or disables the RTC 32 kHz clock output.

#### Parameters

- `base` – `RTC_Type` base pointer.
- `enable` – true to enable, false to disable.

```
void RTC_SetTimerSecondsInterruptFrequency(RTC_Type *base,
 rtc_timer_seconds_interrupt_frequency_t freq)
```

Sets the RTC timer seconds interrupt frequency.

This function sets the RTC timer seconds interrupt frequency.

#### Parameters

- base – RTC peripheral base address
- freq – The timer seconds interrupt frequency. This is a member of the enumeration `rtc_timer_seconds_interrupt_frequency_t`

```
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.

```
struct _rtc_pin_config
```

*#include <fsl\_rtc.h>* RTC pin config structure.

#### Public Members

```
bool inputLogic
```

true: Tamper pin input data is logic one. false: Tamper pin input data is logic zero.

```
bool pinActiveLow
```

true: Tamper pin is active low. false: Tamper pin is active high.

```
bool filterEnable
```

true: Input filter is enabled on the tamper pin. false: Input filter is disabled on the tamper pin.

```
bool pullSelectNegate
```

true: Tamper pin pull resistor direction will negate the tamper pin. false: Tamper pin pull resistor direction will assert the tamper pin.

```
bool pullEnable
```

true: Pull resistor is enabled on tamper pin. false: Pull resistor is disabled on tamper pin.

struct `_rtc_config`

*#include <fsl\_rtc.h>* RTC config structure.

This structure holds the configuration settings for the RTC peripheral. To initialize this structure to reasonable defaults, call the `RTC_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 `clockOutput`

true: The 32 kHz clock is not output to other peripherals; false: The 32 kHz clock is output to other peripherals

bool `wakeupSelect`

true: Wakeup pin outputs the 32 KHz clock; false: Wakeup pin used to wakeup the chip

bool `updateMode`

true: Registers can be written even when locked under certain conditions, false: No writes allowed when registers are locked

bool `supervisorAccess`

true: Non-supervisor accesses are allowed; false: Non-supervisor accesses are not supported

uint32\_t `compensationInterval`

Compensation interval that is written to the CIR field in RTC TCR Register

uint32\_t `compensationTime`

Compensation time that is written to the TCR field in RTC TCR Register

## 2.61 SAI: Serial Audio Interface

### 2.62 SAI Driver

void `SAI_Init(I2S_Type *base)`

Initializes the SAI peripheral.

This API gates the SAI clock. The SAI module can't operate unless `SAI_Init` is called to enable the clock.

#### Parameters

- `base` – SAI base pointer.

void `SAI_Deinit(I2S_Type *base)`

De-initializes the SAI peripheral.

This API gates the SAI clock. The SAI module can't operate unless `SAI_TxInit` or `SAI_RxInit` is called to enable the clock.

#### Parameters

- `base` – SAI base pointer.

`void SAI_TxReset(I2S_Type *base)`

Resets the SAI Tx.

This function enables the software reset and FIFO reset of SAI Tx. After reset, clear the reset bit.

**Parameters**

- `base` – SAI base pointer

`void SAI_RxReset(I2S_Type *base)`

Resets the SAI Rx.

This function enables the software reset and FIFO reset of SAI Rx. After reset, clear the reset bit.

**Parameters**

- `base` – SAI base pointer

`void SAI_TxEnable(I2S_Type *base, bool enable)`

Enables/disables the SAI Tx.

**Parameters**

- `base` – SAI base pointer.
- `enable` – True means enable SAI Tx, false means disable.

`void SAI_RxEnable(I2S_Type *base, bool enable)`

Enables/disables the SAI Rx.

**Parameters**

- `base` – SAI base pointer.
- `enable` – True means enable SAI Rx, false means disable.

`static inline void SAI_TxSetBitClockDirection(I2S_Type *base, sai_master_slave_t masterSlave)`

Set Rx bit clock direction.

Select bit clock direction, master or slave.

**Parameters**

- `base` – SAI base pointer.
- `masterSlave` – reference `sai_master_slave_t`.

`static inline void SAI_RxSetBitClockDirection(I2S_Type *base, sai_master_slave_t masterSlave)`

Set Rx bit clock direction.

Select bit clock direction, master or slave.

**Parameters**

- `base` – SAI base pointer.
- `masterSlave` – reference `sai_master_slave_t`.

`static inline void SAI_RxSetFrameSyncDirection(I2S_Type *base, sai_master_slave_t masterSlave)`

Set Rx frame sync direction.

Select frame sync direction, master or slave.

**Parameters**

- `base` – SAI base pointer.
- `masterSlave` – reference `sai_master_slave_t`.

```
static inline void SAI_TxSetFrameSyncDirection(I2S_Type *base, sai_master_slave_t masterSlave)
```

Set Tx frame sync direction.

Select frame sync direction, master or slave.

#### Parameters

- base – SAI base pointer.
- masterSlave – reference sai\_master\_slave\_t.

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

Transmitter bit clock rate configurations.

#### Parameters

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

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

Receiver bit clock rate configurations.

#### Parameters

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

```
void SAI_TxSetBitclockConfig(I2S_Type *base, sai_master_slave_t masterSlave, sai_bit_clock_t
 *config)
```

Transmitter Bit clock configurations.

#### Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – bit clock other configurations, can be NULL in slave mode.

```
void SAI_RxSetBitclockConfig(I2S_Type *base, sai_master_slave_t masterSlave, sai_bit_clock_t
 *config)
```

Receiver Bit clock configurations.

#### Parameters

- base – SAI base pointer.
- masterSlave – master or slave.
- config – bit clock other configurations, can be NULL in slave mode.

```
void SAI_SetMasterClockConfig(I2S_Type *base, sai_master_clock_t *config)
```

Master clock configurations.

#### Parameters

- base – SAI base pointer.
- config – master clock configurations.

void SAI\_TxSetFifoConfig(I2S\_Type \*base, *sai\_fifo\_t* \*config)  
SAI transmitter fifo configurations.

**Parameters**

- base – SAI base pointer.
- config – fifo configurations.

void SAI\_RxSetFifoConfig(I2S\_Type \*base, *sai\_fifo\_t* \*config)  
SAI receiver fifo configurations.

**Parameters**

- base – SAI base pointer.
- config – fifo configurations.

void SAI\_TxSetFrameSyncConfig(I2S\_Type \*base, *sai\_master\_slave\_t* masterSlave,  
*sai\_frame\_sync\_t* \*config)

SAI transmitter Frame sync configurations.

**Parameters**

- base – SAI base pointer.
- masterSlave – master or slave.
- config – frame sync configurations, can be NULL in slave mode.

void SAI\_RxSetFrameSyncConfig(I2S\_Type \*base, *sai\_master\_slave\_t* masterSlave,  
*sai\_frame\_sync\_t* \*config)

SAI receiver Frame sync configurations.

**Parameters**

- base – SAI base pointer.
- masterSlave – master or slave.
- config – frame sync configurations, can be NULL in slave mode.

void SAI\_TxSetSerialDataConfig(I2S\_Type \*base, *sai\_serial\_data\_t* \*config)  
SAI transmitter Serial data configurations.

**Parameters**

- base – SAI base pointer.
- config – serial data configurations.

void SAI\_RxSetSerialDataConfig(I2S\_Type \*base, *sai\_serial\_data\_t* \*config)  
SAI receiver Serial data configurations.

**Parameters**

- base – SAI base pointer.
- config – serial data configurations.

void SAI\_TxSetConfig(I2S\_Type \*base, *sai\_transceiver\_t* \*config)  
SAI transmitter configurations.

**Parameters**

- base – SAI base pointer.
- config – transmitter configurations.

void SAI\_RxSetConfig(I2S\_Type \*base, sai\_transceiver\_t \*config)

SAI receiver configurations.

**Parameters**

- base – SAI base pointer.
- config – receiver configurations.

void SAI\_GetClassicI2SConfig(sai\_transceiver\_t \*config, sai\_word\_width\_t bitWidth,  
sai\_mono\_stereo\_t mode, uint32\_t saiChannelMask)

Get classic I2S mode configurations.

**Parameters**

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI\_GetLeftJustifiedConfig(sai\_transceiver\_t \*config, sai\_word\_width\_t bitWidth,  
sai\_mono\_stereo\_t mode, uint32\_t saiChannelMask)

Get left justified mode configurations.

**Parameters**

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI\_GetRightJustifiedConfig(sai\_transceiver\_t \*config, sai\_word\_width\_t bitWidth,  
sai\_mono\_stereo\_t mode, uint32\_t saiChannelMask)

Get right justified mode configurations.

**Parameters**

- config – transceiver configurations.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to be enable.

void SAI\_GetTDMConfig(sai\_transceiver\_t \*config, sai\_frame\_sync\_len\_t frameSyncWidth,  
sai\_word\_width\_t bitWidth, uint32\_t dataWordNum, uint32\_t  
saiChannelMask)

Get TDM mode configurations.

**Parameters**

- config – transceiver configurations.
- frameSyncWidth – length of frame sync.
- bitWidth – audio data word width.
- dataWordNum – word number in one frame.
- saiChannelMask – mask value of the channel to be enable.

```
void SAI_GetDSPConfig(sai_transceiver_t *config, sai_frame_sync_len_t frameSyncWidth,
 sai_word_width_t bitWidth, sai_mono_stereo_t mode, uint32_t
 saiChannelMask)
```

Get DSP mode configurations.

DSP/PCM MODE B configuration flow for TX. RX is similiar but uses SAI\_RxSetConfig instead of SAI\_TxSetConfig:

```
SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth, kSAI_Stereo, channelMask)
SAI_TxSetConfig(base, config)
```

**Note:** DSP mode is also called PCM mode which support MODE A and MODE B, DSP/PCM MODE A configuration flow. RX is similiar but uses SAI\_RxSetConfig instead of SAI\_TxSetConfig:

```
SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth, kSAI_Stereo, channelMask)
config->frameSync.frameSyncEarly = true;
SAI_TxSetConfig(base, config)
```

### Parameters

- config – transceiver configurations.
- frameSyncWidth – length of frame sync.
- bitWidth – audio data bitWidth.
- mode – audio data channel.
- saiChannelMask – mask value of the channel to enable.

```
static inline uint32_t SAI_TxGetStatusFlag(I2S_Type *base)
```

Gets the SAI Tx status flag state.

### Parameters

- base – SAI base pointer

### Returns

SAI Tx status flag value. Use the Status Mask to get the status value needed.

```
static inline void SAI_TxClearStatusFlags(I2S_Type *base, uint32_t mask)
```

Clears the SAI Tx status flag state.

### Parameters

- base – SAI base pointer
- mask – State mask. It can be a combination of the following source if defined:
  - kSAI\_WordStartFlag
  - kSAI\_SyncErrorFlag
  - kSAI\_FIFOErrorFlag

```
static inline uint32_t SAI_RxGetStatusFlag(I2S_Type *base)
```

Gets the SAI Tx status flag state.

### Parameters

- base – SAI base pointer



**Returns**

SAI Rx status flag value. Use the Status Mask to get the status value needed.

```
static inline void SAI_RxClearStatusFlags(I2S_Type *base, uint32_t mask)
```

Clears the SAI Rx status flag state.

**Parameters**

- base – SAI base pointer
- mask – State mask. It can be a combination of the following sources if defined.
  - kSAI\_WordStartFlag
  - kSAI\_SyncErrorFlag
  - kSAI\_FIFOErrorFlag

```
void SAI_TxSoftwareReset(I2S_Type *base, sai_reset_type_t resetType)
```

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Tx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like TCR1~TCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

**Parameters**

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

```
void SAI_RxSoftwareReset(I2S_Type *base, sai_reset_type_t resetType)
```

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Rx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like RCR1~RCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

**Parameters**

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

```
void SAI_TxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)
```

Set the Tx channel FIFO enable mask.

**Parameters**

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

```
void SAI_RxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)
```

Set the Rx channel FIFO enable mask.

**Parameters**

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

void SAI\_TxSetDataOrder(I2S\_Type \*base, sai\_data\_order\_t order)

Set the Tx data order.

**Parameters**

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI\_RxSetDataOrder(I2S\_Type \*base, sai\_data\_order\_t order)

Set the Rx data order.

**Parameters**

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI\_TxSetBitClockPolarity(I2S\_Type \*base, sai\_clock\_polarity\_t polarity)

Set the Tx data order.

**Parameters**

- base – SAI base pointer
- polarity –

void SAI\_RxSetBitClockPolarity(I2S\_Type \*base, sai\_clock\_polarity\_t polarity)

Set the Rx data order.

**Parameters**

- base – SAI base pointer
- polarity –

void SAI\_TxSetFrameSyncPolarity(I2S\_Type \*base, sai\_clock\_polarity\_t polarity)

Set the Tx data order.

**Parameters**

- base – SAI base pointer
- polarity –

void SAI\_RxSetFrameSyncPolarity(I2S\_Type \*base, sai\_clock\_polarity\_t polarity)

Set the Rx data order.

**Parameters**

- base – SAI base pointer
- polarity –

void SAI\_TxSetFIFOPacking(I2S\_Type \*base, sai\_fifo\_packing\_t pack)

Set Tx FIFO packing feature.

**Parameters**

- base – SAI base pointer.
- pack – FIFO pack type. It is element of sai\_fifo\_packing\_t.

void SAI\_RxSetFIFOPacking(I2S\_Type \*base, sai\_fifo\_packing\_t pack)

Set Rx FIFO packing feature.

**Parameters**

- base – SAI base pointer.
- pack – FIFO pack type. It is element of sai\_fifo\_packing\_t.

```
static inline void SAI_TxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)
```

Set Tx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in TCSR register.

#### Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

```
static inline void SAI_RxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)
```

Set Rx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in RCSR register.

#### Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

```
static inline void SAI_TxEnableInterrupts(I2S_Type *base, uint32_t mask)
```

Enables the SAI Tx interrupt requests.

#### Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI\_WordStartInterruptEnable
  - kSAI\_SyncErrorInterruptEnable
  - kSAI\_FIFOWarningInterruptEnable
  - kSAI\_FIFORequestInterruptEnable
  - kSAI\_FIFOErrorInterruptEnable

```
static inline void SAI_RxEnableInterrupts(I2S_Type *base, uint32_t mask)
```

Enables the SAI Rx interrupt requests.

#### Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
  - kSAI\_WordStartInterruptEnable
  - kSAI\_SyncErrorInterruptEnable
  - kSAI\_FIFOWarningInterruptEnable
  - kSAI\_FIFORequestInterruptEnable
  - kSAI\_FIFOErrorInterruptEnable

```
static inline void SAI_TxDisableInterrupts(I2S_Type *base, uint32_t mask)
```

Disables the SAI Tx interrupt requests.

#### Parameters

- base – SAI base pointer

- **mask – interrupt source** The parameter can be a combination of the following sources if defined.
  - kSAI\_WordStartInterruptEnable
  - kSAI\_SyncErrorInterruptEnable
  - kSAI\_FIFOWarningInterruptEnable
  - kSAI\_FIFORequestInterruptEnable
  - kSAI\_FIFOErrorInterruptEnable

static inline void SAI\_RxDisableInterrupts(I2S\_Type \*base, uint32\_t mask)

Disables the SAI Rx interrupt requests.

#### Parameters

- **base – SAI base pointer**
- **mask – interrupt source** The parameter can be a combination of the following sources if defined.
  - kSAI\_WordStartInterruptEnable
  - kSAI\_SyncErrorInterruptEnable
  - kSAI\_FIFOWarningInterruptEnable
  - kSAI\_FIFORequestInterruptEnable
  - kSAI\_FIFOErrorInterruptEnable

static inline void SAI\_TxEnableDMA(I2S\_Type \*base, uint32\_t mask, bool enable)

Enables/disables the SAI Tx DMA requests.

#### Parameters

- **base – SAI base pointer**
- **mask – DMA source** The parameter can be combination of the following sources if defined.
  - kSAI\_FIFOWarningDMAEnable
  - kSAI\_FIFORequestDMAEnable
- **enable – True means enable DMA, false means disable DMA.**

static inline void SAI\_RxEnableDMA(I2S\_Type \*base, uint32\_t mask, bool enable)

Enables/disables the SAI Rx DMA requests.

#### Parameters

- **base – SAI base pointer**
- **mask – DMA source** The parameter can be a combination of the following sources if defined.
  - kSAI\_FIFOWarningDMAEnable
  - kSAI\_FIFORequestDMAEnable
- **enable – True means enable DMA, false means disable DMA.**

static inline uintptr\_t SAI\_TxGetDataRegisterAddress(I2S\_Type \*base, uint32\_t channel)

Gets the SAI Tx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

#### Parameters

- **base – SAI base pointer.**

- channel – Which data channel used.

**Returns**

data register address.

```
static inline uintptr_t SAI_RxGetDataRegisterAddress(I2S_Type *base, uint32_t channel)
```

Gets the SAI Rx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

**Parameters**

- base – SAI base pointer.
- channel – Which data channel used.

**Returns**

data register address.

```
void SAI_WriteBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer,
 uint32_t size)
```

Sends data using a blocking method.

---

**Note:** This function blocks by polling until data is ready to be sent.

---

**Parameters**

- base – SAI base pointer.
- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

```
void SAI_WriteMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask,
 uint32_t bitWidth, uint8_t *buffer, uint32_t size)
```

Sends data to multi channel using a blocking method.

---

**Note:** This function blocks by polling until data is ready to be sent.

---

**Parameters**

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

```
static inline void SAI_WriteData(I2S_Type *base, uint32_t channel, uint32_t data)
```

Writes data into SAI FIFO.

**Parameters**

- base – SAI base pointer.
- channel – Data channel used.

- data – Data needs to be written.

```
void SAI_ReadBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer,
 uint32_t size)
```

Receives data using a blocking method.

---

**Note:** This function blocks by polling until data is ready to be sent.

---

#### Parameters

- base – SAI base pointer.
- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

```
void SAI_ReadMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask,
 uint32_t bitWidth, uint8_t *buffer, uint32_t size)
```

Receives multi channel data using a blocking method.

---

**Note:** This function blocks by polling until data is ready to be sent.

---

#### Parameters

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

```
static inline uint32_t SAI_ReadData(I2S_Type *base, uint32_t channel)
```

Reads data from the SAI FIFO.

#### Parameters

- base – SAI base pointer.
- channel – Data channel used.

#### Returns

Data in SAI FIFO.

```
void SAI_TransferTxCreateHandle(I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t
 callback, void *userData)
```

Initializes the SAI Tx handle.

This function initializes the Tx handle for the SAI Tx transactional APIs. Call this function once to get the handle initialized.

#### Parameters

- base – SAI base pointer
- handle – SAI handle pointer.
- callback – Pointer to the user callback function.

- `userData` – User parameter passed to the callback function

`void SAI_TransferRxCreateHandle(I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t callback, void *userData)`

Initializes the SAI Rx handle.

This function initializes the Rx handle for the SAI Rx transactional APIs. Call this function once to get the handle initialized.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI handle pointer.
- `callback` – Pointer to the user callback function.
- `userData` – User parameter passed to the callback function.

`void SAI_TransferTxSetConfig(I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)`  
SAI transmitter transfer configurations.

This function initializes the Tx, include bit clock, frame sync, master clock, serial data and fifo configurations.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI handle pointer.
- `config` – transmitter configurations.

`void SAI_TransferRxSetConfig(I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)`  
SAI receiver transfer configurations.

This function initializes the Rx, include bit clock, frame sync, master clock, serial data and fifo configurations.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI handle pointer.
- `config` – receiver configurations.

`status_t SAI_TransferSendNonBlocking(I2S_Type *base, sai_handle_t *handle, sai_transfer_t *xfer)`

Performs an interrupt non-blocking send transfer on SAI.

---

**Note:** This API returns immediately after the transfer initiates. Call the `SAI_TxGetTransferStatusIRQ` to poll the transfer status and check whether the transfer is finished. If the return status is not `kStatus_SAI_Busy`, the transfer is finished.

---

#### Parameters

- `base` – SAI base pointer.
- `handle` – Pointer to the `sai_handle_t` structure which stores the transfer state.
- `xfer` – Pointer to the `sai_transfer_t` structure.

#### Return values

- `kStatus_Success` – Successfully started the data receive.

- `kStatus_SAI_TxBusy` – Previous receive still not finished.
- `kStatus_InvalidArgument` – The input parameter is invalid.

*status\_t* SAI\_TransferReceiveNonBlocking(I2S\_Type \*base, *sai\_handle\_t* \*handle, *sai\_transfer\_t* \*xfer)

Performs an interrupt non-blocking receive transfer on SAI.

---

**Note:** This API returns immediately after the transfer initiates. Call the `SAI_RxGetTransferStatusIRQ` to poll the transfer status and check whether the transfer is finished. If the return status is not `kStatus_SAI_Busy`, the transfer is finished.

---

#### Parameters

- `base` – SAI base pointer
- `handle` – Pointer to the `sai_handle_t` structure which stores the transfer state.
- `xfer` – Pointer to the `sai_transfer_t` structure.

#### Return values

- `kStatus_Success` – Successfully started the data receive.
- `kStatus_SAI_RxBusy` – Previous receive still not finished.
- `kStatus_InvalidArgument` – The input parameter is invalid.

*status\_t* SAI\_TransferGetSendCount(I2S\_Type \*base, *sai\_handle\_t* \*handle, *size\_t* \*count)

Gets a set byte count.

#### Parameters

- `base` – SAI base pointer.
- `handle` – Pointer to the `sai_handle_t` structure which stores the transfer state.
- `count` – Bytes count sent.

#### Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.

*status\_t* SAI\_TransferGetReceiveCount(I2S\_Type \*base, *sai\_handle\_t* \*handle, *size\_t* \*count)

Gets a received byte count.

#### Parameters

- `base` – SAI base pointer.
- `handle` – Pointer to the `sai_handle_t` structure which stores the transfer state.
- `count` – Bytes count received.

#### Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.



```
void SAI_TransferAbortSend(I2S_Type *base, sai_handle_t *handle)
```

Aborts the current send.

---

**Note:** This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

---

#### Parameters

- base – SAI base pointer.
- handle – Pointer to the `sai_handle_t` structure which stores the transfer state.

```
void SAI_TransferAbortReceive(I2S_Type *base, sai_handle_t *handle)
```

Aborts the current IRQ receive.

---

**Note:** This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

---

#### Parameters

- base – SAI base pointer
- handle – Pointer to the `sai_handle_t` structure which stores the transfer state.

```
void SAI_TransferTerminateSend(I2S_Type *base, sai_handle_t *handle)
```

Terminate all SAI send.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call `SAI_TransferAbortSend`.

#### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

```
void SAI_TransferTerminateReceive(I2S_Type *base, sai_handle_t *handle)
```

Terminate all SAI receive.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call `SAI_TransferAbortReceive`.

#### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

```
void SAI_TransferTxHandleIRQ(I2S_Type *base, sai_handle_t *handle)
```

Tx interrupt handler.

#### Parameters

- base – SAI base pointer.
- handle – Pointer to the `sai_handle_t` structure.

```
void SAI_TransferRxHandleIRQ(I2S_Type *base, sai_handle_t *handle)
```

Tx interrupt handler.

#### Parameters

- base – SAI base pointer.

- handle – Pointer to the sai\_handle\_t structure.

void SAI\_DriverIRQHandler(uint32\_t instance)

SAI driver IRQ handler common entry.

This function provides the common IRQ request entry for SAI.

#### Parameters

- instance – SAI instance.

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\_sai\_status\_t, SAI return status.

*Values:*

enumerator kStatus\_SAI\_TxBusy

SAI Tx is busy.

enumerator kStatus\_SAI\_RxBusy

SAI Rx is busy.

enumerator kStatus\_SAI\_TxError

SAI Tx FIFO error.

enumerator kStatus\_SAI\_RxError

SAI Rx FIFO error.

enumerator kStatus\_SAI\_QueueFull

SAI transfer queue is full.

enumerator kStatus\_SAI\_TxIdle

SAI Tx is idle

enumerator kStatus\_SAI\_RxIdle

SAI Rx is idle

\_sai\_channel\_mask, sai channel mask value, actual channel numbers is depend soc specific

*Values:*

enumerator kSAI\_Channel0Mask

channel 0 mask value

enumerator kSAI\_Channel1Mask

channel 1 mask value

enumerator kSAI\_Channel2Mask

channel 2 mask value

enumerator kSAI\_Channel3Mask

channel 3 mask value

enumerator kSAI\_Channel4Mask

channel 4 mask value

enumerator kSAI\_Channel5Mask

channel 5 mask value

enumerator kSAI\_Channel6Mask

channel 6 mask value

enumerator kSAI\_Channel7Mask  
channel 7 mask value

enum \_sai\_protocol

Define the SAI bus type.

*Values:*

enumerator kSAI\_BusLeftJustified  
Uses left justified format.

enumerator kSAI\_BusRightJustified  
Uses right justified format.

enumerator kSAI\_BusI2S  
Uses I2S format.

enumerator kSAI\_BusPCMA  
Uses I2S PCM A format.

enumerator kSAI\_BusPCMB  
Uses I2S PCM B format.

enum \_sai\_master\_slave

Master or slave mode.

*Values:*

enumerator kSAI\_Master  
Master mode include bclk and frame sync

enumerator kSAI\_Slave  
Slave mode include bclk and frame sync

enumerator kSAI\_Bclk\_Master\_FrameSync\_Slave  
bclk in master mode, frame sync in slave mode

enumerator kSAI\_Bclk\_Slave\_FrameSync\_Master  
bclk in slave mode, frame sync in master mode

enum \_sai\_mono\_stereo

Mono or stereo audio format.

*Values:*

enumerator kSAI\_Stereo  
Stereo sound.

enumerator kSAI\_MonoRight  
Only Right channel have sound.

enumerator kSAI\_MonoLeft  
Only left channel have sound.

enum \_sai\_data\_order

SAI data order, MSB or LSB.

*Values:*

enumerator kSAI\_DataLSB  
LSB bit transferred first

enumerator kSAI\_DataMSB  
MSB bit transferred first

enum \_sai\_clock\_polarity

SAI clock polarity, active high or low.

*Values:*

enumerator kSAI\_PolarityActiveHigh

Drive outputs on rising edge

enumerator kSAI\_PolarityActiveLow

Drive outputs on falling edge

enumerator kSAI\_SampleOnFallingEdge

Sample inputs on falling edge

enumerator kSAI\_SampleOnRisingEdge

Sample inputs on rising edge

enum \_sai\_sync\_mode

Synchronous or asynchronous mode.

*Values:*

enumerator kSAI\_ModeAsync

Asynchronous mode

enumerator kSAI\_ModeSync

Synchronous mode (with receiver or transmit)

enumerator kSAI\_ModeSyncWithOtherTx

Synchronous with another SAI transmit

enumerator kSAI\_ModeSyncWithOtherRx

Synchronous with another SAI receiver

enum \_sai\_bclk\_source

Bit clock source.

*Values:*

enumerator kSAI\_BclkSourceBusclk

Bit clock using bus clock

enumerator kSAI\_BclkSourceMclkOption1

Bit clock MCLK option 1

enumerator kSAI\_BclkSourceMclkOption2

Bit clock MCLK option2

enumerator kSAI\_BclkSourceMclkOption3

Bit clock MCLK option3

enumerator kSAI\_BclkSourceMclkDiv

Bit clock using master clock divider

enumerator kSAI\_BclkSourceOtherSai0

Bit clock from other SAI device

enumerator kSAI\_BclkSourceOtherSai1

Bit clock from other SAI device

\_sai\_interrupt\_enable\_t, The SAI interrupt enable flag

*Values:*

enumerator kSAI\_WordStartInterruptEnable

Word start flag, means the first word in a frame detected

enumerator kSAI\_SyncErrorInterruptEnable

Sync error flag, means the sync error is detected

enumerator kSAI\_FIFOWarningInterruptEnable

FIFO warning flag, means the FIFO is empty

enumerator kSAI\_FIFOErrorInterruptEnable

FIFO error flag

enumerator kSAI\_FIFORequestInterruptEnable

FIFO request, means reached watermark

\_sai\_dma\_enable\_t, The DMA request sources

*Values:*

enumerator kSAI\_FIFOWarningDMAEnable

FIFO warning caused by the DMA request

enumerator kSAI\_FIFORequestDMAEnable

FIFO request caused by the DMA request

\_sai\_flags, The SAI status flag

*Values:*

enumerator kSAI\_WordStartFlag

Word start flag, means the first word in a frame detected

enumerator kSAI\_SyncErrorFlag

Sync error flag, means the sync error is detected

enumerator kSAI\_FIFOErrorFlag

FIFO error flag

enumerator kSAI\_FIFORequestFlag

FIFO request flag.

enumerator kSAI\_FIFOWarningFlag

FIFO warning flag

enum \_sai\_reset\_type

The reset type.

*Values:*

enumerator kSAI\_ResetTypeSoftware

Software reset, reset the logic state

enumerator kSAI\_ResetTypeFIFO

FIFO reset, reset the FIFO read and write pointer

enumerator kSAI\_ResetAll

All reset.

enum \_sai\_fifo\_packing

The SAI packing mode The mode includes 8 bit and 16 bit packing.

*Values:*

enumerator kSAI\_FifoPackingDisabled  
Packing disabled

enumerator kSAI\_FifoPacking8bit  
8 bit packing enabled

enumerator kSAI\_FifoPacking16bit  
16bit packing enabled

enum \_sai\_sample\_rate  
Audio sample rate.

*Values:*

enumerator kSAI\_SampleRate8KHz  
Sample rate 8000 Hz

enumerator kSAI\_SampleRate11025Hz  
Sample rate 11025 Hz

enumerator kSAI\_SampleRate12KHz  
Sample rate 12000 Hz

enumerator kSAI\_SampleRate16KHz  
Sample rate 16000 Hz

enumerator kSAI\_SampleRate22050Hz  
Sample rate 22050 Hz

enumerator kSAI\_SampleRate24KHz  
Sample rate 24000 Hz

enumerator kSAI\_SampleRate32KHz  
Sample rate 32000 Hz

enumerator kSAI\_SampleRate44100Hz  
Sample rate 44100 Hz

enumerator kSAI\_SampleRate48KHz  
Sample rate 48000 Hz

enumerator kSAI\_SampleRate96KHz  
Sample rate 96000 Hz

enumerator kSAI\_SampleRate192KHz  
Sample rate 192000 Hz

enumerator kSAI\_SampleRate384KHz  
Sample rate 384000 Hz

enum \_sai\_word\_width  
Audio word width.

*Values:*

enumerator kSAI\_WordWidth8bits  
Audio data width 8 bits

enumerator kSAI\_WordWidth16bits  
Audio data width 16 bits

enumerator kSAI\_WordWidth24bits  
Audio data width 24 bits

enumerator kSAI\_WordWidth32bits

Audio data width 32 bits

enum \_sai\_data\_pin\_state

sai data pin state definition

*Values:*

enumerator kSAI\_DataPinStateTriState

transmit data pins are tri-stated when slots are masked or channels are disabled

enumerator kSAI\_DataPinStateOutputZero

transmit data pins are never tri-stated and will output zero when slots are masked or channel disabled

enum \_sai\_fifo\_combine

sai fifo combine mode definition

*Values:*

enumerator kSAI\_FifoCombineDisabled

sai TX/RX fifo combine mode disabled

enumerator kSAI\_FifoCombineModeEnabledOnRead

sai TX fifo combine mode enabled on FIFO reads

enumerator kSAI\_FifoCombineModeEnabledOnWrite

sai TX fifo combine mode enabled on FIFO write

enumerator kSAI\_RxFifoCombineModeEnabledOnWrite

sai RX fifo combine mode enabled on FIFO write

enumerator kSAI\_RXFifoCombineModeEnabledOnRead

sai RX fifo combine mode enabled on FIFO reads

enumerator kSAI\_FifoCombineModeEnabledOnReadWrite

sai TX/RX fifo combined mode enabled on FIFO read/writes

enum \_sai\_transceiver\_type

sai transceiver type

*Values:*

enumerator kSAI\_Transmitter

sai transmitter

enumerator kSAI\_Receiver

sai receiver

enum \_sai\_frame\_sync\_len

sai frame sync len

*Values:*

enumerator kSAI\_FrameSyncLenOneBitClk

1 bit clock frame sync len for DSP mode

enumerator kSAI\_FrameSyncLenPerWordWidth

Frame sync length decided by word width

typedef enum \_sai\_protocol sai\_protocol\_t

Define the SAI bus type.

`typedef enum _sai_master_slave sai_master_slave_t`  
Master or slave mode.

`typedef enum _sai_mono_stereo sai_mono_stereo_t`  
Mono or stereo audio format.

`typedef enum _sai_data_order sai_data_order_t`  
SAI data order, MSB or LSB.

`typedef enum _sai_clock_polarity sai_clock_polarity_t`  
SAI clock polarity, active high or low.

`typedef enum _sai_sync_mode sai_sync_mode_t`  
Synchronous or asynchronous mode.

`typedef enum _sai_bclk_source sai_bclk_source_t`  
Bit clock source.

`typedef enum _sai_reset_type sai_reset_type_t`  
The reset type.

`typedef enum _sai_fifo_packing sai_fifo_packing_t`  
The SAI packing mode The mode includes 8 bit and 16 bit packing.

`typedef struct _sai_config sai_config_t`  
SAI user configuration structure.

`typedef enum _sai_sample_rate sai_sample_rate_t`  
Audio sample rate.

`typedef enum _sai_word_width sai_word_width_t`  
Audio word width.

`typedef enum _sai_data_pin_state sai_data_pin_state_t`  
sai data pin state definition

`typedef enum _sai_fifo_combine sai_fifo_combine_t`  
sai fifo combine mode definition

`typedef enum _sai_transceiver_type sai_transceiver_type_t`  
sai transceiver type

`typedef enum _sai_frame_sync_len sai_frame_sync_len_t`  
sai frame sync len

`typedef struct _sai_transfer_format sai_transfer_format_t`  
sai transfer format

`typedef struct _sai_master_clock sai_master_clock_t`  
master clock configurations

`typedef struct _sai_fifo sai_fifo_t`  
sai fifo configurations

`typedef struct _sai_bit_clock sai_bit_clock_t`  
sai bit clock configurations

`typedef struct _sai_frame_sync sai_frame_sync_t`  
sai frame sync configurations

`typedef struct _sai_serial_data sai_serial_data_t`  
sai serial data configurations



```
typedef struct _sai_transceiver sai_transceiver_t
 sai transceiver configurations
typedef struct _sai_transfer sai_transfer_t
 SAI transfer structure.
typedef struct _sai_handle sai_handle_t

typedef void (*sai_transfer_callback_t)(I2S_Type *base, sai_handle_t *handle, status_t status,
void *userData)
 SAI transfer callback prototype.
SAI_XFER_QUEUE_SIZE
 SAI transfer queue size, user can refine it according to use case.
FSL_SAI_HAS_FIFO_EXTEND_FEATURE
 sai fifo feature
struct _sai_config
 #include <fsl_sai.h> SAI user configuration structure.
```

### Public Members

```
sai_protocol_t protocol
 Audio bus protocol in SAI
sai_sync_mode_t syncMode
 SAI sync mode, control Tx/Rx clock sync
bool mclkOutputEnable
 Master clock output enable, true means master clock divider enabled
sai_bclk_source_t bclkSource
 Bit Clock source
sai_master_slave_t masterSlave
 Master or slave
struct _sai_transfer_format
 #include <fsl_sai.h> sai transfer format
```

### Public Members

```
uint32_t sampleRate_Hz
 Sample rate of audio data
uint32_t bitWidth
 Data length of audio data, usually 8/16/24/32 bits
sai_mono_stereo_t stereo
 Mono or stereo
uint32_t masterClockHz
 Master clock frequency in Hz
uint8_t watermark
 Watermark value
uint8_t channel
 Transfer start channel
```

uint8\_t channelMask

enabled channel mask value, reference `_sai_channel_mask`

uint8\_t endChannel

end channel number

uint8\_t channelNums

Total enabled channel numbers

*sai\_protocol\_t* protocol

Which audio protocol used

bool isFrameSyncCompact

True means Frame sync length is configurable according to bitWidth, false means frame sync length is 64 times of bit clock.

struct `_sai_master_clock`

*#include <fsl\_sai.h>* master clock configurations

### Public Members

bool mclkOutputEnable

master clock output enable

uint32\_t mclkHz

target mclk frequency

uint32\_t mclkSourceClkHz

mclk source frequency

struct `_sai_fifo`

*#include <fsl\_sai.h>* sai fifo configurations

### Public Members

bool fifoContinueOnError

fifo continues when error occur

*sai\_fifo\_combine\_t* fifoCombine

fifo combine mode

*sai\_fifo\_packing\_t* fifoPacking

fifo packing mode

uint8\_t fifoWatermark

fifo watermark

struct `_sai_bit_clock`

*#include <fsl\_sai.h>* sai bit clock configurations

### Public Members

bool bclkInputDelay

bit clock actually used by the transmitter is delayed by the pad output delay, this has effect of decreasing the data input setup time, but increasing the data output valid time .

*sai\_clock\_polarity\_t* bclkPolarity

bit clock polarity

*sai\_bclk\_source\_t* bclkSource

bit Clock source

struct *\_sai\_frame\_sync*

*#include <fsl\_sai.h>* sai frame sync configurations

### Public Members

uint8\_t frameSyncWidth

frame sync width in number of bit clocks

bool frameSyncEarly

TRUE is frame sync assert one bit before the first bit of frame FALSE is frame sync assert with the first bit of the frame

bool frameSyncGenerateOnDemand

internal frame sync is generated when FIFO waring flag is clear

*sai\_clock\_polarity\_t* frameSyncPolarity

frame sync polarity

struct *\_sai\_serial\_data*

*#include <fsl\_sai.h>* sai serial data configurations

### Public Members

*sai\_data\_pin\_state\_t* dataMode

sai data pin state when slots masked or channel disabled

*sai\_data\_order\_t* dataOrder

configure whether the LSB or MSB is transmitted first

uint8\_t dataWord0Length

configure the number of bits in the first word in each frame

uint8\_t dataWordNLength

configure the number of bits in the each word in each frame, except the first word

uint8\_t dataWordLength

used to record the data length for dma transfer

uint8\_t dataFirstBitShifted

Configure the bit index for the first bit transmitted for each word in the frame

uint8\_t dataWordNum

configure the number of words in each frame

uint32\_t dataMaskedWord

configure whether the transmit word is masked

struct *\_sai\_transceiver*

*#include <fsl\_sai.h>* sai transceiver configurations

**Public Members**

*sai\_serial\_data\_t* serialData  
serial data configurations

*sai\_frame\_sync\_t* frameSync  
ws configurations

*sai\_bit\_clock\_t* bitClock  
bit clock configurations

*sai\_fifo\_t* fifo  
fifo configurations

*sai\_master\_slave\_t* masterSlave  
transceiver is master or slave

*sai\_sync\_mode\_t* syncMode  
transceiver sync mode

uint8\_t startChannel  
Transfer start channel

uint8\_t channelMask  
enabled channel mask value, reference `_sai_channel_mask`

uint8\_t endChannel  
end channel number

uint8\_t channelNums  
Total enabled channel numbers

struct `_sai_transfer`  
*#include <fsl\_sai.h>* SAI transfer structure.

**Public Members**

uint8\_t \*data  
Data start address to transfer.

size\_t dataSize  
Transfer size.

struct `_sai_handle`  
*#include <fsl\_sai.h>* SAI handle structure.

**Public Members**

I2S\_Type \*base  
base address

uint32\_t state  
Transfer status

*sai\_transfer\_callback\_t* callback  
Callback function called at transfer event

void \*userData  
Callback parameter passed to callback function

`uint8_t bitWidth`  
Bit width for transfer, 8/16/24/32 bits

`uint8_t channel`  
Transfer start channel

`uint8_t channelMask`  
enabled channel mask value, refernece `_sai_channel_mask`

`uint8_t endChannel`  
end channel number

`uint8_t channelNums`  
Total enabled channel numbers

`sai_transfer_t saiQueue[(4U)]`  
Transfer queue storing queued transfer

`size_t transferSize[(4U)]`  
Data bytes need to transfer

`volatile uint8_t queueUser`  
Index for user to queue transfer

`volatile uint8_t queueDriver`  
Index for driver to get the transfer data and size

`uint8_t watermark`  
Watermark value

## 2.63 SAI EDMA Driver

```
void SAI__TransferTxCreateHandleEDMA(I2S_Type *base, sai_edma_handle_t *handle,
 sai_edma_callback_t callback, void *userData,
 edma_handle_t *txDmaHandle)
```

Initializes the SAI eDMA handle.

This function initializes the SAI master DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.
- `callback` – Pointer to user callback function.
- `userData` – User parameter passed to the callback function.
- `txDmaHandle` – eDMA handle pointer; this handle shall be static allocated by users.

```
void SAI__TransferRxCreateHandleEDMA(I2S_Type *base, sai_edma_handle_t *handle,
 sai_edma_callback_t callback, void *userData,
 edma_handle_t *rxDmaHandle)
```

Initializes the SAI Rx eDMA handle.

This function initializes the SAI slave DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- rxDmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

```
void SAI_TransferSetInterleaveType(sai_edma_handle_t *handle, sai_edma_interleave_t
 interleaveType)
```

Initializes the SAI interleave type.

This function initializes the SAI DMA handle member `interleaveType`, it shall be called only when application would like to use type `kSAI_EDMAInterleavePerChannelBlock`, since the default `interleaveType` is `kSAI_EDMAInterleavePerChannelSample` always

### Parameters

- handle – SAI eDMA handle pointer.
- interleaveType – Multi channel interleave type.

```
void SAI_TransferTxSetConfigEDMA(I2S_Type *base, sai_edma_handle_t *handle,
 sai_transceiver_t *saiConfig)
```

Configures the SAI Tx.

**Note:** SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the `channelMask` of `sai_transceiver_t` with the corresponding values of `_sai_channel_mask` enum, enable the FIFO Combine mode by assigning `kSAI_FifoCombineModeEnabledOnWrite` to the `fifoCombine` member of `sai_fifo_combine_t` which is a member of `sai_transceiver_t`. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_
↪Channel1Mask);
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnWrite;
SAI_TransferTxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

```
void SAI_TransferRxSetConfigEDMA(I2S_Type *base, sai_edma_handle_t *handle,
 sai_transceiver_t *saiConfig)
```

Configures the SAI Rx.

**Note:** SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the `channelMask` of `sai_transceiver_t` with the corresponding values of `_sai_channel_mask` enum, enable the FIFO Combine mode by assigning `kSAI_FifoCombineModeEnabledOnRead` to the `fifoCombine` member of `sai_fifo_combine_t`

which is a member of `sai_transceiver_t`. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_
↪Channel1Mask);
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnRead;
SAI_TransferRxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

---

### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

*status\_t* SAI\_TransferSendEDMA(I2S\_Type \*base, *sai\_edma\_handle\_t* \*handle, *sai\_transfer\_t* \*xfer)

Performs a non-blocking SAI transfer using DMA.

This function support multi channel transfer,

- a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
- b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

---

**Note:** This interface returns immediately after the transfer initiates. Call SAI\_GetTransferStatus to poll the transfer status and check whether the SAI transfer is finished.

---

### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

### Return values

- kStatus\_Success – Start a SAI eDMA send successfully.
- kStatus\_InvalidArgument – The input argument is invalid.
- kStatus\_TxBusy – SAI is busy sending data.

*status\_t* SAI\_TransferReceiveEDMA(I2S\_Type \*base, *sai\_edma\_handle\_t* \*handle, *sai\_transfer\_t* \*xfer)

Performs a non-blocking SAI receive using eDMA.

This function support multi channel transfer,

- a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
- b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

**Note:** This interface returns immediately after the transfer initiates. Call the `SAI_GetReceiveRemainingBytes` to poll the transfer status and check whether the SAI transfer is finished.

---

#### Parameters

- `base` – SAI base pointer
- `handle` – SAI eDMA handle pointer.
- `xfer` – Pointer to DMA transfer structure.

#### Return values

- `kStatus_Success` – Start a SAI eDMA receive successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.
- `kStatus_RxBusy` – SAI is busy receiving data.

`status_t` `SAI_TransferSendLoopEDMA(I2S_Type *base, sai_edma_handle_t *handle, sai_transfer_t *xfer, uint32_t loopTransferCount)`

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function `SAI_TransferAbortSendEDMA` to stop the loop transfer.

---

**Note:** This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in `sai_edma_handle_t`, so application could redefine the `SAI_XFER_QUEUE_SIZE` to determine the proper TCD pool size. This function support one sai channel only.

---

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.
- `xfer` – Pointer to the DMA transfer structure, should be a array with elements counts  $\geq 1$ (`loopTransferCount`).
- `loopTransferCount` – the counts of `xfer` array.

#### Return values

- `kStatus_Success` – Start a SAI eDMA send successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.

`status_t` `SAI_TransferReceiveLoopEDMA(I2S_Type *base, sai_edma_handle_t *handle, sai_transfer_t *xfer, uint32_t loopTransferCount)`

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function `SAI_TransferAbortReceiveEDMA` to stop the loop transfer.

---

**Note:** This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required,

---



as the function use the tcd pool in `sai_edma_handle_t`, so application could redefine the `SAI_XFER_QUEUE_SIZE` to determine the proper TCD pool size. This function support one sai channel only.

---

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.
- `xfer` – Pointer to the DMA transfer structure, should be a array with elements counts  $\geq 1$ (`loopTransferCount`).
- `loopTransferCount` – the counts of `xfer` array.

#### Return values

- `kStatus_Success` – Start a SAI eDMA receive successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.

`void SAI_TransferTerminateSendEDMA(I2S_Type *base, sai_edma_handle_t *handle)`

Terminate all SAI send.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call `SAI_TransferAbortSendEDMA`.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.

`void SAI_TransferTerminateReceiveEDMA(I2S_Type *base, sai_edma_handle_t *handle)`

Terminate all SAI receive.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call `SAI_TransferAbortReceiveEDMA`.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.

`void SAI_TransferAbortSendEDMA(I2S_Type *base, sai_edma_handle_t *handle)`

Aborts a SAI transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call `SAI_TransferTerminateSendEDMA`.

#### Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.

`void SAI_TransferAbortReceiveEDMA(I2S_Type *base, sai_edma_handle_t *handle)`

Aborts a SAI receive using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call `SAI_TransferTerminateReceiveEDMA`.

#### Parameters

- `base` – SAI base pointer
- `handle` – SAI eDMA handle pointer.

```
status_t SAI_TransferGetSendCountEDMA(I2S_Type *base, sai_edma_handle_t *handle, size_t
 *count)
```

Gets byte count sent by SAI.

#### Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- count – Bytes count sent by SAI.

#### Return values

- kStatus\_Success – Succeed get the transfer count.
- kStatus\_NoTransferInProgress – There is no non-blocking transaction in progress.

```
status_t SAI_TransferGetReceiveCountEDMA(I2S_Type *base, sai_edma_handle_t *handle, size_t
 *count)
```

Gets byte count received by SAI.

#### Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.
- count – Bytes count received by SAI.

#### Return values

- kStatus\_Success – Succeed get the transfer count.
- kStatus\_NoTransferInProgress – There is no non-blocking transaction in progress.

```
uint32_t SAI_TransferGetValidTransferSlotsEDMA(I2S_Type *base, sai_edma_handle_t *handle)
```

Gets valid transfer slot.

This function can be used to query the valid transfer request slot that the application can submit. It should be called in the critical section, that means the application could call it in the corresponding callback function or disable IRQ before calling it in the application, otherwise, the returned value may not correct.

#### Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.

#### Return values

valid – slot count that application submit.

```
FSL_SAI_EDMA_DRIVER_VERSION
```

Version 2.7.3

```
enum _sai_edma_interleave
```

sai interleave type

Values:

```
enumerator kSAI_EDMAInterleavePerChannelSample
```

```
enumerator kSAI_EDMAInterleavePerChannelBlock
```

```
typedef struct sai_edma_handle sai_edma_handle_t
```

```
typedef void (*sai_edma_callback_t)(I2S_Type *base, sai_edma_handle_t *handle, status_t status, void *userData)
```

SAI eDMA transfer callback function for finish and error.

```
typedef enum _sai_edma_interleave sai_edma_interleave_t
sai_interleave_type
```

MCUX\_SDK\_SAI\_EDMA\_RX\_ENABLE\_INTERNAL

the SAI enable position When calling SAI\_TransferReceiveEDMA

MCUX\_SDK\_SAI\_EDMA\_TX\_ENABLE\_INTERNAL

the SAI enable position When calling SAI\_TransferSendEDMA

```
struct sai_edma_handle
```

*#include <fsl\_sai\_edma.h>* SAI DMA transfer handle, users should not touch the content of the handle.

### Public Members

*edma\_handle\_t* \*dmaHandle

DMA handler for SAI send

uint8\_t nbytes

eDMA minor byte transfer count initially configured.

uint8\_t bytesPerFrame

Bytes in a frame

uint8\_t channelMask

Enabled channel mask value, reference *\_sai\_channel\_mask*

uint8\_t channelNums

total enabled channel nums

uint8\_t channel

Which data channel

uint8\_t count

The transfer data count in a DMA request

uint32\_t state

Internal state for SAI eDMA transfer

*sai\_edma\_callback\_t* callback

Callback for users while transfer finish or error occurs

void \*userData

User callback parameter

uint8\_t tcd[((4U) + 1U) \* sizeof(*edma\_tcd\_t*)]

TCD pool for eDMA transfer.

*sai\_transfer\_t* saiQueue[(4U)]

Transfer queue storing queued transfer.

size\_t transferSize[(4U)]

Data bytes need to transfer

*sai\_edma\_interleave\_t* interleaveType

Transfer interleave type

volatile uint8\_t queueUser

Index for user to queue transfer.

volatile uint8\_t queueDriver

Index for driver to get the transfer data and size

## 2.64 SEMA42: Hardware Semaphores Driver

FSL\_SEMA42\_DRIVER\_VERSION

SEMA42 driver version.

SEMA42 status return codes.

*Values:*

enumerator kStatus\_SEMA42\_Busy

SEMA42 gate has been locked by other processor.

enumerator kStatus\_SEMA42\_Reseting

SEMA42 gate resetting is ongoing.

enum \_sema42\_gate\_status

SEMA42 gate lock status.

*Values:*

enumerator kSEMA42\_Unlocked

The gate is unlocked.

enumerator kSEMA42\_LockedByProc0

The gate is locked by processor 0.

enumerator kSEMA42\_LockedByProc1

The gate is locked by processor 1.

enumerator kSEMA42\_LockedByProc2

The gate is locked by processor 2.

enumerator kSEMA42\_LockedByProc3

The gate is locked by processor 3.

enumerator kSEMA42\_LockedByProc4

The gate is locked by processor 4.

enumerator kSEMA42\_LockedByProc5

The gate is locked by processor 5.

enumerator kSEMA42\_LockedByProc6

The gate is locked by processor 6.

enumerator kSEMA42\_LockedByProc7

The gate is locked by processor 7.

enumerator kSEMA42\_LockedByProc8

The gate is locked by processor 8.

enumerator kSEMA42\_LockedByProc9

The gate is locked by processor 9.

enumerator kSEMA42\_LockedByProc10

The gate is locked by processor 10.

enumerator kSEMA42\_LockedByProc11

The gate is locked by processor 11.

enumerator kSEMA42\_LockedByProc12

The gate is locked by processor 12.

enumerator kSEMA42\_LockedByProc13

The gate is locked by processor 13.

enumerator kSEMA42\_LockedByProc14

The gate is locked by processor 14.

typedef enum *\_sema42\_gate\_status* sema42\_gate\_status\_t  
SEMA42 gate lock status.

void SEMA42\_Init(SEMA42\_Type \*base)

Initializes the SEMA42 module.

This function initializes the SEMA42 module. It only enables the clock but does not reset the gates because the module might be used by other processors at the same time. To reset the gates, call either SEMA42\_ResetGate or SEMA42\_ResetAllGates function.

#### Parameters

- base – SEMA42 peripheral base address.

void SEMA42\_Deinit(SEMA42\_Type \*base)

De-initializes the SEMA42 module.

This function de-initializes the SEMA42 module. It only disables the clock.

#### Parameters

- base – SEMA42 peripheral base address.

status\_t SEMA42\_TryLock(SEMA42\_Type \*base, uint8\_t gateNum, uint8\_t procNum)

Tries to lock the SEMA42 gate.

This function tries to lock the specific SEMA42 gate. If the gate has been locked by another processor, this function returns an error code.

#### Parameters

- base – SEMA42 peripheral base address.
- gateNum – Gate number to lock.
- procNum – Current processor number.

#### Return values

- kStatus\_Success – Lock the sema42 gate successfully.
- kStatus\_SEMA42\_Busy – Sema42 gate has been locked by another processor.

status\_t SEMA42\_Lock(SEMA42\_Type \*base, uint8\_t gateNum, uint8\_t procNum)

Locks the SEMA42 gate.

This function locks the specific SEMA42 gate. If the gate has been locked by other processors, this function waits until it is unlocked and then lock it.

If SEMA42\_BUSY\_POLL\_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus\_Timeout.

#### Parameters

- `base` – SEMA42 peripheral base address.
- `gateNum` – Gate number to lock.
- `procNum` – Current processor number.

**Return values**

- `kStatus_Success` – The gate was successfully locked.
- `kStatus_Timeout` – Timeout occurred while waiting for the gate to be unlocked.

**Returns**

`status_t`

`static inline void SEMA42_Unlock(SEMA42_Type *base, uint8_t gateNum)`

Unlocks the SEMA42 gate.

This function unlocks the specific SEMA42 gate. It only writes unlock value to the SEMA42 gate register. However, it does not check whether the SEMA42 gate is locked by the current processor or not. As a result, if the SEMA42 gate is not locked by the current processor, this function has no effect.

**Parameters**

- `base` – SEMA42 peripheral base address.
- `gateNum` – Gate number to unlock.

`static inline sema42_gate_status_t SEMA42_GetGateStatus(SEMA42_Type *base, uint8_t gateNum)`

Gets the status of the SEMA42 gate.

This function checks the lock status of a specific SEMA42 gate.

**Parameters**

- `base` – SEMA42 peripheral base address.
- `gateNum` – Gate number.

**Returns**

`status` Current status.

`status_t SEMA42_ResetGate(SEMA42_Type *base, uint8_t gateNum)`

Resets the SEMA42 gate to an unlocked status.

This function resets a SEMA42 gate to an unlocked status.

**Parameters**

- `base` – SEMA42 peripheral base address.
- `gateNum` – Gate number.

**Return values**

- `kStatus_Success` – SEMA42 gate is reset successfully.
- `kStatus_SEMA42_Reseting` – Some other reset process is ongoing.

`static inline status_t SEMA42_ResetAllGates(SEMA42_Type *base)`

Resets all SEMA42 gates to an unlocked status.

This function resets all SEMA42 gate to an unlocked status.

**Parameters**

- `base` – SEMA42 peripheral base address.

**Return values**

- kStatus\_Success – SEMA42 is reset successfully.
- kStatus\_SEMA42\_Reseting – Some other reset process is ongoing.

SEMA42\_GATE\_NUM\_RESET\_ALL

The number to reset all SEMA42 gates.

SEMA42\_GATEn(base, n)

SEMA42 gate n register address.

The SEMA42 gates are sorted in the order 3, 2, 1, 0, 7, 6, 5, 4, ... not in the order 0, 1, 2, 3, 4, 5, 6, 7, ... The macro SEMA42\_GATEn gets the SEMA42 gate based on the gate index.

The input gate index is XOR'ed with 3U:  $0 \wedge 3 = 3$   $1 \wedge 3 = 2$   $2 \wedge 3 = 1$   $3 \wedge 3 = 0$   $4 \wedge 3 = 7$   $5 \wedge 3 = 6$   $6 \wedge 3 = 5$   $7 \wedge 3 = 4$  ...

SEMA42\_BUSY\_POLL\_COUNT

Maximum polling iterations for SEMA42 waiting loops.

This parameter defines the maximum number of iterations for any polling loop in the SEMA42 driver code before timing out and returning an error.

It applies to all waiting loops in SEMA42 driver, such as waiting for a gate to be unlocked, waiting for a reset to complete, or waiting for a resource to become available.

This is a count of loop iterations, not a time-based value.

If defined as 0, polling loops will continue indefinitely until their exit condition is met, which could potentially cause the system to hang if hardware doesn't respond or if a resource is never released.

## 2.65 SIM: System Integration Module Driver

FSL\_SIM\_DRIVER\_VERSION

Driver version.

enum \_sim\_usb\_volt\_reg\_enable\_mode

USB voltage regulator enable setting.

*Values:*

enumerator kSIM\_UsbVoltRegEnable

Enable voltage regulator.

enumerator kSIM\_UsbVoltRegEnableInLowPower

Enable voltage regulator in VLPR/VLPW modes.

enumerator kSIM\_UsbVoltRegEnableInStop

Enable voltage regulator in STOP/VLPS/LLS/VLLS modes.

enumerator kSIM\_UsbVoltRegEnableInAllModes

Enable voltage regulator in all power modes.

enum \_sim\_flash\_mode

Flash enable mode.

*Values:*

enumerator kSIM\_FlashDisableInWait

Disable flash in wait mode.

enumerator kSIM\_FlashDisable

Disable flash in normal mode.

```
typedef struct _sim_uid sim_uid_t
 Unique ID.
```

```
typedef struct _sim_rf_addr sim_rf_addr_t
 RF Mac Address.
```

```
void SIM_SetUsbVoltRegulatorEnableMode(uint32_t mask)
 Sets the USB voltage regulator setting.
```

This function configures whether the USB voltage regulator is enabled in normal RUN mode, STOP/VLPS/LLS/VLLS modes, and VLPR/VLPW modes. The configurations are passed in as mask value of `_sim_usb_volt_reg_enable_mode`. For example, to enable USB voltage regulator in RUN/VLPR/VLPW modes and disable in STOP/VLPS/LLS/VLLS mode, use:

```
SIM_SetUsbVoltRegulatorEnableMode(kSIM_UsbVoltRegEnable
kSIM_UsbVoltRegEnableInLowPower);
```

#### Parameters

- mask – USB voltage regulator enable setting.

```
void SIM_GetUniqueId(sim_uid_t *uid)
 Gets the unique identification register value.
```

#### Parameters

- uid – Pointer to the structure to save the UID value.

```
static inline void SIM_SetFlashMode(uint8_t mode)
 Sets the flash enable mode.
```

#### Parameters

- mode – The mode to set; see `_sim_flash_mode` for mode details.

```
void SIM_GetRfAddr(sim_rf_addr_t *info)
 Gets the RF address register value.
```

#### Parameters

- info – Pointer to the structure to save the RF address value.

```
static inline void SIM_EnableSystickClock(bool enable)
 Enable the Systick clock or not.

 The Systick clock is enabled by default.
```

#### Parameters

- enable – The switcher for Systick clock.

```
struct _sim_uid
 #include <fsl_sim.h> Unique ID.
```

#### Public Members

```
uint32_t H
 UIDH.
```

```
uint32_t M
 SIM_UIDM.
```

```
uint32_t L
 UIDL.
```

```
struct _sim_rf_addr
 #include <fsl_sim.h> RF Mac Address.
```



### Public Members

uint32\_t rfAddrL  
RFADDRL.

uint32\_t rfAddrH  
RFADDRH.

## 2.66 Smart Card

FSL\_SMARTCARD\_DRIVER\_VERSION

Smart card driver version 2.3.0.

Smart card Error codes.

*Values:*

enumerator kStatus\_SMARTCARD\_Success  
Transfer ends successfully

enumerator kStatus\_SMARTCARD\_TxBusy  
Transmit in progress

enumerator kStatus\_SMARTCARD\_RxBusy  
Receiving in progress

enumerator kStatus\_SMARTCARD\_NoTransferInProgress  
No transfer in progress

enumerator kStatus\_SMARTCARD\_Timeout  
Transfer ends with time-out

enumerator kStatus\_SMARTCARD\_Initialized  
Smart card driver is already initialized

enumerator kStatus\_SMARTCARD\_PhyInitialized  
Smart card PHY drive is already initialized

enumerator kStatus\_SMARTCARD\_CardNotActivated  
Smart card is not activated

enumerator kStatus\_SMARTCARD\_InvalidInput  
Function called with invalid input arguments

enumerator kStatus\_SMARTCARD\_OtherError  
Some other error occur

enum \_smartcard\_control

Control codes for the Smart card protocol timers and misc.

*Values:*

enumerator kSMARTCARD\_EnableADT

enumerator kSMARTCARD\_DisableADT

enumerator kSMARTCARD\_EnableGTV

enumerator kSMARTCARD\_DisableGTV

enumerator kSMARTCARD\_ResetWWT  
enumerator kSMARTCARD\_EnableWWT  
enumerator kSMARTCARD\_DisableWWT  
enumerator kSMARTCARD\_ResetCWT  
enumerator kSMARTCARD\_EnableCWT  
enumerator kSMARTCARD\_DisableCWT  
enumerator kSMARTCARD\_ResetBWT  
enumerator kSMARTCARD\_EnableBWT  
enumerator kSMARTCARD\_DisableBWT  
enumerator kSMARTCARD\_EnableInitDetect  
enumerator kSMARTCARD\_EnableAnack  
enumerator kSMARTCARD\_DisableAnack  
enumerator kSMARTCARD\_ConfigureBaudrate  
enumerator kSMARTCARD\_SetupATRMMode  
enumerator kSMARTCARD\_SetupT0Mode  
enumerator kSMARTCARD\_SetupT1Mode  
enumerator kSMARTCARD\_EnableReceiverMode  
enumerator kSMARTCARD\_DisableReceiverMode  
enumerator kSMARTCARD\_EnableTransmitterMode  
enumerator kSMARTCARD\_DisableTransmitterMode  
enumerator kSMARTCARD\_ResetWaitTimeMultiplier

enum \_smartcard\_card\_voltage\_class

Defines Smart card interface voltage class values.

*Values:*

enumerator kSMARTCARD\_VoltageClassUnknown  
enumerator kSMARTCARD\_VoltageClassA5\_0V  
enumerator kSMARTCARD\_VoltageClassB3\_3V  
enumerator kSMARTCARD\_VoltageClassC1\_8V

enum \_smartcard\_transfer\_state

Defines Smart card I/O transfer states.

*Values:*

enumerator kSMARTCARD\_IdleState  
enumerator kSMARTCARD\_WaitingForTSSState  
enumerator kSMARTCARD\_InvalidTSDetectedState

enumerator kSMARTCARD\_ReceivingState

enumerator kSMARTCARD\_TransmittingState

enum \_smartcard\_reset\_type

Defines Smart card reset types.

*Values:*

enumerator kSMARTCARD\_ColdReset

enumerator kSMARTCARD\_WarmReset

enumerator kSMARTCARD\_NoColdReset

enumerator kSMARTCARD\_NoWarmReset

enum \_smartcard\_transport\_type

Defines Smart card transport protocol types.

*Values:*

enumerator kSMARTCARD\_T0Transport

enumerator kSMARTCARD\_T1Transport

enum \_smartcard\_parity\_type

Defines Smart card data parity types.

*Values:*

enumerator kSMARTCARD\_EvenParity

enumerator kSMARTCARD\_OddParity

enum \_smartcard\_card\_convention

Defines data Convention format.

*Values:*

enumerator kSMARTCARD\_DirectConvention

enumerator kSMARTCARD\_InverseConvention

enum \_smartcard\_interface\_control

Defines Smart card interface IC control types.

*Values:*

enumerator kSMARTCARD\_InterfaceSetVcc

enumerator kSMARTCARD\_InterfaceSetClockToResetDelay

enumerator kSMARTCARD\_InterfaceReadStatus

enum \_smartcard\_direction

Defines transfer direction.

*Values:*

enumerator kSMARTCARD\_Receive

enumerator kSMARTCARD\_Transmit

typedef enum \_smartcard\_control smartcard\_control\_t

Control codes for the Smart card protocol timers and misc.

`typedef enum _smartcard_card_voltage_class smartcard_card_voltage_class_t`

Defines Smart card interface voltage class values.

`typedef enum _smartcard_transfer_state smartcard_transfer_state_t`

Defines Smart card I/O transfer states.

`typedef enum _smartcard_reset_type smartcard_reset_type_t`

Defines Smart card reset types.

`typedef enum _smartcard_transport_type smartcard_transport_type_t`

Defines Smart card transport protocol types.

`typedef enum _smartcard_parity_type smartcard_parity_type_t`

Defines Smart card data parity types.

`typedef enum _smartcard_card_convention smartcard_card_convention_t`

Defines data Convention format.

`typedef enum _smartcard_interface_control smartcard_interface_control_t`

Defines Smart card interface IC control types.

`typedef enum _smartcard_direction smartcard_direction_t`

Defines transfer direction.

`typedef void (*smartcard_interface_callback_t)(void *smartcardContext, void *param)`

Smart card interface interrupt callback function type.

`typedef void (*smartcard_transfer_callback_t)(void *smartcardContext, void *param)`

Smart card transfer interrupt callback function type.

`typedef void (*smartcard_time_delay_t)(uint32_t us)`

Time Delay function used to passive waiting using RTOS [us].

`typedef struct _smartcard_card_params smartcard_card_params_t`

Defines card-specific parameters for Smart card driver.

`typedef struct _smartcard_timers_state smartcard_timers_state_t`

Smart card defines the state of the EMV timers in the Smart card driver.

`typedef struct _smartcard_interface_config smartcard_interface_config_t`

Defines user specified configuration of Smart card interface.

`typedef struct _smartcard_xfer smartcard_xfer_t`

Defines user transfer structure used to initialize transfer.

`typedef struct _smartcard_context smartcard_context_t`

Runtime state of the Smart card driver.

`SMARTCARD_INIT_DELAY_CLOCK_CYCLES`

Smart card global define which specify number of clock cycles until initial 'TS' character has to be received.

`SMARTCARD_EMV_ATR_DURATION_ETU`

Smart card global define which specify number of clock cycles during which ATR string has to be received.

`SMARTCARD_TS_DIRECT_CONVENTION`

Smart card specification initial TS character definition of direct convention.

`SMARTCARD_TS_INVERSE_CONVENTION`

Smart card specification initial TS character definition of inverse convention.

`struct _smartcard_card_params`

`#include <fsl_smartcard.h>` Defines card-specific parameters for Smart card driver.

**Public Members**

`uint16_t` `Fi`  
4 bits Fi - clock rate conversion integer

`uint8_t` `fMax`  
Maximum Smart card frequency in MHz

`uint8_t` `WI`  
8 bits WI - work wait time integer

`uint8_t` `Di`  
4 bits DI - baud rate divisor

`uint8_t` `BWI`  
4 bits BWI - block wait time integer

`uint8_t` `CWI`  
4 bits CWI - character wait time integer

`uint8_t` `BGI`  
4 bits BGI - block guard time integer

`uint8_t` `GTN`  
8 bits GTN - extended guard time integer

`uint8_t` `IFSC`  
Indicates IFSC value of the card

`uint8_t` `modeNegotiable`  
Indicates if the card acts in negotiable or a specific mode.

`uint8_t` `currentD`  
4 bits DI - current baud rate divisor

`uint8_t` `status`  
Indicates smart card status

`bool` `t0Indicated`  
Indicates ff T=0 indicated in TD1 byte

`bool` `t1Indicated`  
Indicates if T=1 indicated in TD2 byte

`bool` `atrComplete`  
Indicates whether the ATR received from the card was complete or not

`bool` `atrValid`  
Indicates whether the ATR received from the card was valid or not

`bool` `present`  
Indicates if a smart card is present

`bool` `active`  
Indicates if the smart card is activated

`bool` `faulty`  
Indicates whether smart card/interface is faulty

`smartcard_card_convention_t` `convention`  
Card convention, `kSMARTCARD_DirectConvention` for direct convention, `kSMARTCARD_InverseConvention` for inverse convention

struct `_smartcard_timers_state`

*#include <fsl\_smartcard.h>* Smart card defines the state of the EMV timers in the Smart card driver.

### Public Members

volatile bool `adtExpired`

Indicates whether ADT timer expired

volatile bool `wwtExpired`

Indicates whether WWT timer expired

volatile bool `cwtExpired`

Indicates whether CWT timer expired

volatile bool `bwtExpired`

Indicates whether BWT timer expired

volatile bool `initCharTimerExpired`

Indicates whether reception timer for initialization character (TS) after the RST has expired

struct `_smartcard_interface_config`

*#include <fsl\_smartcard.h>* Defines user specified configuration of Smart card interface.

### Public Members

uint32\_t `smartCardClock`

Smart card interface clock [Hz]

uint32\_t `clockToResetDelay`

Indicates clock to RST apply delay [smart card clock cycles]

uint8\_t `clockModule`

Smart card clock module number

uint8\_t `clockModuleChannel`

Smart card clock module channel number

uint8\_t `clockModuleSourceClock`

Smart card clock module source clock [e.g., BusClk]

*smartcard\_card\_voltage\_class\_t* `vcc`

Smart card voltage class

uint8\_t `controlPort`

Smart card PHY control port instance

uint8\_t `controlPin`

Smart card PHY control pin instance

uint8\_t `irqPort`

Smart card PHY Interrupt port instance

uint8\_t `irqPin`

Smart card PHY Interrupt pin instance

uint8\_t `resetPort`

Smart card reset port instance

uint8\_t resetPin

Smart card reset pin instance

uint8\_t vsel0Port

Smart card PHY Vsel0 control port instance

uint8\_t vsel0Pin

Smart card PHY Vsel0 control pin instance

uint8\_t vsel1Port

Smart card PHY Vsel1 control port instance

uint8\_t vsel1Pin

Smart card PHY Vsel1 control pin instance

uint8\_t dataPort

Smart card PHY data port instance

uint8\_t dataPin

Smart card PHY data pin instance

uint8\_t dataPinMux

Smart card PHY data pin mux option

uint8\_t tsTimerId

Numerical identifier of the External HW timer for Initial character detection

struct \_\_smartcard\_xfer

*#include <fsl\_smartcard.h>* Defines user transfer structure used to initialize transfer.

### Public Members

smartcard\_direction\_t direction

Direction of communication. (RX/TX)

uint8\_t \*buff

The buffer of data.

size\_t size

The number of transferred units.

struct \_\_smartcard\_context

*#include <fsl\_smartcard.h>* Runtime state of the Smart card driver.

### Public Members

void \*base

Smart card module base address

smartcard\_direction\_t direction

Direction of communication. (RX/TX)

uint8\_t \*xBuff

The buffer of data being transferred.

volatile size\_t xSize

The number of bytes to be transferred.

volatile bool xIsBusy

True if there is an active transfer.

`uint8_t txFifoEntryCount`  
Number of data word entries in transmit FIFO.

`uint8_t rxFifoThreshold`  
The max value of the receiver FIFO threshold.

`smartcard_interface_callback_t interfaceCallback`  
Callback to invoke after interface IC raised interrupt.

`smartcard_transfer_callback_t transferCallback`  
Callback to invoke after transfer event occur.

`void *interfaceCallbackParam`  
Interface callback parameter pointer.

`void *transferCallbackParam`  
Transfer callback parameter pointer.

`smartcard_time_delay_t timeDelay`  
Function which handles time delay defined by user or RTOS.

`smartcard_reset_type_t resetType`  
Indicates whether a Cold reset or Warm reset was requested.

`smartcard_transport_type_t tType`  
Indicates current transfer protocol (T0 or T1)

`volatile smartcard_transfer_state_t transferState`  
Indicates the current transfer state

`smartcard_timers_state_t timersState`  
Indicates the state of different protocol timers used in driver

`smartcard_card_params_t cardParams`  
Smart card parameters(ATR and current) and interface slots states(ATR and current)

`uint8_t IFSD`  
Indicates the terminal IFSD

`smartcard_parity_type_t parity`  
Indicates current parity even/odd

`volatile bool rxtCrossed`  
Indicates whether RXT thresholds has been crossed

`volatile bool txtCrossed`  
Indicates whether TXT thresholds has been crossed

`volatile bool wtxRequested`  
Indicates whether WTX has been requested or not

`volatile bool parityError`  
Indicates whether a parity error has been detected

`uint8_t statusBytes[2]`  
Used to store Status bytes SW1, SW2 of the last executed card command response

`smartcard_interface_config_t interfaceConfig`  
Smart card interface configuration structure

`bool abortTransfer`  
Used to abort transfer.



## 2.67 Smart Card EMVSIM Driver

`void SMARTCARD_EMVSIM_GetDefaultConfig(smartcard_card_params_t *cardParams)`

Fills in the `smartcard_card_params` structure with default values according to the EMV 4.3 specification.

### Parameters

- `cardParams` – The configuration structure of type `smartcard_interface_config_t`. Function fill in members: `Fi = 372`; `Di = 1`; `currentD = 1`; `WI = 0x0A`; `GTN = 0x00`; with default values.

`status_t SMARTCARD_EMVSIM_Init(EMVSIM_Type *base, smartcard_context_t *context, uint32_t srcClock_Hz)`

Initializes an EMVSIM peripheral for the Smart card/ISO-7816 operation.

This function un-gates the EMVSIM clock, initializes the module to EMV default settings, configures the IRQ, enables the module-level interrupt to the core and, initializes the driver context.

### Parameters

- `base` – The EMVSIM peripheral base address.
- `context` – A pointer to the smart card driver context structure.
- `srcClock_Hz` – Smart card clock generation module source clock.

### Returns

An error code or `kStatus_SMARTCARD_Success`.

`void SMARTCARD_EMVSIM_Deinit(EMVSIM_Type *base)`

This function disables the EMVSIM interrupts, disables the transmitter and receiver, flushes the FIFOs, and gates EMVSIM clock in SIM.

### Parameters

- `base` – The EMVSIM module base address.

`int32_t SMARTCARD_EMVSIM_GetTransferRemainingBytes(EMVSIM_Type *base, smartcard_context_t *context)`

Returns whether the previous EMVSIM transfer has finished.

When performing an async transfer, call this function to ascertain the context of the current transfer: in progress (or busy) or complete (success). If the transfer is still in progress, the user can obtain the number of words that have not been transferred.

### Parameters

- `base` – The EMVSIM module base address.
- `context` – A pointer to a smart card driver context structure.

### Returns

The number of bytes not transferred.

`status_t SMARTCARD_EMVSIM_AbortTransfer(EMVSIM_Type *base, smartcard_context_t *context)`

Terminates an asynchronous EMVSIM transfer early.

During an async EMVSIM transfer, the user can terminate the transfer early if the transfer is still in progress.

### Parameters

- `base` – The EMVSIM peripheral address.
- `context` – A pointer to a smart card driver context structure.

**Return values**

- `kStatus_SMARTCARD_Success` – The transmit abort was successful.
- `kStatus_SMARTCARD_NoTransmitInProgress` – No transmission is currently in progress.

`status_t SMARTCARD_EMVSIM_TransferNonBlocking(EMVSIM_Type *base,  
smartcard_context_t *context,  
smartcard_xfer_t *xfer)`

Transfer data using interrupts.

A non-blocking (also known as asynchronous) function means that the function returns immediately after initiating the transfer function. The application has to get the transfer status to see when the transfer is complete. In other words, after calling the non-blocking (asynchronous) transfer function, the application must get the transfer status to check if the transmit is completed or not.

**Parameters**

- `base` – The EMVSIM peripheral base address.
- `context` – A pointer to a smart card driver context structure.
- `xfer` – A pointer to the smart card transfer structure where the linked buffers and sizes are stored.

**Returns**

An error code or `kStatus_SMARTCARD_Success`.

`status_t SMARTCARD_EMVSIM_Control(EMVSIM_Type *base, smartcard_context_t *context,  
smartcard_control_t control, uint32_t param)`

Controls the EMVSIM module per different user request.

return `kStatus_SMARTCARD_Success` in success. return `kStatus_SMARTCARD_OtherError` in case of error.

**Parameters**

- `base` – The EMVSIM peripheral base address.
- `context` – A pointer to a smart card driver context structure.
- `control` – Control type.
- `param` – Integer value of specific to control command.

`void SMARTCARD_EMVSIM_IRQHandler(EMVSIM_Type *base, smartcard_context_t *context)`

Handles EMVSIM module interrupts.

**Parameters**

- `base` – The EMVSIM peripheral base address.
- `context` – A pointer to a smart card driver context structure.

`enum _emvsim_gpc_clock_select`

General Purpose Counter clock selections.

*Values:*

enumerator `kEMVSIM_GPCClockDisable`  
Disabled

enumerator `kEMVSIM_GPCCardClock`  
Card clock

```
enumerator kEMVSIM_GPCRxClock
 Receive clock
enumerator kEMVSIM_GPCTxClock
 Transmit ETU clock
enum __presence_detect_edge
 EMVSIM card presence detection edge control.
 Values:
 enumerator kEMVSIM_DetectOnFallingEdge
 Presence detected on the falling edge
 enumerator kEMVSIM_DetectOnRisingEdge
 Presence detected on the rising edge
enum __presence_detect_status
 EMVSIM card presence detection status.
 Values:
 enumerator kEMVSIM_DetectPinIsLow
 Presence detected pin is logic low
 enumerator kEMVSIM_DetectPinIsHigh
 Presence detected pin is logic high
typedef enum _emvsim_gpc_clock_select emvsim_gpc_clock_select_t
 General Purpose Counter clock selections.
typedef enum _presence_detect_edge emvsim_presence_detect_edge_t
 EMVSIM card presence detection edge control.
typedef enum _presence_detect_status emvsim_presence_detect_status_t
 EMVSIM card presence detection status.
SMARTCARD_EMV_RX_NACK_THRESHOLD
 EMV RX NACK interrupt generation threshold.
SMARTCARD_EMV_TX_NACK_THRESHOLD
 EMV TX NACK interrupt generation threshold.
SMARTCARD_WWT_ADJUSTMENT
 Smart card Word Wait Timer adjustment value.
SMARTCARD_CWT_ADJUSTMENT
 Smart card Character Wait Timer adjustment value.
```

## 2.68 Smart Card PHY Driver

`void SMARTCARD_PHY_GetDefaultConfig(smartcard_interface_config_t *config)`

Fills in the configuration structure with default values.

### Parameters

- `config` – The Smart card user configuration structure which contains configuration structure of type `smartcard_interface_config_t`. Function fill in members: `clockToResetDelay` = 42000, `vcc` = `kSmartcardVoltageClassB3_3V`, with default values.

*status\_t* SMARTCARD\_PHY\_Init(void \*base, *smartcard\_interface\_config\_t* const \*config, uint32\_t srcClock\_Hz)

Initializes a Smart card interface instance.

#### Parameters

- base – The Smart card peripheral base address.
- config – The user configuration structure of type *smartcard\_interface\_config\_t*. Call the function SMARTCARD\_PHY\_GetDefaultConfig() to fill the configuration structure.
- srcClock\_Hz – Smart card clock generation module source clock.

#### Return values

kStatus\_SMARTCARD\_Success – or kStatus\_SMARTCARD\_OtherError in case of error.

void SMARTCARD\_PHY\_Deinit(void \*base, *smartcard\_interface\_config\_t* const \*config)

De-initializes a Smart card interface, stops the Smart card clock, and disables the VCC.

#### Parameters

- base – The Smart card peripheral module base address.
- config – The user configuration structure of type *smartcard\_interface\_config\_t*.

*status\_t* SMARTCARD\_PHY\_Activate(void \*base, *smartcard\_context\_t* \*context, *smartcard\_reset\_type\_t* resetType)

Activates the Smart card IC.

#### Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- resetType – type of reset to be performed, possible values = kSmartcardColdReset, kSmartcardWarmReset

#### Return values

kStatus\_SMARTCARD\_Success – or kStatus\_SMARTCARD\_OtherError in case of error.

*status\_t* SMARTCARD\_PHY\_Deactivate(void \*base, *smartcard\_context\_t* \*context)

De-activates the Smart card IC.

#### Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.

#### Return values

kStatus\_SMARTCARD\_Success – or kStatus\_SMARTCARD\_OtherError in case of error.

*status\_t* SMARTCARD\_PHY\_Control(void \*base, *smartcard\_context\_t* \*context, *smartcard\_interface\_control\_t* control, uint32\_t param)

Controls the Smart card interface IC.

#### Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- control – A interface command type.

- param – Integer value specific to control type

**Return values**

kStatus\_SMARTCARD\_Success – or kStatus\_SMARTCARD\_OtherError in case of error.

SMARTCARD\_ATR\_DURATION\_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles during which an ATR string has to be received.

SMARTCARD\_INIT\_DELAY\_CLOCK\_CYCLES\_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles until an initial 'TS' character has to be received.

## 2.69 Smart Card PHY EMVSIM Driver

## 2.70 Smart Card PHY TDA8035 Driver

## 2.71 SPM: System Power Manager

static inline void SPM\_GetVersionId(SPM\_Type \*base, *spm\_version\_id\_t* \*versionId)

Gets the SPM version ID.

This function gets the SPM version ID, including major version number, minor version number, and a feature specification number.

**Parameters**

- base – SPM peripheral base address.
- versionId – Pointer to version ID structure.

void SPM\_GetRegulatorStatus(SPM\_Type \*base, *spm\_regulator\_status\_t* \*info)

Gets the regulators Status.

**Parameters**

- base – SPM peripheral base address.
- info – Pointer to status structure, see to *spm\_regulator\_status\_t*.

static inline void SPM\_EnableRegulatorInRunMode(SPM\_Type \*base, bool enable, uint32\_t ldoMask)

Controls which regulators are enabled in RUN and HSRUN modes.

This function controls which regulator (CORE LDO, AUX LDO, and DCDC) are enabled in RUN and HSRUN modes. It sets the SPM\_RCTRL register. Note that the RCTRL bits are reset solely on a POR/LVD only event.

**Parameters**

- base – SPM peripheral base address.
- enable – Enable or disable the LDOs list in ldoMask.
- ldoMask – Mask value of LDO list. See to *\_spm\_ldo\_regulator*.

static inline void SPM\_EnableRegulatorInLowPowerMode(SPM\_Type \*base, bool enable, uint32\_t ldoMask)

Controls which regulators are enabled in low power modes.

This function controls which regulator (CORE LDO, AUX LDO, and DCDC) are enabled in low power modes. It sets the SPM\_LPCTRL register. Note that the SPM\_LPCTRL bits are reset solely on a POR/LVD only event.

#### Parameters

- base – SPM peripheral base address.
- enable – Enable or disable the LDOs list in ldoMask.
- ldoMask – Mask value of LDO list.

```
static inline void SPM_SetCoreLdoRunModeConfig(SPM_Type *base, uint32_t configMask)
```

Configures the CORE LDO working in run modes.

#### Parameters

- base – SPM peripheral base address.
- configMask – Mask value of configuration items. See to `_spm_core_ldo_run_mode_config`.

```
static inline void SPM_SetCoreLdoLowPowerModeConfig(SPM_Type *base, uint32_t configMask)
```

Configures the CORE LDO working in low power modes.

#### Parameters

- base – SPM peripheral base address.
- configMask – Mask value of configuration items. See to `_spm_core_ldo_low_power_mode_config`.

```
static inline bool SPM_GetCoreLdoInRunRegulationFlag(SPM_Type *base)
```

Check if the CORE LDO is in run regulation.

#### Parameters

- base – SPM peripheral base address.

#### Return values

- true – Regulator is in run regulation.
- false – Regulator is in stop regulation or in transition to/from it.

```
static inline void SPM_ForceCoreLdoOffset(SPM_Type *base, bool enable)
```

Force the Core LDO to an offset voltage level.

---

**Note:** Please make sure Core LDO Aux LDO and DCDC regulator both have been enabled before invoking this function.

---

#### Parameters

- base – SPM peripheral base address.
- enable – Enable/Disable Core Ldo voltage offset. true - Apply Core LDO offset. false - Don't apply Core LDO offset.

```
static inline bool SPM_GetPeriphIOIsolationFlag(SPM_Type *base)
```

Gets the acknowledge Peripherals and I/O pads isolation flag.

This function reads the Acknowledge Isolation setting that indicates whether certain peripherals and the I/O pads are in a latched state as a result of having been in the VLLS mode.

**Parameters**

- base – SPM peripheral base address.

**Returns**

ACK isolation 0 - Peripherals and I/O pads are in a normal run state. 1 - Certain peripherals and I/O pads are in an isolated and latched state.

static inline void SPM\_ClearPeriphIOIsolationFlag(SPM\_Type \*base)

Acknowledges the isolation flag to Peripherals and I/O pads.

This function clears the ACK Isolation flag. Writing one to this setting when it is set releases the I/O pads and certain peripherals to their normal run mode state.

**Parameters**

- base – SPM peripheral base address.

void SPM\_SetLowVoltDetectConfig(SPM\_Type \*base, const *spm\_low\_volt\_detect\_config\_t* \*config)

Configures the low-voltage detect setting.

This function configures the low-voltage detect setting, including the trip point voltage setting, enables or disables the interrupt, enables or disables the system reset.

**Parameters**

- base – SPM peripheral base address.
- config – Pointer to low-voltage detect configuration structure, see to *spm\_low\_volt\_detect\_config\_t*.

static inline bool SPM\_GetVddLowVoltDetectFlag(SPM\_Type \*base)

Gets VDD Low-voltage Detect Flag status.

**Parameters**

- base – SPM peripheral base address.

**Returns**

Current low-voltage detect flag

- true: Low-voltage detected
- false: Low-voltage not detected

static inline void SPM\_ClearVddLowVoltDetectFlag(SPM\_Type \*base)

Acknowledges clearing the Low-voltage Detect flag.

This function acknowledges the low-voltage detection errors.

**Parameters**

- base – SPM peripheral base address.

static inline bool SPM\_GetCoreLowVoltDetectFlag(SPM\_Type \*base)

Gets the COREVdds Low-voltage Detect Flag status.

This function reads the current LVDF status. If it returns 1, a low-voltage event is detected.

**Parameters**

- base – SPM peripheral base address.

**Returns**

Current low-voltage detect flag

- true: Low-voltage detected
- false: Low-voltage not detected

static inline void SPM\_ClearCoreLowVoltDetectFlag(SPM\_Type \*base)

Acknowledges clearing the CORE VDD Low-voltage Detect flag.

This function acknowledges the CORE VDD low-voltage detection errors.

#### Parameters

- base – SPM peripheral base address.

void SPM\_SetLowVoltWarningConfig(SPM\_Type \*base, const *spm\_low\_volt\_warning\_config\_t* \*config)

Configures the low-voltage warning setting.

This function configures the low-voltage warning setting, including the trip point voltage setting and enabling or disabling the interrupt.

#### Parameters

- base – SPM peripheral base address.
- config – Pointer to Low-voltage warning configuration structure, see to *spm\_low\_volt\_warning\_config\_t*.

static inline bool SPM\_GetVddLowVoltWarningFlag(SPM\_Type \*base)

Gets Vdd Low-voltage Warning Flag status.

This function polls the current LVWF status. When 1 is returned, it indicates a low-voltage warning event. LVWF is set when V Supply transitions below the trip point or after reset and V Supply is already below the V LVW.

#### Parameters

- base – SPM peripheral base address.

#### Returns

Current LVWF status

- true: Low-voltage Warning Flag is set.
- false: the Low-voltage Warning does not happen.

static inline void SPM\_ClearLowVoltWarningFlag(SPM\_Type \*base)

Acknowledges the Low-voltage Warning flag.

This function acknowledges the low voltage warning errors (write 1 to clear LVWF).

#### Parameters

- base – SPM peripheral base address.

void SPM\_SetHighVoltDetectConfig(SPM\_Type \*base, const *spm\_high\_volt\_detect\_config\_t* \*config)

Configures the high-voltage detect setting.

This function configures the high-voltage detect setting, including the trip point voltage setting, enabling or disabling the interrupt, enabling or disabling the system reset.

#### Parameters

- base – SPM peripheral base address.
- config – High-voltage detect configuration structure, see to *spm\_high\_volt\_detect\_config\_t*.

static inline bool SPM\_GetHighVoltDetectFlag(SPM\_Type \*base)

Gets the High-voltage Detect Flag status.

This function reads the current HVDF status. If it returns 1, a low voltage event is detected.

#### Parameters



- base – SPM peripheral base address.

**Returns**

Current high-voltage detect flag

- true: High-voltage detected
- false: High-voltage not detected

static inline void SPM\_ClearHighVoltDetectFlag(SPM\_Type \*base)

Acknowledges clearing the High-voltage Detect flag.

This function acknowledges the high-voltage detection errors (write 1 to clear HVDF).

**Parameters**

- base – SPM peripheral base address.

void SPM\_SetAuxLdoConfig(SPM\_Type \*base, const *spm\_aux\_ldo\_config\_t* \*config)

Configures the AUX LDO.

**Parameters**

- base – SPM peripheral base address.
- config – Pointer to configuration structure, see to *spm\_rf\_ldo\_config\_t*.

static inline void SPM\_ForceAuxLdoOffset(SPM\_Type \*base, bool enable)

Force auxiliary regulator voltage to an offset level.

---

**Note:** Please make sure DCDC has been enabled before involving this function.

---

**Parameters**

- base – SPM peripheral base address.
- enable – Enable/Disable AUX Ldo voltage offset. true - Force auxiliary regulator voltage to an offset level. false - Do not force auxiliary regulator voltage to an offset level.

void SPM\_SetDcdcBattMonitor(SPM\_Type \*base, uint32\_t batAdcVal)

Sets DCDC battery monitor with its ADC value.

For better accuracy, software would call this function to set the battery voltage value into DCDC measured by ADC.

**Parameters**

- base – SPM peripheral base address.
- batAdcVal – ADC measured battery value with an 8mV LSB resolution. Value 0 would disable the battery monitor.

static inline void SPM\_SetDcdcVbatAdcMeasure(SPM\_Type \*base, *spm\_dcdc\_vbat\_adc\_divider\_t* divider)

Sets DCDC VBAT voltage divider.

The divided VBAT output is input to an ADC channel which allows the battery voltage to be measured.

**Parameters**

- base – SPM peripheral base address.
- divider – Setting divider, see to *spm\_dcdc\_vbat\_adc\_divider\_t*.

```
static inline void SPM_EnablePowerDownCmpOffset(SPM_Type *base, bool enable)
```

Power down output range comparator.

**Parameters**

- base – SPM peripheral base address.
- enable – Power down the CMP or not.

```
static inline uint32_t SPM_GetDcdcStatusFlags(SPM_Type *base)
```

Get the status flags of DCDC module.

**Parameters**

- base – SPM peripheral base address.

**Returns**

Mask value of flags. See to `_spm_dcdc_flags`.

```
void SPM_SetDcdcLoopControlConfig(SPM_Type *base, const spm_dcdc_loop_control_config_t
 *config)
```

Set DCDC loop control config.

**Parameters**

- base – SPM peripheral base address.
- config – The Pointer to the structure `spm_dcdc_loop_control_config_t`.

```
static inline void SPM_EnableVddxStepLock(SPM_Type *base, bool enable)
```

Disable stepping for VDD1P8 and VDD1P2.

Must lock the step for VDD1P8 and VDD1P2 before enteing low power modes.

**Parameters**

- base – SPM peripheral base address.
- enable – Enable the lock or not to VDDx stepping.

```
static inline void SPM_SetDcdcDriveStrength(SPM_Type *base, spm_dcdc_drive_strength_t
 strength)
```

Set the DCDC drive strength.

Do set the DCDC drive strength according to actual loading. The related register bits are:

- DCDC3[DCDC\_MINPWR\_HALF\_FETS]
- DCDC3[DCDC\_MINPWR\_DOUBLE\_FETS]
- DCDC3[DCDC\_MINPWR\_EXTRA\_DOUBLE\_FETS] The more FETs are enabled, the more drive strength DCDC would provide.

**Parameters**

- base – SPM peripheral base address.
- strength – Selection of setting, see to `spm_dcdc_drive_strength_t`

```
static inline void SPM_SplitDcdcClockFreq(SPM_Type *base, bool enable)
```

Split the frequency of DCDC's clock to min the power of DCDC.

---

**Note:** The function can only be invoked in continous mode.

---

**Parameters**

- base – SPM peripheral base address.

- enable – Split the DCDC clock frequency. true - Set DCDC clock to half frequency for the continuous mode. false - Do not set DCDC clock to half frequency for the continuous mode.

void SPM\_BypassDcdcBattMonitor(SPM\_Type \*base, bool enable, uint32\_t value)

Bypasses the ADC measure value.

Forces DCDC to bypass the adc measuring state and loads the user-defined value in this function.

#### Parameters

- base – SPM peripheral base address.
- enable – Enable the bypass or not.
- value – User-setting value to be available instead of ADC measured value.

void SPM\_SetDcdcIntegratorConfig(SPM\_Type \*base, const *spm\_dcdc\_integrator\_config\_t* \*config)

Configure the DCDC integrator value.

Integrator value can be loaded in pulsed mode. Software can program this value according to battery voltage and VDDCORE output target value before goes to the pulsed mode.

```
spm_dcdc_integrator_config_t SpmDcdcIntegratorConfigStruct =
{
 .vddCoreValue = 1.25f,
 .vBatValue = 3.34f
};
```

#### Parameters

- base – SPM peripheral base address.
- config – Pointer to configuration structure, see to *spm\_dcdc\_integrator\_config\_t*. Passing NULL would clear all user-defined setting and use hardware default setting.

static inline void SPC\_BypassDcdcAdcMeasure(SPM\_Type \*base, bool bypass)

Bypass the ADC measure or not.

---

**Note:** If forced to bypass the ADC measure, please invoke SPM\_SetDcdcIntegratorConfig() function to select the integrator value.

---

#### Parameters

- base – SPM peripheral base address.
- bypass – Bypass or not bypass the ADC measure true - Force DCDC to bypass the ADC measuring state. false - Don't force DCDC to bypass the ADC measuring state.

static inline void SPM\_SetDcdcVdd1p2ValueHsruntime(SPM\_Type \*base, uint32\_t trimCode)

Sets the target value of VDD1P2 in buck HSRUN mode.

Sets target value of VDD1P2 in buck HSRUN mode. 25 mV each step from 0x00 to 0x0F. This value is automatically selected on entry into HSRUN. On exit from HSRUN, DCDC VDD1P2 trim values will default back to values set by DCDC\_VDD1P2CTRL\_TRG\_BUCK register, which is operated with the API of SPM\_SetDcdcVdd1p2ValueBuck().

#### Parameters

- base – SPM peripheral base address.

- trimCode – Setting value of VDD1P2 in buck HSRUN mode. Please refer to the reference manual for details.

static inline void SPM\_SetDcdcVdd1p2ValueBuck(SPM\_Type \*base, uint32\_t trimCode)

Sets the target value of VDD1P2 in buck mode.

Sets the target value of VDD1P2 in buck mode, 25 mV each step from 0x00 to 0x0F.

#### Parameters

- base – SPM peripheral base address.
- trimCode – Setting value of VDD1P2 in buck mode. Please refer to the reference manual for details.

static inline void SPM\_SetDcdcVdd1p8Value(SPM\_Type \*base, uint32\_t trimCode)

Sets the target value of VDD1P8.

Sets the target value of VDD1P8 in buck mode, 25 mV each step from 0x00 to 0x3F.

#### Parameters

- base – SPM peripheral base address.
- trimCode – Setting the trimCode of VDD1P8 output. Please refer to the reference manual for details.

static inline void SPM\_SetLowPowerReqOutPinConfig(SPM\_Type \*base, const  
spm\_low\_power\_req\_out\_pin\_config\_t  
\*config)

brief Configures the low power request output pin.

param base SPM peripheral base address. param config Pointer to the configuration structure, see to spm\_low\_power\_req\_out\_pin\_config\_t.

FSL\_SPM\_DRIVER\_VERSION

SPM driver version.

Version 2.3.0.

enum \_spm\_mcu\_low\_power\_mode\_status

Status of last MCU STOP Mode Power Configuration.

Values:

enumerator kSPM\_McuLowPowerModeReserved  
Reserved.

enumerator kSPM\_McuLowPowerModeSTOP  
Last Low Power mode is STOP.

enumerator kSPM\_McuLowPowerModeVLPS  
Last Low Power mode is VLPS.

enumerator kSPM\_McuLowPowerModeLLS  
Last Low Power mode is LLS.

enumerator kSPM\_McuLowPowerModeVLLS23  
Last Low Power mode is VLLS23.

enumerator kSPM\_McuLowPowerModeVLLS01  
Last Low Power mode is VLLS01.

enum \_spm\_ldo\_regulator

define the mask code for LDO regulators.

These mask can be combined with 'or' as a parameter to any function.

*Values:*

enumerator kSPM\_CoreLdo

Mask code for CORE LDO.

enumerator kSPM\_AuxLdo

Mask code for AUX LDO.

enumerator kSPM\_DcdcLdo

Mask code for DCDC LDO.

enum \_spm\_core\_ldo\_run\_mode\_config

Configure the CORE LDO in run modes.

*Values:*

enumerator kSPM\_CoreLdoRunModeEnableRtcPowerMonitor

RTC power monitor enabled in run modes.

enumerator kSPM\_CoreLdoRunModeEnableUsbPowerMonitor

USB power monitor enabled in run modes.

enumerator kSPM\_CoreLdoRunModeEnableVddioPowerMonitor

VDDIO power monitor enabled in run modes.

enum \_spm\_core\_ldo\_low\_power\_mode\_config

Configure the CORE LDO in low power modes.

*Values:*

enumerator kSPM\_CoreLdoLowPowerModeEnableRtcPowerMonitor

RTC power monitor enabled in LP modes.

enumerator kSPM\_CoreLdoLowPowerModeEnableUsbPowerMonitor

USB power monitor enabled in LP modes.

enumerator kSPM\_CoreLdoLowPowerModeEnableVddioPowerMonitor

VDDIO power monitor enabled in LP modes.

enumerator kSPM\_CoreLdoLowPowerModeEnableAllReference

Enable all reference (bandgap, WELL BIAS, 1k clk and LP 25na) in VLLS0/1.

enumerator kSPM\_CoreLdoLowPowerModeEnableHighDrive

Enable high driver in low power.

enumerator kSPM\_CoreLdoLowPowerModeEnableLVD

Enable level voltage detect in low power modes.

enumerator kSPM\_CoreLdoLowPowerModeEnablePOR

POR brownout remains enabled in VLLS0/1 mode.

enumerator kSPM\_CoreLdoLowPowerModeEnableLPO

LPO remains enabled in VLLS0/1 modes.

enumerator kSPM\_CoreLdoLowPowerModeEnableBandgapBufferHightDrive

Enable the high drive for Bandgap Buffer.

enumerator kSPM\_CoreLdoLowPowerModeEnableBandgapBuffer

Enable Bandgap Buffer.

enumerator kSPM\_CoreLdoLowPowerModeEnableBandgapInVLPx  
Enable Bandgap in STOP/VLPx/LLS and VLLSx mode.

enumerator kSPM\_CoreLdoLowPowerModeRemainInHighPower  
Core LDO remains in high power state in VLP/Stop modes.

enum \_spm\_low\_volt\_detect\_volt\_select  
Low-voltage Detect Voltage Select.

*Values:*

enumerator kSPM\_LowVoltDetectLowTrip  
Low-trip point selected (VLVD = VLVDL )

enumerator kSPM\_LowVoltDetectHighTrip  
High-trip point selected (VLVD = VLVDH )

enum \_spm\_low\_volt\_warning\_volt\_select  
Low-voltage Warning Voltage Select.

*Values:*

enumerator kSPM\_LowVoltWarningLowTrip  
Low-trip point selected (VLVW = VLVW1)

enumerator kSPM\_LowVoltWarningMID1Trip  
Mid1-trip point selected (VLVW = VLVW2)

enumerator kSPM\_LowVoltWarningMID2Trip  
Mid2-trip point selected (VLVW = VLVW3)

enumerator kSPM\_LowVoltWarningHighTrip  
High-trip point selected (VLVW = VLVW4)

enum \_spm\_high\_volt\_detect\_volt\_select  
High-voltage Detect Voltage Select.

*Values:*

enumerator kSPM\_HighVoltDetectLowTrip  
Low-trip point selected (VHVD = VHVDL )

enumerator kSPM\_HighVoltDetectHighTrip  
High-trip point selected (VHVD = VHVDH )

enum \_spm\_aux\_ldo\_low\_power\_mode  
Defines the AUX LDO low power behavior when in low power modes.

*Values:*

enumerator kSPM\_AuxLdoEnterLowPowerInLowPowerModes  
AUX LDO regulator enters low power state in VLP/Stop modes.

enumerator kSPM\_AuxLdoRemainInHighPowerInLowPowerModes  
AUX LDO regulator remains in high power state in VLP/Stop modes.

enum \_spm\_aux\_ldo\_io\_soft\_start\_duration  
Selects the soft start duration delay for the IO 1.8 full power regulator.

*Values:*

enumerator kSPM\_AuxLdoSoftStartDuration110us  
110 us.

enumerator kSPM\_AuxLdoSoftStartDuration95us  
95 us.

enumerator kSPM\_AuxLdoSoftStartDuration60us  
60 us.

enumerator kSPM\_AuxLdoSoftStartDuration48us  
48 us.

enumerator kSPM\_AuxLdoSoftStartDuration38us  
38 us.

enumerator kSPM\_AuxLdoSoftStartDuration30us  
30 us.

enumerator kSPM\_AuxLdoSoftStartDuration24us  
24 us.

enumerator kSPM\_AuxLdoSoftStartDuration17us  
17 us.

enum \_\_spm\_aux\_io\_regulator\_volt\_select  
IO Regulator Voltage Select.

*Values:*

enumerator kSPM\_AuxIoRegulatorVoltLevel1p8  
Regulate to 1.8V.

enumerator kSPM\_AuxIoRegulatorVoltLevel1p5  
Regulate to 1.5V.

enum \_\_spm\_dcdc\_vbat\_adc\_divider  
Defines the selection of DCDC vbat voltage divider for ADC measure.

*Values:*

enumerator kSPM\_DcdcVbatAdcOff  
OFF.

enumerator kSPM\_DcdcVbatAdcDivider1  
VBAT.

enumerator kSPM\_DcdcVbatAdcDivider2  
VBAT /2.

enumerator kSPM\_DcdcVbatAdcDivider4  
VBAT /4.

enum \_\_spm\_low\_power\_req\_out\_pin\_pol  
Defines the selection of low power request pin out pin polarity.

*Values:*

enumerator kSPM\_LowPowerReqOutPinHighTruePol  
High true polarity.

enumerator kSPM\_LowPowerReqOutPinLowTruePol  
Low true polarity.

enum \_\_spm\_dcdc\_drive\_strength  
Defines the selection of DCDC driver strength.  
The more FETs are enabled, the more drive strength DCDC would provide.

*Values:*

enumerator kSPM\_DcdcDriveStrengthWithNormal

No additional FET setting.

enumerator kSPM\_DcdcDriveStrengthWithHalfFETs

Half FETs.

enumerator kSPM\_DcdcDriveStrengthWithDoubleFETs

Double FETs.

enumerator kSPM\_DcdcDriveStrengthWithExtraDoubleFETs

Extra Double FETs.

enumerator kSPM\_DcdcDriveStrengthWithHalfAndDoubleFETs

Half + Double FETs.

enumerator kSPM\_DcdcDriveStrengthWithHalfAndExtraDoubleFETs

Half + Extra Double FETs.

enumerator kSPM\_DcdcDriveStrengthWithDoubleAndExtraDoubleFETs

Double + Extra Double FETs.

enumerator kSPM\_DcdcDriveStrengthWithAllFETs

Half + Double + Extra Double FETs.

enum \_spm\_dcdc\_flags

DCDC flags.

*Values:*

enumerator kSPM\_DcdcStableOKFlag

Status flag to indicate DCDC lock.

enumerator kSPM\_DcdcClockFaultFlag

Asserts if DCDC detect a clk fault. Will cause a system lvd reset to assert.

typedef struct \_spm\_version\_id spm\_version\_id\_t

IP version ID definition.

typedef enum \_spm\_mcu\_low\_power\_mode\_status spm\_mcu\_low\_power\_mode\_status\_t

Status of last MCU STOP Mode Power Configuration.

typedef struct \_spm\_regulator\_status spm\_regulator\_status\_t

Keep the regulator status information.

typedef enum \_spm\_low\_volt\_detect\_volt\_select spm\_low\_volt\_detect\_volt\_select\_t

Low-voltage Detect Voltage Select.

typedef struct \_spm\_low\_volt\_detect\_config spm\_low\_volt\_detect\_config\_t

Low-voltage Detect Configuration Structure.

This structure reuses the configuration structure from legacy PMC module.

typedef enum \_spm\_low\_volt\_warning\_volt\_select spm\_low\_volt\_warning\_volt\_select\_t

Low-voltage Warning Voltage Select.

typedef struct \_spm\_low\_volt\_warning\_config spm\_low\_volt\_warning\_config\_t

Low-voltage Warning Configuration Structure.

typedef enum \_spm\_high\_volt\_detect\_volt\_select spm\_high\_volt\_detect\_volt\_select\_t

High-voltage Detect Voltage Select.



`typedef struct _spm_high_volt_detect_config` `spm_high_volt_detect_config_t`

High-voltage Detect Configuration Structure.

This structure reuses the configuration structure from legacy PMC module.

`typedef enum _spm_aux_ldo_low_power_mode` `spm_aux_ldo_low_power_mode_t`

Defines the AUX LDO low power behavior when in low power modes.

`typedef enum _spm_aux_ldo_io_soft_start_duration` `spm_aux_ldo_io_soft_start_duration_t`

Selects the soft start duration delay for the IO 1.8 full power regulator.

`typedef enum _spm_aux_io_regulator_volt_select` `spm_aux_io_regulator_volt_select_t`

IO Regulator Voltage Select.

`typedef struct _spm_aux_ldo_config` `spm_aux_ldo_config_t`

Aux LDO configuration structure.

`typedef struct _spm_dcdc_integrator_value_config` `spm_dcdc_integrator_config_t`

Configuration for setting DCDC integrator value.

`typedef enum _spm_dcdc_vbat_adc_divider` `spm_dcdc_vbat_adc_divider_t`

Defines the selection of DCDC vbat voltage divider for ADC measure.

`typedef enum _spm_low_power_req_out_pin_pol` `spm_low_power_req_out_pin_pol_t`

Defines the selection of low power request pin out pin polarity.

`typedef struct _spm_low_power_req_out_pin_config` `spm_low_power_req_out_pin_config_t`

Configuration structure of low power request out pin.

`typedef enum _spm_dcdc_drive_strength` `spm_dcdc_drive_strength_t`

Defines the selection of DCDC driver strength.

The more FETs are enabled, the more drive strength DCDC would provide.

`typedef struct _spm_dcdc_loop_control_config` `spm_dcdc_loop_control_config_t`

Loop control configuration.

`struct _spm_version_id`

`#include <fsl_spm.h>` IP version ID definition.

### Public Members

`uint16_t` `feature`

Feature set number.

`uint8_t` `minor`

Minor version number.

`uint8_t` `major`

Major version number.

`struct` `_spm_regulator_status`

`#include <fsl_spm.h>` Keep the regulator status information.

### Public Members

`spm_mcu_low_power_mode_status_t` `mcuLowPowerModeStatus`

Status of last MCU STOP Mode Power Configuration.

`bool` `isDcdcLdoOn`

DCDC LDO regulator enabled.

bool isAuxLdoOn

Aux LDO regulator enabled.

bool isCoreLdoOn

Core LDO regulator enabled.

struct \_spm\_low\_volt\_detect\_config

*#include <fsl\_spm.h>* Low-voltage Detect Configuration Structure.

This structure reuses the configuration structure from legacy PMC module.

### Public Members

bool enableIntOnVddLowVolt

Enable interrupt when VDD Low-voltage detect.

bool enableResetOnVddLowVolt

Enable forcing an MCU reset when VDD Low-voltage detect.

spm\_low\_volt\_detect\_volt\_select\_t vddLowVoltDetectSelect

Low-voltage detect trip point voltage selection.

bool enableIntOnCoreLowVolt

Enable interrupt when Core Low-voltage detect.

bool enableResetOnCoreLowVolt

Enable forcing an MCU reset when Core Low-voltage detect.

struct \_spm\_low\_volt\_warning\_config

*#include <fsl\_spm.h>* Low-voltage Warning Configuration Structure.

### Public Members

bool enableIntOnVddLowVolt

Enable interrupt when low-voltage warning

spm\_low\_volt\_warning\_volt\_select\_t vddLowVoltDetectSelect

Low-voltage warning trip point voltage selection

struct \_spm\_high\_volt\_detect\_config

*#include <fsl\_spm.h>* High-voltage Detect Configuration Structure.

This structure reuses the configuration structure from legacy PMC module.

### Public Members

bool enableIntOnVddHighVolt

Enable interrupt when high-voltage detect

bool enableResetOnVddHighVolt

Enable system reset when high-voltage detect

spm\_high\_volt\_detect\_volt\_select\_t vddHighVoltDetectSelect

High-voltage detect trip point voltage selection

struct \_spm\_aux\_ldo\_config

*#include <fsl\_spm.h>* Aux LDO configuration structure.

### Public Members

*spm\_aux\_ldo\_low\_power\_mode\_t* lowPowerMode

AUX LDO low power behaviour when in low power modes.

*spm\_aux\_ldo\_io\_soft\_start\_duration\_t* ioSoftStartDuration

Selects the soft start duration delay for the IO 1.8 full power regulator.

*spm\_aux\_io\_regulator\_volt\_select\_t* ioRegulatorVolt

IO Regulator Voltage Select.

struct *\_spm\_dcdc\_integrator\_value\_config*

*#include <fsl\_spm.h>* Configuration for setting DCDC integrator value.

### Public Members

double vddCoreValue

VDD\_CORE output voltage value.

double vBatValue

Battery input voltage value, or the Vdd\_dcdcin voltage value.

struct *\_spm\_low\_power\_req\_out\_pin\_config*

*#include <fsl\_spm.h>* Configuration structure of low power request out pin.

### Public Members

*spm\_low\_power\_req\_out\_pin\_pol\_t* pinOutPol

Low power request pin out pin polarity.

bool pinOutEnable

Low Power request output pin is enabled or not.

struct *\_spm\_dcdc\_loop\_control\_config*

*#include <fsl\_spm.h>* Loop control configuration.

### Public Members

bool enableCommonHysteresis

Enable hysteresis in switching converter differential mode analog comparators. This feature improves transient supply ripple and efficiency.

bool enableDifferentialHysteresis

Enable hysteresis in switching converter common mode analog comparators. This feature improves transient supply ripple and efficiency.

bool invertHysteresisSign

Invert the sign of the hysteresis in DC-DC analog comparators. Should be enabled when in Pulsed mode.

## 2.72 TPM: Timer PWM Module

```
uint32_t TPM_GetInstance(TPM_Type *base)
```

Gets the instance from the base address.

#### Parameters

- base – TPM peripheral base address

#### Returns

The TPM instance

```
void TPM_Init(TPM_Type *base, const tpm_config_t *config)
```

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

---

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

---

#### Parameters

- base – TPM peripheral base address
- config – Pointer to user's TPM config structure.

```
void TPM_Deinit(TPM_Type *base)
```

Stops the counter and gates the TPM clock.

#### Parameters

- base – TPM peripheral base address

```
void TPM_GetDefaultConfig(tpm_config_t *config)
```

Fill in the TPM config struct with the default settings.

The default values are:

```
config->prescale = kTPM_Prescale_Divide_1;
config->useGlobalTimeBase = false;
config->syncGlobalTimeBase = false;
config->dozeEnable = false;
config->dbgMode = false;
config->enableReloadOnTrigger = false;
config->enableStopOnOverflow = false;
config->enableStartOnTrigger = false;
#if FSL_FEATURE_TPM_HAS_PAUSE_COUNTER_ON_TRIGGER
config->enablePauseOnTrigger = false;
#endif
config->triggerSelect = kTPM_Trigger_Select_0;
#if FSL_FEATURE_TPM_HAS_EXTERNAL_TRIGGER_SELECTION
config->triggerSource = kTPM_TriggerSource_External;
config->extTriggerPolarity = kTPM_ExtTrigger_Active_High;
#endif
#if defined(FSL_FEATURE_TPM_HAS_POL) && FSL_FEATURE_TPM_HAS_POL
config->chnlPolarity = 0U;
#endif
```

#### Parameters

- config – Pointer to user's TPM config structure.

```
tpm_clock_prescale_t TPM_CalculateCounterClkDiv(TPM_Type *base, uint32_t
counterPeriod_Hz, uint32_t srcClock_Hz)
```

Calculates the counter clock prescaler.

This function calculates the values for SC[PS].

return Calculated clock prescaler value.

#### Parameters

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

*status\_t* TPM\_SetupPwm(TPM\_Type \*base, const *tpm\_chnl\_pwm\_signal\_param\_t* \*chnlParams, uint8\_t numOfChnls, *tpm\_pwm\_mode\_t* mode, uint32\_t pwmFreq\_Hz, uint32\_t srcClock\_Hz)

Configures the PWM signal parameters.

User calls this function to configure the PWM signals period, mode, dutycycle and edge. Use this function to configure all the TPM channels that will be used to output a PWM signal

#### Parameters

- base – TPM peripheral base address
- chnlParams – Array of PWM channel parameters to configure the channel(s)
- numOfChnls – Number of channels to configure, this should be the size of the array passed in
- mode – PWM operation mode, options available in enumeration *tpm\_pwm\_mode\_t*
- pwmFreq\_Hz – PWM signal frequency in Hz
- srcClock\_Hz – TPM counter clock in Hz

#### Returns

kStatus\_Success PWM setup successful  
kStatus\_Error PWM setup failed  
kStatus\_Timeout PWM setup timeout when write register CnV or MOD

*status\_t* TPM\_UpdatePwmDutycycle(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber, *tpm\_pwm\_mode\_t* currentPwmMode, uint8\_t dutyCyclePercent)

Update the duty cycle of an active PWM signal.

#### Parameters

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

#### Returns

kStatus\_Success if the PWM setup was successful, kStatus\_Error on failure

void TPM\_UpdateChnlEdgeLevelSelect(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber, uint8\_t level)

Update the edge level selection for a channel.

---

**Note:** When the TPM has PWM pause level select feature (FSL\_FEATURE\_TPM\_HAS\_PAUSE\_LEVEL\_SELECT = 1), the PWM output cannot be turned off by selecting the output level. In this case, must use TPM\_DisableChannel API to close the PWM output.

---

**Parameters**

- base – TPM peripheral base address
- chnlNumber – The channel number
- level – The level to be set to the ELSnB:ELSnA field; valid values are 00, 01, 10, 11. See the appropriate SoC reference manual for details about this field.

static inline uint8\_t TPM\_GetChannelControlBits(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber)

Get the channel control bits value (mode, edge and level bit fields).

This function disables the channel by clearing all mode and level control bits.

**Parameters**

- base – TPM peripheral base address
- chnlNumber – The channel number

**Returns**

The control bits value. This is the logical OR of members of the enumeration *tpm\_chnl\_control\_bit\_mask\_t*.

static inline *status\_t* TPM\_DisableChannel(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber)

Disable the channel.

This function disables the channel by clearing all mode and level control bits.

**Parameters**

- base – TPM peripheral base address
- chnlNumber – The channel number

**Returns**

*kStatus\_Success* PWM setup successful *kStatus\_Timeout* PWM setup timeout when writing register CnSC

static inline *status\_t* TPM\_EnableChannel(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber, uint8\_t control)

Enable the channel according to mode and level configs.

This function enables the channel output according to input mode/level config parameters.

**Parameters**

- base – TPM peripheral base address
- chnlNumber – The channel number
- control – The control bits value. This is the logical OR of members of the enumeration *tpm\_chnl\_control\_bit\_mask\_t*.

**Returns**

*kStatus\_Success* PWM setup successful *kStatus\_Timeout* PWM setup timeout when writing register CnSC

void TPM\_SetupInputCapture(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber, *tpm\_input\_capture\_edge\_t* captureMode)

Enables capturing an input signal on the channel using the function parameters.

When the edge specified in the *captureMode* argument occurs on the channel, the TPM counter is captured into the CnV register. The user has to read the CnV register separately to get this value.

**Parameters**

- base – TPM peripheral base address

- `chnlNumber` – The channel number
- `captureMode` – Specifies which edge to capture

```
status_t TPM_SetupOutputCompare(TPM_Type *base, tpm_chnl_t chnlNumber,
 tpm_output_compare_mode_t compareMode, uint32_t
 compareValue)
```

Configures the TPM to generate timed pulses.

When the TPM counter matches the value of `compareVal` argument (this is written into CnV reg), the channel output is changed based on what is specified in the `compareMode` argument.

#### Parameters

- `base` – TPM peripheral base address
- `chnlNumber` – The channel number
- `compareMode` – Action to take on the channel output when the compare condition is met
- `compareValue` – Value to be programmed in the CnV register.

#### Returns

`kStatus_Success` PWM setup successful  
`kStatus_Timeout` PWM setup timeout when write register CnV

```
void TPM_SetupDualEdgeCapture(TPM_Type *base, tpm_chnl_t chnlPairNumber, const
 tpm_dual_edge_capture_param_t *edgeParam, uint32_t
 filterValue)
```

Configures the dual edge capture mode of the TPM.

This function allows to measure a pulse width of the signal on the input of channel of a channel pair. The filter function is disabled if the `filterVal` argument passed is zero.

#### Parameters

- `base` – TPM peripheral base address
- `chnlPairNumber` – The TPM channel pair number; options are 0, 1, 2, 3
- `edgeParam` – Sets up the dual edge capture function
- `filterValue` – Filter value, specify 0 to disable filter.

```
void TPM_SetupQuadDecode(TPM_Type *base, const tpm_phase_params_t *phaseAParams,
 const tpm_phase_params_t *phaseBParams,
 tpm_quad_decode_mode_t quadMode)
```

Configures the parameters and activates the quadrature decode mode.

#### Parameters

- `base` – TPM peripheral base address
- `phaseAParams` – Phase A configuration parameters
- `phaseBParams` – Phase B configuration parameters
- `quadMode` – Selects encoding mode used in quadrature decoder mode

```
static inline void TPM_SetChannelPolarity(TPM_Type *base, tpm_chnl_t chnlNumber, bool
 enable)
```

Set the input and output polarity of each of the channels.

#### Parameters

- `base` – TPM peripheral base address
- `chnlNumber` – The channel number

- `enable` – `true`: Set the channel polarity to active high; `false`: Set the channel polarity to active low;

```
static inline void TPM_EnableChannelExtTrigger(TPM_Type *base, tpm_chnl_t chnlNumber, bool enable)
```

Enable external trigger input to be used by channel.

In input capture mode, configures the trigger input that is used by the channel to capture the counter value. In output compare or PWM mode, configures the trigger input used to modulate the channel output. When modulating the output, the output is forced to the channel initial value whenever the trigger is not asserted.

---

**Note:** No matter how many external trigger sources there are, only input trigger 0 and 1 are used. The even numbered channels share the input trigger 0 and the odd numbered channels share the second input trigger 1.

---

#### Parameters

- `base` – TPM peripheral base address
- `chnlNumber` – The channel number
- `enable` – `true`: Configures trigger input 0 or 1 to be used by channel; `false`: Trigger input has no effect on the channel

```
void TPM_EnableInterrupts(TPM_Type *base, uint32_t mask)
```

Enables the selected TPM interrupts.

#### Parameters

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

```
void TPM_DisableInterrupts(TPM_Type *base, uint32_t mask)
```

Disables the selected TPM interrupts.

#### Parameters

- `base` – TPM peripheral base address
- `mask` – The interrupts to disable. This is a logical OR of members of the enumeration `tpm_interrupt_enable_t`

```
uint32_t TPM_GetEnabledInterrupts(TPM_Type *base)
```

Gets the enabled TPM interrupts.

#### Parameters

- `base` – TPM peripheral base address

#### Returns

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

```
void TPM_RegisterCallback(TPM_Type *base, tpm_callback_t callback)
```

Register callback.

If channel or overflow interrupt is enabled by the user, then a callback can be registered which will be invoked when the interrupt is triggered.

#### Parameters

- `base` – TPM peripheral base address



- `callback` – Callback function

static inline uint32\_t TPM\_GetChannelValue(TPM\_Type \*base, *tpm\_chnl\_t* chnlNumber)

Gets the TPM channel value.

---

**Note:** The TPM channel value contain the captured TPM counter value for the input modes or the match value for the output modes.

---

#### Parameters

- `base` – TPM peripheral base address
- `chnlNumber` – The channel number

#### Returns

The channle CnV regisyer value.

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

Gets the TPM status flags.

#### Parameters

- `base` – TPM peripheral base address

#### Returns

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

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

Clears the TPM status flags.

#### Parameters

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

static inline *status\_t* TPM\_SetTimerPeriod(TPM\_Type \*base, uint32\_t ticks)

Sets the timer period in units of ticks.

Timers counts from 0 until it equals the count value set here. The count value is written to the MOD register.

---

#### Note:

- This API allows the user to use the TPM module as a timer. Do not mix usage of this API with TPM's PWM setup API's.
  - Call the utility macros provided in the `fsl_common.h` to convert usec or msec to ticks.
- 

#### Parameters

- `base` – TPM peripheral base address
- `ticks` – A timer period in units of ticks, which should be equal or greater than 1.

#### Returns

`kStatus_Success` PWM setup successful  
`kStatus_Timeout` PWM setup timeout when write register CnSC

static inline uint32\_t TPM\_GetCurrentTimerCount(TPM\_Type \*base)

Reads the current timer counting value.

This function returns the real-time timer counting value in a range from 0 to a timer period.

---

**Note:** Call the utility macros provided in the fsl\_common.h to convert ticks to usec or msec.

---

#### Parameters

- base – TPM peripheral base address

#### Returns

The current counter value in ticks

static inline void TPM\_StartTimer(TPM\_Type \*base, tpm\_clock\_source\_t clockSource)

Starts the TPM counter.

#### Parameters

- base – TPM peripheral base address
- clockSource – TPM clock source; once clock source is set the counter will start running

static inline status\_t TPM\_StopTimer(TPM\_Type \*base)

Stops the TPM counter.

#### Parameters

- base – TPM peripheral base address

#### Returns

kStatus\_Success PWM setup successful  
kStatus\_Timeout PWM setup timeout when write register CnSC

FSL\_TPM\_DRIVER\_VERSION

TPM driver version 2.4.0.

enum \_tpm\_chnl

List of TPM channels.

---

**Note:** Actual number of available channels is SoC dependent

---

Values:

enumerator kTPM\_Chnl\_0

TPM channel number 0

enumerator kTPM\_Chnl\_1

TPM channel number 1

enumerator kTPM\_Chnl\_2

TPM channel number 2

enumerator kTPM\_Chnl\_3

TPM channel number 3

enumerator kTPM\_Chnl\_4

TPM channel number 4

enumerator kTPM\_Chnl\_5

TPM channel number 5

enumerator kTPM\_Chnl\_6

TPM channel number 6

enumerator kTPM\_Chnl\_7

TPM channel number 7

enum \_tpm\_pwm\_mode

TPM PWM operation modes.

*Values:*

enumerator kTPM\_EdgeAlignedPwm

Edge aligned PWM

enumerator kTPM\_CenterAlignedPwm

Center aligned PWM

enumerator kTPM\_CombinedPwm

Combined PWM (Edge-aligned, center-aligned, or asymmetrical PWMs can be obtained in combined mode using different software configurations)

enum \_tpm\_pwm\_level\_select

TPM PWM output pulse mode: high-true, low-true or no output.

---

**Note:** When the TPM has PWM pause level select feature, the PWM output cannot be turned off by selecting the output level. In this case, the channel must be closed to close the PWM output.

---

*Values:*

enumerator kTPM\_HighTrue

High true pulses

enumerator kTPM\_LowTrue

Low true pulses

enum \_tpm\_pwm\_pause\_level\_select

TPM PWM output when first enabled or paused: set or clear.

*Values:*

enumerator kTPM\_ClearOnPause

Clear Output when counter first enabled or paused.

enumerator kTPM\_SetOnPause

Set Output when counter first enabled or paused.

enum \_tpm\_chnl\_control\_bit\_mask

List of TPM channel modes and level control bit mask.

*Values:*

enumerator kTPM\_ChnlELSnAMask

Channel ELSA bit mask.

enumerator kTPM\_ChnlELSnBMask

Channel ELSE bit mask.

enumerator kTPM\_ChnlMSAMask

Channel MSA bit mask.

enumerator kTPM\_ChnlMSBMask  
Channel MSB bit mask.

enum \_tpm\_trigger\_select

Trigger sources available.

This is used for both internal & external trigger sources (external trigger sources available in certain SoC's)

---

**Note:** The actual trigger sources available is SoC-specific.

---

*Values:*

enumerator kTPM\_Trigger\_Select\_0

enumerator kTPM\_Trigger\_Select\_1

enumerator kTPM\_Trigger\_Select\_2

enumerator kTPM\_Trigger\_Select\_3

enumerator kTPM\_Trigger\_Select\_4

enumerator kTPM\_Trigger\_Select\_5

enumerator kTPM\_Trigger\_Select\_6

enumerator kTPM\_Trigger\_Select\_7

enumerator kTPM\_Trigger\_Select\_8

enumerator kTPM\_Trigger\_Select\_9

enumerator kTPM\_Trigger\_Select\_10

enumerator kTPM\_Trigger\_Select\_11

enumerator kTPM\_Trigger\_Select\_12

enumerator kTPM\_Trigger\_Select\_13

enumerator kTPM\_Trigger\_Select\_14

enumerator kTPM\_Trigger\_Select\_15

enum \_tpm\_trigger\_source

Trigger source options available.

---

**Note:** This selection is available only on some SoC's. For SoC's without this selection, the only trigger source available is internal trigger.

---

*Values:*

enumerator kTPM\_TriggerSource\_External

Use external trigger input

enumerator kTPM\_TriggerSource\_Internal

Use internal trigger (channel pin input capture)

enum \_tpm\_ext\_trigger\_polarity  
External trigger source polarity.

---

**Note:** Selects the polarity of the external trigger source.

---

*Values:*

enumerator kTPM\_ExtTrigger\_Active\_High  
External trigger input is active high  
enumerator kTPM\_ExtTrigger\_Active\_Low  
External trigger input is active low

enum \_tpm\_output\_compare\_mode  
TPM output compare modes.

*Values:*

enumerator kTPM\_NoOutputSignal  
No channel output when counter reaches CnV  
enumerator kTPM\_ToggleOnMatch  
Toggle output  
enumerator kTPM\_ClearOnMatch  
Clear output  
enumerator kTPM\_SetOnMatch  
Set output  
enumerator kTPM\_HighPulseOutput  
Pulse output high  
enumerator kTPM\_LowPulseOutput  
Pulse output low

enum \_tpm\_input\_capture\_edge  
TPM input capture edge.

*Values:*

enumerator kTPM\_RisingEdge  
Capture on rising edge only  
enumerator kTPM\_FallingEdge  
Capture on falling edge only  
enumerator kTPM\_RiseAndFallEdge  
Capture on rising or falling edge

enum \_tpm\_quad\_decode\_mode  
TPM quadrature decode modes.

---

**Note:** This mode is available only on some SoC's.

---

*Values:*

enumerator kTPM\_QuadPhaseEncode  
Phase A and Phase B encoding mode

enumerator kTPM\_QuadCountAndDir  
Count and direction encoding mode

enum \_tpm\_phase\_polarity  
TPM quadrature phase polarities.

*Values:*

enumerator kTPM\_QuadPhaseNormal  
Phase input signal is not inverted

enumerator kTPM\_QuadPhaseInvert  
Phase input signal is inverted

enum \_tpm\_clock\_source  
TPM clock source selection.

*Values:*

enumerator kTPM\_SystemClock  
System clock

enumerator kTPM\_ExternalClock  
External TPM\_EXTCLK pin clock

enumerator kTPM\_ExternalInputTriggerClock  
Selected external input trigger clock

enum \_tpm\_clock\_prescale  
TPM prescale value selection for the clock source.

*Values:*

enumerator kTPM\_Prescale\_Divide\_1  
Divide by 1

enumerator kTPM\_Prescale\_Divide\_2  
Divide by 2

enumerator kTPM\_Prescale\_Divide\_4  
Divide by 4

enumerator kTPM\_Prescale\_Divide\_8  
Divide by 8

enumerator kTPM\_Prescale\_Divide\_16  
Divide by 16

enumerator kTPM\_Prescale\_Divide\_32  
Divide by 32

enumerator kTPM\_Prescale\_Divide\_64  
Divide by 64

enumerator kTPM\_Prescale\_Divide\_128  
Divide by 128

enum \_tpm\_interrupt\_enable  
List of TPM interrupts.

*Values:*

enumerator kTPM\_Chnl0InterruptEnable  
Channel 0 interrupt.

enumerator kTPM\_Chnl1InterruptEnable  
Channel 1 interrupt.

enumerator kTPM\_Chnl2InterruptEnable  
Channel 2 interrupt.

enumerator kTPM\_Chnl3InterruptEnable  
Channel 3 interrupt.

enumerator kTPM\_Chnl4InterruptEnable  
Channel 4 interrupt.

enumerator kTPM\_Chnl5InterruptEnable  
Channel 5 interrupt.

enumerator kTPM\_Chnl6InterruptEnable  
Channel 6 interrupt.

enumerator kTPM\_Chnl7InterruptEnable  
Channel 7 interrupt.

enumerator kTPM\_TimeOverflowInterruptEnable  
Time overflow interrupt.

enum \_tpm\_status\_flags

List of TPM flags.

*Values:*

enumerator kTPM\_Chnl0Flag  
Channel 0 flag

enumerator kTPM\_Chnl1Flag  
Channel 1 flag

enumerator kTPM\_Chnl2Flag  
Channel 2 flag

enumerator kTPM\_Chnl3Flag  
Channel 3 flag

enumerator kTPM\_Chnl4Flag  
Channel 4 flag

enumerator kTPM\_Chnl5Flag  
Channel 5 flag

enumerator kTPM\_Chnl6Flag  
Channel 6 flag

enumerator kTPM\_Chnl7Flag  
Channel 7 flag

enumerator kTPM\_TimeOverflowFlag  
Time overflow flag

typedef enum \_tpm\_chnl tpm\_chnl\_t

List of TPM channels.

---

**Note:** Actual number of available channels is SoC dependent

---

typedef enum *\_tpm\_pwm\_mode* tpm\_pwm\_mode\_t

TPM PWM operation modes.

typedef enum *\_tpm\_pwm\_level\_select* tpm\_pwm\_level\_select\_t

TPM PWM output pulse mode: high-true, low-true or no output.

---

**Note:** When the TPM has PWM pause level select feature, the PWM output cannot be turned off by selecting the output level. In this case, the channel must be closed to close the PWM output.

---

typedef enum *\_tpm\_pwm\_pause\_level\_select* tpm\_pwm\_pause\_level\_select\_t

TPM PWM output when first enabled or paused: set or clear.

typedef enum *\_tpm\_chnl\_control\_bit\_mask* tpm\_chnl\_control\_bit\_mask\_t

List of TPM channel modes and level control bit mask.

typedef struct *\_tpm\_chnl\_pwm\_signal\_param* tpm\_chnl\_pwm\_signal\_param\_t

Options to configure a TPM channel's PWM signal.

typedef enum *\_tpm\_trigger\_select* tpm\_trigger\_select\_t

Trigger sources available.

This is used for both internal & external trigger sources (external trigger sources available in certain SoC's)

---

**Note:** The actual trigger sources available is SoC-specific.

---

typedef enum *\_tpm\_trigger\_source* tpm\_trigger\_source\_t

Trigger source options available.

---

**Note:** This selection is available only on some SoC's. For SoC's without this selection, the only trigger source available is internal trigger.

---

typedef enum *\_tpm\_ext\_trigger\_polarity* tpm\_ext\_trigger\_polarity\_t

External trigger source polarity.

---

**Note:** Selects the polarity of the external trigger source.

---

typedef enum *\_tpm\_output\_compare\_mode* tpm\_output\_compare\_mode\_t

TPM output compare modes.

typedef enum *\_tpm\_input\_capture\_edge* tpm\_input\_capture\_edge\_t

TPM input capture edge.

typedef struct *\_tpm\_dual\_edge\_capture\_param* tpm\_dual\_edge\_capture\_param\_t

TPM dual edge capture parameters.

---

**Note:** This mode is available only on some SoC's.

---

typedef enum *\_tpm\_quad\_decode\_mode* tpm\_quad\_decode\_mode\_t

TPM quadrature decode modes.

---

**Note:** This mode is available only on some SoC's.

---



typedef enum *\_tpm\_phase\_polarity* tpm\_phase\_polarity\_t

TPM quadrature phase polarities.

typedef struct *\_tpm\_phase\_param* tpm\_phase\_params\_t

TPM quadrature decode phase parameters.

typedef enum *\_tpm\_clock\_source* tpm\_clock\_source\_t

TPM clock source selection.

typedef enum *\_tpm\_clock\_prescale* tpm\_clock\_prescale\_t

TPM prescale value selection for the clock source.

typedef struct *\_tpm\_config* tpm\_config\_t

TPM config structure.

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

The config struct can be made const so it resides in flash

typedef enum *\_tpm\_interrupt\_enable* tpm\_interrupt\_enable\_t

List of TPM interrupts.

typedef enum *\_tpm\_status\_flags* tpm\_status\_flags\_t

List of TPM flags.

typedef void (\*tpm\_callback\_t)(TPM\_Type \*base)

TPM callback function pointer.

#### **Param base**

TPM peripheral base address.

static inline void TPM\_Reset(TPM\_Type \*base)

Performs a software reset on the TPM module.

Reset all internal logic and registers, except the Global Register. Remains set until cleared by software.

---

**Note:** TPM software reset is available on certain SoC's only

---

#### **Parameters**

- base – TPM peripheral base address

void TPM\_DriverIRQHandler(uint32\_t instance)

TPM driver IRQ handler common entry.

This function provides the common IRQ request entry for TPM.

#### **Parameters**

- instance – TPM instance.

TPM\_TIMEOUT

Max loops to wait for writing register.

When writing MOD CnV CnSC and SC register, driver will wait until register is updated. This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

TPM\_MAX\_COUNTER\_VALUE(x)

Help macro to get the max counter value.

struct `_tpm_chnl_pwm_signal_param`

`#include <fsl_tpm.h>` Options to configure a TPM channel's PWM signal.

### Public Members

`tpm_chnl_t` `chnlNumber`

TPM channel to configure. In combined mode (available in some SoC's), this represents the channel pair number

`tpm_pwm_pause_level_select_t` `pauseLevel`

PWM output level when counter first enabled or paused

`tpm_pwm_level_select_t` `level`

PWM output active level select

`uint8_t` `dutyCyclePercent`

PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=always active signal (100% duty cycle)

`uint8_t` `firstEdgeDelayPercent`

Used only in combined PWM mode to generate asymmetrical PWM. Specifies the delay to the first edge in a PWM period. If unsure, leave as 0. Should be specified as percentage of the PWM period, (`dutyCyclePercent` + `firstEdgeDelayPercent`) value should be not greater than 100.

`bool` `enableComplementary`

Used only in combined PWM mode. true: The combined channels output complementary signals; false: The combined channels output same signals;

`tpm_pwm_pause_level_select_t` `secPauseLevel`

Used only in combined PWM mode. Define the second channel output level when counter first enabled or paused

`uint8_t` `deadTimeValue[2]`

The dead time value for channel `n` and `n+1` in combined complementary PWM mode. Deadtime insertion is disabled when this value is zero, otherwise deadtime insertion for channel `n/n+1` is configured as (`deadTimeValue` \* 4) clock cycles. `deadTimeValue`'s available range is 0 ~ 15.

struct `_tpm_dual_edge_capture_param`

`#include <fsl_tpm.h>` TPM dual edge capture parameters.

---

**Note:** This mode is available only on some SoC's.

---

### Public Members

`bool` `enableSwap`

true: Use channel `n+1` input, channel `n` input is ignored; false: Use channel `n` input, channel `n+1` input is ignored

`tpm_input_capture_edge_t` `currChanEdgeMode`

Input capture edge select for channel `n`

`tpm_input_capture_edge_t` `nextChanEdgeMode`

Input capture edge select for channel `n+1`

struct `_tpm_phase_param`

`#include <fsl_tpm.h>` TPM quadrature decode phase parameters.

### Public Members

uint32\_t phaseFilterVal

Filter value, filter is disabled when the value is zero

*tpm\_phase\_polarity\_t* phasePolarity

Phase polarity

struct *\_tpm\_config*

*#include <fsl\_tpm.h>* TPM config structure.

This structure holds the configuration settings for the TPM peripheral. To initialize this structure to reasonable defaults, call the *TPM\_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

*tpm\_clock\_prescale\_t* prescale

Select TPM clock prescale value

bool useGlobalTimeBase

true: The TPM channels use an external global time base (the local counter still use for generate overflow interrupt and DMA request); false: All TPM channels use the local counter as their timebase

bool syncGlobalTimeBase

true: The TPM counter is synchronized to the global time base; false: disabled

*tpm\_trigger\_select\_t* triggerSelect

Input trigger to use for controlling the counter operation

*tpm\_trigger\_source\_t* triggerSource

Decides if we use external or internal trigger.

*tpm\_ext\_trigger\_polarity\_t* extTriggerPolarity

when using external trigger source, need selects the polarity of it.

bool enableDoze

true: TPM counter is paused in doze mode; false: TPM counter continues in doze mode

bool enableDebugMode

true: TPM counter continues in debug mode; false: TPM counter is paused in debug mode

bool enableReloadOnTrigger

true: TPM counter is reloaded on trigger; false: TPM counter not reloaded

bool enableStopOnOverflow

true: TPM counter stops after overflow; false: TPM counter continues running after overflow

bool enableStartOnTrigger

true: TPM counter only starts when a trigger is detected; false: TPM counter starts immediately

bool enablePauseOnTrigger

true: TPM counter will pause while trigger remains asserted; false: TPM counter continues running

uint8\_t chnlPolarity

Defines the input/output polarity of the channels in POL register

## 2.73 TRGMUX: Trigger Mux Driver

`static inline void TRGMUX_LockRegister(TRGMUX_Type *base, uint32_t index)`

Sets the flag of the register which is used to mark writeable.

The function sets the flag of the register which is used to mark writeable. Example:

```
TRGMUX_LockRegister(TRGMUX0, kTRGMUX_Trgmux0Dmamux0);
```

### Parameters

- `base` – TRGMUX peripheral base address.
- `index` – The index of the TRGMUX register, see the enum `trgmux_device_t` defined in `<SOC>.h`.

`status_t TRGMUX_SetTriggerSource(TRGMUX_Type *base, uint32_t index, trgmux_trigger_input_t input, uint32_t trigger_src)`

Configures the trigger source of the appointed peripheral.

The function configures the trigger source of the appointed peripheral. Example:

```
TRGMUX_SetTriggerSource(TRGMUX0, kTRGMUX_Trgmux0Dmamux0, kTRGMUX_TriggerInput0,
↪ kTRGMUX_SourcePortPin);
```

### Parameters

- `base` – TRGMUX peripheral base address.
- `index` – The index of the TRGMUX register, see the enum `trgmux_device_t` defined in `<SOC>.h`.
- `input` – The MUX select for peripheral trigger input
- `trigger_src` – The trigger inputs for various peripherals. See the enum `trgmux_source_t` defined in `<SOC>.h`.

### Return values

- `kStatus_Success` – Configured successfully.
- `kStatus_TRGMUX_Locked` – Configuration failed because the register is locked.

`FSL_TRGMUX_DRIVER_VERSION`

TRGMUX driver version.

TRGMUX configure status.

*Values:*

enumerator `kStatus_TRGMUX_Locked`

Configure failed for register is locked

enum `_trgmux_trigger_input`

Defines the MUX select for peripheral trigger input.

*Values:*

enumerator `kTRGMUX_TriggerInput0`

The MUX select for peripheral trigger input 0

enumerator `kTRGMUX_TriggerInput1`

The MUX select for peripheral trigger input 1

enumerator kTRGMUX\_TriggerInput2

The MUX select for peripheral trigger input 2

enumerator kTRGMUX\_TriggerInput3

The MUX select for peripheral trigger input 3

typedef enum *trgmux\_trigger\_input* trgmux\_trigger\_input\_t

Defines the MUX select for peripheral trigger input.

## 2.74 TRNG: True Random Number Generator

FSL\_TRNG\_DRIVER\_VERSION

TRNG driver version 2.0.19.

Current version: 2.0.19

Change log:

- version 2.0.19
  - Added support for MCXA and MCXL.
- version 2.0.18
  - TRNG health checks now done in software on RT5xx and RT6xx.
- version 2.0.17
  - Added support for RT700.
- version 2.0.16
  - Added support for Dual oscillator mode.
- version 2.0.15
  - Changed TRNG\_USER\_CONFIG\_DEFAULT\_XXX values according to latest recommended by design team.
- version 2.0.14
  - add support for RW610 and RW612
- version 2.0.13
  - After deepsleep it might return error, added clearing bits in TRNG\_GetRandomData() and generating new entropy.
  - Modified reloading entropy in TRNG\_GetRandomData(), for some data length it doesn't reloading entropy correctly.
- version 2.0.12
  - For KW34A4\_SERIES, KW35A4\_SERIES, KW36A4\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv8.
- version 2.0.11
  - Add clearing pending errors in TRNG\_Init().
- version 2.0.10
  - Fixed doxygen issues.
- version 2.0.9
  - Fix HIS\_CCM metrics issues.
- version 2.0.8

- For K32L2A41A\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv4.
- version 2.0.7
  - Fix MISRA 2004 issue rule 12.5.
- version 2.0.6
  - For KW35Z4\_SERIES set TRNG\_USER\_CONFIG\_DEFAULT\_OSC\_DIV to kTRNG\_RingOscDiv8.
- version 2.0.5
  - Add possibility to define default TRNG configuration by device specific preprocessor macros for FRQMIN, FRQMAX and OSCDIV.
- version 2.0.4
  - Fix MISRA-2012 issues.
- Version 2.0.3
  - update TRNG\_Init to restart entropy generation
- Version 2.0.2
  - fix MISRA issues
- Version 2.0.1
  - add support for KL8x and KL28Z
  - update default OSCDIV for K81 to divide by 2

enum `_trng_sample_mode`

TRNG sample mode. Used by `trng_config_t`.

*Values:*

enumerator `kTRNG_SampleModeVonNeumann`

Use von Neumann data in both Entropy shifter and Statistical Checker.

enumerator `kTRNG_SampleModeRaw`

Use raw data into both Entropy shifter and Statistical Checker.

enumerator `kTRNG_SampleModeVonNeumannRaw`

Use von Neumann data in Entropy shifter. Use raw data into Statistical Checker.

enum `_trng_clock_mode`

TRNG clock mode. Used by `trng_config_t`.

*Values:*

enumerator `kTRNG_ClockModeRingOscillator`

Ring oscillator is used to operate the TRNG (default).

enumerator `kTRNG_ClockModeSystem`

System clock is used to operate the TRNG. This is for test use only, and indeterminate results may occur.

enum `_trng_ring_osc_div`

TRNG ring oscillator divide. Used by `trng_config_t`.

*Values:*

enumerator `kTRNG_RingOscDiv0`

Ring oscillator with no divide

enumerator `kTRNG_RingOscDiv2`

Ring oscillator divided-by-2.

enumerator `kTRNG_RingOscDiv4`

Ring oscillator divided-by-4.

enumerator `kTRNG_RingOscDiv8`

Ring oscillator divided-by-8.

typedef enum *trng\_sample\_mode* `trng_sample_mode_t`

TRNG sample mode. Used by `trng_config_t`.

typedef enum *trng\_clock\_mode* `trng_clock_mode_t`

TRNG clock mode. Used by `trng_config_t`.

typedef enum *trng\_ring\_osc\_div* `trng_ring_osc_div_t`

TRNG ring oscillator divide. Used by `trng_config_t`.

typedef struct *trng\_statistical\_check\_limit* `trng_statistical_check_limit_t`

Data structure for definition of statistical check limits. Used by `trng_config_t`.

typedef struct *trng\_user\_config* `trng_config_t`

Data structure for the TRNG initialization.

This structure initializes the TRNG by calling the `TRNG_Init()` function. It contains all TRNG configurations.

*status\_t* `TRNG_GetDefaultConfig(trng_config_t *userConfig)`

Initializes the user configuration structure to default values.

This function initializes the configuration structure to default values. The default values are platform dependent.

#### Parameters

- `userConfig` – User configuration structure.

#### Returns

If successful, returns the `kStatus_TRNG_Success`. Otherwise, it returns an error.

*status\_t* `TRNG_Init(TRNG_Type *base, const trng_config_t *userConfig)`

Initializes the TRNG.

This function initializes the TRNG. When called, the TRNG entropy generation starts immediately.

#### Parameters

- `base` – TRNG base address
- `userConfig` – Pointer to the initialization configuration structure.

#### Returns

If successful, returns the `kStatus_TRNG_Success`. Otherwise, it returns an error.

*void* `TRNG_Deinit(TRNG_Type *base)`

Shuts down the TRNG.

This function shuts down the TRNG.

#### Parameters

- `base` – TRNG base address.

*status\_t* TRNG\_GetRandomData(TRNG\_Type \*base, void \*data, size\_t dataSize)

Gets random data.

This function gets random data from the TRNG.

#### Parameters

- base – TRNG base address.
- data – Pointer address used to store random data.
- dataSize – Size of the buffer pointed by the data parameter.

#### Returns

random data

struct \_\_trng\_statistical\_check\_limit

*#include <fsl\_trng.h>* Data structure for definition of statistical check limits. Used by trng\_config\_t.

#### Public Members

uint32\_t maximum

Maximum limit.

int32\_t minimum

Minimum limit.

struct \_\_trng\_user\_config

*#include <fsl\_trng.h>* Data structure for the TRNG initialization.

This structure initializes the TRNG by calling the TRNG\_Init() function. It contains all TRNG configurations.

#### Public Members

bool lock

Disable programmability of TRNG registers.

trng\_clock\_mode\_t clockMode

Clock mode used to operate TRNG.

trng\_ring\_osc\_div\_t ringOscDiv

Ring oscillator divide used by TRNG.

trng\_sample\_mode\_t sampleMode

Sample mode of the TRNG ring oscillator.

uint16\_t entropyDelay

Entropy Delay. Defines the length (in system clocks) of each Entropy sample taken.

uint16\_t sampleSize

Sample Size. Defines the total number of Entropy samples that will be taken during Entropy generation.

uint16\_t sparseBitLimit

Sparse Bit Limit which defines the maximum number of consecutive samples that may be discarded before an error is generated. This limit is used only for during von Neumann sampling (enabled by TRNG\_HAL\_SetSampleMode()). Samples are discarded if two consecutive raw samples are both 0 or both 1. If this discarding occurs for a long period of time, it indicates that there is insufficient Entropy.



`uint8_t retryCount`

Retry count. It defines the number of times a statistical check may fails during the TRNG Entropy Generation before generating an error.

`uint8_t longRunMaxLimit`

Largest allowable number of consecutive samples of all 1, or all 0, that is allowed during the Entropy generation.

`trng_statistical_check_limit_t monobitLimit`

Maximum and minimum limits for statistical check of number of ones/zero detected during entropy generation.

`trng_statistical_check_limit_t runBit1Limit`

Maximum and minimum limits for statistical check of number of runs of length 1 detected during entropy generation.

`trng_statistical_check_limit_t runBit2Limit`

Maximum and minimum limits for statistical check of number of runs of length 2 detected during entropy generation.

`trng_statistical_check_limit_t runBit3Limit`

Maximum and minimum limits for statistical check of number of runs of length 3 detected during entropy generation.

`trng_statistical_check_limit_t runBit4Limit`

Maximum and minimum limits for statistical check of number of runs of length 4 detected during entropy generation.

`trng_statistical_check_limit_t runBit5Limit`

Maximum and minimum limits for statistical check of number of runs of length 5 detected during entropy generation.

`trng_statistical_check_limit_t runBit6PlusLimit`

Maximum and minimum limits for statistical check of number of runs of length 6 or more detected during entropy generation.

`trng_statistical_check_limit_t pokerLimit`

Maximum and minimum limits for statistical check of “Poker Test”.

`trng_statistical_check_limit_t frequencyCountLimit`

Maximum and minimum limits for statistical check of entropy sample frequency count.

## 2.75 TSTMR: Timestamp Timer Driver

`void TSTMR_Init(TSTMR_Type *base)`

Init TSTMR.

This function initializes the TSTMR module.

### Parameters

- `base` – TSTMR peripheral base address.

`void TSTMR_Deinit(TSTMR_Type *base)`

Deinit TSTMR.

This function deinitializes the TSTMR module.

### Parameters

- `base` – TSTMR peripheral base address.

FSL\_TSTMR\_DRIVER\_VERSION

Version 2.1.0

static inline uint64\_t TSTMR\_ReadTimeStamp(TSTMR\_Type \*base)

Reads the time stamp.

This function reads the low and high registers and returns the 56-bit free running counter value. This can be read by software at any time to determine the software ticks. TSTMR registers can be read with 32-bit accesses only. The TSTMR LOW read should occur first, followed by the TSTMR HIGH read.

**Parameters**

- base – TSTMR peripheral base address.

**Returns**

The 56-bit time stamp value.

void TSTMR\_DelayUs(TSTMR\_Type \*base, uint64\_t delayInUs)

Delays for a specified number of microseconds.

This function repeatedly reads the timestamp register and waits for the user-specified delay value.

**Parameters**

- base – TSTMR peripheral base address.
- delayInUs – Delay value in microseconds.

## 2.76 USDHC: Ultra Secured Digital Host Controller Driver

void USDHC\_Init(USDHC\_Type \*base, const *usdhc\_config\_t* \*config)

USDHC module initialization function.

Configures the USDHC according to the user configuration.

Example:

```
usdhc_config_t config;
config.cardDetectDat3 = false;
config.endianMode = kUSDHC_EndianModeLittle;
config.dmaMode = kUSDHC_DmaModeAdma2;
config.readWatermarkLevel = 128U;
config.writeWatermarkLevel = 128U;
USDHC_Init(USDHC, &config);
```

**Parameters**

- base – USDHC peripheral base address.
- config – USDHC configuration information.

**Return values**

kStatus\_Success – Operate successfully.

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

Deinitializes the USDHC.

**Parameters**

- base – USDHC peripheral base address.

`bool USDHC_Reset(USDHC_Type *base, uint32_t mask, uint32_t timeout)`

Resets the USDHC.

#### Parameters

- `base` – USDHC peripheral base address.
- `mask` – The reset type mask(`_usdhc_reset`).
- `timeout` – Timeout for reset.

#### Return values

- `true` – Reset successfully.
- `false` – Reset failed.

`status_t USDHC_SetAdmaTableConfig(USDHC_Type *base, usdhc_adma_config_t *dmaConfig, usdhc_data_t *dataConfig, uint32_t flags)`

Sets the DMA descriptor table configuration. A high level DMA descriptor configuration function.

#### Parameters

- `base` – USDHC peripheral base address.
- `dmaConfig` – ADMA configuration
- `dataConfig` – Data descriptor
- `flags` – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to `enum _usdhc_adma_flag`.

#### Return values

- `kStatus_OutOfRange` – ADMA descriptor table length isn't enough to describe data.
- `kStatus_Success` – Operate successfully.

`status_t USDHC_SetInternalDmaConfig(USDHC_Type *base, usdhc_adma_config_t *dmaConfig, const uint32_t *dataAddr, bool enAutoCmd23)`

Internal DMA configuration. This function is used to config the USDHC DMA related registers.

#### Parameters

- `base` – USDHC peripheral base address.
- `dmaConfig` – ADMA configuration.
- `dataAddr` – Transfer data address, a simple DMA parameter, if ADMA is used, leave it to NULL.
- `enAutoCmd23` – Flag to indicate Auto CMD23 is enable or not, a simple DMA parameter, if ADMA is used, leave it to false.

#### Return values

- `kStatus_OutOfRange` – ADMA descriptor table length isn't enough to describe data.
- `kStatus_Success` – Operate successfully.

`status_t USDHC_SetADMA2Descriptor(uint32_t *admaTable, uint32_t admaTableWords, const uint32_t *dataBufferAddr, uint32_t dataBytes, uint32_t flags)`

Sets the ADMA2 descriptor table configuration.

#### Parameters

- `admaTable` – ADMA table address.
- `admaTableWords` – ADMA table length.
- `dataBufferAddr` – Data buffer address.
- `dataBytes` – Data Data length.
- `flags` – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to `enum _usdhc_adma_flag`.

**Return values**

- `kStatus_OutOfRange` – ADMA descriptor table length isn't enough to describe data.
- `kStatus_Success` – Operate successfully.

```
status_t USDHC_SetADMA1Descriptor(uint32_t *admaTable, uint32_t admaTableWords, const
 uint32_t *dataBufferAddr, uint32_t dataBytes, uint32_t
 flags)
```

Sets the ADMA1 descriptor table configuration.

**Parameters**

- `admaTable` – ADMA table address.
- `admaTableWords` – ADMA table length.
- `dataBufferAddr` – Data buffer address.
- `dataBytes` – Data length.
- `flags` – ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to `enum _usdhc_adma_flag`.

**Return values**

- `kStatus_OutOfRange` – ADMA descriptor table length isn't enough to describe data.
- `kStatus_Success` – Operate successfully.

```
static inline void USDHC_EnableInternalDMA(USDHC_Type *base, bool enable)
```

Enables internal DMA.

**Parameters**

- `base` – USDHC peripheral base address.
- `enable` – enable or disable flag

```
static inline void USDHC_EnableInterruptStatus(USDHC_Type *base, uint32_t mask)
```

Enables the interrupt status.

**Parameters**

- `base` – USDHC peripheral base address.
- `mask` – Interrupt status flags mask(`_usdhc_interrupt_status_flag`).

```
static inline void USDHC_DisableInterruptStatus(USDHC_Type *base, uint32_t mask)
```

Disables the interrupt status.

**Parameters**

- `base` – USDHC peripheral base address.
- `mask` – The interrupt status flags mask(`_usdhc_interrupt_status_flag`).

static inline void USDHC\_EnableInterruptSignal(USDHC\_Type \*base, uint32\_t mask)

Enables the interrupt signal corresponding to the interrupt status flag.

**Parameters**

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(\_usdhc\_interrupt\_status\_flag).

static inline void USDHC\_DisableInterruptSignal(USDHC\_Type \*base, uint32\_t mask)

Disables the interrupt signal corresponding to the interrupt status flag.

**Parameters**

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(\_usdhc\_interrupt\_status\_flag).

static inline uint32\_t USDHC\_GetEnabledInterruptStatusFlags(USDHC\_Type \*base)

Gets the enabled interrupt status.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

Current interrupt status flags mask(\_usdhc\_interrupt\_status\_flag).

static inline uint32\_t USDHC\_GetInterruptStatusFlags(USDHC\_Type \*base)

Gets the current interrupt status.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

Current interrupt status flags mask(\_usdhc\_interrupt\_status\_flag).

static inline void USDHC\_ClearInterruptStatusFlags(USDHC\_Type \*base, uint32\_t mask)

Clears a specified interrupt status. write 1 clears.

**Parameters**

- base – USDHC peripheral base address.
- mask – The interrupt status flags mask(\_usdhc\_interrupt\_status\_flag).

static inline uint32\_t USDHC\_GetAutoCommand12ErrorStatusFlags(USDHC\_Type \*base)

Gets the status of auto command 12 error.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

Auto command 12 error status flags mask(\_usdhc\_auto\_command12\_error\_status\_flag).

static inline uint32\_t USDHC\_GetAdmaErrorStatusFlags(USDHC\_Type \*base)

Gets the status of the ADMA error.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

ADMA error status flags mask(\_usdhc\_adma\_error\_status\_flag).

```
static inline uint32_t USDHC_GetPresentStatusFlags(USDHC_Type *base)
```

Gets a present status.

This function gets the present USDHC's status except for an interrupt status and an error status.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

Present USDHC's status flags mask(`_usdhc_present_status_flag`).

```
void USDHC_GetCapability(USDHC_Type *base, usdhc_capability_t *capability)
```

Gets the capability information.

**Parameters**

- base – USDHC peripheral base address.
- capability – Structure to save capability information.

```
static inline void USDHC_ForceClockOn(USDHC_Type *base, bool enable)
```

Forces the card clock on.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag

```
uint32_t USDHC_SetSdClock(USDHC_Type *base, uint32_t srcClock_Hz, uint32_t busClock_Hz)
```

Sets the SD bus clock frequency.

**Parameters**

- base – USDHC peripheral base address.
- srcClock\_Hz – USDHC source clock frequency united in Hz.
- busClock\_Hz – SD bus clock frequency united in Hz.

**Returns**

The nearest frequency of busClock\_Hz configured for SD bus.

```
bool USDHC_SetCardActive(USDHC_Type *base, uint32_t timeout)
```

Sends 80 clocks to the card to set it to the active state.

This function must be called each time the card is inserted to ensure that the card can receive the command correctly.

**Parameters**

- base – USDHC peripheral base address.
- timeout – Timeout to initialize card.

**Return values**

- true – Set card active successfully.
- false – Set card active failed.

```
static inline void USDHC_AssertHardwareReset(USDHC_Type *base, bool high)
```

Triggers a hardware reset.

**Parameters**

- base – USDHC peripheral base address.
- high – 1 or 0 level

static inline void USDHC\_SetDataBusWidth(USDHC\_Type \*base, *usdhc\_data\_bus\_width\_t* width)  
Sets the data transfer width.

**Parameters**

- base – USDHC peripheral base address.
- width – Data transfer width.

static inline void USDHC\_WriteData(USDHC\_Type \*base, uint32\_t data)  
Fills the data port.

This function is used to implement the data transfer by Data Port instead of DMA.

**Parameters**

- base – USDHC peripheral base address.
- data – The data about to be sent.

static inline uint32\_t USDHC\_ReadData(USDHC\_Type \*base)  
Retrieves the data from the data port.

This function is used to implement the data transfer by Data Port instead of DMA.

**Parameters**

- base – USDHC peripheral base address.

**Returns**

The data has been read.

void USDHC\_SendCommand(USDHC\_Type \*base, *usdhc\_command\_t* \*command)  
Sends command function.

**Parameters**

- base – USDHC peripheral base address.
- command – configuration

static inline void USDHC\_EnableWakeupEvent(USDHC\_Type \*base, uint32\_t mask, bool enable)  
Enables or disables a wakeup event in low-power mode.

**Parameters**

- base – USDHC peripheral base address.
- mask – Wakeup events mask(*\_usdhc\_wakeup\_event*).
- enable – True to enable, false to disable.

static inline void USDHC\_CardDetectByData3(USDHC\_Type \*base, bool enable)  
Detects card insert status.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag

static inline bool USDHC\_DetectCardInsert(USDHC\_Type \*base)  
Detects card insert status.

**Parameters**

- base – USDHC peripheral base address.

static inline void USDHC\_EnableSdioControl(USDHC\_Type \*base, uint32\_t mask, bool enable)  
Enables or disables the SDIO card control.

#### Parameters

- base – USDHC peripheral base address.
- mask – SDIO card control flags mask(\_usdhc\_sdio\_control\_flag).
- enable – True to enable, false to disable.

static inline void USDHC\_SetContinueRequest(USDHC\_Type \*base)  
Restarts a transaction which has stopped at the block GAP for the SDIO card.

#### Parameters

- base – USDHC peripheral base address.

static inline void USDHC\_RequestStopAtBlockGap(USDHC\_Type \*base, bool enable)  
Request stop at block gap function.

#### Parameters

- base – USDHC peripheral base address.
- enable – True to stop at block gap, false to normal transfer.

void USDHC\_SetMmcBootConfig(USDHC\_Type \*base, const *usdhc\_boot\_config\_t* \*config)  
Configures the MMC boot feature.

Example:

```
usdhc_boot_config_t config;
config.ackTimeoutCount = 4;
config.bootMode = kUSDHC_BootModeNormal;
config.blockCount = 5;
config.enableBootAck = true;
config.enableBoot = true;
config.enableAutoStopAtBlockGap = true;
USDHC_SetMmcBootConfig(USDHC, &config);
```

#### Parameters

- base – USDHC peripheral base address.
- config – The MMC boot configuration information.

static inline void USDHC\_EnableMmcBoot(USDHC\_Type \*base, bool enable)  
Enables or disables the mmc boot mode.

#### Parameters

- base – USDHC peripheral base address.
- enable – True to enable, false to disable.

static inline void USDHC\_SetForceEvent(USDHC\_Type \*base, uint32\_t mask)  
Forces generating events according to the given mask.

#### Parameters

- base – USDHC peripheral base address.
- mask – The force events bit position (\_usdhc\_force\_event).

static inline bool USDHC\_RequestTuningForSDR50(USDHC\_Type \*base)  
Checks the SDR50 mode request tuning bit. When this bit set, application shall perform tuning for SDR50 mode.



**Parameters**

- base – USDHC peripheral base address.

static inline bool USDHC\_RequestReTuning(USDHC\_Type \*base)

Checks the request re-tuning bit. When this bit is set, user should do manual tuning or standard tuning function.

**Parameters**

- base – USDHC peripheral base address.

static inline void USDHC\_EnableAutoTuning(USDHC\_Type \*base, bool enable)

The SDR104 mode auto tuning enable and disable. This function should be called after tuning function execute pass, auto tuning will handle by hardware.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag

void USDHC\_EnableAutoTuningForCmdAndData(USDHC\_Type \*base)

The auto tuning enable for CMD/DATA line.

**Parameters**

- base – USDHC peripheral base address.

void USDHC\_EnableManualTuning(USDHC\_Type \*base, bool enable)

Manual tuning trigger or abort. User should handle the tuning cmd and find the boundary of the delay then calculate a average value which will be configured to the **CLK\_TUNE\_CTRL\_STATUS**. This function should be called before function **USDHC\_AdjustDelayForManualTuning**.

**Parameters**

- base – USDHC peripheral base address.
- enable – tuning enable flag

static inline uint32\_t USDHC\_GetTuningDelayStatus(USDHC\_Type \*base)

Get the tuning delay cell setting.

**Parameters**

- base – USDHC peripheral base address.

**Return values**

CLK – Tuning Control and Status register value.

status\_t USDHC\_SetTuningDelay(USDHC\_Type \*base, uint32\_t preDelay, uint32\_t outDelay, uint32\_t postDelay)

The tuning delay cell setting.

**Parameters**

- base – USDHC peripheral base address.
- preDelay – Set the number of delay cells on the feedback clock between the feedback clock and CLK\_PRE.
- outDelay – Set the number of delay cells on the feedback clock between CLK\_PRE and CLK\_OUT.
- postDelay – Set the number of delay cells on the feedback clock between CLK\_OUT and CLK\_POST.

**Return values**

- kStatus\_Fail – config the delay setting fail
- kStatus\_Success – config the delay setting success

*status\_t* USDHC\_AdjustDelayForManualTuning(USDHC\_Type \*base, uint32\_t delay)  
Adjusts delay for mannual tuning.

*Deprecated:*

Do not use this function. It has been superceded by USDHC\_SetTuingDelay

#### Parameters

- base – USDHC peripheral base address.
- delay – setting configuration

#### Return values

- kStatus\_Fail – config the delay setting fail
- kStatus\_Success – config the delay setting success

static inline void USDHC\_SetStandardTuningCounter(USDHC\_Type \*base, uint8\_t counter)  
set tuning counter tuning.

#### Parameters

- base – USDHC peripheral base address.
- counter – tuning counter

#### Return values

- kStatus\_Fail – config the delay setting fail
- kStatus\_Success – config the delay setting success

void USDHC\_EnableStandardTuning(USDHC\_Type \*base, uint32\_t tuningStartTap, uint32\_t step, bool enable)

The enable standard tuning function. The standard tuning window and tuning counter using the default config tuning cmd is sent by the software, user need to check whether the tuning result can be used for SDR50, SDR104, and HS200 mode tuning.

#### Parameters

- base – USDHC peripheral base address.
- tuningStartTap – start tap
- step – tuning step
- enable – enable/disable flag

static inline uint32\_t USDHC\_GetExecuteStdTuningStatus(USDHC\_Type \*base)  
Gets execute STD tuning status.

#### Parameters

- base – USDHC peripheral base address.

static inline uint32\_t USDHC\_CheckStdTuningResult(USDHC\_Type \*base)  
Checks STD tuning result.

#### Parameters

- base – USDHC peripheral base address.

static inline uint32\_t USDHC\_CheckTuningError(USDHC\_Type \*base)

Checks tuning error.

**Parameters**

- base – USDHC peripheral base address.

void USDHC\_EnableDDRMMode(USDHC\_Type \*base, bool enable, uint32\_t nibblePos)

The enable/disable DDR mode.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag
- nibblePos – nibble position

static inline void USDHC\_EnableHS400Mode(USDHC\_Type \*base, bool enable)

The enable/disable HS400 mode.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag

static inline void USDHC\_ResetStrobeDLL(USDHC\_Type \*base)

Resets the strobe DLL.

**Parameters**

- base – USDHC peripheral base address.

static inline void USDHC\_EnableStrobeDLL(USDHC\_Type \*base, bool enable)

Enables/disables the strobe DLL.

**Parameters**

- base – USDHC peripheral base address.
- enable – enable/disable flag

void USDHC\_ConfigStrobeDLL(USDHC\_Type \*base, uint32\_t delayTarget, uint32\_t updateInterval)

Configs the strobe DLL delay target and update interval.

**Parameters**

- base – USDHC peripheral base address.
- delayTarget – delay target
- updateInterval – update interval

static inline void USDHC\_SetStrobeDllOverride(USDHC\_Type \*base, uint32\_t delayTaps)

Enables manual override for slave delay chain using **STROBE\_SLV\_OVERRIDE\_VAL**.

**Parameters**

- base – USDHC peripheral base address.
- delayTaps – Valid delay taps range from 1 - 128 taps. A value of 0 selects tap 1, and a value of 0x7F selects tap 128.

static inline uint32\_t USDHC\_GetStrobeDLLStatus(USDHC\_Type \*base)

Gets the strobe DLL status.

**Parameters**

- base – USDHC peripheral base address.

```
void USDHC_SetDataConfig(USDHC_Type *base, usdhc_transfer_direction_t dataDirection,
 uint32_t blockCount, uint32_t blockSize)
```

USDHC data configuration.

#### Parameters

- base – USDHC peripheral base address.
- dataDirection – Data direction, tx or rx.
- blockCount – Data block count.
- blockSize – Data block size.

```
void USDHC_TransferCreateHandle(USDHC_Type *base, usdhc_handle_t *handle, const
 usdhc_transfer_callback_t *callback, void *userData)
```

Creates the USDHC handle.

#### Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle pointer.
- callback – Structure pointer to contain all callback functions.
- userData – Callback function parameter.

```
status_t USDHC_TransferNonBlocking(USDHC_Type *base, usdhc_handle_t *handle,
 usdhc_adma_config_t *dmaConfig, usdhc_transfer_t
 *transfer)
```

Transfers the command/data using an interrupt and an asynchronous method.

This function sends a command and data and returns immediately. It doesn't wait for the transfer to complete or to encounter an error. The application must not call this API in multiple threads at the same time. Because of that this API doesn't support the re-entry mechanism.

---

**Note:** Call API `USDHC_TransferCreateHandle` when calling this API.

---

#### Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle.
- dmaConfig – ADMA configuration.
- transfer – Transfer content.

#### Return values

- `kStatus_InvalidArgument` – Argument is invalid.
- `kStatus_USDHC_BusyTransferring` – Busy transferring.
- `kStatus_USDHC_PrepareAdmaDescriptorFailed` – Prepare ADMA descriptor failed.
- `kStatus_Success` – Operate successfully.

```
status_t USDHC_TransferBlocking(USDHC_Type *base, usdhc_adma_config_t *dmaConfig,
 usdhc_transfer_t *transfer)
```

Transfers the command/data using a blocking method.

This function waits until the command response/data is received or the USDHC encounters an error by polling the status flag.

The application must not call this API in multiple threads at the same time. Because this API doesn't support the re-entry mechanism.

---

**Note:** There is no need to call API USDHC\_TransferCreateHandle when calling this API.

---

#### Parameters

- base – USDHC peripheral base address.
- dmaConfig – adma configuration
- transfer – Transfer content.

#### Return values

- kStatus\_InvalidArgument – Argument is invalid.
- kStatus\_USDHC\_PrepareAdmaDescriptorFailed – Prepare ADMA descriptor failed.
- kStatus\_USDHC\_SendCommandFailed – Send command failed.
- kStatus\_USDHC\_TransferDataFailed – Transfer data failed.
- kStatus\_Success – Operate successfully.

void USDHC\_TransferHandleIRQ(USDHC\_Type \*base, *usdhc\_handle\_t* \*handle)  
IRQ handler for the USDHC.

This function deals with the IRQs on the given host controller.

#### Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle.

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Driver version 2.8.5.

Enum\_usdhc\_status. USDHC status.

*Values:*

enumerator kStatus\_USDHC\_BusyTransferring  
Transfer is on-going.

enumerator kStatus\_USDHC\_PrepareAdmaDescriptorFailed  
Set DMA descriptor failed.

enumerator kStatus\_USDHC\_SendCommandFailed  
Send command failed.

enumerator kStatus\_USDHC\_TransferDataFailed  
Transfer data failed.

enumerator kStatus\_USDHC\_DMADDataAddrNotAlign  
Data address not aligned.

enumerator kStatus\_USDHC\_ReTuningRequest  
Re-tuning request.

enumerator kStatus\_USDHC\_TuningError  
Tuning error.

enumerator kStatus\_USDHC\_NotSupport  
Not support.

enumerator kStatus\_USDHC\_TransferDataComplete  
Transfer data complete.

enumerator kStatus\_USDHC\_SendCommandSuccess  
Transfer command complete.

enumerator kStatus\_USDHC\_TransferDMAComplete  
Transfer DMA complete.

Enum \_usdhc\_capability\_flag. Host controller capabilities flag mask. .

*Values:*

enumerator kUSDHC\_SupportAdmaFlag  
Support ADMA.

enumerator kUSDHC\_SupportHighSpeedFlag  
Support high-speed.

enumerator kUSDHC\_SupportDmaFlag  
Support DMA.

enumerator kUSDHC\_SupportSuspendResumeFlag  
Support suspend/resume.

enumerator kUSDHC\_SupportV330Flag  
Support voltage 3.3V.

enumerator kUSDHC\_SupportV300Flag  
Support voltage 3.0V.

enumerator kUSDHC\_Support4BitFlag  
Flag in HTCAPBLT\_MBL's position, supporting 4-bit mode.

enumerator kUSDHC\_Support8BitFlag  
Flag in HTCAPBLT\_MBL's position, supporting 8-bit mode.

enumerator kUSDHC\_SupportDDR50Flag  
SD version 3.0 new feature, supporting DDR50 mode.

enumerator kUSDHC\_SupportSDR104Flag  
Support SDR104 mode.

enumerator kUSDHC\_SupportSDR50Flag  
Support SDR50 mode.

Enum \_usdhc\_wakeup\_event. Wakeup event mask. .

*Values:*

enumerator kUSDHC\_WakeupEventOnCardInt  
Wakeup on card interrupt.

enumerator kUSDHC\_WakeupEventOnCardInsert  
Wakeup on card insertion.

enumerator kUSDHC\_WakeupEventOnCardRemove  
Wakeup on card removal.

enumerator kUSDHC\_WakeupEventsAll  
All wakeup events

Enum \_usdhc\_reset. Reset type mask. .

*Values:*

enumerator kUSDHC\_ResetAll  
Reset all except card detection.

enumerator kUSDHC\_ResetCommand  
Reset command line.

enumerator kUSDHC\_ResetData  
Reset data line.

enumerator kUSDHC\_ResetTuning  
Reset tuning circuit.

enumerator kUSDHC\_ResetsAll  
All reset types

Enum \_usdhc\_transfer\_flag. Transfer flag mask.

*Values:*

enumerator kUSDHC\_EnableDmaFlag  
Enable DMA.

enumerator kUSDHC\_CommandTypeSuspendFlag  
Suspend command.

enumerator kUSDHC\_CommandTypeResumeFlag  
Resume command.

enumerator kUSDHC\_CommandTypeAbortFlag  
Abort command.

enumerator kUSDHC\_EnableBlockCountFlag  
Enable block count.

enumerator kUSDHC\_EnableAutoCommand12Flag  
Enable auto CMD12.

enumerator kUSDHC\_DataReadFlag  
Enable data read.

enumerator kUSDHC\_MultipleBlockFlag  
Multiple block data read/write.

enumerator kUSDHC\_EnableAutoCommand23Flag  
Enable auto CMD23.

enumerator kUSDHC\_ResponseLength136Flag  
136-bit response length.

enumerator kUSDHC\_ResponseLength48Flag  
48-bit response length.

enumerator kUSDHC\_ResponseLength48BusyFlag

48-bit response length with busy status.

enumerator kUSDHC\_EnableCrcCheckFlag

Enable CRC check.

enumerator kUSDHC\_EnableIndexCheckFlag

Enable index check.

enumerator kUSDHC\_DataPresentFlag

Data present flag.

Enum \_usdhc\_present\_status\_flag. Present status flag mask. .

*Values:*

enumerator kUSDHC\_CommandInhibitFlag

Command inhibit.

enumerator kUSDHC\_DataInhibitFlag

Data inhibit.

enumerator kUSDHC\_DataLineActiveFlag

Data line active.

enumerator kUSDHC\_SdClockStableFlag

SD bus clock stable.

enumerator kUSDHC\_WriteTransferActiveFlag

Write transfer active.

enumerator kUSDHC\_ReadTransferActiveFlag

Read transfer active.

enumerator kUSDHC\_BufferWriteEnableFlag

Buffer write enable.

enumerator kUSDHC\_BufferReadEnableFlag

Buffer read enable.

enumerator kUSDHC\_ReTuningRequestFlag

Re-tuning request flag, only used for SDR104 mode.

enumerator kUSDHC\_DelaySettingFinishedFlag

Delay setting finished flag.

enumerator kUSDHC\_CardInsertedFlag

Card inserted.

enumerator kUSDHC\_CommandLineLevelFlag

Command line signal level.

enumerator kUSDHC\_Data0LineLevelFlag

Data0 line signal level.

enumerator kUSDHC\_Data1LineLevelFlag

Data1 line signal level.

enumerator kUSDHC\_Data2LineLevelFlag

Data2 line signal level.



enumerator kUSDHC\_Data3LineLevelFlag

Data3 line signal level.

enumerator kUSDHC\_Data4LineLevelFlag

Data4 line signal level.

enumerator kUSDHC\_Data5LineLevelFlag

Data5 line signal level.

enumerator kUSDHC\_Data6LineLevelFlag

Data6 line signal level.

enumerator kUSDHC\_Data7LineLevelFlag

Data7 line signal level.

Enum \_usdhc\_interrupt\_status\_flag. Interrupt status flag mask. .

*Values:*

enumerator kUSDHC\_CommandCompleteFlag

Command complete.

enumerator kUSDHC\_DataCompleteFlag

Data complete.

enumerator kUSDHC\_BlockGapEventFlag

Block gap event.

enumerator kUSDHC\_DmaCompleteFlag

DMA interrupt.

enumerator kUSDHC\_BufferWriteReadyFlag

Buffer write ready.

enumerator kUSDHC\_BufferReadReadyFlag

Buffer read ready.

enumerator kUSDHC\_CardInsertionFlag

Card inserted.

enumerator kUSDHC\_CardRemovalFlag

Card removed.

enumerator kUSDHC\_CardInterruptFlag

Card interrupt.

enumerator kUSDHC\_ReTuningEventFlag

Re-Tuning event, only for SD3.0 SDR104 mode.

enumerator kUSDHC\_TuningPassFlag

SDR104 mode tuning pass flag.

enumerator kUSDHC\_TuningErrorFlag

SDR104 tuning error flag.

enumerator kUSDHC\_CommandTimeoutFlag

Command timeout error.

enumerator kUSDHC\_CommandCrcErrorFlag

Command CRC error.

enumerator kUSDHC\_CommandEndBitErrorFlag

Command end bit error.

enumerator kUSDHC\_CommandIndexErrorFlag

Command index error.

enumerator kUSDHC\_DataTimeoutFlag

Data timeout error.

enumerator kUSDHC\_DataCrcErrorFlag

Data CRC error.

enumerator kUSDHC\_DataEndBitErrorFlag

Data end bit error.

enumerator kUSDHC\_AutoCommand12ErrorFlag

Auto CMD12 error.

enumerator kUSDHC\_DmaErrorFlag

DMA error.

enumerator kUSDHC\_CommandErrorFlag

Command error

enumerator kUSDHC\_DataErrorFlag

Data error

enumerator kUSDHC\_ErrorFlag

All error

enumerator kUSDHC\_DataFlag

Data interrupts

enumerator kUSDHC\_DataDMAFlag

Data interrupts

enumerator kUSDHC\_CommandFlag

Command interrupts

enumerator kUSDHC\_CardDetectFlag

Card detection interrupts

enumerator kUSDHC\_SDR104TuningFlag

SDR104 tuning flag.

enumerator kUSDHC\_AllInterruptFlags

All flags mask

Enum \_usdhc\_auto\_command12\_error\_status\_flag. Auto CMD12 error status flag mask. .

*Values:*

enumerator kUSDHC\_AutoCommand12NotExecutedFlag

Not executed error.

enumerator kUSDHC\_AutoCommand12TimeoutFlag

Timeout error.

enumerator kUSDHC\_AutoCommand12EndBitErrorFlag

End bit error.

enumerator kUSDHC\_\_AutoCommand12CrcErrorFlag  
CRC error.

enumerator kUSDHC\_\_AutoCommand12IndexErrorFlag  
Index error.

enumerator kUSDHC\_\_AutoCommand12NotIssuedFlag  
Not issued error.

Enum \_usdhc\_standard\_tuning. Standard tuning flag.

*Values:*

enumerator kUSDHC\_\_ExecuteTuning  
Used to start tuning procedure.

enumerator kUSDHC\_\_TuningSampleClockSel  
When **std\_tuning\_en** bit is set, this bit is used to select sampling clock.

Enum \_usdhc\_adma\_error\_status\_flag. ADMA error status flag mask. .

*Values:*

enumerator kUSDHC\_\_AdmaLenghMismatchFlag  
Length mismatch error.

enumerator kUSDHC\_\_AdmaDescriptorErrorFlag  
Descriptor error.

Enum \_usdhc\_adma\_error\_state. ADMA error state.

This state is the detail state when ADMA error has occurred.

*Values:*

enumerator kUSDHC\_\_AdmaErrorStateStopDma  
Stop DMA, previous location set in the ADMA system address is errored address.

enumerator kUSDHC\_\_AdmaErrorStateFetchDescriptor  
Fetch descriptor, current location set in the ADMA system address is errored address.

enumerator kUSDHC\_\_AdmaErrorStateChangeAddress  
Change address, no DMA error has occurred.

enumerator kUSDHC\_\_AdmaErrorStateTransferData  
Transfer data, previous location set in the ADMA system address is errored address.

enumerator kUSDHC\_\_AdmaErrorStateInvalidLength  
Invalid length in ADMA descriptor.

enumerator kUSDHC\_\_AdmaErrorStateInvalidDescriptor  
Invalid descriptor fetched by ADMA.

enumerator kUSDHC\_\_AdmaErrorState  
ADMA error state

Enum \_usdhc\_force\_event. Force event bit position. .

*Values:*

enumerator kUSDHC\_ForceEventAutoCommand12NotExecuted  
Auto CMD12 not executed error.

enumerator kUSDHC\_ForceEventAutoCommand12Timeout  
Auto CMD12 timeout error.

enumerator kUSDHC\_ForceEventAutoCommand12CrcError  
Auto CMD12 CRC error.

enumerator kUSDHC\_ForceEventEndBitError  
Auto CMD12 end bit error.

enumerator kUSDHC\_ForceEventAutoCommand12IndexError  
Auto CMD12 index error.

enumerator kUSDHC\_ForceEventAutoCommand12NotIssued  
Auto CMD12 not issued error.

enumerator kUSDHC\_ForceEventCommandTimeout  
Command timeout error.

enumerator kUSDHC\_ForceEventCommandCrcError  
Command CRC error.

enumerator kUSDHC\_ForceEventCommandEndBitError  
Command end bit error.

enumerator kUSDHC\_ForceEventCommandIndexError  
Command index error.

enumerator kUSDHC\_ForceEventDataTimeout  
Data timeout error.

enumerator kUSDHC\_ForceEventDataCrcError  
Data CRC error.

enumerator kUSDHC\_ForceEventDataEndBitError  
Data end bit error.

enumerator kUSDHC\_ForceEventAutoCommand12Error  
Auto CMD12 error.

enumerator kUSDHC\_ForceEventCardInt  
Card interrupt.

enumerator kUSDHC\_ForceEventDmaError  
Dma error.

enumerator kUSDHC\_ForceEventTuningError  
Tuning error.

enumerator kUSDHC\_ForceEventsAll  
All force event flags mask.

enum \_\_usdhc\_transfer\_direction  
Data transfer direction.

*Values:*

enumerator kUSDHC\_TransferDirectionReceive  
USDHC transfer direction receive.

enumerator kUSDHC\_TransferDirectionSend  
USDHC transfer direction send.

enum \_\_usdhc\_data\_bus\_width  
Data transfer width.

*Values:*

enumerator kUSDHC\_DataBusWidth1Bit  
1-bit mode

enumerator kUSDHC\_DataBusWidth4Bit  
4-bit mode

enumerator kUSDHC\_DataBusWidth8Bit  
8-bit mode

enum \_\_usdhc\_endian\_mode  
Endian mode.

*Values:*

enumerator kUSDHC\_EndianModeBig  
Big endian mode.

enumerator kUSDHC\_EndianModeHalfWordBig  
Half word big endian mode.

enumerator kUSDHC\_EndianModeLittle  
Little endian mode.

enum \_\_usdhc\_dma\_mode  
DMA mode.

*Values:*

enumerator kUSDHC\_DmaModeSimple  
External DMA.

enumerator kUSDHC\_DmaModeAdma1  
ADMA1 is selected.

enumerator kUSDHC\_DmaModeAdma2  
ADMA2 is selected.

enumerator kUSDHC\_ExternalDMA  
External DMA mode selected.

Enum \_\_usdhc\_sdio\_control\_flag. SDIO control flag mask. .

*Values:*

enumerator kUSDHC\_StopAtBlockGapFlag  
Stop at block gap.

enumerator kUSDHC\_ReadWaitControlFlag  
Read wait control.

enumerator kUSDHC\_InterruptAtBlockGapFlag  
Interrupt at block gap.

enumerator kUSDHC\_ReadDoneNo8CLK  
Read done without 8 clk for block gap.

enumerator kUSDHC\_ExactBlockNumberReadFlag  
Exact block number read.

enum \_\_usdhc\_boot\_mode  
MMC card boot mode.

*Values:*

enumerator kUSDHC\_BootModeNormal  
Normal boot

enumerator kUSDHC\_BootModeAlternative  
Alternative boot

enum \_\_usdhc\_card\_command\_type  
The command type.

*Values:*

enumerator kCARD\_CommandTypeNormal  
Normal command

enumerator kCARD\_CommandTypeSuspend  
Suspend command

enumerator kCARD\_CommandTypeResume  
Resume command

enumerator kCARD\_CommandTypeAbort  
Abort command

enumerator kCARD\_CommandTypeEmpty  
Empty command

enum \_\_usdhc\_card\_response\_type  
The command response type.

Defines the command response type from card to host controller.

*Values:*

enumerator kCARD\_ResponseTypeNone  
Response type: none

enumerator kCARD\_ResponseTypeR1  
Response type: R1

enumerator kCARD\_ResponseTypeR1b  
Response type: R1b

enumerator kCARD\_ResponseTypeR2  
Response type: R2

enumerator kCARD\_ResponseTypeR3  
Response type: R3

enumerator kCARD\_ResponseTypeR4  
Response type: R4

enumerator kCARD\_ResponseTypeR5  
Response type: R5

enumerator kCARD\_ResponseTypeR5b  
Response type: R5b

enumerator kCARD\_ResponseTypeR6

Response type: R6

enumerator kCARD\_ResponseTypeR7

Response type: R7

Enum `_usdhc_adma1_descriptor_flag`. The mask for the control/status field in ADMA1 descriptor.

*Values:*

enumerator kUSDHC\_Adma1DescriptorValidFlag

Valid flag.

enumerator kUSDHC\_Adma1DescriptorEndFlag

End flag.

enumerator kUSDHC\_Adma1DescriptorInterruptFlag

Interrupt flag.

enumerator kUSDHC\_Adma1DescriptorActivity1Flag

Activity 1 flag.

enumerator kUSDHC\_Adma1DescriptorActivity2Flag

Activity 2 flag.

enumerator kUSDHC\_Adma1DescriptorTypeNop

No operation.

enumerator kUSDHC\_Adma1DescriptorTypeTransfer

Transfer data.

enumerator kUSDHC\_Adma1DescriptorTypeLink

Link descriptor.

enumerator kUSDHC\_Adma1DescriptorTypeSetLength

Set data length.

Enum `_usdhc_adma2_descriptor_flag`. ADMA1 descriptor control and status mask.

*Values:*

enumerator kUSDHC\_Adma2DescriptorValidFlag

Valid flag.

enumerator kUSDHC\_Adma2DescriptorEndFlag

End flag.

enumerator kUSDHC\_Adma2DescriptorInterruptFlag

Interrupt flag.

enumerator kUSDHC\_Adma2DescriptorActivity1Flag

Activity 1 mask.

enumerator kUSDHC\_Adma2DescriptorActivity2Flag

Activity 2 mask.

enumerator kUSDHC\_Adma2DescriptorTypeNop

No operation.

enumerator kUSDHC\_Adma2DescriptorTypeReserved

Reserved.

enumerator kUSDHC\_Adma2DescriptorTypeTransfer  
Transfer type.

enumerator kUSDHC\_Adma2DescriptorTypeLink  
Link type.

Enum \_usdhc\_adma\_flag. ADMA descriptor configuration flag. .

*Values:*

enumerator kUSDHC\_AdmaDescriptorSingleFlag

Try to finish the transfer in a single ADMA descriptor. If transfer size is bigger than one ADMA descriptor's ability, new another descriptor for data transfer.

enumerator kUSDHC\_AdmaDescriptorMultipleFlag

Create multiple ADMA descriptors within the ADMA table, this is used for mmc boot mode specifically, which need to modify the ADMA descriptor on the fly, so the flag should be used combining with stop at block gap feature.

enum \_usdhc\_burst\_len

DMA transfer burst len config.

*Values:*

enumerator kUSDHC\_EnBurstLenForINCR

Enable burst len for INCR.

enumerator kUSDHC\_EnBurstLenForINCR4816

Enable burst len for INCR4/INCR8/INCR16.

enumerator kUSDHC\_EnBurstLenForINCR4816WRAP

Enable burst len for INCR4/8/16 WRAP.

Enum \_usdhc\_transfer\_data\_type. Tansfer data type definition.

*Values:*

enumerator kUSDHC\_TransferDataNormal

Transfer normal read/write data.

enumerator kUSDHC\_TransferDataTuning

Transfer tuning data.

enumerator kUSDHC\_TransferDataBoot

Transfer boot data.

enumerator kUSDHC\_TransferDataBootcontinous

Transfer boot data continuously.

typedef enum \_usdhc\_transfer\_direction usdhc\_transfer\_direction\_t

Data transfer direction.

typedef enum \_usdhc\_data\_bus\_width usdhc\_data\_bus\_width\_t

Data transfer width.

typedef enum \_usdhc\_endian\_mode usdhc\_endian\_mode\_t

Endian mode.

typedef enum \_usdhc\_dma\_mode usdhc\_dma\_mode\_t

DMA mode.



typedef enum *\_usdhc\_boot\_mode* usdhc\_boot\_mode\_t

MMC card boot mode.

typedef enum *\_usdhc\_card\_command\_type* usdhc\_card\_command\_type\_t

The command type.

typedef enum *\_usdhc\_card\_response\_type* usdhc\_card\_response\_type\_t

The command response type.

Defines the command response type from card to host controller.

typedef enum *\_usdhc\_burst\_len* usdhc\_burst\_len\_t

DMA transfer burst len config.

typedef uint32\_t usdhc\_adma1\_descriptor\_t

Defines the ADMA1 descriptor structure.

typedef struct *\_usdhc\_adma2\_descriptor* usdhc\_adma2\_descriptor\_t

Defines the ADMA2 descriptor structure.

typedef struct *\_usdhc\_capability* usdhc\_capability\_t

USDHC capability information.

Defines a structure to save the capability information of USDHC.

typedef struct *\_usdhc\_boot\_config* usdhc\_boot\_config\_t

Data structure to configure the MMC boot feature.

typedef struct *\_usdhc\_config* usdhc\_config\_t

Data structure to initialize the USDHC.

typedef struct *\_usdhc\_command* usdhc\_command\_t

Card command descriptor.

Defines card command-related attribute.

typedef struct *\_usdhc\_adma\_config* usdhc\_adma\_config\_t

ADMA configuration.

typedef struct *\_usdhc\_scatter\_gather\_data\_list* usdhc\_scatter\_gather\_data\_list\_t

Card scatter gather data list.

Allow application register uncontinuous data buffer for data transfer.

typedef struct *\_usdhc\_scatter\_gather\_data* usdhc\_scatter\_gather\_data\_t

Card scatter gather data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

typedef struct *\_usdhc\_scatter\_gather\_transfer* usdhc\_scatter\_gather\_transfer\_t

usdhc scatter gather transfer.

typedef struct *\_usdhc\_data* usdhc\_data\_t

Card data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

typedef struct *\_usdhc\_transfer* usdhc\_transfer\_t

Transfer state.

```
typedef struct _usdhc_handle usdhc_handle_t
```

USDHC handle typedef.

```
typedef struct _usdhc_transfer_callback usdhc_transfer_callback_t
```

USDHC callback functions.

```
typedef status_t (*usdhc_transfer_function_t)(USDHC_Type *base, usdhc_transfer_t *content)
```

USDHC transfer function.

```
typedef struct _usdhc_host usdhc_host_t
```

USDHC host descriptor.

```
USDHC_MAX_BLOCK_COUNT
```

Maximum block count can be set one time.

```
FSL_USDHC_ENABLE_SCATTER_GATHER_TRANSFER
```

USDHC scatter gather feature control macro.

```
USDHC_ADMA1_ADDRESS_ALIGN
```

The alignment size for ADDRESS filed in ADMA1's descriptor.

```
USDHC_ADMA1_LENGTH_ALIGN
```

The alignment size for LENGTH field in ADMA1's descriptor.

```
USDHC_ADMA2_ADDRESS_ALIGN
```

The alignment size for ADDRESS field in ADMA2's descriptor.

```
USDHC_ADMA2_LENGTH_ALIGN
```

The alignment size for LENGTH filed in ADMA2's descriptor.

```
USDHC_ADMA1_DESCRIPTOR_ADDRESS_SHIFT
```

The bit shift for ADDRESS filed in ADMA1's descriptor.

| Address/page field     | Reserved | Attribute |      |    |     |     |       |
|------------------------|----------|-----------|------|----|-----|-----|-------|
| 31 12                  | 11 6     | 05        | 04   | 03 | 02  | 01  | 00    |
| address or data length | 000000   | Act2      | Act1 | 0  | Int | End | Valid |

| Act2 | Act1 | Comment         | 31-28              | 27-12       |
|------|------|-----------------|--------------------|-------------|
| 0    | 0    | No op           | Don't care         |             |
| 0    | 1    | Set data length | 0000               | Data Length |
| 1    | 0    | Transfer data   | Data address       |             |
| 1    | 1    | Link descriptor | Descriptor address |             |

```
USDHC_ADMA1_DESCRIPTOR_ADDRESS_MASK
```

The bit mask for ADDRESS field in ADMA1's descriptor.

```
USDHC_ADMA1_DESCRIPTOR_LENGTH_SHIFT
```

The bit shift for LENGTH filed in ADMA1's descriptor.

```
USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK
```

The mask for LENGTH field in ADMA1's descriptor.

## USDHC\_ADMA1\_DESCRIPTOR\_MAX\_LENGTH\_PER\_ENTRY

The maximum value of LENGTH filed in ADMA1's descriptor. Since the max transfer size ADMA1 support is 65535 which is indivisible by 4096, so to make sure a large data load transfer (>64KB) continuously (require the data address be always align with 4096), software will set the maximum data length for ADMA1 to (64 - 4)KB.

## USDHC\_ADMA2\_DESCRIPTOR\_LENGTH\_SHIFT

The bit shift for LENGTH field in ADMA2's descriptor.

| Address field  | Length        | Reserved   | Attribute |      |    |     |     |       |  |
|----------------|---------------|------------|-----------|------|----|-----|-----|-------|--|
| 63 32          | 31 16         | 15 06      | 05        | 04   | 03 | 02  | 01  | 00    |  |
| 32-bit address | 16-bit length | 0000000000 | Act2      | Act1 | 0  | Int | End | Valid |  |

| Act2 | Act1 | Comment         | Operation                                                         |
|------|------|-----------------|-------------------------------------------------------------------|
| 0    | 0    | No op           | Don't care                                                        |
| 0    | 1    | Reserved        | Read this line and go to next one                                 |
| 1    | 0    | Transfer data   | Transfer data with address and length set in this descriptor line |
| 1    | 1    | Link descriptor | Link to another descriptor                                        |

## USDHC\_ADMA2\_DESCRIPTOR\_LENGTH\_MASK

The bit mask for LENGTH field in ADMA2's descriptor.

## USDHC\_ADMA2\_DESCRIPTOR\_MAX\_LENGTH\_PER\_ENTRY

The maximum value of LENGTH field in ADMA2's descriptor.

struct \_\_usdhc\_adma2\_descriptor

*#include <fsl\_usdhc.h>* Defines the ADMA2 descriptor structure.

**Public Members**

uint32\_t attribute

The control and status field.

uint32\_t address

The address field.

struct \_\_usdhc\_capability

*#include <fsl\_usdhc.h>* USDHC capability information.

Defines a structure to save the capability information of USDHC.

**Public Members**

uint32\_t sdVersion

Support SD card/sdio version.

uint32\_t mmcVersion

Support EMMC card version.

uint32\_t maxBlockLength

Maximum block length united as byte.

uint32\_t maxBlockCount

Maximum block count can be set one time.

uint32\_t flags

Capability flags to indicate the support information(\_usdhc\_capability\_flag).

struct \_\_usdhc\_boot\_config

*#include <fsl\_usdhc.h>* Data structure to configure the MMC boot feature.

### Public Members

uint32\_t ackTimeoutCount

Timeout value for the boot ACK. The available range is 0 ~ 15.

usdhc\_boot\_mode\_t bootMode

Boot mode selection.

uint32\_t blockCount

Stop at block gap value of automatic mode. Available range is 0 ~ 65535.

size\_t blockSize

Block size.

bool enableBootAck

Enable or disable boot ACK.

bool enableAutoStopAtBlockGap

Enable or disable auto stop at block gap function in boot period.

struct \_\_usdhc\_config

*#include <fsl\_usdhc.h>* Data structure to initialize the USDHC.

### Public Members

uint32\_t dataTimeout

Data timeout value.

usdhc\_endian\_mode\_t endianMode

Endian mode.

uint8\_t readWatermarkLevel

Watermark level for DMA read operation. Available range is 1 ~ 128.

uint8\_t writeWatermarkLevel

Watermark level for DMA write operation. Available range is 1 ~ 128.

struct \_\_usdhc\_command

*#include <fsl\_usdhc.h>* Card command descriptor.

Defines card command-related attribute.

### Public Members

uint32\_t index

Command index.

uint32\_t argument

Command argument.

*usdhc\_card\_command\_type\_t* type

Command type.

*usdhc\_card\_response\_type\_t* responseType

Command response type.

uint32\_t response[4U]

Response for this command.

uint32\_t responseErrorFlags

Response error flag, which need to check the command reponse.

uint32\_t flags

Cmd flags.

struct \_\_usdhc\_adma\_config

*#include <fsl\_usdhc.h>* ADMA configuration.

### Public Members

*usdhc\_dma\_mode\_t* dmaMode

DMA mode.

uint32\_t \*admaTable

ADMA table address, can't be null if transfer way is ADMA1/ADMA2.

uint32\_t admaTableWords

ADMA table length united as words, can't be 0 if transfer way is ADMA1/ADMA2.

struct \_\_usdhc\_scatter\_gather\_data\_list

*#include <fsl\_usdhc.h>* Card scatter gather data list.

Allow application register uncontinuous data buffer for data transfer.

struct \_\_usdhc\_scatter\_gather\_data

*#include <fsl\_usdhc.h>* Card scatter gather data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

### Public Members

bool enableAutoCommand12

Enable auto CMD12.

bool enableAutoCommand23

Enable auto CMD23.

bool enableIgnoreError

Enable to ignore error event to read/write all the data.

*usdhc\_transfer\_direction\_t* dataDirection

data direction

uint8\_t dataType

this is used to distinguish the normal/tuning/boot data.

size\_t blockSize

Block size.

usdhc\_scatter\_gather\_data\_list\_t sgData

scatter gather data

struct \_\_usdhc\_scatter\_gather\_transfer

#include <fsl\_usdhc.h> usdhc scatter gather transfer.

### Public Members

usdhc\_scatter\_gather\_data\_t \*data

Data to transfer.

usdhc\_command\_t \*command

Command to send.

struct \_\_usdhc\_data

#include <fsl\_usdhc.h> Card data descriptor.

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

### Public Members

bool enableAutoCommand12

Enable auto CMD12.

bool enableAutoCommand23

Enable auto CMD23.

bool enableIgnoreError

Enable to ignore error event to read/write all the data.

uint8\_t dataType

this is used to distinguish the normal/tuning/boot data.

size\_t blockSize

Block size.

uint32\_t blockCount

Block count.

uint32\_t \*rxData

Buffer to save data read.

const uint32\_t \*txData

Data buffer to write.

struct \_\_usdhc\_transfer

#include <fsl\_usdhc.h> Transfer state.

### Public Members

usdhc\_data\_t \*data

Data to transfer.

*usdhc\_command\_t* \*command  
Command to send.

struct \_\_usdhc\_transfer\_callback  
*#include <fsl\_usdhc.h>* USDHC callback functions.

### Public Members

void (\*CardInserted)(USDHC\_Type \*base, void \*userData)  
Card inserted occurs when DAT3/CD pin is for card detect

void (\*CardRemoved)(USDHC\_Type \*base, void \*userData)  
Card removed occurs

void (\*SdioInterrupt)(USDHC\_Type \*base, void \*userData)  
SDIO card interrupt occurs

void (\*BlockGap)(USDHC\_Type \*base, void \*userData)  
stopped at block gap event

void (\*TransferComplete)(USDHC\_Type \*base, *usdhc\_handle\_t* \*handle, *status\_t* status, void \*userData)  
Transfer complete callback.

void (\*ReTuning)(USDHC\_Type \*base, void \*userData)  
Handle the re-tuning.

struct \_\_usdhc\_handle  
*#include <fsl\_usdhc.h>* USDHC handle.  
Defines the structure to save the USDHC state information and callback function.

---

**Note:** All the fields except interruptFlags and transferredWords must be allocated by the user.

---

### Public Members

*usdhc\_data\_t* \*volatile data  
Transfer parameter. Data to transfer.

*usdhc\_command\_t* \*volatile command  
Transfer parameter. Command to send.

volatile uint32\_t transferredWords  
Transfer status. Words transferred by DATAPORT way.

*usdhc\_transfer\_callback\_t* callback  
Callback function.

void \*userData  
Parameter for transfer complete callback.

struct \_\_usdhc\_host  
*#include <fsl\_usdhc.h>* USDHC host descriptor.

**Public Members**

USDHC\_Type \*base

USDHC peripheral base address.

uint32\_t sourceClock\_Hz

USDHC source clock frequency united in Hz.

*usdhc\_config\_t* config

USDHC configuration.

*usdhc\_capability\_t* capability

USDHC capability information.

*usdhc\_transfer\_function\_t* transfer

USDHC transfer function.

## 2.77 VREF: Voltage Reference Driver

*status\_t* VREF\_Init(VREF\_Type \*base, const *vref\_config\_t* \*config)

Enables the clock gate and configures the VREF module according to the configuration structure.

This function must be called before calling all other VREF driver functions, read/write registers, and configurations with user-defined settings. The example below shows how to set up *vref\_config\_t* parameters and how to call the VREF\_Init function by passing in these parameters. This is an example.

```
vref_config_t vrefConfig;
vrefConfig.bufferMode = kVREF_ModeHighPowerBuffer;
vrefConfig.enableExternalVoltRef = false;
vrefConfig.enableLowRef = false;
VREF_Init(VREF, &vrefConfig);
```

**Parameters**

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

**Return values**

- kStatus\_Success – run success.
- kStatus\_Timeout – timeout occurs.

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

Stops and disables the clock for the VREF module.

This function should be called to shut down the module. This is an example.

```
vref_config_t vrefUserConfig;
VREF_Init(VREF);
VREF_GetDefaultConfig(&vrefUserConfig);
...
VREF_Deinit(VREF);
```

**Parameters**

- base – VREF peripheral address.



`void VREF_GetDefaultConfig(vref_config_t *config)`

Initializes the VREF configuration structure.

This function initializes the VREF configuration structure to default values. This is an example.

```
vrefConfig->bufferMode = kVREF_ModeHighPowerBuffer;
vrefConfig->enableExternalVoltRef = false;
vrefConfig->enableLowRef = false;
```

#### Parameters

- `config` – Pointer to the initialization structure.

`status_t VREF_SetTrimVal(VREF_Type *base, uint8_t trimValue)`

Sets a TRIM value for the reference voltage.

This function sets a TRIM value for the reference voltage. Note that the TRIM value maximum is 0x3F.

#### Parameters

- `base` – VREF peripheral address.
- `trimValue` – Value of the trim register to set the output reference voltage (maximum 0x3F (6-bit)).

#### Return values

- `kStatus_Success` – run success.
- `kStatus_Timeout` – timeout occurs.

`static inline uint8_t VREF_GetTrimVal(VREF_Type *base)`

Reads the value of the TRIM meaning output voltage.

This function gets the TRIM value from the TRM register.

#### Parameters

- `base` – VREF peripheral address.

#### Returns

Six-bit value of trim setting.

`status_t VREF_SetTrim2V1Val(VREF_Type *base, uint8_t trimValue)`

Sets a TRIM value for the reference voltage (2V1).

This function sets a TRIM value for the reference voltage (2V1). Note that the TRIM value maximum is 0x3F.

#### Parameters

- `base` – VREF peripheral address.
- `trimValue` – Value of the trim register to set the output reference voltage (maximum 0x3F (6-bit)).

#### Return values

- `kStatus_Success` – run success.
- `kStatus_Timeout` – timeout occurs.

`static inline uint8_t VREF_GetTrim2V1Val(VREF_Type *base)`

Reads the value of the TRIM meaning output voltage (2V1).

This function gets the TRIM value from the VREF\_TRM4 register.

#### Parameters

- base – VREF peripheral address.

**Returns**

Six-bit value of trim setting.

`status_t VREF_SetLowReferenceTrimVal(VREF_Type *base, uint8_t trimValue)`

Sets the TRIM value for the low voltage reference.

This function sets the TRIM value for low reference voltage. Note the following.

- The TRIM value maximum is 0x05U
- The values 111b and 110b are not valid/allowed.

**Parameters**

- base – VREF peripheral address.
- trimValue – Value of the trim register to set output low reference voltage (maximum 0x05U (3-bit)).

**Return values**

- kStatus\_Success – run success.
- kStatus\_Timeout – timeout occurs.

`static inline uint8_t VREF_GetLowReferenceTrimVal(VREF_Type *base)`

Reads the value of the TRIM meaning output voltage.

This function gets the TRIM value from the VREFL\_TRM register.

**Parameters**

- base – VREF peripheral address.

**Returns**

Three-bit value of the trim setting.

`FSL_VREF_DRIVER_VERSION`

Version 2.1.3.

`VREF_INTERNAL_VOLTAGE_STABLE_TIMEOUT`

Max loops to wait for VREF internal voltage stable.

This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

`enum _vref_buffer_mode`

VREF modes.

*Values:*

enumerator `kVREF_ModeBandgapOnly`

Bandgap on only, for stabilization and startup

enumerator `kVREF_ModeHighPowerBuffer`

High-power buffer mode enabled

enumerator `kVREF_ModeLowPowerBuffer`

Low-power buffer mode enabled

`typedef enum _vref_buffer_mode vref_buffer_mode_t`

VREF modes.

`typedef struct _vref_config vref_config_t`

The description structure for the VREF module.

VREF\_SC\_MODE\_LV

VREF\_SC\_REGEN

VREF\_SC\_VREFEN

VREF\_SC\_ICOMPEN

VREF\_SC\_REGEN\_MASK

VREF\_SC\_VREFST\_MASK

VREF\_SC\_VREFEN\_MASK

VREF\_SC\_MODE\_LV\_MASK

VREF\_SC\_ICOMPEN\_MASK

TRM

VREF\_TRM\_TRIM

VREF\_TRM\_CHOPEN\_MASK

VREF\_TRM\_TRIM\_MASK

VREF\_TRM\_CHOPEN\_SHIFT

VREF\_TRM\_TRIM\_SHIFT

VREF\_SC\_MODE\_LV\_SHIFT

VREF\_SC\_REGEN\_SHIFT

VREF\_SC\_VREFST\_SHIFT

VREF\_SC\_ICOMPEN\_SHIFT

struct \_vref\_config

*#include <fsl\_vref.h>* The description structure for the VREF module.

### Public Members

*vref\_buffer\_mode\_t* bufferMode

Buffer mode selection

bool enableLowRef

Set VREFL (0.4 V) reference buffer enable or disable

bool enableExternalVoltRef

Select external voltage reference or not (internal)

bool enable2V1VoltRef

Enable Internal Voltage Reference (2.1V)

## 2.78 WDOG32: 32-bit Watchdog Timer

**void WDOG32\_GetDefaultConfig(*wdog32\_config\_t* \*config)**

Initializes the WDOG32 configuration structure.

This function initializes the WDOG32 configuration structure to default values. The default values are:

```
wdog32Config->enableWdog32 = true;
wdog32Config->clockSource = kWDOG32_ClockSource1;
wdog32Config->prescaler = kWDOG32_ClockPrescalerDivide1;
wdog32Config->workMode.enableWait = true;
wdog32Config->workMode.enableStop = false;
wdog32Config->workMode.enableDebug = false;
wdog32Config->testMode = kWDOG32_TestModeDisabled;
wdog32Config->enableUpdate = true;
wdog32Config->enableInterrupt = false;
wdog32Config->enableWindowMode = false;
wdog32Config->windowValue = 0U;
wdog32Config->timeoutValue = 0xFFFFU;
```

#### See also:

`wdog32_config_t`

#### Parameters

- config – Pointer to the WDOG32 configuration structure.

**AT\_QUICKACCESS\_SECTION\_CODE** (status\_t WDOG32\_Init(WDOG\_Type \*base, const wdog32\_config\_t \*config))

Initializes the WDOG32 module.

This function initializes the WDOG32. To reconfigure the WDOG32 without forcing a reset first, enableUpdate must be set to true in the configuration.

Example:

```
wdog32_config_t config;
WDOG32_GetDefaultConfig(&config);
config.timeoutValue = 0x7ffU;
config.enableUpdate = true;
WDOG32_Init(wdog_base,&config);
```

**Note:** If there is errata ERR010536 (FSL\_FEATURE\_WDOG\_HAS\_ERRATA\_010536 defined as 1), then after calling this function, user need delay at least 4 LPO clock cycles before accessing other WDOG32 registers.

#### Parameters

- base – WDOG32 peripheral base address.
- config – The configuration of the WDOG32.

#### Return values

- kStatus\_Success – The initialization was successful
- kStatus\_Timeout – The initialization timed out

**status\_t WDOG32\_Deinit(WDOG\_Type \*base)**

De-initializes the WDOG32 module.

This function shuts down the WDOG32. Ensure that the WDOG\_CS.UPDATE is 1, which means that the register update is enabled.

**Parameters**

- base – WDOG32 peripheral base address.

**Return values**

- kStatus\_Success – The de-initialization was successful
- kStatus\_Timeout – The de-initialization timed out

AT\_QUICKACCESS\_SECTION\_CODE (status\_t WDOG32\_Unlock(WDOG\_Type \*base))

Unlocks the WDOG32 register written.

This function unlocks the WDOG32 register written.

Before starting the unlock sequence and following the configuration, disable the global interrupts. Otherwise, an interrupt could effectively invalidate the unlock sequence and the WCT may expire. After the configuration finishes, re-enable the global interrupts.

**Parameters**

- base – WDOG32 peripheral base address

**Return values**

- kStatus\_Success – The unlock sequence was successful
- kStatus\_Timeout – The unlock sequence timed out

AT\_QUICKACCESS\_SECTION\_CODE (void WDOG32\_Enable(WDOG\_Type \*base))

Enables the WDOG32 module.

Disables the WDOG32 module.

This function writes a value into the WDOG\_CS register to enable the WDOG32. The WDOG\_CS register is a write-once register. Please check the enableUpdate is set to true for calling WDOG32\_Init to do wdog initialize. Before call the re-configuration APIs, ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

This function writes a value into the WDOG\_CS register to disable the WDOG32. The WDOG\_CS register is a write-once register. Please check the enableUpdate is set to true for calling WDOG32\_Init to do wdog initialize. Before call the re-configuration APIs, ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

**Parameters**

- base – WDOG32 peripheral base address.
- base – WDOG32 peripheral base address

AT\_QUICKACCESS\_SECTION\_CODE (void WDOG32\_EnableInterrupts(WDOG\_Type \*base, uint32\_t mask))

Enables the WDOG32 interrupt.

Clears the WDOG32 flag.

Disables the WDOG32 interrupt.

This function writes a value into the WDOG\_CS register to enable the WDOG32 interrupt. The WDOG\_CS register is a write-once register. Please check the enableUpdate is set to true for calling WDOG32\_Init to do wdog initialize. Before call the re-configuration APIs, ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Example to clear an interrupt flag:

```
WDOG32_ClearStatusFlags(wdog_base, kWDOG32_InterruptFlag);
```

### Parameters

- base – WDOG32 peripheral base address.
- mask – The interrupts to enable. The parameter can be a combination of the following source if defined:
  - kWDOG32\_InterruptEnable

This function writes a value into the WDOG\_CS register to disable the WDOG32 interrupt. The WDOG\_CS register is a write-once register. Please check the enableUpdate is set to true for calling WDOG32\_Init to do wdog initialize. Before call the re-configuration APIs, ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

- base – WDOG32 peripheral base address.
- mask – The interrupts to disabled. The parameter can be a combination of the following source if defined:
  - kWDOG32\_InterruptEnable

This function clears the WDOG32 status flag.

- base – WDOG32 peripheral base address.
- mask – The status flags to clear. The parameter can be any combination of the following values:
  - kWDOG32\_InterruptFlag

```
static inline uint32_t WDOG32_GetStatusFlags(WDOG_Type *base)
```

Gets the WDOG32 all status flags.

This function gets all status flags.

Example to get the running flag:

```
uint32_t status;
status = WDOG32_GetStatusFlags(wdog_base) & kWDOG32_RunningFlag;
```

### See also:

\_wdog32\_status\_flags\_t

- true: related status flag has been set.
- false: related status flag is not set.

### Parameters

- base – WDOG32 peripheral base address

### Returns

State of the status flag: asserted (true) or not-asserted (false).

```
AT_QUICKACCESS_SECTION_CODE (void WDOG32_SetTimeoutValue(WDOG_Type *base,
uint16_t timeoutCount))
```

Sets the WDOG32 timeout value.

This function writes a timeout value into the WDOG\_TOVAL register. The WDOG\_TOVAL register is a write-once register. To ensure the reconfiguration fits the timing of WCT, unlock function will be called inline.

**Parameters**

- base – WDOG32 peripheral base address
- timeoutCount – WDOG32 timeout value, count of WDOG32 clock ticks.

AT\_QUICKACCESS\_SECTION\_CODE (void WDOG32\_SetWindowValue(WDOG\_Type \*base, uint16\_t windowValue))

Sets the WDOG32 window value.

This function writes a window value into the WDOG\_WIN register. The WDOG\_WIN register is a write-once register. Please check the enableUpdate is set to true for calling WDOG32\_Init to do wdog initialize. Before call the re-configuration APIs, ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

**Parameters**

- base – WDOG32 peripheral base address.
- windowValue – WDOG32 window value.

static inline void WDOG32\_Refresh(WDOG\_Type \*base)

Refreshes the WDOG32 timer.

This function feeds the WDOG32. This function should be called before the Watchdog timer is in timeout. Otherwise, a reset is asserted.

**Parameters**

- base – WDOG32 peripheral base address

static inline uint16\_t WDOG32\_GetCounterValue(WDOG\_Type \*base)

Gets the WDOG32 counter value.

This function gets the WDOG32 counter value.

**Parameters**

- base – WDOG32 peripheral base address.

**Returns**

Current WDOG32 counter value.

WDOG\_FIRST\_WORD\_OF\_UNLOCK

First word of unlock sequence

WDOG\_SECOND\_WORD\_OF\_UNLOCK

Second word of unlock sequence

WDOG\_FIRST\_WORD\_OF\_REFRESH

First word of refresh sequence

WDOG\_SECOND\_WORD\_OF\_REFRESH

Second word of refresh sequence

FSL\_WDOG32\_DRIVER\_VERSION

WDOG32 driver version.

enum \_\_wdog32\_clock\_source

Max loops to wait for WDOG32 unlock sequence complete.

This is the maximum number of loops to wait for the wdog32 unlock sequence to complete. If set to 0, it will wait indefinitely until the unlock sequence is complete.

Max loops to wait for WDOG32 reconfiguration complete.

This is the maximum number of loops to wait for the wdog32 reconfiguration to complete. If set to 0, it will wait indefinitely until the reconfiguration is complete.

Describes WDOG32 clock source.

*Values:*

enumerator kWDOG32\_ClockSource0

Clock source 0

enumerator kWDOG32\_ClockSource1

Clock source 1

enumerator kWDOG32\_ClockSource2

Clock source 2

enumerator kWDOG32\_ClockSource3

Clock source 3

enum \_\_wdog32\_clock\_prescaler

Describes the selection of the clock prescaler.

*Values:*

enumerator kWDOG32\_ClockPrescalerDivide1

Divided by 1

enumerator kWDOG32\_ClockPrescalerDivide256

Divided by 256

enum \_\_wdog32\_test\_mode

Describes WDOG32 test mode.

*Values:*

enumerator kWDOG32\_TestModeDisabled

Test Mode disabled

enumerator kWDOG32\_UserModeEnabled

User Mode enabled

enumerator kWDOG32\_LowByteTest

Test Mode enabled, only low byte is used

enumerator kWDOG32\_HighByteTest

Test Mode enabled, only high byte is used

enum \_\_wdog32\_interrupt\_enable\_t

WDOG32 interrupt configuration structure.

This structure contains the settings for all of the WDOG32 interrupt configurations.

*Values:*

enumerator kWDOG32\_InterruptEnable

Interrupt is generated before forcing a reset

enum \_\_wdog32\_status\_flags\_t

WDOG32 status flags.

This structure contains the WDOG32 status flags for use in the WDOG32 functions.

*Values:*

enumerator kWDOG32\_RunningFlag

Running flag, set when WDOG32 is enabled

enumerator kWDOG32\_InterruptFlag

Interrupt flag, set when interrupt occurs



`typedef enum _wdog32_clock_source` `wdog32_clock_source_t`  
Max loops to wait for WDOG32 unlock sequence complete.  
This is the maximum number of loops to wait for the wdog32 unlock sequence to complete. If set to 0, it will wait indefinitely until the unlock sequence is complete.  
Max loops to wait for WDOG32 reconfiguration complete.  
This is the maximum number of loops to wait for the wdog32 reconfiguration to complete. If set to 0, it will wait indefinitely until the reconfiguration is complete.  
Describes WDOG32 clock source.

`typedef enum _wdog32_clock_prescaler` `wdog32_clock_prescaler_t`  
Describes the selection of the clock prescaler.

`typedef struct _wdog32_work_mode` `wdog32_work_mode_t`  
Defines WDOG32 work mode.

`typedef enum _wdog32_test_mode` `wdog32_test_mode_t`  
Describes WDOG32 test mode.

`typedef struct _wdog32_config` `wdog32_config_t`  
Describes WDOG32 configuration structure.

`struct _wdog32_work_mode`  
`#include <fsl_wdog32.h>` Defines WDOG32 work mode.

### Public Members

`bool enableWait`  
Enables or disables WDOG32 in wait mode

`bool enableStop`  
Enables or disables WDOG32 in stop mode

`bool enableDebug`  
Enables or disables WDOG32 in debug mode

`struct _wdog32_config`  
`#include <fsl_wdog32.h>` Describes WDOG32 configuration structure.

### Public Members

`bool enableWdog32`  
Enables or disables WDOG32

`wdog32_clock_source_t clockSource`  
Clock source select

`wdog32_clock_prescaler_t prescaler`  
Clock prescaler value

`wdog32_work_mode_t workMode`  
Configures WDOG32 work mode in debug stop and wait mode

`wdog32_test_mode_t testMode`  
Configures WDOG32 test mode

`bool enableUpdate`  
Update write-once register enable

`bool enableInterrupt`  
Enables or disables WDOG32 interrupt

`bool enableWindowMode`  
Enables or disables WDOG32 window mode

`uint16_t windowValue`  
Window value

`uint16_t timeoutValue`  
Timeout value

## 2.79 XRDC: Extended Resource Domain Controller

`void XRDC_GetHardwareConfig(XRDC_Type *base, xrdc_hardware_config_t *config)`

Gets the XRDC hardware configuration.

This function gets the XRDC hardware configurations, including number of bus masters, number of domains, number of MRCs and number of PACs.

### Parameters

- `base` – XRDC peripheral base address.
- `config` – Pointer to the structure to get the configuration.

`static inline void XRDC_LockGlobalControl(XRDC_Type *base)`

Locks the XRDC global control register `XRDC_CR`.

This function locks the `XRDC_CR` register. After it is locked, the register is read-only until the next reset.

### Parameters

- `base` – XRDC peripheral base address.

`static inline void XRDC_SetGlobalValid(XRDC_Type *base, bool valid)`

Sets the XRDC global valid.

This function sets the XRDC global valid or invalid. When the XRDC is global invalid, all accesses from all bus masters to all slaves are allowed.

### Parameters

- `base` – XRDC peripheral base address.
- `valid` – True to valid XRDC.

`static inline uint8_t XRDC_GetCurrentMasterDomainId(XRDC_Type *base)`

Gets the domain ID of the current bus master.

This function returns the domain ID of the current bus master.

### Parameters

- `base` – XRDC peripheral base address.

### Returns

Domain ID of current bus master.

`status_t XRDC_GetAndClearFirstDomainError(XRDC_Type *base, xrdc_error_t *error)`

Gets and clears the first domain error of the current domain.

This function gets the first access violation information for the current domain and clears the pending flag. There might be multiple access violations pending for the current domain. This function only processes the first error.

**Parameters**

- base – XRDC peripheral base address.
- error – Pointer to the error information.

**Returns**

If the access violation is captured, this function returns the `kStatus_Success`. The error information can be obtained from the parameter `error`. If no access violation is captured, this function returns the `kStatus_XRDC_NoError`.

```
status_t XRDC_GetAndClearFirstSpecificDomainError(XRDC_Type *base, xrdc_error_t *error,
 uint8_t domainId)
```

Gets and clears the first domain error of the specific domain.

This function gets the first access violation information for the specific domain and clears the pending flag. There might be multiple access violations pending for the current domain. This function only processes the first error.

**Parameters**

- base – XRDC peripheral base address.
- error – Pointer to the error information.
- domainId – The error of which domain to get and clear.

**Returns**

If the access violation is captured, this function returns the `kStatus_Success`. The error information can be obtained from the parameter `error`. If no access violation is captured, this function returns the `kStatus_XRDC_NoError`.

```
void XRDC_GetPidDefaultConfig(xrdc_pid_config_t *config)
```

Gets the default PID configuration structure.

This function initializes the configuration structure to default values. The default values are:

```
config->pid = 0U;
config->tsmEnable = 0U;
config->sp4smEnable = 0U;
config->lockMode = kXRDC_PidLockSecurePrivilegeWritable;
```

**Parameters**

- config – Pointer to the configuration structure.

```
void XRDC_SetPidConfig(XRDC_Type *base, xrdc_master_t master, const xrdc_pid_config_t
 *config)
```

Configures the PID for a specific bus master.

This function configures the PID for a specific bus master. Do not use this function for non-processor bus masters.

**Parameters**

- base – XRDC peripheral base address.
- master – Which bus master to configure.
- config – Pointer to the configuration structure.

```
static inline void XRDC_SetPidLockMode(XRDC_Type *base, xrdc_master_t master,
 xrdc_pid_lock_t lockMode)
```

Sets the PID configuration register lock mode.

This function sets the PID configuration register lock `XRDC_PIDn[LK2]`.

### Parameters

- base – XRDC peripheral base address.
- master – Which master's PID to lock.
- lockMode – Lock mode to set.

```
void XRDC_GetDefaultNonProcessorDomainAssignment(xrdc_non_processor_domain_assignment_t
 *domainAssignment)
```

Gets the default master domain assignment for non-processor bus master.

This function gets the default master domain assignment for non-processor bus master. It should only be used for the non-processor bus masters, such as DMA. This function sets the assignment as follows:

```
assignment->domainId = 0U;
assignment->privilegeAttr = kXRDC_ForceUser;
assignment->privilegeAttr = kXRDC_ForceSecure;
assignment->bypassDomainId = 0U;
assignment->blogicPartId = 0U;
assignment->benableLogicPartId = 0U;
assignment->lock = 0U;
```

### Parameters

- domainAssignment – Pointer to the assignment structure.

```
void XRDC_GetDefaultProcessorDomainAssignment(xrdc_processor_domain_assignment_t
 *domainAssignment)
```

Gets the default master domain assignment for the processor bus master.

This function gets the default master domain assignment for the processor bus master. It should only be used for the processor bus masters, such as CORE0. This function sets the assignment as follows:

```
assignment->domainId = 0U;
assignment->domainIdSelect = kXRDC_DidMda;
assignment->dpidEnable = kXRDC_PidDisable;
assignment->pidMask = 0U;
assignment->pid = 0U;
assignment->logicPartId = 0U;
assignment->enableLogicPartId = 0U;
assignment->lock = 0U;
```

### Parameters

- domainAssignment – Pointer to the assignment structure.

```
void XRDC_SetNonProcessorDomainAssignment(XRDC_Type *base, xrdc_master_t master, uint8_t
 assignIndex, const
 xrdc_non_processor_domain_assignment_t
 *domainAssignment)
```

Sets the non-processor bus master domain assignment.

This function sets the non-processor master domain assignment as valid. One bus master might have multiple domain assignment registers. The parameter `assignIndex` specifies which assignment register to set.

Example: Set domain assignment for DMA0.

```
xrdc_non_processor_domain_assignment_t nonProcessorAssignment;

XRDC_GetDefaultNonProcessorDomainAssignment(&nonProcessorAssignment);
```

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```

nonProcessorAssignment.domainId = 1;
nonProcessorAssignment.xxx = xxx;

XRDC_SetMasterDomainAssignment(XRDC, kXrdcMasterDma0, 0U, &nonProcessorAssignment);

```

### Parameters

- base – XRDC peripheral base address.
- master – Which master to configure.
- assignIndex – Which assignment register to set.
- domainAssignment – Pointer to the assignment structure.

```

void XRDC_SetProcessorDomainAssignment(XRDC_Type *base, xrdc_master_t master, uint8_t
 assignIndex, const
 xrdc_processor_domain_assignment_t
 *domainAssignment)

```

Sets the processor bus master domain assignment.

This function sets the processor master domain assignment as valid. One bus master might have multiple domain assignment registers. The parameter `assignIndex` specifies which assignment register to set.

Example: Set domain assignment for core 0. In this example, there are 3 assignment registers for core 0.

```

xrdc_processor_domain_assignment_t processorAssignment;

XRDC_GetDefaultProcessorDomainAssignment(&processorAssignment);

processorAssignment.domainId = 1;
processorAssignment.xxx = xxx;
XRDC_SetMasterDomainAssignment(XRDC, kXrdcMasterCpu0, 0U, &processorAssignment);

processorAssignment.domainId = 2;
processorAssignment.xxx = xxx;
XRDC_SetMasterDomainAssignment(XRDC, kXrdcMasterCpu0, 1U, &processorAssignment);

processorAssignment.domainId = 0;
processorAssignment.xxx = xxx;
XRDC_SetMasterDomainAssignment(XRDC, kXrdcMasterCpu0, 2U, &processorAssignment);

```

### Parameters

- base – XRDC peripheral base address.
- master – Which master to configure.
- assignIndex – Which assignment register to set.
- domainAssignment – Pointer to the assignment structure.

```

static inline void XRDC_LockMasterDomainAssignment(XRDC_Type *base, xrdc_master_t master,
 uint8_t assignIndex)

```

Locks the bus master domain assignment register.

This function locks the master domain assignment. One bus master might have multiple domain assignment registers. The parameter `assignIndex` specifies which assignment register to lock. After it is locked, the register can't be changed until next reset.

### Parameters

- base – XRDC peripheral base address.

- master – Which master to configure.
- assignIndex – Which assignment register to lock.

```
static inline void XRDC_SetMasterDomainAssignmentValid(XRDC_Type *base, xrdc_master_t
 master, uint8_t assignIndex, bool
 valid)
```

Sets the master domain assignment as valid or invalid.

This function sets the master domain assignment as valid or invalid. One bus master might have multiple domain assignment registers. The parameter `assignIndex` specifies which assignment register to configure.

#### Parameters

- base – XRDC peripheral base address.
- master – Which master to configure.
- assignIndex – Index for the domain assignment register.
- valid – True to set valid, false to set invalid.

```
void XRDC_GetMemAccessDefaultConfig(xrdc_mem_access_config_t *config)
```

Gets the default memory region access policy.

This function gets the default memory region access policy. It sets the policy as follows:

```
config->enableSema = false;
config->semaNum = 0U;
config->subRegionDisableMask = 0U;
config->size = kXrdcMemSizeNone;
config->lockMode = kXRDC_AccessConfigLockWritable;
config->baseAddress = 0U;
config->policy[0] = kXRDC_AccessPolicyNone;
config->policy[1] = kXRDC_AccessPolicyNone;
...
config->policy[15] = kXRDC_AccessPolicyNone;
```

#### Parameters

- config – Pointer to the configuration structure.

```
void XRDC_SetMemAccessConfig(XRDC_Type *base, const xrdc_mem_access_config_t *config)
```

Sets the memory region access policy.

This function sets the memory region access configuration as valid. There are two methods to use it:

**Example 1:** Set one configuration run time. Set memory region 0x20000000 ~ 0x20000400 accessible by domain 0, use MRC0\_1.

```
xrdc_mem_access_config_t config =
{
 .mem = kXRDC_MemMrc0_1,
 .baseAddress = 0x20000000U,
 .size = kXRDC_MemSize1K,
 .policy[0] = kXRDC_AccessPolicyAll
};
XRDC_SetMemAccessConfig(XRDC, &config);
```

**Example 2:** Set multiple configurations during startup. Set memory region 0x20000000 ~ 0x20000400 accessible by domain 0, use MRC0\_1. Set memory region 0x1FFF0000 ~ 0x1FFF0800 accessible by domain 0, use MRC0\_2.

```
xrdc_mem_access_config_t configs[] =
{
 {
 .mem = kXRDC_MemMrc0_1,
 .baseAddress = 0x20000000U,
 .size = kXRDC_MemSize1K,
 .policy[0] = kXRDC_AccessPolicyAll
 },
 {
 .mem = kXRDC_MemMrc0_2,
 .baseAddress = 0x1FFF0000U,
 .size = kXRDC_MemSize2K,
 .policy[0] = kXRDC_AccessPolicyAll
 }
};

for (i=0U; i<((sizeof(configs)/sizeof(configs[0]))); i++)
{
 XRDC_SetMemAccessConfig(XRDC, &configs[i]);
}
```

### Parameters

- base – XRDC peripheral base address.
- config – Pointer to the access policy configuration structure.

```
static inline void XRDC_SetMemAccessLockMode(XRDC_Type *base, xrdc_mem_t mem,
 xrdc_access_config_lock_t lockMode)
```

Sets the memory region descriptor register lock mode.

### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region descriptor to lock.
- lockMode – The lock mode to set.

```
static inline void XRDC_SetMemAccessValid(XRDC_Type *base, xrdc_mem_t mem, bool valid)
```

Sets the memory region descriptor as valid or invalid.

This function sets the memory region access configuration dynamically. For example:

```
xrdc_mem_access_config_t config =
{
 .mem = kXRDC_MemMrc0_1,
 .baseAddress = 0x20000000U,
 .size = kXRDC_MemSize1K,
 .policy[0] = kXRDC_AccessPolicyAll
};
XRDC_SetMemAccessConfig(XRDC, &config);

XRDC_SetMemAccessValid(kXRDC_MemMrc0_1, false);

XRDC_SetMemAccessValid(kXRDC_MemMrc0_1, true);
```

### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region descriptor to set.
- valid – True to set valid, false to set invalid.

```
void XRDC_SetMemExclAccessLockMode(XRDC_Type *base, xrdc_mem_t mem,
 xrdc_excl_access_lock_config_t lockMode)
```

Sets the memory region exclusive access lock mode configuration.

Note: Any write to MRGD\_W[0-3]\_n clears the MRGD\_W4\_n[VLD] indicator so a coherent register state can be supported. It is indispensable to re-assert the valid bit when dynamically changing the EAL in the MRGD, which is done in this API.

#### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region's exclusive access lock mode to configure.
- lockMode – The exclusive access lock mode to set.

```
void XRDC_ForceMemExclAccessLockRelease(XRDC_Type *base, xrdc_mem_t mem)
```

Forces the release of the memory region exclusive access lock.

A lock can be forced to the available state (EAL=10) by a domain that does not own the lock through the forced lock release procedure: The procedure to force a exclusive access lock release is as follows:

- a. Write 0x02000046 to W1 register (PAC/MSD) or W3 register (MRC)
- b. Write 0x02000052 to W1 register (PAC/MSD) or W3 register (MRC)

Note: The two writes must be consecutive, any intervening write to the register resets the sequence.

#### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region's exclusive access lock to force release.

```
static inline uint8_t XRDC_GetMemExclAccessLockDomainOwner(XRDC_Type *base, xrdc_mem_t
 mem)
```

Gets the exclusive access lock domain owner of the memory region.

This function returns the domain ID of the exclusive access lock owner of the memory region.

#### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region's exclusive access lock domain owner to get.

#### Returns

Domain ID of the memory region exclusive access lock owner.

```
void XRDC_SetMemAccsetLock(XRDC_Type *base, xrdc_mem_t mem, xrdc_mem_accset_t accset,
 bool lock)
```

Sets the memory region ACCSET (programmable access flags) lock.

#### Parameters

- base – XRDC peripheral base address.
- mem – Which memory region descriptor to lock.
- accset – Which set/index of ACCSET to lock.
- lock – True to set lock, false to set unlock.

```
void XRDC_GetPeriphAccessDefaultConfig(xrdc_periph_access_config_t *config)
```

Gets the default peripheral access configuration.

The default configuration is set as follows:



```
config->enableSema = false;
config->semaNum = 0U;
config->lockMode = kXRDC_AccessConfigLockWritable;
config->policy[0] = kXRDC_AccessPolicyNone;
config->policy[1] = kXRDC_AccessPolicyNone;
...
config->policy[15] = kXRDC_AccessPolicyNone;
```

### Parameters

- config – Pointer to the configuration structure.

`void XRDC_SetPeriphAccessConfig(XRDC_Type *base, const xrdc_periph_access_config_t *config)`

Sets the peripheral access configuration.

This function sets the peripheral access configuration as valid. Two methods to use it:

Method 1: Set for one peripheral, which is used for runtime settings. Example: set LPTMR0 accessible by domain 0

```
xrdc_periph_access_config_t config;

config.periph = kXRDC_PeriphLptmr0;
config.policy[0] = kXRDC_AccessPolicyAll;
XRDC_SetPeriphAccessConfig(XRDC, &config);
```

Method 2: Set for multiple peripherals, which is used for initialization settings.

```
xrdc_periph_access_config_t configs[] =
{
 {
 .periph = kXRDC_PeriphLptmr0,
 .policy[0] = kXRDC_AccessPolicyAll,
 .policy[1] = kXRDC_AccessPolicyAll
 },
 {
 .periph = kXRDC_PeriphLpuart0,
 .policy[0] = kXRDC_AccessPolicyAll,
 .policy[1] = kXRDC_AccessPolicyAll
 }
};

for (i=0U; i<(sizeof(configs)/sizeof(configs[0])), i++)
{
 XRDC_SetPeriphAccessConfig(XRDC, &config[i]);
}
```

### Parameters

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

`static inline void XRDC_SetPeriphAccessLockMode(XRDC_Type *base, xrdc_periph_t periph, xrdc_access_config_lock_t lockMode)`

Sets the peripheral access configuration register lock mode.

### Parameters

- base – XRDC peripheral base address.
- periph – Which peripheral access configuration register to lock.
- lockMode – The lock mode to set.

```
static inline void XRDC_SetPeriphAccessValid(XRDC_Type *base, xrdc_periph_t periph, bool
 valid)
```

Sets the peripheral access as valid or invalid.

This function sets the peripheral access configuration dynamically. For example:

```
xrdc_periph_access_config_t config =
{
 .periph = kXRDC_PeriphLptmr0;
 .policy[0] = kXRDC_AccessPolicyAll;
};
XRDC_SetPeriphAccessConfig(XRDC, &config);

XRDC_SetPeriphAccessValid(kXrdcPeriLptmr0, false);

XRDC_SetPeriphAccessValid(kXrdcPeriLptmr0, true);
```

#### Parameters

- base – XRDC peripheral base address.
- periph – Which peripheral access configuration to set.
- valid – True to set valid, false to set invalid.

```
static inline void XRDC_SetPeriphExclAccessLockMode(XRDC_Type *base, xrdc_periph_t periph,
 xrdc_excl_access_lock_config_t
 lockMode)
```

Sets the peripheral exclusive access lock mode configuration.

#### Parameters

- base – XRDC peripheral base address.
- periph – Which peripheral's exclusive access lock mode to configure.
- lockMode – The exclusive access lock mode to set.

```
void XRDC_ForcePeriphExclAccessLockRelease(XRDC_Type *base, xrdc_periph_t periph)
```

Forces the release of the peripheral exclusive access lock.

A lock can be forced to the available state (EAL=10) by a domain that does not own the lock through the forced lock release procedure: The procedure to force a exclusive access lock release is as follows:

- Write 0x02000046 to W1 register (PAC/MSC) or W3 register (MRC)
- Write 0x02000052 to W1 register (PAC/MSC) or W3 register (MRC)

Note: The two writes must be consecutive, any intervening write to the register resets the sequence.

#### Parameters

- base – XRDC peripheral base address.
- periph – Which peripheral's exclusive access lock to force release.

```
static inline uint8_t XRDC_GetPeriphExclAccessLockDomainOwner(XRDC_Type *base,
 xrdc_periph_t periph)
```

Gets the exclusive access lock domain owner of the peripheral.

This function returns the domain ID of the exclusive access lock owner of the peripheral.

#### Parameters

- base – XRDC peripheral base address.
- periph – Which peripheral's exclusive access lock domain owner to get.

**Returns**

Domain ID of the peripheral exclusive access lock owner.

XRDC status `_xrdc_status`.

*Values:*

enumerator `kStatus_XRDC_NoError`

No error captured.

enum `_xrdc_pid_enable`

XRDC PID enable mode, the register bit `XRDC_MDA_Wx[PE]`, used for domain hit evaluation.

*Values:*

enumerator `kXRDC_PidDisable`

PID is not used in domain hit evaluation.

enumerator `kXRDC_PidDisable1`

PID is not used in domain hit evaluation.

enumerator `kXRDC_PidExp0`

$((\text{XRDC\_MDA\_W}[\text{PID}] \ \& \ \sim\text{XRDC\_MDA\_W}[\text{PIDM}]) \ == \ (\text{XRDC\_PID}[\text{PID}] \ \& \ \sim\text{XRDC\_MDA\_W}[\text{PIDM}]))$ .

enumerator `kXRDC_PidExp1`

$\sim((\text{XRDC\_MDA\_W}[\text{PID}] \ \& \ \sim\text{XRDC\_MDA\_W}[\text{PIDM}]) \ == \ (\text{XRDC\_PID}[\text{PID}] \ \& \ \sim\text{XRDC\_MDA\_W}[\text{PIDM}]))$ .

enum `_xrdc_did_sel`

XRDC domain ID select method, the register bit `XRDC_MDA_Wx[DIDS]`, used for domain hit evaluation.

*Values:*

enumerator `kXRDC_DidMda`

Use `MDAn[3:0]` as DID.

enumerator `kXRDC_DidInput`

Use the input DID (`DID_in`) as DID.

enumerator `kXRDC_DidMdaAndInput`

Use `MDAn[3:2]` concatenated with `DID_in[1:0]` as DID.

enumerator `kXRDC_DidReserved`

Reserved.

enum `_xrdc_secure_attr`

XRDC secure attribute, the register bit `XRDC_MDA_Wx[SA]`, used for non-processor bus master domain assignment.

*Values:*

enumerator `kXRDC_ForceSecure`

Force the bus attribute for this master to secure.

enumerator `kXRDC_ForceNonSecure`

Force the bus attribute for this master to non-secure.

enumerator `kXRDC_MasterSecure`

Use the bus master's secure/nonsecure attribute directly.

enumerator kXRDC\_MasterSecure1

Use the bus master's secure/nonsecure attribute directly.

enum \_xrdc\_privilege\_attr

XRDC privileged attribute, the register bit XRDC\_MDA\_Wx[PA], used for non-processor bus master domain assignment.

*Values:*

enumerator kXRDC\_ForceUser

Force the bus attribute for this master to user.

enumerator kXRDC\_ForcePrivilege

Force the bus attribute for this master to privileged.

enumerator kXRDC\_MasterPrivilege

Use the bus master's attribute directly.

enumerator kXRDC\_MasterPrivilege1

Use the bus master's attribute directly.

enum \_xrdc\_pid\_lock

XRDC PID LK2 definition XRDC\_PIDn[LK2].

*Values:*

enumerator kXRDC\_PidLockSecurePrivilegeWritable

Writable by any secure privileged write.

enumerator kXRDC\_PidLockSecurePrivilegeWritable1

Writable by any secure privileged write.

enumerator kXRDC\_PidLockMasterXOnly

PIDx is only writable by master x.

enumerator kXRDC\_PidLockLocked

Read-only until the next reset.

enum \_xrdc\_access\_policy

XRDC domain access control policy.

*Values:*

enumerator kXRDC\_AccessPolicyNone

enumerator kXRDC\_AccessPolicySpuR

enumerator kXRDC\_AccessPolicySpRw

enumerator kXRDC\_AccessPolicySpuRw

enumerator kXRDC\_AccessPolicySpuRwNpR

enumerator kXRDC\_AccessPolicySpuRwNpuR

enumerator kXRDC\_AccessPolicySpuRwNpRw

enumerator kXRDC\_AccessPolicyAll

enum \_xrdc\_access\_config\_lock

Access configuration lock mode, the register field PDAC and MRGD LK2.

*Values:*

enumerator kXRDC\_AccessConfigLockWritable

Entire PDACn/MRGDn can be written.

enumerator kXRDC\_AccessConfigLockWritable1

Entire PDACn/MRGDn can be written.

enumerator kXRDC\_AccessConfigLockDomainXOnly

Domain x only write the DxACP field.

enumerator kXRDC\_AccessConfigLockLocked

PDACn is read-only until the next reset.

enum \_xrdc\_excl\_access\_lock\_config

Exclusive access lock mode configuration, the register field PDAC and MRGD EAL.

*Values:*

enumerator kXRDC\_ExclAccessLockDisabled

Lock disabled.

enumerator kXRDC\_ExclAccessLockDisabledUntilNextRst

Lock disabled until next reset.

enumerator kXRDC\_ExclAccessLockEnabledStateAvail

Lock enabled, lock state = available.

enumerator kXRDC\_ExclAccessLockEnabledStateNotAvail

Lock enabled, lock state = not available.

enum \_xrdc\_mem\_accset

XRDC memory ACCSET (SET of programmable access flags).

*Values:*

enumerator kXRDC\_MemAccset1

Memory region SET 1 of programmable access flags.

enumerator kXRDC\_MemAccset2

Memory region SET 2 of programmable access flags.

enum \_xrdc\_mem\_code\_region

XRDC memory code region indicator.

*Values:*

enumerator kXRDC\_MemCodeRegion0

Code region indicator 0=data.

enumerator kXRDC\_MemCodeRegion1

Code region indicator 1=code.

enum \_xrdc\_access\_flags\_select

XRDC domain access flags/policy select.

Policy: {R,W,X} Read, write, execute flags. flag = 0 : inhibits access, flag = 1 : allows access. policy => SecurePriv\_NonSecurePriv\_SecureUser\_NonSecureUsr xxx\_xxx\_xxx\_xxx => PS{R,W,X}\_PN{R,W,X}\_US{R,W,X}\_UN{R,W,X}

|                   |                   |
|-------------------|-------------------|
| PS > PN > US > UN | PS > PN > US > UN |
|-------------------|-------------------|

DxSEL CodeRegion = 0 CodeRegion = 1 000 000\_000\_000\_000 = 0x000 000\_000\_000\_000 = 0x000 001 ACCSET1 010 ACCSET2 011 110\_000\_000\_000 = 0xC00 001\_001\_001\_001 = 0x249 100 110\_110\_000\_000 = 0xD80 111\_000\_000\_000 = 0xE00 101 110\_110\_100\_100 = 0xDA4

110\_111\_000\_000 = 0xDC0 110 110\_110\_110\_000 = 0xDB0 110\_110\_111\_000 = 0xDB8 111  
110\_110\_110\_110 = 0xDB6 110\_110\_111\_111 = 0xDBF

*Values:*

enumerator kXRDC\_\_AccessFlagsNone

enumerator kXRDC\_\_AccessFlagsAlt1

enumerator kXRDC\_\_AccessFlagsAlt2

enumerator kXRDC\_\_AccessFlagsAlt3

enumerator kXRDC\_\_AccessFlagsAlt4

enumerator kXRDC\_\_AccessFlagsAlt5

enumerator kXRDC\_\_AccessFlagsAlt6

enumerator kXRDC\_\_AccessFlagsAlt7

enum \_\_xrdc\_controller

XRDC controller definition for domain error check.

*Values:*

enumerator kXRDC\_MemController0

Memory region controller 0.

enumerator kXRDC\_MemController1

Memory region controller 1.

enumerator kXRDC\_MemController2

Memory region controller 2.

enumerator kXRDC\_MemController3

Memory region controller 3.

enumerator kXRDC\_MemController4

Memory region controller 4.

enumerator kXRDC\_MemController5

Memory region controller 5.

enumerator kXRDC\_MemController6

Memory region controller 6.

enumerator kXRDC\_MemController7

Memory region controller 7.

enumerator kXRDC\_MemController8

Memory region controller 8.

enumerator kXRDC\_MemController9

Memory region controller 9.

enumerator kXRDC\_MemController10

Memory region controller 10.

enumerator kXRDC\_MemController11

Memory region controller 11.

enumerator kXRDC\_MemController12

Memory region controller 12.

enumerator kXRDC\_MemController13

Memory region controller 13.

enumerator kXRDC\_MemController14

Memory region controller 14.

enumerator kXRDC\_MemController15

Memory region controller 15.

enumerator kXRDC\_PeriphController0

Peripheral access controller 0.

enumerator kXRDC\_PeriphController1

Peripheral access controller 1.

enumerator kXRDC\_PeriphController2

Peripheral access controller 2.

enumerator kXRDC\_PeriphController3

Peripheral access controller 3.

enum \_xrdc\_error\_state

XRDC domain error state definition XRDC\_DERR\_W1\_n[EST].

*Values:*

enumerator kXRDC\_ErrorStateNone

No access violation detected.

enumerator kXRDC\_ErrorStateNone1

No access violation detected.

enumerator kXRDC\_ErrorStateSingle

Single access violation detected.

enumerator kXRDC\_ErrorStateMulti

Multiple access violation detected.

enum \_xrdc\_error\_attr

XRDC domain error attribute definition XRDC\_DERR\_W1\_n[EATR].

*Values:*

enumerator kXRDC\_ErrorSecureUserInst

Secure user mode, instruction fetch access.

enumerator kXRDC\_ErrorSecureUserData

Secure user mode, data access.

enumerator kXRDC\_ErrorSecurePrivilegeInst

Secure privileged mode, instruction fetch access.

enumerator kXRDC\_ErrorSecurePrivilegeData

Secure privileged mode, data access.

enumerator kXRDC\_ErrorNonSecureUserInst

NonSecure user mode, instruction fetch access.

enumerator kXRDC\_ErrorNonSecureUserData

NonSecure user mode, data access.

enumerator kXRDC\_ErrorNonSecurePrivilegeInst

NonSecure privileged mode, instruction fetch access.

```

 enumerator kXRDC_ErrorNonSecurePrivilegeData
 NonSecure privileged mode, data access.
enum _xrdc_error_type
 XRDC domain error access type definition XRDC_DERR_W1_n[ERW].
 Values:
 enumerator kXRDC_ErrorTypeRead
 Error occurs on read reference.
 enumerator kXRDC_ErrorTypeWrite
 Error occurs on write reference.
typedef struct _xrdc_hardware_config xrdc_hardware_config_t
 XRDC hardware configuration.
typedef enum _xrdc_pid_enable xrdc_pid_enable_t
 XRDC PID enable mode, the register bit XRDC_MDA_Wx[PE], used for domain hit evaluation.
typedef enum _xrdc_did_sel xrdc_did_sel_t
 XRDC domain ID select method, the register bit XRDC_MDA_Wx[DIDS], used for domain hit
 evaluation.
typedef enum _xrdc_secure_attr xrdc_secure_attr_t
 XRDC secure attribute, the register bit XRDC_MDA_Wx[SA], used for non-processor bus
 master domain assignment.
typedef enum _xrdc_privilege_attr xrdc_privilege_attr_t
 XRDC privileged attribute, the register bit XRDC_MDA_Wx[PA], used for non-processor bus
 master domain assignment.
typedef struct _xrdc_processor_domain_assignment xrdc_processor_domain_assignment_t
 Domain assignment for the processor bus master.
typedef struct _xrdc_non_processor_domain_assignment
xrdc_non_processor_domain_assignment_t
 Domain assignment for the non-processor bus master.
typedef enum _xrdc_pid_lock xrdc_pid_lock_t
 XRDC PID LK2 definition XRDC_PIDn[LK2].
typedef struct _xrdc_pid_config xrdc_pid_config_t
 XRDC process identifier (PID) configuration.
typedef enum _xrdc_access_policy xrdc_access_policy_t
 XRDC domain access control policy.
typedef enum _xrdc_access_config_lock xrdc_access_config_lock_t
 Access configuration lock mode, the register field PDAC and MRGD LK2.
typedef enum _xrdc_excl_access_lock_config xrdc_excl_access_lock_config_t
 Exclusive access lock mode configuration, the register field PDAC and MRGD EAL.
typedef struct _xrdc_periph_access_config xrdc_periph_access_config_t
 XRDC peripheral domain access control configuration.
typedef enum _xrdc_mem_accset xrdc_mem_accset_t
 XRDC memory ACCSET (SET of programmable access flags).
typedef enum _xrdc_mem_code_region xrdc_mem_code_region_t
 XRDC memory code region indicator.

```



typedef enum *\_xrdc\_access\_flags\_select* xrdc\_access\_flags\_select\_t

XRDC domain access flags/policy select.

Policy: {R,W,X} Read, write, execute flags. flag = 0 : inhibits access, flag = 1 : allows access. policy => SecurePriv\_NonSecurePriv\_SecureUser\_NonSecureUsr xxx\_xxx\_xxx\_xxx => PS{R,W,X}\_PN{R,W,X}\_US{R,W,X}\_UN{R,W,X}

PS > PN > US > UN      PS > PN > US > UN

DxSEL CodeRegion = 0 CodeRegion = 1 000 000\_000\_000\_000 = 0x000 000\_000\_000\_000 = 0x000 001 ACCSET1 010 ACCSET2 011 110\_000\_000\_000 = 0xC00 001\_001\_001\_001 = 0x249 100 110\_110\_000\_000 = 0xD80 111\_000\_000\_000 = 0xE00 101 110\_110\_100\_100 = 0xDA4 110\_111\_000\_000 = 0xDC0 110 110\_110\_110\_000 = 0xDB0 110\_110\_111\_000 = 0xDB8 111 110\_110\_110\_110 = 0xDB6 110\_110\_111\_111 = 0xDBF

typedef struct *\_xrdc\_mem\_access\_config* xrdc\_mem\_access\_config\_t

XRDC memory region domain access control configuration.

typedef enum *\_xrdc\_controller* xrdc\_controller\_t

XRDC controller definition for domain error check.

typedef enum *\_xrdc\_error\_state* xrdc\_error\_state\_t

XRDC domain error state definition XRDC\_DERR\_W1\_n[EST].

typedef enum *\_xrdc\_error\_attr* xrdc\_error\_attr\_t

XRDC domain error attribute definition XRDC\_DERR\_W1\_n[EATR].

typedef enum *\_xrdc\_error\_type* xrdc\_error\_type\_t

XRDC domain error access type definition XRDC\_DERR\_W1\_n[ERW].

typedef struct *\_xrdc\_error* xrdc\_error\_t

XRDC domain error definition.

void XRDC\_Init(XRDC\_Type \*base)

Initializes the XRDC module.

This function enables the XRDC clock.

#### Parameters

- base – XRDC peripheral base address.

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

De-initializes the XRDC module.

This function disables the XRDC clock.

#### Parameters

- base – XRDC peripheral base address.

FSL\_XRDC\_DRIVER\_VERSION

struct *\_xrdc\_hardware\_config*

*#include <fsl\_xrdc.h>* XRDC hardware configuration.

#### Public Members

uint8\_t masterNumber

Number of bus masters.

uint8\_t domainNumber

Number of domains.

uint8\_t pacNumber  
Number of PACs.

uint8\_t mrcNumber  
Number of MRCs.

struct \_\_xrdc\_processor\_domain\_assignment  
*#include <fsl\_xrdc.h>* Domain assignment for the processor bus master.

### Public Members

uint32\_t domainId  
Domain ID.

uint32\_t domainIdSelect  
Domain ID select method, see xrdc\_did\_sel\_t.

uint32\_t pidEnable  
PId enable method, see xrdc\_pid\_enable\_t.

uint32\_t pidMask  
PId mask.

uint32\_t \_\_pad0\_\_  
Reserved.

uint32\_t pid  
PId value.

uint32\_t \_\_pad1\_\_  
Reserved.

uint32\_t \_\_pad2\_\_  
Reserved.

uint32\_t \_\_pad3\_\_  
Reserved.

uint32\_t \_\_pad4\_\_  
Reserved.

uint32\_t lock  
Lock the register.

uint32\_t \_\_pad5\_\_  
Reserved.

struct \_\_xrdc\_non\_processor\_domain\_assignment  
*#include <fsl\_xrdc.h>* Domain assignment for the non-processor bus master.

### Public Members

uint32\_t domainId  
Domain ID.

uint32\_t privilegeAttr  
Privileged attribute, see xrdc\_privilege\_attr\_t.

uint32\_t secureAttr  
Secure attribute, see xrdc\_secure\_attr\_t.

uint32\_t bypassDomainId

Bypass domain ID.

uint32\_t \_\_pad0\_\_

Reserved.

uint32\_t \_\_pad1\_\_

Reserved.

uint32\_t \_\_pad2\_\_

Reserved.

uint32\_t \_\_pad3\_\_

Reserved.

uint32\_t lock

Lock the register.

uint32\_t \_\_pad4\_\_

Reserved.

struct \_\_xrdc\_pid\_config

*#include <fsl\_xrdc.h>* XRDC process identifier (PID) configuration.

### Public Members

uint32\_t pid

PID value, PIDn[PID].

uint32\_t \_\_pad0\_\_

Reserved.

uint32\_t tsmEnable

Enable three-state model.

uint32\_t lockMode

PIDn configuration lock mode, see `xrdc_pid_lock_t`.

uint32\_t \_\_pad1\_\_

Reserved.

struct \_\_xrdc\_periph\_access\_config

*#include <fsl\_xrdc.h>* XRDC peripheral domain access control configuration.

### Public Members

xrdc\_periph\_t periph

Peripheral name.

*xrdc\_access\_config\_lock\_t* lockMode

PDACn lock configuration.

*xrdc\_excl\_access\_lock\_config\_t* exclAccessLockMode

Exclusive access lock configuration.

*xrdc\_access\_policy\_t* policy[1]

Access policy for each domain.

struct \_\_xrdc\_mem\_access\_config

*#include <fsl\_xrdc.h>* XRDC memory region domain access control configuration.

## Public Members

*xrdc\_mem\_t* mem

Memory region descriptor name.

bool enableAccset1Lock

Enable ACCSET1 access lock or not.

bool enableAccset2Lock

Enable ACCSET2 access lock or not.

uint16\_t accset1

SET 1 of Programmable access flags.      xxx\_xxx\_xxx\_xxx =>  
PS{R,W,X}\_PN{R,W,X}\_US{R,W,X}\_UN{R,W,X}. flag = 0 : inhibits access, flag = 1 :  
allows access.

uint16\_t accset2

SET 2 of Programmable access flags.      xxx\_xxx\_xxx\_xxx =>  
PS{R,W,X}\_PN{R,W,X}\_US{R,W,X}\_UN{R,W,X}. flag = 0 : inhibits access, flag = 1 :  
allows access.

*xrdc\_access\_config\_lock\_t* lockMode

MRGDn lock configuration.

*xrdc\_access\_flags\_select\_t* policy[1]

Access policy/flags select for each domain.

*xrdc\_mem\_code\_region\_t* codeRegion

Code region select. *xrdc\_mem\_code\_region\_t*.

uint32\_t baseAddress

Memory region base/start address.

uint32\_t endAddress

Memory region end address. The 5 LSB of end address is ignored and forced to 0x1F  
by hardware.

*xrdc\_excl\_access\_lock\_config\_t* exclAccessLockMode

Exclusive access lock configuration.

struct *\_xrdc\_error*

#include <fsl\_xrdc.h> XRDC domain error definition.

## Public Members

*xrdc\_controller\_t* controller

Which controller captured access violation.

uint32\_t address

Access address that generated access violation.

*xrdc\_error\_state\_t* errorState

Error state.

*xrdc\_error\_attr\_t* errorAttr

Error attribute.

*xrdc\_error\_type\_t* errorType

Error type.

uint8\_t errorPort

Error port.

uint8\_t domainId

Domain ID.

# 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><br>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><br>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><br>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><br>Generally, this is an unsigned 8-bit value.                                                                                                                                                        | Data type used to hold the Application Command code.                                                                                |
| <i>FM-STR_APPCM</i><br>Generally, this is an unsigned 8-bit value.                                                                                                                                                        | Data type used to create the Application Command data buffer.                                                                       |
| <i>FM-STR_APPCM</i><br>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.<br>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.<br>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.<br>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.<br>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.<br>This is used to store the data buffer sizes.        |
| <i>FM-STR_PPIPEF</i>  | Pointer to the pipe handler function.<br>See <a href="#">FM-STR_PipeOpen</a> for more details.                 |

**Internal types** The table describes the data types used internally by the FreeMASTER driver. The data types are declared in the platform-specific header file and they are not available in the application code.



|                                                                                                          |                                                                         |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| <i>FMSTR_U8</i>                                                                                          | The smallest memory entity.                                             |
| On the vast majority of platforms, this is an unsigned 8-bit integer.                                    |                                                                         |
| On the 56F8xx DSP platform, this is defined as an unsigned 16-bit integer.                               |                                                                         |
| <i>FMSTR_U16</i>                                                                                         | Unsigned 16-bit integer.                                                |
| <i>FMSTR_U32</i>                                                                                         | Unsigned 32-bit integer.                                                |
| <i>FMSTR_S8</i>                                                                                          | Signed 8-bit integer.                                                   |
| <i>FMSTR_S16</i>                                                                                         | Signed 16-bit integer.                                                  |
| <i>FMSTR_S32</i>                                                                                         | Signed 32-bit integer.                                                  |
| <i>FMSTR_FLOAT</i>                                                                                       | 4-byte standard IEEE floating-point type.                               |
| <i>FMSTR_FLAGS</i>                                                                                       | Data type forming a union with a structure of flag bit-fields.          |
| <i>FMSTR_SIZE8</i>                                                                                       | Data type holding a general size value, at least 8 bits wide.           |
| <i>FMSTR_INDEX</i>                                                                                       | General for-loop index. Must be signed, at least 16 bits wide.          |
| <i>FMSTR_BCHR</i>                                                                                        | A single character in the communication buffer.                         |
| Typically, this is an 8-bit unsigned integer, except for the DSP platforms where it is a 16-bit integer. |                                                                         |
| <i>FMSTR_BPTR</i>                                                                                        | A pointer to the communication buffer (an array of <i>FMSTR_BCHR</i> ). |

## Document references

### Links

- This document online: <https://mcuxpresso.nxp.com/mcuxsdk/latest/html/middleware/freemaster/doc/index.html>

- FreeMASTER tool home: [www.nxp.com/freemaster](http://www.nxp.com/freemaster)
- FreeMASTER community area: [community.nxp.com/community/freemaster](http://community.nxp.com/community/freemaster)
- FreeMASTER GitHub code repo: <https://github.com/nxp-mcuxpresso/mcux-freemaster>
- MCUXpresso SDK home: [www.nxp.com/mcuxpresso](http://www.nxp.com/mcuxpresso)
- MCUXpresso SDK builder: [mcuxpresso.nxp.com/en](http://mcuxpresso.nxp.com/en)

## Documents

- *FreeMASTER Usage Serial Driver Implementation* (document [AN4752](#))
- *Integrating FreeMASTER Time Debugging Tool With CodeWarrior For Microcontrollers v10.X Project* (document [AN4771](#))
- *Flash Driver Library For MC56F847xx And MC56F827xx DSC Family* (document [AN4860](#))

**Revision history** This Table summarizes the changes done to this document since the initial release.

| Revision | Date    | Description                                                                                                                                                                                                                                                                                                          |
|----------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0      | 03/2006 | Limited initial release                                                                                                                                                                                                                                                                                              |
| 2.0      | 09/2007 | Updated for FreeMASTER version. New Freescale document template used.                                                                                                                                                                                                                                                |
| 2.1      | 12/2007 | Added description of the new Fast Recorder feature and its API.                                                                                                                                                                                                                                                      |
| 2.2      | 04/2010 | Added support for MPC56xx platform, Added new API for use CAN interface.                                                                                                                                                                                                                                             |
| 2.3      | 04/2011 | Added support for Kxx Kinetis platform and MQX operating system.                                                                                                                                                                                                                                                     |
| 2.4      | 06/2011 | Serial driver update, adds support for USB CDC interface.                                                                                                                                                                                                                                                            |
| 2.5      | 08/2011 | Added Packet Driven BDM interface.                                                                                                                                                                                                                                                                                   |
| 2.7      | 12/2013 | Added FLEXCAN32 interface, byte access and isr callback configuration option.                                                                                                                                                                                                                                        |
| 2.8      | 06/2014 | Removed obsolete license text, see the software package content for up-to-date license.                                                                                                                                                                                                                              |
| 2.9      | 03/2015 | Update for driver version 1.8.2 and 1.9: FreeMASTER Pipes, TSA Active Content, LIN Transport Layer support, DEBUG-TX communication troubleshooting, Kinetis SDK support.                                                                                                                                             |
| 3.0      | 08/2016 | Update for driver version 2.0: Added support for MPC56xx, MPC57xx, KEAxx and S32Kxx platforms. New NXP document template as well as new license agreement used. added MCAN interface. Folders structure at the installation destination was rearranged.                                                              |
| 4.0      | 04/2019 | Update for driver released as part of FreeMASTER v3.0 and MCUXpresso SDK 2.6. Updated to match new V4 serial communication protocol and new configuration options. This version of the document removes substantial portion of outdated information related to S08, S12, ColdFire, Power and other legacy platforms. |
| 4.1      | 04/2020 | Minor update for FreeMASTER driver included in MCUXpresso SDK 2.8.                                                                                                                                                                                                                                                   |
| 4.2      | 09/2020 | Added example applications description and information about the MCUXpresso Config Tools. Fixed the pipe-related API description.                                                                                                                                                                                    |
| 4.3      | 10/2024 | Added description of Network and Segger J-Link RTT interface configuration. Accompanying the MCUXpresso SDK version 24.12.00.                                                                                                                                                                                        |
| 4.4      | 04/2025 | Added Zephyr-specific information. Accompanying the MCUXpresso SDK version 25.06.00.                                                                                                                                                                                                                                 |

# Chapter 4

## RTOS

### 4.1 FreeRTOS

#### 4.1.1 FreeRTOS kernel

Open source RTOS kernel for small devices.

**FreeRTOS kernel for MCUXpresso SDK Readme**

**FreeRTOS kernel for MCUXpresso SDK**

**Overview** The purpose of this document is to describes the [FreeRTOS kernel repo](#) integration into the [NXP MCUXpresso Software Development Kit: mcuxsdk](#). MCUXpresso SDK provides a comprehensive development solutions designed to optimize, ease, and help accelerate embedded system development of applications based on MCUs from NXP. This project involves the FreeRTOS kernel repo fork with:

- cmake and Kconfig support to allow the configuration and build in MCUXpresso SDK ecosystem
- FreeRTOS OS additions, such as [FreeRTOS driver wrappers](#), RTOS ready FatFs file system, and the implementation of FreeRTOS tickless mode

The history of changes in FreeRTOS kernel repo for MCUXpresso SDK are summarized in [CHANGELOG\\_mcuxsdk.md](#) file.

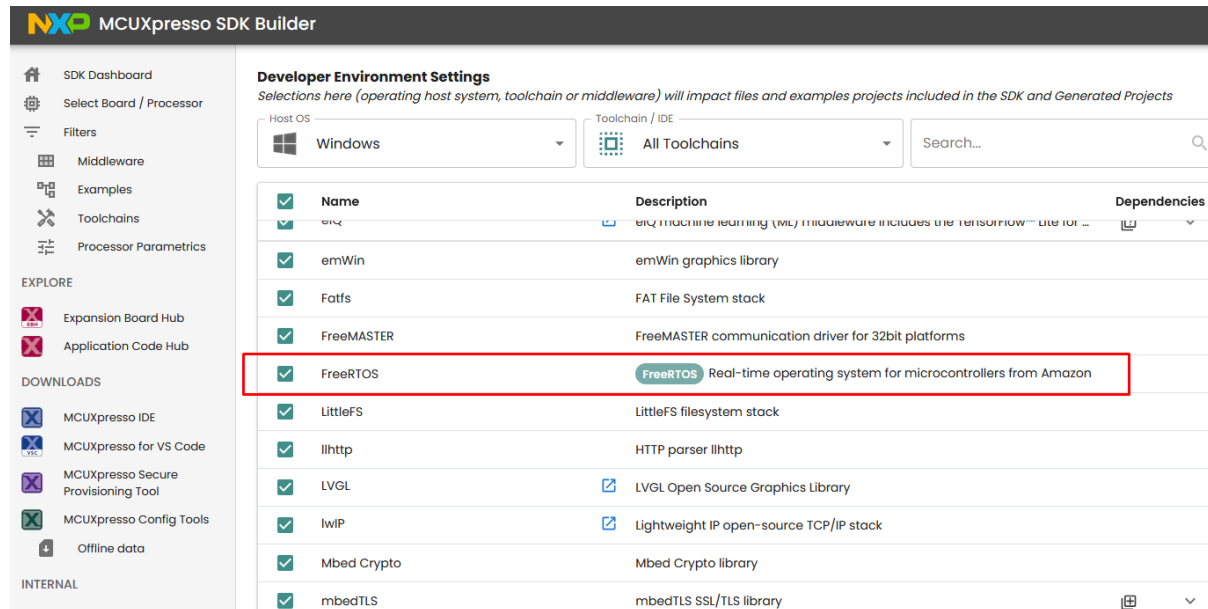
The MCUXpresso SDK framework also contains a set of FreeRTOS examples which show basic FreeRTOS OS features. This makes it easy to start a new FreeRTOS project or begin experimenting with FreeRTOS OS. Selected drivers and middleware are RTOS ready with related FreeRTOS adaptation layer.

**FreeRTOS example applications** The FreeRTOS examples are written to demonstrate basic FreeRTOS features and the interaction between peripheral drivers and the RTOS.

**List of examples** The list of freertos\_examples, their description and availability for individual supported MCUXpresso SDK development boards can be obtained here: [https://mcuxpresso.nxp.com/mcuxsdk/latest/html/examples/freertos\\_examples/index.html](https://mcuxpresso.nxp.com/mcuxsdk/latest/html/examples/freertos_examples/index.html)

**Location of examples** The FreeRTOS examples are located in [mcuxsdk-examples](#) repository, see the `freertos_examples` folder.

Once using MCUXpresso SDK zip packages created via the [MCUXpresso SDK Builder](#) the FreeRTOS kernel library and associated `freertos_examples` are added into final zip package once FreeRTOS components is selected on the Developer Environment Settings page:



The FreeRTOS examples in MCUXpresso SDK zip packages are located in `<MCUXpressoSDK_install_dir>/boards/<board_name>/freertos_examples/` subfolders.

**Building a FreeRTOS example application** For information how to use the cmake and Kconfig based build and configuration system and how to build `freertos_examples` visit: [MCUXpresso SDK documentation for Build And Configuration MCUXpresso SDK Getting Start Guide](#)

Tip: To list all FreeRTOS example projects and targets that can be built via the west build command, use this `west list_project` command in `mcuxsdk` workspace:

```
west list_project -p examples/freertos_examples
```

**FreeRTOS aware debugger plugin** NXP provides FreeRTOS task aware debugger for GDB. The plugin is compatible with Eclipse-based (MCUXpressoIDE) and is available after the installation.

| Task List (FreeRTOS) |           |             |            |          |              |                          |               |
|----------------------|-----------|-------------|------------|----------|--------------|--------------------------|---------------|
| TCB#                 | Task Name | Task Handle | Task State | Priority | Stack Usage  | Event Object             | Runtime       |
| 1                    | task_one  | 0x1fffecc8  | Blocked    | 1 (1)    | 0 B / 880 B  | MyCountingSemaphore (Rx) | 0x0 (0.0%)    |
| 2                    | task_two  | 0x1ffff130  | Blocked    | 2 (2)    | 0 B / 888 B  | MyCountingSemaphore (Rx) | 0x1 (0.1%)    |
| 3                    | IDLE      | 0x1ffff330  | Running    | 0 (0)    | 0 B / 296 B  |                          | 0x3e5 (99.6%) |
| 4                    | Tmr Svc   | 0x1ffff6b8  | Blocked    | 17 (17)  | 28 B / 672 B | TmrQ (Rx)                | 0x3 (0.3%)    |

## FreeRTOS kernel for MCUXpresso SDK ChangeLog

**Changelog FreeRTOS kernel for MCUXpresso SDK** All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

## [Unreleased]

### Added

- Kconfig added `CONFIG_FREERTOS_USE_CUSTOM_CONFIG_FRAGMENT` config to optionally include custom FreeRTOSConfig fragment include file `FreeRTOSConfig_frag.h`. File must be provided by application.
- Added missing Kconfig option for `configUSE_PICOLIBC_TLS`.
- Add correct header files to build when `configUSE_NEWLIB_REENTRANT` and `configUSE_PICOLIBC_TLS` is selected in config.

## [11.1.0\_rev0]

- update amazon freertos version

## [11.0.1\_rev0]

- update amazon freertos version

## [10.5.1\_rev0]

- update amazon freertos version

## [10.4.3\_rev1]

- Apply CM33 security fix from 10.4.3-LTS-Patch-2. See `rtos/freertos/freertos_kernel/History.txt`
- Apply CM33 security fix from 10.4.3-LTS-Patch-1. See `rtos/freertos/freertos_kernel/History.txt`

## [10.4.3\_rev0]

- update amazon freertos version.

## [10.4.3\_rev0]

- update amazon freertos version.

## [9.0.0\_rev3]

- New features:
  - Tickless idle mode support for Cortex-A7. Add `fsl_tickless_epit.c` and `fsl_tickless_generic.h` in `portable/IAR/ARM_CA9` folder.
  - Enabled float context saving in IAR for Cortex-A7. Added `configUSE_TASK_FPU_SUPPORT` macros. Modified `port.c` and `portmacro.h` in `portable/IAR/ARM_CA9` folder.
- Other changes:
  - Transformed ARM\_CM core specific tickless low power support into generic form under `freertos/Source/portable/low_power_tickless/`.

### [9.0.0\_rev2]

- New features:
  - Enabled MCUXpresso thread aware debugging. Add `freertos_tasks_c_additions.h` and `configINCLUDE_FREERTOS_TASK_C_ADDITIONS_H` and `configFREERTOS_MEMORY_SCHEME` macros.

### [9.0.0\_rev1]

- New features:
  - Enabled `-flto` optimization in GCC by adding `attribute((used))` for `vTaskSwitchContext`.
  - Enabled KDS Task Aware Debugger. Apply FreeRTOS patch to enable `configRECORD_STACK_HIGH_ADDRESS` macro. Modified files are `task.c` and `FreeRTOS.h`.

### [9.0.0\_rev0]

- New features:
  - Example `freertos_sem_static`.
  - Static allocation support RTOS driver wrappers.
- Other changes:
  - Tickless idle rework. Support for different timers is in separated files (`fsl_tickless_systick.c`, `fsl_tickless_lptmr.c`).
  - Removed configuration option `configSYSTICK_USE_LOW_POWER_TIMER`. Low power timer is now selected by linking of appropriate file `fsl_tickless_lptmr.c`.
  - Removed `configOVERRIDE_DEFAULT_TICK_CONFIGURATION` in RVDS port. Use of `attribute((weak))` is the preferred solution. Not same as `_weak`!

### [8.2.3]

- New features:
  - Tickless idle mode support.
  - Added template application for Kinetis Expert (KEx) tool (`template_application`).
- Other changes:
  - Folder structure reduction. Keep only Kinetis related parts.

## FreeRTOS kernel Readme

**MCUXpresso SDK: FreeRTOS kernel** This repository is a fork of FreeRTOS kernel (<https://github.com/FreeRTOS/FreeRTOS-Kernel>)(11.1.0). Modifications have been made to adapt to NXP MCUXpresso SDK. `CMakeLists.txt` and `Kconfig` added to enable FreeRTOS kernel repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository `mcuxsdk-manifests`(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

For more information about the FreeRTOS kernel repo adoption see [README\\_mcuxsdk.md: FreeRTOS kernel for MCUXpresso SDK Readme](#) document.



**Getting started** This repository contains FreeRTOS kernel source/header files and kernel ports only. This repository is referenced as a submodule in [FreeRTOS/FreeRTOS](#) repository, which contains pre-configured demo application projects under [FreeRTOS/Demo](#) directory.

The easiest way to use FreeRTOS is to start with one of the pre-configured demo application projects. That way you will have the correct FreeRTOS source files included, and the correct include paths configured. Once a demo application is building and executing you can remove the demo application files, and start to add in your own application source files. See the [FreeRTOS Kernel Quick Start Guide](#) for detailed instructions and other useful links.

Additionally, for FreeRTOS kernel feature information refer to the [Developer Documentation](#), and [API Reference](#).

Also for contributing and creating a Pull Request please refer to *the instructions here*.

**Getting help** If you have any questions or need assistance troubleshooting your FreeRTOS project, we have an active community that can help on the [FreeRTOS Community Support Forum](#).

## To consume FreeRTOS-Kernel

**Consume with CMake** If using CMake, it is recommended to use this repository using FetchContent. Add the following into your project's main or a subdirectory's CMakeLists.txt:

- Define the source and version/tag you want to use:

```
FetchContent_Declare(freertos_kernel
 GIT_REPOSITORY https://github.com/FreeRTOS/FreeRTOS-Kernel.git
 GIT_TAG main #Note: Best practice to use specific git-hash or tagged version
)
```

In case you prefer to add it as a git submodule, do:

```
git submodule add https://github.com/FreeRTOS/FreeRTOS-Kernel.git <path of the submodule>
git submodule update --init
```

- Add a freertos\_config library (typically an INTERFACE library) The following assumes the directory structure:

– include/FreeRTOSConfig.h

```
add_library(freertos_config INTERFACE)

target_include_directories(freertos_config SYSTEM
INTERFACE
 include
)

target_compile_definitions(freertos_config
INTERFACE
 projCOVERAGE_TEST=0
)
```

In case you installed FreeRTOS-Kernel as a submodule, you will have to add it as a subdirectory:

```
add_subdirectory(${FREERTOS_PATH})
```

- Configure the FreeRTOS-Kernel and make it available
  - this particular example supports a native and cross-compiled build option.



```
set(FREERTOS_HEAP "4" CACHE STRING "" FORCE)
Select the native compile PORT
set(FREERTOS_PORT "GCC_POSIX" CACHE STRING "" FORCE)
Select the cross-compile PORT
if (CMAKE_CROSSCOMPILING)
 set(FREERTOS_PORT "GCC_ARM_CA9" CACHE STRING "" FORCE)
endif()

FetchContent_MakeAvailable(freertos_kernel)
```

- In case of cross compilation, you should also add the following to `freertos_config`:

```
target_compile_definitions(freertos_config INTERFACE ${definitions})
target_compile_options(freertos_config INTERFACE ${options})
```

### Consuming stand-alone - Cloning this repository

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/FreeRTOS-Kernel.git
```

Using SSH:

```
git clone git@github.com:FreeRTOS/FreeRTOS-Kernel.git
```

### Repository structure

- The root of this repository contains the three files that are common to every port - `list.c`, `queue.c` and `tasks.c`. The kernel is contained within these three files. `croutine.c` implements the optional co-routine functionality - which is normally only used on very memory limited systems.
- The `./portable` directory contains the files that are specific to a particular microcontroller and/or compiler. See the readme file in the `./portable` directory for more information.
- The `./include` directory contains the real time kernel header files.
- The `./template_configuration` directory contains a sample `FreeRTOSConfig.h` to help jumpstart a new project. See the *FreeRTOSConfig.h* file for instructions.

**Code Formatting** FreeRTOS files are formatted using the “`uncrustify`” tool. The configuration file used by `uncrustify` can be found in the [FreeRTOS/CI-CD-GitHub-Actions's uncrustify.cfg](#) file.

**Line Endings** File checked into the FreeRTOS-Kernel repository use unix-style LF line endings for the best compatibility with git.

For optimal compatibility with Microsoft Windows tools, it is best to enable the git `autocrlf` feature. You can enable this setting for the current repository using the following command:

```
git config core.autocrlf true
```

**Git History Optimizations** Some commits in this repository perform large refactors which touch many lines and lead to unwanted behavior when using the `git blame` command. You can configure git to ignore the list of large refactor commits in this repository with the following command:

```
git config blame.ignoreRevsFile .git-blame-ignore-revs
```

**Spelling and Formatting** We recommend using [Visual Studio Code](#), commonly referred to as VSCode, when working on the FreeRTOS-Kernel. The FreeRTOS-Kernel also uses [cSpell](#) as part of its spelling check. The config file for which can be found at [cspell.config.yaml](#). There is additionally a [cSpell plugin for VSCode](#) that can be used as well. [.cSpellWords.txt](#) contains words that are not traditionally found in an English dictionary. It is used by the spellchecker to verify the various jargon, variable names, and other odd words used in the FreeRTOS code base are correct. If your pull request fails to pass the spelling and you believe this is a mistake, then add the word to [.cSpellWords.txt](#). When adding a word please then sort the list, which can be done by running the bash command: `sort -u .cSpellWords.txt -o .cSpellWords.txt`. Note that only the FreeRTOS-Kernel Source Files, *include*, *portable/MemMang*, and *portable/Common* files are checked for proper spelling, and formatting at this time.

### 4.1.2 FreeRTOS drivers

This is set of NXP provided FreeRTOS reentrant bus drivers.

### 4.1.3 backoffalgorithm

Algorithm for calculating exponential backoff with jitter for network retry attempts.

#### Readme

**MCUXpresso SDK: backoffAlgorithm Library** This repository is a fork of backoffAlgorithm library (<https://github.com/FreeRTOS/backoffalgorithm>)(1.3.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable backoffAlgorithm repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk-manifests](https://github.com/nxp-mcuxpresso/mcuxsdk-manifests)(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**backoffAlgorithm Library** This repository contains the backoffAlgorithm library, a utility library to calculate backoff period using an exponential backoff with jitter algorithm for retrying network operations (like failed network connection with server). This library uses the “Full Jitter” strategy for the exponential backoff with jitter algorithm. More information about the algorithm can be seen in the [Exponential Backoff and Jitter](#) AWS blog.

The backoffAlgorithm library is distributed under the *MIT Open Source License*.

Exponential backoff with jitter is typically used when retrying a failed network connection or operation request with the server. An exponential backoff with jitter helps to mitigate failed network operations with servers, that are caused due to network congestion or high request load on the server, by spreading out retry requests across multiple devices attempting network operations. Besides, in an environment with poor connectivity, a client can get disconnected at any time. A backoff strategy helps the client to conserve battery by not repeatedly attempting reconnections when they are unlikely to succeed.

See memory requirements for this library [here](#).

**backoffAlgorithm v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**backoffAlgorithm v1.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

**Reference example** The example below shows how to use the backoffAlgorithm library on a POSIX platform to retry a DNS resolution query for amazon.com.

```
#include "backoff_algorithm.h"
#include <stdlib.h>
#include <string.h>
#include <netdb.h>
#include <unistd.h>
#include <time.h>

/* The maximum number of retries for the example code. */
#define RETRY_MAX_ATTEMPTS (5U)

/* The maximum back-off delay (in milliseconds) for between retries in the example. */
#define RETRY_MAX_BACKOFF_DELAY_MS (5000U)

/* The base back-off delay (in milliseconds) for retry configuration in the example. */
#define RETRY_BACKOFF_BASE_MS (500U)

int main()
{
 /* Variables used in this example. */
 BackoffAlgorithmStatus_t retryStatus = BackoffAlgorithmSuccess;
 BackoffAlgorithmContext_t retryParams;
 char serverAddress[] = "amazon.com";
 uint16_t nextRetryBackoff = 0;

 int32_t dnsStatus = -1;
 struct addrinfo hints;
 struct addrinfo ** pListHead = NULL;
 struct timespec tp;

 /* Add hints to retrieve only TCP sockets in getaddrinfo. */
 (void) memset(&hints, 0, sizeof(hints));

 /* Address family of either IPv4 or IPv6. */
 hints.ai_family = AF_UNSPEC;
 /* TCP Socket. */
 hints.ai_socktype = (int32_t) SOCK_STREAM;
 hints.ai_protocol = IPPROTO_TCP;

 /* Initialize reconnect attempts and interval. */
 BackoffAlgorithm_InitializeParams(&retryParams,
 RETRY_BACKOFF_BASE_MS,
 RETRY_MAX_BACKOFF_DELAY_MS,
 RETRY_MAX_ATTEMPTS);

 /* Seed the pseudo random number generator used in this example (with call to
 * rand() function provided by ISO C standard library) for use in backoff period
 * calculation when retrying failed DNS resolution. */

 /* Get current time to seed pseudo random number generator. */
 (void) clock_gettime(CLOCK_REALTIME, &tp);
 /* Seed pseudo random number generator with seconds. */
 srand(tp.tv_sec);

 do
 {
 /* Perform a DNS lookup on the given host name. */
 dnsStatus = getaddrinfo(serverAddress, NULL, &hints, pListHead);
 }
```

(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                                                       |
|----------------------------------------------------------------|
| <a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a> |

Note that the latest included version of coreHTTP may differ across repositories.

**Generating Documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

**Contributing** See *CONTRIBUTING.md* for information on contributing.

## 4.1.5 corejson

JSON parser.

### Readme

**MCUXpresso SDK: coreJSON Library** This repository is a fork of coreJSON library (<https://github.com/FreeRTOS/corejson>)(3.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreJSON repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**coreJSON Library** This repository contains the coreJSON library, a parser that strictly enforces the ECMA-404 JSON standard and is suitable for low memory footprint embedded devices. The coreJSON library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

**coreJSON v3.2.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**coreJSON v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

### Reference example



```

#include <stdio.h>
#include "core_json.h"

int main()
{
 // Variables used in this example.
 JSONStatus_t result;
 char buffer[] = "{\"foo\":\"abc\", \"bar\":{\"foo\":\"xyz\"}}";
 size_t bufferLength = sizeof(buffer) - 1;
 char queryKey[] = "bar.foo";
 size_t queryKeyLength = sizeof(queryKey) - 1;
 char * value;
 size_t valueLength;

 // Calling JSON_Validate() is not necessary if the document is guaranteed to be valid.
 result = JSON_Validate(buffer, bufferLength);

 if(result == JSONSuccess)
 {
 result = JSON_Search(buffer, bufferLength, queryKey, queryKeyLength,
 &value, &valueLength);
 }

 if(result == JSONSuccess)
 {
 // The pointer "value" will point to a location in the "buffer".
 char save = value[valueLength];
 // After saving the character, set it to a null byte for printing.
 value[valueLength] = '\0';
 // "Found: bar.foo -> xyz" will be printed.
 printf("Found: %s -> %s\n", queryKey, value);
 // Restore the original character.
 value[valueLength] = save;
 }

 return 0;
}

```

A search may descend through nested objects when the queryKey contains matching key strings joined by a separator, .. In the example above, bar has the value { "foo": "xyz" }. Therefore, a search for query key bar.foo would output xyz.

**Building coreJSON** A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses 2 header files introduced in ISO C99, *stdbool.h* and *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h* respectively.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/core_json.c -o example
./example
```

*gcc* can also produce an output file to be linked:

```
gcc -I source/include -c source/core_json.c
```

## Documentation



**Existing documentation** For pre-generated documentation, please see the documentation linked in the locations below:

| Location                                                       |
|----------------------------------------------------------------|
| <a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a> |

Note that the latest included version of the coreJSON library may differ across repositories.

**Generating documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

## Building unit tests

**Checkout Unity Submodule** By default, the submodules in this repository are configured with `update=none` in `.gitmodules`, to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/Unity
```

## Platform Prerequisites

- For running unit tests
  - C90 compiler like gcc
  - CMake 3.13.0 or later
  - Ruby 2.0.0 or later is additionally required for the Unity test framework (that we use).
- For running the coverage target, gcov is additionally required.

## Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described [above](#).)
2. Create build directory: `mkdir build && cd build`
3. Run `cmake` while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

**CBMC** To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

**Contributing** See *CONTRIBUTING.md* for information on contributing.

### 4.1.6 coremqtt

MQTT publish/subscribe messaging library.

#### MCUXpresso SDK: coreMQTT Library

This repository is a fork of coreMQTT library (<https://github.com/FreeRTOS/coremqtt>)(2.1.1). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

#### coreMQTT Client Library

This repository contains the coreMQTT library that has been optimized for a low memory footprint. The coreMQTT library is compliant with the [MQTT 3.1.1](#) standard. It has no dependencies on any additional libraries other than the standard C library, a customer-implemented network transport interface, and *optionally* a user-implemented platform time function. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

**coreMQTT v2.1.1 source code is part of the FreeRTOS 20210.01 LTS release.**

**MQTT Config File** The MQTT client library exposes build configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *core\_mqtt\_config\_defaults.h*. To provide custom values for the configuration macros, a custom config file named *core\_mqtt\_config.h* can be provided by the application to the library.

By default, a *core\_mqtt\_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `MQTT_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

**Thus, the MQTT library can be built by either:**

- Defining a *core\_mqtt\_config.h* file in the application, and adding it to the include directories list of the library
- OR**
- Defining the `MQTT_DO_NOT_USE_CUSTOM_CONFIG` preprocessor macro for the library build.

**Sending metrics to AWS IoT** When establishing a connection with AWS IoT, users can optionally report the Operating System, Hardware Platform and MQTT client version information of their device to AWS. This information can help AWS IoT provide faster issue resolution and technical support. If users want to report this information, they can send a specially formatted string (see below) in the username field of the MQTT CONNECT packet.

#### Format

The format of the username string with metrics is:

```
<Actual_Username>?SDK=<OS_Name>&Version=<OS_Version>&Platform=<Hardware_Platform>&MQTTLib=<MQTT_Library_name>@<MQTT_Library_version>
```

#### Where

- <Actual\_Username> is the actual username used for authentication, if username and password are used for authentication. When username and password based authentication is not used, this is an empty value.
- <OS\_Name> is the Operating System the application is running on (e.g. FreeRTOS)
- <OS\_Version> is the version number of the Operating System (e.g. V10.4.3)
- <Hardware\_Platform> is the Hardware Platform the application is running on (e.g. WinSim)
- <MQTT\_Library\_name> is the MQTT Client library being used (e.g. coreMQTT)
- <MQTT\_Library\_version> is the version of the MQTT Client library being used (e.g. 1.0.2)

#### Example

- Actual\_Username = "iotuser", OS\_Name = FreeRTOS, OS\_Version = V10.4.3, Hardware\_Platform\_Name = WinSim, MQTT\_Library\_Name = coremqtt, MQTT\_Library\_version = 2.1.1. If username is not used, then "iotuser" can be removed.

```
/* Username string:
 * iotuser?SDK=FreeRTOS&Version=v10.4.3&Platform=WinSim&MQTTLib=coremqtt@2.1.1
 */

#define OS_NAME "FreeRTOS"
#define OS_VERSION "V10.4.3"
#define HARDWARE_PLATFORM_NAME "WinSim"
#define MQTT_LIB "coremqtt@2.1.1"

#define USERNAME_STRING "iotuser?SDK=" OS_NAME "&Version=" OS_VERSION "&Platform=" HARDWARE_PLATFORM_NAME "&MQTTLib=" MQTT_LIB
#define USERNAME_STRING_LENGTH ((uint16_t) (sizeof(USERNAME_STRING) - 1))

MQTTConnectInfo_t connectInfo;
connectInfo.userName = USERNAME_STRING;
connectInfo.userNameLength = USERNAME_STRING_LENGTH;
mqttStatus = MQTT_Connect(pMqttContext, &connectInfo, NULL, CONNACK_RECV_TIMEOUT_MS,
 pSessionPresent);
```

**Upgrading to v2.0.0 and above** With coreMQTT versions >=v2.0.0, there are breaking changes. Please refer to the *coreMQTT version >=v2.0.0 Migration Guide*.

**Building the Library** The *mqttFilePaths.cmake* file contains the information of all source files and the header include path required to build the MQTT library.

Additionally, the MQTT library requires two header files that are not part of the ISO C90 standard library, *stdbool.h* and *stdint.h*. For compilers that do not provide these header files, the

*source/include* directory contains the files *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h*, respectively, to provide the type definitions required by MQTT.

As mentioned in the previous section, either a custom config file (i.e. *core\_mqtt\_config.h*) OR *MQTT\_DO\_NOT\_USE\_CUSTOM\_CONFIG* macro needs to be provided to build the MQTT library.

For a CMake example of building the MQTT library with the *mqttFilePaths.cmake* file, refer to the *coverity\_analysis* library target in *test/CMakeLists.txt* file.

## Building Unit Tests

**Checkout CMock Submodule** By default, the submodules in this repository are configured with *update=none* in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

## Platform Prerequisites

- Docker

or the following:

- For running unit tests
  - **C90 compiler** like gcc
  - **CMake 3.13.0 or later**
  - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

## Steps to build Unit Tests

1. If using docker, launch the container:
  1. `docker build -t coremqtt .`
  2. `docker run -it -v "$PWD":/workspaces/coreMQTT -w /workspaces/coreMQTT coremqtt`
2. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#))
3. Run the *cmake* command: `cmake -S test -B build`
4. Run this command to build the library and unit tests: `make -C build all`
5. The generated test executables will be present in *build/bin/tests* folder.
6. Run `cd build && ctest` to execute all tests and view the test run summary.

**CBMC** To learn more about CBMC and proofs specifically, review the training material [here](#).

The *test/cbmc/proofs* directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

**Reference examples** Please refer to the demos of the MQTT client library in the following locations for reference examples on POSIX and FreeRTOS platforms:

| Platform | Location                                            | Transport Interface Implementation                 |
|----------|-----------------------------------------------------|----------------------------------------------------|
| POSIX    | <a href="#">AWS IoT Device SDK for Embedded C</a>   | POSIX sockets for TCP/IP and OpenSSL for TLS stack |
| FreeRTOS | <a href="#">FreeRTOS/FreeRTOS</a>                   | FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack  |
| FreeRTOS | <a href="#">FreeRTOS AWS Reference Integrations</a> | Based on Secure Sockets Abstraction                |

## Documentation

**Existing Documentation** For pre-generated documentation, please see the documentation linked in the locations below:

| Location                                          |
|---------------------------------------------------|
| <a href="#">AWS IoT Device SDK for Embedded C</a> |
| <a href="#">FreeRTOS.org</a>                      |

Note that the latest included version of coreMQTT may differ across repositories.

**Generating Documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

**Contributing** See *CONTRIBUTING.md* for information on contributing.

### 4.1.7 coremqtt-agent

The coreMQTT Agent library is a high level API that adds thread safety to the coreMQTT library.

## Readme

**MCUXpresso SDK: coreMQTT Agent Library** This repository is a fork of coreMQTT Agent library (<https://github.com/FreeRTOS/coremqtt-agent>)(1.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT Agent repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**coreMQTT Agent Library** The coreMQTT Agent library is a high level API that adds thread safety to the [coreMQTT](#) library. The library provides thread safe equivalents to the coreMQTT's APIs, greatly simplifying its use in multi-threaded environments. The coreMQTT Agent library manages the MQTT connection by serializing the access to the coreMQTT library and reducing implementation overhead (e.g., removing the need for the application to repeatedly call to MQTT\_ProcessLoop). This allows your multi-threaded applications to share the same MQTT connection, and enables you to design an embedded application without having to worry about coreMQTT thread safety.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

**Cloning this repository** This repo uses [Git Submodules](#) to bring in dependent components.

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

Using SSH:

```
git clone git@github.com:FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

If you have downloaded the repo without using the `--recurse-submodules` argument, you need to run:

```
git submodule update --init --recursive
```

**coreMQTT Agent Library Configurations** The MQTT Agent library uses the same `core_mqtt_config.h` configuration file as coreMQTT, with the addition of configuration constants listed at the top of `core_mqtt_agent.h` and `core_mqtt_agent_command_functions.h`. Documentation for these configurations can be found [here](#).

To provide values for these configuration values, they must be either:

- Defined in `core_mqtt_config.h` used by coreMQTT **OR**
- Passed as compile time preprocessor macros

**Porting the coreMQTT Agent Library** In order to use the MQTT Agent library on a platform, you need to supply thread safe functions for the agent's *messaging interface*.

**Messaging Interface** Each of the following functions must be thread safe.

| Function Pointer          | Description                                                                                                                                                                                                                                                                   |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MQTTAgentMessageSend_t    | A function that sends commands (as MQTTAgentCommand_t * pointers) to be received by MQTTAgent_CommandLoop. This can be implemented by pushing to a thread safe queue.                                                                                                         |
| MQTTAgentMessageRecv_t    | A function used by MQTTAgent_CommandLoop to receive MQTTAgentCommand_t * pointers that were sent by API functions. This can be implemented by receiving from a thread safe queue.                                                                                             |
| MQTTAgentCommandGet_t     | A function that returns a pointer to an allocated MQTTAgentCommand_t structure, which is used to hold information and arguments for a command to be executed in MQTTAgent_CommandLoop(). If using dynamic memory, this can be implemented using malloc().                     |
| MQTTAgentCommandRelease_t | A function called to indicate that a command structure that had been allocated with the MQTTAgentCommandGet_t function pointer will no longer be used by the agent, so it may be freed or marked as not in use. If using dynamic memory, this can be implemented with free(). |

Reference implementations for the interface functions can be found in the [reference examples](#) below.

### Additional Considerations

**Static Memory** If only static allocation is used, then the MQTTAgentCommandGet\_t and MQTTAgentCommandRelease\_t could instead be implemented with a pool of MQTTAgentCommand\_t structures, with a queue or semaphore used to control access and provide thread safety. The below [reference examples](#) use static memory with a command pool.

**Subscription Management** The MQTT Agent does not track subscriptions for MQTT topics. The receipt of any incoming PUBLISH packet will result in the invocation of a single MQTTAgentIncomingPublishCallback\_t callback, which is passed to MQTTAgent\_Init() for initialization. If it is desired for different handlers to be invoked for different incoming topics, then the publish callback will have to manage subscriptions and fan out messages. A platform independent subscription manager example is implemented in the [reference examples](#) below.

**Building the Library** You can build the MQTT Agent source files that are in the *source* directory, and add *source/include* to your compiler's include path. Additionally, the MQTT Agent library requires the coreMQTT library, whose files follow the same *source/* and *source/include* pattern as the agent library; its build instructions can be found [here](#).

If using CMake, the *mqttAgentFilePaths.cmake* file contains the above information of the source files and the header include path from this repository. The same information is found for coreMQTT from *mqttFilePaths.cmake* in the *coreMQTT submodule*.

For a CMake example of building the MQTT Agent library with the *mqttAgentFilePaths.cmake* file, refer to the *coverity\_analysis* library target in *test/CMakeLists.txt* file.

### Building Unit Tests



**Checkout CMock Submodule** To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

### Unit Test Platform Prerequisites

- For running unit tests
  - **C90 compiler** like gcc
  - **CMake 3.13.0 or later**
  - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

### Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#))
2. Run the *cmake* command: `cmake -S test -B build`
3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

**CBMC** To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

**Reference examples** Please refer to the demos of the MQTT Agent library in the following locations for reference examples on FreeRTOS platforms:

| Location                             |
|--------------------------------------|
| <a href="#">coreMQTT Agent Demos</a> |
| <a href="#">FreeRTOS/FreeRTOS</a>    |

**Documentation** The MQTT Agent API documentation can be found [here](#).

**Generating documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages yourself, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

**Getting help** You can use your Github login to get support from both the FreeRTOS community and directly from the primary FreeRTOS developers on our [active support forum](#). You can find a list of [frequently asked questions](#) [here](#).



**Contributing** See *CONTRIBUTING.md* for information on contributing.

**License** This library is licensed under the MIT License. See the *LICENSE* file.

### 4.1.8 corepkcs11

PKCS #11 key management library.

#### Readme

**MCUXpresso SDK: corePKCS11 Library** This repository is a fork of PKCS #11 key management library (<https://github.com/FreeRTOS/corePKCS11/tree/v3.5.0>)(v3.5.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable corepkcs11 repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**corePKCS11 Library** PKCS #11 is a standardized and widely used API for manipulating common cryptographic objects. It is important because the functions it specifies allow application software to use, create, modify, and delete cryptographic objects, without ever exposing those objects to the application's memory. For example, FreeRTOS AWS reference integrations use a small subset of the PKCS #11 API to, among other things, access the secret (private) key necessary to create a network connection that is authenticated and secured by the [Transport Layer Security \(TLS\)](#) protocol – without the application ever ‘seeing’ the key.

The Cryptoki or PKCS #11 standard defines a platform-independent API to manage and use cryptographic tokens. The name, “PKCS #11”, is used interchangeably to refer to the API itself and the standard which defines it.

This repository contains a software based mock implementation of the PKCS #11 interface (API) that uses the cryptographic functionality provided by Mbed TLS. Using a software mock enables rapid development and flexibility, but it is expected that the mock be replaced by an implementation specific to your chosen secure key storage in production devices.

Only a subset of the PKCS #11 standard is implemented, with a focus on operations involving asymmetric keys, random number generation, and hashing.

The targeted use cases include certificate and key management for TLS authentication and code-sign signature verification, on small embedded devices.

corePKCS11 is implemented on PKCS #11 v2.4.0, the full PKCS #11 standard can be found on the [oasis website](#).

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#) and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

**corePKCS11 v3.5.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**corePKCS11 v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

**Purpose** Generally vendors for secure cryptoprocessors such as Trusted Platform Module (TPM), Hardware Security Module (HSM), Secure Element, or any other type of secure hardware enclave, distribute a PKCS #11 implementation with the hardware. The purpose of the corePKCS11 software only mock library is therefore to provide a non hardware specific PKCS #11 implementation that allows for rapid prototyping and development before switching to a cryptoprocessor specific PKCS #11 implementation in production devices.

Since the PKCS #11 interface is defined as part of the PKCS #11 [specification](#) replacing this library with another implementation should require little porting effort, as the interface will not change. The system tests distributed in this repository can be leveraged to verify the behavior of a different implementation is similar to corePKCS11.

**corePKCS11 Configuration** The corePKCS11 library exposes preprocessor macros which must be defined prior to building the library. A list of all the configurations and their default values are defined in the doxygen documentation for this library.

## Build Prerequisites

**Library Usage** For building the library the following are required:

- **A C99 compiler**
- **mbedcrypto** library from [mbedtls](#) version 2.x or 3.x.
- **pkcs11 API header(s)** available from [OASIS](#) or [OpenSC](#)

Optionally, variables from the `pkcsFilePaths.cmake` file may be referenced if your project uses `cmake`.

**Integration and Unit Tests** In order to run the integration and unit test suites the following are dependencies are necessary:

- **C Compiler**
- **CMake 3.13.0 or later**
- **Ruby 2.0.0 or later** required by CMock.
- **Python 3** required for configuring mbedtls.
- **git** required for fetching dependencies.
- **GNU Make** or **Ninja**

The *mbedtls*, *CMock*, and *Unity* libraries are downloaded and built automatically using the `cmake` `FetchContent` feature.

**Coverage Measurement and Instrumentation** The following software is required to run the coverage target:

- Linux, MacOS, or another POSIX-like environment.
- A recent version of **GCC** or **Clang** with support for gcov-like coverage instrumentation.
- **gcov** binary corresponding to your chosen compiler
- **lcov** from the [Linux Test Project](#)
- **perl** needed to run the `lcov` utility.

Coverage builds are validated on recent versions of Ubuntu Linux.

## Running the Integration and Unit Tests

1. Navigate to the root directory of this repository in your shell.
2. Run **cmake** to construct a build tree: `cmake -S test -B build`
  - You may specify your preferred build tool by appending `-G'Unix Makefiles'` or `-GNinja` to the command above.
  - You may append `-DUNIT_TESTS=0` or `-DSYSTEM_TESTS=0` to disable Unit Tests or Integration Tests respectively.
3. Build the test binaries: `cmake --build ./build --target all`
4. Run `ctest --test-dir ./build` or `cmake --build ./build --target test` to run the tests without capturing coverage.
5. Run `cmake --build ./build --target coverage` to run the tests and capture coverage data.

**CBMC** To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

**Reference examples** The FreeRTOS-Labs repository contains demos using the PKCS #11 library [here](#) using FreeRTOS on the Windows simulator platform. These can be used as reference examples for the library API.

**Porting Guide** Documentation for porting corePKCS11 to a new platform can be found on the AWS [docs](#) web page.

corePKCS11 is not meant to be ported to projects that have a TPM, HSM, or other hardware for offloading crypto-processing. This library is specifically meant to be used for development and prototyping.

**Related Example Implementations** These projects implement the PKCS #11 interface on real hardware and have similar behavior to corePKCS11. It is preferred to use these, over corePKCS11, as they allow for offloading Cryptography to separate hardware.

- ARM's [Platform Security Architecture](#).
- Microchip's [cryptoauthlib](#).
- Infineon's [Optiga Trust X](#).

## Documentation

**Existing Documentation** For pre-generated documentation, please see the documentation linked in the locations below:

| Location                                                       |
|----------------------------------------------------------------|
| <a href="#">AWS IoT Device SDK for Embedded C FreeRTOS.org</a> |

Note that the latest included version of corePKCS11 may differ across repositories.

**Generating Documentation** The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

**Security** See *CONTRIBUTING* for more information.

**License** This library is licensed under the MIT-0 License. See the LICENSE file.

### 4.1.9 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

#### Readme

**MCUXpresso SDK: FreeRTOS-Plus-TCP Library** This repository is a fork of FreeRTOS-Plus-TCP library (<https://github.com/FreeRTOS/freertos-plus-tcp>)(4.3.3). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable FreeRTOS-Plus-TCP repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

**FreeRTOS-Plus-TCP Library** FreeRTOS-Plus-TCP is a lightweight TCP/IP stack for FreeRTOS. It provides a familiar Berkeley sockets interface, making it as simple to use and learn as possible. FreeRTOS-Plus-TCP's features and RAM footprint are fully scalable, making FreeRTOS-Plus-TCP equally applicable to smaller lower throughput microcontrollers as well as larger higher throughput microprocessors.

This library has undergone static code analysis and checks for compliance with the [MISRA coding standard](#). Any deviations from the MISRA C:2012 guidelines are documented under [MISRA Deviations](#). The library is validated for memory safety and data structure invariance through the [CBMC automated reasoning tool](#) for the functions that parse data originating from the network. The library is also protocol tested using Maxwell protocol tester for both IPv4 and IPv6.

**FreeRTOS-Plus-TCP Library V4.2.2 source code is part of the FreeRTOS 202406.01 LTS release.**

**Getting started** The easiest way to use version 4.0.0 and later of FreeRTOS-Plus-TCP is to refer the Getting started Guide (found [here](#)) Another way is to start with the pre-configured IPv4 Windows Simulator demo (found in [this directory](#)) or IPv6 Multi-endpoint Windows Simulator demo (found in [this directory](#)). That way you will have the correct FreeRTOS source files included, and the correct include paths configured. Once a demo application is building and executing you can remove the demo application files, and start to add in your own application source files. See the [FreeRTOS Kernel Quick Start Guide](#) for detailed instructions and other useful links.

Additionally, for FreeRTOS-Plus-TCP source code organization refer to the [Documentation](#), and [API Reference](#).

**Getting help** If you have any questions or need assistance troubleshooting your FreeRTOS project, we have an active community that can help on the [FreeRTOS Community Support Forum](#). Please also refer to [FAQ](#) for frequently asked questions.

Also see the [Submitting a bug/feature request](#) section of CONTRIBUTING.md for more details.

**Note:** All the remaining sections are generic and applies to all the versions from V3.0.0 onwards.

**Upgrading to V4.3.0 and above** For users of STM32 network interfaces:

Starting from version V4.3.0, the STM32 network interfaces have been consolidated into a single unified implementation located at `source/portable/NetworkInterface/STM32/NetworkInterface.c`, supporting STM32 F4, F7, and H7 series microcontrollers, with newly added support for STM32 H5. The new interface has been tested with the STM32 HAL Ethernet (ETH) drivers, available at `source/portable/NetworkInterface/STM32/Drivers`. For compatibility, the legacy interfaces (STM32Fxx and STM32Hxx) have been retained and relocated to `source/portable/NetworkInterface/STM32/Legacy`.

**Upgrading to V3.0.0 and V3.1.0** In version 3.0.0 or 3.1.0, the folder structure of FreeRTOS-Plus-TCP has changed and the files have been broken down into smaller logically separated modules. This change makes the code more modular and conducive to unit-tests. FreeRTOS-Plus-TCP V3.0.0 improves the robustness, security, and modularity of the library. Version 3.0.0 adds comprehensive unit test coverage for all lines and branches of code and has undergone protocol testing, and penetration testing by AWS Security to reduce the exposure to security vulnerabilities. Additionally, the source files have been moved to a `source` directory. This change requires modification of any existing project(s) to include the modified source files and directories.

**FreeRTOS-Plus-TCP V3.1.0 [source code\(.c .h\)](#) is part of the [FreeRTOS 20210.00 LTS](#) release.**

**Generating pre V3.0.0 folder structure for backward compatibility:** If you wish to continue using a version earlier than V3.0.0 i.e. continue to use your existing source code organization, a script is provided to generate the folder structure similar to [this](#).

**Note:** After running the script, while the `.c` files will have same names as the pre V3.0.0 source, the files in the `include` directory will have different names and the number of files will differ as well. This should, however, not pose any problems to most projects as projects generally include all files in a given directory.

Running the script to generate pre V3.0.0 folder structure: For running the script, you will need Python version > 3.7. You can download/install it from [here](#).

Once python is downloaded and installed, you can verify the version from your terminal/command window by typing `python --version`.

To run the script, you should switch to the FreeRTOS-Plus-TCP directory Then run `python <Path/to/the/script>/GenerateOriginalFiles.py`.

## To consume FreeRTOS+TCP

**Consume with CMake** If using CMake, it is recommended to use this repository using FetchContent. Add the following into your project's main or a subdirectory's `CMakeLists.txt`:

- Define the source and version/tag you want to use:

```
FetchContent_Declare(freertos_plus_tcp
 GIT_REPOSITORY https://github.com/FreeRTOS/FreeRTOS-Plus-TCP.git
 GIT_TAG main #Note: Best practice to use specific git-hash or tagged version
```

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```
GIT_SUBMODULES "" # Don't grab any submodules since not latest
)
```

- Configure the FreeRTOS-Kernel and make it available
  - this particular example supports a native and cross-compiled build option.

```
Select the native compile PORT
set(FREERTOS_PLUS_TCP_NETWORK_IF "POSIX" CACHE STRING "" FORCE)
Or: select a cross-compile PORT
if (CMAKE_CROSSCOMPILING)
 # Eg. STM32Hxx version of port
 set(FREERTOS_PLUS_TCP_NETWORK_IF "STM32HXX" CACHE STRING "" FORCE)
endif()

FetchContent_MakeAvailable(freertos_plus_tcp)
```

**Consuming stand-alone** This repository uses [Git Submodules](#) to bring in dependent components.

Note: If you download the ZIP file provided by GitHub UI, you will not get the contents of the submodules. (The ZIP file is also not a valid Git repository)

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/FreeRTOS-Plus-TCP.git ./FreeRTOS-Plus-TCP
cd ./FreeRTOS-Plus-TCP
git submodule update --checkout --init --recursive tools/CMock test/FreeRTOS-Kernel
```

Using SSH:

```
git clone git@github.com:FreeRTOS/FreeRTOS-Plus-TCP.git ./FreeRTOS-Plus-TCP
cd ./FreeRTOS-Plus-TCP
git submodule update --checkout --init --recursive tools/CMock test/FreeRTOS-Kernel
```

**Porting** The porting guide is available on [this page](#).

**Repository structure** This repository contains the FreeRTOS-Plus-TCP repository and a number of supplementary libraries for testing/PR Checks. Below is the breakdown of what each directory contains:

- tools
  - This directory contains the tools and related files (CMock/uncrustify) required to run tests/checks on the TCP source code.
- tests
  - This directory contains all the tests (unit tests and CBMC) and the dependencies ([FreeRTOS-Kernel/Litani-port](#)) the tests require.
- source/portable
  - This directory contains the portable files required to compile the FreeRTOS-Plus-TCP source code for different hardware/compilers.
- source/include
  - The include directory has all the ‘core’ header files of FreeRTOS-Plus-TCP source.
- source

- This directory contains all the [.c] source files.

**Note** At this time it is recommended to use BufferAllocation\_2.c in which case it is essential to use the heap\_4.c memory allocation scheme. See [memory management](#).

**Kernel sources** The FreeRTOS Kernel Source is in [FreeRTOS/FreeRTOS-Kernel repository](#), and it is consumed by testing/PR checks as a submodule in this repository.

The version of the FreeRTOS Kernel Source in use could be accessed at `./test/FreeRTOS-Kernel` directory.

**CBMC** The `test/cbmc/proofs` directory contains CBMC proofs.

To learn more about CBMC and proofs specifically, review the training material [here](#).

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).