



MCUXpresso SDK Documentation

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NXP
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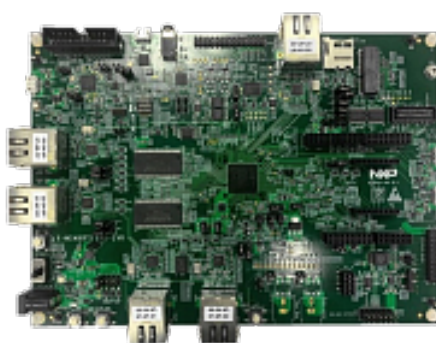
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This documentation contains information specific to the evkmimxrt1180 board.

Chapter 1

MIMXRT1180-EVK

1.1 Overview



MCU device and part on board is shown below:

- Device: MIMXRT1189
- PartNumber: MIMXRT1189CVM8B

1.2 Getting Started with MCUXpresso SDK Package

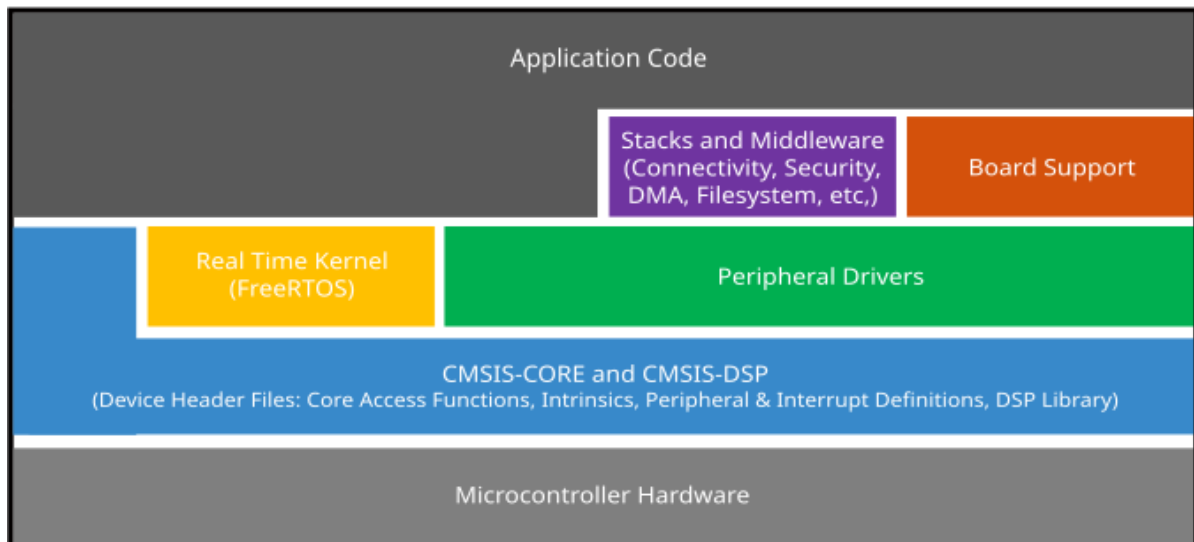
1.2.1 Getting Started with Package

Overview

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

For supported toolchain versions, see *MCUXpresso SDK Release Notes for MIMXRT1180-EVK* (document MCUXSDKMIMXRT118XKRN).

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



MCUXpresso SDK board support package folders

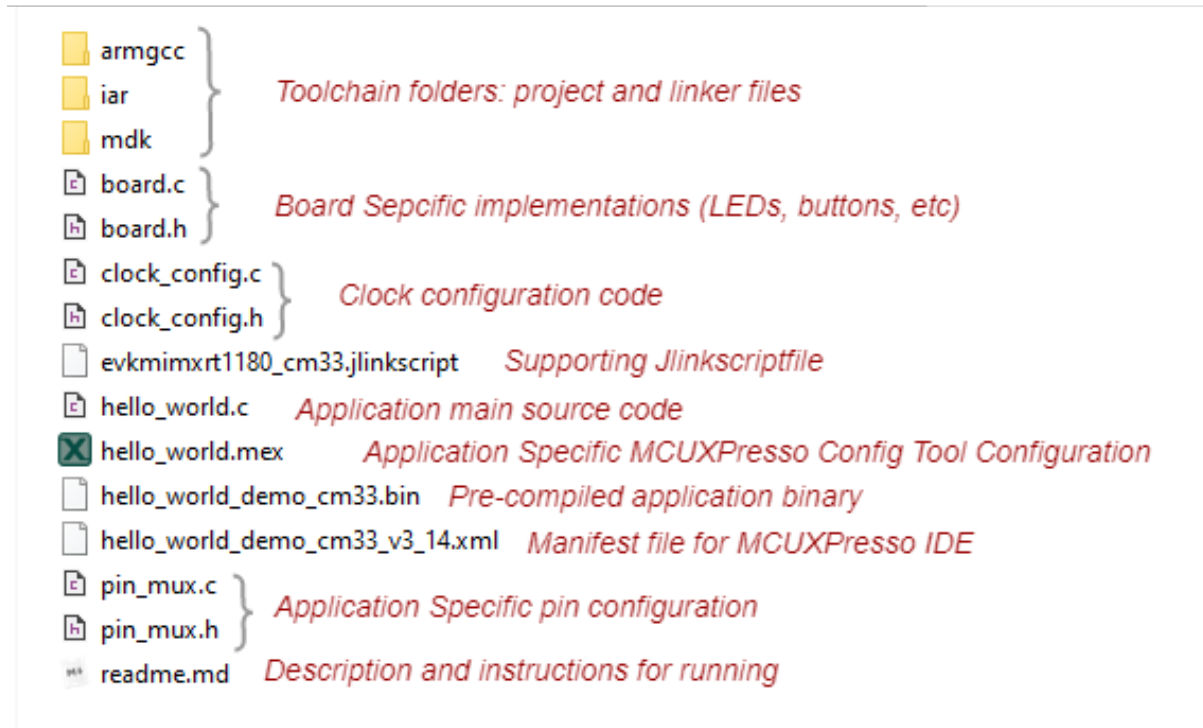
MCUXpresso SDK board support package provides example applications for NXP development and evaluation boards for Arm Cortex-M cores. Board support packages are found inside the top level boards folder and each supported board has its own folder (an MCUXpresso SDK package can support multiple boards).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

- `cmsis_driver_examples`: Simple applications intended to show how to use CMSIS drivers.
- `demo_apps`: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- `driver_examples`: Simple applications that show how to use the MCUXpresso SDK's peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI conversion using DMA).
- `rtos_examples`: Basic FreeRTOS examples that show the use of various RTOS objects (semaphores, queues, and so on) and interfaces with the MCUXpresso SDK's RTOS drivers.
- `Other_examples`: See detail in package `boards/evkmimxrt1180`.

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.

The `hello_world` application folder contains the following contents:



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

Parent topic: [MCUXpresso SDK board support package folders](#)

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

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

- devices/<device_name>: The CMSIS header file of the device, MCUXpresso SDK feature file and a few other files
- devices/<device_name>/drivers: All 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_template: Project template used in CMSIS PACK new project creation

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

Parent topic: [MCUXpresso SDK board support package folders](#)

Run a demo using MCUXpresso IDE

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 MIMXRT1180-EVK hardware platform is used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

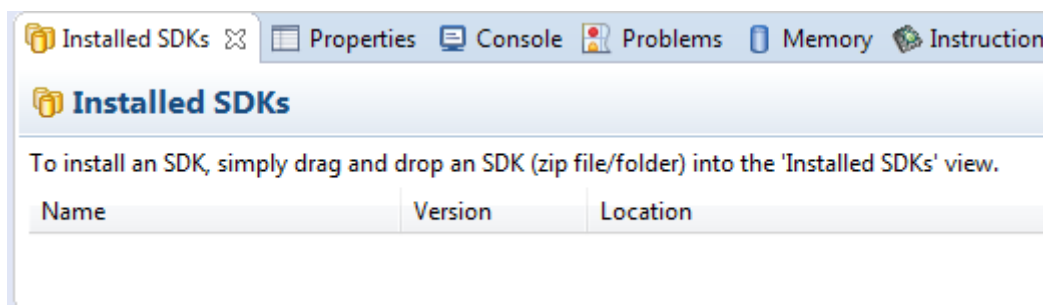
Both CMSIS-DAP and J-Link debugging interface is supported for MCUX IDE. When using CMSIS-DAP debugging interface to debug CM33, the SW5[1..4] should be put to 0100 for SPI boot mode.

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 the 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 locate outside the MCUXpresso SDK tree.

Parent topic: [Run a demo using MCUXpresso IDE](#)

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

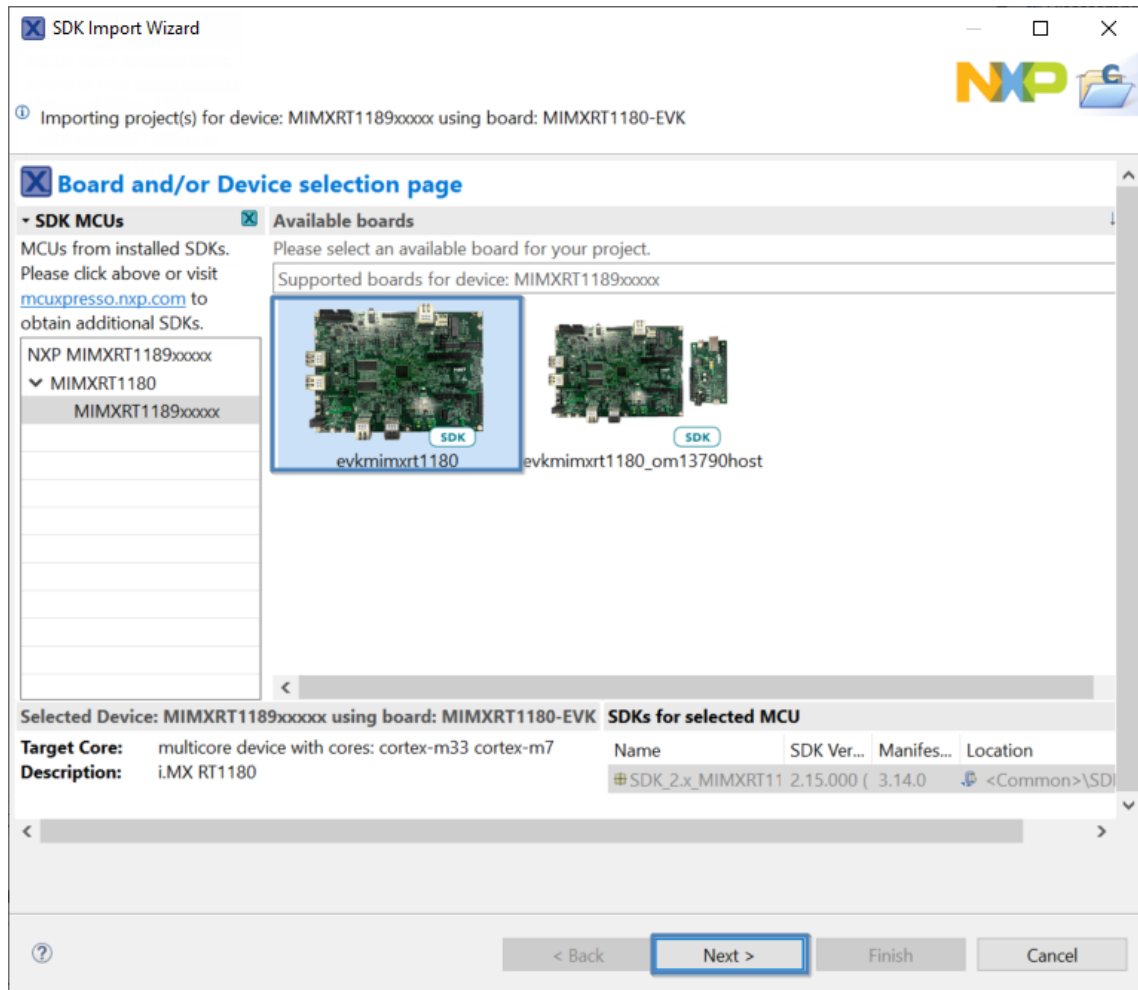
1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.



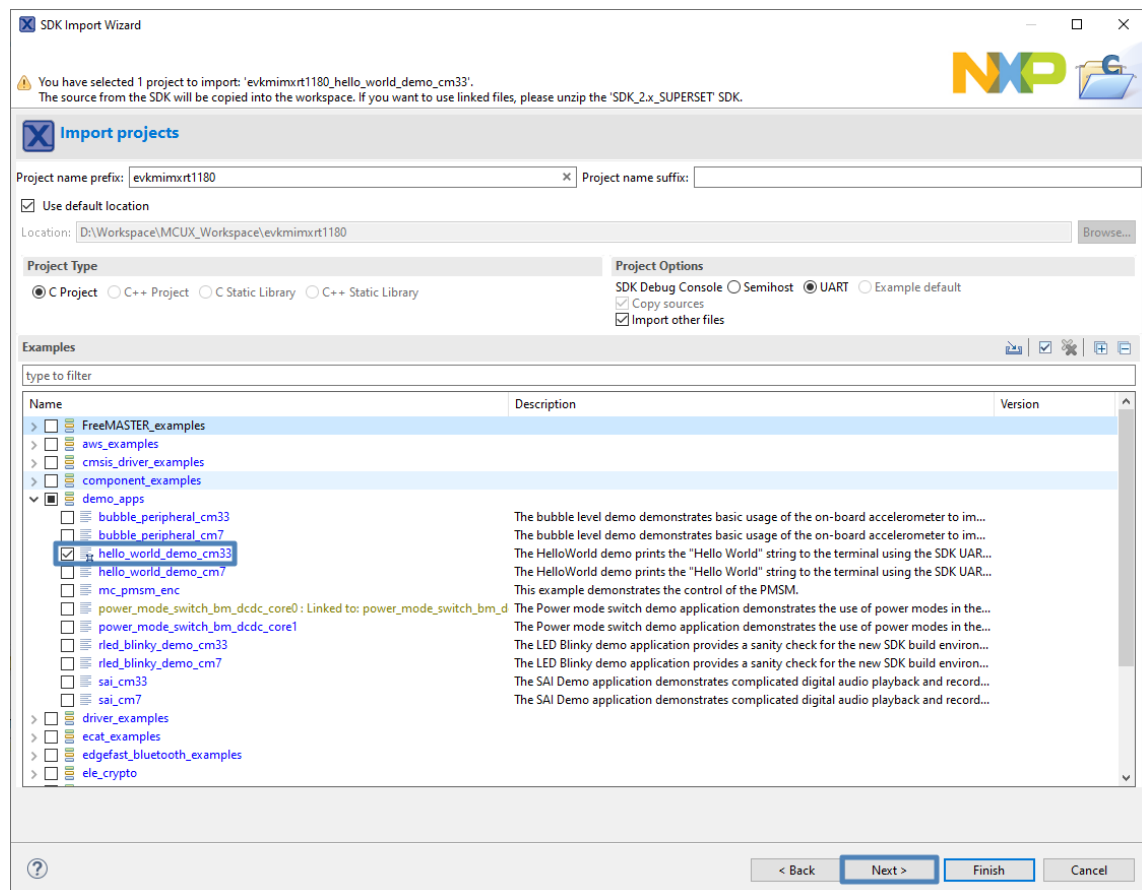
2. On the **Quickstart Panel**, click **Import SDK example(s)...**



3. In the window that appears, select **evkmimxrt1180** or **kits** and click **Next**.



4. Expand the *demo_apps* folder and select *hello_world_demo_cm33*. Then, click **Next**.

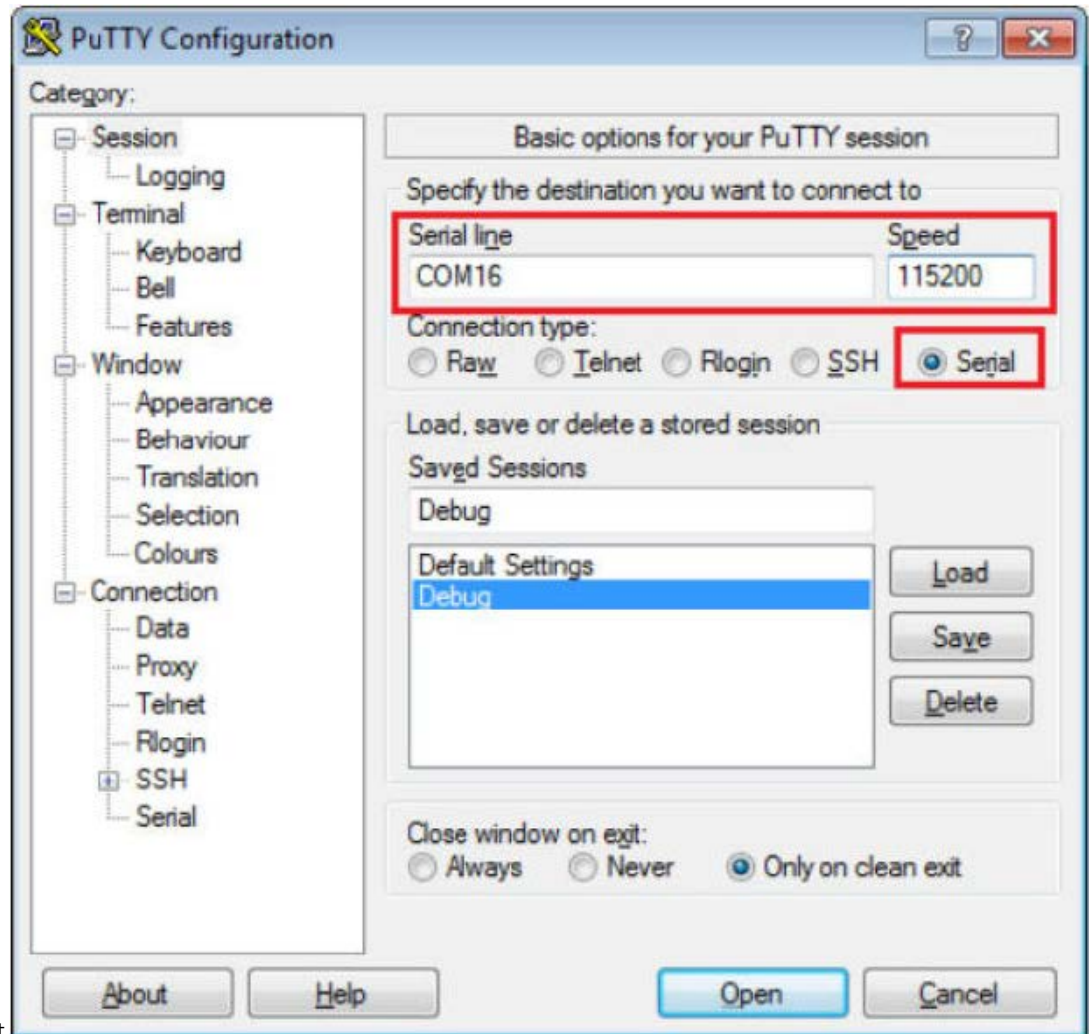


5. Click **Finish**.

Parent topic: [Run a demo using MCUXpresso IDE](#)

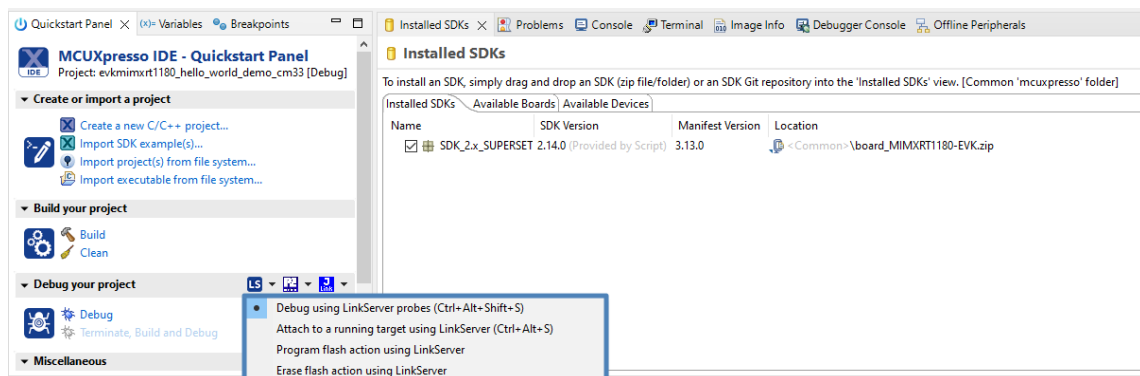
Run an example application To download and run the application, perform the following steps:

1. See [Table 1](#) to determine the debug interface that comes loaded on your specific hardware platform.
 - For EVKMIMXRT1180, LPC55S69 is used.
 - J53 is used as the debugging port which provides both debugging functionality and console out.
2. Connect USB cable between J53 on EVK and PC USB port.
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 baud rate or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the *board.h* file)
 2. No parity
 3. 8 data bits



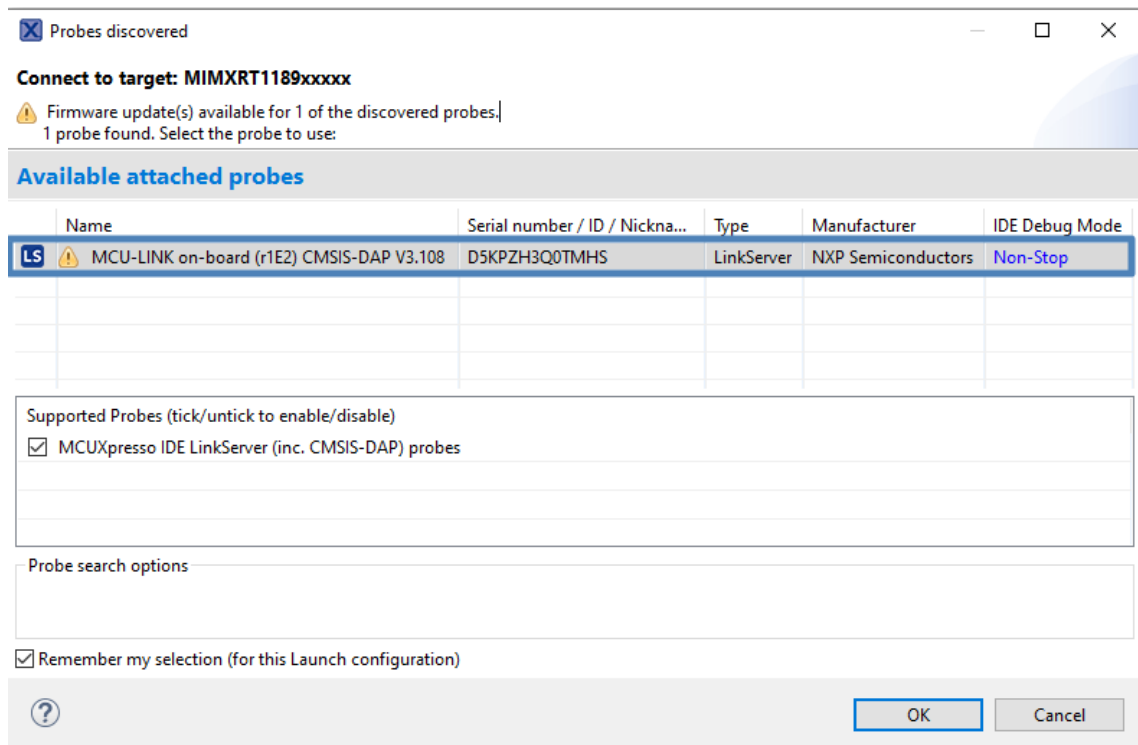
4. 1 stop bit

4. On the **Quickstart Panel**, click **Debug**.

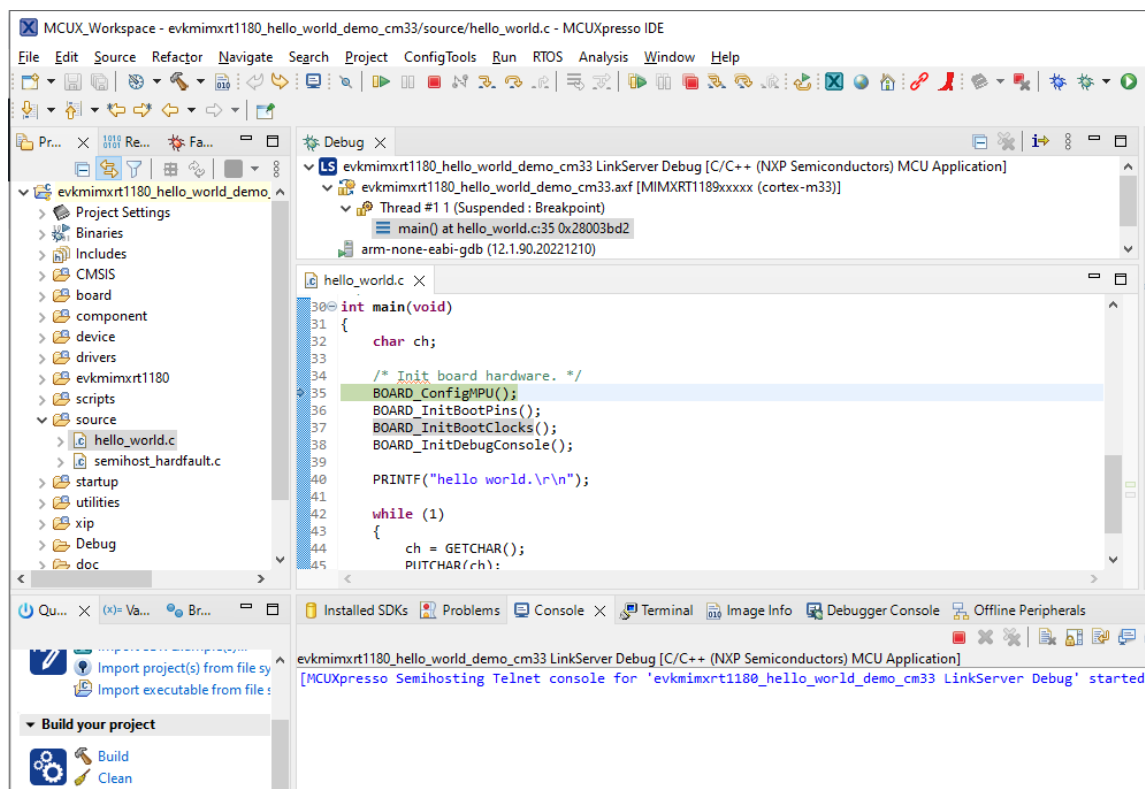


Note: Erase the flash memory before running the MCUX IDE projects for the first time. To do so, use the **Erase Flash action using LinkServer** in *Figure 2* with SW5[1..4] on 0100. In the worst case when MCUX IDE cannot erase the flash, use the secure provisioning tool. For more information, see *Use Secure Provisioning Tool to erase flash*.

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**. Here we assume that you are using a CMSIS-DAP debug interface. (For any future debug sessions, the stored probe selection is automatically used, unless the probe cannot be found.)



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

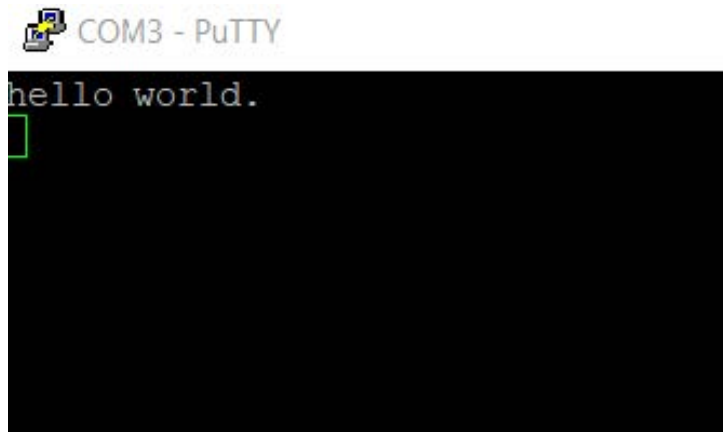


7. Start the application by clicking **Resume**.



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

check your terminal settings and connections.



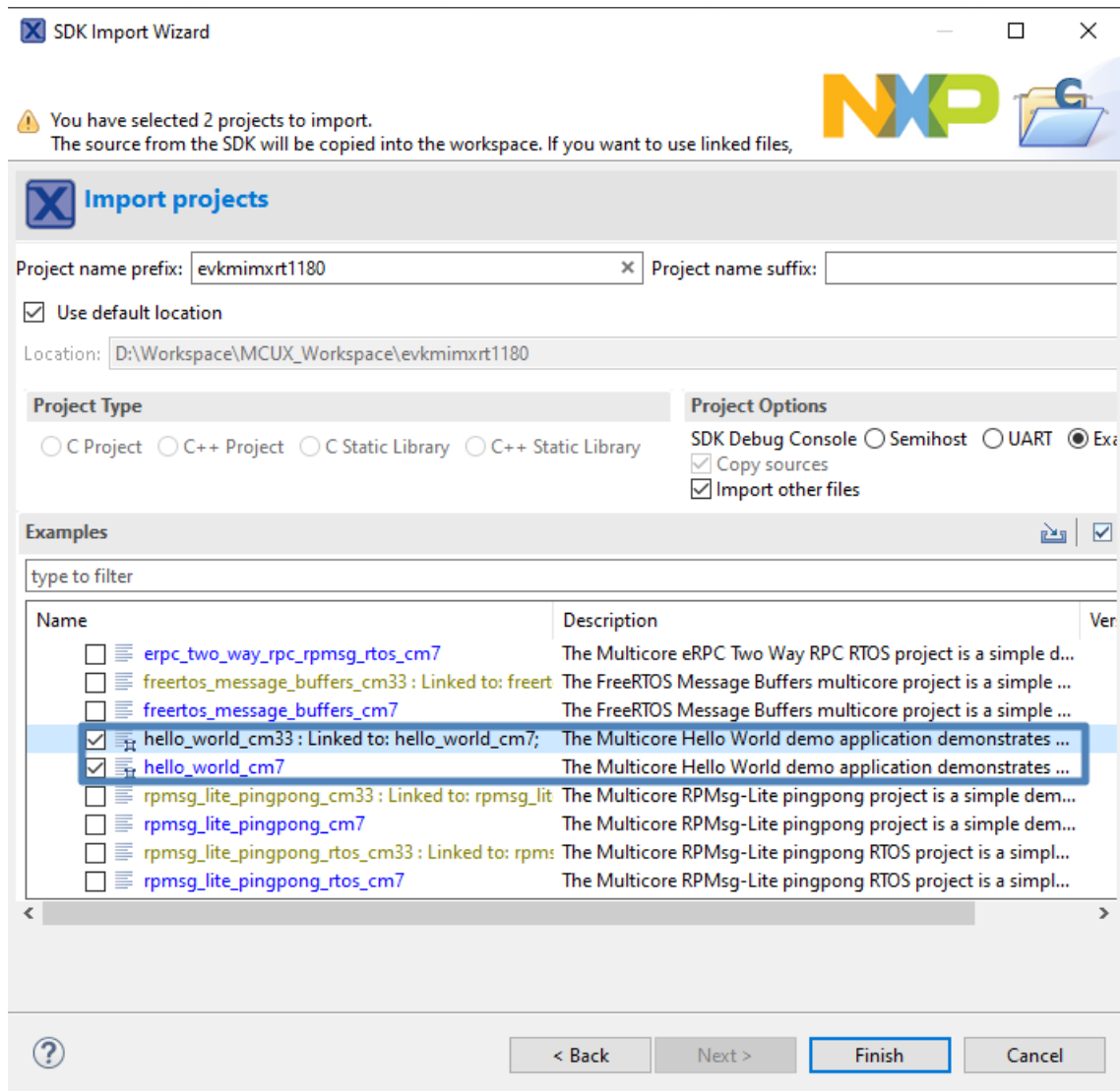
Parent topic: [Run a demo using MCUXpresso IDE](#)

Build a multicore example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of `hello_world` example application targeted for the **evkmimxrt1180** hardware platform is used as an example.

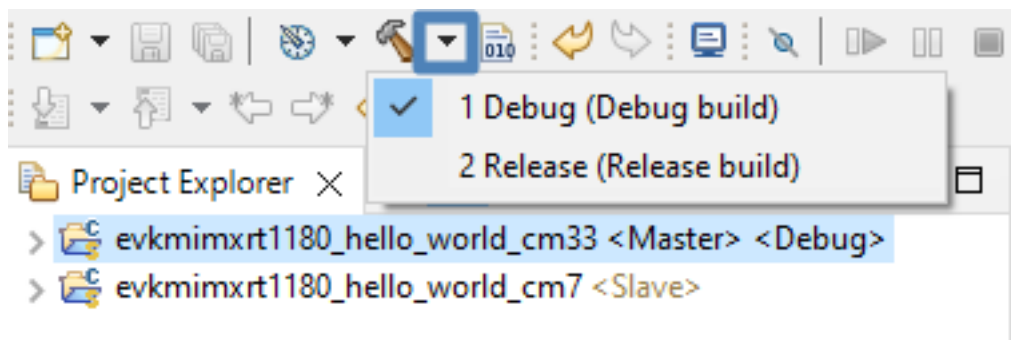
1. Multicore examples are imported into the workspace in a similar way as single core applications, explained in [Build an example application](#). When the SDK zip package for **evkmimxrt1180** is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, select **evkmimxrt1180** and click **Next**.



2. Expand the `multicore_examples` folder and select **hello_world_cm33**. The `hello_world_cm7` counterpart project is automatically imported with the `cm33` project, because the multicore examples are linked together and there is no need to select it explicitly. Click **Finish**.



- Now, two projects should be imported into the workspace. To start building the multi-core application, highlight the `hello_world_cm33` project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing arrow next to the hammer icon, as shown in Figure 3. For this example, select **Debug**.

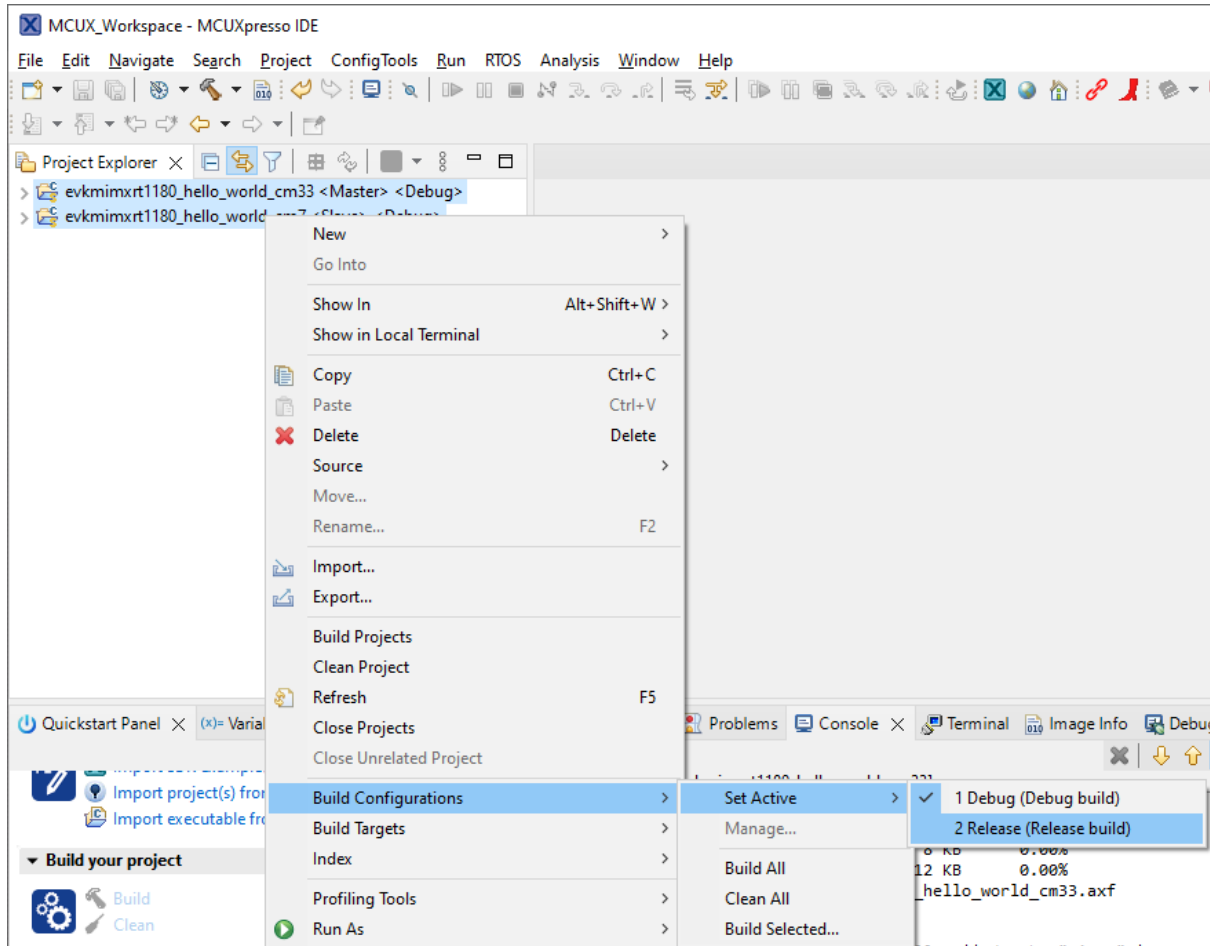


Press the **Build** button to start the multi-core project build.. Because of the project reference settings in multicore projects, triggering the build of the primary core application (cm33) also makes the referenced auxiliary core application (cm7) to build.

Note:

When the **Release** build is requested, it is necessary to change the build configuration of both

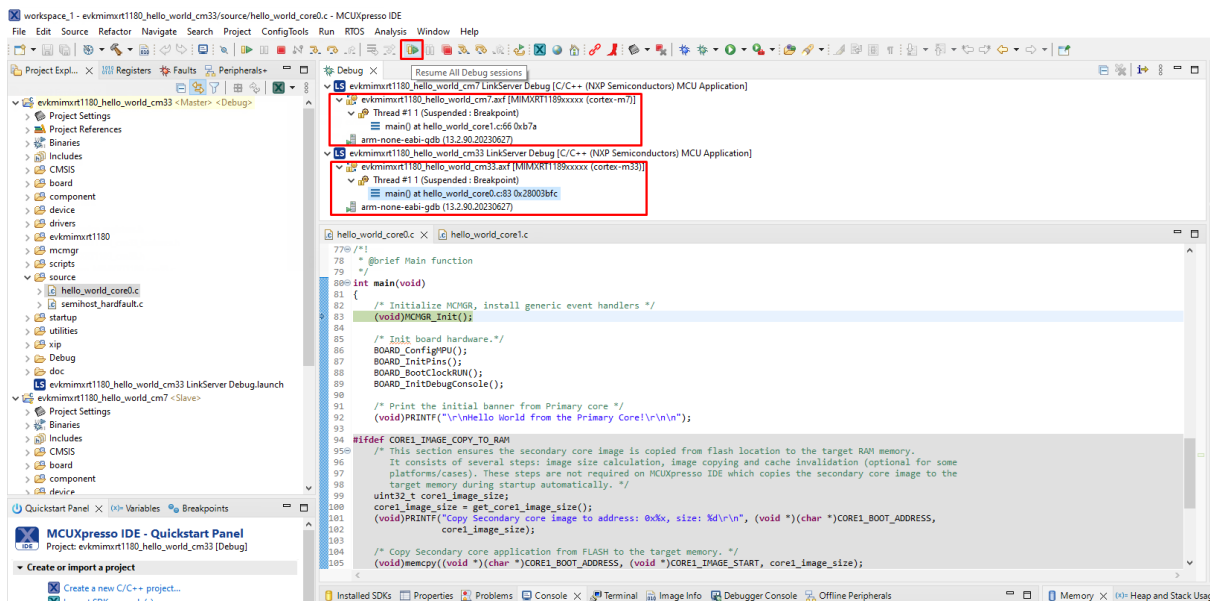
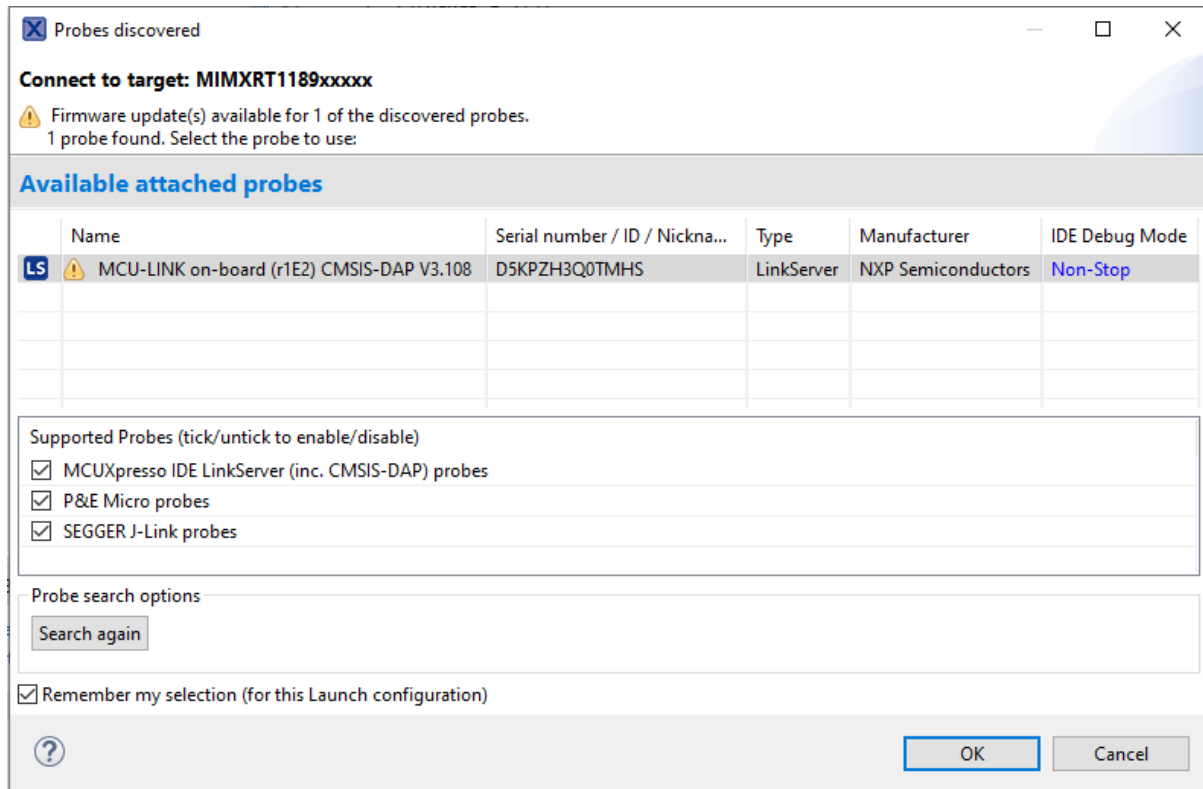
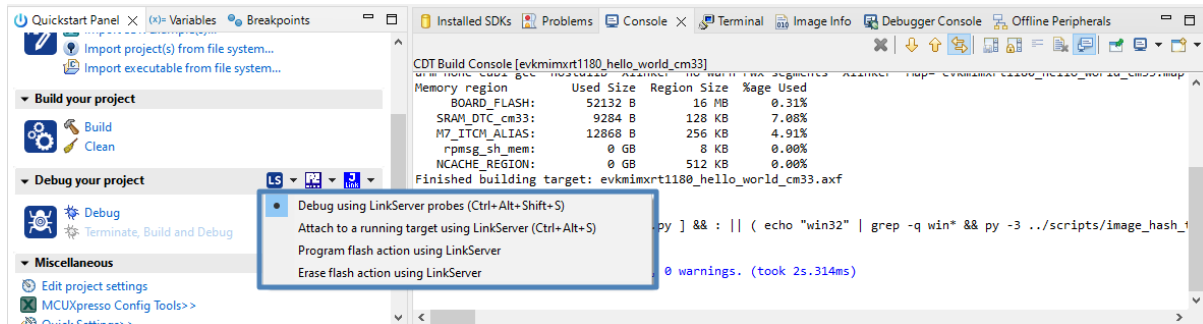
the primary and auxiliary core application projects first. To do this, select both projects in the Project Explorer view and then right click which displays the context-sensitive menu. Select **Build Configurations** -> **Set Active** -> **Release**. This alternate navigation using the menu item is **Project** -> **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 (cm33) build.



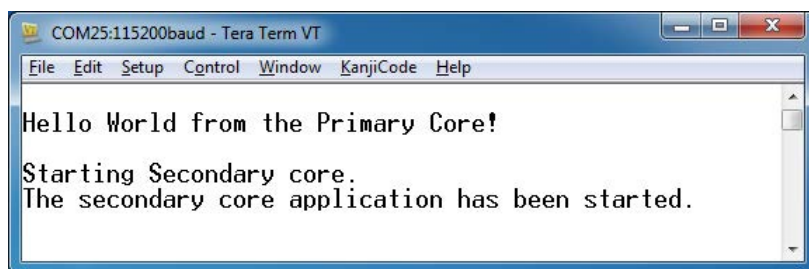
Parent topic: [Run a demo using MCUXpresso IDE](#)

Run a multicore example application The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in [Run an example application](#). These steps are common for both single-core applications and the primary side of dual-core applications, ensuring both sides of the multicore application are properly loaded and started. Select the `cm7` project and start debugging the CM7 project. Then, select the `cm33` project and start debugging the CM33 project.

See [Figure 1](#) to [Figure 3](#) for reference.



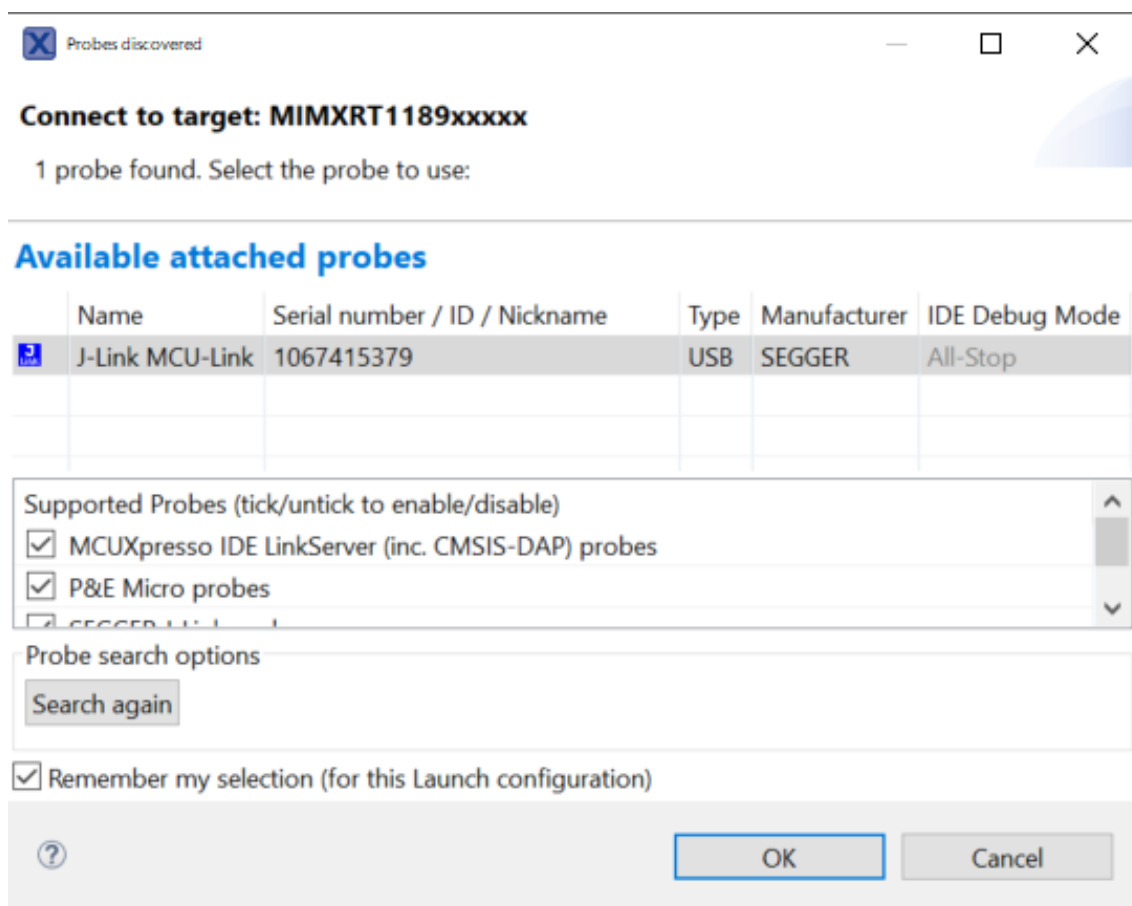
After clicking **Resume All Debug** sessions, the `hello_world` multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.



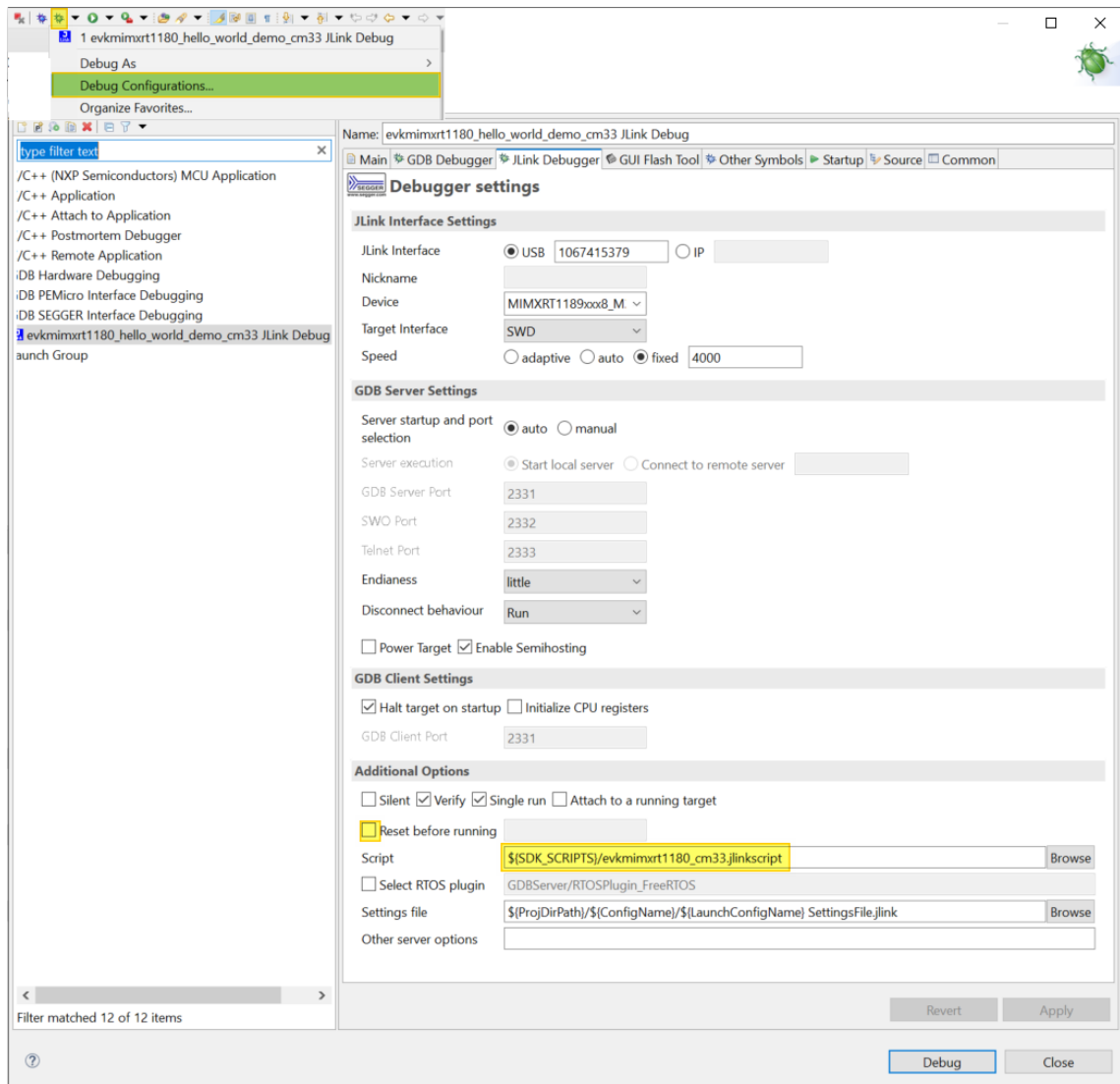
Parent topic: [Run a demo using MCUXpresso IDE](#)

Run applications via JLink Debug Interface The previous sections assume that you are using the CMSIS-DAP debugging interface for MCUXpresso IDE to do the debugging. If you are using J-Link probe as a debugging interface, the configurations are slightly different.

1. After you click the **Debug** button, the IDE shows the J-Link probe identified. Click **OK** to continue the debugging.



2. If you investigate on debug configurations, you will notice two settings, which are different from CMSIS-DAP debugging. The **Reset before running** is unchecked, and a jlinkscript is specified. This is because of the difference in CMSIS-DAP and JLink debugging implementation. The differences are pre-configured by MCUX default project settings.



3. The screenshot here shows a CM33 demo. For CM7 demo, situations are similar.

Parent topic: [Run a demo using MCUXpresso IDE](#)

Run a demo using IAR

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK. This document uses hello_world demo application targeted for the MIMXRT1180-EVK as an example. These steps can be applied to any example application in the MCUXpresso SDK.

Both CMSIS-DAP and J-Link debugging interfaces are supported for IAR IDE. Though not mandatory, it is recommended to reset board for each download/debug.

Changes on IAR debugging support after 25.03.00 Starting from 25.03.00, we make enhancement to debugging experience to make it more robust and user friendly

These changes involves debugging code update on both SDK side and IAR toolchain side. It is expected to be integrated to IAR Embedded Workbench for Arm 9.60.4.

Update to latest IAR version You can check [IAR Product Updates](#) to know when IAR Embedded Workbench for Arm 9.60.4 will be rolled out. Befor that, the following manual change is needed

inside you IAR installation directory.

Necessary Change in your IAR installation (<= 9.60.3)

1. Navigate to <iar installation directory>/arm/config/devices/NXP/i.MX/i.MXRT/, change MIMXRT1189xxx8_M33.i79 and MIMXRT1189xxx8_M7.i79, commenting out the following lines

```
// JLinkScriptFile=$TOOLKIT_DIR$/config/debugger/NXP/mimxrt1180_cm33.jlinkscript
// JLinkScriptFile=$TOOLKIT_DIR$/config/debugger/NXP/mimxrt1180_cm7.jlinkscript
```

2. Replace the following files under <iar installation directory>/arm/config/debugger/NXP with the files in <SDK root>/boards/evkmimxrt1180/dmac/iMXRT_1180.dmac

```
iMXRT_1180.dmac
iMXRT_1180_cm33.dmac
iMXRT_1180_cm7.dmac
```

Build an example application To build the hello_world demo application, perform the following steps:

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

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

Using the MIMXRT1180-EVK hardware platform as an example, the hello_world workspace is located in:

<install_dir>/boards/evkmimxrt1180/demo_apps/hello_world/cm33/iar/hello_world_demo_cm33.eww

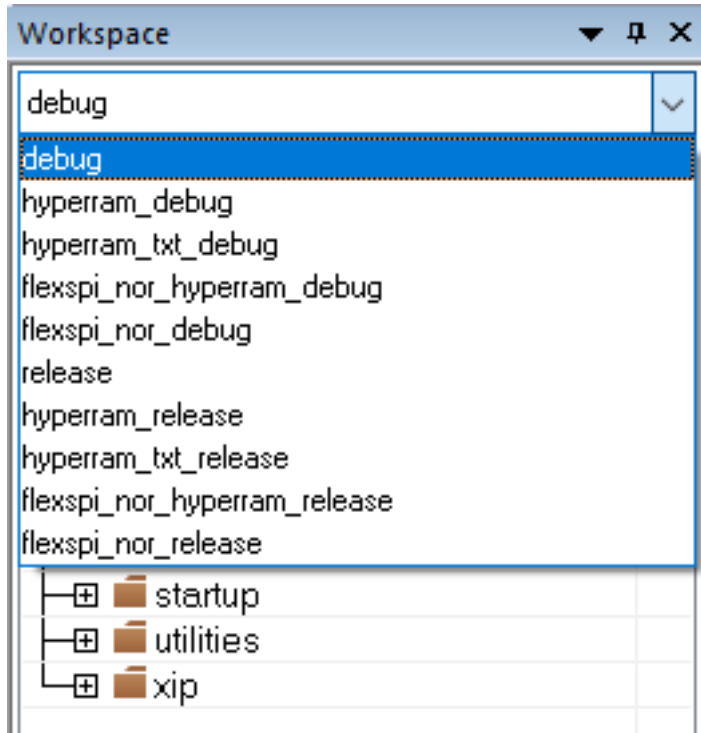
Other example applications may have additional folders in their path.

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

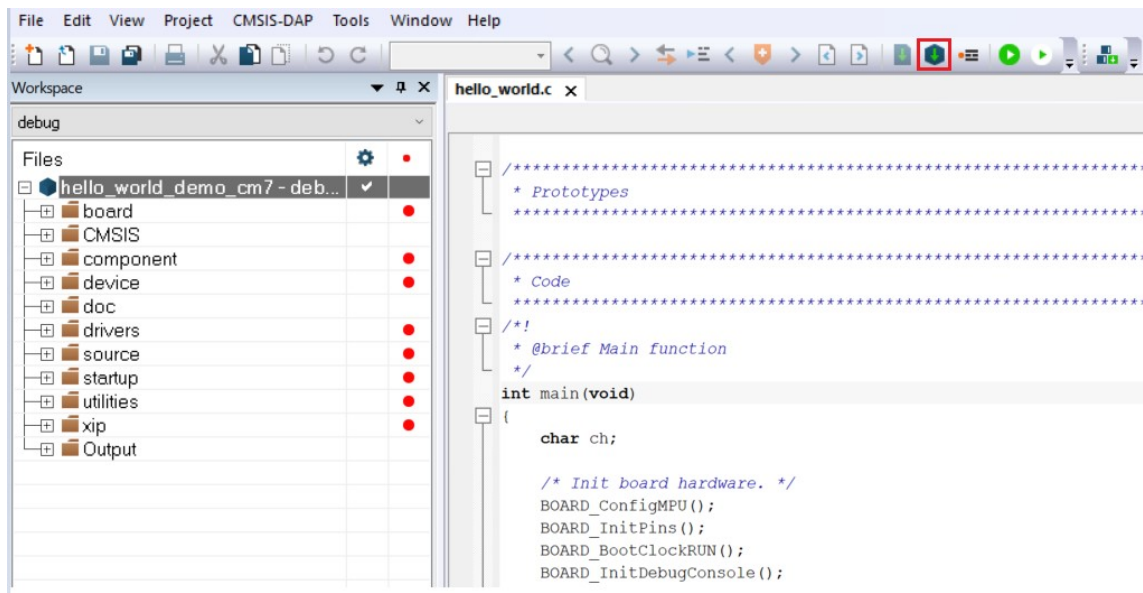
The below lists project configurations (build targets) supported across MCUXpresso SDK projects:

- Debug – Compiler optimization is set to low, and debug information is generated for the executable. The linker file is RAMlinker, where text and data section is put in internal TCM.
- Release – Compiler optimization is set to high, and debug information is not generated. The linker file is RAM linker, where text and data section is put in internal TCM.
- flexspi_nor_debug – Project configuration is same as the debug target. The linker file is flexspi_nor linker, where text is put in flash and data put in TCM.
- flexspi_nor_release – Project configuration is same as the release target. The linker file is flexspi_nor linker, where text is put in flash and data put in TCM.
- hyperram_debug – Project configuration is same as the debug target. The linker file is HYPERRAM linker, where text is put in internal TCM and data put in HYPERRAM.
- hyperram_release – Project configuration is same as the release target. The linker file is HYPERRAM linker, where text is put in internal TCM and data put in HYPERRAM.
- hyperram_txt_debug – Project configuration is same as the debug target. The linker file is HYPERRAM_txt linker, where text and data section is put in HYPERRAM.
- hyperram_txt_release – Project configuration is same as the release target. The linker file is HYPERRAM_txt linker, where text and data section is put in HYPERRAM.

- flexspi_nor_hyperram_release - Project configuration is same as the release target. The linker file is flexspi_nor_hyperram linker, where text is put in flash and data put in HY-PERRAM.
- flexspi_nor_hyperram_debug – Project configuration is same as the debug target. The linker file is flexspi_nor_hyperram linker, where text is put in flash and data put in HY-PERRAM. For this example, select **hello_world_demo– debug**.



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



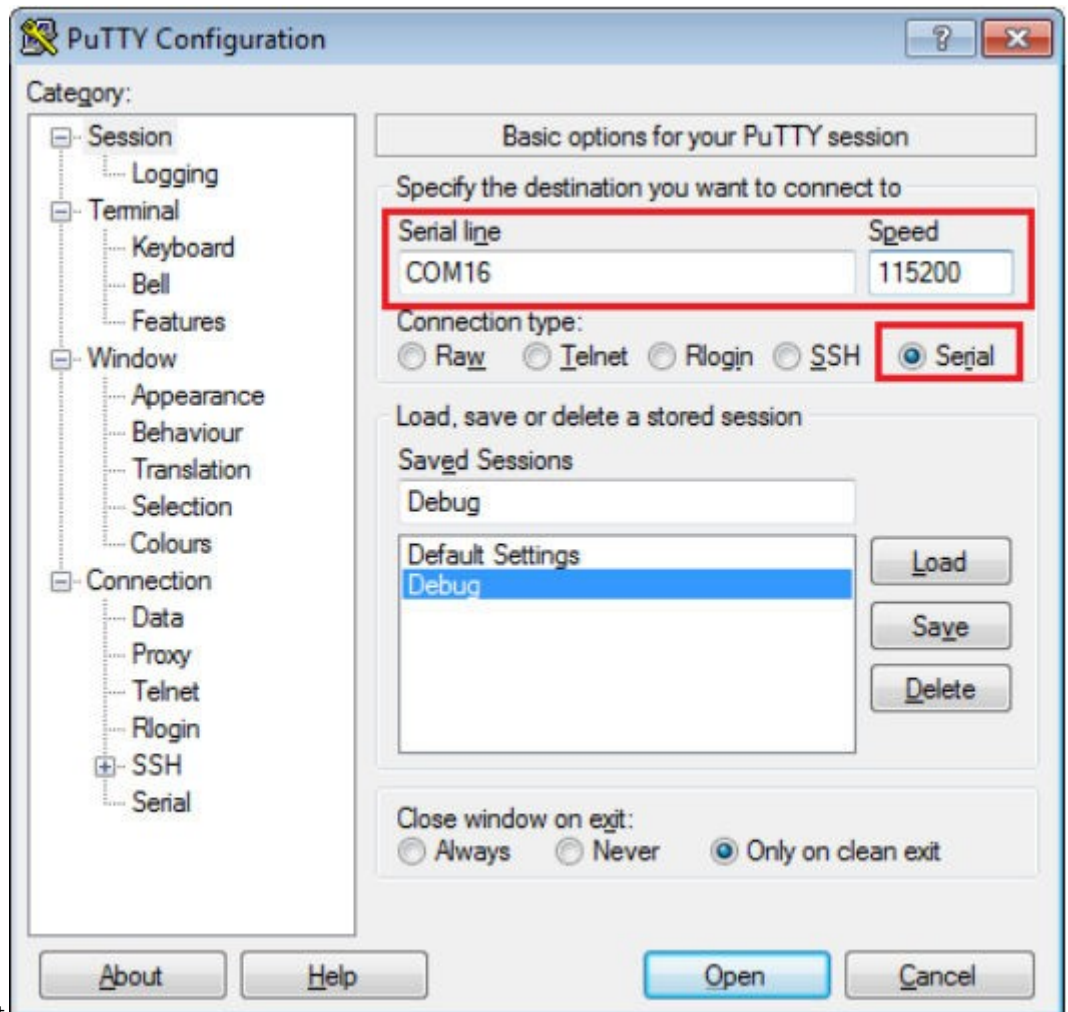
4. The build completes without errors.

Parent topic: [Run a demo using IAR](#)

Run an example application The default IAR project setting assumes that CMSIS-DAP debug interface is used. When such a debug interface is used, perform the following steps to do the

debugging:

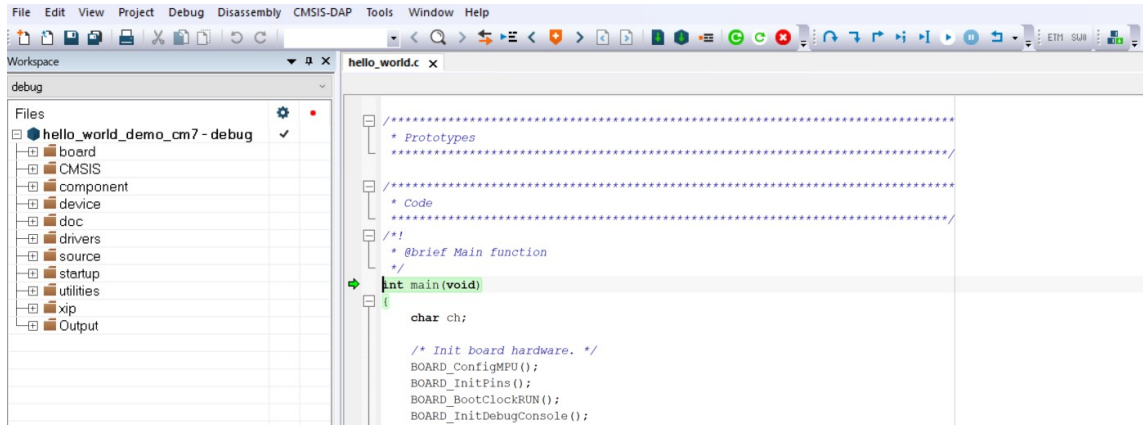
1. Connect the development platform to your PC via USB cable. Connect the USB cable to **J53** for serial output.
2. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug COM port (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:
 1. 115200 baud 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
3. In IAR, click the **Download and Debug** button to download the application to the target.



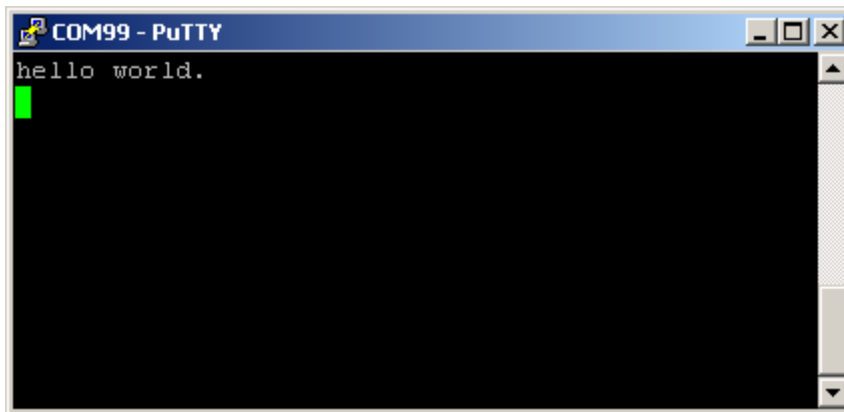
4. The application is then downloaded to the target and automatically runs to the `main()` function.



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



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



Parent topic: [Run a demo using IAR](#)

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

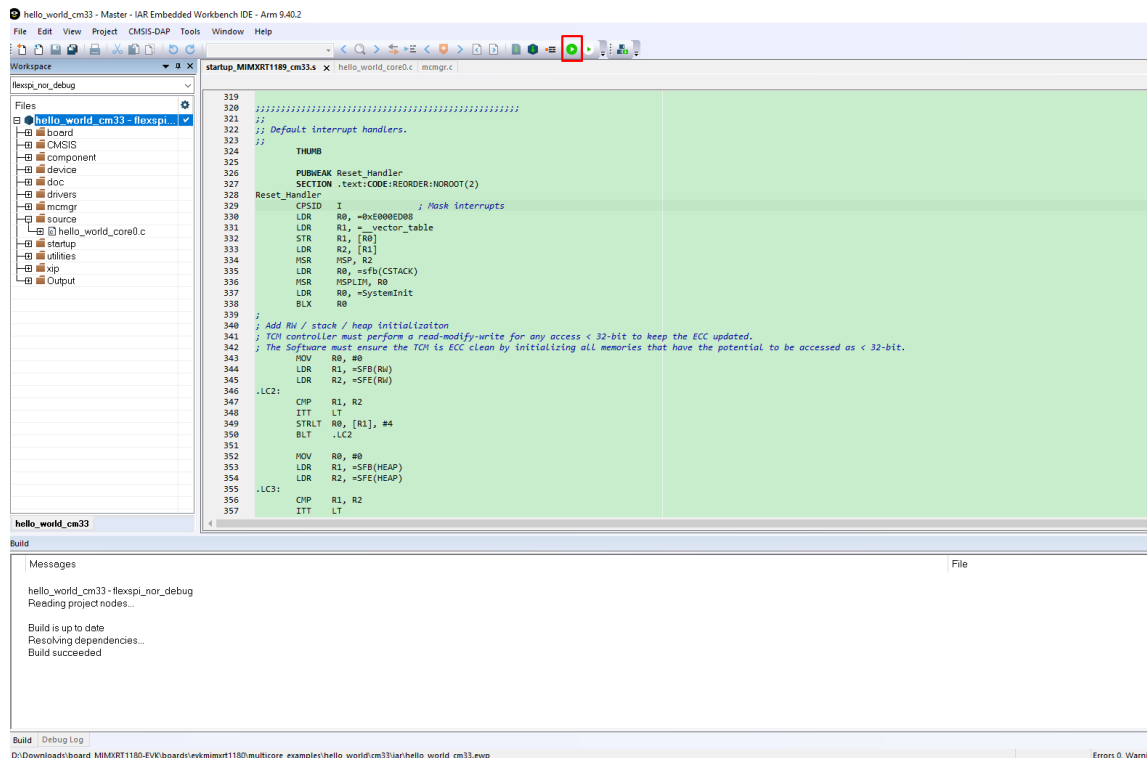
`<install_dir>/boards/evkmimxrt1180/multicore_examples/hello_world/cm7/iar/hello_world_cm7.eww`

`<install_dir>/boards/evkmimxrt1180/multicore_examples/hello_world/cm33/iar/hello_world_cm33.eww`

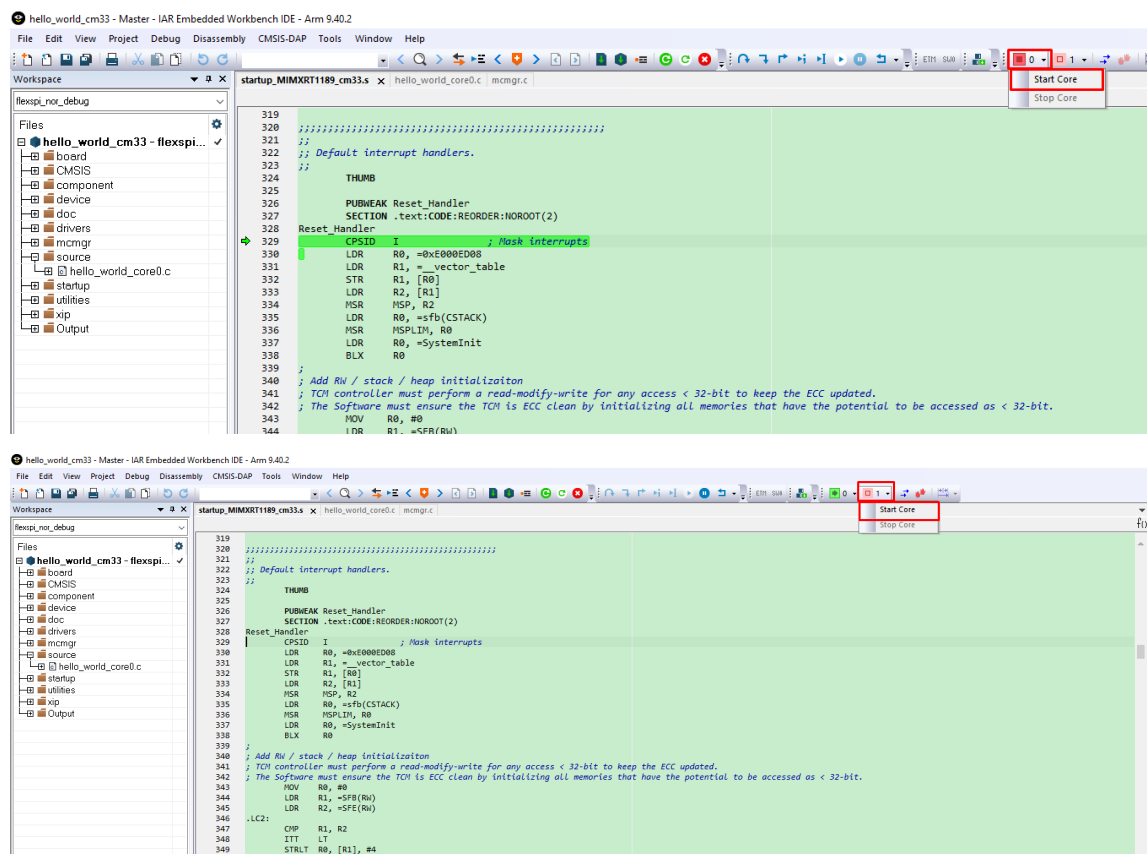
Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm7) first, because the primary core application project (cm33) must know the auxiliary core application binary when running the linker. When the auxiliary core application binary is not ready, it is impossible to finish the primary core linker.

By default, the primary core flexspi_nor_debug target links the auxiliary core debug target, and the primary core flexspi_nor_release target links the auxiliary core release target. During the primary core execution, the auxiliary core image is copied from flash into the CM7 RAM and executed.

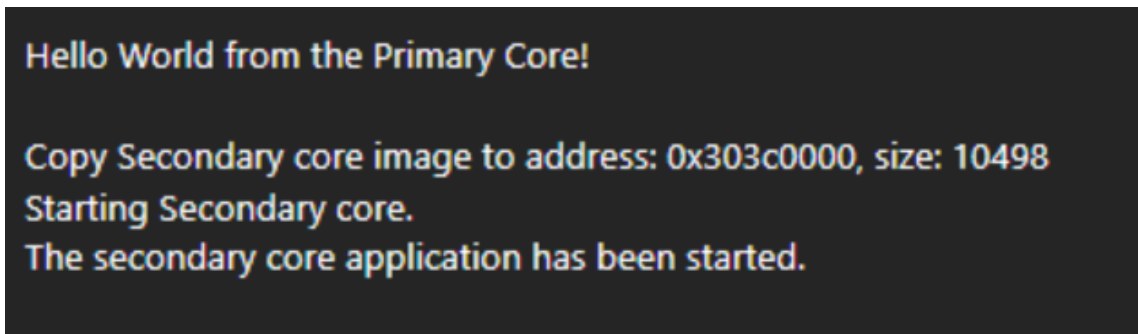
1. Build the CM7 and CM33 projects respectively.
2. Only click the Download and Debug button on the CM33 project, IAR could help start to debug a multicore project. It is user-friendly to debug multicore examples with CMSIS-DAP on IAR (Multicore Project is set on Debugger->Multicore window).



3. Start core0 and then start core1 on the CM33 project.



- Hello_World multicore demos are now running. A banner appears on the terminal and the LED D6 blinks. If this is not true, check your terminal settings and connections.

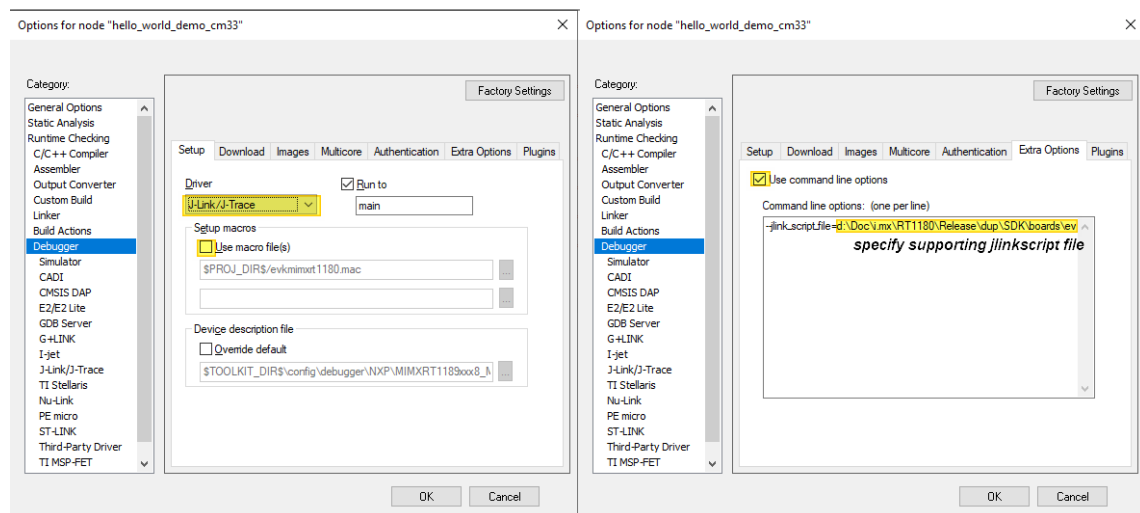


Parent topic: [Run a demo using IAR](#)

Run applications via JLink debug interface When JLink Debug Interface is used, manually revise **Debug Configuration** under **Project > Options > Debugging**.

- Change the debug driver to J-Link/J-Trace.
- Uncheck **Use macro file(s)**.
- In the **Extra Options**, specify a jlinkscript. The jlinkscript files can be found in example folder in SDK package.

evkmimxrt1180_cm33.jlinkscript is for CM33 projects and evkmimxrt1180_cm7.jlinkscript is for CM7 projects. Use `--jlink_script_file=<full patch>` to specify it.



After these settings, debugging can be performed via the J-Link debugging interface.

Note: If IAR version is higher than or equal to 9.60.1, perform just *Step 1*.

Parent topic: [Run a demo using IAR](#)

Run a demo using Keil MDK/μVision

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

Both CMSIS-DAP and J-Link debugging interfaces are supported for Keil IDE. It is recommended to reset board for each download/debug.

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 MIMXRT118x CMSIS pack.

1. Download the MIMXRT1181, MIMXRT1182, MIMXRT1187, and MIMXRT1189 packs.
2. After downloading the DFP, double click to install it.

Parent topic: [Run a demo using Keil MDK/μVision](#)

Build an example application

1. Open the desired example application workspace in:

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

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

`<install_dir>/boards/evkmimxrt1180/demo_apps/hello_world/cm33/mdk/hello_world_demo_cm33.uvmpw`

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

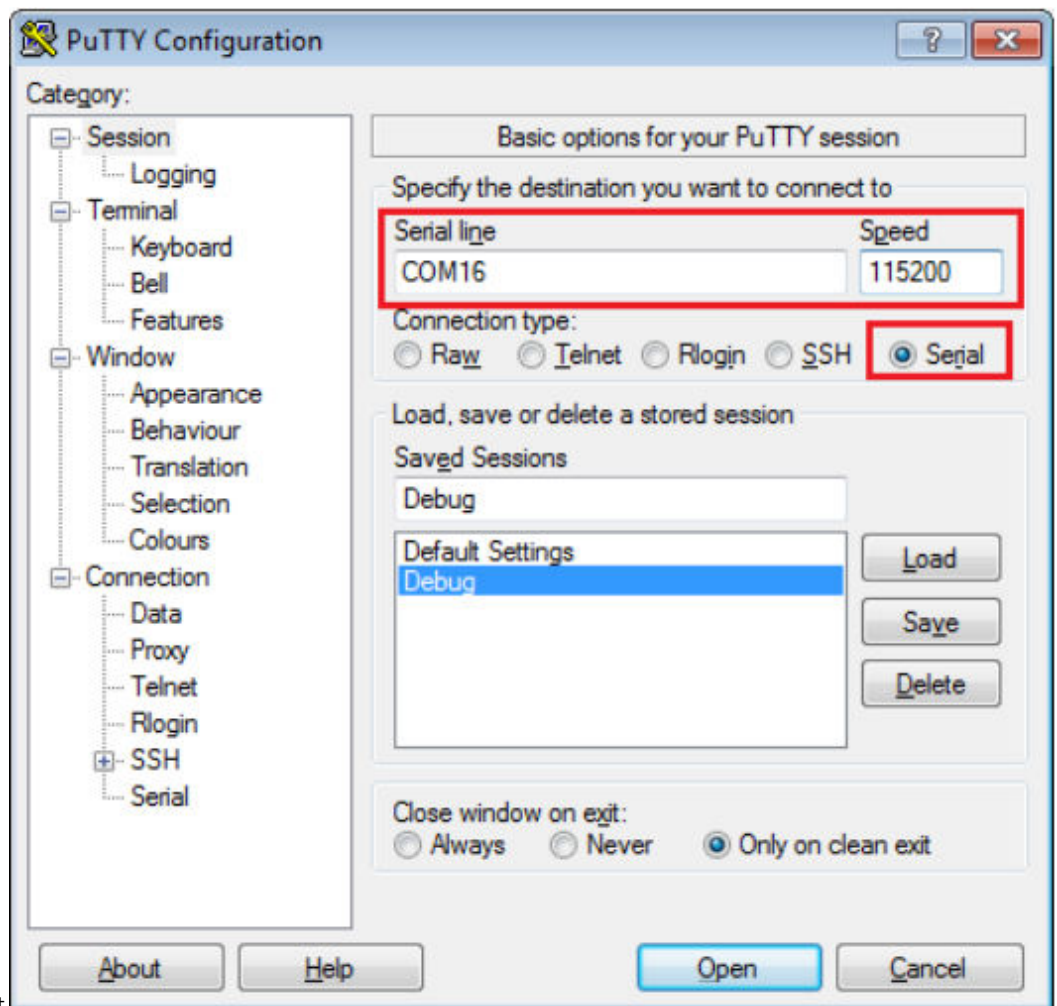


3. The build completes without errors.

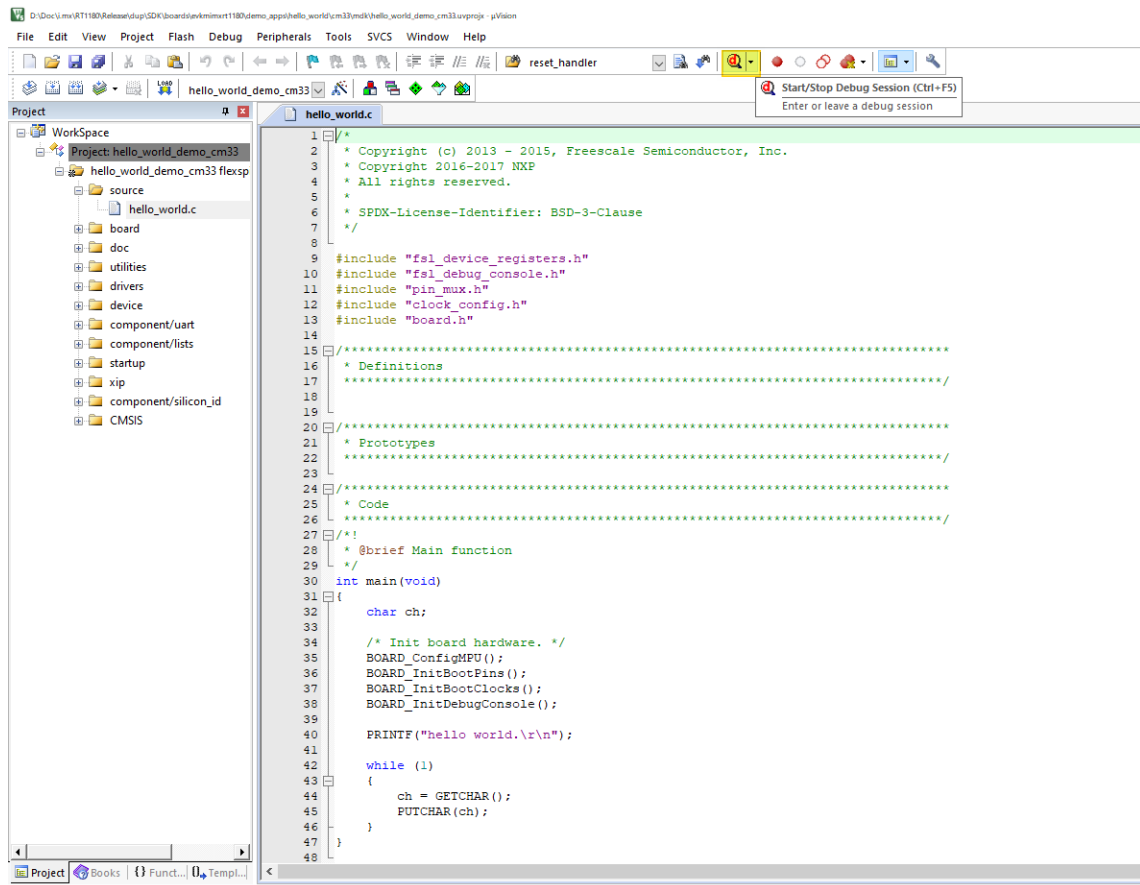
Parent topic: [Run a demo using Keil MDK/μVision](#)

Run an example application The default MDK project settings assumes CMSIS-DAP debug interface is used. If you are using a CMSIS-DAP debugging interface, perform the following steps:

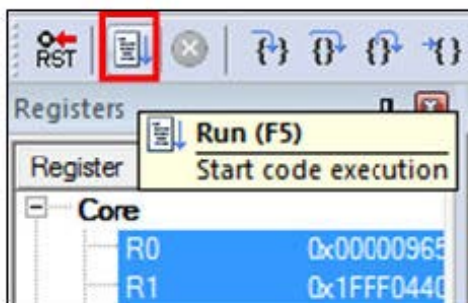
1. Connect the development platform to your PC via USB cable.
2. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number. To determine the COM port number, see [How to determine COM port](#). Configure the terminal with these settings:
 1. 115200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



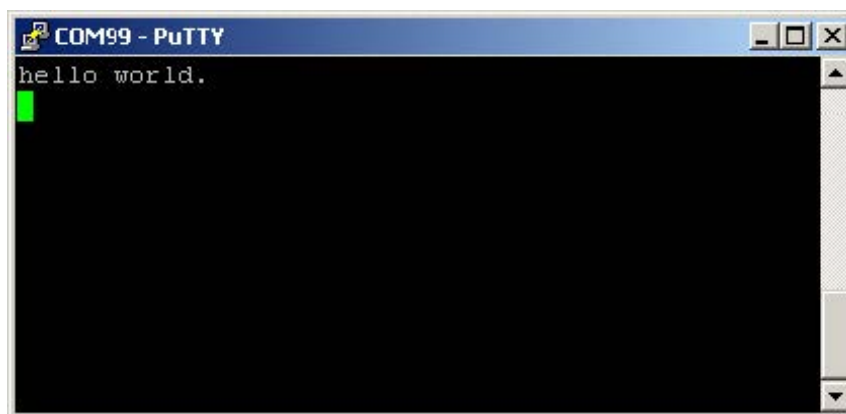
4. 1 stop bit
3. To debug the application, click the **Start/Stop Debug Session** button or **Ctrl + F5**, highlighted in *Figure 2*.



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



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



Parent topic: [Run a demo using Keil MDK/μVision](#)

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

```
<install_dir>/boards/evkmimxrt1180/multicore_examples/<application_name>/<core_type>/mdk
```

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

```
<install_dir>/boards/evkmimxrt1180/multicore_examples/hello_world/cm7/mdk/hello_world_cm7.uvmpw
```

```
<install_dir>/boards/evkmimxrt1180/multicore_examples/hello_world/cm33/mdk/hello_world_cm33.uvmpw
```

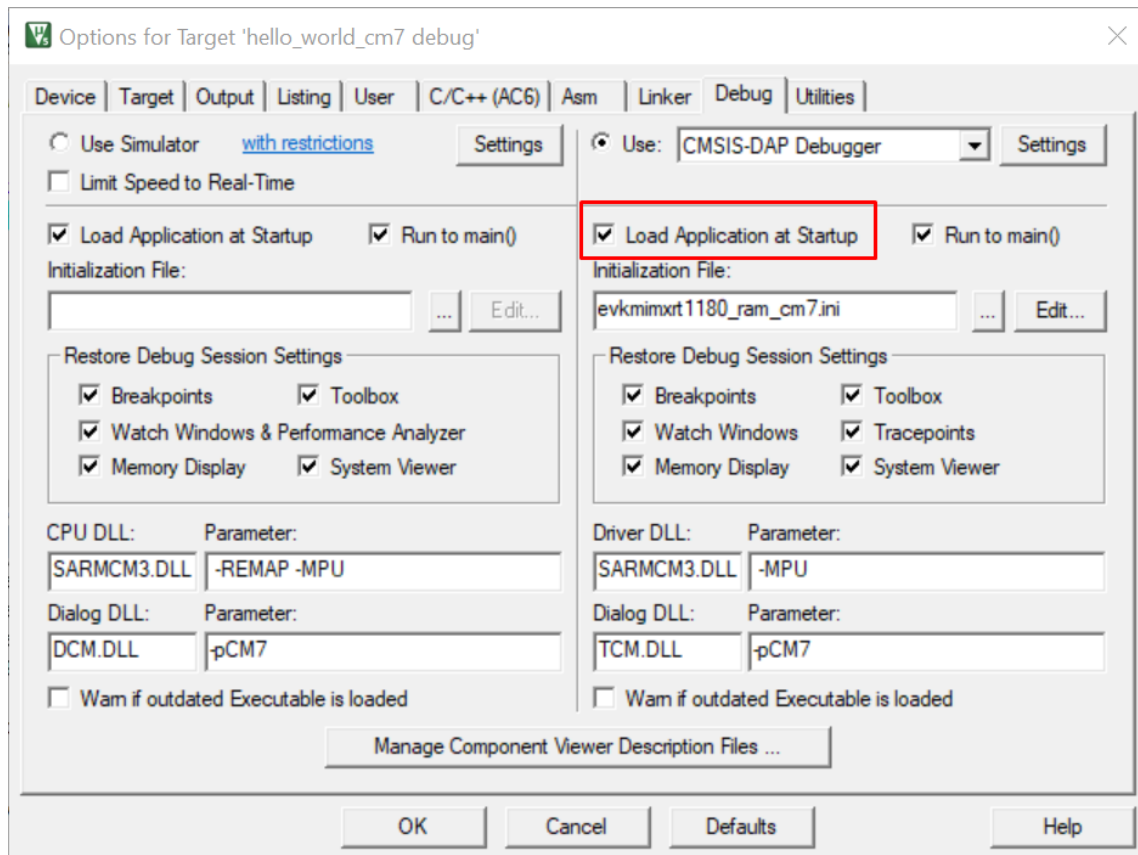
Build both applications separately by clicking the **Rebuild** button. Build the application for the auxiliary core (cm7) first, because the primary core application project (cm33) needs to know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker when the auxiliary core application binary is not ready.

Because the auxiliary core runs always from RAM, debug and release RAM targets are present in the project only. When building the primary core project, it is possible to select flexspi_nor_debug/flexspi_nor_release Flash targets. When choosing Flash targets the auxiliary core binary is linked with the primary core image and stored in the external SPI Flash memory. During the primary core execution the auxiliary core image is copied from flash into the CM7 RAM and executed.

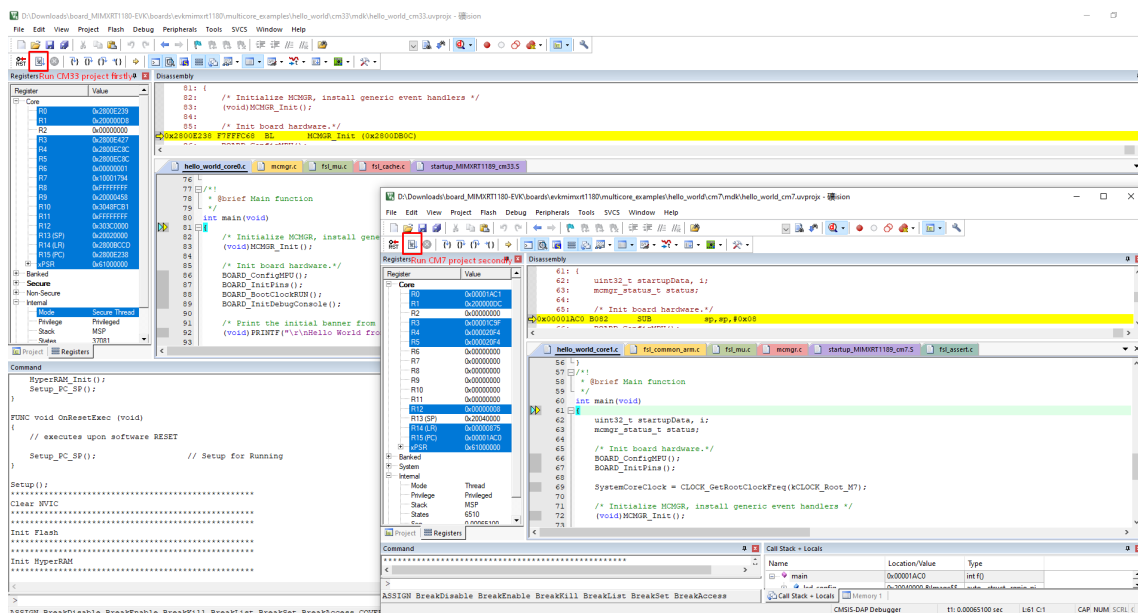
Parent topic:[Run a demo using Keil MDK/μVision](#)

Run a multicore example application This section describes the steps to run a multicore example application. The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory.

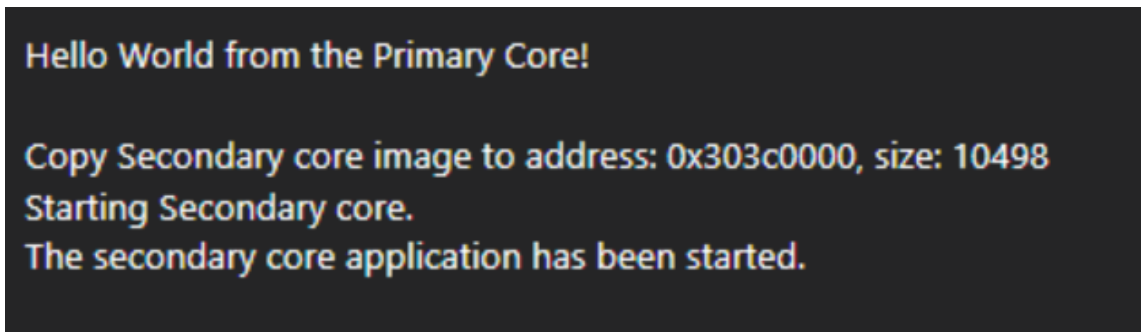
1. To download and run the multicore application, switch to the primary core application project and perform Step 1 – Step 3 as described in Build a multicore example application.
2. For the secondary core project, select the Load Application at Startup button as shown in *Figure 1*. These steps are common for both single-core and dual-core applications in μVision.



3. Run the primary core project and then run the secondary core project.



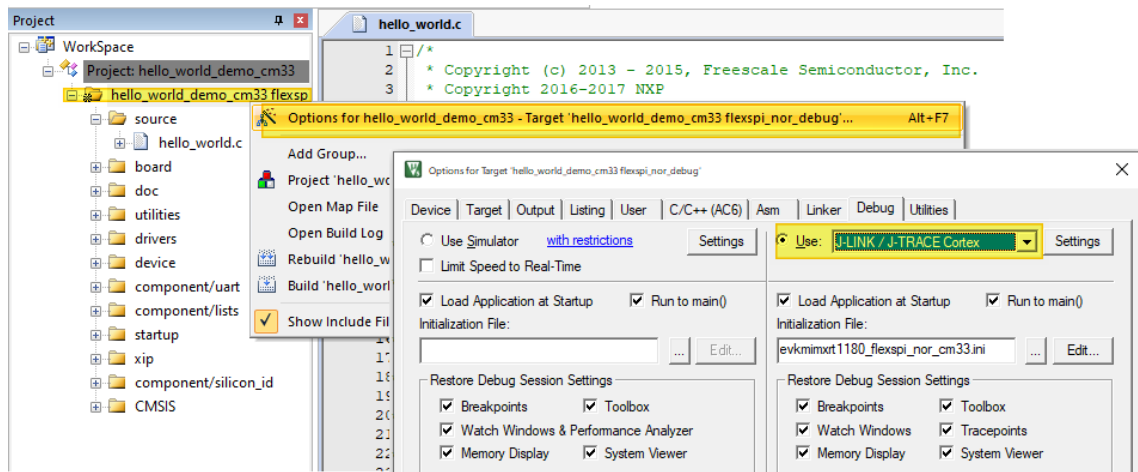
4. Hello_World multicore demos are now running. A banner appears on the terminal and the LED D6 blinks. If this is not true, check your terminal settings and connections.



Parent topic: [Run a demo using Keil MDK/μVision](#)

Run applications via JLink debug interface When JLink Debug Interface is used, manually revise **Debug Configuration**.

1. Under **Project > Options > Debug**, change the debug interface to J-LINK / J-TRACE Cortex.



2. Copy the supporting JLinkscript file from example folder to project root mdk. For CM33 projects, use evkmimxrt1180_cm33.jlinkscript and for CM7 projects, use evkmimxrt1180_cm7.jlinkscript. Rename them to JLinkSettings.JLinkScript.

i.mx > RT1180 > Release > dup > SDK > boards > evkmimxrt1180 > demo_apps > hello_world > cm33 > mdk				
Name	Date modified	Type	Size	
flexspi_nor_debug	2024/1/27 21:16	File folder		
output	2024/1/27 21:16	File folder		
EventRecorderStub.scvd	2024/1/27 21:18	SCVD File	1 KB	
evkmimxrt1180_flexspi_nor_cm33	2024/1/27 12:09	Configuration settings	13 KB	
evkmimxrt1180_hyperram_txt_cm33	2024/1/27 12:09	Configuration settings	13 KB	
evkmimxrt1180_ram_cm33	2024/1/27 12:09	Configuration settings	13 KB	
hello_world_demo_cm33.uvuiux.nxa08246	2024/1/27 21:16	NXA08246 File	4 KB	
hello_world_demo_cm33	2024/1/27 21:16	Revision Multi-Project	1 KB	
hello_world_demo_cm33.uvmpw.uvui.nxa08246	2024/1/27 21:17	NXA08246 File	88 KB	
hello_world_demo_cm33.uvoptx	2024/1/27 21:17	UVOPTX File	91 KB	
hello_world_demo_cm33	2024/1/27 21:17	Revision5 Project	272 KB	
JLinkSettings	2024/1/27 21:13	Configuration settings	1 KB	
JLinkSettings.JLinkScript	2024/1/27 21:15	JLINKSCRIPT File	21 KB	
MIMXRT1189xxxxx_cm33_flexspi_nor	2024/1/27 12:09	File Explorer Command	8 KB	
MIMXRT1189xxxxx_cm33_flexspi_nor_hyperram	2024/1/27 12:09	File Explorer Command	8 KB	
MIMXRT1189xxxxx_cm33_hyperram	2024/1/27 12:09	File Explorer Command	7 KB	
MIMXRT1189xxxxx_cm33_hyperram_txt	2024/1/27 12:09	File Explorer Command	7 KB	
MIMXRT1189xxxxx_cm33_ram	2024/1/27 12:09	File Explorer Command	6 KB	

After these settings, debugging can be performed via the J-Link debugging interface.

Parent topic: [Run a demo using Keil MDK/μVision](#)

Run a demo using Arm GCC

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

Only J-Link debugging interface is supported for JLinkGDBServer and GDB.

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

Install GCC Arm Embedded tool chain Download and run the installer from [GNU Arm Embedded Toolchain](#). This is the actual toolset (in other words, compiler, linker, etc.). The GCC toolchain should correspond to the latest supported version, as described in *MCUXpresso SDK Release Notes for MIMXRT1180-EVK* (document MCUXSDKMIMXRT118XKRN).

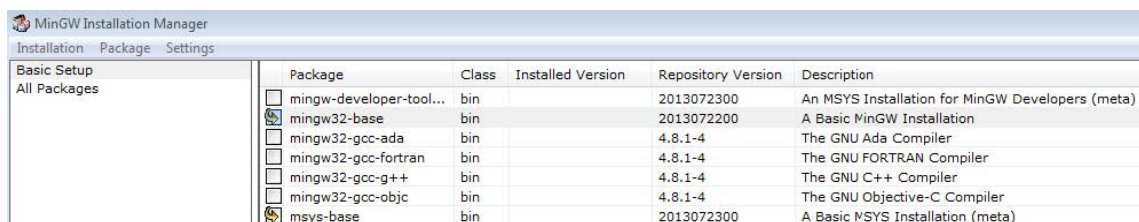
Parent topic:Set up toolchain

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

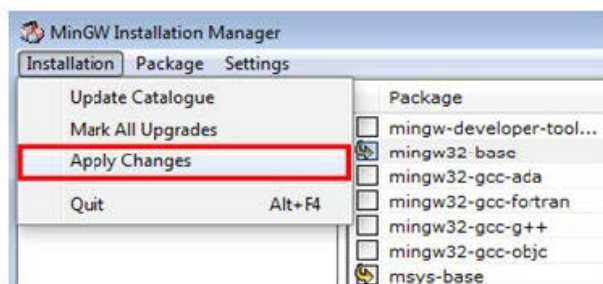
1. Download the latest MinGW mingw-get-setup installer from [SOURCEFORGE](#).
2. Run the installer. The recommended installation path is `C:|MinGW`. However, you may install to any location.

Note: The installation path cannot contain any spaces.

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



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

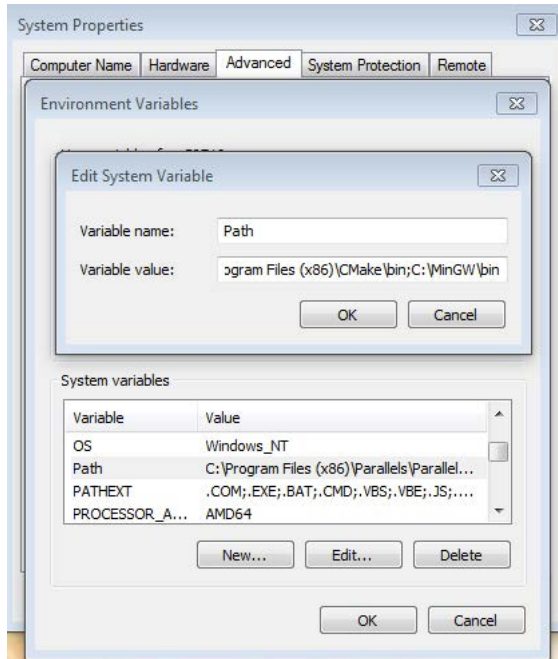


5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel->System and Security->System->Advanced System Settings** in the ****Environment Variables...**** section. The path is:

<mingw_install_dir>\bin

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

Note: If you have *C:\MinGW\msys\1.0\bin* in your PATH variable (as required by Kinetis SDK 1.0.0), remove it to ensure that the new GCC build system works correctly.



Parent topic:Set up toolchain

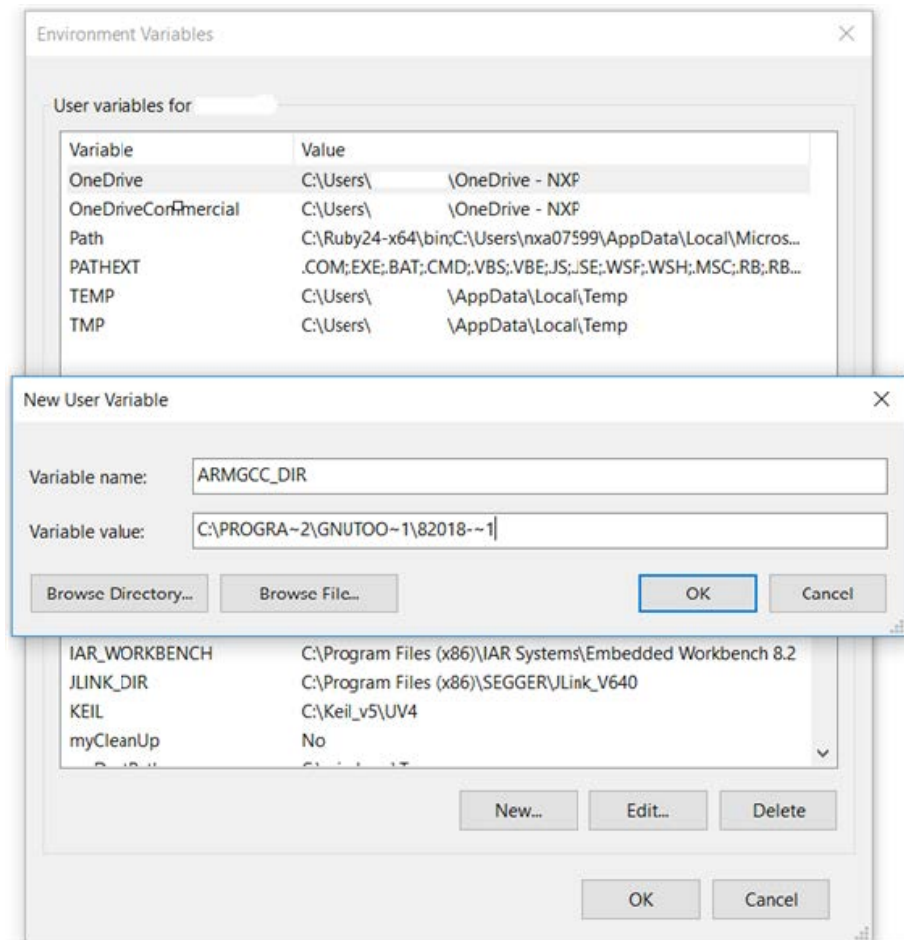
Add a system environment variable for ARMGCC_DIR Create a system environment variable and name it as ARMGCC_DIR. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

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 path name of your installation.

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

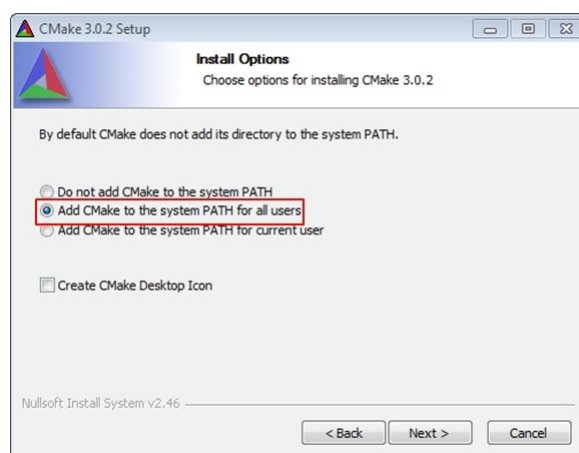
```
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>for %I in (.) do echo %~sI
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>echo C:\PROGRA~2\GNUTOO~1\82018~1
C:\PROGRA~2\GNUTOO~1\82018~1
```



Parent topic:Set up toolchain

Install CMake

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



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

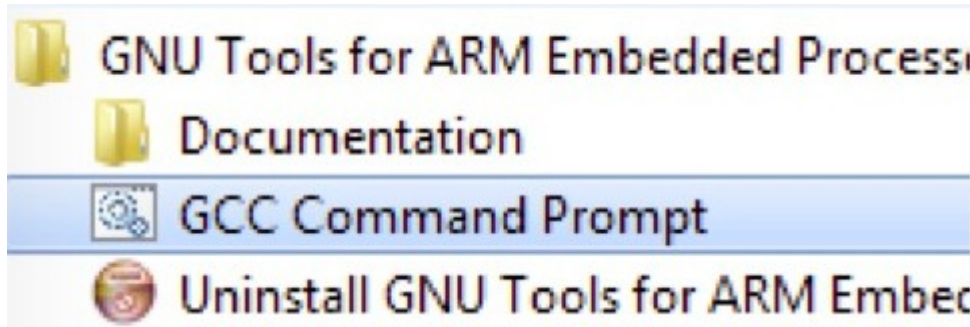
5. Make sure sh.exe is not in the Environment Variable PATH. This is a limitation of mingw32-make.

Parent topic:Set up toolchain

Parent topic:[Run a demo using Arm GCC](#)

Build an example application To build an example application, perform the following steps.

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



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

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

For this example, the exact path is:

```
<install_dir>/examples/evkmimxrt1180/demo_apps/hello_world/cm33/armgcc
```

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

```
[ 95%] Building C object CMakeFiles/hello_world_demo_cm33.elf.dir/C:/repol/mcu-sdk-2.0/platforms/evkmimxrt1180/examples/hello_world_cm33/armgcc/hello_world_demo_cm33.c.obj
[100%] Linking C executable debug\hello_world_demo_cm33.elf
Memory region      Used Size  Region Size  %age Used
m_interrupts:       1 KB      1 KB      100.00%
m_text:             20432 B    127 KB      15.71%
m_data:             1232 B    127 KB       0.95%
m_ncache:            0 GB     256 KB       0.00%
m_data2:            0 GB     256 KB       0.00%
rpmsg_sh_mem:       0 GB      0 GB       0.00%
m_heap:             1 KB      1 KB      100.00%
[100%] Built target hello_world_demo_cm33.elf
```

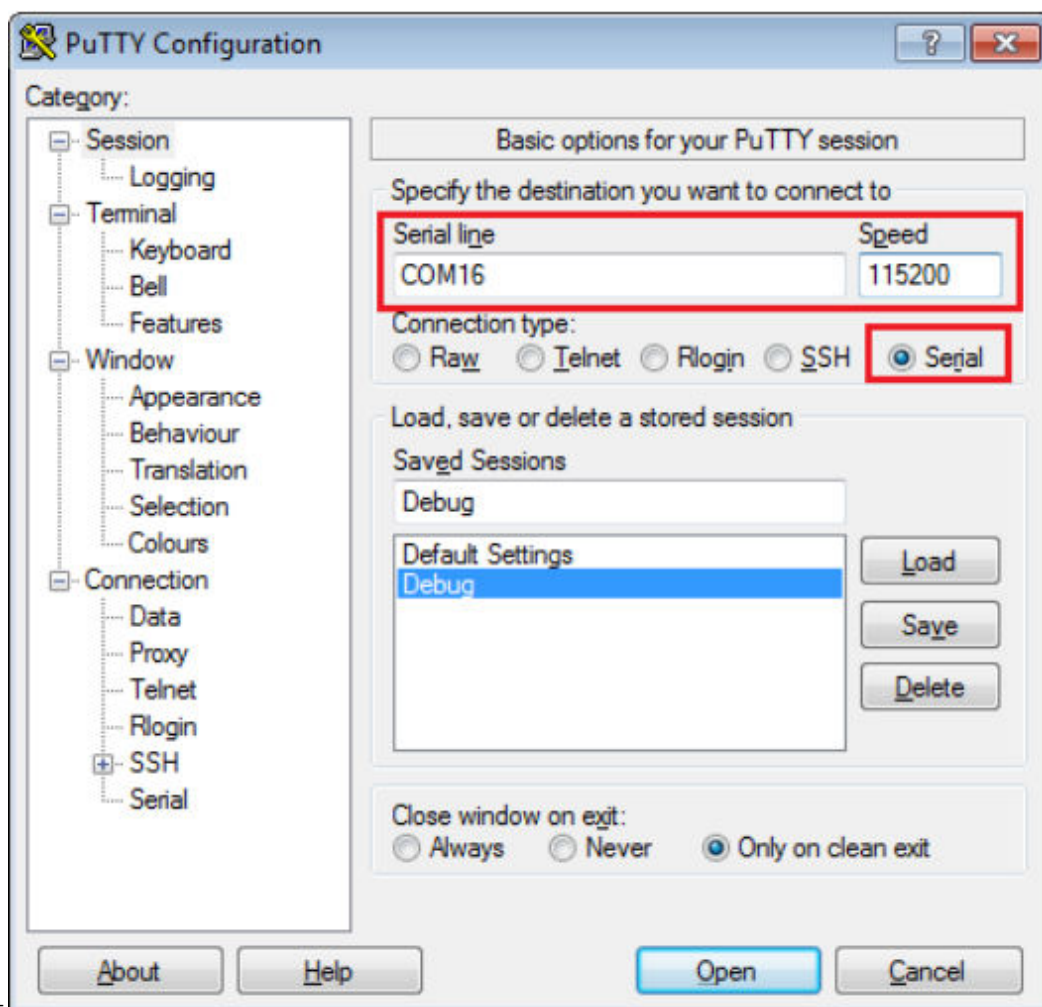
Parent topic:[Run a demo using Arm GCC](#)

Run an example application This section describes steps to run a demo application using J-Link GDB Server application. To perform this exercise, make sure that a standalone J-Link pod is connected to the debug interface of your board.

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

1. This board supports the J-Link debug probe. Before using it, install SEGGER software, which can be downloaded from [SEGGER](#).
2. Connect the development platform to your PC via USB cable between the OpenSDA USB connector and the PC USB connector.

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 the *board.h* file)
 2. No parity
 3. 8 data bits



4. 1 stop bit
4. Open the J-Link GDB Server application. Go to the SEGGER install folder. For example, *C:\Program Files(x86)\SEGGER\JLink_Vxxx*. Open the command windows. To debug CM33, run the following command:

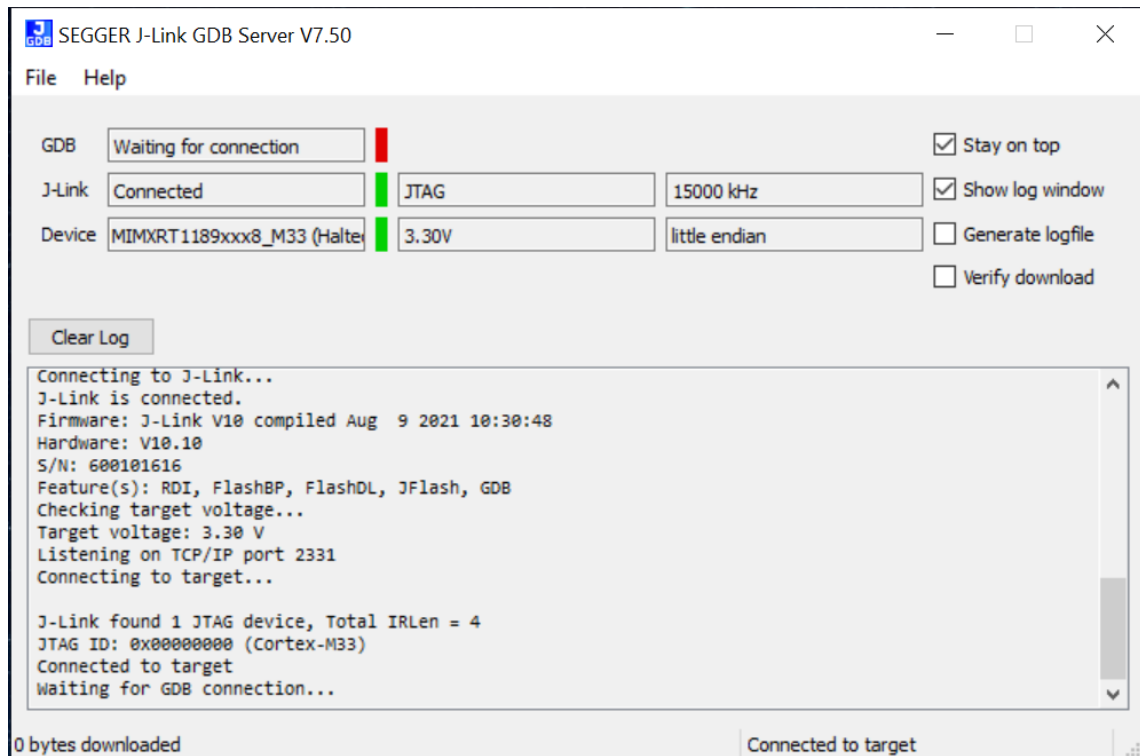
```
JLinkGDBServer.exe -device MIMXRT1189xxx8_M33 -if SWD -speed 4000 -jlinkscriptfile
➔ <evkmimxrt1180_cm33.jlinkscript> -stayontop -ir
```

To debug CM7, run the following command:

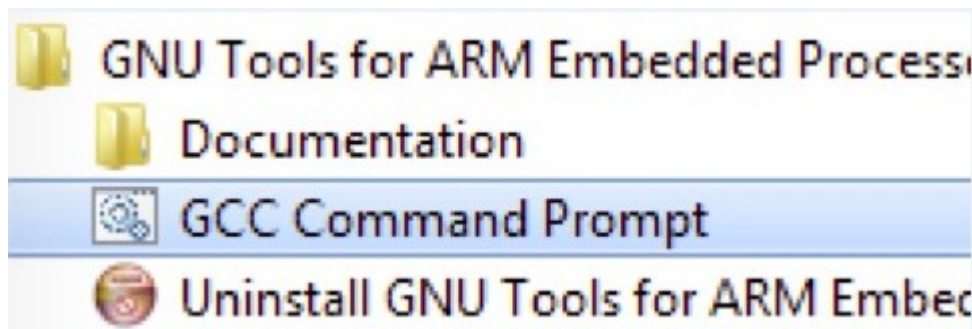
```
JLinkGDBServer.exe -device MIMXRT1189xxx8_M7 -if SWD -speed 4000 -jlinkscriptfile
➔ <evkmimxrt1180_cm7.jlinkscript> -stayontop -ir
```

Note: The supporting jlinkscript file can be found in *boards/evkmimxrt1180/jlinkscript*.

5. After it is connected, the screen should resemble *Figure 2*.



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>/<core>/armgcc/<target>`

For this example, the path is:

`<install_dir>/boards/evkmimxrt1180/demo_apps/hello_world/<core>/armgcc/debug`

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


```
C:\Program Files (x86)\GNU Arm Embedded Toolchain\9 2020-q2-update\bin>arm-none-eabi-gdb.exe C:\repol\
mcu-sdk-2.0\boards\evbmimxrt1180\demo_apps\hello_world\cm33\armgcc\debug\hello_world_demo_cm33.elf
C:\Program Files (x86)\GNU Arm Embedded Toolchain\9 2020-q2-update\bin\arm-none-eabi-gdb.exe: warning:
  Couldn't determine a path for the index cache directory.
GNU gdb (GNU Arm Embedded Toolchain 9-2020-q2-update) 8.3.1.20191211-git
Copyright (C) 2019 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:\repol\mcu-sdk-2.0\boards\evbmimxrt1180\demo_apps\hello_world\cm33\armgcc\debug
\hello_world_demo_cm33.elf...
(gdb)
```

9. Run these commands:

```
target remote localhost:2331
monitor reset
monitor halt
load
```

10. The application is now downloaded and halted at the reset vector. Execute the `continue` or `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 is not true, check your terminal settings and connections.

 COM3 - PuTTY

```
hello world.
```

Parent topic: [Run a demo using Arm GCC](#)

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

```
<install_dir>/boards/evkmimxrt1180/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/evkmimxrt1180/multicore_examples/hello_world/cm7/armgcc/build_debug.bat
```

```
<install_dir>/boards/evkmimxrt1180/multicore_examples/hello_world/cm33/armgcc/build_flexspi_nor_debug.bat
```

Build the application for the auxiliary core (cm7) first, because the primary core application project (cm33) 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.

By default, the primary core **flexspi_nor_debug** target links the auxiliary core **debug** target, and the primary core **flexspi_nor_release** target links the auxiliary core **release** target. During the primary core execution, the auxiliary core image is copied from flash into CM7 RAM and executed.

Parent topic: [Run a demo using Arm GCC](#)

Bootable image generation

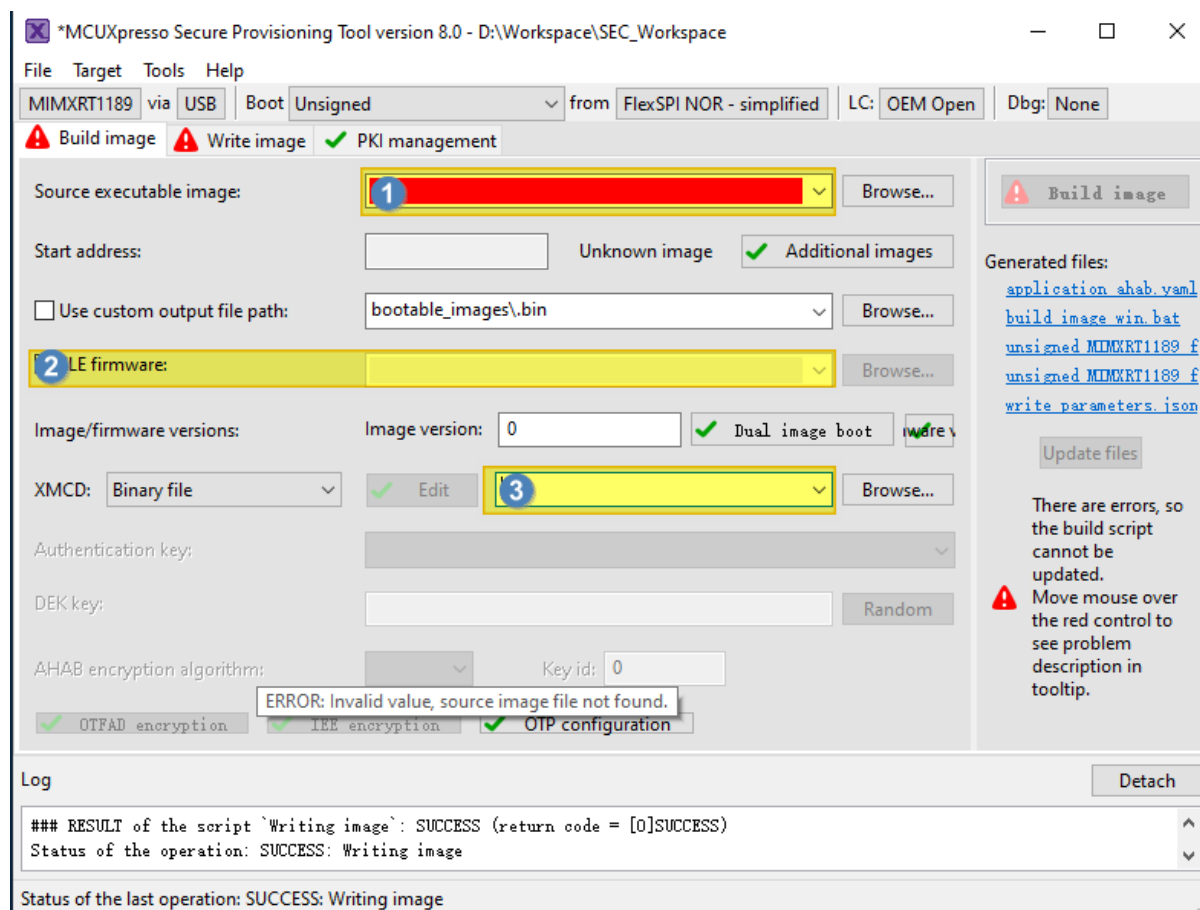
RT1180 can only boot from CM33. For CM33 application image to boot, a sophisticated boot header structure is needed. To ease the customer from complex settings, the **Secure Provisioning Tool** is provided. Among other rich features, it provides an easy way to use GUI for customer to generate bootable image from raw application image. In addition, in order for users to run the CM7 image conveniently, SDK provides the `multicore_trigger` demo for users to kick off CM7 image, combined with the SPT tool, we can run CM7 image by from POR.

In this section, two kinds of images are defined

Terminology	Description
RAW image	Demo image without boot header
POR image	Demo image with boot header

Most examples that we provided in SDK package create RAW images from project settings. Only some OOB examples can create POR image. POR image can provide good out-of-box experience, but the cost is losing some flexibility. While RAW images, with the usage of Secure Provisioning Tool, have the most widely usage like image signing, multiple image combination, and so on. For demos that by default generate a POR boot image, see RAW/POR image switch.

Use SPT tool to boot cm33 image Run the Secure Provisioning Tool, and the following GUI shows.



Select the following items:

1. Toolchain generated images

All SDK generated images are supported no matter they boot from TCM, FlexSPI Nor, or HyperRAM.

Toolchain	Suffix
ARMGCC	.elf
IAR	.out
MDK	.out/.hex
MCUX	.axf

Note:

- Use the RAW image for CM33. Some SDK project targets are POR image by default, it must to be switched to RAW image for SPT usage. For more information, see RAW/POR image switch.
- It is recommended to use elf/out files, thus SPT can parse the **Start address** automatically.

2. XMCD file

This is on-board SDRAM/HyperRAM initialization file. For the RT1180 EVK board, select *boards/evkmimxrt1180/xmcd/hyperram_xmc_auto_detect.bin*.

Note:

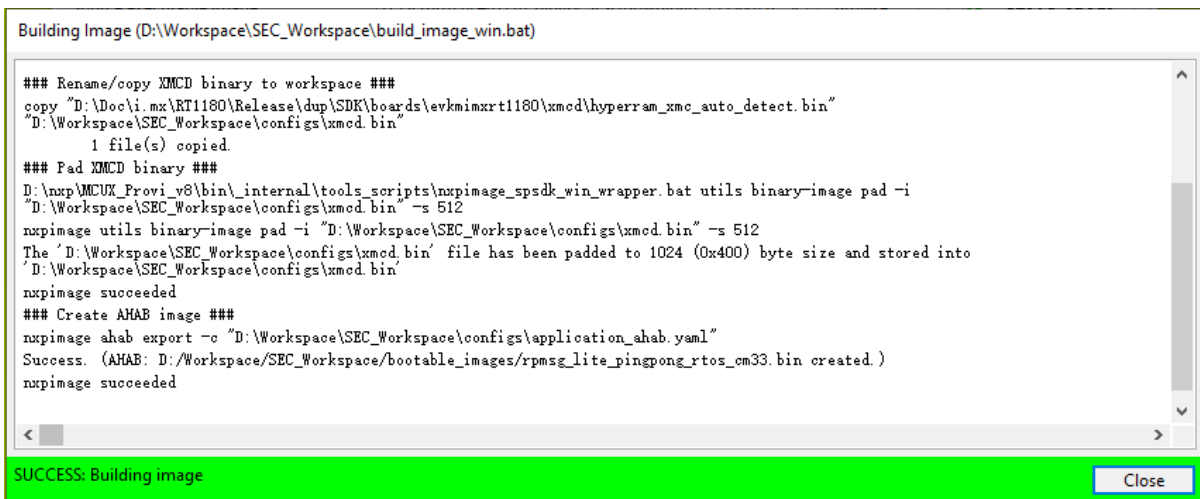
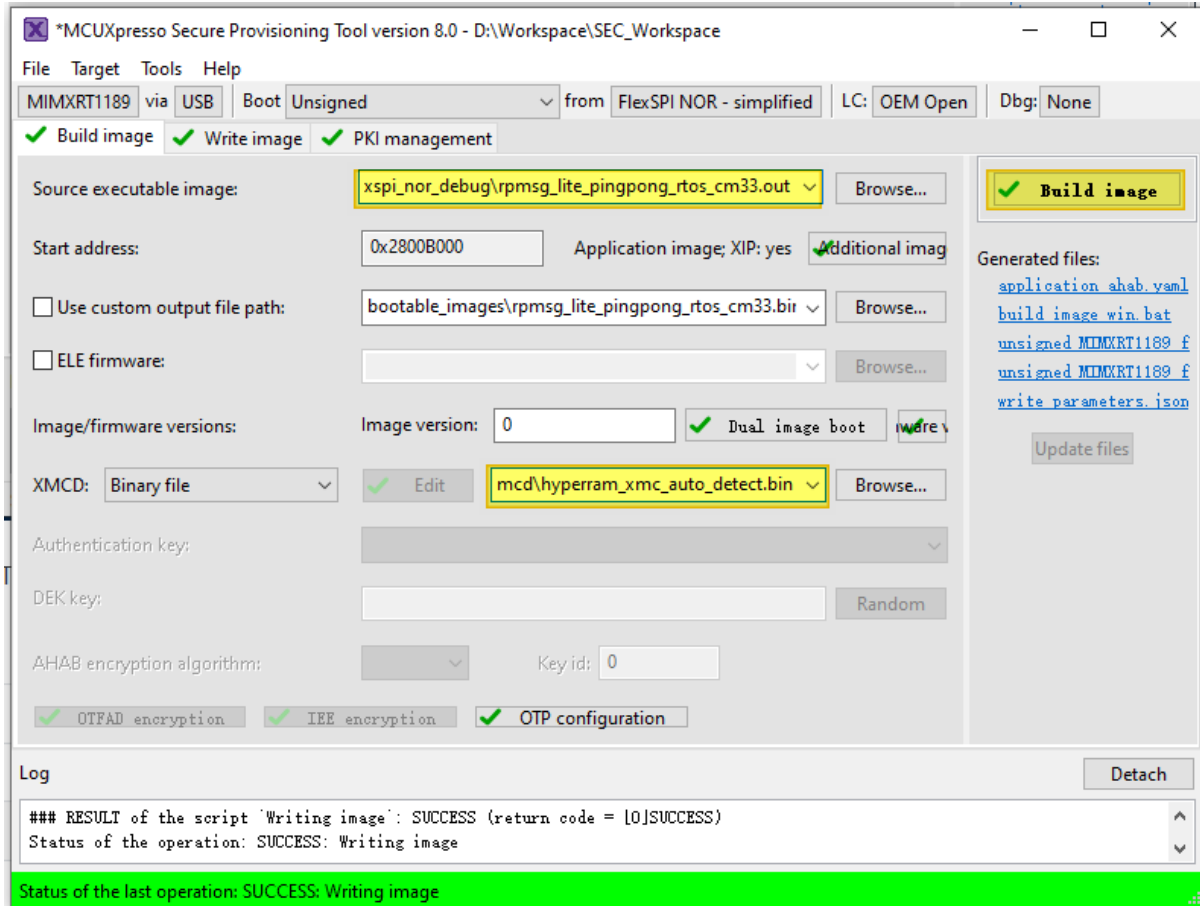
- If the application image uses hyperram (target *hyperram_debug/release*, *flexspi_hyperram_debug/release*, *hyperram_txt_debug/release*), the XMCD is necessary.

- *hyperram_xmc_auto_detect.bin* is board specific.

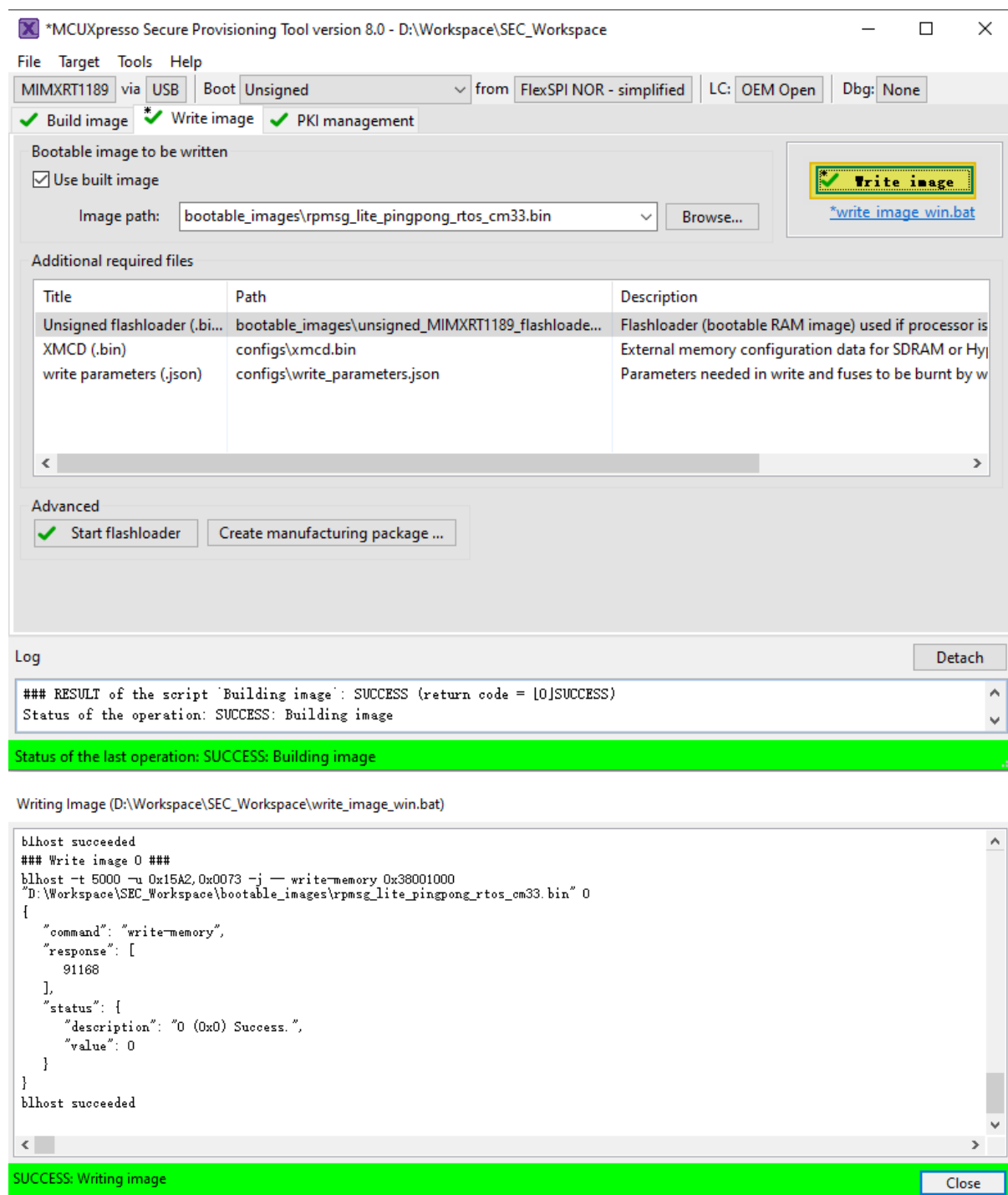
3. (Optional) ELE firmware

This is needed for certain application images which need special ELE FW service. For most SDK demos, simply leave it empty.

After the selection, click Build Image to generate the bootable image (POR image).



Now switch to the **Write Image** tab. All information is automatically generated from the previous page. Connect both USB OTG1 port (J33) and MCU-Link port (J53) to the computer and power up the board (or reset via SW3). Make sure that the EVK board boot configuration switch SW5[1..4] are on 0001 SDP mode and click **Write Image**.

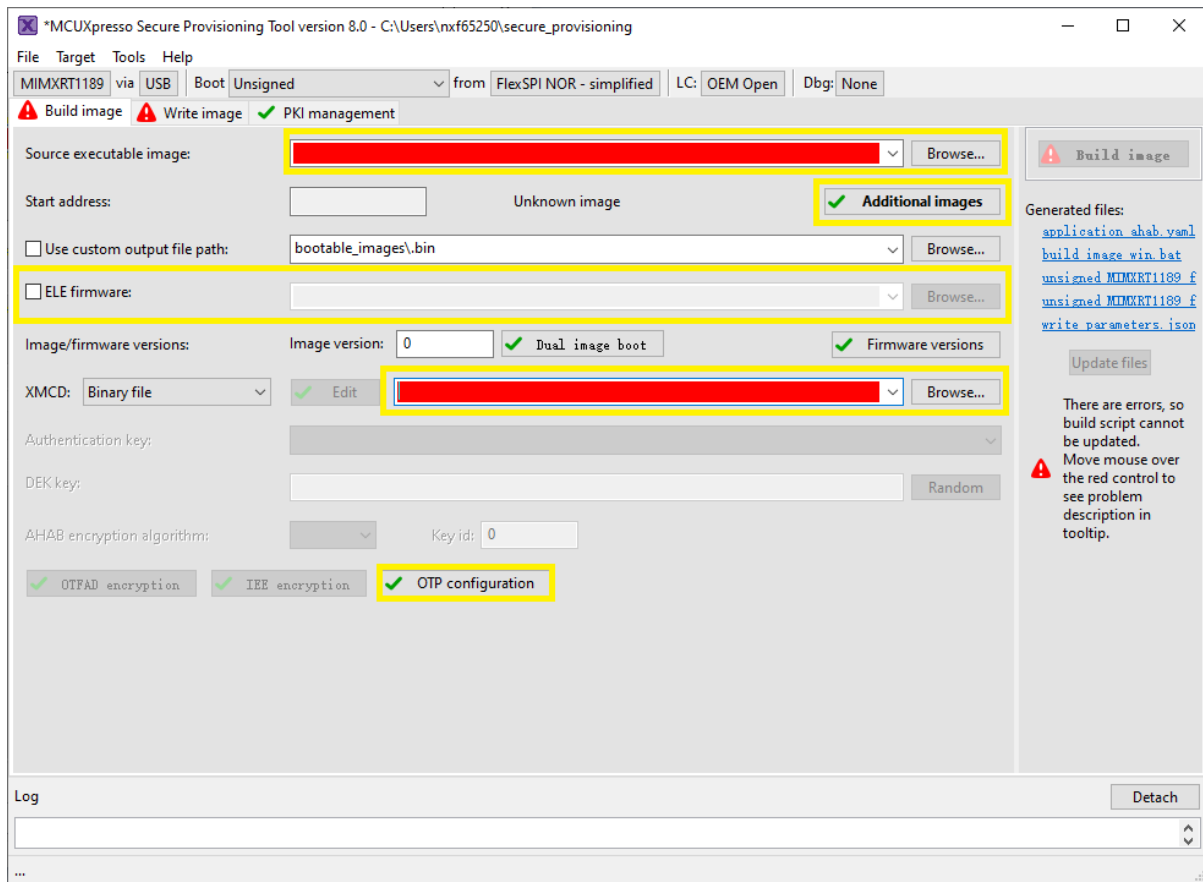


Change the SW5[1..4] to QSPI boot mode 0100 and reset the board, and then you can observe that the image is running from POR boot.

Parent topic: [Bootable image generation](#)

Use SPT tool and multicore_trigger image to kick off cm7 binary image This section introduces how to create a CM7 POR boot image with the aid of a CM33 kicker application. The CM33 kicker application is located in `demo_apps/multicore_trigger`.

For a secure provisioning tool to generate such a bootable CM7 image, specify the CM33 multicore_trigger image in Source executable image. The CM7 application image to be kicked off must be specified with additional images.



CM7 XIP image runs from external FLASH, and multicore_trigger CM33 image runs from internal RAM Perform the following steps:

1. Prepare the multicore_trigger_demo_cm33 ram image (debug or release targets) and specify it in Source executable image.
2. Specify the XMCD file if necessary, refer to Use SPT tool to boot cm33 image.
3. Use Additional images to specify CM7 application image running from flash memory. See *Table 1* for how to fill in the necessary information for this additional image.

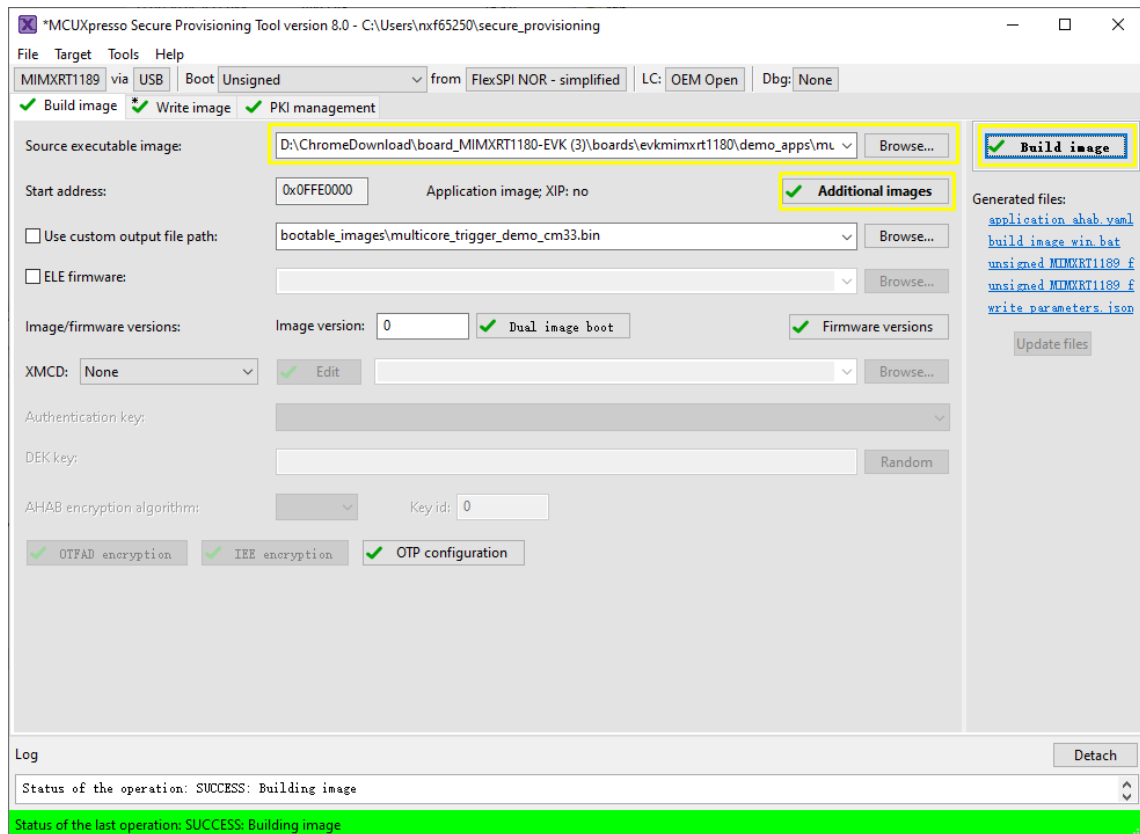
Parameter	Value	Explanation
Image offset	0x007	The offset in bytes from the beginning of the current container header to beginning of the image. In our case, the CM7 image is flashed to 0x2880_0000. The container header is put to 0x2800_1000 and the yield offset = 0x7F_F000
Load address	0x288	The destination address of the CM7 image. ROM copies the image to load address, if it is not within flash address space. In our case, copy does not happen
Entry point	0x288	The start address of CM7 image vector table from the CM7 core address space
Core ID	cortex-m7	Specify the core ID
Image type	Executable	Specify the image type
Encryption	No	Specify the encryption

Additional User/OEM Images									✕
	Use for build	Image binary path		Image offset	Load address	Entry point	Image type	Core ID	Encrypted
1	☒	D:\Archive\Release\RT1180_EVK_SDK\boards\evkmimrt1180\demo_apps\hello_world\cm7\armgcc\flexspi_nor_debug\hello_world.bin		0x007FF000	0x28800000	0x28800000	executable	cortex-m7	no
2	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
3	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
4	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
5	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
6	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
7	☐			0x00000000	0x00000000	0x00000000	data	cortex-m33	no
App. binary image	☒	source_images\multicore_trigger_cm33.bin		0x00804C00	0x0FFE0000	0x0FFE0000	executable	cortex-m33	no

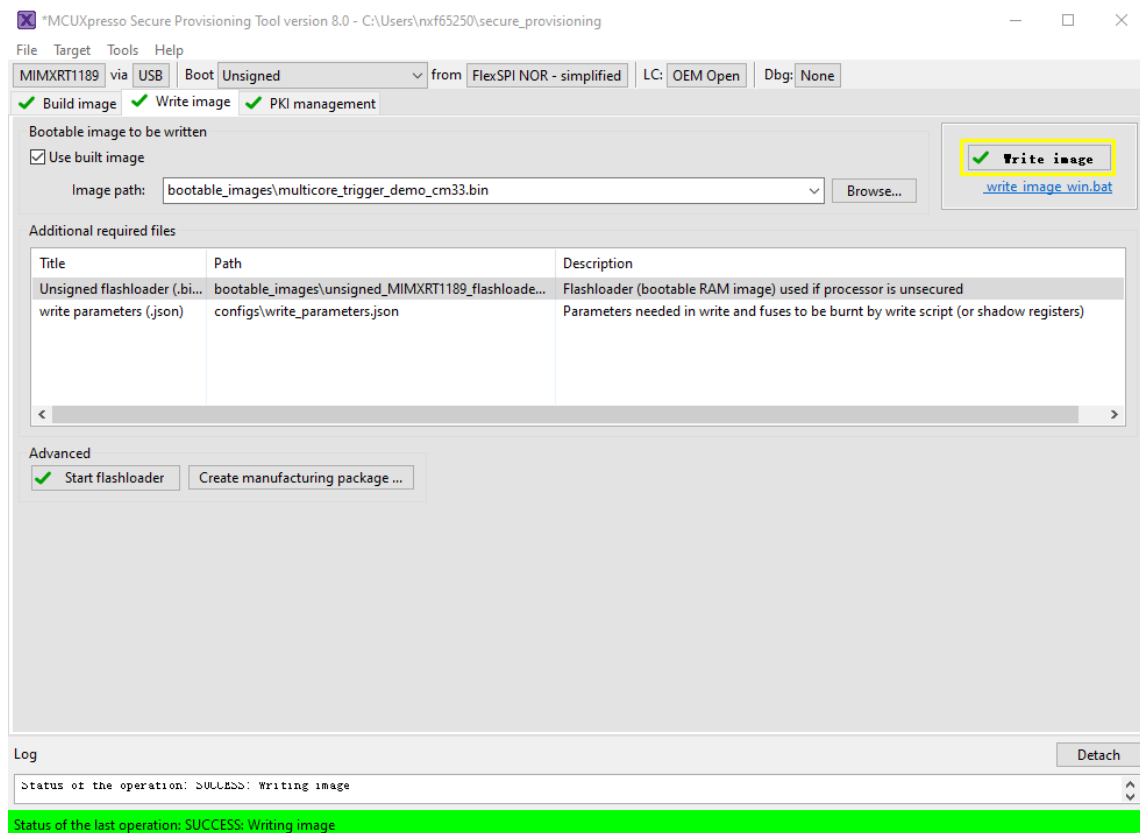
4. (Optional) ELE firmware.

It is required for certain application images which need special ELE FW service. For most SDK demos, leaves it empty.

- Use Build image to build the combined bootable image. SW5[1..4] needs to be set to 0001 to let the SOC in serial download mode here.



6. Use Write image to flash the image.



```

Writing Image (D:\Workspace\SEC_Workspace\write_image_win.bat)

blhost succeeded
### Write image 0 ###
blhost -t 5000 -u 0x15A2,0x0073 -j -- write-memory 0x38001000
"D:\Workspace\SEC_Workspace\bootable_images\rpmmsg_lite_pingpong_rtos_cm33.bin" 0
{
  "command": "write-memory",
  "response": [
    91168
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
blhost succeeded

SUCCESS: Writing image
Close

```

After a successful write, change the SW5[1..4] to QSPI boot mode 0100 and reset the board. You can observe that the image is running from POR boot.

Parent topic: Use SPT tool and multicore_trigger image to kick off cm7 binary image

CM7 binary image runs from internal TCM, and multicore_trigger CM33 image runs from external FLASH **Note:** Be very careful that this scenario requires fuse manipulation, which is not revertible.

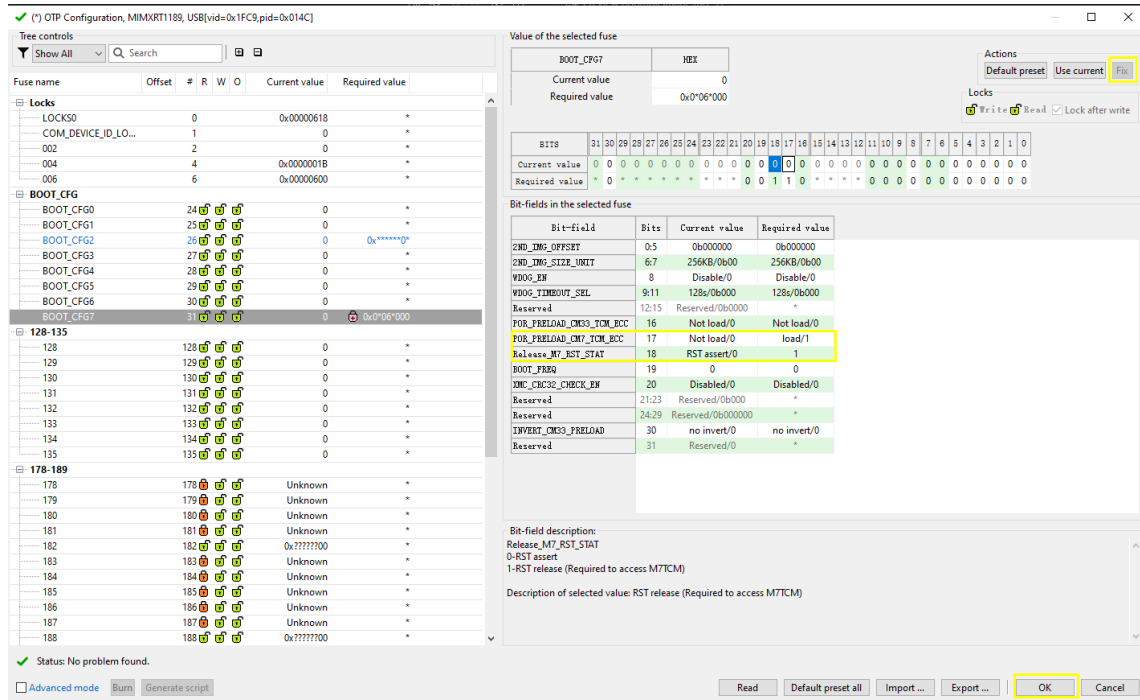
1. Prepare the multicore_trigger_demo_cm33 flash target image (flexspi_nor_debug or flexspi_nor_release) and specify it in Source executable image.
2. Use Additional images to specify CM7 application image running from ITCM memory. See *Table 1* for how to fill in necessary information for this additional image.

Parameter	Value	Explanation
Image offset	0xFF	The offset in bytes from the beginning of the current container header to beginning of the image. In our case, the CM7 TCM image is flashed to 0x2810_0000. The container header is put to 0x2800_1000 and the yield offset = 0xF_F000
Load address	0x30F	The secured alias of CM7 ITCM in CM33/ROM memory space. ROM will copy image to this address
Entry point	0x0	The start address of vector table from CM7 core address space
Core ID	cortex-m7	Specify the core ID
Image type	Executable	Specify the image type
Encryption	No	Specify the encryption

Additional User/OEM Images									
	Use for build	Image path	Image offset	Load address	Entry point	Image type	Core ID	Encrypted	
1	☒	D:\ChromeDownload\board_MIMXRT1180-EVK (3)\boards\evkmimxrt1180_demo_apps\led_blinky\cm7\iar\Debug\rlcd_blinky_demo_cm7.bin	0x0000A000	0x30FC0000	0x0	executable	cortex-m7	no	
2	☐								
3	☐								
4	☐								
5	☐								
6	☐								
7	☐								
App. binary image	☒	source_images\multicore_trigger_demo_cm33.bin	0x0010A000	0x2810B000	0x2810B000	executable	cortex-m33	no	

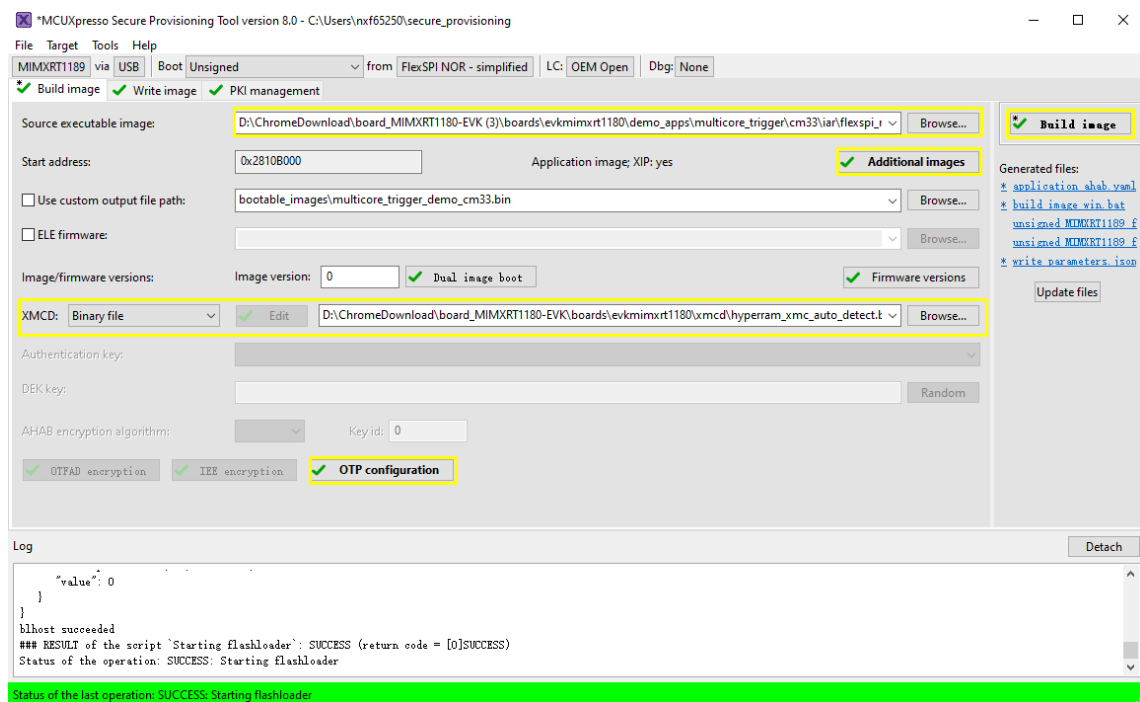
- For ROM to successful copy image from flash to CM7 TCM. CM7 TCM ECC should be pre-configured. To archive this, a Fuse need to be set. Click OTP configuration, set POR_PRELOAD_CM7_TCM_ECC and RELEASE_M7_RST_STAT fuses in BOOT_CFG7 to 1.

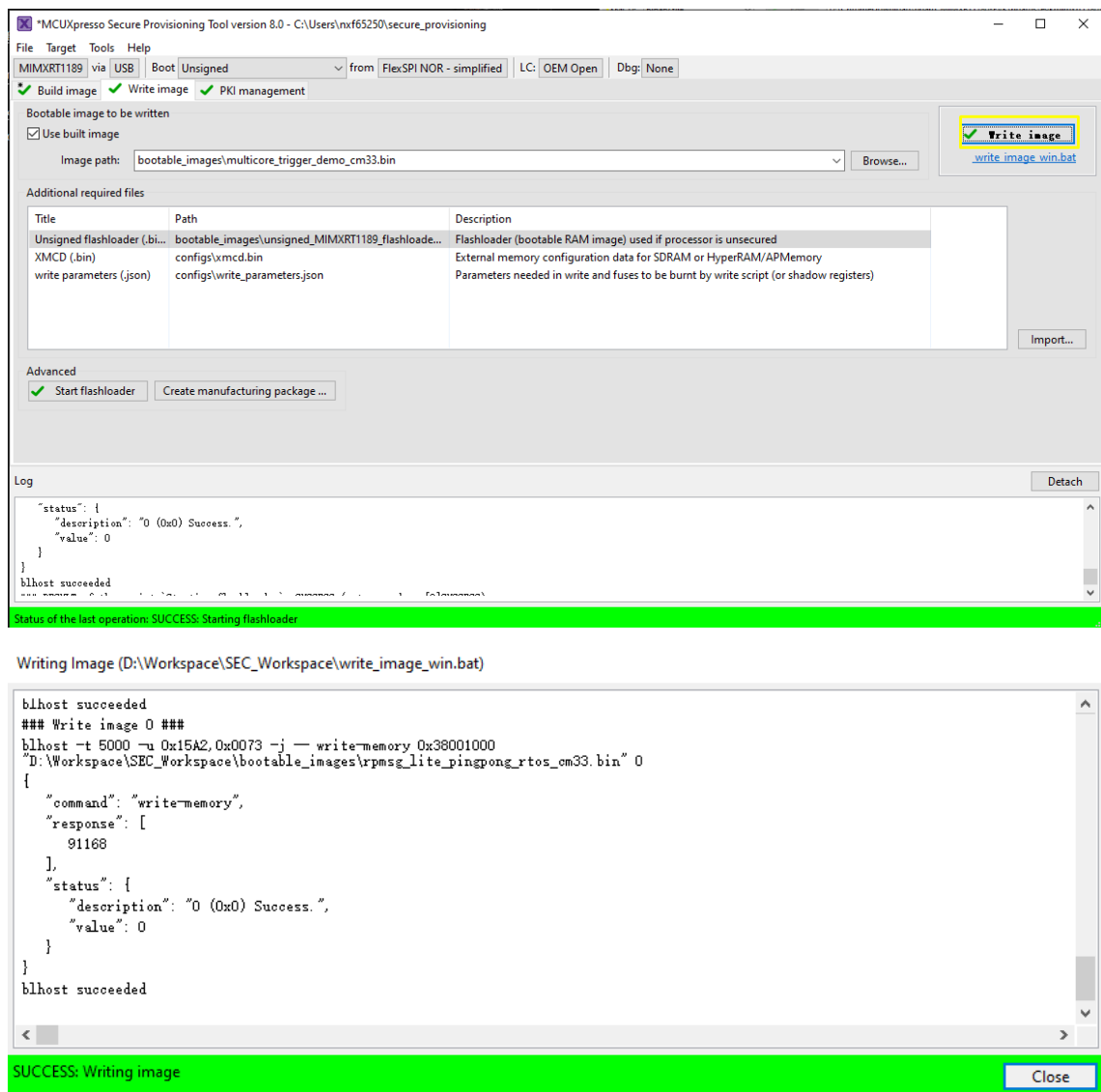
Note: Be very careful that any setting on OTP cannot be reverted once set. There is possibility that the chip get bricked if you are fusing the wrong fuse word. Only do this if you really need to try this boot scenario.



- (Optional) ELE firmware.

It is needed for a certain application image which needs a special ELE FW service. For most SDK demos, simply leave it empty.





After a successful write, change the SW5[1..4] to QSPI boot mode 0100 and reset the board. You can observe that the image is running from the POR boot.

Note:

1. The new image constructed under **Build images** is still not a complete image, and the Memory Configuration Block is missing. When writing image, SPT downloads the contents of the Memory Configuration Block to FLASH.
2. When CM33 + CM7 image runs with the following target combination, it is required to set CM33_SET_TRDC to 1U in multicore_trigger demo, also requires to set CM33_SET_TRDC to 1U in CM7 demo if it exists.

- CM33 flexspi + CM7 flexspi, flexspi means flexspi_nor_debug/release, flexspi_nor_sdram_debug/release, flexspi_nor_hyperram_debug/release
- CM33 HYPERRAM + CM7 HYPERRAM, HYPERRAM means hyperram_txt_debug/release.

3. Only those cm7 projects whose linkages are similar with hello_world_demo_cm7, support POR run via multicore_trigger_cm33.

Parent topic: Use SPT tool and multicore_trigger image to kick off cm7 binary image

Parent topic: [Bootable image generation](#)

RAW/POR image switch In current delivered SDK package, most demos generate RAW images. To enhance customer OOB experience, the following RT1180 SDK CM33 project/targets generate POR image, which means that they can POR run after you debug/download it in IDE.

- IAR/GCC/MDK, *hello_world_demo_cm33* *flexspi_nor_debug/release,*
flexspi_nor_hyperram_debug/release
- IAR/GCC/MDK, *multicore_hello_world_cm33* *flexspi_nor_debug/release,*
flexspi_nor_hyperram_debug/release
- MCUX CM33 image are all POR images except the *multicore_trigger* demo.

Note:

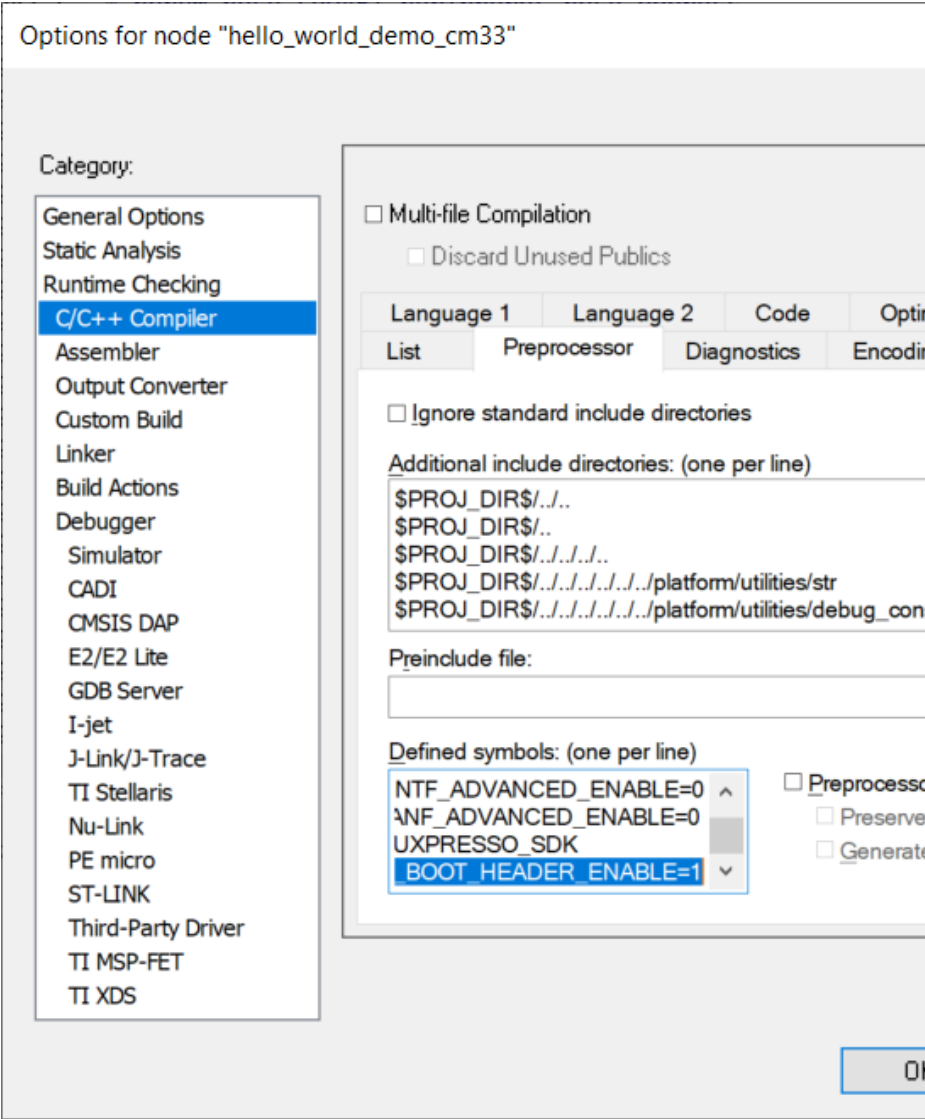
- These POR images are not signed, just for develop convenience, not recommended for product usage.
- It is highly recommended to use SPT for image download.

For the SDK CM33 IAR/MDK/ARMGCC project, *flexspi_nor* targets, as well as for MCUX project, debug/release targets. It is easy to switch RAW/POR image, via the project macro *XIP_BOOT_HEADER_ENABLE* setting. *Table 1* describes the rules.

XIP_BOOT_HEADER_ENABLE setting	Image type
1	POR
0	RAW

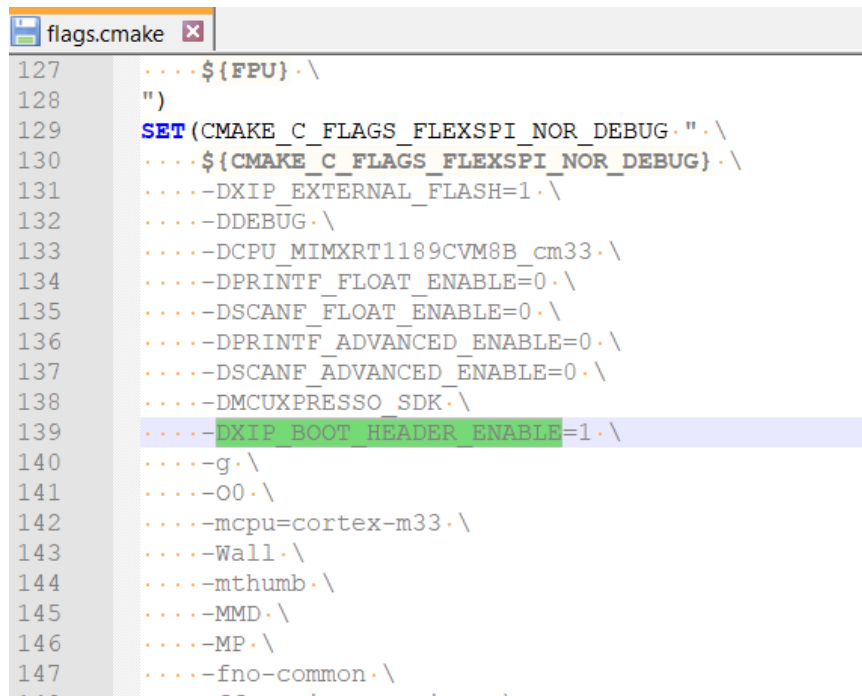
- For IAR/ARMGCC, change the macro *XIP_BOOT_HEADER_ENABLE* in the compiler setting.
- For MDK, change the macro *XIP_BOOT_HEADER_ENABLE* in compiler and link setting simultaneously.

For detailed settings, see the following sections.



IAR settings for image type switch

Parent topic:RAW/POR image switch



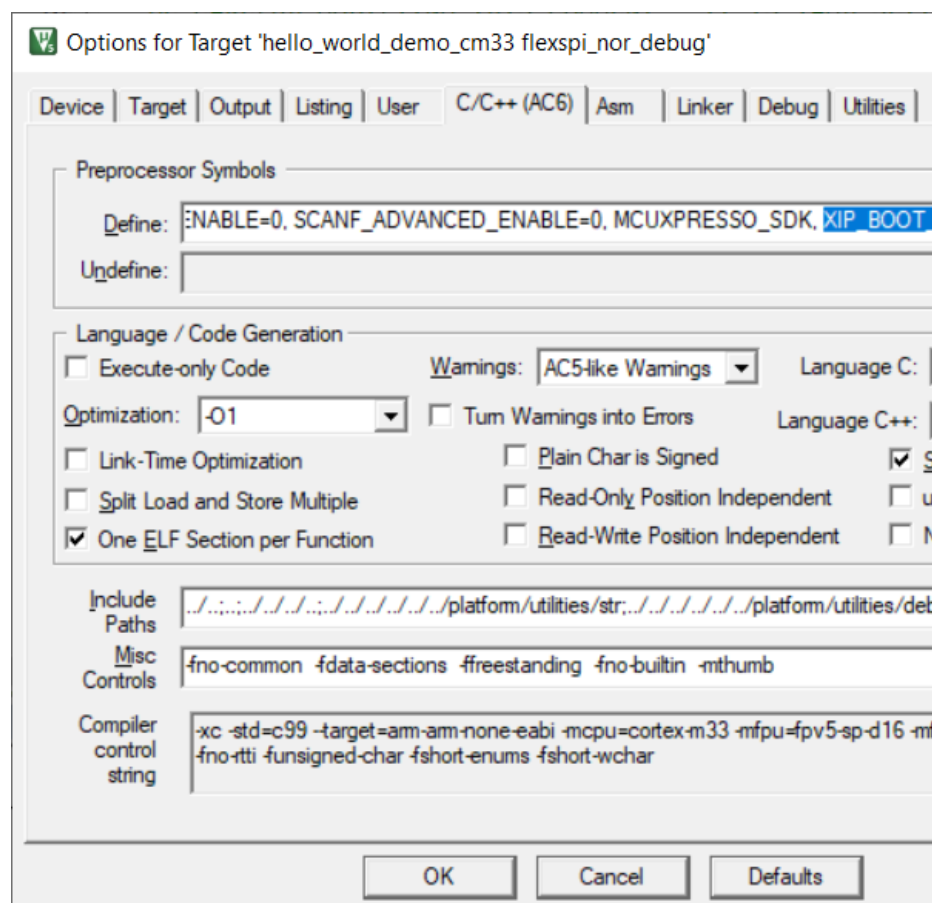
```

127     ... ${FPU} . \
128     ")
129     SET(CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG " . \
130     ... ${CMAKE_C_FLAGS_FLEXSPI_NOR_DEBUG} . \
131     ... -DXIP_EXTERNAL_FLASH=1 . \
132     ... -DDEBUG . \
133     ... -DCPU_MIMXRT1189CVM8B_cm33 . \
134     ... -DPRINTF_FLOAT_ENABLE=0 . \
135     ... -DSCANF_FLOAT_ENABLE=0 . \
136     ... -DPRINTF_ADVANCED_ENABLE=0 . \
137     ... -DSCANF_ADVANCED_ENABLE=0 . \
138     ... -DMCUXPRESSO_SDK . \
139     ... -DXIP_BOOT_HEADER_ENABLE=1 . \
140     ... -g . \
141     ... -O0 . \
142     ... -mcpu=cortex-m33 . \
143     ... -Wall . \
144     ... -mthumb . \
145     ... -MMD . \
146     ... -MP . \
147     ... -fno-common . \

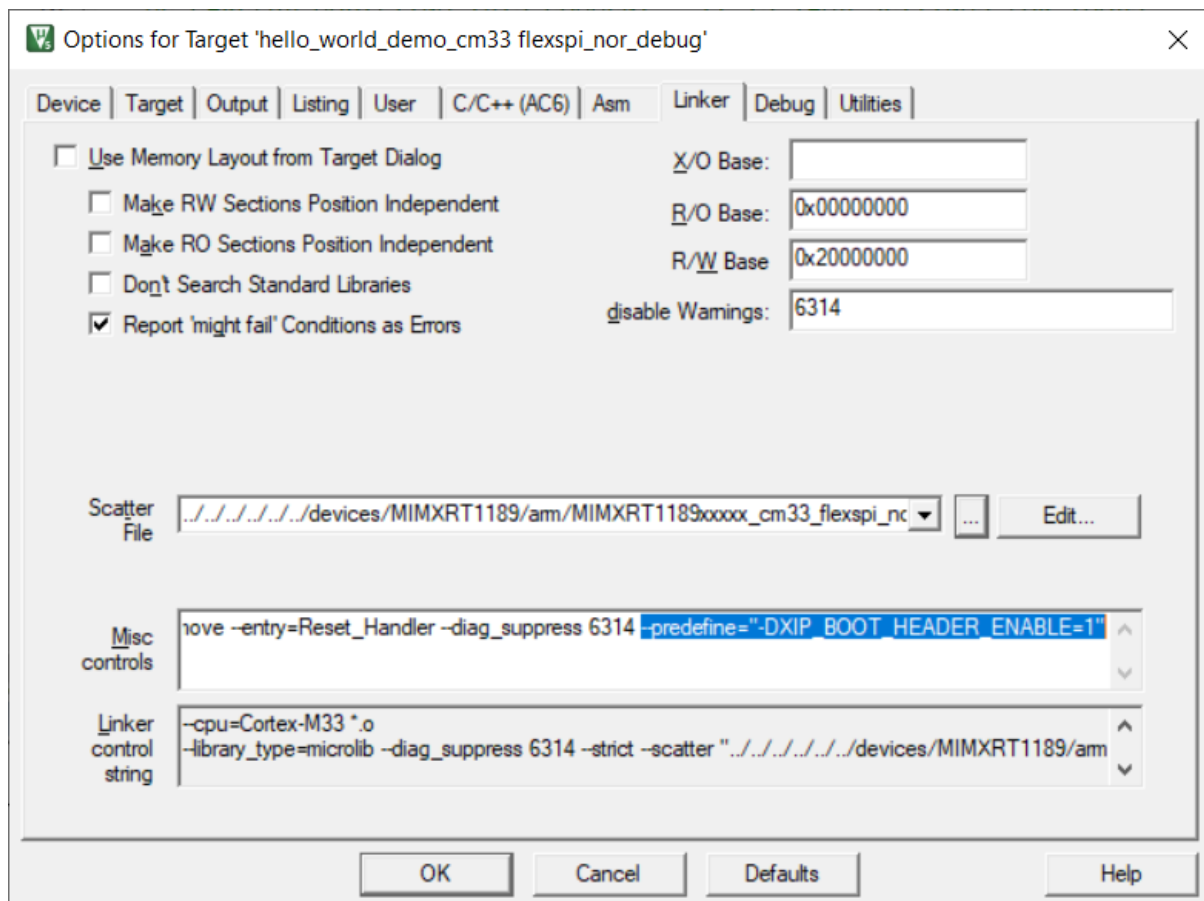
```

ARMGCC settings for image type switch

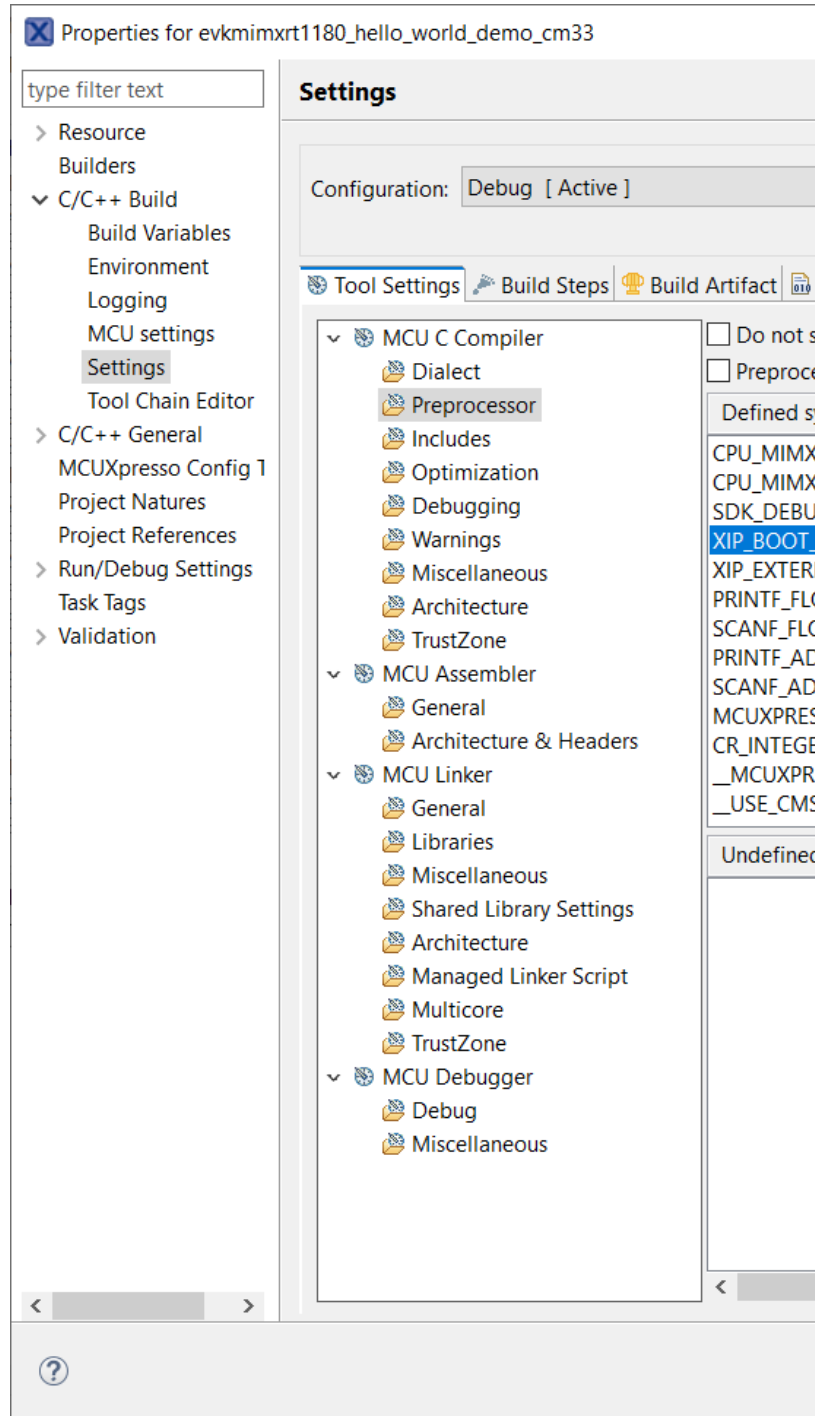
Parent topic: RAW/POR image switch



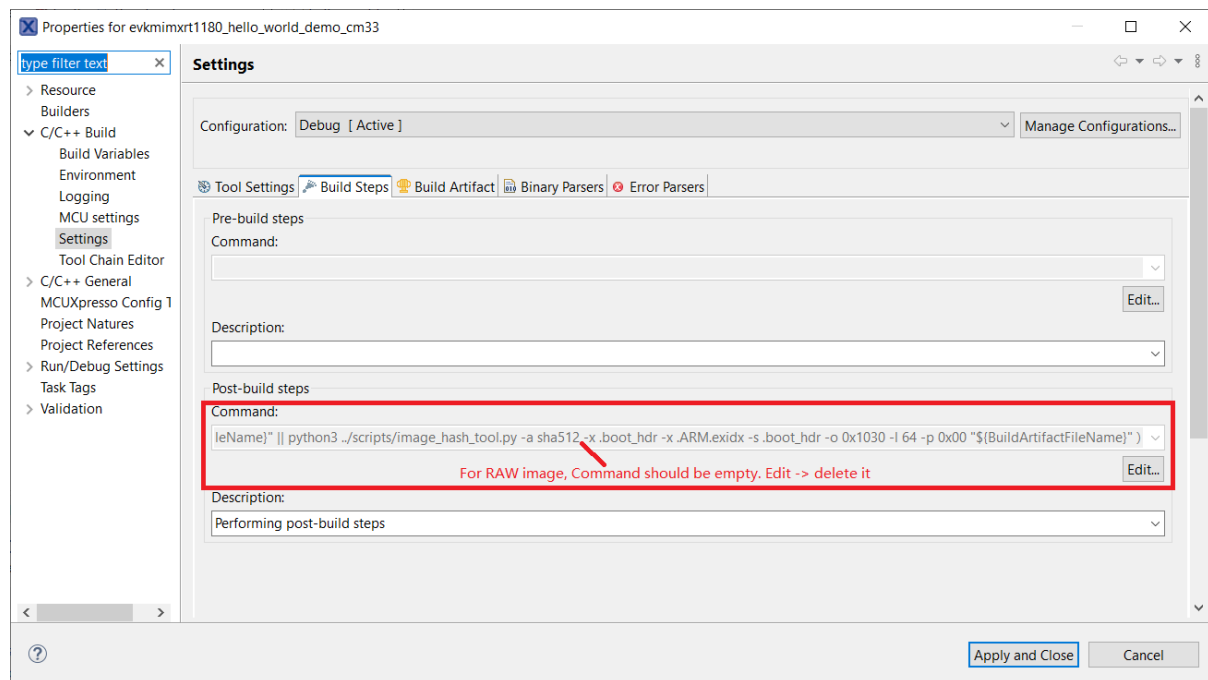
MDK setting for image type switch



Parent topic:RAW/POR image switch



MCUXpresso settings for image type switch

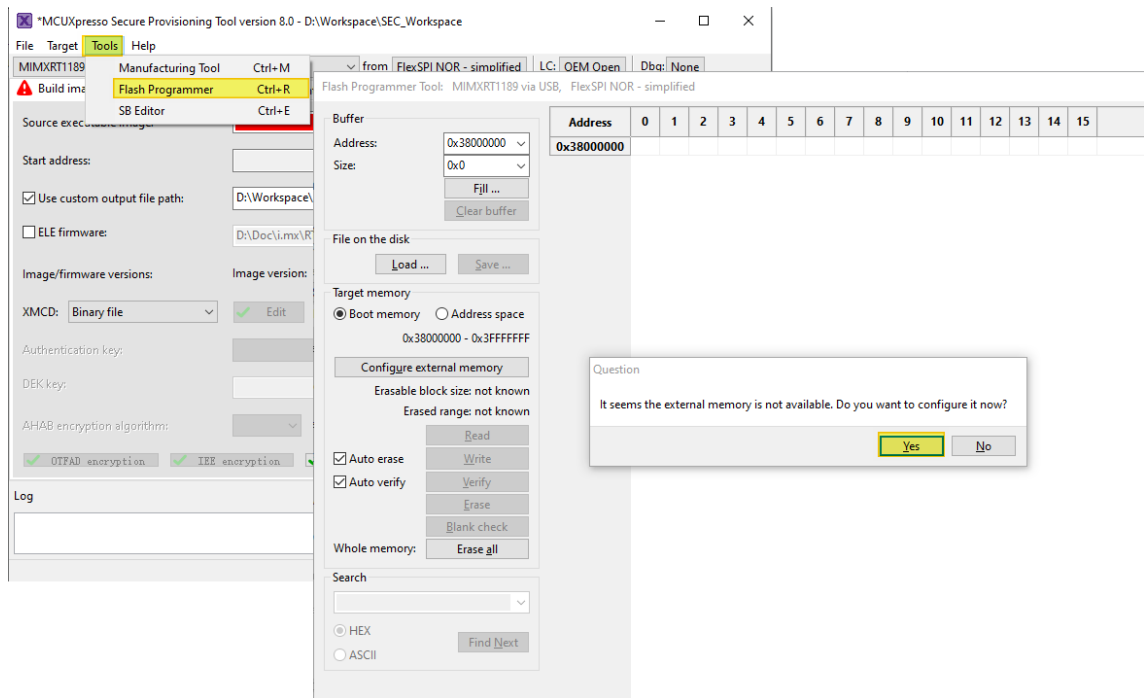


Parent topic:RAW/POR image switch

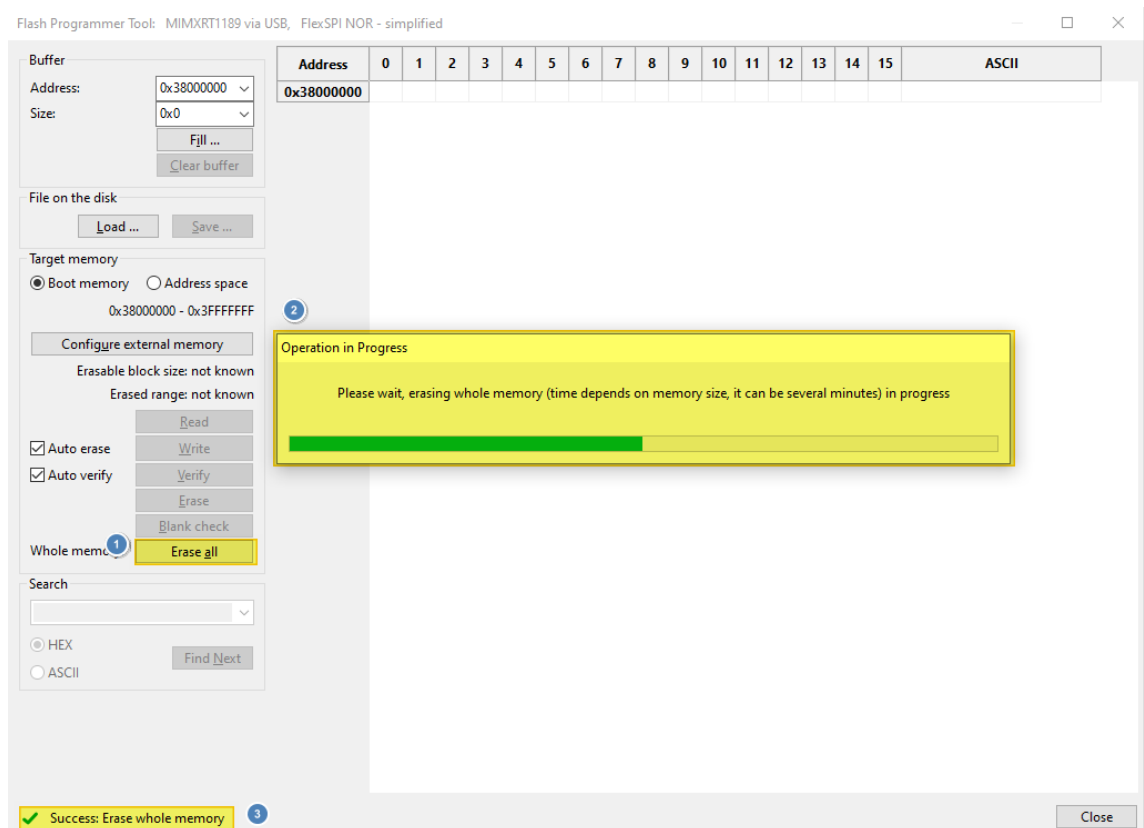
Parent topic:[Bootable image generation](#)

Use Secure Provisioning Tool to erase flash In worst cases a debugger cannot successfully connect to the board. A major reason for this is there are POR boot image inside the on board flash memory which causes the whole system in a trouble state. Secure Provisioning Tool provide a reliable way to erase the flash in this worst case. To achieve this

1. Set SW5[1:4] to 0001.
2. Connect the board to your PC from both J53 (Debugging) and J33 (USB OTG 1), then power up the board.
3. Start Secure Provisioning Tool, select Tool > Flash Programmer or Ctrl + R.
4. Click Yes to prompt up questions, wait memory initialization finish.



5. Click Erase all button and wait a minute for the erase process to finish.



6. After Success: Erase whole memory shows up, the board should have restored to a good state to work in various mode.

Parent topic: [Bootable image generation](#)

MCUXpresso configuration 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 configuration for the selected board or processor. The generated code is used with MCUXpresso SDK version 2.x.

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

Config tool	Description	Image
Pins tool	For configuration of pin routing and pin electrical properties.	
Clock tool	For system clock configuration.	
Peripherals tools	For configuration of other peripherals	
TEE tool	Configures access policies for memory area and peripherals helping to protect and isolate sensitive parts of the application.	

MCUXpresso Config Tools can be accessed in the following products:

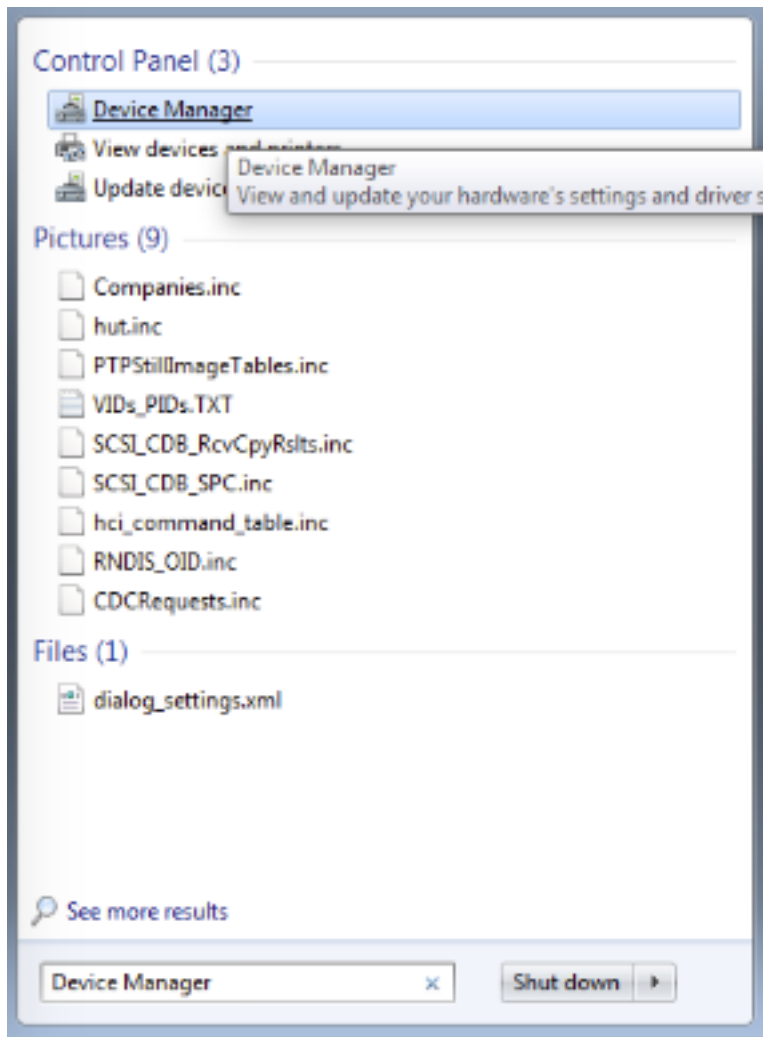
- **Integrated** in the MCUXpresso IDE. Config tools are integrated with both compiler and debugger which makes it the easiest way to begin the development.
- **Standalone version** available for download from [MCUXPRESSO](#). Recommended for customers using IAR Embedded Workbench, Keil MDK µVision, or Arm GCC.
- **Online version** available on [MCUXPRESSO](#). Recommended 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

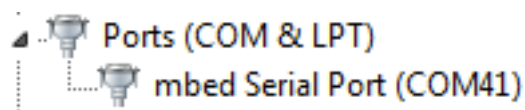
This section describes the steps necessary to determine the debug COM port number of your NXP hardware development platform.

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

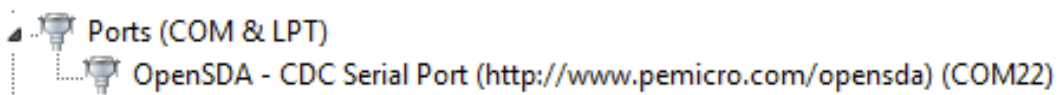


2. In the **Device Manager**, expand the **Ports (COM & LPT)** section to view the available ports. Depending on the NXP board you're using, the COM port can be named differently.

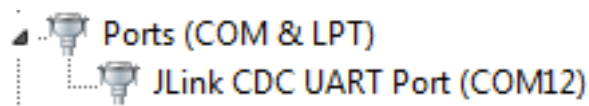
1. OpenSDA – CMSIS-DAP/mbed/DAPLink interface:



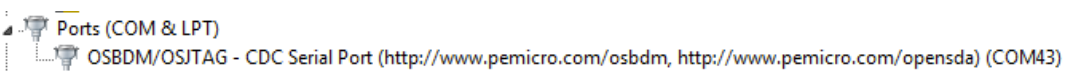
2. OpenSDA – P&E Micro:



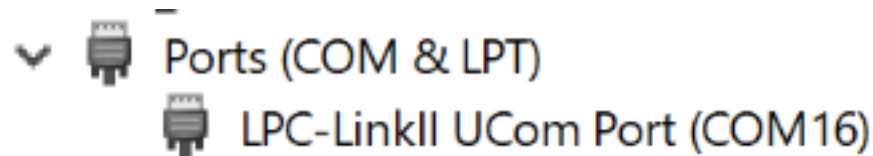
3. OpenSDA – J-Link:



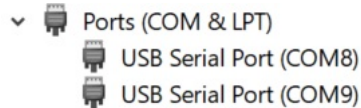
4. P&E Micro OSJTAG:



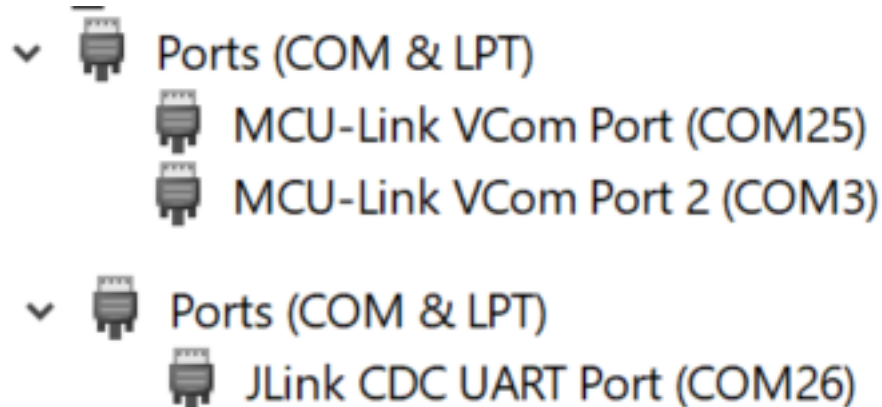
5. LPC-Link2:



6. FTDI UART:



7. MCU-Link::



Default debug interfaces

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

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

continues on next page

Table 1 – continued from previous page

Hardware platform	Default interface	OpenSDA details ¹
FRDM-KL46Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL81Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KL82Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KV10Z	CMSIS-DAP	OpenSDA v2.1
FRDM-KV11Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KV31F	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KW24	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.1
FRDM-KW36	DAPLink	OpenSDA v2.2
FRDM-KW41Z	CMSIS-DAP/DAPLink	OpenSDA v2.1 or greater
Hexiwear	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.0
HVP-KE18F	DAPLink	OpenSDA v2.2
HVP-KV46F150M	P&E Micro OpenSDA	OpenSDA v1
HVP-KV11Z75M	CMSIS-DAP	OpenSDA v2.1
HVP-KV58F	CMSIS-DAP	OpenSDA v2.1
HVP-KV31F120M	P&E Micro OpenSDA	OpenSDA v1
JN5189DK6	CMSIS-DAP	N/A
LPC54018 IoT Module	N/A	N/A
LPCXpresso54018	CMSIS-DAP	N/A
LPCXpresso54102	CMSIS-DAP	N/A
LPCXpresso54114	CMSIS-DAP	N/A
LPCXpresso51U68	CMSIS-DAP	N/A
LPCXpresso54608	CMSIS-DAP	N/A
LPCXpresso54618	CMSIS-DAP	N/A
LPCXpresso54628	CMSIS-DAP	N/A
LPCXpresso54S018M	CMSIS-DAP	N/A
LPCXpresso55s16	CMSIS-DAP	N/A
LPCXpresso55s28	CMSIS-DAP	N/A
LPCXpresso55s69	CMSIS-DAP	N/A
MAPS-KS22	J-Link OpenSDA	OpenSDA v2.0
MIMXRT1170-EVK	CMSIS-DAP	N/A
MIMXRT1180-EVK	CMSIS-DAP	OpenSDA v2.2
TWR-K21D50M	P&E Micro OSJTAG	N/AOpenSDA v2.0
TWR-K21F120M	P&E Micro OSJTAG	N/A
TWR-K22F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K24F120M	CMSIS-DAP/mbd	OpenSDA v2.1
TWR-K60D100M	P&E Micro OSJTAG	N/A
TWR-K64D120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K64F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K80F150M	CMSIS-DAP	OpenSDA v2.1
TWR-K81F150M	CMSIS-DAP	OpenSDA v2.1
TWR-KE18F	DAPLink	OpenSDA v2.1
TWR-KL28Z72M	P&E Micro OpenSDA	OpenSDA v2.1
TWR-KL43Z48M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KL81Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KL82Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KM34Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KM35Z75M	DAPLink	OpenSDA v2.2
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV11Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV31F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV46F150M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV58F220M	CMSIS-DAP	OpenSDA v2.1

continues on next page

Table 1 – continued from previous page

Hardware platform	Default interface	OpenSDA details ¹
TWR-KW24D512	P&E Micro OpenSDA	OpenSDA v1.0
USB-KW24D512	N/A External probe	N/A
USB-KW41Z	CMSIS-DAP\DAPLink	OpenSDA v2.1 or greater

¹ The OpenSDA details is not applicable to LPC.

Note about the source code in the document

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1.3 Getting Started with MCUXpresso SDK GitHub

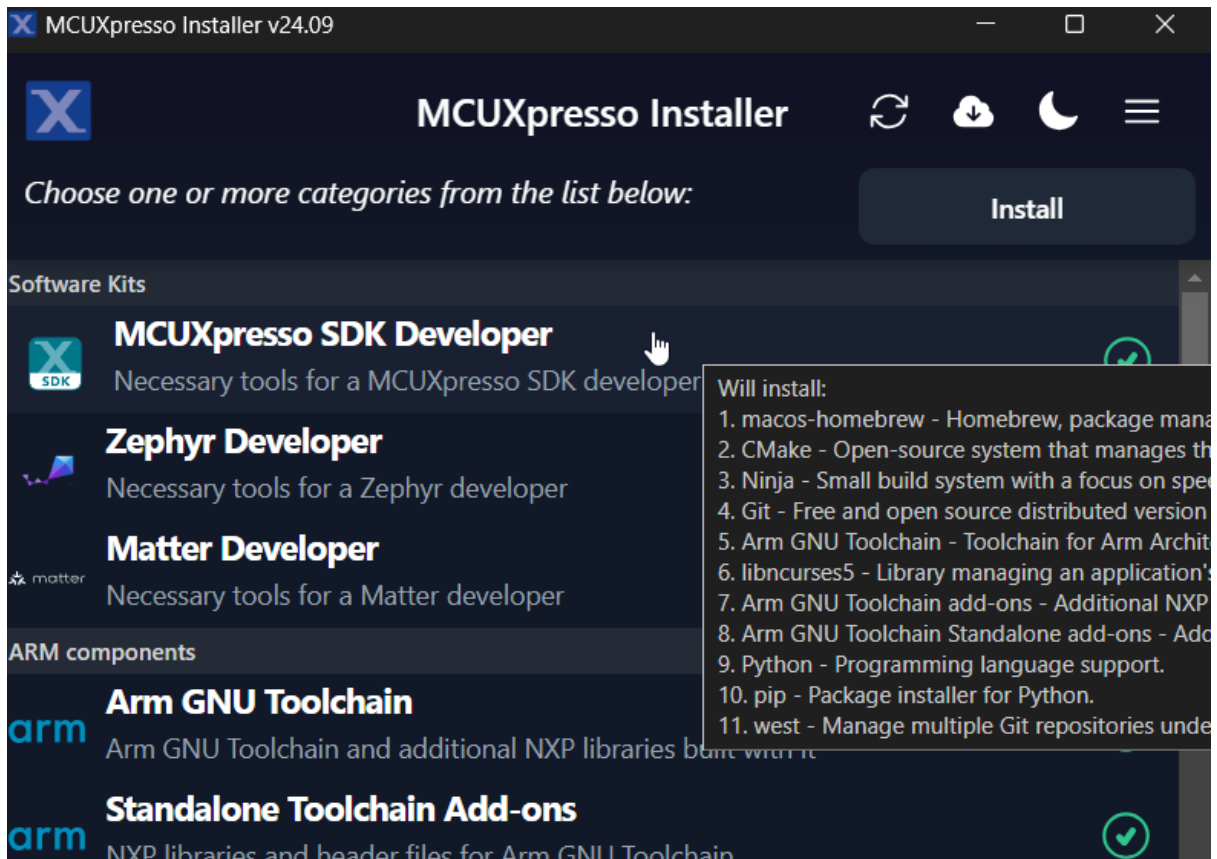
1.3.1 Getting Started with MCUXpresso SDK Repository

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.

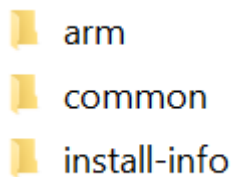
Toolchain MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

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_SDK	c:\NXP\zephyr-sdk-<version> for windows/opt/zephyr-sdk-<version> for Linux	– toolchain zephyr
CodeWarrior	CW_DIR	C:\Freescall\CW MCU v11.2 for windowsCodeWarrior is not supported with Linux	– toolchain code-warrior
Xtensa	XCC_DIR	C:\xtensa\XtDevTools\install\tools\RI-2023.11-win32\XtensaTools for windows/opt/xtensa/XtDevTools/install/tools/RI-2023.11-Linux/XtensaTools for Linux	– toolchain xtensa
NXP S32Compiler RISC-V Zen-V	RISCV-LVM_DIR	C:\riscv-llvm-win32_b298_b298_2024.08.12 for Windows/opt/riscv-llvm-Linux-x64_b298_b298_2024.08.12 for Linux	– toolchain riscv-llvm

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



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

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

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

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

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

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

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

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

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

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

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

Get MCUXpresso SDK Repo

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

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

# Update the west projects
cd mcuxpresso-sdk
west update

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

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

1. Navigate to the core directory:

```
cd mcuxsdk
```

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

```
python -m venv .venv

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

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

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

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

3. Install the required Python packages:

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

Explore Contents

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

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

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

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

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

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

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

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

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

Run a demo using MCUXpresso for VS Code

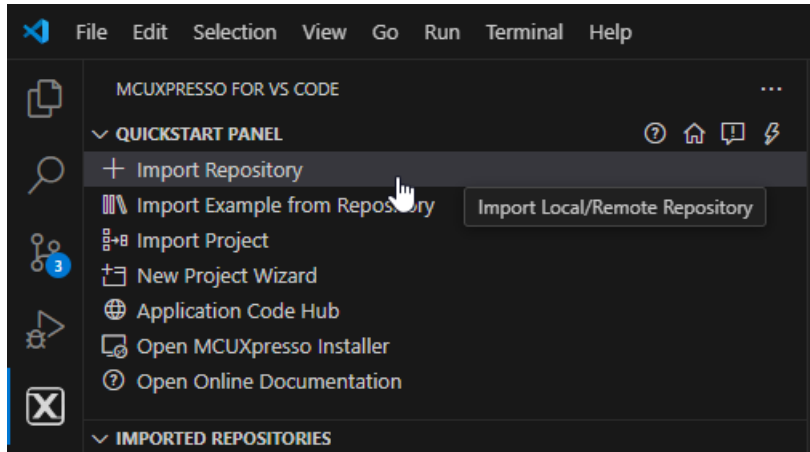
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the `hello_world` demo application as an example. However, these

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

Build an example application This section assumes that the user has already obtained the SDK as outlined in [Get MCUXpresso SDK Repo](#).

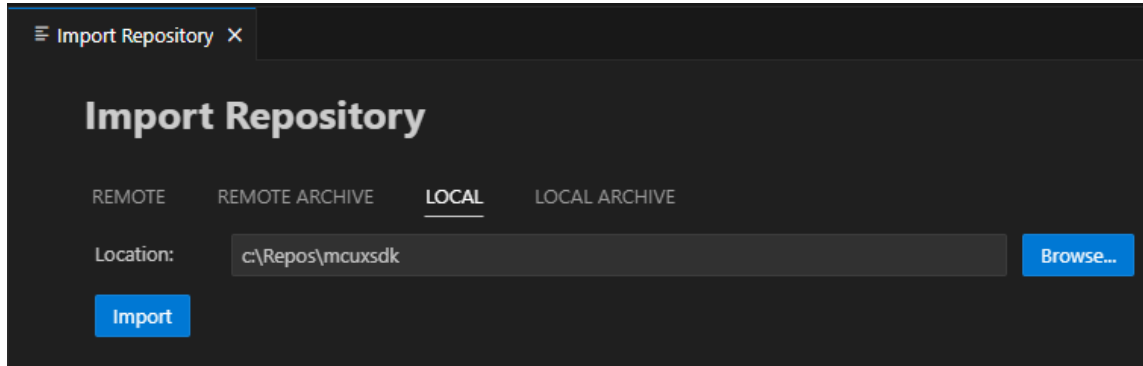
To build an example application:

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

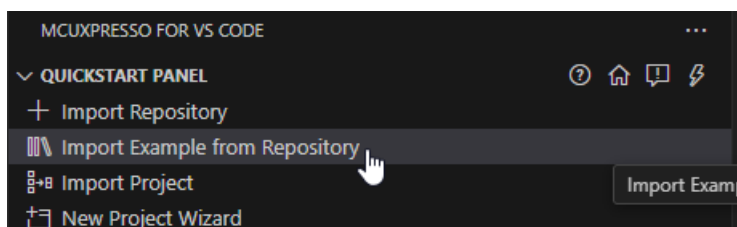


Note: You can import the SDK in several ways. Refer to [MCUXpresso for VS Code Wiki](#) for details.

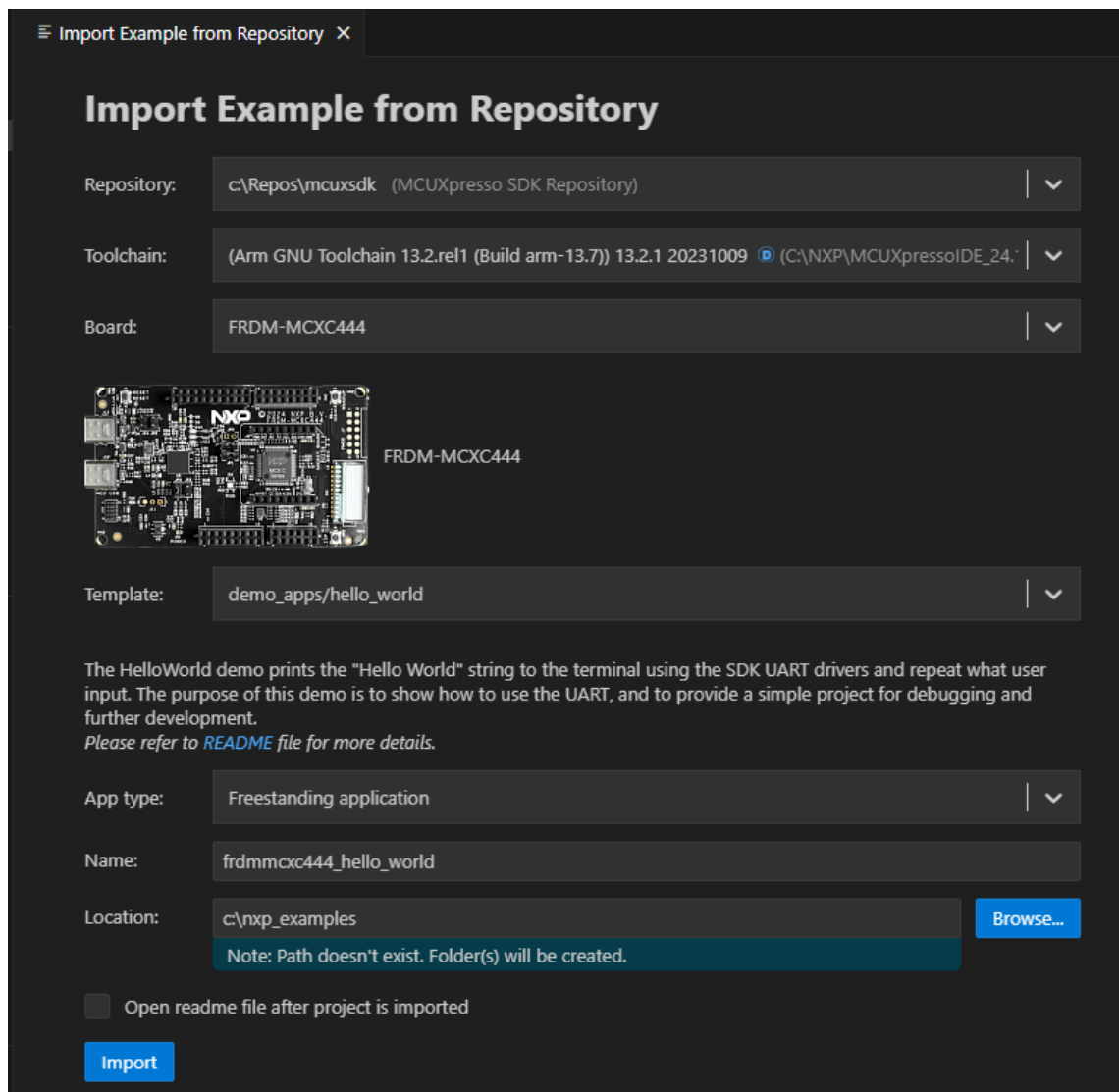
Select **Local** if you've already obtained the SDK as seen in [Get MCUXpresso SDK Repo](#). Select your location and click **Import**.



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



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



Import Example from Repository

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

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

Board: FRDM-MCXC444 | v

 FRDM-MCXC444

Template: demo_apps/hello_world | v

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

App type: Freestanding application | v

Name: frdmmcxc444_hello_world

Location: c:\nxp_examples [Browse...](#)

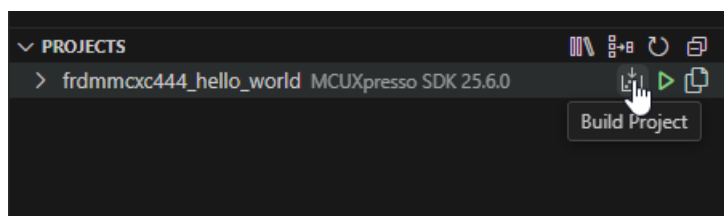
Note: Path doesn't exist. Folder(s) will be created.

☐ Open readme file after project is imported

[Import](#)

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

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



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

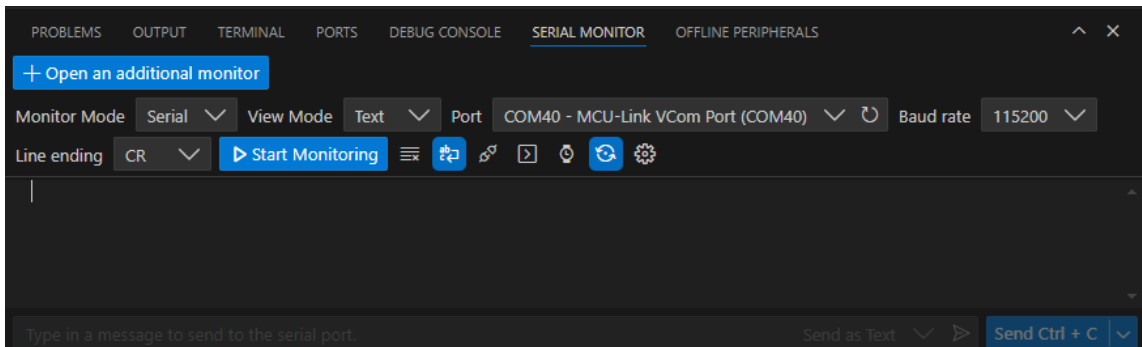

```

[17/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/components/debug_console_lite/fsl_debug_console.c.obj
[18/21] Building C object CMakeFiles/hello_world.dir/C:/Repos/mcuxsdk/mcuxsdk/devices/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.

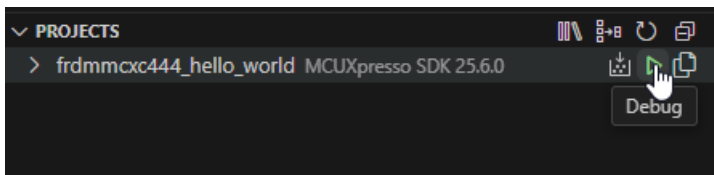
```

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

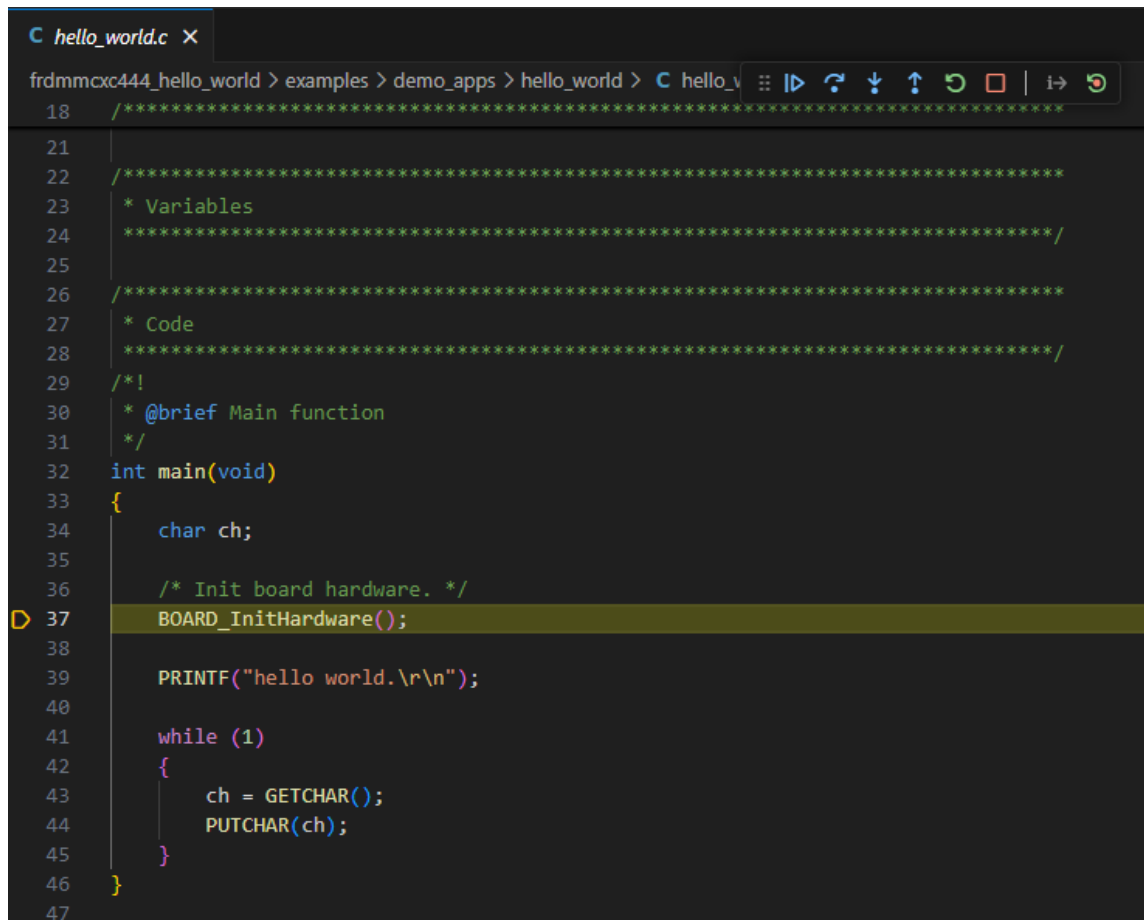
1. Open the **Serial Monitor** from the VS Code's integrated terminal. Select the VCom Port for your device and set the baud rate to 115200.



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.

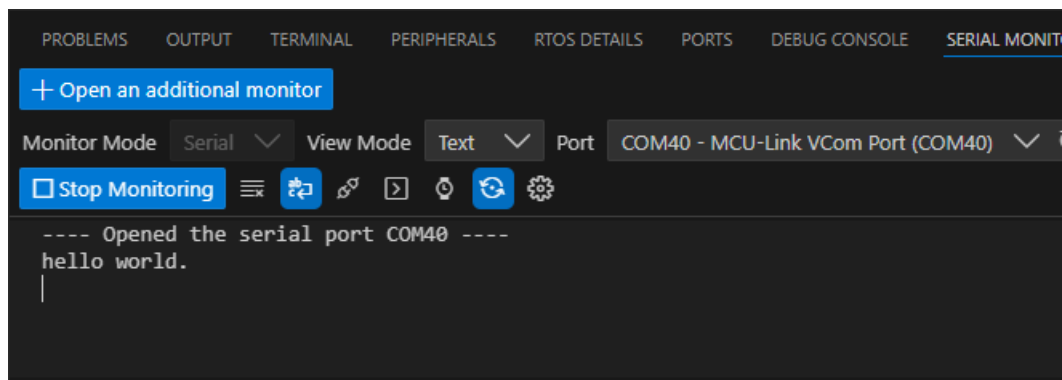


```

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)

```

↪ evkbnimxrt1060]
INFO: [ 4]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1170 -Dcore_id=cm4]
INFO: [ 5]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1170 -Dcore_id=cm7]
INFO: [ 6]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimxrt1060]
INFO: [ 7]west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪ evkbnimx7ulp]
...

```

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

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

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

Here are some typical usages for generating a SDK example:

```

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

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

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

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

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

```

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

```

west build -b evkbnimxrt1170 examples/demo_apps/hello_world --toolchain iar -Dcore_id=cm7 --config_
↪ flexspi_nor_debug

```

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

```

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

```

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

```

west build -b evkbnimxrt1170 --sysbuild ./examples/multicore_examples/hello_world/primary -Dcore_
↪ id=cm7 --config flexspi_nor_debug --toolchain=armgcc -p always

```

For more details, please refer to System build.

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

1. Run cmake configuration

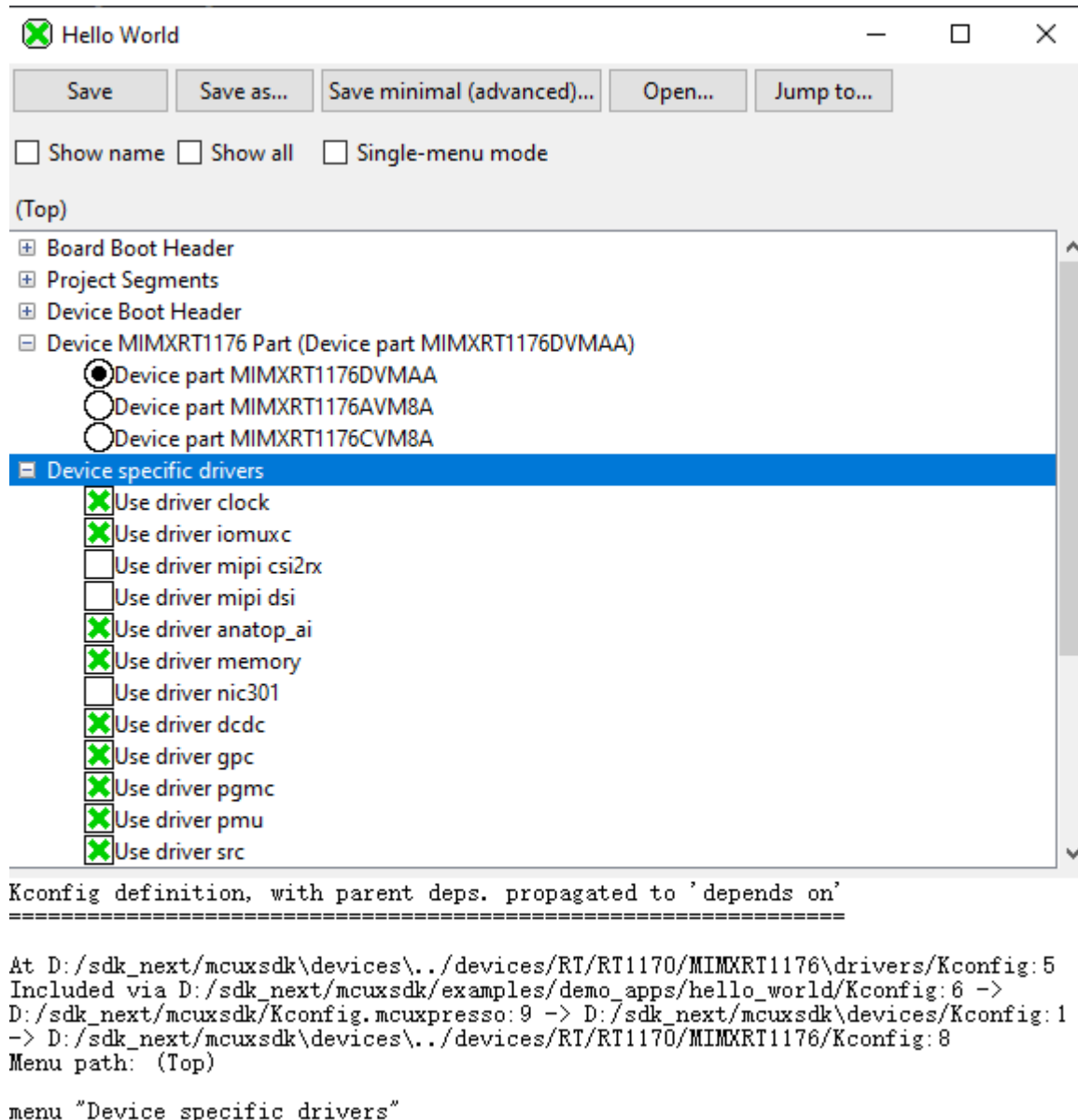
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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

2. Run guiconfig target

```
west build -t guiconfig
```

Then you will get the Kconfig GUI launched, like



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

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

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

```
west flash -r linkserver
```

Debug Start a gdb interface by following command:

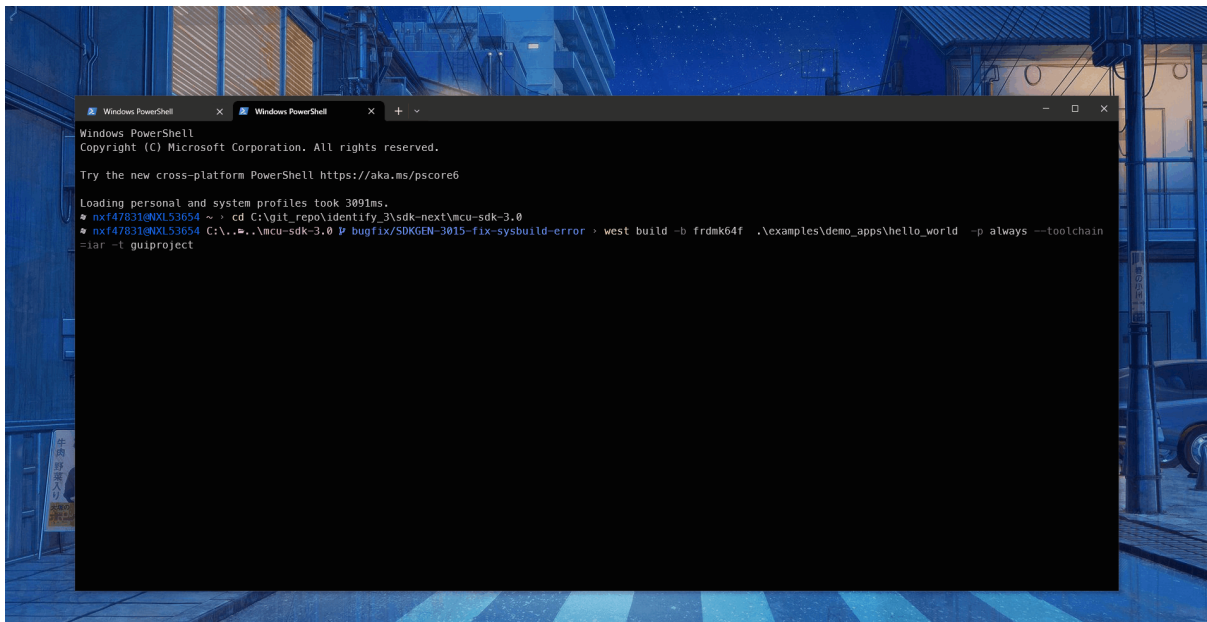
```
west debug -r linkserver
```

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

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

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

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



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

1.4 Release Notes

1.4.1 MCUXpresso SDK Release Notes

Overview

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

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

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

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

MCUXpresso SDK

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

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

Development tools

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

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

Supported development systems

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

De- vel- op- ment board	MCU devices
MIMX	MIMXRT1181CVP2B, MIMXRT1181CVP2C, MIMXRT1181XVP2B, MIMXRT1181XVP2C,
EVK	MIMXRT1182CVP2B, MIMXRT1182CVP2C, MIMXRT1182XVP2B, MIMXRT1182XVP2C,
	MIMXRT1187AVM8B, MIMXRT1187AVM8C, MIMXRT1187CVM8B,
	MIMXRT1187CVM8C, MIMXRT1187XVM8B, MIMXRT1187XVM8C,
	MIMXRT1189CVM8B, MIMXRT1189CVM8C , MIMXRT1189XVM8B,
	MIMXRT1189XVM8C

MCUXpresso SDK release package

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

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

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

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

RTOS

FreeRTOS Real-time operating system for microcontrollers from Amazon

Middleware

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

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

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

Ethermind BT/BLE Stack nxp_bt_ble_stack

coreHTTP coreHTTP

wpa_supplicant-rtos NXP Wi-Fi WPA Supplicant

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

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

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

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

TinyCBOR Concise Binary Object Representation (CBOR) Library

PSA Test Suite Arm Platform Security Architecture Test Suite

FreeModbus FreeModbus Library

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

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

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

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

MCU Boot Open source MCU Bootloader.

mbedTLS mbedtls SSL/TLS library v3.x

mbedTLS mbedtls SSL/TLS library v2.x

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

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

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

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

eIQ machine learning SDK containing:

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

llhttp HTTP parser llhttp

LittleFS LittleFS filesystem stack

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.

NAND Flash Management Stack NAND Flash Management Stack

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

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

ELE Crypto Crypto functionality provided Edgelock Core

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.

Flashing CM7 Image After Bootable CM33 Image Breaks Build

Issue Description In SPI boot mode ($SW5[1..4] = 0100$), after using IDE/Secure Provisioning Tool to flash a bootable CM33 image, if any flexspi_nor target CM7 image is programmed using IDE, the SOC will enter an unresponsive state and all further debugging attempts will fail.

Prevention To avoid this issue:

- After flashing a bootable CM33 image, always erase the flash before flashing any non-bootable CM7 image.

Recovery Steps If you accidentally enter this state:

1. Change to Internal Boot mode or Serial Download mode ($SW[1..4] = 0000/0001$)
2. Use IDE/Secure Provisioning Tool to erase the flash
3. The system should now be restored to normal operation

Note for Customer Boards For customer boards without a boot mode switch, we are working on a permanent fix which is expected to roll out soon.

Reference

Ticket	Description	Version
MCUX-76778	Flash a CM7 image following a CM33 bootable image will break the build	25.03.00

Segger version

The lowest required J-Link version is v7.94g.

AWS examples are not fully tested

The examples under `boards/evkmimxrt1180/aws_examples` are not fully tested. The associated features and functionalities are only for the evaluation purpose. Full feature verification will be covered in a future release.

Missing fsl_cache when create new project with board or kit

When creating a new C/C++ project, if `evkmimxrt1180` or `evkmimxrt1180_om13790host` kit is selected, `fsl_cache` component gets missed and causes build failure. To avoid the build failure, manually select it in **SDK Wizard** page.

Debugging problems

When debugging `hyperram_txt_debug` or `hyperram_txt_release` target, user may encounter issue when debug with breakpoint. The reason is because code is cached. The default breakpoint type is auto/software breakpoint, it will lead soc core and debugger misaligned. As a workaround, please set breakpoint type to hardware breakpoint.

In addition, `hyperram_txt` targets can't debug on IAR versions: 9.50.1, 9.50.2, 9.60.1. The resolution is: delete the selected contents as shown in *Figure 1* in IAR path: `arm\config\flashloader\NXP\FlashIMXRT1180-EVK_FlexSPI_M33.board`.

Other issues

The following are additional known issues in this release.

Ticket	Description	History
MCUX-66649	Build erros when create new project wizard with various component	2.15.000 RT1180
MCUX-65840	Semihost terminal is not working well with JLink	2.15.000 RT1180
MCUX-66442	Edgefast a2dp_sink does not work properly on release target of MDK toolchain	2.15.000 RT1180
MCUX-65874	WIFI wifi_cli and wifi_wpa_supplicant will show no iperf summary in UDP server mode with both ipv4 and ipv6 in CM33 core	2.15.000 RT1180

Security ELE requires ping every 24 hours

The security ELE requires ping every 24 hours, which is mandatory.

Most of RT118x demos don't ping ELE every 24 hours, because those demos focus on the function demonstrate only. It is still **MUST** to ping ELE every 24 hours if demo run duration > 24 hours.

Check `hello_world_demo_cm33` for example on how to ping ELE.

CM33 NPW project in MCUXpresso does not support POR run by default

When creating a new CM33 C/C++ project in MCUXpresso, the default is RAW image, which means it does not support POR run.

To make a default POR image, check the “**RAW/POR image switch**” section in Getting Started document.

Example `hello_world_ns` fails with mdk toolchain

The example `hello_world_ns` fails with mdk toolchain while switching to the non-secure world.

Examples: `hello_world_ns`, `hello_world_s` **Affected toolchains:** mdk **Affected platforms:** evk-mimxrt1180

The `aws_examples` don't work

The example stucks during TLS connection.

Affected toolchains: mcux **Affected platforms:** evkmimxrt1180

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

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

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

Affected toolchains: mdk, iar

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

1.5 ChangeLog

1.5.1 MCUXpresso SDK Changelog

Board Support Files

`board`

[25.06.00]

- Initial version
 - Replaced the XXX_SERIES macros with the CPU_xxx macros in the common configuration file
 - Added the legacy IAR supporting Mac file

clock_config**[25.06.00]**

- Initial version
 - Updated the clock_config.c to align with the latest part number and the clock tool model
 - Removed the OSC RC 400M dating control, which is not supported by the hardware

pin_mux**[25.06.00]**

- Initial version
 - Updated pin_mux.c to align with the latest part number and the pin tool model
-

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.

[MIMXRT1189](#)

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 SDK](#)

1.7.2 MCU Boot

[mcuboot_opensource](#)

1.7.3 eIQ

[eiq](#)

1.7.4 FreeMASTER

freemaster

1.7.5 AWS IoT

AWS IoT

1.7.6 NXP Wi-Fi

Wi-Fi, Bluetooth, 802.15.4

1.7.7 FreeRTOS

FreeRTOS

1.7.8 Wireless EdgeFast Bluetooth PAL

edgefast_bluetooth

1.7.9 lwIP

lwIP

1.7.10 File systemFatfs

FatFs

Chapter 2

MIMXRT1189

2.1 ACMP: Analog Comparator Driver

`void ACMP_Init(CMP_Type *base, const acmp_config_t *config)`

Initializes the ACMP.

The default configuration can be got by calling `ACMP_GetDefaultConfig()`.

Parameters

- `base` – ACMP peripheral base address.
- `config` – Pointer to ACMP configuration structure.

`void ACMP_Deinit(CMP_Type *base)`

Deinitializes the ACMP.

Parameters

- `base` – ACMP peripheral base address.

`void ACMP_GetDefaultConfig(acmp_config_t *config)`

Gets the default configuration for ACMP.

This function initializes the user configuration structure to default value. The default value are:

Example:

```
config->enableHighSpeed = false;
config->enableInvertOutput = false;
config->useUnfilteredOutput = false;
config->enablePinOut = false;
config->enableHysteresisBothDirections = false;
config->hysteresisMode = kACMP_hysteresisMode0;
```

Parameters

- `config` – Pointer to ACMP configuration structure.

`void ACMP_Enable(CMP_Type *base, bool enable)`

Enables or disables the ACMP.

Parameters

- `base` – ACMP peripheral base address.
- `enable` – True to enable the ACMP.

`void ACMP_EnableLinkToDAC(CMP_Type *base, bool enable)`

Enables the link from CMP to DAC enable.

When this bit is set, the DAC enable/disable is controlled by the bit `CMP_C0[EN]` instead of `CMP_C1[DACEN]`.

Parameters

- `base` – ACMP peripheral base address.
- `enable` – Enable the feature or not.

`void ACMP_SetChannelConfig(CMP_Type *base, const acmp_channel_config_t *config)`

Sets the channel configuration.

Note that the plus/minus mux's setting is only valid when the positive/negative port's input isn't from DAC but from channel mux.

Example:

```
acmp_channel_config_t configStruct = {0};
configStruct.positivePortInput = kACMP_PortInputFromDAC;
configStruct.negativePortInput = kACMP_PortInputFromMux;
configStruct.minusMuxInput = 1U;
ACMP_SetChannelConfig(CMP0, &configStruct);
```

Parameters

- `base` – ACMP peripheral base address.
- `config` – Pointer to channel configuration structure.

`void ACMP_EnableDMA(CMP_Type *base, bool enable)`

Enables or disables DMA.

Parameters

- `base` – ACMP peripheral base address.
- `enable` – True to enable DMA.

`void ACMP_SetFilterConfig(CMP_Type *base, const acmp_filter_config_t *config)`

Configures the filter.

The filter can be enabled when the filter count is bigger than 1, the filter period is greater than 0 and the sample clock is from divided bus clock or the filter is bigger than 1 and the sample clock is from external clock. Detailed usage can be got from the reference manual.

Example:

```
acmp_filter_config_t configStruct = {0};
configStruct.filterCount = 5U;
configStruct.filterPeriod = 200U;
configStruct.enableSample = false;
ACMP_SetFilterConfig(CMP0, &configStruct);
```

Parameters

- `base` – ACMP peripheral base address.
- `config` – Pointer to filter configuration structure.

`void ACMP_SetDACConfig(CMP_Type *base, const acmp_dac_config_t *config)`

Configures the internal DAC.

Example:

```
acmp_dac_config_t configStruct = {0};
configStruct.referenceVoltageSource = kACMP_VrefSourceVin1;
configStruct.DACValue = 20U;
configStruct.enableOutput = false;
configStruct.workMode = kACMP_DACWorkLowSpeedMode;
ACMP_SetDACConfig(CMP0, &configStruct);
```

Parameters

- base – ACMP peripheral base address.
- config – Pointer to DAC configuration structure. “NULL” is for disabling the feature.

void ACMP_EnableInterrupts(CMP_Type *base, uint32_t mask)

Enables interrupts.

Parameters

- base – ACMP peripheral base address.
- mask – Interrupts mask. See “_acmp_interrupt_enable”.

void ACMP_DisableInterrupts(CMP_Type *base, uint32_t mask)

Disables interrupts.

Parameters

- base – ACMP peripheral base address.
- mask – Interrupts mask. See “_acmp_interrupt_enable”.

uint32_t ACMP_GetStatusFlags(CMP_Type *base)

Gets status flags.

Parameters

- base – ACMP peripheral base address.

Returns

Status flags asserted mask. See “_acmp_status_flags”.

void ACMP_ClearStatusFlags(CMP_Type *base, uint32_t mask)

Clears status flags.

Parameters

- base – ACMP peripheral base address.
- mask – Status flags mask. See “_acmp_status_flags”.

void ACMP_SetDiscreteModeConfig(CMP_Type *base, const *acmp_discrete_mode_config_t* *config)

Configure the discrete mode.

Configure the discrete mode when supporting 3V domain with 1.8V core.

Parameters

- base – ACMP peripheral base address.
- config – Pointer to configuration structure. See “acmp_discrete_mode_config_t”.

void ACMP_GetDefaultDiscreteModeConfig(*acmp_discrete_mode_config_t* *config)

Get the default configuration for discrete mode setting.

Parameters

- `config` – Pointer to configuration structure to be restored with the setting values.

FSL_ACMP_DRIVER_VERSION

ACMP driver version 2.3.0.

enum `_acmp_interrupt_enable`

Interrupt enable/disable mask.

Values:

enumerator `kACMP_OutputRisingInterruptEnable`

Enable the interrupt when comparator outputs rising.

enumerator `kACMP_OutputFallingInterruptEnable`

Enable the interrupt when comparator outputs falling.

enum `_acmp_status_flags`

Status flag mask.

Values:

enumerator `kACMP_OutputRisingEventFlag`

Rising-edge on compare output has occurred.

enumerator `kACMP_OutputFallingEventFlag`

Falling-edge on compare output has occurred.

enumerator `kACMP_OutputAssertEventFlag`

Return the current value of the analog comparator output.

enum `_acmp_offset_mode`

Comparator hard block offset control.

If OFFSET level is 1, then there is no hysteresis in the case of positive port input crossing negative port input in the positive direction (or negative port input crossing positive port input in the negative direction). Hysteresis still exists for positive port input crossing negative port input in the falling direction. If OFFSET level is 0, then the hysteresis selected by `acmp_hysteresis_mode_t` is valid for both directions.

Values:

enumerator `kACMP_OffsetLevel0`

The comparator hard block output has level 0 offset internally.

enumerator `kACMP_OffsetLevel1`

The comparator hard block output has level 1 offset internally.

enum `_acmp_hysteresis_mode`

Comparator hard block hysteresis control.

See chip data sheet to get the actual hysteresis value with each level.

Values:

enumerator `kACMP_HysteresisLevel0`

Offset is level 0 and Hysteresis is level 0.

enumerator `kACMP_HysteresisLevel1`

Offset is level 0 and Hysteresis is level 1.

enumerator `kACMP_HysteresisLevel2`

Offset is level 0 and Hysteresis is level 2.

enumerator kACMP_HysteresisLevel3

Offset is level 0 and Hysteresis is level 3.

enum _acmp_reference_voltage_source

CMP Voltage Reference source.

Values:

enumerator kACMP_VrefSourceVin1

Vin1 is selected as resistor ladder network supply reference Vin.

enumerator kACMP_VrefSourceVin2

Vin2 is selected as resistor ladder network supply reference Vin.

enum _acmp_port_input

Port input source.

Values:

enumerator kACMP_PortInputFromDAC

Port input from the 8-bit DAC output.

enumerator kACMP_PortInputFromMux

Port input from the analog 8-1 mux.

enum _acmp_dac_work_mode

Internal DAC's work mode.

Values:

enumerator kACMP_DACWorkLowSpeedMode

DAC is selected to work in low speed and low power mode.

enumerator kACMP_DACWorkHighSpeedMode

DAC is selected to work in high speed high power mode.

typedef enum _acmp_offset_mode acmp_offset_mode_t

Comparator hard block offset control.

If OFFSET level is 1, then there is no hysteresis in the case of positive port input crossing negative port input in the positive direction (or negative port input crossing positive port input in the negative direction). Hysteresis still exists for positive port input crossing negative port input in the falling direction. If OFFSET level is 0, then the hysteresis selected by acmp_hysteresis_mode_t is valid for both directions.

typedef enum _acmp_hysteresis_mode acmp_hysteresis_mode_t

Comparator hard block hysteresis control.

See chip data sheet to get the actual hysteresis value with each level.

typedef enum _acmp_reference_voltage_source acmp_reference_voltage_source_t

CMP Voltage Reference source.

typedef enum _acmp_port_input acmp_port_input_t

Port input source.

typedef enum _acmp_dac_work_mode acmp_dac_work_mode_t

Internal DAC's work mode.

typedef struct _acmp_config acmp_config_t

Configuration for ACMP.

```
typedef struct _acmp_channel_config acmp_channel_config_t
```

Configuration for channel.

The comparator's port can be input from channel mux or DAC. If port input is from channel mux, detailed channel number for the mux should be configured.

```
typedef struct _acmp_filter_config acmp_filter_config_t
```

Configuration for filter.

```
typedef struct _acmp_dac_config acmp_dac_config_t
```

Configuration for DAC.

```
typedef struct _acmp_discrete_mode_config acmp_discrete_mode_config_t
```

Configuration for discrete mode.

```
CMP_C0_CFx_MASK
```

The mask of status flags cleared by writing 1.

```
struct _acmp_config
```

#include <fsl_acmp.h> Configuration for ACMP.

Public Members

acmp_offset_mode_t offsetMode

Offset mode.

acmp_hysteresis_mode_t hysteresisMode

Hysteresis mode.

bool enableHighSpeed

Enable High Speed (HS) comparison mode.

bool enableInvertOutput

Enable inverted comparator output.

bool useUnfilteredOutput

Set compare output(COUT) to equal COUTA(true) or COUT(false).

bool enablePinOut

The comparator output is available on the associated pin.

```
struct _acmp_channel_config
```

#include <fsl_acmp.h> Configuration for channel.

The comparator's port can be input from channel mux or DAC. If port input is from channel mux, detailed channel number for the mux should be configured.

Public Members

acmp_port_input_t positivePortInput

Input source of the comparator's positive port.

uint32_t plusMuxInput

Plus mux input channel(0~7).

acmp_port_input_t negativePortInput

Input source of the comparator's negative port.

uint32_t minusMuxInput

Minus mux input channel(0~7).

struct _acmp_filter_config
#include <fsl_acmp.h> Configuration for filter.

Public Members

uint32_t filterCount
Filter Sample Count. Available range is 1-7, 0 would cause the filter disabled.

uint32_t filterPeriod
Filter Sample Period. The divider to bus clock. Available range is 0-255.

struct _acmp_dac_config
#include <fsl_acmp.h> Configuration for DAC.

Public Members

acmp_reference_voltage_source_t referenceVoltageSource
Supply voltage reference source.

uint32_t DACValue
Value for DAC Output Voltage. Available range is 0-255.

bool enableOutput
Enable the DAC output.

struct _acmp_discrete_mode_config
#include <fsl_acmp.h> Configuration for discrete mode.

Public Members

bool enablePositiveChannelDiscreteMode
Positive Channel Continuous Mode Enable. By default, the continuous mode is used.

bool enableNegativeChannelDiscreteMode
Negative Channel Continuous Mode Enable. By default, the continuous mode is used.

2.2 AOI: Crossbar AND/OR/INVERT Driver

void AOI_Init(AOI_Type *base)
Initializes an AOI instance for operation.
This function un-gates the AOI clock.

Parameters

- base – AOI peripheral address.

void AOI_Deinit(AOI_Type *base)
Deinitializes an AOI instance for operation.
This function shutdowns AOI module.

Parameters

- base – AOI peripheral address.

```
void AOI_GetEventLogicConfig(AOI_Type *base, aoi_event_t event, aoi_event_config_t *config)
```

Gets the Boolean evaluation associated.

This function returns the Boolean evaluation associated.

Example:

```
aoi_event_config_t demoEventLogicStruct;

AOI_GetEventLogicConfig(AOI, kAOI_Event0, &demoEventLogicStruct);
```

Parameters

- base – AOI peripheral address.
- event – Index of the event which will be set of type `aoi_event_t`.
- config – Selected input configuration .

```
void AOI_SetEventLogicConfig(AOI_Type *base, aoi_event_t event, const aoi_event_config_t *eventConfig)
```

Configures an AOI event.

This function configures an AOI event according to the `aoiEventConfig` structure. This function configures all inputs (A, B, C, and D) of all product terms (0, 1, 2, and 3) of a desired event.

Example:

```
aoi_event_config_t demoEventLogicStruct;

demoEventLogicStruct.PT0AC = kAOI_InvInputSignal;
demoEventLogicStruct.PT0BC = kAOI_InputSignal;
demoEventLogicStruct.PT0CC = kAOI_LogicOne;
demoEventLogicStruct.PT0DC = kAOI_LogicOne;

demoEventLogicStruct.PT1AC = kAOI_LogicZero;
demoEventLogicStruct.PT1BC = kAOI_LogicOne;
demoEventLogicStruct.PT1CC = kAOI_LogicOne;
demoEventLogicStruct.PT1DC = kAOI_LogicOne;

demoEventLogicStruct.PT2AC = kAOI_LogicZero;
demoEventLogicStruct.PT2BC = kAOI_LogicOne;
demoEventLogicStruct.PT2CC = kAOI_LogicOne;
demoEventLogicStruct.PT2DC = kAOI_LogicOne;

demoEventLogicStruct.PT3AC = kAOI_LogicZero;
demoEventLogicStruct.PT3BC = kAOI_LogicOne;
demoEventLogicStruct.PT3CC = kAOI_LogicOne;
demoEventLogicStruct.PT3DC = kAOI_LogicOne;

AOI_SetEventLogicConfig(AOI, kAOI_Event0, demoEventLogicStruct);
```

Parameters

- base – AOI peripheral address.
- event – Event which will be configured of type `aoi_event_t`.
- eventConfig – Pointer to type `aoi_event_config_t` structure. The user is responsible for filling out the members of this structure and passing the pointer to this function.

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Version 2.0.2.

enum `_aoi_input_config`

AOI input configurations.

The selection item represents the Boolean evaluations.

Values:

enumerator `kAOI_LogicZero`

Forces the input to logical zero.

enumerator `kAOI_InputSignal`

Passes the input signal.

enumerator `kAOI_InvInputSignal`

Inverts the input signal.

enumerator `kAOI_LogicOne`

Forces the input to logical one.

enum `_aoi_event`

AOI event indexes, where an event is the collection of the four product terms (0, 1, 2, and 3) and the four signal inputs (A, B, C, and D).

Values:

enumerator `kAOI_Event0`

Event 0 index

enumerator `kAOI_Event1`

Event 1 index

enumerator `kAOI_Event2`

Event 2 index

enumerator `kAOI_Event3`

Event 3 index

typedef enum `_aoi_input_config` `aoi_input_config_t`

AOI input configurations.

The selection item represents the Boolean evaluations.

typedef enum `_aoi_event` `aoi_event_t`

AOI event indexes, where an event is the collection of the four product terms (0, 1, 2, and 3) and the four signal inputs (A, B, C, and D).

typedef struct `_aoi_event_config` `aoi_event_config_t`

AOI event configuration structure.

Defines structure `_aoi_event_config` and use the `AOI_SetEventLogicConfig()` function to make whole event configuration.

AOI

AOI peripheral address

struct `_aoi_event_config`

`#include <fsl_aoi.h>` AOI event configuration structure.

Defines structure `_aoi_event_config` and use the `AOI_SetEventLogicConfig()` function to make whole event configuration.

Public Members

aoi_input_config_t PT0AC
Product term 0 input A

aoi_input_config_t PT0BC
Product term 0 input B

aoi_input_config_t PT0CC
Product term 0 input C

aoi_input_config_t PT0DC
Product term 0 input D

aoi_input_config_t PT1AC
Product term 1 input A

aoi_input_config_t PT1BC
Product term 1 input B

aoi_input_config_t PT1CC
Product term 1 input C

aoi_input_config_t PT1DC
Product term 1 input D

aoi_input_config_t PT2AC
Product term 2 input A

aoi_input_config_t PT2BC
Product term 2 input B

aoi_input_config_t PT2CC
Product term 2 input C

aoi_input_config_t PT2DC
Product term 2 input D

aoi_input_config_t PT3AC
Product term 3 input A

aoi_input_config_t PT3BC
Product term 3 input B

aoi_input_config_t PT3CC
Product term 3 input C

aoi_input_config_t PT3DC
Product term 3 input D

2.3 ASRC: Asynchronous sample rate converter

2.4 ASRC Driver

uint32_t ASRC_GetInstance(ASRC_Type *base)
Get instance number of the ASRC peripheral.

Parameters

- base – ASRC base pointer.

void ASRC_Init(ASRC_Type *base, uint32_t asrcPeripheralClock_Hz)

brief Initializes the asrc peripheral.

This API gates the asrc clock. The asrc module can't operate unless ASRC_Init is called to enable the clock.

param base asrc base pointer. param asrcPeripheralClock_Hz peripheral clock of ASRC.

void ASRC_Deinit(ASRC_Type *base)

De-initializes the ASRC peripheral.

This API gates the ASRC clock and disable ASRC module. The ASRC module can't operate unless ASRC_Init

Parameters

- base – ASRC base pointer.

void ASRC_SoftwareReset(ASRC_Type *base)

Do software reset .

This software reset bit is self-clear bit, it will generate a software reset signal inside ASRC. After 9 cycles of the ASRC processing clock, this reset process will stop and this bit will cleared automatically.

Parameters

- base – ASRC base pointer

status_t ASRC_SetChannelPairConfig(ASRC_Type *base, *asrc_channel_pair_t* channelPair, *asrc_channel_pair_config_t* *config, uint32_t inputSampleRate, uint32_t outputSampleRate)

ASRC configure channel pair.

Parameters

- base – ASRC base pointer.
- channelPair – index of channel pair, reference _asrc_channel_pair.
- config – ASRC channel pair configuration pointer.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

uint32_t ASRC_GetOutSamplesSize(ASRC_Type *base, *asrc_channel_pair_t* channelPair, uint32_t inSampleRate, uint32_t outSampleRate, uint32_t inSamplesize)

Get output sample buffer size.

Note: This API is depends on the ASRC output configuration, should be called after the ASRC_SetChannelPairConfig.

Parameters

- base – asrc base pointer.
- channelPair – ASRC channel pair number.
- inSampleRate – input sample rate.
- outSampleRate – output sample rate.
- inSamplesize – input sampleS size.

Return values

output – buffer size in byte.

```
uint32_t ASRC_MapSamplesWidth(ASRC_Type *base, asrc_channel_pair_t channelPair, uint32_t
                               *inWidth, uint32_t *outWidth)
```

Map register sample width to real sample width.

Note: This API is depends on the ASRC configuration, should be called after the ASRC_SetChannelPairConfig.

Parameters

- base – asrc base pointer.
- channelPair – asrc channel pair index.
- inWidth – ASRC channel pair number.
- outWidth – input sample rate.

Return values

input – sample mask value.

```
uint32_t ASRC_GetRemainFifoSamples(ASRC_Type *base, asrc_channel_pair_t channelPair,
                                   uint32_t *buffer, uint32_t outSampleWidth, uint32_t
                                   remainSamples)
```

Get left samples in fifo.

Parameters

- base – asrc base pointer.
- channelPair – ASRC channel pair number.
- buffer – input sample numbers.
- outSampleWidth – output sample width.
- remainSamples – output sample rate.

Return values

remain – samples number.

```
static inline void ASRC_ModuleEnable(ASRC_Type *base, bool enable)
```

ASRC module enable.

Parameters

- base – ASRC base pointer.
- enable – true is enable, false is disable

```
static inline void ASRC_ChannelPairEnable(ASRC_Type *base, asrc_channel_pair_t channelPair,
                                           bool enable)
```

ASRC enable channel pair.

Parameters

- base – ASRC base pointer.
- channelPair – channel pair mask value, reference _asrc_channel_pair_mask.
- enable – true is enable, false is disable.

```
static inline void ASRC_EnableInterrupt(ASRC_Type *base, uint32_t mask)
```

ASRC interrupt enable This function enable the ASRC interrupt with the provided mask.

Parameters

- base – ASRC peripheral base address.
- mask – The interrupts to enable. Logical OR of `_asrc_interrupt_mask`.

```
static inline void ASRC_DisableInterrupt(ASRC_Type *base, uint32_t mask)
```

ASRC interrupt disable This function disable the ASRC interrupt with the provided mask.

Parameters

- base – ASRC peripheral base address.
- mask – The interrupts to disable. Logical OR of `_asrc_interrupt_mask`.

```
static inline uint32_t ASRC_GetStatus(ASRC_Type *base)
```

Gets the ASRC status flag state.

Parameters

- base – ASRC base pointer

Returns

ASRC Tx status flag value. Use the Status Mask to get the status value needed.

```
static inline bool ASRC_GetChannelPairInitialStatus(ASRC_Type *base, asrc_channel_pair_t  
                                                    channel)
```

Gets the ASRC channel pair initialization state.

Parameters

- base – ASRC base pointer
- channel – ASRC channel pair.

Returns

ASRC Tx status flag value. Use the Status Mask to get the status value needed.

```
static inline uint32_t ASRC_GetChannelPairFifoStatus(ASRC_Type *base, asrc_channel_pair_t  
                                                    channelPair)
```

Gets the ASRC channel A fifo a status flag state.

Parameters

- base – ASRC base pointer
- channelPair – ASRC channel pair.

Returns

ASRC channel pair a fifo status flag value. Use the Status Mask to get the status value needed.

```
static inline void ASRC_ChannelPairWriteData(ASRC_Type *base, asrc_channel_pair_t  
                                              channelPair, uint32_t data)
```

Writes data into ASRC channel pair FIFO. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.
- data – Data needs to be written.

```
static inline uint32_t ASRC_ChannelPairReadData(ASRC_Type *base, asrc_channel_pair_t
                                              channelPair)
```

Read data from ASRC channel pair FIFO. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.

Return values

value – read from fifo.

```
static inline uint32_t ASRC_GetInputDataRegisterAddress(ASRC_Type *base, asrc_channel_pair_t
                                                       channelPair)
```

Get input data fifo address. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.

```
static inline uint32_t ASRC_GetOutputDataRegisterAddress(ASRC_Type *base,
                                                         asrc_channel_pair_t channelPair)
```

Get output data fifo address. Note: ASRC fifo width is 24bit.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.

```
status_t ASRC_SetIdealRatioConfig(ASRC_Type *base, asrc_channel_pair_t channelPair, uint32_t
                                  inputSampleRate, uint32_t outputSampleRate)
```

ASRC configure ideal ratio. The ideal ratio should be used when input clock source is not available.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

```
status_t ASRC_TransferSetChannelPairConfig(ASRC_Type *base, asrc_handle_t *handle,
                                             asrc_channel_pair_config_t *config, uint32_t
                                             inputSampleRate, uint32_t outputSampleRate)
```

ASRC configure channel pair.

Parameters

- base – ASRC base pointer.
- handle – ASRC transactional handle pointer.
- config – ASRC channel pair configuration pointer.
- inputSampleRate – input audio data sample rate.
- outputSampleRate – output audio data sample rate.

```
void ASRC_TransferCreateHandle(ASRC_Type *base, asrc_handle_t *handle, asrc_channel_pair_t
                               channelPair, asrc_transfer_callback_t inCallback,
                               asrc_transfer_callback_t outCallback, void *userData)
```

Initializes the ASRC handle.

This function initializes the handle for the ASRC transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – ASRC base pointer
- handle – ASRC handle pointer.
- channelPair – ASRC channel pair.
- inCallback – Pointer to the user callback function.
- outCallback – Pointer to the user callback function.
- userData – User parameter passed to the callback function

status_t ASRC_TransferNonBlocking(*ASRC_Type* *base, *asrc_handle_t* *handle, *asrc_transfer_t* *xfer)

Performs an interrupt non-blocking convert on asrc.

Note: This API returns immediately after the transfer initiates, application should check the wait and check the callback status.

Parameters

- base – asrc base pointer.
- handle – Pointer to the *asrc_handle_t* structure which stores the transfer state.
- xfer – Pointer to the *ASRC_transfer_t* structure.

Return values

- *kStatus_Success* – Successfully started the data receive.
- *kStatus_ASRCBusy* – Previous receive still not finished.

status_t ASRC_TransferBlocking(*ASRC_Type* *base, *asrc_channel_pair_t* channelPair, *asrc_transfer_t* *xfer)

Performs an blocking convert on asrc.

Note: This API returns immediately after the convert finished.

Parameters

- base – asrc base pointer.
- channelPair – channel pair index.
- xfer – Pointer to the *ASRC_transfer_t* structure.

Return values

kStatus_Success – Successfully started the data receive.

status_t ASRC_TransferGetConvertedCount(*ASRC_Type* *base, *asrc_handle_t* *handle, *size_t* *count)

Get converted byte count.

Parameters

- base – ASRC base pointer.

- `handle` – Pointer to the `asrc_handle_t` structure which stores the transfer state.
- `count` – Bytes count sent.

Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_ASRCIdle` – There is not a non-blocking transaction currently in progress.

`void ASRC_TransferAbortConvert(ASRC_Type *base, asrc_handle_t *handle)`

Aborts the current convert.

Note: This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- `base` – ASRC base pointer.
- `handle` – Pointer to the `asrc_handle_t` structure which stores the transfer state.

`void ASRC_TransferTerminateConvert(ASRC_Type *base, asrc_handle_t *handle)`

Terminate all ASRC convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call `ASRC_TransferAbortConvert`.

Parameters

- `base` – ASRC base pointer.
- `handle` – ASRC eDMA handle pointer.

`void ASRC_TransferHandleIRQ(ASRC_Type *base, asrc_handle_t *handle)`

ASRC convert interrupt handler.

Parameters

- `base` – ASRC base pointer.
- `handle` – Pointer to the `asrc_handle_t` structure.

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ASRC return status .

Values:

enumerator `kStatus_ASRCIdle`

ASRC is idle.

enumerator `kStatus_ASRCInIdle`

ASRC in is idle.

enumerator `kStatus_ASRCOutIdle`

ASRC out is idle.

enumerator `kStatus_ASRCBusy`

ASRC is busy.

enumerator kStatus_ASRCInvalidArgument

ASRC invalid argument.

enumerator kStatus_ASRCCLockConfigureFailed

ASRC clock configure failed

enumerator kStatus_ASRCChannelPairConfigureFailed

ASRC clock configure failed

enumerator kStatus_ASRCConvertError

ASRC clock configure failed

enumerator kStatus_ASRCNotSupport

ASRC not support

enumerator kStatus_ASRCQueueFull

ASRC queue is full

enumerator kStatus_ASRCOutQueueIdle

ASRC out queue is idle

enumerator kStatus_ASRCInQueueIdle

ASRC in queue is idle

enum _asrc_channel_pair

ASRC channel pair mask.

Values:

enumerator kASRC_ChannelPairA

channel pair A value

enumerator kASRC_ChannelPairB

channel pair B value

enumerator kASRC_ChannelPairC

channel pair C value

ASRC support sample rate .

Values:

enumerator kASRC_SampleRate_8000HZ

asrc sample rate 8KHZ

enumerator kASRC_SampleRate_11025HZ

asrc sample rate 11.025KHZ

enumerator kASRC_SampleRate_12000HZ

asrc sample rate 12KHZ

enumerator kASRC_SampleRate_16000HZ

asrc sample rate 16KHZ

enumerator kASRC_SampleRate_22050HZ

asrc sample rate 22.05KHZ

enumerator kASRC_SampleRate_24000HZ

asrc sample rate 24KHZ

enumerator kASRC_SampleRate_30000HZ

asrc sample rate 30KHZ

enumerator kASRC_SampleRate_32000HZ
asrc sample rate 32KHZ

enumerator kASRC_SampleRate_44100HZ
asrc sample rate 44.1KHZ

enumerator kASRC_SampleRate_48000HZ
asrc sample rate 48KHZ

enumerator kASRC_SampleRate_64000HZ
asrc sample rate 64KHZ

enumerator kASRC_SampleRate_88200HZ
asrc sample rate 88.2KHZ

enumerator kASRC_SampleRate_96000HZ
asrc sample rate 96KHZ

enumerator kASRC_SampleRate_128000HZ
asrc sample rate 128KHZ

enumerator kASRC_SampleRate_176400HZ
asrc sample rate 176.4KHZ

enumerator kASRC_SampleRate_192000HZ
asrc sample rate 192KHZ

The ASRC interrupt enable flag .

Values:

enumerator kASRC_FPinWaitStateInterruptEnable
FP in wait state mask

enumerator kASRC_OverLoadInterruptMask
overload interrupt mask

enumerator kASRC_DataOutputCInterruptMask
data output c interrupt mask

enumerator kASRC_DataOutputBInterruptMask
data output b interrupt mask

enumerator kASRC_DataOutputAInterruptMask
data output a interrupt mask

enumerator kASRC_DataInputCInterruptMask
data input c interrupt mask

enumerator kASRC_DataInputBInterruptMask
data input b interrupt mask

enumerator kASRC_DataInputAInterruptMask
data input a interrupt mask

The ASRC interrupt status .

Values:

enumerator kASRC_StatusDSLCounterReady
DSL counter

enumerator kASRC__StatusTaskQueueOverLoad
task queue overload

enumerator kASRC__StatusPairCOutputOverLoad
pair c output overload

enumerator kASRC__StatusPairBOutputOverLoad
pair b output overload

enumerator kASRC__StatusPairAOutputOverLoad
pair a output overload

enumerator kASRC__StatusPairCInputOverLoad
pair c input overload

enumerator kASRC__StatusPairBInputOverLoad
pair b input overload

enumerator kASRC__StatusPairAInputOverLoad
pair a input overload

enumerator kASRC__StatusPairCOutputOverflow
pair c output overflow

enumerator kASRC__StatusPairBOutputOverflow
pair b output overflow

enumerator kASRC__StatusPairAOutputOverflow
pair a output overflow

enumerator kASRC__StatusPairCInputUnderflow
pair c input underflow

enumerator kASRC__StatusPairBInputUnderflow
pair b input under flow

enumerator kASRC__StatusPairAInputUnderflow
pair a input underflow

enumerator kASRC__StatusFPInWaitState
FP in wait state

enumerator kASRC__StatusOverloadError
overload error

enumerator kASRC__StatusInputError
input error status

enumerator kASRC__StatusOutputError
output error status

enumerator kASRC__StatusPairCOutputReady
pair c output ready

enumerator kASRC__StatusPairBOutputReady
pair b output ready

enumerator kASRC__StatusPairAOutputReady
pair a output ready

enumerator kASRC__StatusPairCInputReady
pair c input ready

enumerator kASRC__StatusPairBInputReady
pair b input ready

enumerator kASRC__StatusPairAInputReady
pair a input ready

enumerator kASRC__StatusPairAInterrupt
pair A interrupt

enumerator kASRC__StatusPairBInterrupt
pair B interrupt

enumerator kASRC__StatusPairCInterrupt
pair C interrupt

ASRC channel pair status .

Values:

enumerator kASRC__OutputFifoNearFull
channel pair output fifo near full

enumerator kASRC__InputFifoNearEmpty
channel pair input fifo near empty

enum _asrc_ratio

ASRC ideal ratio.

Values:

enumerator kASRC__RatioNotUsed
ideal ratio not used

enumerator kASRC__RatioUseInternalMeasured
ideal ratio use internal measure ratio, can be used for real time streaming audio

enumerator kASRC__RatioUseIdealRatio
ideal ratio use manual configure ratio, can be used for the non-real time streaming audio

enum _asrc_audio_channel

Number of channels in audio data.

Values:

enumerator kASRC__ChannelsNumber1
channel number is 1

enumerator kASRC__ChannelsNumber2
channel number is 2

enumerator kASRC__ChannelsNumber3
channel number is 3

enumerator kASRC__ChannelsNumber4
channel number is 4

enumerator kASRC__ChannelsNumber5
channel number is 5

enumerator kASRC__ChannelsNumber6
channel number is 6

enumerator kASRC_ChannelsNumber7
channel number is 7

enumerator kASRC_ChannelsNumber8
channel number is 8

enumerator kASRC_ChannelsNumber9
channel number is 9

enumerator kASRC_ChannelsNumber10
channel number is 10

enum _asrc_data_width
data width

Values:

enumerator kASRC_DataWidth24Bit
data width 24bit

enumerator kASRC_DataWidth16Bit
data width 16bit

enumerator kASRC_DataWidth8Bit
data width 8bit

enum _asrc_data_align
data alignment

Values:

enumerator kASRC_DataAlignMSB
data alignment MSB

enumerator kASRC_DataAlignLSB
data alignment LSB

enum _asrc_sign_extension
sign extension

Values:

enumerator kASRC_NoSignExtension
no sign extension

enumerator kASRC_SignExtension
sign extension

typedef enum _asrc_channel_pair asrc_channel_pair_t
ASRC channel pair mask.

typedef enum _asrc_ratio asrc_ratio_t
ASRC ideal ratio.

typedef enum _asrc_audio_channel asrc_audio_channel_t
Number of channels in audio data.

typedef enum _asrc_data_width asrc_data_width_t
data width

typedef enum _asrc_data_align asrc_data_align_t
data alignment

```
typedef enum _asrc_sign_extension asrc_sign_extension_t
    sign extension

typedef struct _asrc_channel_pair_config asrc_channel_pair_config_t
    asrc channel pair configuration

typedef struct _asrc_transfer asrc_transfer_t
    SAI transfer structure.

typedef struct _asrc_handle asrc_handle_t
    asrc handler

typedef void (*asrc_transfer_callback_t)(ASRC_Type *base, asrc_handle_t *handle, status_t
status, void *userData)
    ASRC transfer callback prototype.

typedef struct _asrc_in_handle asrc_in_handle_t
    asrc in handler

typedef struct _asrc_out_handle asrc_out_handle_t
    output handler

ASRC_XFER_QUEUE_SIZE
    ASRC transfer queue size, user can refine it according to use case.

FSL_ASRC_CHANNEL_PAIR_COUNT
    ASRC channel pair count.

FSL_ASRC_CHANNEL_PAIR_FIFO_DEPTH
    ASRC FIFO depth.

ASRC_ASRCCTR_AT_MASK(index)
    ASRC register access macro.

ASRC_ASRCCTR_RATIO_MASK(index)

ASRC_ASRCCTR_RATIO(ratio, index)

ASRC_ASRIER_INPUT_INTERRUPT_MASK(index)

ASRC_ASRIER_OUTPUT_INTERRUPT_MASK(index)

ASRC_ASRCNCR_CHANNEL_COUNTER_MASK(index)

ASRC_ASRCNCR_CHANNEL_COUNTER(counter, index)

ASRC_ASRCFG_PRE_MODE_MASK(index)

ASRC_ASRCFG_PRE_MODE(mode, index)

ASRC_ASRCFG_POST_MODE_MASK(index)

ASRC_ASRCFG_POST_MODE(mode, index)

ASRC_ASRCFG_INIT_DONE_MASK(index)

ASRC_ASRC_SR_INPUT_CLOCK_SOURCE_MASK(index)

ASRC_ASRC_SR_INPUT_CLOCK_SOURCE(source, index)

ASRC_ASRC_SR_OUTPUT_CLOCK_SOURCE_MASK(index)

ASRC_ASRC_SR_OUTPUT_CLOCK_SOURCE(source, index)
```

ASRC_ASRCDR_INPUT_PRESCALER_MASK(index)
ASRC_ASRCDR_INPUT_PRESCALER(prescaler, index)
ASRC_ASRCDR_INPUT_DIVIDER_MASK(index)
ASRC_ASRCDR_INPUT_DIVIDER(divider, index)
ASRC_ASRCDR_OUTPUT_PRESCALER_MASK(index)
ASRC_ASRCDR_OUTPUT_PRESCALER(prescaler, index)
ASRC_ASRCDR_OUTPUT_DIVIDER_MASK(index)
ASRC_ASRCDR_OUTPUT_DIVIDER(divider, index)
ASRC_ASRCDR_OUTPUT_CLOCK_DIVIDER_PRESCALER(value, index)
ASRC_ASRCDR_INPUT_CLOCK_DIVIDER_PRESCALER(value, index)
ASRC_IDEAL_RATIO_HIGH(base, index)
ASRC_IDEAL_RATIO_LOW(base, index)
ASRC_ASRMCR(base, index)
ASRC_ASRMCR1(base, index)
ASRC_ASRDI(base, index)
ASRC_ASRDO(base, index)
ASRC_ASRDI_ADDR(base, index)
ASRC_ASRDO_ADDR(base, index)
ASRC_ASRFST_ADDR(base, index)
ASRC_GET_CHANNEL_COUNTER(base, index)
struct _asrc_channel_pair_config
 #include <fsl_asrc.h> asrc channel pair configuration

Public Members

asrc_audio_channel_t audioDataChannels
 audio data channel numbers
asrc_clock_source_t inClockSource
 input clock source, reference the clock source definition in SOC header file
uint32_t inSourceClock_Hz
 input source clock frequency
asrc_clock_source_t outClockSource
 output clock source, reference the clock source definition in SOC header file
uint32_t outSourceClock_Hz
 output source clock frequency
asrc_ratio_t sampleRateRatio
 sample rate ratio type

asrc_data_width_t inDataWidth
input data width

asrc_data_align_t inDataAlign
input data alignment

asrc_data_width_t outDataWidth
output data width

asrc_data_align_t outDataAlign
output data alignment

asrc_sign_extension_t outSignExtension
output extension

uint8_t outFifoThreshold
output fifo threshold

uint8_t inFifoThreshold
input fifo threshold

bool bufStallWhenFifoEmptyFull
stall Pair A conversion in case of Buffer near empty full condition

struct *_asrc_transfer*
#include <fsl_asrc.h> SAI transfer structure.

Public Members

void *inData
Data address to convert.

size_t inDataSize
input data size.

void *outData
Data address to store converted data

size_t outDataSize
output data size.

struct *_asrc_in_handle*
#include <fsl_asrc.h> asrc in handler

Public Members

asrc_transfer_callback_t callback
Callback function called at convert complete

uint32_t sampleWidth
data width

uint32_t sampleMask
data mask

uint32_t fifoThreshold
fifo threshold

uint8_t *asrcQueue[(4U)]
Transfer queue storing queued transfer

```
size_t transferSamples[(4U)]
    Data bytes need to convert
volatile uint8_t queueUser
    Index for user to queue transfer
volatile uint8_t queueDriver
    Index for driver to get the transfer data and size
struct __asrc_out_handle
    #include <fsl_asrc.h> output handler
```

Public Members

```
asrc_transfer_callback_t callback
    Callback function called at convert complete
uint32_t sampleWidth
    data width
uint32_t fifoThreshold
    fifo threshold
uint8_t *asrcQueue[(4U)]
    Transfer queue storing queued transfer
size_t transferSamples[(4U)]
    Data bytes need to convert
volatile uint8_t queueUser
    Index for user to queue transfer
volatile uint8_t queueDriver
    Index for driver to get the transfer data and size
struct __asrc_handle
    #include <fsl_asrc.h> ASRC handle structure.
```

Public Members

```
ASRC_Type *base
    base address
uint32_t state
    Transfer status
void *userData
    Callback parameter passed to callback function
asrc_audio_channel_t audioDataChannels
    audio channel number
asrc_channel_pair_t channelPair
    channel pair mask
asrc_in_handle_t in
    asrc input handler
asrc_out_handle_t out
    asrc output handler
```


2.5 ASRC EDMA Driver

```
void ASRC__TransferInCreateHandleEDMA(ASRC_Type *base, asrc_edma_handle_t *handle,  
                                     asrc_channel_pair_t channelPair,  
                                     asrc_edma_callback_t callback, edma_handle_t  
                                     *inDmaHandle, const asrc_p2p_edma_config_t  
                                     *periphConfig, void *userData)
```

Initializes the ASRC IN eDMA handle.

This function initializes the ASRC DMA handle, which can be used for other ASRC transactional APIs. Usually, for a specified ASRC channel pair, call this API once to get the initialized handle.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair
- handle – ASRC eDMA handle pointer.
- callback – Pointer to user callback function.
- inDmaHandle – DMA handler for ASRC in.
- periphConfig – peripheral configuration.
- userData – User parameter passed to the callback function.

```
void ASRC__TransferOutCreateHandleEDMA(ASRC_Type *base, asrc_edma_handle_t *handle,  
                                       asrc_channel_pair_t channelPair,  
                                       asrc_edma_callback_t callback, edma_handle_t  
                                       *outDmaHandle, const asrc_p2p_edma_config_t  
                                       *periphConfig, void *userData)
```

Initializes the ASRC OUT eDMA handle.

This function initializes the ASRC DMA handle, which can be used for other ASRC transactional APIs. Usually, for a specified ASRC channel pair, call this API once to get the initialized handle.

Parameters

- base – ASRC base pointer.
- channelPair – ASRC channel pair
- handle – ASRC eDMA handle pointer.
- callback – Pointer to user callback function.
- outDmaHandle – DMA handler for ASRC out.
- periphConfig – peripheral configuration.
- userData – User parameter passed to the callback function.

```
status_t ASRC__TransferSetChannelPairConfigEDMA(ASRC_Type *base, asrc_edma_handle_t  
                                                *handle, asrc_channel_pair_config_t  
                                                *asrcConfig, uint32_t inSampleRate,  
                                                uint32_t outSampleRate)
```

Configures the ASRC P2P channel pair.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.
- asrcConfig – asrc configurations.

- inSampleRate – ASRC input sample rate.
- outSampleRate – ASRC output sample rate.

```
uint32_t ASRC_GetOutSamplesSizeEDMA(ASRC_Type *base, asrc_edma_handle_t *handle,  
                                     uint32_t inSampleRate, uint32_t outSampleRate,  
                                     uint32_t inSamplesize)
```

Get output sample buffer size can be transferred by edma.

Note: This API is depends on the ASRC output configuration, should be called after the ASRC_TransferSetChannelPairConfigEDMA.

Parameters

- base – asrc base pointer.
- handle – ASRC channel pair edma handle.
- inSampleRate – input sample rate.
- outSampleRate – output sample rate.
- inSamplesize – input sampleS size.

Return values

output – buffer size in byte.

```
status_t ASRC_TransferEDMA(ASRC_Type *base, asrc_edma_handle_t *handle, asrc_transfer_t  
                           *xfer)
```

Performs a non-blocking ASRC m2m convert using EDMA.

Note: This interface returns immediately after the transfer initiates.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- kStatus_Success – Start a ASRC eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_ASRCQueueFull – ASRC EDMA driver queue is full.

```
void ASRC_TransferInAbortEDMA(ASRC_Type *base, asrc_edma_handle_t *handle)
```

Aborts a ASRC IN transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call ASRC_TransferTerminalP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferOutAbortEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Aborts a ASRC OUT transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call ASRC_TransferTerminalP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferInTerminalEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Terminate In ASRC Convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call ASRC_TransferAbortPP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

void ASRC_TransferOutTerminalEDMA(ASRC_Type *base, *asrc_edma_handle_t* *handle)

Terminate Out ASRC Convert.

This function will clear all transfer slots buffered in the asrc queue. If users only want to abort the current transfer slot, please call ASRC_TransferAbortPP2PEDMA.

Parameters

- base – ASRC base pointer.
- handle – ASRC eDMA handle pointer.

FSL_ASRC_EDMA_DRIVER_VERSION

Version 2.2.0

typedef struct *_asrc_edma_handle* *asrc_edma_handle_t*

typedef void (**asrc_edma_callback_t*)(ASRC_Type *base, *asrc_edma_handle_t* *handle, *status_t* status, void *userData)

ASRC eDMA transfer callback function for finish and error.

typedef void (**asrc_start_peripheral_t*)(bool start)

ASRC trigger peripheral function pointer.

typedef struct *_asrc_p2p_edma_config* *asrc_p2p_edma_config_t*

destination peripheral configuration

typedef struct *_asrc_in_edma_handle* *asrc_in_edma_handle_t*

@ brief asrc in edma handler

typedef struct *_asrc_out_edma_handle* *asrc_out_edma_handle_t*

@ brief asrc out edma handler

ASRC_XFER_IN_QUEUE_SIZE

ASRC IN edma QUEUE size.

<

ASRC_XFER_OUT_QUEUE_SIZE

struct *_asrc_p2p_edma_config*

#include <*fsl_asrc_edma.h*> destination peripheral configuration

Public Members

asrc_start_peripheral_t startPeripheral
trigger peripheral start

struct *_asrc_in_edma_handle*
#include <fsl_asrc_edma.h> @ brief asrc in edma handler

Public Members

edma_handle_t *inDmaHandle
DMA handler for ASRC in

uint8_t tcd[(4U + 1U) * sizeof(*edma_tcd_t*)]
TCD pool for eDMA send.

uint32_t sampleWidth
input data width

uint32_t fifoThreshold
ASRC input fifo threshold

uint32_t *asrcQueue[4U]
Transfer queue storing queued transfer.

size_t transferSize[4U]
Data bytes need to transfer

volatile uint8_t queueUser
Index for user to queue transfer.

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

uint32_t state
Internal state for ASRC eDMA transfer

const *asrc_p2p_edma_config_t* *peripheralConfig
peripheral configuration pointer

struct *_asrc_out_edma_handle*
#include <fsl_asrc_edma.h> @ brief asrc out edma handler

Public Members

edma_handle_t *outDmaHandle
DMA handler for ASRC out

uint8_t tcd[(((4U) * 2U) + 1U) * sizeof(*edma_tcd_t*)]
TCD pool for eDMA send.

uint32_t sampleWidth
output data width

uint32_t fifoThreshold
ASRC output fifo threshold

uint32_t *asrcQueue[(((4U) * 2U)]
Transfer queue storing queued transfer.

```
size_t transferSize[((4U) * 2U)]
    Data bytes need to transfer
volatile uint8_t queueUser
    Index for user to queue transfer.
volatile uint8_t queueDriver
    Index for driver to get the transfer data and size
uint32_t state
    Internal state for ASRC eDMA transfer
const asrc_p2p_edma_config_t *peripheralConfig
    peripheral configuration pointer
struct _asrc_edma_handle
    #include <fsl_asrc_edma.h> ASRC DMA transfer handle.
```

Public Members

```
asrc_in_edma_handle_t in
    asrc in handler
asrc_out_edma_handle_t out
    asrc out handler
asrc_channel_pair_t channelPair
    channel pair
void *userData
    User callback parameter
asrc_edma_callback_t callback
    Callback for users while transfer finish or error occurs
```

2.6 Battery-Backed Non-Secure Module

```
void BBNSM_Init(BBNSM_Type *base)
    Init the BBNSM section.
```

Parameters

- base – BBNSM peripheral base address

```
void BBNSM_Deinit(BBNSM_Type *base)
    Deinit the BBNSM section.
```

Parameters

- base – BBNSM peripheral base address

```
FSL_BBNSM_DRIVER_VERSION
    Version 2.0.0
```

```
enum _bbnsn_interrupts
    List of BBNSM interrupts.
    Values:
```

enumerator kBBNSM_RTC_AlarmInterrupt

RTC time alarm interrupt

enumerator kBBNSM_RTC_RolloverInterrupt

RTC rollover interrupt

enum _bbnsm_status_flags

List of BBNSM flags.

Values:

enumerator kBBNSM_RTC_AlarmInterruptFlag

RTC time alarm interrupt flag

enumerator kBBNSM_RTC_RolloverInterruptFlag

RTC rollover interrupt flag

enumerator kBBNSM_PWR_ON_InterruptFlag

power on interrupt flag

enumerator kBBNSM_PWR_OFF_InterruptFlag

power off interrupt flag

enumerator kBBNSM_EMG_OFF_InterruptFlag

emergency power off interrupt flag

typedef enum *_bbnsm_interrupts* bbnsm_interrupts_t

List of BBNSM interrupts.

typedef enum *_bbnsm_status_flags* bbnsm_status_flags_t

List of BBNSM flags.

typedef struct *_bbnsm_rtc_config* bbnsm_rtc_config_t

BBNSM config structure.

This structure holds the configuration settings for the BBNSM peripheral. To initialize this structure to reasonable defaults, call the BBNSM_RTC_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

void BBNSM_RTC_Init(BBNSM_Type *base, const *bbnsm_rtc_config_t* *config)

Un gates the BBNSM clock and configures the peripheral for basic operation.

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

Parameters

- base – BBNSM peripheral base address
- config – Pointer to the user's BBNSM rtc configuration structure.

void BBNSM_RTC_Deinit(BBNSM_Type *base)

Stops the RTC timer.

Parameters

- base – BBNSM peripheral base address

void BBNSM_RTC_GetDefaultConfig(*bbnsm_rtc_config_t* *config)

Fills in the BBNSM RTC config struct with the default settings.

The default values are as follows.

```
config->rtccalenable = false;  
config->rtccalvalue = 0U;
```

Parameters

- config – Pointer to the user's BBNSM configuration structure.

status_t BBNSM_RTC_SetAlarm(BBNSM_Type *base, uint32_t alarmSeconds)

Sets the BBNSM RTC alarm time.

The function sets the RTC alarm. It also checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error. Please note, that RTC alarm has limited resolution because only 32 most significant bits of RTC counter are compared to RTC Alarm register. If the alarm time is beyond RTC resolution, the function does not set the alarm and returns an error.

Parameters

- base – BBNSM peripheral base address
- alarmSeconds –

Returns

kStatus_Success: success in setting the BBNSM RTC alarm
kStatus_InvalidArgument: Error because the alarm datetime format is incorrect
kStatus_Fail: Error because the alarm time has already passed or is beyond resolution

uint32_t BBNSM_RTC_GetAlarm(BBNSM_Type *base)

Returns the BBNSM RTC alarm time.

Parameters

- base – BBNSM peripheral base address

struct _bbnsn_rtc_config

#include <fsl_bbnsn.h> BBNSM config structure.

This structure holds the configuration settings for the BBNSM peripheral. To initialize this structure to reasonable defaults, call the BBNSM_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 rtcCalEnable

true: RTC calibration mechanism is enabled; false: No calibration is used

uint32_t rtcCalValue

Defines signed calibration value for RTC; This is a 5-bit 2's complement value, range from -16 to +15

2.7 CACHE: ARMV7-M7 CACHE Memory Controller

static inline void L1CACHE_EnableICache(void)

Enables cortex-m7 L1 instruction cache.

static inline void L1CACHE_DisableICache(void)

Disables cortex-m7 L1 instruction cache.

```
static inline void L1CACHE_InvalidateICache(void)
```

Invalidate cortex-m7 L1 instruction cache.

```
void L1CACHE_InvalidateICacheByRange(uint32_t address, uint32_t size_byte)
```

Invalidate cortex-m7 L1 instruction cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1ICACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 I-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

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

```
static inline void L1CACHE_EnableDCache(void)
```

Enables cortex-m7 L1 data cache.

```
static inline void L1CACHE_DisableDCache(void)
```

Disables cortex-m7 L1 data cache.

```
static inline void L1CACHE_InvalidateDCache(void)
```

Invalidates cortex-m7 L1 data cache.

```
static inline void L1CACHE_CleanDCache(void)
```

Cleans cortex-m7 L1 data cache.

```
static inline void L1CACHE_CleanInvalidateDCache(void)
```

Cleans and Invalidates cortex-m7 L1 data cache.

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

Invalidates cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

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

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

Cleans cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be cleaned.
- size_byte – The memory size.

```
static inline void L1CACHE_CleanInvalidateDCacheByRange(uint32_t address, uint32_t
                                                         size_byte)
```

Cleans and Invalidates cortex-m7 L1 data cache by range.

Note: The start address and size_byte should be 32-byte(FSL_FEATURE_L1DCACHE_LINESIZE_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The start address of the memory to be clean and invalidated.
- size_byte – The memory size.

```
void ICACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)
```

Invalidates all instruction caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

```
void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)
```

Invalidates all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated.

```
void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)
```

Cleans all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size

if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned.

void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates all data caches by range.

Both cortex-m7 L1 cache line and L2 PL310 cache line length is 32-byte.

Note: address and size should be aligned to cache line size 32-Byte due to the cache operation unit is one cache line. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned and invalidated.

FSL_CACHE_DRIVER_VERSION

cache driver version 2.0.4.

2.8 Clock Driver

enum _clock_lpcg

Clock LPCG index.

Values:

enumerator kCLOCK_M7

Clock LPCG M7

enumerator kCLOCK_M33

Clock LPCG M33

enumerator kCLOCK_Edgelock

Clock LPCG Edgelock

enumerator kCLOCK_Sim_Aon

Clock LPCG Sim_Aon

enumerator kCLOCK_Sim_Wakeup

Clock LPCG Sim_Wakeup

enumerator kCLOCK_Sim_Mega

Clock LPCG Sim_Mega

enumerator kCLOCK_Sim_R

Clock LPCG Sim_R

enumerator kCLOCK_Anadig

Clock LPCG Anadig

enumerator kCLOCK__Dcdc
Clock LPCG Dcdc

enumerator kCLOCK__Src
Clock LPCG Src

enumerator kCLOCK__Ccm
Clock LPCG Ccm

enumerator kCLOCK__Gpc
Clock LPCG Gpc

enumerator kCLOCK__Adc1
Clock LPCG Adc1

enumerator kCLOCK__Adc2
Clock LPCG Adc2

enumerator kCLOCK__Dac
Clock LPCG Dac

enumerator kCLOCK__Acmp1
Clock LPCG Acmp1

enumerator kCLOCK__Acmp2
Clock LPCG Acmp2

enumerator kCLOCK__Acmp3
Clock LPCG Acmp3

enumerator kCLOCK__Acmp4
Clock LPCG Acmp4

enumerator kCLOCK__Wdog1
Clock LPCG Wdog1

enumerator kCLOCK__Wdog2
Clock LPCG Wdog2

enumerator kCLOCK__Wdog3
Clock LPCG Wdog3

enumerator kCLOCK__Wdog4
Clock LPCG Wdog4

enumerator kCLOCK__Wdog5
Clock LPCG Wdog5

enumerator kCLOCK__Ewm0
Clock LPCG Ewm0

enumerator kCLOCK__Sema1
Clock LPCG Sema1

enumerator kCLOCK__Sema2
Clock LPCG Sema2

enumerator kCLOCK__Mu_A
Clock LPCG Mu_A

enumerator kCLOCK__Mu_B
Clock LPCG Mu_B

enumerator kCLOCK_Edma3
Clock LPCG Edma3

enumerator kCLOCK_Edma4
Clock LPCG Edma4

enumerator kCLOCK_Romcp
Clock LPCG Romcp

enumerator kCLOCK_Ocram1
Clock LPCG Ocram1

enumerator kCLOCK_Ocram2
Clock LPCG Ocram2

enumerator kCLOCK_Flexspi1
Clock LPCG Flexspi1

enumerator kCLOCK_Flexspi2
Clock LPCG Flexspi2

enumerator kCLOCK_Flexspi_Slv
Clock LPCG Flexspi_Slv

enumerator kCLOCK_Trdc
Clock LPCG Trdc

enumerator kCLOCK_Ocotp
Clock LPCG Ocotp

enumerator kCLOCK_Semc
Clock LPCG Semc

enumerator kCLOCK_Iee
Clock LPCG Iee

enumerator kCLOCK_Cstrace
Clock LPCG Cstrace

enumerator kCLOCK_Csswo
Clock LPCG Csswo

enumerator kCLOCK_Iomuxc1
Clock LPCG Iomuxc1

enumerator kCLOCK_Iomuxc2
Clock LPCG Iomuxc2

enumerator kCLOCK_Gpio1
Clock LPCG Gpio1

enumerator kCLOCK_Gpio2
Clock LPCG Gpio2

enumerator kCLOCK_Gpio3
Clock LPCG Gpio3

enumerator kCLOCK_Gpio4
Clock LPCG Gpio4

enumerator kCLOCK_Gpio5
Clock LPCG Gpio5

enumerator kCLOCK_Gpio6
Clock LPCG Gpio6

enumerator kCLOCK_Flexio1
Clock LPCG Flexio1

enumerator kCLOCK_Flexio2
Clock LPCG Flexio2

enumerator kCLOCK_Lpit1
Clock LPCG Lpit1

enumerator kCLOCK_Lpit2
Clock LPCG Lpit2

enumerator kCLOCK_Lpit3
Clock LPCG Lpit3

enumerator kCLOCK_Lptmr1
Clock LPCG Lptmr1

enumerator kCLOCK_Lptmr2
Clock LPCG Lptmr2

enumerator kCLOCK_Lptmr3
Clock LPCG Lptmr3

enumerator kCLOCK_Tpm1
Clock LPCG Tpm1

enumerator kCLOCK_Tpm2
Clock LPCG Tpm2

enumerator kCLOCK_Tpm3
Clock LPCG Tpm3

enumerator kCLOCK_Tpm4
Clock LPCG Tpm4

enumerator kCLOCK_Tpm5
Clock LPCG Tpm5

enumerator kCLOCK_Tpm6
Clock LPCG Tpm6

enumerator kCLOCK_Qtimer1
Clock LPCG Qtimer1

enumerator kCLOCK_Qtimer2
Clock LPCG Qtimer2

enumerator kCLOCK_Qtimer3
Clock LPCG Qtimer3

enumerator kCLOCK_Qtimer4
Clock LPCG Qtimer4

enumerator kCLOCK_Qtimer5
Clock LPCG Qtimer5

enumerator kCLOCK_Qtimer6
Clock LPCG Qtimer6

enumerator kCLOCK_Qtimer7
Clock LPCG Qtimer7

enumerator kCLOCK_Qtimer8
Clock LPCG Qtimer8

enumerator kCLOCK_Gpt1
Clock LPCG Gpt1

enumerator kCLOCK_Gpt2
Clock LPCG Gpt2

enumerator kCLOCK_Syscount
Clock LPCG Syscount

enumerator kCLOCK_Can1
Clock LPCG Can1

enumerator kCLOCK_Can2
Clock LPCG Can2

enumerator kCLOCK_Can3
Clock LPCG Can3

enumerator kCLOCK_Lpuart1
Clock LPCG Lpuart1

enumerator kCLOCK_Lpuart2
Clock LPCG Lpuart2

enumerator kCLOCK_Lpuart3
Clock LPCG Lpuart3

enumerator kCLOCK_Lpuart4
Clock LPCG Lpuart4

enumerator kCLOCK_Lpuart5
Clock LPCG Lpuart5

enumerator kCLOCK_Lpuart6
Clock LPCG Lpuart6

enumerator kCLOCK_Lpuart7
Clock LPCG Lpuart7

enumerator kCLOCK_Lpuart8
Clock LPCG Lpuart8

enumerator kCLOCK_Lpuart9
Clock LPCG Lpuart9

enumerator kCLOCK_Lpuart10
Clock LPCG Lpuart10

enumerator kCLOCK_Lpuart11
Clock LPCG Lpuart11

enumerator kCLOCK_Lpuart12
Clock LPCG Lpuart12

enumerator kCLOCK_Lpi2c1
Clock LPCG Lpi2c1

enumerator kCLOCK_Lpi2c2
Clock LPCG Lpi2c2

enumerator kCLOCK_Lpi2c3
Clock LPCG Lpi2c3

enumerator kCLOCK_Lpi2c4
Clock LPCG Lpi2c4

enumerator kCLOCK_Lpi2c5
Clock LPCG Lpi2c5

enumerator kCLOCK_Lpi2c6
Clock LPCG Lpi2c6

enumerator kCLOCK_Lpspi1
Clock LPCG Lpspi1

enumerator kCLOCK_Lpspi2
Clock LPCG Lpspi2

enumerator kCLOCK_Lpspi3
Clock LPCG Lpspi3

enumerator kCLOCK_Lpspi4
Clock LPCG Lpspi4

enumerator kCLOCK_Lpspi5
Clock LPCG Lpspi5

enumerator kCLOCK_Lpspi6
Clock LPCG Lpspi6

enumerator kCLOCK_I3c1
Clock LPCG I3c1

enumerator kCLOCK_I3c2
Clock LPCG I3c2

enumerator kCLOCK_Usdhc1
Clock LPCG Usdhc1

enumerator kCLOCK_Usdhc2
Clock LPCG Usdhc2

enumerator kCLOCK_Usb
Clock LPCG Usb

enumerator kCLOCK_Sinc1
Clock LPCG Sinc1

enumerator kCLOCK_Sinc2
Clock LPCG Sinc2

enumerator kCLOCK_Sinc3
Clock LPCG Sinc3

enumerator kCLOCK_Xbar1
Clock LPCG Xbar1

enumerator kCLOCK_Xbar2
Clock LPCG Xbar2

enumerator kCLOCK_Xbar3
Clock LPCG Xbar3

enumerator kCLOCK_Aoi1
Clock LPCG Aoi1

enumerator kCLOCK_Aoi2
Clock LPCG Aoi2

enumerator kCLOCK_Aoi3
Clock LPCG Aoi3

enumerator kCLOCK_Aoi4
Clock LPCG Aoi4

enumerator kCLOCK_Enc1
Clock LPCG Enc1

enumerator kCLOCK_Enc2
Clock LPCG Enc2

enumerator kCLOCK_Enc3
Clock LPCG Enc3

enumerator kCLOCK_Enc4
Clock LPCG Enc4

enumerator kCLOCK_Kpp
Clock LPCG Kpp

enumerator kCLOCK_Pwm1
Clock LPCG Pwm1

enumerator kCLOCK_Pwm2
Clock LPCG Pwm2

enumerator kCLOCK_Pwm3
Clock LPCG Pwm3

enumerator kCLOCK_Pwm4
Clock LPCG Pwm4

enumerator kCLOCK_Ecat
Clock LPCG Ecat

enumerator kCLOCK_Netc
Clock LPCG Netc

enumerator kCLOCK_Serdes1
Clock LPCG Serdes1

enumerator kCLOCK_Serdes2
Clock LPCG Serdes2

enumerator kCLOCK_Serdes3
Clock LPCG Serdes3

enumerator kCLOCK_Xcelbusx
Clock LPCG Xcelbusx

enumerator kCLOCK_Xriocu4
Clock LPCG Xriocu4

enumerator kCLOCK__Sptp
Clock LPCG Sptp

enumerator kCLOCK__Mctrl
Clock LPCG Mctrl

enumerator kCLOCK__Sai1
Clock LPCG Sai1

enumerator kCLOCK__Sai2
Clock LPCG Sai2

enumerator kCLOCK__Sai3
Clock LPCG Sai3

enumerator kCLOCK__Sai4
Clock LPCG Sai4

enumerator kCLOCK__Spdif
Clock LPCG Spdif

enumerator kCLOCK__Asrc
Clock LPCG Asrc

enumerator kCLOCK__Pdm
Clock LPCG Mic

enumerator kCLOCK__Vref
Clock LPCG Vref

enumerator kCLOCK__Bist
Clock LPCG Bist

enumerator kCLOCK__Ssi_W2M7
Clock LPCG Ssi_W2M7

enumerator kCLOCK__Ssi_M72W
Clock LPCG Ssi_M72W

enumerator kCLOCK__Ssi_W2Ao
Clock LPCG Ssi_W2Ao

enumerator kCLOCK__Ssi_Ao2W
Clock LPCG Ssi_Ao2W

enumerator kCLOCK__IpInvalid
Invalid value.

enum __clock_name

Clock name.

Values:

enumerator kCLOCK__OscRc24M
24MHz RC Oscillator.

enumerator kCLOCK__OscRc400M
400MHz RC Oscillator.

enumerator kCLOCK__Osc24M
24MHz Oscillator.

enumerator kCLOCK_Osc24MOut
24MHz Oscillator Out.

enumerator kCLOCK_ArmPll
ARM PLL.

enumerator kCLOCK_ArmPllOut
ARM PLL Out.

enumerator kCLOCK_SysPll2
SYS PLL2.

enumerator kCLOCK_SysPll2Out
SYS PLL2 OUT.

enumerator kCLOCK_SysPll2Pfd0
SYS PLL2 PFD0.

enumerator kCLOCK_SysPll2Pfd1
SYS PLL2 PFD1.

enumerator kCLOCK_SysPll2Pfd2
SYS PLL2 PFD2.

enumerator kCLOCK_SysPll2Pfd3
SYS PLL2 PFD3.

enumerator kCLOCK_SysPll3
SYS PLL3.

enumerator kCLOCK_SysPll3Out
SYS PLL3 OUT.

enumerator kCLOCK_SysPll3Div2
SYS PLL3 DIV2

enumerator kCLOCK_SysPll3Pfd0
SYS PLL3 PFD0.

enumerator kCLOCK_SysPll3Pfd1
SYS PLL3 PFD1

enumerator kCLOCK_SysPll3Pfd2
SYS PLL3 PFD2

enumerator kCLOCK_SysPll3Pfd3
SYS PLL3 PFD3

enumerator kCLOCK_SysPll1
SYS PLL1.

enumerator kCLOCK_SysPll1Out
SYS PLL1 OUT.

enumerator kCLOCK_SysPll1Div2
SYS PLL1 DIV2.

enumerator kCLOCK_SysPll1Div5
SYS PLL1 DIV5.

enumerator kCLOCK_AudioPll
SYS AUDIO PLL.

enumerator kCLOCK_AudioPllOut
SYS AUDIO PLL OUT.

enumerator kCLOCK_CpuClk
SYS CPU CLK.

enumerator kCLOCK_CoreSysClk
SYS CORE SYS CLK.

enum _clock_root

Root clock index.

Values:

enumerator kCLOCK_Root_M7
CLOCK Root M7

enumerator kCLOCK_Root_M33
CLOCK Root M33

enumerator kCLOCK_Root_Edgelock
CLOCK Root Edgelock

enumerator kCLOCK_Root_Bus_Aon
CLOCK Root Bus_Aon

enumerator kCLOCK_Root_Bus_Wakeup
CLOCK Root Bus_Wakeup

enumerator kCLOCK_Root_Wakeup_Axi
CLOCK Root Wakeup_Axi

enumerator kCLOCK_Root_Swo_Trace
CLOCK Root Swo_Trace

enumerator kCLOCK_Root_M33_Systick
CLOCK Root M33_Systick

enumerator kCLOCK_Root_M7_Systick
CLOCK Root M7_Systick

enumerator kCLOCK_Root_Flexio1
CLOCK Root Flexio1

enumerator kCLOCK_Root_Flexio2
CLOCK Root Flexio2

enumerator kCLOCK_Root_Lpit3
CLOCK Root Lpit3

enumerator kCLOCK_Root_Lptimer1
CLOCK Root Lptimer1

enumerator kCLOCK_Root_Lptimer2
CLOCK Root Lptimer2

enumerator kCLOCK_Root_Lptimer3
CLOCK Root Lptimer3

enumerator kCLOCK_Root_Tpm2
CLOCK Root Tpm2

enumerator kCLOCK_Root_Tpm4
CLOCK Root Tpm4

enumerator kCLOCK_Root_Tpm5
CLOCK Root Tpm5

enumerator kCLOCK_Root_Tpm6
CLOCK Root Tpm6

enumerator kCLOCK_Root_Gpt1
CLOCK Root Gpt1

enumerator kCLOCK_Root_Gpt2
CLOCK Root Gpt2

enumerator kCLOCK_Root_Flexspi1
CLOCK Root Flexspi1

enumerator kCLOCK_Root_Flexspi2
CLOCK Root Flexspi2

enumerator kCLOCK_Root_Flexspi_Slv
CLOCK Root Flexspi_Slv

enumerator kCLOCK_Root_Can1
CLOCK Root Can1

enumerator kCLOCK_Root_Can2
CLOCK Root Can2

enumerator kCLOCK_Root_Can3
CLOCK Root Can3

enumerator kCLOCK_Root_Lpuart0102
CLOCK Root Lpuart0102

enumerator kCLOCK_Root_Lpuart0304
CLOCK Root Lpuart0304

enumerator kCLOCK_Root_Lpuart0506
CLOCK Root Lpuart0506

enumerator kCLOCK_Root_Lpuart0708
CLOCK Root Lpuart0708

enumerator kCLOCK_Root_Lpuart0910
CLOCK Root Lpuart0910

enumerator kCLOCK_Root_Lpuart1112
CLOCK Root Lpuart1112

enumerator kCLOCK_Root_Lpi2c0102
CLOCK Root Lpi2c0102

enumerator kCLOCK_Root_Lpi2c0304
CLOCK Root Lpi2c0304

enumerator kCLOCK_Root_Lpi2c0506
CLOCK Root Lpi2c0506

enumerator kCLOCK_Root_Lpspi0102
CLOCK Root Lpspi0102

enumerator kCLOCK_Root_Lpspi0304
CLOCK Root Lpspi0304

enumerator kCLOCK_Root_Lpspi0506
CLOCK Root Lpspi0506

enumerator kCLOCK_Root_I3c1
CLOCK Root I3c1

enumerator kCLOCK_Root_I3c2
CLOCK Root I3c2

enumerator kCLOCK_Root_Usdhc1
CLOCK Root Usdhc1

enumerator kCLOCK_Root_Usdhc2
CLOCK Root Usdhc2

enumerator kCLOCK_Root_Semc
CLOCK Root Semc

enumerator kCLOCK_Root_Adc1
CLOCK Root Adc1

enumerator kCLOCK_Root_Adc2
CLOCK Root Adc2

enumerator kCLOCK_Root_Acmp
CLOCK Root Acmp

enumerator kCLOCK_Root_Ecat
CLOCK Root Ecat

enumerator kCLOCK_Root_Enet
CLOCK Root Enet

enumerator kCLOCK_Root_Tmr_1588
CLOCK Root Tmr_1588

enumerator kCLOCK_Root_Netc
CLOCK Root Netc

enumerator kCLOCK_Root_Mac0
CLOCK Root Mac0

enumerator kCLOCK_Root_Mac1
CLOCK Root Mac1

enumerator kCLOCK_Root_Mac2
CLOCK Root Mac2

enumerator kCLOCK_Root_Mac3
CLOCK Root Mac3

enumerator kCLOCK_Root_Mac4
CLOCK Root Mac4

enumerator kCLOCK_Root_Serdes0
CLOCK Root Serdes0

enumerator kCLOCK_Root_Serdes1
CLOCK Root Serdes1

enumerator kCLOCK_Root_Serdes2
CLOCK Root Serdes2

enumerator kCLOCK_Root_Serdes0_1G
CLOCK Root Serdes0_1G

enumerator kCLOCK_Root_Serdes1_1G
CLOCK Root Serdes1_1G

enumerator kCLOCK_Root_Serdes2_1G
CLOCK Root Serdes2_1G

enumerator kCLOCK_Root_Xcelbusx
CLOCK Root Xcelbusx

enumerator kCLOCK_Root_Xriocu4
CLOCK Root Xriocu4

enumerator kCLOCK_Root_Mctrl
CLOCK Root Mctrl

enumerator kCLOCK_Root_Sai1
CLOCK Root Sai1

enumerator kCLOCK_Root_Sai2
CLOCK Root Sai2

enumerator kCLOCK_Root_Sai3
CLOCK Root Sai3

enumerator kCLOCK_Root_Sai4
CLOCK Root Sai4

enumerator kCLOCK_Root_Spdif
CLOCK Root Spdif

enumerator kCLOCK_Root_Asrc
CLOCK Root Asrc

enumerator kCLOCK_Root_Mic
CLOCK Root Mic

enumerator kCLOCK_Root_Cko1
CLOCK Root Cko1

enumerator kCLOCK_Root_Cko2
CLOCK Root Cko2

enum _clock_root_mux_source

The enumerator of clock roots' clock source mux value.

Values:

enumerator kCLOCK_M7_ClockRoot_MuxOscRc24M
M7 mux from OscRc24M.

enumerator kCLOCK_M7_ClockRoot_MuxOscRc400M
M7 mux from OscRc400M.

enumerator kCLOCK_M7_ClockRoot_MuxArmPllOut
M7 mux from ArmPllOut.

enumerator kCLOCK_M7_ClockRoot_MuxSysPll3Out
M7 mux from SysPll3Out.

enumerator kCLOCK_M33_ClockRoot_MuxOscRc24M
M33 mux from OscRc24M.

enumerator kCLOCK_M33_ClockRoot_MuxOscRc400M
M33 mux from OscRc400M.

enumerator kCLOCK_M33_ClockRoot_MuxSysPll3Out
M33 mux from SysPll3Out.

enumerator kCLOCK_M33_ClockRoot_MuxArmPllOut
M33 mux from ArmPllOut.

enumerator kCLOCK_EDGELOCK_ClockRoot_MuxOscRc24M
EDGELOCK mux from OscRc24M.

enumerator kCLOCK_EDGELOCK_ClockRoot_MuxOscRc400M
EDGELOCK mux from OscRc400M.

enumerator kCLOCK_EDGELOCK_ClockRoot_MuxSysPll1Out
EDGELOCK mux from SysPll1Out.

enumerator kCLOCK_EDGELOCK_ClockRoot_MuxSysPll2Pfd1
EDGELOCK mux from SysPll2Pfd1.

enumerator kCLOCK_BUS_AON_ClockRoot_MuxOscRc24M
BUS_AON mux from OscRc24M.

enumerator kCLOCK_BUS_AON_ClockRoot_MuxOscRc400M
BUS_AON mux from OscRc400M.

enumerator kCLOCK_BUS_AON_ClockRoot_MuxSysPll2Out
BUS_AON mux from SysPll2Out.

enumerator kCLOCK_BUS_AON_ClockRoot_MuxSysPll3Pfd2
BUS_AON mux from SysPll3Pfd2.

enumerator kCLOCK_BUS_WAKEUP_ClockRoot_MuxOscRc24M
BUS_WAKEUP mux from OscRc24M.

enumerator kCLOCK_BUS_WAKEUP_ClockRoot_MuxOscRc400M
BUS_WAKEUP mux from OscRc400M.

enumerator kCLOCK_BUS_WAKEUP_ClockRoot_MuxSysPll2Out
BUS_WAKEUP mux from SysPll2Out.

enumerator kCLOCK_BUS_WAKEUP_ClockRoot_MuxSysPll3Pfd1
BUS_WAKEUP mux from SysPll3Pfd1.

enumerator kCLOCK_WAKEUP_AXI_ClockRoot_MuxOscRc24M
WAKEUP_AXI mux from OscRc24M.

enumerator kCLOCK_WAKEUP_AXI_ClockRoot_MuxOscRc400M
WAKEUP_AXI mux from OscRc400M.

enumerator kCLOCK_WAKEUP_AXI_ClockRoot_MuxSysPll3Out
WAKEUP_AXI mux from SysPll3Out.

enumerator kCLOCK_WAKEUP_AXI_ClockRoot_MuxSysPll2Pfd1
WAKEUP_AXI mux from SysPll2Pfd1.

enumerator kCLOCK_SWO_TRACE_ClockRoot_MuxOscRc24M
SWO_TRACE mux from OscRc24M.

enumerator kCLOCK_SWO_TRACE_ClockRoot_MuxOscRc400M
SWO_TRACE mux from OscRc400M.

enumerator kCLOCK_SWO_TRACE_ClockRoot_MuxSysPll3Div2
SWO_TRACE mux from SysPll3Div2.

enumerator kCLOCK_SWO_TRACE_ClockRoot_MuxSysPll1Div5
SWO_TRACE mux from SysPll1Div5.

enumerator kCLOCK_M33_SYSTICK_ClockRoot_MuxOscRc24M
M33_SYSTICK mux from OscRc24M.

enumerator kCLOCK_M33_SYSTICK_ClockRoot_MuxOscRc400M
M33_SYSTICK mux from OscRc400M.

enumerator kCLOCK_M33_SYSTICK_ClockRoot_MuxOsc24MOut
M33_SYSTICK mux from Osc24MOut.

enumerator kCLOCK_M33_SYSTICK_ClockRoot_MuxSysPll3Div2
M33_SYSTICK mux from SysPll3Div2.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOscRc24M
M7_SYSTICK mux from OscRc24M.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOscRc400M
M7_SYSTICK mux from OscRc400M.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxOsc24MOut
M7_SYSTICK mux from Osc24MOut.

enumerator kCLOCK_M7_SYSTICK_ClockRoot_MuxSysPll3Div2
M7_SYSTICK mux from SysPll3Div2.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOscRc24M
FLEXIO1 mux from OscRc24M.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxOscRc400M
FLEXIO1 mux from OscRc400M.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll3Div2
FLEXIO1 mux from SysPll3Div2.

enumerator kCLOCK_FLEXIO1_ClockRoot_MuxSysPll1Div5
FLEXIO1 mux from SysPll1Div5.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOscRc24M
FLEXIO2 mux from OscRc24M.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxOscRc400M
FLEXIO2 mux from OscRc400M.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll3Div2
FLEXIO2 mux from SysPll3Div2.

enumerator kCLOCK_FLEXIO2_ClockRoot_MuxSysPll1Div5
FLEXIO2 mux from SysPll1Div5.

enumerator kCLOCK_LPIT3_ClockRoot_MuxOscRc24M
LPIT3 mux from OscRc24M.

enumerator kCLOCK_LPIT3_ClockRoot_MuxOscRc400M
LPIT3 mux from OscRc400M.

enumerator kCLOCK_LPIT3_ClockRoot_MuxSysPll3Div2
LPIT3 mux from SysPll3Div2.

enumerator kCLOCK_LPIT3_ClockRoot_MuxSysPll2Pfd3
LPIT3 mux from SysPll2Pfd3.

enumerator kCLOCK_LPTIMER1_ClockRoot_MuxOscRc24M
LPTIMER1 mux from OscRc24M.

enumerator kCLOCK_LPTIMER1_ClockRoot_MuxOscRc400M
LPTIMER1 mux from OscRc400M.

enumerator kCLOCK_LPTIMER1_ClockRoot_MuxSysPll3Div2
LPTIMER1 mux from SysPll3Div2.

enumerator kCLOCK_LPTIMER1_ClockRoot_MuxSysPll2Pfd3
LPTIMER1 mux from SysPll2Pfd3.

enumerator kCLOCK_LPTIMER2_ClockRoot_MuxOscRc24M
LPTIMER2 mux from OscRc24M.

enumerator kCLOCK_LPTIMER2_ClockRoot_MuxOscRc400M
LPTIMER2 mux from OscRc400M.

enumerator kCLOCK_LPTIMER2_ClockRoot_MuxSysPll3Div2
LPTIMER2 mux from SysPll3Div2.

enumerator kCLOCK_LPTIMER2_ClockRoot_MuxSysPll2Pfd3
LPTIMER2 mux from SysPll2Pfd3.

enumerator kCLOCK_LPTIMER3_ClockRoot_MuxOscRc24M
LPTIMER3 mux from OscRc24M.

enumerator kCLOCK_LPTIMER3_ClockRoot_MuxOscRc400M
LPTIMER3 mux from OscRc400M.

enumerator kCLOCK_LPTIMER3_ClockRoot_MuxSysPll3Div2
LPTIMER3 mux from SysPll3Div2.

enumerator kCLOCK_LPTIMER3_ClockRoot_MuxSysPll2Pfd3
LPTIMER3 mux from SysPll2Pfd3.

enumerator kCLOCK_TPM2_ClockRoot_MuxOscRc24M
TPM2 mux from OscRc24M.

enumerator kCLOCK_TPM2_ClockRoot_MuxOscRc400M
TPM2 mux from OscRc400M.

enumerator kCLOCK_TPM2_ClockRoot_MuxSysPll3Div2
TPM2 mux from SysPll3Div2.

enumerator kCLOCK_TPM2_ClockRoot_MuxSysPll2Pfd3
TPM2 mux from SysPll2Pfd3.

enumerator kCLOCK_TPM4_ClockRoot_MuxOscRc24M
TPM4 mux from OscRc24M.

enumerator kCLOCK_TPM4_ClockRoot_MuxOscRc400M
TPM4 mux from OscRc400M.

enumerator kCLOCK_TPM4_ClockRoot_MuxSysPll3Div2
TPM4 mux from SysPll3Div2.

enumerator kCLOCK_TPM4_ClockRoot_MuxSysPll2Pfd3
TPM4 mux from SysPll2Pfd3.

enumerator kCLOCK_TPM5_ClockRoot_MuxOscRc24M
TPM5 mux from OscRc24M.

enumerator kCLOCK_TPM5_ClockRoot_MuxOscRc400M
TPM5 mux from OscRc400M.

enumerator kCLOCK_TPM5_ClockRoot_MuxSysPll3Div2
TPM5 mux from SysPll3Div2.

enumerator kCLOCK_TPM5_ClockRoot_MuxSysPll2Pfd3
TPM5 mux from SysPll2Pfd3.

enumerator kCLOCK_TPM6_ClockRoot_MuxOscRc24M
TPM6 mux from OscRc24M.

enumerator kCLOCK_TPM6_ClockRoot_MuxOscRc400M
TPM6 mux from OscRc400M.

enumerator kCLOCK_TPM6_ClockRoot_MuxSysPll3Div2
TPM6 mux from SysPll3Div2.

enumerator kCLOCK_TPM6_ClockRoot_MuxSysPll2Pfd3
TPM6 mux from SysPll2Pfd3.

enumerator kCLOCK_GPT1_ClockRoot_MuxOscRc24M
GPT1 mux from OscRc24M.

enumerator kCLOCK_GPT1_ClockRoot_MuxOscRc400M
GPT1 mux from OscRc400M.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll3Div2
GPT1 mux from SysPll3Div2.

enumerator kCLOCK_GPT1_ClockRoot_MuxSysPll2Pfd3
GPT1 mux from SysPll2Pfd3.

enumerator kCLOCK_GPT2_ClockRoot_MuxOscRc24M
GPT2 mux from OscRc24M.

enumerator kCLOCK_GPT2_ClockRoot_MuxOscRc400M
GPT2 mux from OscRc400M.

enumerator kCLOCK_GPT2_ClockRoot_MuxSysPll3Div2
GPT2 mux from SysPll3Div2.

enumerator kCLOCK_GPT2_ClockRoot_MuxSysPll2Pfd3
GPT2 mux from SysPll2Pfd3.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOscRc24M
FLEXSPI1 mux from OscRc24M.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxOscRc400M
FLEXSPI1 mux from OscRc400M.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll3Pfd0
FLEXSPI1 mux from SysPll3Pfd0.

enumerator kCLOCK_FLEXSPI1_ClockRoot_MuxSysPll2Pfd0
FLEXSPI1 mux from SysPll2Pfd0.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOscRc24M
FLEXSPI2 mux from OscRc24M.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxOscRc400M
FLEXSPI2 mux from OscRc400M.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll3Pfd2
FLEXSPI2 mux from SysPll3Pfd2.

enumerator kCLOCK_FLEXSPI2_ClockRoot_MuxSysPll2Pfd1
FLEXSPI2 mux from SysPll2Pfd1.

enumerator kCLOCK_FLEXSPI_SLV_ClockRoot_MuxOscRc24M
FLEXSPI_SLV mux from OscRc24M.

enumerator kCLOCK_FLEXSPI_SLV_ClockRoot_MuxOscRc400M
FLEXSPI_SLV mux from OscRc400M.

enumerator kCLOCK_FLEXSPI_SLV_ClockRoot_MuxSysPll2Out
FLEXSPI_SLV mux from SysPll2Out.

enumerator kCLOCK_FLEXSPI_SLV_ClockRoot_MuxSysPll1Out
FLEXSPI_SLV mux from SysPll1Out.

enumerator kCLOCK_CAN1_ClockRoot_MuxOscRc24M
CAN1 mux from OscRc24M.

enumerator kCLOCK_CAN1_ClockRoot_MuxOscRc400M
CAN1 mux from OscRc400M.

enumerator kCLOCK_CAN1_ClockRoot_MuxSysPll3Out
CAN1 mux from SysPll3Out.

enumerator kCLOCK_CAN1_ClockRoot_MuxOsc24MOut
CAN1 mux from Osc24MOut.

enumerator kCLOCK_CAN2_ClockRoot_MuxOscRc24M
CAN2 mux from OscRc24M.

enumerator kCLOCK_CAN2_ClockRoot_MuxOscRc400M
CAN2 mux from OscRc400M.

enumerator kCLOCK_CAN2_ClockRoot_MuxSysPll3Out
CAN2 mux from SysPll3Out.

enumerator kCLOCK_CAN2_ClockRoot_MuxOsc24MOut
CAN2 mux from Osc24MOut.

enumerator kCLOCK_CAN3_ClockRoot_MuxOscRc24M
CAN3 mux from OscRc24M.

enumerator kCLOCK_CAN3_ClockRoot_MuxOscRc400M
CAN3 mux from OscRc400M.

enumerator kCLOCK_CAN3_ClockRoot_MuxSysPll3Out
CAN3 mux from SysPll3Out.

enumerator kCLOCK_CAN3_ClockRoot_MuxOsc24MOut
CAN3 mux from Osc24MOut.

enumerator kCLOCK_LPUART0102_ClockRoot_MuxOscRc24M
LPUART0102 mux from OscRc24M.

enumerator kCLOCK_LPUART0102_ClockRoot_MuxOscRc400M
LPUART0102 mux from OscRc400M.

enumerator kCLOCK_LPUART0102_ClockRoot_MuxSysPll3Div2
LPUART0102 mux from SysPll3Div2.

enumerator kCLOCK_LPUART0102_ClockRoot_MuxSysPll2Pfd3
LPUART0102 mux from SysPll2Pfd3.

enumerator kCLOCK_LPUART0304_ClockRoot_MuxOscRc24M
LPUART0304 mux from OscRc24M.

enumerator kCLOCK_LPUART0304_ClockRoot_MuxOscRc400M
LPUART0304 mux from OscRc400M.

enumerator kCLOCK_LPUART0304_ClockRoot_MuxSysPll3Div2
LPUART0304 mux from SysPll3Div2.

enumerator kCLOCK_LPUART0304_ClockRoot_MuxSysPll2Pfd3
LPUART0304 mux from SysPll2Pfd3.

enumerator kCLOCK_LPUART0506_ClockRoot_MuxOscRc24M
LPUART0506 mux from OscRc24M.

enumerator kCLOCK_LPUART0506_ClockRoot_MuxOscRc400M
LPUART0506 mux from OscRc400M.

enumerator kCLOCK_LPUART0506_ClockRoot_MuxSysPll3Div2
LPUART0506 mux from SysPll3Div2.

enumerator kCLOCK_LPUART0506_ClockRoot_MuxSysPll2Pfd3
LPUART0506 mux from SysPll2Pfd3.

enumerator kCLOCK_LPUART0708_ClockRoot_MuxOscRc24M
LPUART0708 mux from OscRc24M.

enumerator kCLOCK_LPUART0708_ClockRoot_MuxOscRc400M
LPUART0708 mux from OscRc400M.

enumerator kCLOCK_LPUART0708_ClockRoot_MuxSysPll3Div2
LPUART0708 mux from SysPll3Div2.

enumerator kCLOCK_LPUART0708_ClockRoot_MuxSysPll2Pfd3
LPUART0708 mux from SysPll2Pfd3.

enumerator kCLOCK_LPUART0910_ClockRoot_MuxOscRc24M
LPUART0910 mux from OscRc24M.

enumerator kCLOCK_LPUART0910_ClockRoot_MuxOscRc400M
LPUART0910 mux from OscRc400M.

enumerator kCLOCK_LPUART0910_ClockRoot_MuxSysPll3Div2
LPUART0910 mux from SysPll3Div2.

enumerator kCLOCK_LPUART0910_ClockRoot_MuxSysPll2Pfd3
LPUART0910 mux from SysPll2Pfd3.

enumerator kCLOCK_LPUART1112_ClockRoot_MuxOscRc24M
LPUART1112 mux from OscRc24M.

enumerator kCLOCK_LPUART1112_ClockRoot_MuxOscRc400M
LPUART1112 mux from OscRc400M.

enumerator kCLOCK_LPUART1112_ClockRoot_MuxSysPll3Div2
LPUART1112 mux from SysPll3Div2.

enumerator kCLOCK_LPUART1112_ClockRoot_MuxSysPll2Pfd3
LPUART1112 mux from SysPll2Pfd3.

enumerator kCLOCK_LPI2C0102_ClockRoot_MuxOscRc24M
LPI2C0102 mux from OscRc24M.

enumerator kCLOCK_LPI2C0102_ClockRoot_MuxOscRc400M
LPI2C0102 mux from OscRc400M.

enumerator kCLOCK_LPI2C0102_ClockRoot_MuxSysPll3Div2
LPI2C0102 mux from SysPll3Div2.

enumerator kCLOCK_LPI2C0102_ClockRoot_MuxSysPll2Pfd3
LPI2C0102 mux from SysPll2Pfd3.

enumerator kCLOCK_LPI2C0304_ClockRoot_MuxOscRc24M
LPI2C0304 mux from OscRc24M.

enumerator kCLOCK_LPI2C0304_ClockRoot_MuxOscRc400M
LPI2C0304 mux from OscRc400M.

enumerator kCLOCK_LPI2C0304_ClockRoot_MuxSysPll3Div2
LPI2C0304 mux from SysPll3Div2.

enumerator kCLOCK_LPI2C0304_ClockRoot_MuxSysPll2Pfd3
LPI2C0304 mux from SysPll2Pfd3.

enumerator kCLOCK_LPI2C0506_ClockRoot_MuxOscRc24M
LPI2C0506 mux from OscRc24M.

enumerator kCLOCK_LPI2C0506_ClockRoot_MuxOscRc400M
LPI2C0506 mux from OscRc400M.

enumerator kCLOCK_LPI2C0506_ClockRoot_MuxSysPll3Div2
LPI2C0506 mux from SysPll3Div2.

enumerator kCLOCK_LPI2C0506_ClockRoot_MuxSysPll2Pfd3
LPI2C0506 mux from SysPll2Pfd3.

enumerator kCLOCK_LPSPi0102_ClockRoot_MuxOscRc24M
LPSPi0102 mux from OscRc24M.

enumerator kCLOCK_LPSPi0102_ClockRoot_MuxOscRc400M
LPSPi0102 mux from OscRc400M.

enumerator kCLOCK_LPSPi0102_ClockRoot_MuxSysPll3Pfd1
LPSPi0102 mux from SysPll3Pfd1.

enumerator kCLOCK_LPSPi0102_ClockRoot_MuxSysPll2Out
LPSPi0102 mux from SysPll2Out.

enumerator kCLOCK_LPSPi0304_ClockRoot_MuxOscRc24M
LPSPi0304 mux from OscRc24M.

enumerator kCLOCK_LPSPi0304_ClockRoot_MuxOscRc400M
LPSPi0304 mux from OscRc400M.

enumerator kCLOCK_LPSPi0304_ClockRoot_MuxSysPll3Pfd1
LPSPi0304 mux from SysPll3Pfd1.

enumerator kCLOCK_LPSPi0304_ClockRoot_MuxSysPll2Out
LPSPi0304 mux from SysPll2Out.

enumerator kCLOCK_LPSPi0506_ClockRoot_MuxOscRc24M
LPSPi0506 mux from OscRc24M.

enumerator kCLOCK_LPSPi0506_ClockRoot_MuxOscRc400M
LPSPi0506 mux from OscRc400M.

enumerator kCLOCK_LPSPi0506_ClockRoot_MuxSysPll3Pfd1
LPSPi0506 mux from SysPll3Pfd1.

enumerator kCLOCK_LPSPi0506_ClockRoot_MuxSysPll2Out
LPSPi0506 mux from SysPll2Out.

enumerator kCLOCK_I3C1_ClockRoot_MuxOscRc24M
I3C1 mux from OscRc24M.

enumerator kCLOCK_I3C1_ClockRoot_MuxOscRc400M
I3C1 mux from OscRc400M.

enumerator kCLOCK_I3C1_ClockRoot_MuxSysPll3Div2
I3C1 mux from SysPll3Div2.

enumerator kCLOCK_I3C1_ClockRoot_MuxSysPll2Pfd3
I3C1 mux from SysPll2Pfd3.

enumerator kCLOCK_I3C2_ClockRoot_MuxOscRc24M
I3C2 mux from OscRc24M.

enumerator kCLOCK_I3C2_ClockRoot_MuxOscRc400M
I3C2 mux from OscRc400M.

enumerator kCLOCK_I3C2_ClockRoot_MuxSysPll3Div2
I3C2 mux from SysPll3Div2.

enumerator kCLOCK_I3C2_ClockRoot_MuxSysPll2Pfd3
I3C2 mux from SysPll2Pfd3.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOscRc24M
USDHC1 mux from OscRc24M.

enumerator kCLOCK_USDHC1_ClockRoot_MuxOscRc400M
USDHC1 mux from OscRc400M.

enumerator kCLOCK_USDHC1_ClockRoot_MuxSysPll2Pfd2
USDHC1 mux from SysPll2Pfd2.

enumerator kCLOCK_USDHC1_ClockRoot_MuxSysPll1Div5
USDHC1 mux from SysPll1Div5.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOscRc24M
USDHC2 mux from OscRc24M.

enumerator kCLOCK_USDHC2_ClockRoot_MuxOscRc400M
USDHC2 mux from OscRc400M.

enumerator kCLOCK_USDHC2_ClockRoot_MuxSysPll2Pfd2
USDHC2 mux from SysPll2Pfd2.

enumerator kCLOCK_USDHC2_ClockRoot_MuxSysPll1Div5
USDHC2 mux from SysPll1Div5.

enumerator kCLOCK_SEMC_ClockRoot_MuxOscRc24M
SEMC mux from OscRc24M.

enumerator kCLOCK_SEMC_ClockRoot_MuxOscRc400M
SEMC mux from OscRc400M.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll1Out
SEMC mux from SysPll1Out.

enumerator kCLOCK_SEMC_ClockRoot_MuxSysPll2Pfd0
SEMC mux from SysPll2Pfd0.

enumerator kCLOCK_ADC1_ClockRoot_MuxOscRc24M
ADC1 mux from OscRc24M.

enumerator kCLOCK_ADC1_ClockRoot_MuxOscRc400M
ADC1 mux from OscRc400M.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll3Div2
ADC1 mux from SysPll3Div2.

enumerator kCLOCK_ADC1_ClockRoot_MuxSysPll2Pfd3
ADC1 mux from SysPll2Pfd3.

enumerator kCLOCK_ADC2_ClockRoot_MuxOscRc24M
ADC2 mux from OscRc24M.

enumerator kCLOCK_ADC2_ClockRoot_MuxOscRc400M
ADC2 mux from OscRc400M.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll3Div2
ADC2 mux from SysPll3Div2.

enumerator kCLOCK_ADC2_ClockRoot_MuxSysPll2Pfd3
ADC2 mux from SysPll2Pfd3.

enumerator kCLOCK_ACMP_ClockRoot_MuxOscRc24M
ACMP mux from OscRc24M.

enumerator kCLOCK_ACMP_ClockRoot_MuxOscRc400M
ACMP mux from OscRc400M.

enumerator kCLOCK_ACMP_ClockRoot_MuxSysPll3Out
ACMP mux from SysPll3Out.

enumerator kCLOCK_ACMP_ClockRoot_MuxSysPll2Pfd3
ACMP mux from SysPll2Pfd3.

enumerator kCLOCK_ECAT_ClockRoot_MuxOscRc24M
ECAT mux from OscRc24M.

enumerator kCLOCK_ECAT_ClockRoot_MuxOscRc400M
ECAT mux from OscRc400M.

enumerator kCLOCK_ECAT_ClockRoot_MuxSysPll1Div2
ECAT mux from SysPll1Div2.

enumerator kCLOCK_ECAT_ClockRoot_MuxSysPll1Div5
ECAT mux from SysPll1Div5.

enumerator kCLOCK_ENET_ClockRoot_MuxOscRc24M
ENET mux from OscRc24M.

enumerator kCLOCK_ENET_ClockRoot_MuxOscRc400M
ENET mux from OscRc400M.

enumerator kCLOCK_ENET_ClockRoot_MuxSysPll1Div2
ENET mux from SysPll1Div2.

enumerator kCLOCK_ENET_ClockRoot_MuxSysPll1Div5
ENET mux from SysPll1Div5.

enumerator kCLOCK_TMR_1588_ClockRoot_MuxOscRc24M
TMR_1588 mux from OscRc24M.

enumerator kCLOCK_TMR_1588_ClockRoot_MuxOscRc400M
TMR_1588 mux from OscRc400M.

enumerator kCLOCK_TMR_1588_ClockRoot_MuxSysPll3Out
TMR_1588 mux from SysPll3Out.

enumerator kCLOCK_TMR_1588_ClockRoot_MuxSysPll2Pfd3
TMR_1588 mux from SysPll2Pfd3.

enumerator kCLOCK_NETC_ClockRoot_MuxOscRc24M
NETC mux from OscRc24M.

enumerator kCLOCK_NETC_ClockRoot_MuxOscRc400M
NETC mux from OscRc400M.

enumerator kCLOCK_NETC_ClockRoot_MuxSysPll3Pfd3
NETC mux from SysPll3Pfd3.

enumerator kCLOCK_NETC_ClockRoot_MuxSysPll2Pfd1
NETC mux from SysPll2Pfd1.

enumerator kCLOCK_MAC0_ClockRoot_MuxOscRc24M
MAC0 mux from OscRc24M.

enumerator kCLOCK_MAC0_ClockRoot_MuxOscRc400M
MAC0 mux from OscRc400M.

enumerator kCLOCK_MAC0_ClockRoot_MuxSysPll1Div2
MAC0 mux from SysPll1Div2.

enumerator kCLOCK_MAC0_ClockRoot_MuxSysPll1Div5
MAC0 mux from SysPll1Div5.

enumerator kCLOCK_MAC1_ClockRoot_MuxOscRc24M
MAC1 mux from OscRc24M.

enumerator kCLOCK_MAC1_ClockRoot_MuxOscRc400M
MAC1 mux from OscRc400M.

enumerator kCLOCK_MAC1_ClockRoot_MuxSysPll1Div2
MAC1 mux from SysPll1Div2.

enumerator kCLOCK_MAC1_ClockRoot_MuxSysPll1Div5
MAC1 mux from SysPll1Div5.

enumerator kCLOCK_MAC2_ClockRoot_MuxOscRc24M
MAC2 mux from OscRc24M.

enumerator kCLOCK_MAC2_ClockRoot_MuxOscRc400M
MAC2 mux from OscRc400M.

enumerator kCLOCK_MAC2_ClockRoot_MuxSysPll1Div2
MAC2 mux from SysPll1Div2.

enumerator kCLOCK_MAC2_ClockRoot_MuxSysPll1Div5
MAC2 mux from SysPll1Div5.

enumerator kCLOCK_MAC3_ClockRoot_MuxOscRc24M
MAC3 mux from OscRc24M.

enumerator kCLOCK_MAC3_ClockRoot_MuxOscRc400M
MAC3 mux from OscRc400M.

enumerator kCLOCK_MAC3_ClockRoot_MuxSysPll1Div2
MAC3 mux from SysPll1Div2.

enumerator kCLOCK_MAC3_ClockRoot_MuxSysPll1Div5
MAC3 mux from SysPll1Div5.

enumerator kCLOCK_MAC4_ClockRoot_MuxOscRc24M
MAC4 mux from OscRc24M.

enumerator kCLOCK_MAC4_ClockRoot_MuxOscRc400M
MAC4 mux from OscRc400M.

enumerator kCLOCK_MAC4_ClockRoot_MuxSysPll1Div2
MAC4 mux from SysPll1Div2.

enumerator kCLOCK_MAC4_ClockRoot_MuxSysPll1Div5
MAC4 mux from SysPll1Div5.

enumerator kCLOCK_SERDES0_ClockRoot_MuxOscRc24M
SERDES0 mux from OscRc24M.

enumerator kCLOCK_SERDES0_ClockRoot_MuxOscRc400M
SERDES0 mux from OscRc400M.

enumerator kCLOCK_SERDES0_ClockRoot_MuxSysPll1Div2
SERDES0 mux from SysPll1Div2.

enumerator kCLOCK_SERDES0_ClockRoot_MuxSysPll1Div5
SERDES0 mux from SysPll1Div5.

enumerator kCLOCK_SERDES1_ClockRoot_MuxOscRc24M
SERDES1 mux from OscRc24M.

enumerator kCLOCK_SERDES1_ClockRoot_MuxOscRc400M
SERDES1 mux from OscRc400M.

enumerator kCLOCK_SERDES1_ClockRoot_MuxSysPll1Div2
SERDES1 mux from SysPll1Div2.

enumerator kCLOCK_SERDES1_ClockRoot_MuxSysPll1Div5
SERDES1 mux from SysPll1Div5.

enumerator kCLOCK_SERDES2_ClockRoot_MuxOscRc24M
SERDES2 mux from OscRc24M.

enumerator kCLOCK_SERDES2_ClockRoot_MuxOscRc400M
SERDES2 mux from OscRc400M.

enumerator kCLOCK_SERDES2_ClockRoot_MuxSysPll1Div2
SERDES2 mux from SysPll1Div2.

enumerator kCLOCK_SERDES2_ClockRoot_MuxSysPll1Div5
SERDES2 mux from SysPll1Div5.

enumerator kCLOCK_SERDES0_1G_ClockRoot_MuxOscRc24M
SERDES0_1G mux from OscRc24M.

enumerator kCLOCK_SERDES0_1G_ClockRoot_MuxOscRc400M
SERDES0_1G mux from OscRc400M.

enumerator kCLOCK_SERDES0_1G_ClockRoot_MuxSysPll1Out
SERDES0_1G mux from SysPll1Out.

enumerator kCLOCK_SERDES0_1G_ClockRoot_MuxAudioPllOut
SERDES0_1G mux from AudioPllOut.

enumerator kCLOCK_SERDES1_1G_ClockRoot_MuxOscRc24M
SERDES1_1G mux from OscRc24M.

enumerator kCLOCK_SERDES1_1G_ClockRoot_MuxOscRc400M
SERDES1_1G mux from OscRc400M.

enumerator kCLOCK_SERDES1_1G_ClockRoot_MuxSysPll1Out
SERDES1_1G mux from SysPll1Out.

enumerator kCLOCK_SERDES1_1G_ClockRoot_MuxAudioPllOut
SERDES1_1G mux from AudioPllOut.

enumerator kCLOCK_SERDES2_1G_ClockRoot_MuxOscRc24M
SERDES2_1G mux from OscRc24M.

enumerator kCLOCK_SERDES2_1G_ClockRoot_MuxOscRc400M
SERDES2_1G mux from OscRc400M.

enumerator kCLOCK_SERDES2_1G_ClockRoot_MuxSysPll1Out
SERDES2_1G mux from SysPll1Out.

enumerator kCLOCK_SERDES2_1G_ClockRoot_MuxAudioPllOut
SERDES2_1G mux from AudioPllOut.

enumerator kCLOCK_XCELBUSX_ClockRoot_MuxOscRc24M
XCELBUSX mux from OscRc24M.

enumerator kCLOCK_XCELBUSX_ClockRoot_MuxOscRc400M
XCELBUSX mux from OscRc400M.

enumerator kCLOCK_XCELBUSX_ClockRoot_MuxSysPll3Out
XCELBUSX mux from SysPll3Out.

enumerator kCLOCK_XCELBUSX_ClockRoot_MuxSysPll3Pfd1
XCELBUSX mux from SysPll3Pfd1.

enumerator kCLOCK_XRIOCU4_ClockRoot_MuxOscRc24M
XRIOCU4 mux from OscRc24M.

enumerator kCLOCK_XRIOCU4_ClockRoot_MuxOscRc400M
XRIOCU4 mux from OscRc400M.

enumerator kCLOCK_XRIOCU4_ClockRoot_MuxOsc24MOut
XRIOCU4 mux from Osc24MOut.

enumerator kCLOCK_XRIOCU4_ClockRoot_MuxSysPll3Div2
XRIOCU4 mux from SysPll3Div2.

enumerator kCLOCK_MCTRL_ClockRoot_MuxOscRc24M
MCTRL mux from OscRc24M.

enumerator kCLOCK_MCTRL_ClockRoot_MuxOscRc400M
MCTRL mux from OscRc400M.

enumerator kCLOCK_MCTRL_ClockRoot_MuxSysPll1Div5
MCTRL mux from SysPll1Div5.

enumerator kCLOCK_MCTRL_ClockRoot_MuxAudioPllOut
MCTRL mux from AudioPllOut.

enumerator kCLOCK_SAI1_ClockRoot_MuxOscRc24M
SAI1 mux from OscRc24M.

enumerator kCLOCK_SAI1_ClockRoot_MuxOscRc400M
SAI1 mux from OscRc400M.

enumerator kCLOCK_SAI1_ClockRoot_MuxAudioPllOut
SAI1 mux from AudioPllOut.

enumerator kCLOCK_SAI1_ClockRoot_MuxSysPll3Pfd2
SAI1 mux from SysPll3Pfd2.

enumerator kCLOCK_SAI2_ClockRoot_MuxOscRc24M
SAI2 mux from OscRc24M.

enumerator kCLOCK_SAI2_ClockRoot_MuxOscRc400M
SAI2 mux from OscRc400M.

enumerator kCLOCK_SAI2_ClockRoot_MuxAudioPllOut
SAI2 mux from AudioPllOut.

enumerator kCLOCK_SAI2_ClockRoot_MuxSysPll3Pfd2
SAI2 mux from SysPll3Pfd2.

enumerator kCLOCK_SAI3_ClockRoot_MuxOscRc24M
SAI3 mux from OscRc24M.

enumerator kCLOCK_SAI3_ClockRoot_MuxOscRc400M
SAI3 mux from OscRc400M.

enumerator kCLOCK_SAI3_ClockRoot_MuxAudioPllOut
SAI3 mux from AudioPllOut.

enumerator kCLOCK_SAI3_ClockRoot_MuxSysPll3Pfd2
SAI3 mux from SysPll3Pfd2.

enumerator kCLOCK_SAI4_ClockRoot_MuxOscRc24M
SAI4 mux from OscRc24M.

enumerator kCLOCK_SAI4_ClockRoot_MuxOscRc400M
SAI4 mux from OscRc400M.

enumerator kCLOCK_SAI4_ClockRoot_MuxAudioPllOut
SAI4 mux from AudioPllOut.

enumerator kCLOCK_SAI4_ClockRoot_MuxSysPll3Pfd2
SAI4 mux from SysPll3Pfd2.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOscRc24M
SPDIF mux from OscRc24M.

enumerator kCLOCK_SPDIF_ClockRoot_MuxOscRc400M
SPDIF mux from OscRc400M.

enumerator kCLOCK_SPDIF_ClockRoot_MuxAudioPllOut
SPDIF mux from AudioPllOut.

enumerator kCLOCK_SPDIF_ClockRoot_MuxSysPll3Pfd2
SPDIF mux from SysPll3Pfd2.

enumerator kCLOCK_ASRC_ClockRoot_MuxOscRc24M
ASRC mux from OscRc24M.

enumerator kCLOCK_ASRC_ClockRoot_MuxOscRc400M
ASRC mux from OscRc400M.

enumerator kCLOCK_ASRC_ClockRoot_MuxSysPll3Out
ASRC mux from SysPll3Out.

enumerator kCLOCK_ASRC_ClockRoot_MuxAudioPllOut
ASRC mux from AudioPllOut.

enumerator kCLOCK_MIC_ClockRoot_MuxOscRc24M
MIC mux from OscRc24M.

enumerator kCLOCK_MIC_ClockRoot_MuxOscRc400M
MIC mux from OscRc400M.

enumerator kCLOCK_MIC_ClockRoot_MuxSysPll3Div2
MIC mux from SysPll3Div2.

enumerator kCLOCK_MIC_ClockRoot_MuxAudioPllOut
MIC mux from AudioPllOut.

enumerator kCLOCK_CKO1_ClockRoot_MuxOscRc24M
CKO1 mux from OscRc24M.

enumerator kCLOCK_CKO1_ClockRoot_MuxOscRc400M
CKO1 mux from OscRc400M.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll3Div2
CKO1 mux from SysPll3Div2.

enumerator kCLOCK_CKO1_ClockRoot_MuxSysPll1Div2
CKO1 mux from SysPll1Div2.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc24M
CKO2 mux from OscRc24M.

enumerator kCLOCK_CKO2_ClockRoot_MuxOscRc400M
CKO2 mux from OscRc400M.

enumerator kCLOCK_CKO2_ClockRoot_MuxSysPll1Div5
CKO2 mux from SysPll1Div5.

enumerator kCLOCK_CKO2_ClockRoot_MuxArmPllOut
CKO2 mux from ArmPllOut.

enum _clock_osc
OSC 24M sorce select.

Values:

enumerator kCLOCK_RcOsc

On chip OSC.

enumerator kCLOCK_XtalOsc

24M Xtal OSC

enum _clock_gate_value

Clock gate value.

Values:

enumerator kCLOCK_Off

Clock is off.

enumerator kCLOCK_On

Clock is on

enum _clock_mode_t

System clock mode.

Values:

enumerator kCLOCK_ModeRun

Remain in run mode.

enumerator kCLOCK_ModeWait

Transfer to wait mode.

enumerator kCLOCK_ModeStop

Transfer to stop mode.

enum _clock_usb_src

USB clock source definition.

Values:

enumerator kCLOCK_Usb480M

Use 480M.

enumerator kCLOCK_UsbSrcUnused

Used when the function does not care the clock source.

enum _clock_usb_phy_src

Source of the USB HS PHY.

Values:

enumerator kCLOCK_Usbphy480M

Use 480M.

enum _clock_pll_clk_src

PLL clock source, bypass clcco source also.

Values:

enumerator kCLOCK_PllClkSrc24M

Pll clock source 24M

enumerator kCLOCK_PllSrcClkPN

Pll clock source CLK1_P and CLK1_N

enum _clock_pll_post_div

PLL post divider enumeration.

Values:

enumerator kCLOCK_PllPostDiv2

Divide by 2.

enumerator kCLOCK_PllPostDiv4

Divide by 4.

enumerator kCLOCK_PllPostDiv8

Divide by 8.

enumerator kCLOCK_PllPostDiv1

Divide by 1.

enum _clock_output1_selection

The enumerator of clock output1's clock source.

Values:

enumerator kCLOCK_CKO1OutputMuxOscRc24M

CKO1 mux from OscRc24M.

enumerator kCLOCK_CKO1OutputMuxOscRc400M

CKO1 mux from OscRc400M.

enumerator kCLOCK_CKO1OutputMuxSysPll3Div2

CKO1 mux from SysPll3Div2.

enumerator kCLOCK_CKO1OutputMuxSysPll1Div2

CKO1 mux from SysPll1Div2.

enum _clock_output2_selection

The enumerator of clock output2's clock source.

Values:

enumerator kCLOCK_CKO2OutputMuxOscRc24M

CKO2 mux from OscRc24M.

enumerator kCLOCK_CKO2OutputMuxOscRc400M

CKO2 mux from OscRc400M.

enumerator kCLOCK_CKO2OutputMuxSysPll1Div5

CKO2 mux from SysPll1Div5.

enumerator kCLOCK_CKO2OutputMuxArmPllOut

CKO2 mux from ArmPllOut.

enum _clock_pll

PLL name.

Values:

enumerator kCLOCK_PllArm

ARM PLL.

enumerator kCLOCK_PllSys1

SYS1 PLL, it has a dedicated frequency of 1GHz.

enumerator kCLOCK_PllSys2

SYS2 PLL, it has a dedicated frequency of 528MHz.

enumerator kCLOCK_PllSys3

SYS3 PLL, it has a dedicated frequency of 480MHz.

enumerator kCLOCK_PllAudio
Audio PLL.

enumerator kCLOCK_PllInvalid
Invalid value.

enum _clock_pfd
PLL PFD name.

Values:

enumerator kCLOCK_Pfd0
PLL PFD0

enumerator kCLOCK_Pfd1
PLL PFD1

enumerator kCLOCK_Pfd2
PLL PFD2

enumerator kCLOCK_Pfd3
PLL PFD3

enum _clock_control_mode
The enumeration of control mode.

Values:

enumerator kCLOCK_SoftwareMode
Software control mode.

enumerator kCLOCK_GpcMode
GPC control mode.

enum _clock_24MOsc_mode
The enumeration of 24MHz crystal oscillator mode.

Values:

enumerator kCLOCK_24MOscHighGainMode
24MHz crystal oscillator work as high gain mode.

enumerator kCLOCK_24MOscBypassMode
24MHz crystal oscillator work as bypass mode.

enumerator kCLOCK_24MOscLowPowerMode
24MHz crystal oscillator work as low power mode.

enum _clock_1MHzOut_behavior
The enumeration of 1MHz output clock behavior, including disabling 1MHz output, enabling locked 1MHz clock output, and enabling free-running 1MHz clock output.

Values:

enumerator kCLOCK_1MHzOutDisable
Disable 1MHz output clock.

enumerator kCLOCK_1MHzOutEnableLocked1Mhz
Enable 1MHz output clock, and select locked 1MHz to output.

enumerator kCLOCK_1MHzOutEnableFreeRunning1Mhz
Enable 1MHz output clock, and select free-running 1MHz to output.

enum `_clock_level`

The clock dependence level.

Values:

enumerator `kCLOCK_Level0`

Not needed in any mode.

enumerator `kCLOCK_Level1`

Needed in RUN mode.

enumerator `kCLOCK_Level2`

Needed in RUN and WAIT mode.

enumerator `kCLOCK_Level3`

Needed in RUN, WAIT and STOP mode.

enumerator `kCLOCK_Level4`

Always on in any mode.

typedef enum `_clock_lpcg` `clock_lpcg_t`

Clock LPCG index.

typedef enum `_clock_name` `clock_name_t`

Clock name.

typedef enum `_clock_root` `clock_root_t`

Root clock index.

typedef enum `_clock_root_mux_source` `clock_root_mux_source_t`

The enumerator of clock roots' clock source mux value.

typedef enum `_clock_osc` `clock_osc_t`

OSC 24M source select.

typedef enum `_clock_gate_value` `clock_gate_value_t`

Clock gate value.

typedef enum `_clock_mode_t` `clock_mode_t`

System clock mode.

typedef enum `_clock_usb_src` `clock_usb_src_t`

USB clock source definition.

typedef enum `_clock_usb_phy_src` `clock_usb_phy_src_t`

Source of the USB HS PHY.

typedef enum `_clock_pll_post_div` `clock_pll_post_div_t`

PLL post divider enumeration.

typedef enum `_clock_output1_selection` `clock_output1_selection_t`

The enumerator of clock output1's clock source.

typedef enum `_clock_output2_selection` `clock_output2_selection_t`

The enumerator of clock output2's clock source.

typedef struct `_clock_arm_pll_config` `clock_arm_pll_config_t`

PLL configuration for ARM.

The output clock frequency is:

$F_{out} = F_{in} * \text{loopDivider} / (2 * \text{postDivider})$.

F_{in} is always 24MHz.


```
typedef struct _clock_usb_pll_config clock_usb_pll_config_t
```

PLL configuration for USB.

```
typedef struct _clock_pll_ss_config clock_pll_ss_config_t
```

Spread specturm configure Pll.

```
typedef struct _clock_sys_pll2_config clock_sys_pll2_config_t
```

PLL configure for Sys Pll2.

```
typedef struct _clock_sys_pll1_config clock_sys_pll1_config_t
```

PLL configure for Sys Pll1.

```
typedef struct _clock_audio_pll_config clock_audio_pll_config_t
```

PLL configuration for AUDIO.

```
typedef struct _clock_root_config_t clock_root_config_t
```

Clock root configuration.

```
typedef enum _clock_pll clock_pll_t
```

PLL name.

```
typedef enum _clock_pfd clock_pfd_t
```

PLL PFD name.

```
typedef enum _clock_control_mode clock_control_mode_t
```

The enumeration of control mode.

```
typedef enum _clock_24MOsc_mode clock_24MOsc_mode_t
```

The enumeration of 24MHz crystal oscillator mode.

```
typedef enum _clock_1MHzOut_behavior clock_1MHzOut_behavior_t
```

The enumeration of 1MHz output clock behavior, including disabling 1MHz output, enabling locked 1MHz clock output, and enabling free-running 1MHz clock output.

```
typedef enum _clock_level clock_level_t
```

The clock dependence level.

```
const clock_name_t s_clockSourceName[][4]
```

```
static inline void CLOCK_SetRootClockMux(clock_root_t root, uint8_t src)
```

Set CCM Root Clock MUX node to certain value.

Parameters

- `root` – Which root clock node to set, see `clock_root_t`.
- `src` – Clock mux value to set, different mux has different value range. See `clock_root_mux_source_t`.

```
static inline uint32_t CLOCK_GetRootClockMux(clock_root_t root)
```

Get CCM Root Clock MUX value.

Parameters

- `root` – Which root clock node to get, see `clock_root_t`.

Returns

Clock mux value.

```
static inline clock_name_t CLOCK_GetRootClockSource(clock_root_t root, uint32_t src)
```

Get CCM Root Clock Source.

Parameters

- `root` – Which root clock node to get, see `clock_root_t`.

- `src` – Clock mux value to get, see `clock_root_mux_source_t`.

Returns

Clock source

static inline void `CLOCK_SetRootClockDiv`(*clock_root_t* root, uint32_t div)

Set CCM Root Clock DIV certain value.

Parameters

- `root` – Which root clock to set, see `clock_root_t`.
- `div` – Clock div value to set, different divider has different value range.

static inline uint32_t `CLOCK_GetRootClockDiv`(*clock_root_t* root)

Get CCM DIV node value.

Parameters

- `root` – Which root clock node to get, see `clock_root_t`.

Returns

divider set for this root

static inline void `CLOCK_PowerOffRootClock`(*clock_root_t* root)

Power Off Root Clock.

Parameters

- `root` – Which root clock node to set, see `clock_root_t`.

static inline void `CLOCK_PowerOnRootClock`(*clock_root_t* root)

Power On Root Clock.

Parameters

- `root` – Which root clock node to set, see `clock_root_t`.

static inline void `CLOCK_SetRootClock`(*clock_root_t* root, const *clock_root_config_t* *config)

Configure Root Clock.

Parameters

- `root` – Which root clock node to set, see `clock_root_t`.
- `config` – root clock config, see `clock_root_config_t`

static inline void `CLOCK_ControlGate`(*clock_lpcg_t* name, *clock_gate_value_t* value)

Control the clock gate for specific IP.

Note: This API will not have any effect when this clock is in CPULPM or SetPoint Mode

Parameters

- `name` – Which clock to enable, see `clock_lpcg_t`.
- `value` – Clock gate value to set, see `clock_gate_value_t`.

static inline void `CLOCK_EnableClock`(*clock_lpcg_t* name)

Enable the clock for specific IP.

Parameters

- `name` – Which clock to enable, see `clock_lpcg_t`.

static inline void CLOCK_DisableClock(*clock_lpcg_t* name)

Disable the clock for specific IP.

Parameters

- name – Which clock to disable, see *clock_lpcg_t*.

uint32_t CLOCK_GetFreq(*clock_name_t* name)

Gets the clock frequency for a specific clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in *clock_name_t*.

Parameters

- name – Clock names defined in *clock_name_t*

Returns

Clock frequency value in hertz

static inline uint32_t CLOCK_GetRootClockFreq(*clock_root_t* root)

Gets the clock frequency for a specific root clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in *clock_root_t*.

Parameters

- root – Clock names defined in *clock_root_t*

Returns

Clock frequency value in hertz

uint32_t CLOCK_GetM7Freq(void)

Get the CCM CPU/core/system frequency.

Returns

Clock frequency; If the clock is invalid, returns 0.

uint32_t CLOCK_GetM33Freq(void)

Get the CCM CPU/core/system frequency.

Returns

Clock frequency; If the clock is invalid, returns 0.

static inline bool CLOCK_IsPllBypassed(*clock_pll_t* pll)

Check if PLL is bypassed.

Parameters

- pll – PLL control name (see *clock_pll_t* enumeration)

Returns

PLL bypass status.

- true: The PLL is bypassed.
- false: The PLL is not bypassed.

static inline bool CLOCK_IsPllEnabled(*clock_pll_t* pll)

Check if PLL is enabled.

Parameters

- pll – PLL control name (see *clock_pll_t* enumeration)

Returns

PLL bypass status.

- true: The PLL is enabled.

- false: The PLL is not enabled.

FSL_CLOCK_DRIVER_VERSION

CLOCK driver version.

SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY

CCSR_OFFSET

CCM registers offset.

CBCDR_OFFSET

CBCMR_OFFSET

CSCMR1_OFFSET

CSCMR2_OFFSET

CSCDR1_OFFSET

CDCDR_OFFSET

CSCDR2_OFFSET

CSCDR3_OFFSET

CACRR_OFFSET

CS1CDR_OFFSET

CS2CDR_OFFSET

ARM_PLL_OFFSET

CCM Analog registers offset.

PLL_SYS_OFFSET

PLL_USB1_OFFSET

PLL_AUDIO_OFFSET

PLL_VIDEO_OFFSET

PLL_ENET_OFFSET

PLL_USB2_OFFSET

CCM_TUPLE(reg, shift, mask, busyShift)

CCM_TUPLE_REG(base, tuple)

CCM_TUPLE_SHIFT(tuple)

CCM_TUPLE_MASK(tuple)

CCM_TUPLE_BUSY_SHIFT(tuple)

CCM_BUSY_WAIT

CCM_ANALOG_TUPLE(reg, shift)

CCM ANALOG tuple macros to map corresponding registers and bit fields.

CCM_ANALOG_TUPLE_SHIFT(tuple)

CCM_ANALOG_TUPLE_REG_OFF(base, tuple, off)

CCM_ANALOG_TUPLE_REG(base, tuple)

PLL_SYS1_1G_FREQ

SYS_PLL_FREQ frequency in Hz.

PLL_SYS2_528_MFI

PLL_SYS2_528_FREQ

PLL_SYS3_480_MFI

PLL_SYS3_480_FREQ

XTAL_FREQ

VREF_CLOCKS

Clock gate name array for VREF.

LPADC_CLOCKS

Clock gate name array for LPADC.

AOI_CLOCKS

Clock gate name array for AOI.

ASRC_CLOCKS

Clock ip name array for ASRC.

CMP_CLOCKS

Clock ip name array for CMP.

DAC_CLOCKS

Clock ip name array for DAC.

DCDC_CLOCKS

Clock gate name array for DCDC.

ECAT_CLOCKS

Clock ip name array for ECAT.

EDMA_CLOCKS

Clock gate name array for EDMA.

ENC_CLOCKS

Clock ip name array for ENC.

EWM_CLOCKS

Clock gate name array for EWM.

FLEXCAN_CLOCKS

Clock ip name array for FLEXCAN.

FLEXIO_CLOCKS

Clock ip name array for FLEXIO.

FLEXSPI_CLOCKS

Clock gate name array for FLEXSPI.

FLEXSPI_SLV_CLOCKS

Clock gate name array for FLEXSPI_SLV.

GPC_CLOCKS

Clock gate name array for GPC.

GPIO_CLOCKS

Clock ip name array for GPIO.

GPT_CLOCKS

Clock ip name array for GPT.

I3C_CLOCKS

Clock ip name array for I3C.

IEE_CLOCKS

Clock ip name array for IEE.

KPP_CLOCKS

Clock ip name array for KPP.

LPI2C_CLOCKS

Clock ip name array for LPI2C.

LPIT_CLOCKS

Clock ip name array for LPIT.

LPSPi_CLOCKS

Clock ip name array for LPSPi.

LPTMR_CLOCKS

Clock ip name array for LPTMR.

LPUART_CLOCKS

Clock ip name array for LPUART.

PDM_CLOCKS

Clock ip name array for MIC.

MU_CLOCKS

Clock gate name array for MU.

NETC_CLOCKS

Clock ip name array for NETC.

OCOTP_CLOCKS

Clock ip name array for OCOTP.

PWM_CLOCKS

Clock ip name array for PWM.

SAI_CLOCKS

Clock ip name array for SAI.

SEMA42_CLOCKS

Clock gate name array for Sema.

SEMC_CLOCKS

Clock ip name array for SEMC.

SERDES_CLOCKS

Clock ip name array for SERDES.

SINC_CLOCKS

Clock ip name array for SINC.

SPDIF_CLOCKS

Clock ip name array for SPDIF.

SRC_CLOCKS

Clock gate name array for SRC.

TMR_CLOCKS

Clock ip name array for QTIMER.

TPM_CLOCKS

Clock ip name array for TPM.

USB_CLOCKS

Clock ip name array for USB.

USDHC_CLOCKS

Clock ip name array for USDHC.

WDOG_CLOCKS

Clock gate name array for WDOG.

XBAR_CLOCKS

Clock ip name array for XBAR.

CCM_OBS_OSC_RC_24M

CCM_OBS_OSC_RC_400M

CCM_OBS_OSC_24M_OUT

CCM_OBS_PLL_ARM_OUT

CCM_OBS_PLL_528_OUT

CCM_OBS_PLL_528_PFD0

CCM_OBS_PLL_528_PFD1

CCM_OBS_PLL_528_PFD2

CCM_OBS_PLL_528_PFD3

CCM_OBS_PLL_480_OUT

CCM_OBS_PLL_480_DIV2

CCM_OBS_PLL_480_PFD0

CCM_OBS_PLL_480_PFD1

CCM_OBS_PLL_480_PFD2

CCM_OBS_PLL_480_PFD3

CCM_OBS_PLL_1G_OUT

CCM_OBS_PLL_1G_DIV2

CCM_OBS_PLL_1G_DIV5

CCM_OBS_PLL_AUDIO_OUT

CCM_OBS_M7_CLK_ROOT

CCM_OBS_M33_CLK_ROOT

CCM_OBS_EDGELOCK_CLK_ROOT

CCM_OBS_BUS_AON_CLK_ROOT
CCM_OBS_BUS_WAKEUP_CLK_ROOT
CCM_OBS_WAKEUP_AXI_CLK_ROOT
CCM_OBS_SWO_TRACE_CLK_ROOT
CCM_OBS_M33_SYSTICK_CLK_ROOT
CCM_OBS_M7_SYSTICK_CLK_ROOT
CCM_OBS_FLEXIO1_CLK_ROOT
CCM_OBS_FLEXIO2_CLK_ROOT
CCM_OBS_LPIT3_CLK_ROOT
CCM_OBS_LPTMR1_CLK_ROOT
CCM_OBS_LPTMR2_CLK_ROOT
CCM_OBS_LPTMR3_CLK_ROOT
CCM_OBS_TPM2_CLK_ROOT
CCM_OBS_TPM4_CLK_ROOT
CCM_OBS_TPM5_CLK_ROOT
CCM_OBS_TPM6_CLK_ROOT
CCM_OBS_GPT1_CLK_ROOT
CCM_OBS_GPT2_CLK_ROOT
CCM_OBS_FLEXSPI1_CLK_ROOT
CCM_OBS_FLEXSPI2_CLK_ROOT
CCM_OBS_FLEXSPI_SLV_CLK_ROOT
CCM_OBS_CAN1_CLK_ROOT
CCM_OBS_CAN2_CLK_ROOT
CCM_OBS_CAN3_CLK_ROOT
CCM_OBS_LPUART0102_CLK_ROOT
CCM_OBS_LPUART0304_CLK_ROOT
CCM_OBS_LPUART0506_CLK_ROOT
CCM_OBS_LPUART0708_CLK_ROOT
CCM_OBS_LPUART0910_CLK_ROOT
CCM_OBS_LPUART1112_CLK_ROOT
CCM_OBS_LPI2C0102_CLK_ROOT
CCM_OBS_LPI2C0304_CLK_ROOT
CCM_OBS_LPI2C0506_CLK_ROOT

CCM_OBS_LPSP10102_CLK_ROOT
CCM_OBS_LPSP10304_CLK_ROOT
CCM_OBS_LPSP10506_CLK_ROOT
CCM_OBS_I3C1_CLK_ROOT
CCM_OBS_I3C2_CLK_ROOT
CCM_OBS_USDHC1_CLK_ROOT
CCM_OBS_USDHC2_CLK_ROOT
CCM_OBS_SEMC_CLK_ROOT
CCM_OBS_ADC1_CLK_ROOT
CCM_OBS_ADC2_CLK_ROOT
CCM_OBS_ACMP_CLK_ROOT
CCM_OBS_ECAT_CLK_ROOT
CCM_OBS_ENET_REFCLK_ROOT
CCM_OBS_TMR_1588_CLK_ROOT
CCM_OBS_NETC_CLK_ROOT
CCM_OBS_MAC0_CLK_ROOT
CCM_OBS_MAC1_CLK_ROOT
CCM_OBS_MAC2_CLK_ROOT
CCM_OBS_MAC3_CLK_ROOT
CCM_OBS_MAC4_CLK_ROOT
CCM_OBS_SERDES0_CLK_ROOT
CCM_OBS_SERDES1_CLK_ROOT
CCM_OBS_SERDES2_CLK_ROOT
CCM_OBS_SERDES0_1G_CLK_ROOT
CCM_OBS_SERDES1_1G_CLK_ROOT
CCM_OBS_SERDES2_1G_CLK_ROOT
CCM_OBS_XCELBUSX_CLK_ROOT
CCM_OBS_XRIOCU4_CLK_ROOT
CCM_OBS_MOTORCTRL_CLK_ROOT
CCM_OBS_SAI1_CLK_ROOT
CCM_OBS_SAI2_CLK_ROOT
CCM_OBS_SAI3_CLK_ROOT
CCM_OBS_SAI4_CLK_ROOT

CCM_OBS_SPDIF_CLK_ROOT

CCM_OBS_ASRC_CLK_ROOT

CCM_OBS_MIC_CLK_ROOT

CCM_OBS_CCM_CK01_CLK_ROOT

CCM_OBS_CCM_CK02_CLK_ROOT

CCM_OBS_DIV

clock_ip_name_t

CLOCK_GetCpuClkFreq

CLOCK_GetCoreSysClkFreq

For compatible with other platforms without CCM.

PLL_PFD_COUNT

static inline uint32_t CLOCK_GetRtcFreq(void)

Gets the RTC clock frequency.

Returns

Clock frequency; If the clock is invalid, returns 0.

void CLOCK_SetClockSourceControlMode(*clock_name_t* name, *clock_control_mode_t* controlMode)

Set the control mode of a specified clock.

Parameters

- name – Clock names defined in *clock_name_t*
- controlMode – The control mode to be set, please refer to *clock_control_mode_t*.

static inline void CLOCK_OSC_EnableOscRc24M(bool enable)

Enable/disable 24MHz RC oscillator.

Parameters

- enable – Used to enable or disable the 24MHz RC oscillator.
 - **true** Enable the 24MHz RC oscillator.
 - **false** Disable the 24MHz RC oscillator.

void CLOCK_OSC_EnableOsc24M(void)

Enable OSC 24Mhz.

This function enables OSC 24Mhz.

static inline void CLOCK_OSC_GateOsc24M(bool enableGate)

Gate/ungate the 24MHz crystal oscillator output.

Note: Gating the 24MHz crystal oscillator can save power.

Parameters

- enableGate – Used to gate/ungate the 24MHz crystal oscillator.
 - **true** Gate the 24MHz crystal oscillator to save power.
 - **false** Ungate the 24MHz crystal oscillator.

void CLOCK_OSC_SetOsc24MWorkMode(*clock_24MOsc_mode_t* workMode)

Set the work mode of 24MHz crystal oscillator, the available modes are high gain mode, low power mode, and bypass mode.

Parameters

- workMode – The work mode of 24MHz crystal oscillator, please refer to *clock_24MOsc_mode_t* for details.

void CLOCK_OSC_EnableOscRc400M(void)

Enable OSC RC 400Mhz.

This function enables OSC RC 400Mhz.

void CLOCK_OSC_TrimOscRc400M(bool enable, bool bypass, uint16_t trim)

Trims OSC RC 400MHz.

Parameters

- enable – Used to enable trim function.
- bypass – Bypass the trim function.
- trim – Trim value.

void CLOCK_OSC_SetOscRc400MRefClkDiv(uint8_t divValue)

Set the divide value for ref_clk to generate slow clock.

Note: $\text{slow\_clk} = \text{ref\_clk} / (\text{divValue} + 1)$, and the recommend divide value is 24.

Parameters

- divValue – The divide value to be set, the available range is 0~63.

void CLOCK_OSC_SetOscRc400MFastClkCount(uint16_t targetCount)

Set the target count for the fast clock.

Parameters

- targetCount – The desired target for the fast clock, should be the number of clock cycles of the fast_clk per divided ref_clk.

void CLOCK_OSC_SetOscRc400MHysteresisValue(uint8_t negHysteresis, uint8_t posHysteresis)

Set the negative and positive hysteresis value for the tuned clock.

Note: The hysteresis value should be set after the clock is tuned.

Parameters

- negHysteresis – The negative hysteresis value for the turned clock, this value in number of clock cycles of the fast clock
- posHysteresis – The positive hysteresis value for the turned clock, this value in number of clock cycles of the fast clock

void CLOCK_OSC_BypassOscRc400MTuneLogic(bool enableBypass)

Bypass/un-bypass the tune logic.

Parameters

- enableBypass – Used to control whether to bypass the turn logic.

- **true** Bypass the tune logic and use the programmed oscillator frequency to run the oscillator. Function `CLOCK_OSC_SetOscRc400MTuneValue()` can be used to set oscillator frequency.
- **false** Use the output of tune logic to run the oscillator.

`void CLOCK_OSC_EnableOscRc400MTuneLogic(bool enable)`

Start/Stop the tune logic.

Parameters

- `enable` – Used to start or stop the tune logic.
 - **true** Start tuning
 - **false** Stop tuning and reset the tuning logic.

`void CLOCK_OSC_FreezeOscRc400MTuneValue(bool enableFreeze)`

Freeze/Unfreeze the tuning value.

Parameters

- `enableFreeze` – Used to control whether to freeze the tune value.
 - **true** Freeze the tune at the current tuned value and the oscillator runs at the frozen tune value.
 - **false** Unfreezes and continues the tune operation.

`void CLOCK_OSC_SetOscRc400MTuneValue(uint8_t tuneValue)`

Set the 400MHz RC oscillator tune value when the tune logic is disabled.

Parameters

- `tuneValue` – The tune value to determine the frequency of Oscillator.

`void CLOCK_OSC_Set1MHzOutputBehavior(clock_1MHzOut_behavior_t behavior)`

Set the behavior of the 1MHz output clock, such as disable the 1MHz clock output, enable the free-running 1MHz clock output, enable the locked 1MHz clock output.

Note: The 1MHz clock is divided from 400M RC Oscillator.

Parameters

- `behavior` – The behavior of 1MHz output clock, please refer to `clock_1MHzOut_behavior_t` for details.

`void CLOCK_OSC_SetLocked1MHzCount(uint16_t count)`

Set the count for the locked 1MHz clock out.

Parameters

- `count` – Used to set the desired target for the locked 1MHz clock out, the value in number of clock cycles of the fast clock per divided `ref_clk`.

`bool CLOCK_OSC_CheckLocked1MHzErrorFlag(void)`

Check the error flag for locked 1MHz clock out.

Returns

The error flag for locked 1MHz clock out.

- **true** The count value has been reached within one divided ref clock period
- **false** No effect.

`void CLOCK_OSC_ClearLocked1MHzErrorFlag(void)`

Clear the error flag for locked 1MHz clock out.

`uint16_t CLOCK_OSC_GetCurrentOscRc400MFastClockCount(void)`

Get current count for the fast clock during the tune process.

Returns

The current count for the fast clock.

`uint8_t CLOCK_OSC_GetCurrentOscRc400MTuneValue(void)`

Get current tune value used by oscillator during tune process.

Returns

The current tune value.

`void CLOCK_InitArmPll(const clock_arm_pll_config_t *config)`

Initialize the ARM PLL.

This function initialize the ARM PLL with specific settings

Parameters

- `config` – configuration to set to PLL.

`status_t CLOCK_CalcArmPllFreq(clock_arm_pll_config_t *config, uint32_t freqInMhz)`

Calculate corresponding config values per given frequency.

This function calculates config valudes per given frequency for Arm PLL

Parameters

- `config` – pll config structure
- `freqInMhz` – target frequency

`status_t CLOCK_InitArmPllWithFreq(uint32_t freqInMhz)`

Initializes the Arm PLL with Specific Frequency (in Mhz).

This function initializes the Arm PLL with specific frequency

Parameters

- `freqInMhz` – target frequency

`void CLOCK_DeinitArmPll(void)`

De-initialize the ARM PLL.

`void CLOCK_CalcPllSpreadSpectrum(uint32_t factor, uint32_t range, uint32_t mod, clock_pll_ss_config_t *ss)`

Calculate spread spectrum step and stop.

This function calculate spread spectrum step and stop according to given parameters. For integer PLL (syspll2) the factor is mfd, while for other fractional PLLs (audio/syspll1), the factor is denominator.

Parameters

- `factor` – factor to calculate step/stop
- `range` – spread spectrum range
- `mod` – spread spectrum modulation frequency
- `ss` – calculated spread spectrum values

`void CLOCK_InitSysPll1(const clock_sys_pll1_config_t *config)`

Initialize the System PLL1.

This function initializes the System PLL1 with specific settings

Parameters

- config – Configuration to set to PLL1.

void CLOCK_DeinitSysPll1(void)

De-initialize the System PLL1.

void CLOCK_InitSysPll2(const *clock_sys_pll2_config_t* *config)

Initialize the System PLL2.

This function initializes the System PLL2 with specific settings

Parameters

- config – Configuration to configure spread spectrum. This parameter can be NULL, if no need to enabled spread spectrum

void CLOCK_DeinitSysPll2(void)

De-initialize the System PLL2.

bool CLOCK_IsSysPll2PfdEnabled(*clock_pfd_t* pfd)

Check if Sys PLL2 PFD is enabled.

Note: Only useful in software control mode.

Parameters

- pfd – PFD control name

Returns

PFD bypass status.

- true: power on.
- false: power off.

void CLOCK_InitSysPll3(void)

Initialize the System PLL3.

This function initializes the System PLL3 with specific settings

void CLOCK_DeinitSysPll3(void)

De-initialize the System PLL3.

bool CLOCK_IsSysPll3PfdEnabled(*clock_pfd_t* pfd)

Check if Sys PLL3 PFD is enabled.

Note: Only useful in software control mode.

Parameters

- pfd – PFD control name

Returns

PFD bypass status.

- true: power on.
- false: power off.

void CLOCK_SetPllBypass(*clock_pll_t* pll, bool bypass)

PLL bypass setting.

Parameters

- pll – PLL control name (see `clock_pll_t` enumeration)
- bypass – Bypass the PLL.
 - true: Bypass the PLL.
 - false: Not bypass the PLL.

`status_t` `CLOCK_CalcAudioPllFreq(clock_audio_pll_config_t *config, uint32_t freqInMhz)`

Calculate corresponding config values per given frequency.

This function calculates config values per given frequency for Audio PLL.

Parameters

- config – pll config structure
- freqInMhz – target frequency

`status_t` `CLOCK_InitAudioPllWithFreq(uint32_t freqInMhz, bool ssEnable, uint32_t ssRange, uint32_t ssMod)`

Initializes the Audio PLL with Specific Frequency (in Mhz).

This function initializes the Audio PLL with specific frequency

Parameters

- freqInMhz – target frequency
- ssEnable – enable spread spectrum or not
- ssRange – range spread spectrum range
- ssMod – spread spectrum modulation frequency

`void` `CLOCK_InitAudioPll(const clock_audio_pll_config_t *config)`

Initializes the Audio PLL.

This function initializes the Audio PLL with specific settings

Parameters

- config – Configuration to set to PLL.

`void` `CLOCK_DeinitAudioPll(void)`

De-initialize the Audio PLL.

`uint32_t` `CLOCK_GetPllFreq(clock_pll_t pll)`

Get current PLL output frequency.

This function get current output frequency of specific PLL

Parameters

- pll – pll name to get frequency.

Returns

The PLL output frequency in hertz.

`void` `CLOCK_InitPfd(clock_pll_t pll, clock_pfd_t pfd, uint8_t frac)`

Initialize PLL PFD.

This function initializes the System PLL PFD. During new value setting, the clock output is disabled to prevent glitch.

Note: It is recommended that PFD settings are kept between 13-35.

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – Which PFD clock to enable.
- frac – The PFD FRAC value.

void CLOCK_DeinitPfd(*clock_pll_t* pll, *clock_pfd_t* pfd)

De-initialize selected PLL PFD.

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – Which PFD clock to enable.

uint32_t CLOCK_GetPfdFreq(*clock_pll_t* pll, *clock_pfd_t* pfd)

Get current PFD output frequency.

This function get current output frequency of specific System PLL PFD

Parameters

- pll – Which PLL of targeting PFD to be operated.
- pfd – pfd name to get frequency.

Returns

The PFD output frequency in hertz.

uint32_t CLOCK_GetFreqFromObs(uint8_t obsIndex, uint32_t obsSigIndex)

bool CLOCK_EnableUsbhs0Clock(*clock_usb_src_t* src, uint32_t freq)

Enable USB HS clock.

This function only enables the access to USB HS peripheral, upper layer should first call the CLOCK_EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

- src – USB HS does not care about the clock source, here must be kCLOCK_UsbSrcUnused.
- freq – USB HS does not care about the clock source, so this parameter is ignored.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

bool CLOCK_EnableUsbhs0PhyPllClock(*clock_usb_phy_src_t* src, uint32_t freq)

brief Enable USB HS PHY PLL clock.

This function enables the internal 480MHz USB PHY PLL clock.

Parameters

- src – USB HS PHY PLL clock source.
- freq – The frequency specified by src.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

void CLOCK_DisableUsbhs0PhyPllClock(void)

Disable USB HS PHY PLL clock.

This function disables USB HS PHY PLL clock.

bool CLOCK_EnableUsbhs1Clock(*clock_usb_src_t* src, uint32_t freq)

Enable USB HS clock.

This function only enables the access to USB HS peripheral, upper layer should first call the CLOCK_EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

- src – USB HS does not care about the clock source, here must be kCLOCK_UsbSrcUnused.
- freq – USB HS does not care about the clock source, so this parameter is ignored.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

bool CLOCK_EnableUsbhs1PhyPllClock(*clock_usb_phy_src_t* src, uint32_t freq)

Enable USB HS PHY PLL clock.

This function enables the internal 480MHz USB PHY PLL clock.

Parameters

- src – USB HS PHY PLL clock source.
- freq – The frequency specified by src.

Return values

- true – The clock is set successfully.
- false – The clock source is invalid to get proper USB HS clock.

void CLOCK_DisableUsbhs1PhyPllClock(void)

Disable USB HS PHY PLL clock.

This function disables USB HS PHY PLL clock.

static inline void CLOCK_OSCPLL_LockWhiteList(*clock_name_t* name)

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.

static inline void CLOCK_OSCPLL_SetWhiteList(*clock_name_t* name, uint8_t domainId)

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock source name, see clock_name_t.
- domainId – Domains that on the whitelist can change this clock.

```
void CLOCK_OSCPLL_ControlByCpuLowPowerMode(clock_name_t name, uint32_t domainMap,  
                                             clock_level_t level)
```

Set this clock works in CPU Low Power Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock source name, see *clock_name_t*.
- domainMap – Domains that on the whitelist can change this clock.
- level – Depend level of this clock.

```
static inline void CLOCK_ROOT_LockWhiteList(clock_root_t name)
```

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock root name, see *clock_root_t*.

```
static inline void CLOCK_ROOT_SetWhiteList(clock_root_t name, uint8_t domainId)
```

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock root name, see *clock_root_t*.
- domainId – Domains that on the whitelist can change this clock.

```
static inline void CLOCK_LPCG_LockWhiteList(clock_lpcg_t name)
```

Lock the value of Domain ID white list for this clock.

Note: Once locked, this bit and domain ID white list can not be changed until next system reset.

Parameters

- name – Clock gate name, see *clock_lpcg_t*.

```
static inline void CLOCK_LPCG_SetWhiteList(clock_lpcg_t name, uint8_t domainId)
```

Set domain ID that can change this clock.

Note: If LOCK_LIST bit is set, domain ID white list can not be changed until next system reset.

Parameters

- name – Clock gate name, see `clock_lpcg_t`.
- domainId – Domains that on the whitelist can change this clock.

```
void CLOCK_LPCG_ControlByCpuLowPowerMode(clock_lpcg_t name, uint32_t domainMap,  
                                           clock_level_t level)
```

Set this clock works in CPU Low Power Mode.

Note: When LOCK_MODE bit is set, control mode can not be changed until next system reset.

Parameters

- name – Clock gate name, see `clock_lpcg_t`.
- domainMap – Domains that on the whitelist can change this clock.
- level – Depend level of this clock.

```
static inline void CLOCK_SetClockOutput1(clock_output1_selection_t selection, uint32_t  
                                         divider)
```

Set the clock source and the divider of the clock output1.

param selection The clock source to be output, please refer to `clock_output1_selection_t`.
param divider The divider of the output clock signal.

```
static inline void CLOCK_SetClockOutput2(clock_output2_selection_t selection, uint32_t  
                                         divider)
```

Set the clock source and the divider of the clock output2.

param selection The clock source to be output, please refer to `clock_output2_selection_t`.
param divider The divider of the output clock signal.

```
static inline uint32_t CLOCK_GetClockOutCLKO1Freq(void)
```

Get the frequency of clock output1 clock signal.

Returns

The frequency of clock output1 clock signal.

```
static inline uint32_t CLOCK_GetClockOutClkO2Freq(void)
```

Get the frequency of clock output2 clock signal.

Returns

The frequency of clock output2 clock signal.

```
clock_pll_post_div_t postDivider
```

Post divider.

```
uint32_t loopDivider
```

PLL loop divider. Valid range: 104-208.

```
uint8_t loopDivider
```

PLL loop divider. 0 - Fout=Fref*20; 1 - Fout=Fref*22

```
uint8_t src
```

Pll clock source, reference `_clock_pll_clk_src`

```
uint16_t stop
```

Spread spectrum stop value to get frequency change.

```
uint16_t step
```

Spread spectrum step value to get frequency change step.

uint32_t mfd

Denominator of spread spectrum

clock_pll_ss_config_t *ss

Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable

Enable spread spectrum flag

bool pllDiv2En

Enable Sys Pll1 divide-by-2 clock or not.

bool pllDiv5En

Enable Sys Pll1 divide-by-5 clock or not.

clock_pll_ss_config_t *ss

Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable

Enable spread spectrum flag

uint8_t loopDivider

PLL loop divider. Valid range for DIV_SELECT divider value: 27~54.

uint8_t postDivider

Divider after the PLL, 0x0=divided by 1, 0x1=divided by 2, 0x2=divided by 4, 0x3=divided by 8, 0x4=divided by 16, 0x5=divided by 32.

uint32_t numerator

30 bit numerator of fractional loop divider.

uint32_t denominator

30 bit denominator of fractional loop divider

clock_pll_ss_config_t *ss

Spread spectrum parameter, it can be NULL, if ssEnable is set to false

bool ssEnable

Enable spread spectrum flag

bool clockOff

uint8_t mux

See clock_root_mux_source_t for details.

uint8_t div

it's the actual divider

FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL

Configure whether driver controls clock.

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

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

```
struct _clock_arm_pll_config
    #include <fsl_clock.h> PLL configuration for ARM.
    The output clock frequency is:
    Fout=Fin*loopDivider/(2 * postDivider).
    Fin is always 24MHz.

struct _clock_usb_pll_config
    #include <fsl_clock.h> PLL configuration for USB.

struct _clock_pll_ss_config
    #include <fsl_clock.h> Spread specturm configure Pll.

struct _clock_sys_pll2_config
    #include <fsl_clock.h> PLL configure for Sys Pll2.

struct _clock_sys_pll1_config
    #include <fsl_clock.h> PLL configure for Sys Pll1.

struct _clock_audio_pll_config
    #include <fsl_clock.h> PLL configuration for AUDIO.

struct _clock_root_config_t
    #include <fsl_clock.h> Clock root configuration.
```

2.9 DAC12: 12-bit Digital-to-Analog Converter Driver

void DAC12_GetHardwareInfo(DAC_Type *base, *dac12_hardware_info_t* *info)
Get hardware information about this module.

Parameters

- base – DAC12 peripheral base address.
- info – Pointer to info structure, see to *dac12_hardware_info_t*.

void DAC12_Init(DAC_Type *base, const *dac12_config_t* *config)
Initialize the DAC12 module.

Parameters

- base – DAC12 peripheral base address.
- config – Pointer to configuration structure, see to *dac12_config_t*.

void DAC12_GetDefaultConfig(*dac12_config_t* *config)
Initializes the DAC12 user configuration structure.

This function initializes the user configuration structure to a default value. The default values are:

```
config->fifoWatermarkLevel = 0U;
config->fifoWorkMode = kDAC12_FIFODisabled;
config->referenceVoltageSource = kDAC12_ReferenceVoltageSourceAlt1;
config->fifoTriggerMode = kDAC12_FIFOTriggerByHardwareMode;
config->referenceCurrentSource = kDAC12_ReferenceCurrentSourceAlt0;
config->speedMode = kDAC12_SpeedLowMode;
config->speedMode = false;
config->currentReferenceInternalTrimValue = 0x4;
```

Parameters

- config – Pointer to the configuration structure. See “dac12_config_t”.

void DAC12_Deinit(DAC_Type *base)

De-initialize the DAC12 module.

Parameters

- base – DAC12 peripheral base address.

static inline void DAC12_Enable(DAC_Type *base, bool enable)

Enable the DAC12's converter or not.

Parameters

- base – DAC12 peripheral base address.
- enable – Enable the DAC12's converter or not.

static inline void DAC12_ResetConfig(DAC_Type *base)

Reset all internal logic and registers.

Parameters

- base – DAC12 peripheral base address.

static inline void DAC12_ResetFIFO(DAC_Type *base)

Reset the FIFO pointers.

FIFO pointers should only be reset when the DAC12 is disabled. This function can be used to configure both pointers to the same address to reset the FIFO as empty.

Parameters

- base – DAC12 peripheral base address.

static inline uint32_t DAC12_GetStatusFlags(DAC_Type *base)

Get status flags.

Parameters

- base – DAC12 peripheral base address.

Returns

Mask of current status flags. See to _dac12_status_flags.

static inline void DAC12_ClearStatusFlags(DAC_Type *base, uint32_t flags)

Clear status flags.

Note: Not all the flags can be cleared by this API. Several flags need special condition to clear them according to target chip's reference manual document.

Parameters

- base – DAC12 peripheral base address.
- flags – Mask of status flags to be cleared. See to _dac12_status_flags.

static inline void DAC12_EnableInterrupts(DAC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – DAC12 peripheral base address.
- mask – Mask value of interrupts to be enabled. See to _dac12_interrupt_enable.

```
static inline void DAC12_DisableInterrupts(DAC_Type *base, uint32_t mask)
```

Disable interrupts.

Parameters

- `base` – DAC12 peripheral base address.
- `mask` – Mask value of interrupts to be disabled. See to `_dac12_interrupt_enable`.

```
static inline void DAC12_EnableDMA(DAC_Type *base, bool enable)
```

Enable DMA or not.

When DMA is enabled, the DMA request will be generated by original interrupts. The interrupts will not be presented on this module at the same time.

```
static inline void DAC12_SetData(DAC_Type *base, uint32_t value)
```

Set data into the entry of FIFO buffer.

When the DAC FIFO is disabled, and the one entry buffer is enabled, the DAC converts the data in the buffer to analog output voltage. Any write to the DATA register will replace the data in the buffer and push data to analog conversion without trigger support. When the DAC FIFO is enabled. Writing data would increase the write pointer of FIFO. Also, the data would be restored into the FIFO buffer.

Parameters

- `base` – DAC12 peripheral base address.
- `value` – Setting value into FIFO buffer.

```
static inline void DAC12_DoSoftwareTrigger(DAC_Type *base)
```

Do trigger the FIFO by software.

When the DAC FIFO is enabled, and software trigger is used. Doing trigger would increase the read pointer, and the data in the entry pointed by read pointer would be converted as new output.

Parameters

- `base` – DAC12 peripheral base address.

```
static inline uint32_t DAC12_GetFIFOReadPointer(DAC_Type *base)
```

Get the current read pointer of FIFO.

Parameters

- `base` – DAC12 peripheral base address.

Returns

Read pointer index of FIFO buffer.

```
static inline uint32_t DAC12_GetFIFOWritePointer(DAC_Type *base)
```

Get the current write pointer of FIFO.

Parameters

- `base` – DAC12 peripheral base address.

Returns

Write pointer index of FIFO buffer

```
FSL_DAC12_DRIVER_VERSION
```

DAC12 driver version 2.1.2.

```
enum _dac12_status_flags
```

DAC12 flags.

Values:

enumerator kDAC12_OverflowFlag

FIFO overflow status flag, which indicates that more data has been written into FIFO than it can hold.

enumerator kDAC12_UnderflowFlag

FIFO underflow status flag, which means that there is a new trigger after the FIFO is nearly empty.

enumerator kDAC12_WatermarkFlag

FIFO watermark status flag, which indicates the remaining FIFO data is less than the watermark setting.

enumerator kDAC12_NearlyEmptyFlag

FIFO nearly empty flag, which means there is only one data remaining in FIFO.

enumerator kDAC12_FullFlag

FIFO full status flag, which means that the FIFO read pointer equals the write pointer, as the write pointer increase.

enum _dac12_interrupt_enable

DAC12 interrupts.

Values:

enumerator kDAC12_UnderOrOverflowInterruptEnable

Underflow and overflow interrupt enable.

enumerator kDAC12_WatermarkInterruptEnable

Watermark interrupt enable.

enumerator kDAC12_NearlyEmptyInterruptEnable

Nearly empty interrupt enable.

enumerator kDAC12_FullInterruptEnable

Full interrupt enable.

enum _dac12_fifo_size_info

DAC12 FIFO size information provided by hardware.

Values:

enumerator kDAC12_FIFOSize2

FIFO depth is 2.

enumerator kDAC12_FIFOSize4

FIFO depth is 4.

enumerator kDAC12_FIFOSize8

FIFO depth is 8.

enumerator kDAC12_FIFOSize16

FIFO depth is 16.

enumerator kDAC12_FIFOSize32

FIFO depth is 32.

enumerator kDAC12_FIFOSize64

FIFO depth is 64.

enumerator kDAC12_FIFOSize128

FIFO depth is 128.

enumerator kDAC12_FIFOSize256

FIFO depth is 256.

enum _dac12_fifo_work_mode

DAC12 FIFO work mode.

Values:

enumerator kDAC12_FIFODisabled

FIFO disabled and only one level buffer is enabled. Any data written from this buffer goes to conversion.

enumerator kDAC12_FIFOWorkAsNormalMode

Data will first read from FIFO to buffer then go to conversion.

enumerator kDAC12_FIFOWorkAsSwingMode

In Swing mode, the FIFO must be set up to be full. In Swing back mode, a trigger changes the read pointer to make it swing between the FIFO Full and Nearly Empty state. That is, the trigger increases the read pointer till FIFO is nearly empty and decreases the read pointer till the FIFO is full.

enum _dac12_reference_voltage_source

DAC12 reference voltage source.

Values:

enumerator kDAC12_ReferenceVoltageSourceAlt1

The DAC selects DACREF_1 as the reference voltage.

enumerator kDAC12_ReferenceVoltageSourceAlt2

The DAC selects DACREF_2 as the reference voltage.

enum _dac12_fifo_trigger_mode

DAC12 FIFO trigger mode.

Values:

enumerator kDAC12_FIFOTriggerByHardwareMode

Buffer would be triggered by hardware.

enumerator kDAC12_FIFOTriggerBySoftwareMode

Buffer would be triggered by software.

enum _dac12_reference_current_source

DAC internal reference current source.

Analog module needs reference current to keep working . Such reference current can generated by IP itself, or by on-chip PMC's "reference part". If no current reference be selected, analog module can't working normally ,even when other register can still be assigned, DAC would waste current but no function. To make the DAC work, either kDAC12_ReferenceCurrentSourceAlt0 should be selected.

Values:

enumerator kDAC12_ReferenceCurrentSourceDisabled

None of reference current source is enabled.

enumerator kDAC12_ReferenceCurrentSourceAlt0

Use the internal reference current generated by the module itself.

enumerator kDAC12_ReferenceCurrentSourceAlt1

Use the ZTC(Zero Temperature Coefficient) reference current generated by on-chip power management module.

enumerator kDAC12_ReferenceCurrentSourceAlt2

Use the PTAT(Proportional To Absolution Temperature) reference current generated by power management module.

enum _dac12_speed_mode

DAC analog buffer speed mode for conversion.

Values:

enumerator kDAC12_SpeedLowMode

Low speed mode.

enumerator kDAC12_SpeedMiddleMode

Middle speed mode.

enumerator kDAC12_SpeedHighMode

High speed mode.

typedef enum _dac12_fifo_size_info dac12_fifo_size_info_t

DAC12 FIFO size information provided by hardware.

typedef enum _dac12_fifo_work_mode dac12_fifo_work_mode_t

DAC12 FIFO work mode.

typedef enum _dac12_reference_voltage_source dac12_reference_voltage_source_t

DAC12 reference voltage source.

typedef enum _dac12_fifo_trigger_mode dac12_fifo_trigger_mode_t

DAC12 FIFO trigger mode.

typedef enum _dac12_reference_current_source dac12_reference_current_source_t

DAC internal reference current source.

Analog module needs reference current to keep working . Such reference current can generated by IP itself, or by on-chip PMC's "reference part". If no current reference be selected, analog module can't working normally ,even when other register can still be assigned, DAC would waste current but no function. To make the DAC work, either kDAC12_ReferenceCurrentSourceAlt2 should be selected.

typedef enum _dac12_speed_mode dac12_speed_mode_t

DAC analog buffer speed mode for conversion.

typedef struct _dac12_hardware_info dac12_hardware_info_t

DAC12 hardware information.

DAC12_CR_W1C_FLAGS_MASK

Define "write 1 to clear" flags.

DAC12_CR_ALL_FLAGS_MASK

Define all the flag bits in DACx_CR register.

struct _dac12_hardware_info

#include <fsl_dac12.h> DAC12 hardware information.

Public Members

dac12_fifo_size_info_t fifoSizeInfo

The number of words in this device's DAC buffer.

struct dac12_config_t

#include <fsl_dac12.h> DAC12 module configuration.

Actually, the most fields are for FIFO buffer.

Public Members

uint32_t fifoWatermarkLevel

FIFO's watermark, the max value can be the hardware FIFO size.

dac12_fifo_work_mode_t fifoWorkMode

FIFO's work mode about pointers.

dac12_reference_voltage_source_t referenceVoltageSource

Select the reference voltage source.

dac12_reference_current_source_t referenceCurrentSource

Select the trigger mode for FIFO. Select the reference current source.

dac12_speed_mode_t speedMode

Select the speed mode for conversion.

bool enableAnalogBuffer

Enable analog buffer for high drive.

2.10 Dcdc_soc

void DCDC_Init(DCDC_Type *base, const *dcdc_config_t* *config)

Initializes the basic resource of DCDC module, such as control mode, etc.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to the *dcdc_config_t* structure.

void DCDC_Deinit(DCDC_Type *base)

De-initializes the DCDC module.

Parameters

- base – DCDC peripheral base address.

void DCDC_GetDefaultConfig(*dcdc_config_t* *config)

Gets the default setting for DCDC, such as control mode, etc.

This function initializes the user configuration structure to a default value. The default values are:

```
config->controlMode          = kDCDC_StaticControl;
config->trimInputMode        = kDCDC_SampleTrimInput;
config->enableDcdcTimeout     = false;
config->enableSwitchingConverterOutput = false;
```

Parameters

- config – Pointer to configuration structure. See to *dcdc_config_t*.

static inline void DCDC_SetVDD1P0LowPowerModeTargetVoltage(DCDC_Type *base,
 dcdc_core_slice_t core,
 dcdc_1P0_target_vol_t
 targetVoltage)

static inline uint16_t DCDC_GetVDD1P0LowPowerModeTargetVoltage(DCDC_Type *base)

Gets the target value of VDD1P0 in low power mode, the result takes “mV” as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P0's voltage value in low power mode and the unit is “mV”.

```
static inline void DCDC__EnableVDD1P0LowPowerMode(DCDC_Type *base, dcdc_core_slice_t
                                                    core, bool enable)
```

```
static inline void DCDC__SetVDD1P0BuckModeTargetVoltage(DCDC_Type *base, dcdc_core_slice_t
                                                         core, dcdc_1P0_target_vol_t
                                                         targetVoltage)
```

Sets the target value(ranges from 0.6V to 1.375V) of VDD1P0 in buck mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- core – Core for DCDC to control.
- targetVoltage – The target value of VDD1P0 in buck mode, see dcdc_1P0_target_vol_t.

```
static inline uint16_t DCDC__GetVDD1P0BuckModeTargetVoltage(DCDC_Type *base)
```

Gets the target value of VDD1P0 in buck mode, the result takes “mV” as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P0's voltage value in buck mode and the unit is “mV”.

```
static inline void DCDC__GPC__SetVDD1P0BuckModeTargetVoltage(DCDC_Type *base,
                                                             dcdc_core_slice_t core,
                                                             dcdc_1P0_target_vol_t
                                                             targetVoltage)
```

```
static inline void DCDC__GPC__SetVDD1P0LowPowerModeTargetVoltage(DCDC_Type *base,
                                                                  dcdc_core_slice_t core,
                                                                  dcdc_1P0_target_vol_t
                                                                  targetVoltage)
```

Sets the target value(ranges from 0.625V to 1.4V) of VDD1P0 in low power mode, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- core – Core for DCDC to control.
- targetVoltage – The target value of VDD1P0 in low power mode, see dcdc_1P0_target_vol_t.

```
static inline void DCDC__GPC__EnableVDD1P0LowPowerMode(DCDC_Type *base,
                                                         dcdc_core_slice_t core, bool
                                                         enable)
```

Enable VDD1P0 in low power mode.

Parameters

- base – DCDC peripheral base address.
- core – Core for DCDC to control.
- enable – Enable the output or not.

```
static inline void DCDC_SetVDD1P8TargetVoltage(DCDC_Type *base, dcdc_core_slice_t core,
                                              dcdc_1P8_target_vol_t targetVoltage)
```

Sets the target value(ranges from 1.5V to 2.275V) of VDD1P8, 25mV each step.

Parameters

- base – DCDC peripheral base address.
- core – Core for DCDC to control.
- targetVoltage – The target value of VDD1P8, see *dcdc_1P8_target_vol_t*.

```
static inline uint16_t DCDC_GetVDD1P8TargetVoltage(DCDC_Type *base)
```

Gets the target value of VDD1P8, the result takes “mV” as the unit.

Parameters

- base – DCDC peripheral base address.

Returns

The VDD1P8's voltage value and the unit is “mV”.

```
static inline void DCDC_EnableVDD1P0TargetVoltageStepping(DCDC_Type *base, bool enable)
```

Enables/Disables stepping for VDD1P0, before entering low power modes the stepping for VDD1P0 must be disabled.

Parameters

- base – DCDC peripheral base address.
- enable – Used to control the behavior.
 - **true** Enables stepping for VDD1P0.
 - **false** Disables stepping for VDD1P0.

```
void DCDC_GetDefaultDetectionConfig(dcdc_detection_config_t *config)
```

Gets the default setting for detection configuration.

The default configuration are set according to responding registers' setting when powered on. They are:

```
config->enableXtalokDetection = false;
config->powerDownOverVoltageVdd1P8Detection = true;
config->powerDownOverVoltageVdd1P0Detection = true;
config->powerDownLowVoltageDetection = false;
config->powerDownOverCurrentDetection = true;
config->powerDownPeakCurrentDetection = true;
config->powerDownZeroCrossDetection = true;
config->OverCurrentThreshold = kDCDC_OverCurrentThresholdAlt0;
config->PeakCurrentThreshold = kDCDC_PeakCurrentThresholdAlt0;
```

Parameters

- config – Pointer to configuration structure. See to *dcdc_detection_config_t*.

```
void DCDC_SetDetectionConfig(DCDC_Type *base, const dcdc_detection_config_t *config)
```

Configures the DCDC detection.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to *dcdc_detection_config_t*.

void DCDC_SetClockSource(DCDC_Type *base, *dcdc_clock_source_t* clockSource)

Configures the DCDC clock source.

Parameters

- base – DCDC peripheral base address.
- clockSource – Clock source for DCDC. See to *dcdc_clock_source_t*.

static inline void DCDC_SetBandgapVoltageTrimValue(DCDC_Type *base, uint32_t trimValue)

Sets the bangap trim value(0~31) to trim bandgap voltage.

Parameters

- base – DCDC peripheral base address.
- trimValue – The bangap trim value. Available range is 0U-31U.

void DCDC_GetDefaultLoopControlConfig(*dcdc_loop_control_config_t* *config)

Gets the default setting for loop control configuration.

The default configuration are set according to responding registers' setting when powered on. They are:

```
config->enableCommonHysteresis = false;
config->enableCommonThresholdDetection = false;
config->enableInvertHysteresisSign = false;
config->enableRCThresholdDetection = false;
config->enableRCScaleCircuit = 0U;
config->complementFeedForwardStep = 0U;
config->controlParameterMagnitude = 2U;
config->integralProportionalRatio = 2U;
```

Parameters

- config – Pointer to configuration structure. See to *dcdc_loop_control_config_t*.

void DCDC_SetLoopControlConfig(DCDC_Type *base, const *dcdc_loop_control_config_t* *config)

Configures the DCDC loop control.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to *dcdc_loop_control_config_t*.

void DCDC_SetInternalRegulatorConfig(DCDC_Type *base, const *dcdc_internal_regulator_config_t* *config)

Configures the DCDC internal regulator.

Parameters

- base – DCDC peripheral base address.
- config – Pointer to configuration structure. See to *dcdc_internal_regulator_config_t*.

static inline void DCDC_EnableAdjustDelay(DCDC_Type *base, bool enable)

Adjusts delay to reduce ground noise.

Parameters

- base – DCDC peripheral base address.
- enable – Enable the feature or not.

```
static inline uint32_t DCDC_GetStatusFlags(DCDC_Type *base)
```

Get DCDC status flags.

Parameters

- base – peripheral base address.

Returns

Mask of asserted status flags. See to `_dcdc_status_flags`.

```
void DCDC_BootIntoCCM(DCDC_Type *base)
```

Boots DCDC into CCM(continous conduction mode).

```
pwd_zcd=0x1;  
pwd_cmp_offset=0x0;  
dcdc_loopctrl_en_rcscale=0x3;
```

Parameters

- base – DCDC peripheral base address.

```
enum _dcdc_status_flags
```

The enumeration of DCDC status flags.

Values:

enumerator `kDCDC_AlreadySettledStatusFlag`

Indicate DCDC status. 1'b1: DCDC already settled 1'b0: DCDC is settling.

```
enum _dcdc_core_slice
```

CORE slice.

Values:

enumerator `kDCDC_CORE0`

CORE slice 0.

enumerator `kDCDC_CORE1`

CORE slice 1.

```
enum _dcdc_control_mode
```

DCDC control mode, including software control mode and GPC control mode.

Values:

enumerator `kDCDC_SoftwareControl`

Controlled by software.

enumerator `kDCDC_GPCControl`

Controlled by GPC.

```
enum _dcdc_trim_input_mode
```

DCDC trim input mode, including sample trim input and hold trim input.

Values:

enumerator `kDCDC_SampleTrimInput`

Sample trim input.

enumerator `kDCDC_HoldTrimInput`

Hold trim input.

```
enum _dcdc_1P0_target_vol
```

The enumeration VDD1P0's target voltage value.

Values:

enumerator kDCDC_1P0Target0P6V

The target voltage value of VDD1P0 is 0.6V.

enumerator kDCDC_1P0Target0P625V

The target voltage value of VDD1P0 is 0.625V.

enumerator kDCDC_1P0Target0P65V

The target voltage value of VDD1P0 is 0.65V.

enumerator kDCDC_1P0Target0P675V

The target voltage value of VDD1P0 is 0.675V.

enumerator kDCDC_1P0Target0P7V

The target voltage value of VDD1P0 is 0.7V.

enumerator kDCDC_1P0Target0P725V

The target voltage value of VDD1P0 is 0.725V.

enumerator kDCDC_1P0Target0P75V

The target voltage value of VDD1P0 is 0.75V.

enumerator kDCDC_1P0Target0P775V

The target voltage value of VDD1P0 is 0.775V.

enumerator kDCDC_1P0Target0P8V

The target voltage value of VDD1P0 is 0.8V.

enumerator kDCDC_1P0Target0P825V

The target voltage value of VDD1P0 is 0.825V.

enumerator kDCDC_1P0Target0P85V

The target voltage value of VDD1P0 is 0.85V.

enumerator kDCDC_1P0Target0P875V

The target voltage value of VDD1P0 is 0.875V.

enumerator kDCDC_1P0Target0P9V

The target voltage value of VDD1P0 is 0.9V.

enumerator kDCDC_1P0Target0P925V

The target voltage value of VDD1P0 is 0.925V.

enumerator kDCDC_1P0Target0P95V

The target voltage value of VDD1P0 is 0.95V.

enumerator kDCDC_1P0Target0P975V

The target voltage value of VDD1P0 is 0.975V.

enumerator kDCDC_1P0Target1P0V

The target voltage value of VDD1P0 is 1.0V.

enumerator kDCDC_1P0Target1P025V

The target voltage value of VDD1P0 is 1.025V.

enumerator kDCDC_1P0Target1P05V

The target voltage value of VDD1P0 is 1.05V.

enumerator kDCDC_1P0Target1P075V

The target voltage value of VDD1P0 is 1.075V.

enumerator kDCDC_1P0Target1P1V

The target voltage value of VDD1P0 is 1.1V.

enumerator kDCDC_1P0Target1P125V

The target voltage value of VDD1P0 is 1.125V.

enumerator kDCDC_1P0Target1P15V

The target voltage value of VDD1P0 is 1.15V.

enumerator kDCDC_1P0Target1P175V

The target voltage value of VDD1P0 is 1.175V.

enumerator kDCDC_1P0Target1P2V

The target voltage value of VDD1P0 is 1.2V.

enumerator kDCDC_1P0Target1P225V

The target voltage value of VDD1P0 is 1.225V.

enumerator kDCDC_1P0Target1P25V

The target voltage value of VDD1P0 is 1.25V.

enumerator kDCDC_1P0Target1P275V

The target voltage value of VDD1P0 is 1.275V.

enumerator kDCDC_1P0Target1P3V

The target voltage value of VDD1P0 is 1.3V.

enumerator kDCDC_1P0Target1P325V

The target voltage value of VDD1P0 is 1.325V.

enumerator kDCDC_1P0Target1P35V

The target voltage value of VDD1P0 is 1.35V.

enumerator kDCDC_1P0Target1P375V

The target voltage value of VDD1P0 is 1.375V.

enum _dcdc_1P8_target_vol

The enumeration VDD1P8's target voltage value.

Values:

enumerator kDCDC_1P8Target1P5V

The target voltage value of VDD1P8 is 1.5V.

enumerator kDCDC_1P8Target1P525V

The target voltage value of VDD1P8 is 1.525V.

enumerator kDCDC_1P8Target1P55V

The target voltage value of VDD1P8 is 1.55V.

enumerator kDCDC_1P8Target1P575V

The target voltage value of VDD1P8 is 1.575V.

enumerator kDCDC_1P8Target1P6V

The target voltage value of VDD1P8 is 1.6V.

enumerator kDCDC_1P8Target1P625V

The target voltage value of VDD1P8 is 1.625V.

enumerator kDCDC_1P8Target1P65V

The target voltage value of VDD1P8 is 1.65V.

enumerator kDCDC_1P8Target1P675V

The target voltage value of VDD1P8 is 1.675V.

enumerator kDCDC_1P8Target1P7V

The target voltage value of VDD1P8 is 1.7V.

enumerator kDCDC_1P8Target1P725V

The target voltage value of VDD1P8 is 1.725V.

enumerator kDCDC_1P8Target1P75V

The target voltage value of VDD1P8 is 1.75V.

enumerator kDCDC_1P8Target1P775V

The target voltage value of VDD1P8 is 1.775V.

enumerator kDCDC_1P8Target1P8V

The target voltage value of VDD1P8 is 1.8V.

enumerator kDCDC_1P8Target1P825V

The target voltage value of VDD1P8 is 1.825V.

enumerator kDCDC_1P8Target1P85V

The target voltage value of VDD1P8 is 1.85V.

enumerator kDCDC_1P8Target1P875V

The target voltage value of VDD1P8 is 1.875V.

enumerator kDCDC_1P8Target1P9V

The target voltage value of VDD1P8 is 1.9V.

enumerator kDCDC_1P8Target1P925V

The target voltage value of VDD1P8 is 1.925V.

enumerator kDCDC_1P8Target1P95V

The target voltage value of VDD1P8 is 1.95V.

enumerator kDCDC_1P8Target1P975V

The target voltage value of VDD1P8 is 1.975V.

enumerator kDCDC_1P8Target2P0V

The target voltage value of VDD1P8 is 2.0V.

enumerator kDCDC_1P8Target2P025V

The target voltage value of VDD1P8 is 2.025V.

enumerator kDCDC_1P8Target2P05V

The target voltage value of VDD1P8 is 2.05V.

enumerator kDCDC_1P8Target2P075V

The target voltage value of VDD1P8 is 2.075V.

enumerator kDCDC_1P8Target2P1V

The target voltage value of VDD1P8 is 2.1V.

enumerator kDCDC_1P8Target2P125V

The target voltage value of VDD1P8 is 2.125V.

enumerator kDCDC_1P8Target2P15V

The target voltage value of VDD1P8 is 2.15V.

enumerator kDCDC_1P8Target2P175V

The target voltage value of VDD1P8 is 2.175V.

enumerator kDCDC_1P8Target2P2V

The target voltage value of VDD1P8 is 2.2V.

enumerator kDCDC_1P8Target2P225V

The target voltage value of VDD1P8 is 2.225V.

enumerator kDCDC_1P8Target2P25V

The target voltage value of VDD1P8 is 2.25V.

enumerator kDCDC_1P8Target2P275V

The target voltage value of VDD1P8 is 2.275V.

enum __dcdc_comparator_current_bias

The current bias of low power comparator.

Values:

enumerator kDCDC_ComparatorCurrentBias50nA

The current bias of low power comparator is 50nA.

enumerator kDCDC_ComparatorCurrentBias100nA

The current bias of low power comparator is 100nA.

enumerator kDCDC_ComparatorCurrentBias200nA

The current bias of low power comparator is 200nA.

enumerator kDCDC_ComparatorCurrentBias400nA

The current bias of low power comparator is 400nA.

enum __dcdc_peak_current_threshold

The threshold if peak current detection.

Values:

enumerator kDCDC_PeakCurrentRunMode250mALPMode1P5A

Over peak current threshold in low power mode is 250mA, in run mode is 1.5A

enumerator kDCDC_PeakCurrentRunMode200mALPMode1P5A

Over peak current threshold in low power mode is 200mA, in run mode is 1.5A

enumerator kDCDC_PeakCurrentRunMode250mALPMode2A

Over peak current threshold in low power mode is 250mA, in run mode is 2A

enumerator kDCDC_PeakCurrentRunMode200mALPMode2A

Over peak current threshold in low power mode is 200mA, in run mode is 2A

enum __dcdc_clock_source

Oscillator clock option.

Values:

enumerator kDCDC_ClockAutoSwitch

Automatic clock switch from internal oscillator to external clock.

enumerator kDCDC_ClockInternalOsc

Use internal oscillator.

enumerator kDCDC_ClockExternalOsc

Use external 24M crystal oscillator.

enum __dcdc_voltage_output_sel

Voltage output option.

Values:

enumerator kDCDC_VoltageOutput1P8

1.8V output.

enumerator `kDCDC_VoltageOutput1P0`
1.0V output.

typedef enum `_dcdc_core_slice` `dcdc_core_slice_t`
CORE slice.

typedef enum `_dcdc_control_mode` `dcdc_control_mode_t`
DCDC control mode, including software control mode and GPC control mode.

typedef enum `_dcdc_trim_input_mode` `dcdc_trim_input_mode_t`
DCDC trim input mode, including sample trim input and hold trim input.

typedef enum `_dcdc_1P0_target_vol` `dcdc_1P0_target_vol_t`
The enumeration VDD1P0's target voltage value.

typedef enum `_dcdc_1P8_target_vol` `dcdc_1P8_target_vol_t`
The enumeration VDD1P8's target voltage value.

typedef enum `_dcdc_comparator_current_bias` `dcdc_comparator_current_bias_t`
The current bias of low power comparator.

typedef enum `_dcdc_peak_current_threshold` `dcdc_peak_current_threshold_t`
The threshold if peak current detection.

typedef enum `_dcdc_clock_source` `dcdc_clock_source_t`
Oscillator clock option.

typedef enum `_dcdc_voltage_output_sel` `dcdc_voltage_output_sel_t`
Voltage output option.

typedef struct `_dcdc_config` `dcdc_config_t`
Configuration for DCDC.

typedef struct `_dcdc_min_power_config` `dcdc_min_power_config_t`
Configuration for min power setting.

typedef struct `_dcdc_detection_config` `dcdc_detection_config_t`
Configuration for DCDC detection.

typedef struct `_dcdc_loop_control_config` `dcdc_loop_control_config_t`
Configuration for the loop control.

typedef struct `_dcdc_internal_regulator_config` `dcdc_internal_regulator_config_t`
Configuration for DCDC internal regulator.

FSL_DCDC_DRIVER_VERSION
DCDC driver version.
Version 2.0.1.

VDD1P0_TARGET_VOLTAGE
The array of VDD1P0 target voltage.

VDD1P8_TARGET_VOLTAGE
The array of VDD1P8 target voltage.

struct `_dcdc_config`
`#include <fsl_dcdc.h>` Configuration for DCDC.

Public Members

dcdc_control_mode_t controlMode

DCDC control mode.

dcdc_trim_input_mode_t trimInputMode

Hold trim input.

struct *_dcdc_min_power_config*

#include <fsl_dcdc.h> Configuration for min power setting.

Public Members

bool enableUseHalfFreqForContinuous

Set DCDC clock to half frequency for the continuous mode.

struct *_dcdc_detection_config*

#include <fsl_dcdc.h> Configuration for DCDC detection.

Public Members

bool enableXtalokDetection

Enable xtalok detection circuit.

bool powerDownOverVoltageVdd1P8Detection

Power down over-voltage detection comparator for VDD1P8.

bool powerDownOverVoltageVdd1P0Detection

Power down over-voltage detection comparator for VDD1P0.

bool powerDownLowVoltageDetection

Power down low-voltage detection comparator.

bool powerDownOverCurrentDetection

Power down over-current detection.

struct *_dcdc_loop_control_config*

#include <fsl_dcdc.h> Configuration for the loop control.

Public Members

bool enableCommonHysteresis

Enable hysteresis in switching converter common mode analog comparators. This feature will improve transient supply ripple and efficiency.

bool enableCommonThresholdDetection

Increase the threshold detection for common mode analog comparator.

bool enableDifferentialHysteresis

Enable hysteresis in switching converter differential mode analog comparators. This feature will improve transient supply ripple and efficiency.

bool enableDifferentialThresholdDetection

Increase the threshold detection for differential mode analog comparators.

bool enableInvertHysteresisSign

Invert the sign of the hysteresis in DC-DC analog comparators.

bool enableRCThresholdDetection

Increase the threshold detection for RC scale circuit.

uint32_t enableRCScaleCircuit

Available range is 0~7. Enable analog circuit of DC-DC converter to respond faster under transient load conditions.

uint32_t complementFeedForwardStep

Available range is 0~7. Two's complement feed forward step in duty cycle in the switching DC-DC converter. Each time this field makes a transition from 0x0, the loop filter of the DC-DC converter is stepped once by a value proportional to the change. This can be used to force a certain control loop behavior, such as improving response under known heavy load transients.

uint32_t controlParameterMagnitude

Available range is 0~15. Magnitude of proportional control parameter in the switching DC-DC converter control loop.

uint32_t integralProportionalRatio

Available range is 0~3. Ratio of integral control parameter to proportional control parameter in the switching DC-DC converter, and can be used to optimize efficiency and loop response.

struct _dcdc_internal_regulator_config

#include <fsl_dcdc.h> Configuration for DCDC internal regulator.

Public Members

uint32_t feedbackPoint

Available range is 0~3. Select the feedback point of the internal regulator.

2.11 eDMA: Enhanced Direct Memory Access (eDMA) Controller Driver

void EDMA_Init(*EDMA_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(*EDMA_Type* *base)

Deinitializes the eDMA peripheral.

This function gates the eDMA clock.

Parameters

- base – eDMA peripheral base address.

```
void EDMA__InstallTCD(EDMA_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.

```
void EDMA__InitChannel(EDMA_Type *base, uint32_t channel, edma_channel_config_t  
                      *channelConfig)
```

EDMA Channel initialization.

Parameters

- base – eDMA4 peripheral base address.
- channel – eDMA4 channel number.
- channelConfig – pointer to user's eDMA4 channel config structure, see *edma_channel_config_t* for detail.

```
static inline void EDMA__SetChannelMemoryAttribute(EDMA_Type *base, uint32_t channel,  
                                                  edma_channel_memory_attribute_t  
                                                  writeAttribute,  
                                                  edma_channel_memory_attribute_t  
                                                  readAttribute)
```

Set channel memory attribute.

Parameters

- base – eDMA4 peripheral base address.
- channel – eDMA4 channel number.
- writeAttribute – Attributes associated with a write transaction.
- readAttribute – Attributes associated with a read transaction.

```
static inline void EDMA__SetChannelSignExtension(EDMA_Type *base, uint32_t channel, uint8_t  
                                                position)
```

Set channel sign extension.

Parameters

- base – eDMA4 peripheral base address.
- channel – eDMA4 channel number.
- position – A non-zero value specifying the sign extend bit position. If 0, sign extension is disabled.

```
static inline void EDMA_SetChannelSwapSize(EDMA_Type *base, uint32_t channel,  
                                           edma_channel_swap_size_t swapSize)
```

Set channel swap size.

Parameters

- base – eDMA4 peripheral base address.
- channel – eDMA4 channel number.
- swapSize – Swap occurs with respect to the specified transfer size. If 0, swap is disabled.

```
static inline void EDMA_SetChannelAccessType(EDMA_Type *base, uint32_t channel,  
                                             edma_channel_access_type_t  
                                             channelAccessType)
```

Set channel access type.

Parameters

- base – eDMA4 peripheral base address.
- channel – eDMA4 channel number.
- channelAccessType – eDMA4's transactions type on the system bus when the channel is active.

```
static inline void EDMA_SetChannelMux(EDMA_Type *base, uint32_t channel, uint32_t  
                                     channelRequestSource)
```

Set channel request source.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- channelRequestSource – eDMA hardware service request source for the channel. User need to use the `dma_request_source_t` type as the input parameter. Note that devices may use other enum type to express dma request source and User can find it in SOC header or `fsl_edma_soc.h`.

```
static inline uint32_t EDMA_GetChannelSystemBusInformation(EDMA_Type *base, uint32_t  
                                                         channel)
```

Gets the channel identification and attribute information on the system bus interface.

Parameters

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

Returns

The mask of the channel system bus information. Users need to use the `_edma_channel_sys_bus_info` type to decode the return variables.

```
static inline void EDMA_EnableChannelMasterIDReplication(EDMA_Type *base, uint32_t  
                                                       channel, bool enable)
```

Set channel master ID replication.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- enable – true is enable, false is disable.


```
static inline void EDMA_SetChannelProtectionLevel(EDMA_Type *base, uint32_t channel,  
                                                edma_channel_protection_level_t level)
```

Set channel security level.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- level – security level.

```
void EDMA_ResetChannel(EDMA_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(EDMA_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, &tcd);
```

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(EDMA_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(EDMA_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(EDMA_Type *base, uint32_t channel, edma_channel_link_type_t  
                        type, 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.
- type – 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(EDMA_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(EDMA_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(EDMA_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(EDMA_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(EDMA_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(EDMA_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(EDMA_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_ConfigChannelSoftwareTCD(edma_tcd_t *tcd, const edma_transfer_config_t  
                                   *transfer)
```

Sets TCD fields according to the user's channel transfer configuration structure, `edma_transfer_config_t`.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_ConfigChannelSoftwareTCDExt`

Application should be careful about the TCD pool buffer storage class,

- For the platform has cache, the software TCD should be put in non cache section
- The TCD pool buffer should have a consistent storage class.

Note: This function enables the auto stop request feature.

Parameters

- tcd – Pointer to the TCD structure.
- transfer – channel transfer configuration pointer.

```
void EDMA_TcdReset(edma_tcd_t *tcd)
```

Sets all fields to default values for the TCD structure.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdResetExt`

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdSetTransferConfigExt`

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdSetMinorOffsetConfigExt`

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 type, uint32_t linkedChannel)`

Sets the channel link for the eDMA TCD.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdSetChannelLinkExt`

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.
- `type` – 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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdSetBandWidthExt`

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdSetModuloExt`

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API `EDMA_TcdEnableAutoStopRequestExt`

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API EDMA_TcdEnableInterruptsExt

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API EDMA_TcdDisableInterruptsExt

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.

@Note This API only supports EDMA4 TCD type. It can be used to support all types with extension API EDMA_TcdSetMajorOffsetConfigExt

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.

void EDMA__ConfigChannelSoftwareTCDExt(*EDMA_Type* *base, *edma_tcd_t* *tcd, const *edma_transfer_config_t* *transfer)

Sets TCD fields according to the user's channel transfer configuration structure, *edma_transfer_config_t*.

Application should be careful about the TCD pool buffer storage class,

- For the platform has cache, the software TCD should be put in non cache section
- The TCD pool buffer should have a consistent storage class.

Note: This function enables the auto stop request feature.

Parameters

- base – eDMA peripheral base address.
- tcd – Pointer to the TCD structure.
- transfer – channel transfer configuration pointer.

```
void EDMA_TcdResetExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- tcd – Pointer to the TCD structure.

```
void EDMA_TcdSetTransferConfigExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- 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_TcdSetMinorOffsetConfigExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- tcd – A point to the TCD structure.
- config – A pointer to the minor offset configuration structure.


```
void EDMA__TcdSetChannelLinkExt(EDMA_Type *base, edma_tcd_t *tcd,  
                                edma_channel_link_type_t type, 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

- base – eDMA peripheral base address.
- tcd – Point to the TCD structure.
- type – Channel link type, it can be one of:
 - kEDMA_LinkNone
 - kEDMA_MinorLink
 - kEDMA_MajorLink
- linkedChannel – The linked channel number.

```
static inline void EDMA__TcdSetBandWidthExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- tcd – A pointer to the TCD structure.
- bandWidth – A bandwidth setting, which can be one of the following:
 - kEDMABandwidthStallNone
 - kEDMABandwidthStall4Cycle
 - kEDMABandwidthStall8Cycle

```
void EDMA__TcdSetModuloExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- tcd – A pointer to the TCD structure.
- srcModulo – A source modulo value.
- destModulo – A destination modulo value.

```
static inline void EDMA__TcdEnableAutoStopRequestExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- tcd – A pointer to the TCD structure.
- enable – The command to enable (true) or disable (false).

```
void EDMA__TcdEnableInterruptsExt(EDMA_Type *base, edma_tcd_t *tcd, uint32_t mask)
```

Enables the interrupt source for the eDMA TCD.

Parameters

- base – eDMA peripheral base address.
- 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__TcdDisableInterruptsExt(EDMA_Type *base, edma_tcd_t *tcd, uint32_t mask)
```

Disables the interrupt source for the eDMA TCD.

Parameters

- base – eDMA peripheral base address.
- 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__TcdSetMajorOffsetConfigExt(EDMA_Type *base, 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

- base – eDMA peripheral base address.
- 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(EDMA_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(EDMA_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(EDMA_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(EDMA_Type *base, uint32_t channel)
```

Gets the remaining major loop count from the eDMA current channel TCD.

This function checks the TCD (Task Control Descriptor) status for a specified eDMA channel and returns the number of major loop count that has not finished.

Note: 1. This function can only be used to get unfinished major loop count of transfer without the next TCD, or it might be inaccuracy.

- a. The unfinished/remaining transfer bytes cannot be obtained directly from registers while the channel is running. Because to calculate the remaining bytes, the initial NBYTES configured in DMA_TCDn_NBYTES_MLNO register is needed while the eDMA IP does not support getting it while a channel is active. In another word, the NBYTES value reading is always the actual (decrementing) NBYTES value the dma_engine is working with while a channel is running. Consequently, to get the remaining transfer bytes, a software-saved initial value of NBYTES (for example copied before enabling the channel) is needed. The formula to calculate it is shown below: RemainingBytes = RemainingMajorLoopCount * NBYTES(initially configured)
-

Parameters

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

Returns

Major loop count which has not been transferred yet for the current TCD.

```
static inline uint32_t EDMA_GetErrorStatusFlags(EDMA_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(EDMA_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(EDMA_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, EDMA_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). User can check if 128 bytes support is available for specific instance by FSL_FEATURE_EDMA_INSTANCE_SUPPORT_128_BYTES_TRANSFERn.

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 type)
```

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.
- type – eDMA transfer type.

```
void EDMA_PrepareTransferTCD(edma_handle_t *handle, edma_tcd_t *tcd, void *srcAddr,
                             uint32_t srcWidth, int16_t srcOffset, void *destAddr, uint32_t
                             destWidth, int16_t destOffset, uint32_t bytesEachRequest,
                             uint32_t transferBytes, edma_tcd_t *nextTcd)
```

Prepares the eDMA transfer content descriptor.

This function prepares the transfer content descriptor 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

- handle – eDMA handle pointer.
- tcd – Pointer to eDMA transfer content descriptor structure.
- 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.
- nextTcd – eDMA transfer linked TCD address.

```
status_t EDMA_SubmitTransferTCD(edma_handle_t *handle, edma_tcd_t *tcd)
```

Submits the eDMA transfer content descriptor.

This function submits the eDMA transfer request according to the transfer content descriptor. 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.

Typical user case:

a. submit single transfer

```
edma_tcd_t tcd;
EDMA_PrepareTransferTCD(handle, tcd, ...)
EDMA_SubmitTransferTCD(handle, tcd)
EDMA_StartTransfer(handle)
```

b. submit static link transfer,

```
edma_tcd_t tcd[2];
EDMA_PrepareTransferTCD(handle, &tcd[0], ...)
EDMA_PrepareTransferTCD(handle, &tcd[1], ...)
EDMA_SubmitTransferTCD(handle, &tcd[0])
EDMA_StartTransfer(handle)
```

c. submit dynamic link transfer

```
edma_tcd_t tcdpool[2];
EDMA_InstallTCDMemory(&g_DMA_Handle, tcdpool, 2);
edma_tcd_t tcd;
```

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```
EDMA_PrepareTransferTCD(handle, tcd, ...)
EDMA_SubmitTransferTCD(handle, tcd)
EDMA_PrepareTransferTCD(handle, tcd, ...)
EDMA_SubmitTransferTCD(handle, tcd)
EDMA_StartTransfer(handle)
```

d. submit loop transfer

```
edma_tcd_t tcd[2];
EDMA_PrepareTransferTCD(handle, &tcd[0], ..., &tcd[1])
EDMA_PrepareTransferTCD(handle, &tcd[1], ..., &tcd[0])
EDMA_SubmitTransferTCD(handle, &tcd[0])
EDMA_StartTransfer(handle)
```

Parameters

- handle – eDMA handle pointer.
- tcd – Pointer to eDMA transfer content descriptor 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.

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.

status_t EDMA_SubmitLoopTransfer(*edma_handle_t* *handle, *edma_transfer_config_t* *transfer, *uint32_t* transferLoopCount)

Submits the eDMA scatter gather transfer configurations.

The function is target for submit loop transfer request, the ring transfer request means that the transfer request TAIL is link to HEAD, such as, A->B->C->D->A, or A->A

To use the ring transfer feature, the application should allocate several transfer object, such as

```
edma_channel_transfer_config_t transfer[2];
EDMA_TransferSubmitLoopTransfer(psHandle, &transfer, 2U);
```

Then eDMA driver will link transfer[0] and transfer[1] to each other

Note: Application should check the return value of this function to avoid transfer request submit failed

Parameters

- handle – eDMA handle pointer
- transfer – pointer to user's eDMA channel configure structure, see `edma_channel_transfer_config_t` for detail
- transferLoopCount – the count of the transfer ring, if loop count is 1, that means that the one will link to itself.

Return values

- `kStatus_Success` – It means submit transfer request succeed
- `kStatus_EDMA_Busy` – channel is in busy status
- `kStatus_InvalidArgument` – Invalid Argument

`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 2.10.6.

```
_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.

```
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

enumerator kEDMA_TransferSize64Bytes

Source/Destination data transfer size is 64 bytes every time

enumerator kEDMA_TransferSize128Bytes

Source/Destination data transfer size is 128 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_TransferCanceledFlag

Transfer cancelled

enumerator kEDMA_ValidFlag

No error occurred, this bit is 0. Otherwise, it is 1.

_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

enum edma_channel_memory_attribute

eDMA channel memory attribute

Values:

enumerator kEDMA_ChannelNoWriteNoReadNoCacheNoBuffer

No write allocate, no read allocate, non-cacheable, non-bufferable.

enumerator kEDMA_ChannelNoWriteNoReadNoCacheBufferable

No write allocate, no read allocate, non-cacheable, bufferable.

enumerator kEDMA_ChannelNoWriteNoReadCacheableNoBuffer

No write allocate, no read allocate, cacheable, non-bufferable.

enumerator kEDMA_ChannelNoWriteNoReadCacheableBufferable

No write allocate, no read allocate, cacheable, bufferable.

enumerator kEDMA_ChannelNoWriteReadNoCacheNoBuffer

No write allocate, read allocate, non-cacheable, non-bufferable.

enumerator kEDMA_ChannelNoWriteReadNoCacheBufferable

No write allocate, read allocate, non-cacheable, bufferable.

enumerator kEDMA_ChannelNoWriteReadCacheableNoBuffer

No write allocate, read allocate, cacheable, non-bufferable.

enumerator kEDMA_ChannelNoWriteReadCacheableBufferable

No write allocate, read allocate, cacheable, bufferable.

enumerator kEDMA_ChannelWriteNoReadNoCacheNoBuffer

write allocate, no read allocate, non-cacheable, non-bufferable.

enumerator kEDMA_ChannelWriteNoReadNoCacheBufferable

write allocate, no read allocate, non-cacheable, bufferable.

enumerator kEDMA_ChannelWriteNoReadCacheableNoBuffer

write allocate, no read allocate, cacheable, non-bufferable.

enumerator kEDMA_ChannelWriteNoReadCacheableBufferable

write allocate, no read allocate, cacheable, bufferable.

enumerator kEDMA_ChannelWriteReadNoCacheNoBuffer

write allocate, read allocate, non-cacheable, non-bufferable.

enumerator kEDMA_ChannelWriteReadNoCacheBufferable

write allocate, read allocate, non-cacheable, bufferable.

enumerator kEDMA_ChannelWriteReadCacheableNoBuffer

write allocate, read allocate, cacheable, non-bufferable.

enumerator kEDMA_ChannelWriteReadCacheableBufferable

write allocate, read allocate, cacheable, bufferable.

enum _edma_channel_swap_size

eDMA4 channel swap size

Values:

enumerator kEDMA_ChannelSwapDisabled

Swap is disabled.

enumerator kEDMA_ChannelReadWith8bitSwap

Swap occurs with respect to the read 8bit.

enumerator kEDMA_ChannelReadWith16bitSwap

Swap occurs with respect to the read 16bit.

enumerator kEDMA_ChannelReadWith32bitSwap

Swap occurs with respect to the read 32bit.

enumerator kEDMA_ChannelWriteWith8bitSwap

Swap occurs with respect to the write 8bit.

enumerator kEDMA_ChannelWriteWith16bitSwap

Swap occurs with respect to the write 16bit.

enumerator kEDMA_ChannelWriteWith32bitSwap

Swap occurs with respect to the write 32bit.

eDMA channel system bus information, _edma_channel_sys_bus_info

Values:

enumerator kEDMA_PrivilegedAccessLevel

Privileged Access Level for DMA transfers. 0b - User protection level; 1b - Privileged protection level.

enumerator kEDMA_MasterId

DMA's master ID when channel is active and master ID replication is enabled.

enum _edma_channel_access_type

eDMA4 channel access type

Values:

enumerator kEDMA_ChannelDataAccess

Data access for eDMA4 transfers.

enumerator kEDMA_ChannelInstructionAccess

Instruction access for eDMA4 transfers.

enum _edma_channel_protection_level

eDMA4 channel protection level

Values:

enumerator kEDMA_ChannelProtectionLevelUser

user protection level for eDMA transfers.

enumerator kEDMA_ChannelProtectionLevelPrivileged

Privileged protection level eDMA transfers.

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_transfer_type edma_transfer_type_t

eDMA transfer type

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 enum edma_channel_memory_attribute edma_channel_memory_attribute_t

eDMA channel memory attribute

typedef enum _edma_channel_swap_size edma_channel_swap_size_t

eDMA4 channel swap size

typedef enum _edma_channel_access_type edma_channel_access_type_t

eDMA4 channel access type

typedef enum _edma_channel_protection_level edma_channel_protection_level_t

eDMA4 channel protection level

typedef struct _edma_channel_config edma_channel_config_t

eDMA4 channel configuration

```
typedef edma_core_tcd_t 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 struct _edma_transfer_config edma_transfer_config_t  
    edma4 channel transfer configuration
```

The transfer configuration structure support full feature configuration of the transfer control descriptor.

1.To perform a simple transfer, below members should be initialized at least .srcAddr - source address .dstAddr - destination address .srcWidthOfEachTransfer - data width of source address .dstWidthOfEachTransfer - data width of destination address, normally it should be as same as srcWidthOfEachTransfer .bytesEachRequest - bytes to be transferred in each DMA request .totalBytes - total bytes to be transferred .srcOffsetOfEachTransfer - offset value in bytes unit to be applied to source address as each source read is completed .dstOffsetOfEachTransfer - offset value in bytes unit to be applied to destination address as each destination write is completed enablchannelRequest - channel request can be enabled together with transfer configure submission

2.The transfer configuration structure also support advance feature: Programmable source/destination address range(MODULO) Programmable minor loop offset Programmable major loop offset Programmable channel chain feature Programmable channel transfer control descriptor link feature

Note: User should pay attention to the transfer size alignment limitation

- a. the bytesEachRequest should align with the srcWidthOfEachTransfer and the dstWidthOfEachTransfer that is to say bytesEachRequest % srcWidthOfEachTransfer should be 0
 - b. the srcOffsetOfEachTransfer and dstOffsetOfEachTransfer must be aligne with transfer width
 - c. the totalBytes should align with the bytesEachRequest
 - d. the srcAddr should align with the srcWidthOfEachTransfer
 - e. the dstAddr should align with the dstWidthOfEachTransfer
 - f. the srcAddr should align with srcAddrModulo if modulo feature is enabled
 - g. the dstAddr should align with dstAddrModulo if modulo feature is enabled If anyone of above condition can not be satisfied, the edma4 interfaces will generate assert error.
-

```
typedef struct _edma_config edma_config_t  
    eDMA global configuration structure.
```

```
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

```
FSL_EDMA_DRIVER_EDMA4
```

EDMA driver name

```
EDMA_ALLOCATE_TCD(name, number)
```

Macro used for allocate edma TCD.

```
DMA_DCHPRI_INDEX(channel)
```

Compute the offset unit from DCHPRI3.

```
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_channel_config
```

#include <fsl_edma.h> EDMA4 channel configuration

Public Members

edma_channel_Preemption_config_t channelPreemptionConfig
channel preemption configuration

edma_channel_memory_attribute_t channelReadMemoryAttribute
channel memory read attribute configuration

edma_channel_memory_attribute_t channelWriteMemoryAttribute
channel memory write attribute configuration

edma_channel_swap_size_t channelSwapSize
channel swap size configuration

edma_channel_access_type_t channelAccessType
channel access type configuration

uint8_t channelDataSignExtensionBitPosition
channel data sign extension bit position configuration

uint32_t channelRequestSource
hardware service request source for the channel

bool enableMasterIDReplication
enable master ID replication

edma_channel_protection_level_t protectionLevel
protection level

struct __edma_transfer_config
#include <fsl_edma.h> edma4 channel transfer configuration

The transfer configuration structure support full feature configuration of the transfer control descriptor.

1.To perform a simple transfer, below members should be initialized at least .srcAddr - source address .dstAddr - destination address .srcWidthOfEachTransfer - data width of source address .dstWidthOfEachTransfer - data width of destination address, normally it should be as same as srcWidthOfEachTransfer .bytesEachRequest - bytes to be transferred in each DMA request .totalBytes - total bytes to be transferred .srcOffsetOfEachTransfer - offset value in bytes unit to be applied to source address as each source read is completed .dstOffsetOfEachTransfer - offset value in bytes unit to be applied to destination address as each destination write is completed enableChannelRequest - channel request can be enabled together with transfer configure submission

2.The transfer configuration structure also support advance feature: Programmable source/destination address range(MODULO) Programmable minor loop offset Programmable major loop offset Programmable channel chain feature Programmable channel transfer control descriptor link feature

Note: User should pay attention to the transfer size alignment limitation

- a. the bytesEachRequest should align with the srcWidthOfEachTransfer and the dstWidthOfEachTransfer that is to say bytesEachRequest % srcWidthOfEachTransfer should be 0
- b. the srcOffsetOfEachTransfer and dstOffsetOfEachTransfer must be aligne with transfer width
- c. the totalBytes should align with the bytesEachRequest
- d. the srcAddr should align with the srcWidthOfEachTransfer

- e. the dstAddr should align with the dstWidthOfEachTransfer
 - f. the srcAddr should align with srcAddrModulo if modulo feature is enabled
 - g. the dstAddr should align with dstAddrModulo if modulo feature is enabled If anyone of above condition can not be satisfied, the edma4 interfaces will generate assert error.
-

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 value in byte unit applied to the current source address to form the next-state value as each source read is completed

int16_t destOffset

Sign-extended offset value in byte unit applied to the current destination address to form the next-state value as each destination write is completed.

uint32_t minorLoopBytes

bytes in each minor loop or each request range: $1 - (2^{30} - 1)$ when minor loop mapping is enabled range: $1 - (2^{10} - 1)$ when minor loop mapping is enabled and source or dest minor loop offset is enabled range: $1 - (2^{32} - 1)$ when minor loop mapping is disabled

uint32_t majorLoopCounts

minor loop counts in each major loop, should be 1 at least for each transfer range: $(0 - (2^{15} - 1))$ when minor loop channel link is disabled range: $(0 - (2^9 - 1))$ when minor loop channel link is enabled total bytes in a transfer = minorLoopCountsEachMajorLoop * bytesEachMinorLoop

uint16_t enabledInterruptMask

channel interrupt to enable, can be OR'ed value of _edma_interrupt_enable

edma_modulo_t srcAddrModulo

source circular data queue range

int32_t srcMajorLoopOffset

source major loop offset

edma_modulo_t dstAddrModulo

destination circular data queue range

int32_t dstMajorLoopOffset

destination major loop offset

bool enableSrcMinorLoopOffset

enable source minor loop offset

bool enableDstMinorLoopOffset

enable dest minor loop offset

`int32_t` minorLoopOffset
burst offset, the offset will be applied after minor loop update

`bool` enableChannelMajorLoopLink
channel link when major loop complete

`uint32_t` majorLoopLinkChannel
major loop link channel number

`bool` enableChannelMinorLoopLink
channel link when minor loop complete

`uint32_t` minorLoopLinkChannel
minor loop link channel number

`edma_tcd_t *linkTCD`
pointer to the link transfer control descriptor

`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` enableMasterIdReplication
Enable (true) master ID replication. If Master ID replication is disabled, the privileged protection level (supervisor mode) for eDMA4 transfers is used.

`bool` enableGlobalChannelLink
Enable(true) channel linking is available and controlled by each channel's link settings.

`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` enableDebugMode
Enable(true) eDMA4 debug mode. When in debug mode, the eDMA4 stalls the start of a new channel. Executing channels are allowed to complete.

`bool` enableRoundRobinArbitration
Enable(true) channel linking is available and controlled by each channel's link settings.

`edma_channel_config_t *channelConfig[1]`
channel preemption configuration

`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.

EDMA_ChannelType *channelBase
eDMA peripheral channel base address.

EDMA_Type *base
eDMA peripheral base address

EDMA_TCDType *tcdBase
eDMA peripheral tcd base address.

edma_tcd_t *tcdPool
Pointer to memory stored TCDs.

uint32_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.

2.12 eDMA core Driver

enum _edma_tcd_type
eDMA tcd flag type
Values:
enumerator kEDMA_EDMA4Flag
Data access for eDMA4 transfers.
enumerator kEDMA_EDMA5Flag
Instruction access for eDMA4 transfers.

typedef struct _edma_core_mp edma_core_mp_t
edma core channel struture definition

typedef struct _edma_core_channel edma_core_channel_t
edma core channel struture definition

typedef enum _edma_tcd_type edma_tcd_type_t
eDMA tcd flag type

typedef struct _edma5_core_tcd edma5_core_tcd_t
edma5 core TCD struture definition

typedef struct _edma4_core_tcd edma4_core_tcd_t
edma4 core TCD struture definition

typedef struct _edma_core_tcd edma_core_tcd_t
edma core TCD struture definition

```
typedef edma_core_channel_t EDMA_ChannelType
```

```
    EDMA typedef.
```

```
typedef edma_core_tcd_t EDMA_TCDType
```

```
typedef void EDMA_Type
```

```
DMA_CORE_MP_CSR_EDBG_MASK
```

```
DMA_CORE_MP_CSR_ERCA_MASK
```

```
DMA_CORE_MP_CSR_HAE_MASK
```

```
DMA_CORE_MP_CSR_HALT_MASK
```

```
DMA_CORE_MP_CSR_GCLC_MASK
```

```
DMA_CORE_MP_CSR_GMRC_MASK
```

```
DMA_CORE_MP_CSR_EDBG(x)
```

```
DMA_CORE_MP_CSR_ERCA(x)
```

```
DMA_CORE_MP_CSR_HAE(x)
```

```
DMA_CORE_MP_CSR_HALT(x)
```

```
DMA_CORE_MP_CSR_GCLC(x)
```

```
DMA_CORE_MP_CSR_GMRC(x)
```

```
DMA_CSR_INTMAJOR_MASK
```

```
DMA_CSR_INTHALF_MASK
```

```
DMA_CSR_DREQ_MASK
```

```
DMA_CSR_ESG_MASK
```

```
DMA_CSR_BWC_MASK
```

```
DMA_CSR_BWC(x)
```

```
DMA_CSR_START_MASK
```

```
DMA_CITER_ELINKNO_CITER_MASK
```

```
DMA_BITER_ELINKNO_BITER_MASK
```

```
DMA_CITER_ELINKNO_CITER_SHIFT
```

```
DMA_CITER_ELINKYES_CITER_MASK
```

```
DMA_CITER_ELINKYES_CITER_SHIFT
```

```
DMA_ATTR_SMOD_MASK
```

```
DMA_ATTR_DMOD_MASK
```

```
DMA_CITER_ELINKNO_ELINK_MASK
```

```
DMA_CSR_MAJORELINK_MASK
```

```
DMA_BITER_ELINKYES_ELINK_MASK
```

DMA_CITER_ELINKYES_ELINK_MASK
DMA_CSR_MAJORLINKCH_MASK
DMA_BITER_ELINKYES_LINKCH_MASK
DMA_CITER_ELINKYES_LINKCH_MASK
DMA_NBYTES_MLOFFYES_MLOFF_MASK
DMA_NBYTES_MLOFFYES_DMLOE_MASK
DMA_NBYTES_MLOFFYES_SMLOE_MASK
DMA_NBYTES_MLOFFNO_NBYTES_MASK
DMA_ATTR_DMOD(x)
DMA_ATTR_SMOD(x)
DMA_BITER_ELINKYES_LINKCH(x)
DMA_CITER_ELINKYES_LINKCH(x)
DMA_NBYTES_MLOFFYES_MLOFF(x)
DMA_NBYTES_MLOFFYES_DMLOE(x)
DMA_NBYTES_MLOFFYES_SMLOE(x)
DMA_NBYTES_MLOFFNO_NBYTES(x)
DMA_NBYTES_MLOFFYES_NBYTES(x)
DMA_ATTR_DSIZE(x)
DMA_ATTR_SSIZE(x)
DMA_CSR_DREQ(x)
DMA_CSR_MAJORLINKCH(x)
DMA_CH_MATTR_WCACHE(x)
DMA_CH_MATTR_RCACHE(x)
DMA_CH_CSR_SIGNEXT_MASK
DMA_CH_CSR_SIGNEXT_SHIFT
DMA_CH_CSR_SWAP_MASK
DMA_CH_CSR_SWAP_SHIFT
DMA_CH_SBR_INSTR_MASK
DMA_CH_SBR_INSTR_SHIFT
DMA_CH_MUX_SOURCE(x)
DMA_ERR_DBE_FLAG
 DMA error flag.
DMA_ERR_SBE_FLAG

DMA_ERR_SGE_FLAG
DMA_ERR_NCE_FLAG
DMA_ERR_DOE_FLAG
DMA_ERR_DAE_FLAG
DMA_ERR_SOE_FLAG
DMA_ERR_SAE_FLAG
DMA_ERR_ERRCHAN_FLAG
DMA_ERR_ECX_FLAG
DMA_ERR_FLAG
DMA_CLEAR_DONE_STATUS(base, channel)
 get/clear DONE bit
DMA_GET_DONE_STATUS(base, channel)
DMA_ENABLE_ERROR_INT(base, channel)
 enable/disable error interrupt
DMA_DISABLE_ERROR_INT(base, channel)
DMA_CLEAR_ERROR_STATUS(base, channel)
 get/clear error status
DMA_GET_ERROR_STATUS(base, channel)
DMA_CLEAR_INT_STATUS(base, channel)
 get/clear INT status
DMA_GET_INT_STATUS(base, channel)
DMA_ENABLE_MAJOR_INT(base, channel)
 enable/disable MAJOR/HALF INT
DMA_ENABLE_HALF_INT(base, channel)
DMA_DISABLE_MAJOR_INT(base, channel)
DMA_DISABLE_HALF_INT(base, channel)
EDMA_TCD_ALIGN_SIZE
 EDMA tcd align size.
EDMA_CORE_BASE(base)
 EDMA base address convert macro.
EDMA_MP_BASE(base)
EDMA_CHANNEL_BASE(base, channel)
EDMA_TCD_BASE(base, channel)
EDMA_TCD_TYPE(x)
 EDMA TCD type macro.
EDMA_TCD_SADDR(tcd, flag)
 EDMA TCD address convert macro.

EDMA_TCD_SOFF(tcd, flag)

EDMA_TCD_ATTR(tcd, flag)

EDMA_TCD_NBYTES(tcd, flag)

EDMA_TCD_SLAST(tcd, flag)

EDMA_TCD_DADDR(tcd, flag)

EDMA_TCD_DOFF(tcd, flag)

EDMA_TCD_CITER(tcd, flag)

EDMA_TCD_DLAST_SGA(tcd, flag)

EDMA_TCD_CSR(tcd, flag)

EDMA_TCD_BITER(tcd, flag)

struct __edma_core_mp

#include <fsl_edma_core.h> edma core channel struture definition

Public Members

__IO uint32_t MP_CSR

Channel Control and Status, array offset: 0x10000, array step: 0x10000

__IO uint32_t MP_ES

Channel Error Status, array offset: 0x10004, array step: 0x10000

struct __edma_core_channel

#include <fsl_edma_core.h> edma core channel struture definition

Public Members

__IO uint32_t CH_CSR

Channel Control and Status, array offset: 0x10000, array step: 0x10000

__IO uint32_t CH_ES

Channel Error Status, array offset: 0x10004, array step: 0x10000

__IO uint32_t CH_INT

Channel Interrupt Status, array offset: 0x10008, array step: 0x10000

__IO uint32_t CH_SBR

Channel System Bus, array offset: 0x1000C, array step: 0x10000

__IO uint32_t CH_PRI

Channel Priority, array offset: 0x10010, array step: 0x10000

struct __edma5_core_tcd

#include <fsl_edma_core.h> edma5 core TCD struture definition

Public Members

__IO uint32_t SADDR

SADDR register, used to save source address

```

__IO uint32_t SADDR_HIGH
    SADDR HIGH 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 SLAST_SDA_HIGH
    SLAST SDA HIGH register
__IO uint32_t DADDR
    DADDR register, used for destination address
__IO uint32_t DADDR_HIGH
    DADDR HIGH register, used for destination address
__IO uint32_t DLAST_SGA
    DLASTSGA register, next tcd address used in scatter-gather mode
__IO uint32_t DLAST_SGA_HIGH
    DLASTSGA HIGH register, next tcd address used in scatter-gather mode
__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 uint16_t CSR
    CSR register, for TCD control status
__IO uint16_t BITER
    BITER register, begin minor loop count.
uint8_t RESERVED[16]
    Aligned 64 bytes
struct __edma4_core_tcd
    #include <fsl_edma_core.h> edma4 core TCD struture definition

```

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_core_tcd
#include <fsl_edma_core.h> edma core TCD struture definition

union MP_REGS

Public Members

struct _edma_core_mp EDMA5_REG

struct EDMA5_REG

Public Members

__IO uint32_t MP_INT_LOW
Channel Control and Status, array offset: 0x10008, array step: 0x10000

__IO uint32_t MP_INT_HIGH
Channel Control and Status, array offset: 0x1000C, array step: 0x10000

__IO uint32_t MP_HRS_LOW
Channel Control and Status, array offset: 0x10010, array step: 0x10000

__IO uint32_t MP_HRS_HIGH
Channel Control and Status, array offset: 0x10014, array step: 0x10000

__IO uint32_t MP_STOPCH
Channel Control and Status, array offset: 0x10020, array step: 0x10000

__IO uint32_t MP_SSR_LOW
Channel Control and Status, array offset: 0x10030, array step: 0x10000

__IO uint32_t MP_SSR_HIGH
Channel Control and Status, array offset: 0x10034, array step: 0x10000

__IO uint32_t CH_GRPRI [64]
Channel Control and Status, array offset: 0x10100, array step: 0x10000

__IO uint32_t CH_MUX [64]
Channel Control and Status, array offset: 0x10200, array step: 0x10000

__IO uint32_t CH_PROT [64]

Channel Control and Status, array offset: 0x10400, array step: 0x10000

union CH_REGS

Public Members

struct *_edma_core_channel* EDMA5_REG

struct *_edma_core_channel* EDMA4_REG

struct EDMA5_REG

Public Members

__IO uint32_t CH_MATTR

Memory Attributes Register, array offset: 0x10018, array step: 0x8000

struct EDMA4_REG

Public Members

__IO uint32_t CH_MUX

Channel Multiplexor Configuration, array offset: 0x10014, array step: 0x10000

__IO uint16_t CH_MATTR

Memory Attributes Register, array offset: 0x10018, array step: 0x8000

union TCD_REGS

Public Members

edma4_core_tcd_t edma4_tcd

2.13 eDMA soc Driver

FSL_EDMA_SOC_DRIVER_VERSION

Driver version 2.1.0.

FSL_EDMA_SOC_IP_DMA3

DMA IP version.

FSL_EDMA_SOC_IP_DMA4

EDMA_BASE_PTRS

DMA base table.

EDMA_CHN_IRQS

Verify dma base and request source

EDMA_CHANNEL_HAS_REQUEST_SOURCE(base, source)

EDMA_CHANNEL_OFFSET

EDMA base address convert macro.

EDMA_CHANNEL_ARRAY_STEP(base)

2.14 Ele_base_api

status_t ELE_BaseAPI_Ping(S3MU_Type *mu)

Ping ELE.

This function Ping EdgeLock Enclave, can be sent at any time to verify ELE is alive. Additionally, this command reloads the fuse shadow registers and kick the Sentinel active bit. This active bit must be kicked at least once every day (24 hours).

Parameters

- mu – MU peripheral base address

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_GetFwVersion(S3MU_Type *mu, uint32_t *EleFwVersion)

Get ELE FW Version.

This function is used to retrieve the Sentinel FW version.

Parameters

- mu – MU peripheral base address
- EleFwVersion – Pointer where ELE firmware version will be stored

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_GetFwStatus(S3MU_Type *mu, uint32_t *EleFwStatus)

Get ELE FW Status.

This function is used to retrieve the Sentinel FW status.

Parameters

- mu – MU peripheral base address
- EleFwStatus – Pointer where ELE firmware status will be stored

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_EnableAPC(S3MU_Type *mu)

Enable APC (Application core)

This function is used by RTC (real time core) to release APC (Application core) when needed.

Parameters

- mu – MU peripheral base address

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_ForwardLifecycle(S3MU_Type *mu, uint32_t Lifecycle)

Forward Lifecycle update.

This function is to change chip lifecycle 0x01U for NXP provisioned 0x02U for OEM Open 0x08U for OEM Closed 0x80U for OEM Locked

Parameters

- mu – MU peripheral base address

- Lifecycle – to switch

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_ReleaseRDC(S3MU_Type *mu, uint32_t RdcID, uint32_t CoreID)

Release RDC.

This function is used to release specied RDC to the core identified in this function. The RDC will be released only if the FW of the core to which is the RDC ownership is going to be transferred has been properly authenticated and verified.

Parameters

- mu – MU peripheral base address
- RdcID – Resource Domain Control identifier
- CoreID – Core identifier

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_StartRng(S3MU_Type *mu)

Start the initialization of the RNG context.

The RNG must be started before using some of the ELE services.

Parameters

- mu – MU peripheral base address

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_EnableOtfad(S3MU_Type *mu, uint8_t OtfadID)

Enable an instance of OTFAD.

Parameters

- mu – MU peripheral base address
- OtfadID – ID of the OTFAD instance to enable - used only if there are multiple instances on the SoC

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_ClockChangeStart(S3MU_Type *mu)

Start the clock change process.

Parameters

- mu – MU peripheral base address

Returns

Status kStatus_Success if success, kStatus_Fail if fail Possible errors: kStatus_S3MU_InvalidArgument, kStatus_S3MU_AgumentOutOfRange

status_t ELE_BaseAPI_ClockChangeFinish(S3MU_Type *mu, uint8_t NewClockRateELE, uint8_t NewClockRateCM33)

Change ELE and/or CM33 clock.

It is valid to pass both parameters at the same time if the SoC supports both.

Parameters

- `mu` – MU peripheral base address
- `NewClockRateELE` – the new clock rate for ELE
- `NewClockRateCM33` – the new clock rate for the CM33 core

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

status_t ELE_BaseAPI_VoltageChangeStart(S3MU_Type *mu)

Start the voltage change process.

Parameters

- `mu` – MU peripheral base address

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

status_t ELE_BaseAPI_VoltageChangeFinish(S3MU_Type *mu)

Finish the voltage change process.

Parameters

- `mu` – MU peripheral base address

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

FSL_ELE_BASE_API_DRIVER_VERSION

Defines ELE Base API version 1.0.0.

Change log:

- Version 1.0.0
 - initial version

RESPONSE_SUCCESS

SHIFT_16

SHIFT_8

MSG_RESPONSE_MAX

MSG_TAG_CMD

MSG_TAG_RESP

PING

PING_SIZE

PING_RESPONSE_HDR

GET_FW_VERSION

GET_FW_VERSION_SIZE

GET_FW_VERSION_RESPONSE_HDR

CLOCK_CHANGE_START
CLOCK_CHANGE_START_SIZE
CLOCK_CHANGE_START_RESPONSE_HDR
CLOCK_CHANGE_FINISH
CLOCK_CHANGE_FINISH_SIZE
CLOCK_CHANGE_FINISH_RESPONSE_HDR
VOLTAGE_CHANGE_START
VOLTAGE_CHANGE_START_SIZE
VOLTAGE_CHANGE_START_RESPONSE_HDR
VOLTAGE_CHANGE_FINISH
VOLTAGE_CHANGE_FINISH_SIZE
VOLTAGE_CHANGE_FINISH_RESPONSE_HDR
GET_FW_STATUS
GET_FW_STATUS_SIZE
GET_FW_STATUS_RESPONSE_HDR
ENABLE_APC
ENABLE_APC_SIZE
ENABLE_APC_RESPONSE_HDR
START_RNG
START_RNG_SIZE
START_RNG_RESPONSE_HDR
FORWARD_LIFECYCLE
FORWARD_LIFECYCLE_SIZE
FORWARD_LIFECYCLE_RESPONSE_HDR
ENABLE_OTFAD
ENABLE_OTFAD_SIZE
ENABLE_OTFAD_RESPONSE_HDR
RELEASE_RDC
RELEASE_RDC_SIZE
RELEASE_RDC_RESPONSE_HDR

2.15 EQDC: Enhanced Quadrature Encoder/Decoder

`void EQDC_Init(EQDC_Type *base, const eqdc_config_t *psConfig)`

Initializes the EQDC module.

This function initializes the EQDC by enabling the IP bus clock (optional).

Parameters

- `base` – EQDC peripheral base address.
- `psConfig` – Pointer to configuration structure.

`void EQDC_GetDefaultConfig(eqdc_config_t *psConfig)`

Gets an available pre-defined configuration.

The default value are:

```
psConfig->enableReverseDirection    = false;
psConfig->countOnce                  = false;
psConfig->operateMode                = kEQDC_QuadratureDecodeOperationMode;
psConfig->countMode                  = kEQDC_QuadratureX4;
psConfig->homeEnableInitPosCounterMode = kEQDC_HomeInitPosCounterDisabled;
psConfig->indexPresetInitPosCounterMode = kEQDC_IndexInitPosCounterDisabled;
psConfig->enableIndexInitPositionCounter = false;
psConfig->enableDma                  = false;
psConfig->bufferedRegisterLoadMode    = false;
psConfig->enableTriggerInitPositionCounter = false;
psConfig->enableTriggerClearPositionRegisters = false;
psConfig->enableTriggerHoldPositionRegisters = false;
psConfig->enableWatchdog              = false;
psConfig->watchdogTimeoutValue        = 0xFFFFU;
psConfig->filterPhaseA                = 0U;
psConfig->filterPhaseB                = 0U;
psConfig->filterIndPre                = 0U;
psConfig->filterHomEna                = 0U;
psConfig->filterClockSourceselection  = false;
psConfig->filterSampleCount           = kEQDC_Filter3Samples;
psConfig->filterSamplePeriod          = 0U;
psConfig->outputPulseMode             = kEQDC_OutputPulseOnCounterEqualCompare;
psConfig->positionCompareValue[0]     = 0xFFFFFFFFU;
psConfig->positionCompareValue[1]     = 0xFFFFFFFFU;
psConfig->positionCompareValue[2]     = 0xFFFFFFFFU;
psConfig->positionCompareValue[3]     = 0xFFFFFFFFU;
psConfig->revolutionCountCondition    = kEQDC_RevolutionCountOnIndexPulse;
psConfig->positionModulusValue        = 0U;
psConfig->positionInitialValue        = 0U;
psConfig->positionCounterValue        = 0U;
psConfig->enablePeriodMeasurement     = false;
psConfig->prescaler                   = kEQDC_Prescaler1;
psConfig->enabledInterruptsMask       = 0U;
```

Parameters

- `psConfig` – Pointer to configuration structure.

`void EQDC_Deinit(EQDC_Type *base)`

De-initializes the EQDC module.

This function deinitializes the EQDC by disabling the IP bus clock (optional).

Parameters

- `base` – EQDC peripheral base address.

```
void EQDC_SetOperateMode(EQDC_Type *base, eqdc_operate_mode_t operateMode)
```

Initializes the mode of operation.

This function initializes mode of operation by enabling the IP bus clock (optional).

Parameters

- base – EQDC peripheral base address.
- operateMode – Select operation mode.

```
static inline void EQDC_SetCountMode(EQDC_Type *base, eqdc_count_mode_t countMode)
```

Initializes the mode of count.

These bits control the basic counting and behavior of Position Counter and Position Difference Counter. Setting CTRL[REV] to 1 can reverse the counting direction. 1.In quadrature Mode (CTRL[PH1] = 0): 00b - CM0: Normal/Reverse Quadrature X4 01b - CM1: Normal/Reverse Quadrature X2 10b - CM2: Normal/Reverse Quadrature X1 11b - CM3: Reserved 2.In Single Phase Mode (CTRL[PH1] = 1): 00b - CM0: UP/DOWN Pulse Count Mode 01b - CM1: Signed Mode, count PHASEA rising/falling edge, position counter counts up when PHASEB is low and counts down when PHASEB is high 10b - CM2: Signed Count Mode, count PHASEA rising edge only, position counter counts up when PHASEB is low and counts down when PHASEB is high 11b - CM3: Reserved

Parameters

- base – EQDC peripheral base address.
- countMode – Select count mode.

```
static inline void EQDC_EnableWatchdog(EQDC_Type *base, bool bEnable)
```

Enable watchdog for EQDC module.

Parameters

- base – EQDC peripheral base address
- bEnable – Enables or disables the watchdog

```
static inline void EQDC_SetWatchdogTimeout(EQDC_Type *base, uint16_t u16Timeout)
```

Set watchdog timeout value.

Parameters

- base – EQDC peripheral base address
- u16Timeout – Number of clock cycles, plus one clock cycle that the watchdog timer counts before timing out

```
static inline void EQDC_EnableDMA(EQDC_Type *base, bool bEnable)
```

Enable DMA for EQDC module.

Parameters

- base – EQDC peripheral base address
- bEnable – Enables or disables the DMA

```
static inline void EQDC_SetBufferedRegisterLoadUpdateMode(EQDC_Type *base)
```

Set Buffered Register Load (Update) Mode.

This bit selects the loading time point of the buffered compare registers UCOMPx/LCOMPx, x=0~3, initial register (UNIT/LINIT), and modulus register (UMOD/LMOD). Buffered registers are loaded and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address

static inline void EQDC_ClearBufferedRegisterLoadUpdateMode(EQDC_Type *base)

Clear Buffered Register Load (Update) Mode.

Buffered Register Load (Update) Mode bit selects the loading time point of the buffered compare registers UCOMPx/LCOMPx, x=0~3, initial register (UINIT/LINIT), and modulus register (UMOD/LMOD). Buffered registers are loaded and take effect immediately upon CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address

static inline void EQDC_SetEqdcLdok(EQDC_Type *base)

Set load okay.

Load okay enables that the outer-set values of buffered compare registers (UCOMPx/LCOMPx, x=0~3), initial register(UINIT/LINIT) and modulus register(UMOD/LMOD) can be loaded into their inner-sets and take effect. When LDOK is set, this loading action occurs at the next position counter roll-over or roll-under if CTRL2[LDMOD] is set, or it occurs immediately if CTRL2[LDMOD] is cleared. LDOK is automatically cleared after the values in outer-set is loaded into the inner-set.

Parameters

- base – EQDC peripheral base address.

static inline uint8_t EQDC_GetEqdcLdok(EQDC_Type *base)

Get load okay.

Parameters

- base – EQDC peripheral base address.

static inline void EQDC_ClearEqdcLdok(EQDC_Type *base)

Clear load okay.

Parameters

- base – EQDC peripheral base address.

static inline uint32_t EQDC_GetStatusFlags(EQDC_Type *base)

Get the status flags.

Parameters

- base – EQDC peripheral base address.

Returns

Logical OR'ed value of the status flags, _eqdc_status_flags.

static inline void EQDC_ClearStatusFlags(EQDC_Type *base, uint32_t u32Flags)

Clear the status flags.

Parameters

- base – EQDC peripheral base address.
- u32Flags – Logical OR'ed value of the flags to clear, _eqdc_status_flags.

static inline uint16_t EQDC_GetSignalStatusFlags(EQDC_Type *base)

Get the signals' real-time status.

Parameters

- base – EQDC peripheral base address.

Returns

Logical OR'ed value of the real-time signal status, _eqdc_signal_status.

```
static inline eqdc_count_direction_flag_t EQDC_GetLastCountDirection(EQDC_Type *base)
```

Get the direction of the last count.

Parameters

- base – EQDC peripheral base address.

Returns

Direction of the last count.

```
static inline void EQDC_EnableInterrupts(EQDC_Type *base, uint32_t u32Interrupts)
```

Enable the interrupts.

Parameters

- base – EQDC peripheral base address.
- u32Interrupts – Logical OR'ed value of the interrupts, _eqdc_interrupt_enable.

```
static inline void EQDC_DisableInterrupts(EQDC_Type *base, uint32_t u32Interrupts)
```

Disable the interrupts.

Parameters

- base – EQDC peripheral base address.
- u32Interrupts – Logical OR'ed value of the interrupts, _eqdc_interrupt_enable.

```
static inline void EQDC_DoSoftwareLoadInitialPositionValue(EQDC_Type *base)
```

Load the initial position value to position counter.

Software trigger to load the initial position value (UNIT and LINIT) contents to position counter (UPOS and LPOS), so that to provide the consistent operation the position counter registers.

Parameters

- base – EQDC peripheral base address.

```
static inline void EQDC_SetInitialPositionValue(EQDC_Type *base, uint32_t  
u32PositionInitValue)
```

Set initial position value for EQDC module.

Set the position counter initial value (UNIT, LINIT). After writing values to the UNIT and LINIT registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- u32PositionInitValue – Position initial value

```
static inline void EQDC_SetPositionCounterValue(EQDC_Type *base, uint32_t  
positionCounterValue)
```

Set position counter value.

Set the position counter value (POS or UPOS, LPOS).

Parameters

- base – EQDC peripheral base address
- positionCounterValue – Position counter value

```
static inline void EQDC_SetPositionModulusValue(EQDC_Type *base, uint32_t
                                              positionModulusValue)
```

Set position counter modulus value.

Set the position counter modulus value (UMOD, LMOD). After writing values to the UMOD and LMOD registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- positionModulusValue – Position modulus value

```
static inline void EQDC_SetPositionCompare0Value(EQDC_Type *base, uint32_t
                                              u32PositionComp0Value)
```

Set position counter compare 0 value.

Set the position counter compare 0 value (UCOMP0, LCOMP0). After writing values to the UCOMP0 and LCOMP0 registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- u32PositionComp0Value – Position modulus value

```
static inline void EQDC_SetPositionCompare1Value(EQDC_Type *base, uint32_t
                                              u32PositionComp1Value)
```

Set position counter compare 1 value.

Set the position counter compare 1 value (UCOMP1, LCOMP1). After writing values to the UCOMP1 and LCOMP1 registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- u32PositionComp1Value – Position modulus value

```
static inline void EQDC_SetPositionCompare2Value(EQDC_Type *base, uint32_t
                                                u32PositionComp2Value)
```

Set position counter compare 2 value.

Set the position counter compare 2 value (UCOMP2, LCOMP2). After writing values to the UCOMP2 and LCOMP2 registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- u32PositionComp2Value – Position modulus value

```
static inline void EQDC_SetPositionCompare3Value(EQDC_Type *base, uint32_t
                                                u32PositionComp3Value)
```

Set position counter compare 3 value.

Set the position counter compare 3 value (UCOMP3, LCOMP3). After writing values to the UCOMP3 and LCOMP3 registers, the values are “buffered” into outer-set registers temporarily. Values will be loaded into inner-set registers and take effect using the following two methods:

- a. If CTRL2[LDMODE] is 1, “buffered” values are loaded into inner-set and take effect at the next roll-over or roll-under if CTRL[LDOK] is set.
- b. If CTRL2[LDMODE] is 0, “buffered” values are loaded into inner-set and take effect immediately when CTRL[LDOK] is set.

Parameters

- base – EQDC peripheral base address
- u32PositionComp3Value – Position modulus value

```
static inline uint32_t EQDC_GetPosition(EQDC_Type *base)
```

Get the current position counter’s value.

Parameters

- base – EQDC peripheral base address.

Returns

Current position counter’s value.

```
static inline uint32_t EQDC_GetHoldPosition(EQDC_Type *base)
```

Get the hold position counter’s value.

The position counter (POS or UPOS, LPOS) value is loaded to hold position (POSH or UPOSH, LPOSH) when:

- a. Position register (POS or UPOS, LPOS), or position difference register (POSD), or revolution register (REV) is read.
- b. TRIGGER happens and TRIGGER is enabled to update the hold registers.

Parameters

- base – EQDC peripheral base address.

Returns

Hold position counter's value.

```
static inline uint32_t EQDC_GetHoldPosition1(EQDC_Type *base)
```

Get the hold position counter1's value.

The Upper Position Counter Hold Register 1(UPOSH1) shares the same address with UCOMP1. When read, this register means the value of UPOSH1, which is the upper 16 bits of POSH1. The Lower Position Counter Hold Register 1(LPOSH1) shares the same address with LCOMP1. When read, this register means the value of LPOSH1, which is the lower 16 bits of POSH1. Position counter is captured into POSH1 on the rising edge of ICAP[1].

Parameters

- base – EQDC peripheral base address.

Returns

Hold position counter1's value.

```
static inline uint32_t EQDC_GetHoldPosition2(EQDC_Type *base)
```

Get the hold position counter2's value.

The Upper Position Counter Hold Register 2(UPOSH2) shares the same address with UCOMP2. When read, this register means the value of UPOSH2, which is the upper 16 bits of POSH2. The Lower Position Counter Hold Register 2(LPOSH2) shares the same address with LCOMP2. When read, this register means the value of LPOSH2, which is the lower 16 bits of POSH2. Position counter is captured into POSH2 on the rising edge of ICAP[2].

Parameters

- base – EQDC peripheral base address.

Returns

Hold position counter2's value.

```
static inline uint32_t EQDC_GetHoldPosition3(EQDC_Type *base)
```

Get the hold position counter3's value.

The Upper Position Counter Hold Register 3(UPOSH3) shares the same address with UCOMP3. When read, this register means the value of UPOSH3, which is the upper 16 bits of POSH3. The Lower Position Counter Hold Register 3(LPOSH3) shares the same address with LCOMP3. When read, this register means the value of LPOSH3, which is the lower 16 bits of POSH3. Position counter is captured into POSH3 on the rising edge of ICAP[3].

Parameters

- base – EQDC peripheral base address.

Returns

Hold position counter3's value.

```
static inline uint16_t EQDC_GetPositionDifference(EQDC_Type *base)
```

Get the position difference counter's value.

Parameters

- base – EQDC peripheral base address.

Returns

The position difference counter's value.

```
static inline uint16_t EQDC_GetHoldPositionDifference(EQDC_Type *base)
```

Get the hold position difference counter's value.

The position difference (POSD) value is loaded to hold position difference (POSDH) when:

- a. Position register (POS or UPOS, LPOS), or position difference register (POSD), or revolution register (REV) is read. When Period Measurement is enabled (CTRL3[PMEN] = 1), POSDH will only be updated when reading POSD.
- b. TRIGGER happens and TRIGGER is enabled to update the hold registers.

Parameters

- base – EQDC peripheral base address.

Returns

Hold position difference counter's value.

```
static inline uint16_t EQDC_GetRevolution(EQDC_Type *base)
```

Get the revolution counter's value.

Get the revolution counter (REV) value.

Parameters

- base – EQDC peripheral base address.

Returns

The revolution counter's value.

```
static inline uint16_t EQDC_GetHoldRevolution(EQDC_Type *base)
```

Get the hold revolution counter's value.

The revolution counter (REV) value is loaded to hold revolution (REXH) when:

- a. Position register (POS or UPOS, LPOS), or position difference register (POSD), or revolution register (REV) is read.
- b. TRIGGER happens and TRIGGER is enabled to update the hold registers.

Parameters

- base – EQDC peripheral base address.

Returns

Hold position revolution counter's value.

```
static inline uint16_t EQDC_GetLastEdgeTime(EQDC_Type *base)
```

Get the last edge time.

Last edge time (LASTEDGE) is the time since the last edge occurred on PHASEA or PHASEB. The last edge time register counts up using the peripheral clock after prescaler. Any edge on PHASEA or PHASEB will reset this register to 0 and start counting. If the last edge timer count reaches 0xffff, the counting will stop in order to prevent an overflow. Counting will continue when an edge occurs on PHASEA or PHASEB.

Parameters

- base – EQDC peripheral base address.

Returns

The last edge time.

```
static inline uint16_t EQDC_GetHoldLastEdgeTime(EQDC_Type *base)
```

Get the hold last edge time.

The hold of last edge time (LASTEDGEH) is update to last edge time (LASTEDGE) when the position difference register (POSD) is read.

Parameters

- base – EQDC peripheral base address.

Returns

Hold of last edge time.

static inline uint16_t EQDC_GetPositionDifferencePeriod(EQDC_Type *base)

Get the Position Difference Period counter value.

The Position Difference Period counter (POSDPER) counts up using the prescaled peripheral clock. When reading the position difference register(POSD), the last edge time (LAST-EDGE) will be loaded to position difference period counter(POSDPER). If the POSDPER count reaches 0xffff, the counting will stop in order to prevent an overflow. Counting will continue when an edge occurs on PHASEA or PHASEB.

Parameters

- base – EQDC peripheral base address.

Returns

The position difference period counter value.

static inline uint16_t EQDC_GetBufferedPositionDifferencePeriod(EQDC_Type *base)

Get buffered Position Difference Period counter value.

The Bufferd Position Difference Period (POSDPERBFR) value is updated with the position difference period counter(POSDPER) when any edge occurs on PHASEA or PHASEB.

Parameters

- base – EQDC peripheral base address.

Returns

The buffered position difference period counter value.

static inline uint16_t EQDC_GetHoldPositionDifferencePeriod(EQDC_Type *base)

Get Hold Position Difference Period counter value.

The hold position difference period(POSDPERH) is updated with the value of buffered position difference period(POSDPERBFR) when the position difference(POSD) register is read.

Parameters

- base – EQDC peripheral base address.

Returns

The hold position difference period counter value.

enum _eqdc_status_flags

EQDC status flags, these flags indicate the counter's events. .

Values:

enumerator kEQDC_HomeEnableTransitionFlag

HOME/ENABLE signal transition occurred.

enumerator kEQDC_IndexPresetPulseFlag

INDEX/PRESET pulse occurred.

enumerator kEQDC_WatchdogTimeoutFlag

Watchdog timeout occurred.

enumerator kEQDC_SimultPhaseChangeFlag

Simultaneous change of PHASEA and PHASEB occurred.

enumerator kEQDC_CountDirectionChangeFlag

Count direction change interrupt enable.

enumerator kEQDC_PositionRollOverFlag

Position counter rolls over from 0xFFFFFFFF to 0, or from MOD value to INIT value.

enumerator kEQDC_PositionRollUnderFlag

Position register roll under from 0 to 0xFFFFFFFF, or from INIT value to MOD value.

enumerator kEQDC_PositionCompare0Flag

Position counter match the COMP0 value.

enumerator kEQDC_PositionCompare1Flag

Position counter match the COMP1 value.

enumerator kEQDC_PositionCompare2Flag

Position counter match the COMP2 value.

enumerator kEQDC_PositionCompare3Flag

Position counter match the COMP3 value.

enumerator kEQDC_StatusAllFlags

enum _eqdc_signal_status

Signal status, these flags indicate the raw and filtered input signal status. .

Values:

enumerator kEQDC_SignalStatusRawHomeEnable

Raw HOME/ENABLE input.

enumerator kEQDC_SignalStatusRawIndexPreset

Raw INDEX/PRESET input.

enumerator kEQDC_SignalStatusRawPhaseB

Raw PHASEB input.

enumerator kEQDC_SignalStatusRawPhaseA

Raw PHASEA input.

enumerator kEQDC_SignalStatusFilteredHomeEnable

The filtered HOME/ENABLE input.

enumerator kEQDC_SignalStatusFilteredIndexPreset

The filtered INDEX/PRESET input.

enumerator kEQDC_SignalStatusFilteredPhaseB

The filtered PHASEB input.

enumerator kEQDC_SignalStatusFilteredPhaseA

The filtered PHASEA input.

enumerator kEQDC_SignalStatusPositionCompare0Flag

Position Compare 0 Flag Output.

enumerator kEQDC_SignalStatusPositionCompare1Flag

Position Compare 1 Flag Output.

enumerator kEQDC_SignalStatusPositionCompare2Flag

Position Compare 2 Flag Output.

enumerator kEQDC_SignalStatusPositionCompare3Flag

Position Compare 3 Flag Output.

enumerator kEQDC_SignalStatusCountDirectionFlagHold

Count Direction Flag Hold.

enumerator kEQDC_SignalStatusCountDirectionFlag

Count Direction Flag Output.

enumerator kEQDC_SignalStatusAllFlags

enum _eqdc_interrupt_enable

Interrupt enable/disable mask. .

Values:

enumerator kEQDC_HomeEnableTransitionInterruptEnable

HOME/ENABLE signal transition interrupt enable.

enumerator kEQDC_IndexPresetPulseInterruptEnable

INDEX/PRESET pulse interrupt enable.

enumerator kEQDC_WatchdogTimeoutInterruptEnable

Watchdog timeout interrupt enable.

enumerator kEQDC_SimultPhaseChangeInterruptEnable

Simultaneous PHASEA and PHASEB change interrupt enable.

enumerator kEQDC_CountDirectionChangeInterruptEnable

Count direction change interrupt enable.

enumerator kEQDC_PositionRollOverInterruptEnable

Roll-over interrupt enable.

enumerator kEQDC_PositionRollUnderInterruptEnable

Roll-under interrupt enable.

enumerator kEQDC_AllInterruptEnable

enum _eqdc_home_enable_init_pos_counter_mode

Define HOME/ENABLE signal's trigger mode.

Values:

enumerator kEQDC_HomeInitPosCounterDisabled

Don't use HOME/ENABLE signal to initialize the position counter.

enumerator kEQDC_HomeInitPosCounterOnRisingEdge

Use positive going edge to trigger initialization of position counters.

enumerator kEQDC_HomeInitPosCounterOnFallingEdge

Use negative going edge to trigger initialization of position counters.

enum _eqdc_index_preset_init_pos_counter_mode

Define INDEX/PRESET signal's trigger mode.

Values:

enumerator kEQDC_IndexInitPosCounterDisabled

INDEX/PRESET pulse does not initialize the position counter.

enumerator kEQDC_IndexInitPosCounterOnRisingEdge

Use INDEX/PRESET pulse rising edge to initialize position counter.

enumerator kEQDC_IndexInitPosCounterOnFallingEdge

Use INDEX/PRESET pulse falling edge to initialize position counter.

enum _eqdc_operate_mode

Define type for decoder operation mode.

The Quadrature Decoder operates in following 4 operation modes: 1.Quadrature Decode(QDC) Operation Mode (CTRL[PH1] = 0,CTRL2[OPMODE] = 0) In QDC operation mode, Module uses PHASEA, PHASEB, INDEX, HOME, TRIGGER and ICAP[3:1] to decode the

PHASEA and PHASEB signals from Speed/Position sensor. 2.Quadrature Count(QCT) Operation Mode (CTRL[PH1] = 0,CTRL2[OPMODE] = 1) In QCT operation mode, Module uses PHASEA, PHASEB, PRESET, ENABLE, TRIGGER and ICAP[3:1] to count the PHASEA and PHASEB signals from Speed/Position sensor. 3.Single Phase Decode(PH1DC) Operation Mode (CTRL[PH1] = 1,CTRL2[OPMODE] = 0) In PH1DC operation mode, the module uses PHASEA, PHASEB, INDEX, HOME, TRIGGER and ICAP[3:1] to decode the PHASEA and PHASEB signals from Speed/Position sensor. 4.Single Phase Count(PH1CT) Operation Mode (CTRL[PH1] = 1,CTRL2[OPMODE] = 1) In PH1CT operation mode, the module uses PHASEA, PHASEB, PRESET, ENABLE, TRIGGER and ICAP[3:1] to count the PHASEA and PHASEB signals from Speed/Position sensor.

Values:

enumerator kEQDC_QuadratureDecodeOperationMode

Use standard quadrature decoder with PHASEA/PHASEB, INDEX/HOME.

enumerator kEQDC_QuadratureCountOperationMode

Use quadrature count operation mode with PHASEA/PHASEB, PRESET/ENABLE.

enumerator kEQDC_SinglePhaseDecodeOperationMode

Use single phase quadrature decoder with PHASEA/PHASEB, INDEX/HOME.

enumerator kEQDC_SinglePhaseCountOperationMode

Use single phase count decoder with PHASEA/PHASEB, PRESET/ENABLE.

enum _eqdc_count_mode

Define type for decoder count mode.

In decode mode, it uses the standard quadrature decoder with PHASEA and PHASEB, PHASEA = 0 and PHASEB = 0 mean reverse direction.

- If PHASEA leads PHASEB, then motion is in the positive direction.
- If PHASEA trails PHASEB, then motion is in the negative direction. In single phase mode, there are three count modes:
- In Signed Count mode (Single Edge). Both position counter (POS) and position difference counter (POSD) count on the input PHASEA rising edge while the input PHASEB provides the selected position counter direction (up/down). If CTRL[REV] is 1, then the position counter will count in the opposite direction.
- In Signed Count mode (double edge), both position counter (POS) and position difference counter (POSD) count the input PHASEA on both rising edge and falling edge while the input PHASEB provides the selected position counter direction (up/down).
- In UP/DOWN Pulse Count mode. Both position counter (POS) and position difference counter (POSD) count in the up direction when input PHASEA rising edge occurs. Both counters count in the down direction when input PHASEB rising edge occurs. If CTRL[REV] is 1, then the position counter will count in the opposite direction.

Values:

enumerator kEQDC_QuadratureX4

Active on kEQDC_QuadratureDecodeOperationMode/kEQDC_QuadratureCountOperationMode.

enumerator kEQDC_QuadratureX2

Active on kEQDC_QuadratureDecodeOperationMode/kEQDC_QuadratureCountOperationMode.

enumerator kEQDC_QuadratureX1

Active on kEQDC_QuadratureDecodeOperationMode/kEQDC_QuadratureCountOperationMode.

enumerator kEQDC_UpDownPulseCount

Active on kEQDC_SinglePhaseDecodeOperationMode/kEQDC_SinglePhaseCountOperationMode.

enumerator kEQDC_SignedCountDoubleEdge

Active on kEQDC_SinglePhaseDecodeOperationMode/kEQDC_SinglePhaseCountOperationMode.

enumerator kEQDC_SignedCountSingleEdge

Active on kEQDC_SinglePhaseDecodeOperationMode/kEQDC_SinglePhaseCountOperationMode.

enum _eqdc_output_pulse_mode

Define type for the condition of POSMATCH pulses.

Values:

enumerator kEQDC_OutputPulseOnCounterEqualCompare

POSMATCH pulses when a match occurs between the position counters (POS) and the compare value (UCOMPx/LCOMPx)(x range is 0-3).

enumerator kEQDC_OutputPulseOnReadingPositionCounter

POSMATCH pulses when reading position counter(POS and LPOS), revolution counter(REV), position difference counter(POSD).

enum _eqdc_revolution_count_condition

Define type for determining how the revolution counter (REV) is incremented/decremented.

Values:

enumerator kEQDC_RevolutionCountOnIndexPulse

Use INDEX pulse to increment/decrement revolution counter.

enumerator kEQDC_RevolutionCountOnRollOverModulus

Use modulus counting roll-over/under to increment/decrement revolution counter.

enum _eqdc_filter_sample_count

Input Filter Sample Count.

The Input Filter Sample Count represents the number of consecutive samples that must agree, before the input filter accepts an input transition

Values:

enumerator kEQDC_Filter3Samples

3 samples.

enumerator kEQDC_Filter4Samples

4 samples.

enumerator kEQDC_Filter5Samples

5 samples.

enumerator kEQDC_Filter6Samples

6 samples.

enumerator kEQDC_Filter7Samples

7 samples.

enumerator kEQDC_Filter8Samples

8 samples.

enumerator kEQDC_Filter9Samples

9 samples.

enumerator kEQDC_Filter10Samples

10 samples.

enum _eqdc_count_direction_flag

Count direction.

Values:

enumerator kEQDC_CountDirectionDown

Last count was in down direction.

enumerator kEQDC_CountDirectionUp

Last count was in up direction.

enum _eqdc_prescaler

Prescaler used by Last Edge Time (LASTEDGE) and Position Difference Period Counter (POS-DPER).

Values:

enumerator kEQDC_Prescaler1

Prescaler value 1.

enumerator kEQDC_Prescaler2

Prescaler value 2.

enumerator kEQDC_Prescaler4

Prescaler value 4.

enumerator kEQDC_Prescaler8

Prescaler value 8.

enumerator kEQDC_Prescaler16

Prescaler value 16.

enumerator kEQDC_Prescaler32

Prescaler value 32.

enumerator kEQDC_Prescaler64

Prescaler value 64.

enumerator kEQDC_Prescaler128

Prescaler value 128.

enumerator kEQDC_Prescaler256

Prescaler value 256.

enumerator kEQDC_Prescaler512

Prescaler value 512.

enumerator kEQDC_Prescaler1024

Prescaler value 1024.

enumerator kEQDC_Prescaler2048

Prescaler value 2048.

enumerator kEQDC_Prescaler4096

Prescaler value 4096.

enumerator kEQDC_Prescaler8192

Prescaler value 8192.

enumerator kEQDC_Prescaler16384

Prescaler value 16384.

enumerator kEQDC_Prescaler32768

Prescaler value 32768.

```
typedef enum _eqdc_home_enable_init_pos_counter_mode
eqdc_home_enable_init_pos_counter_mode_t
```

Define HOME/ENABLE signal's trigger mode.

```
typedef enum _eqdc_index_preset_init_pos_counter_mode
eqdc_index_preset_init_pos_counter_mode_t
```

Define INDEX/PRESET signal's trigger mode.

```
typedef enum _eqdc_operate_mode eqdc_operate_mode_t
```

Define type for decoder operation mode.

The Quadrature Decoder operates in following 4 operation modes: 1.Quadrature Decode(QDC) Operation Mode (CTRL[PH1] = 0,CTRL2[OPMODE] = 0) In QDC operation mode, Module uses PHASEA, PHASEB, INDEX, HOME, TRIGGER and ICAP[3:1] to decode the PHASEA and PHASEB signals from Speed/Position sensor. 2.Quadrature Count(QCT) Operation Mode (CTRL[PH1] = 0,CTRL2[OPMODE] = 1) In QCT operation mode, Module uses PHASEA, PHASEB, PRESET, ENABLE, TRIGGER and ICAP[3:1] to count the PHASEA and PHASEB signals from Speed/Position sensor. 3.Single Phase Decode(PH1DC) Operation Mode (CTRL[PH1] = 1,CTRL2[OPMODE] = 0) In PH1DC operation mode, the module uses PHASEA, PHASEB, INDEX, HOME, TRIGGER and ICAP[3:1] to decode the PHASEA and PHASEB signals from Speed/Position sensor. 4.Single Phase Count(PH1CT) Operation Mode (CTRL[PH1] = 1,CTRL2[OPMODE] = 1) In PH1CT operation mode, the module uses PHASEA, PHASEB, PRESET, ENABLE, TRIGGER and ICAP[3:1] to count the PHASEA and PHASEB signals from Speed/Position sensor.

```
typedef enum _eqdc_count_mode eqdc_count_mode_t
```

Define type for decoder count mode.

In decode mode, it uses the standard quadrature decoder with PHASEA and PHASEB, PHASEA = 0 and PHASEB = 0 mean reverse direction.

- If PHASEA leads PHASEB, then motion is in the positive direction.
- If PHASEA trails PHASEB, then motion is in the negative direction. In single phase mode, there are three count modes:
- In Signed Count mode (Single Edge). Both position counter (POS) and position difference counter (POSD) count on the input PHASEA rising edge while the input PHASEB provides the selected position counter direction (up/down). If CTRL[REV] is 1, then the position counter will count in the opposite direction.
- In Signed Count mode (double edge), both position counter (POS) and position difference counter (POSD) count the input PHASEA on both rising edge and falling edge while the input PHASEB provides the selected position counter direction (up/down).
- In UP/DOWN Pulse Count mode. Both position counter (POS) and position difference counter (POSD) count in the up direction when input PHASEA rising edge occurs. Both counters count in the down direction when input PHASEB rising edge occurs. If CTRL[REV] is 1, then the position counter will count in the opposite direction.

```
typedef enum _eqdc_output_pulse_mode eqdc_output_pulse_mode_t
```

Define type for the condition of POSMATCH pulses.

```
typedef enum _eqdc_revolution_count_condition eqdc_revolution_count_condition_t
```

Define type for determining how the revolution counter (REV) is incremented/decremented.

```
typedef enum _eqdc_filter_sample_count eqdc_filter_sample_count_t
```

Input Filter Sample Count.

The Input Filter Sample Count represents the number of consecutive samples that must agree, before the input filter accepts an input transition

```
typedef enum _eqdc_count_direction_flag eqdc_count_direction_flag_t
    Count direction.

typedef enum _eqdc_prescaler eqdc_prescaler_t
    Prescaler used by Last Edge Time (LASTEDGE) and Position Difference Period Counter (POS-
    DPER).

typedef struct _eqdc_config eqdc_config_t
    Define user configuration structure for EQDC module.

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EQDC_CTRL_W1C_FLAGS
    W1C bits in EQDC CTRL registers.

EQDC_INTCTRL_W1C_FLAGS
    W1C bits in EQDC INTCTRL registers.

EQDC_CTRL_INT_EN
    Interrupt enable bits in EQDC CTRL registers.

EQDC_INTCTRL_INT_EN
    Interrupt enable bits in EQDC INTCTRL registers.

EQDC_CTRL_INT_FLAGS
    Interrupt flag bits in EQDC CTRL registers.

EQDC_INTCTRL_INT_FLAGS
    Interrupt flag bits in EQDC INTCTRL registers.

struct _eqdc_config
    #include <fsl_eqdc.h> Define user configuration structure for EQDC module.
```

Public Members

```
bool enableReverseDirection
    Enable reverse direction counting.

bool countOnce
    Selects modulo loop or one shot counting mode.

bool enableDma
    Enable DMA for new written buffer values of COMPx/INIT/MOD(x range is 0-3)

bool bufferedRegisterLoadMode
    selects the loading time point of the buffered compare registers UCOMPx/LCOMPx,
    x=0~3, initial register (UINIT/LINIT), and modulus register (UMOD/LMOD).

bool enableTriggerInitPositionCounter
    Initialize position counter with initial register(UINIT, LINIT) value on TRIGGER's rising
    edge.

bool enableIndexInitPositionCounter
    Enables the feature that the position counter to be initialized by Index Event Edge
    Mark.

    This option works together with _eqdc_index_preset_init_pos_counter_mode and en-
    ableReverseDirection; If enabled, the behavior is like this:

    When PHA leads PHB (Clockwise): If _eqdc_index_preset_init_pos_counter_mode
    is kEQDC_IndexInitPosCounterOnRisingEdge, then INDEX rising edge re-
    set position counter. If _eqdc_index_preset_init_pos_counter_mode is kE-
    QDC_IndexInitPosCounterOnFallingEdge, then INDEX falling edge reset position
```


counter. If enableReverseDirection is false, then Reset position counter to initial value. If enableReverseDirection is true, then reset position counter to modulus value.

When PHA lags PHB (Counter Clockwise): If `_eqdc_index_preset_init_pos_counter_mode` is `kEQDC_IndexInitPosCounterOnRisingEdge`, then INDEX falling edge reset position counter. If `_eqdc_index_preset_init_pos_counter_mode` is `kEQDC_IndexInitPosCounterOnFallingEdge`, then INDEX rising edge reset position counter. If enableReverseDirection is false, then Reset position counter to modulus value. If enableReverseDirection is true, then reset position counter to initial value.

`bool enableTriggerClearPositionRegisters`

Clear position counter(POS), revolution counter(REV), position difference counter(POSD) on TRIGGER's rising edge.

`bool enableTriggerHoldPositionRegisters`

Load position counter(POS), revolution counter(REV), position difference counter(POSD) values to hold registers on TRIGGER's rising edge.

`bool filterPhaseA`

Filter operation on PHASEA input, when write 1, it means filter for PHASEA input is bypassed.

`bool filterPhaseB`

Filter operation on PHASEB input, when write 1, it means filter for PHASEB input is bypassed.

`bool filterIndPre`

Filter operation on INDEX/PRESET input, when write 1, it means filter for INDEX/PRESET input is bypassed.

`bool filterHomEna`

Filter operation on HOME/ENABLE input, when write 1, it means filter for HOME/ENABLE input is bypassed.

`bool enableWatchdog`

Enable the watchdog to detect if the target is moving or not.

`uint16_t watchdogTimeoutValue`

Watchdog timeout count value. It stores the timeout count for the quadrature decoder module watchdog timer.

`eqdc_prescaler_t prescaler`

Prescaler.

`bool filterClockSourceselection`

Filter Clock Source selection.

`eqdc_filter_sample_count_t filterSampleCount`

Input Filter Sample Count. This value should be chosen to reduce the probability of noisy samples causing an incorrect transition to be recognized. The value represent the number of consecutive samples that must agree prior to the input filter accepting an input transition.

`uint8_t filterSamplePeriod`

Input Filter Sample Period. This value should be set such that the sampling period is larger than the period of the expected noise. This value represents the sampling period (in IPBus clock cycles) of the decoder input signals. The available range is 0 - 255.

`eqdc_operate_mode_t operateMode`

Selects operation mode.

eqdc_count_mode_t countMode

Selects count mode.

eqdc_home_enable_init_pos_counter_mode_t homeEnableInitPosCounterMode

Select how HOME/Enable signal used to initialize position counters.

eqdc_index_preset_init_pos_counter_mode_t indexPresetInitPosCounterMode

Select how INDEX/Preset signal used to initialize position counters.

eqdc_output_pulse_mode_t outputPulseMode

The condition of POSMATCH pulses.

uint32_t positionCompareValue[4]

Position compare 0 ~ 3 value. The available value is a 32-bit number.

eqdc_revolution_count_condition_t revolutionCountCondition

Revolution Counter Modulus Enable.

uint32_t positionModulusValue

Position modulus value. The available value is a 32-bit number.

uint32_t positionInitialValue

Position initial value. The available value is a 32-bit number.

uint32_t positionCounterValue

Position counter value. When Modulo mode enabled, the positionCounterValue should be in the range of positionInitialValue and positionModulusValue.

bool enablePeriodMeasurement

Enable period measurement. When enabled, the position difference hold register (POSDH) is only updated when position difference register (POSD) is read.

uint16_t enabledInterruptsMask

Mask of interrupts to be enabled, should be OR'ed value of *_eqdc_interrupt_enable*.

2.16 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

2.17 FGPIO Driver

2.18 FlexCAN: Flex Controller Area Network Driver

2.19 FlexCAN Driver

```
bool FLEXCAN_IsInstanceHasFDMode(CAN_Type *base)
```

Determine whether the FlexCAN instance support CAN FD mode at run time.

Note: Use this API only if different soc parts share the SOC part name macro define. Otherwise, a different SOC part name can be used to determine at compile time whether the FlexCAN instance supports CAN FD mode or not. If need use this API to determine if CAN FD mode is supported, the FLEXCAN_Init function needs to be executed first, and then call this API and use the return to value determines whether to supports CAN FD mode, if return true, continue calling FLEXCAN_FDInit to enable CAN FD mode.

Parameters

- base – FlexCAN peripheral base address.

Returns

return TRUE if instance support CAN FD mode, FALSE if instance only support classic CAN (2.0) mode.

status_t FLEXCAN_EnterFreezeMode(CAN_Type *base)

Enter FlexCAN Freeze Mode.

This function makes the FlexCAN work under Freeze Mode.

Parameters

- base – FlexCAN peripheral base address.

Returns

kStatus_Success Enter Freeze Mode successful kStatus_Timeout Timeout when wait for Freeze Mode Acknowledge

status_t FLEXCAN_ExitFreezeMode(CAN_Type *base)

Exit FlexCAN Freeze Mode.

This function makes the FlexCAN leave Freeze Mode.

Parameters

- base – FlexCAN peripheral base address.

Returns

kStatus_Success Enter Freeze Mode successful kStatus_Timeout Timeout when wait for Freeze Mode Acknowledge

uint32_t FLEXCAN_GetInstance(CAN_Type *base)

Get the FlexCAN instance from peripheral base address.

Parameters

- base – FlexCAN peripheral base address.

Returns

FlexCAN instance.

bool FLEXCAN_CalculateImprovedTimingValues(CAN_Type *base, *uint32_t* bitRate, *uint32_t* sourceClock_Hz, *flexcan_timing_config_t* *pTimingConfig)

Calculates the improved timing values by specific bit Rates for classical CAN.

This function use to calculates the Classical CAN timing values according to the given bit rate. The Calculated timing values will be set in CTRL1/CBT/ENCBT register. The calculation is based on the recommendation of the CiA 301 v4.2.0 and previous version document.

Parameters

- base – FlexCAN peripheral base address.
- bitRate – The classical CAN speed in bps defined by user, should be less than or equal to 1Mbps.
- sourceClock_Hz – The Source clock frequency in Hz.
- pTimingConfig – Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration.

void FLEXCAN_Init(CAN_Type *base, const *flexcan_config_t* *pConfig, uint32_t sourceClock_Hz)
 Initializes a FlexCAN instance.

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the *flexcan_config_t* parameters and how to call the FLEXCAN_Init function by passing in these parameters.

```
flexcan_config_t flexcanConfig;
flexcanConfig.clkSrc      = kFLEXCAN_ClkSrc0;
flexcanConfig.bitRate     = 1000000U;
flexcanConfig.maxMbNum    = 16;
flexcanConfig.enableLoopBack = false;
flexcanConfig.enableSelfWakeup = false;
flexcanConfig.enableIndividMask = false;
flexcanConfig.enableDoze    = false;
flexcanConfig.disableSelfReception = false;
flexcanConfig.enableListenOnlyMode = false;
flexcanConfig.timingConfig = timingConfig;
FLEXCAN_Init(CAN0, &flexcanConfig, 4000000UL);
```

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the user-defined configuration structure.
- sourceClock_Hz – FlexCAN Protocol Engine clock source frequency in Hz.

bool FLEXCAN_FDCalculateImprovedTimingValues(CAN_Type *base, uint32_t bitRate, uint32_t bitRateFD, uint32_t sourceClock_Hz, *flexcan_timing_config_t* *pTimingConfig)

Calculates the improved timing values by specific bit rates for CANFD.

This function use to calculates the CANFD timing values according to the given nominal phase bit rate and data phase bit rate. The Calculated timing values will be set in CBT/ENCBT and FDCBT/EDCBT registers. The calculation is based on the recommendation of the CiA 1301 v1.0.0 document.

Parameters

- base – FlexCAN peripheral base address.
- bitRate – The CANFD bus control speed in bps defined by user.
- bitRateFD – The CAN FD data phase speed in bps defined by user. Equal to bitRate means disable bit rate switching.
- sourceClock_Hz – The Source clock frequency in Hz.
- pTimingConfig – Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

void FLEXCAN_FDInit(CAN_Type *base, const *flexcan_config_t* *pConfig, uint32_t sourceClock_Hz, *flexcan_mb_size_t* dataSize, bool brs)

Initializes a FlexCAN instance.

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the *flexcan_config_t* parameters and how to call the FLEXCAN_FDInit function by passing in these parameters.

```
flexcan_config_t flexcanConfig;
flexcanConfig.clkSrc      = kFLEXCAN_ClkSrc0;
flexcanConfig.bitRate     = 1000000U;
```

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(continued from previous page)

```

flexcanConfig.bitRateFD      = 2000000U;
flexcanConfig.maxMbNum      = 16;
flexcanConfig.enableLoopBack = false;
flexcanConfig.enableSelfWakeup = false;
flexcanConfig.enableIndividMask = false;
flexcanConfig.disableSelfReception = false;
flexcanConfig.enableListenOnlyMode = false;
flexcanConfig.enableDoze      = false;
flexcanConfig.timingConfig    = timingConfig;
FLEXCAN_FDIInit(CAN0, &flexcanConfig, 80000000UL, kFLEXCAN_16BperMB, true);

```

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the user-defined configuration structure.
- sourceClock_Hz – FlexCAN Protocol Engine clock source frequency in Hz.
- dataSize – FlexCAN Message Buffer payload size. The actual transmitted or received CAN FD frame data size needs to be less than or equal to this value.
- brs – True if bit rate switch is enabled in FD mode.

void FLEXCAN_Deinit(CAN_Type *base)

De-initializes a FlexCAN instance.

This function disables the FlexCAN module clock and sets all register values to the reset value.

Parameters

- base – FlexCAN peripheral base address.

void FLEXCAN_GetDefaultConfig(*flexcan_config_t* *pConfig)

Gets the default configuration structure.

This function initializes the FlexCAN configuration structure to default values. The default values are as follows. `flexcanConfig->clkSrc = kFLEXCAN_ClkSrc0; flexcanConfig->bitRate = 1000000U; flexcanConfig->bitRateFD = 2000000U; flexcanConfig->maxMbNum = 16; flexcanConfig->enableLoopBack = false; flexcanConfig->enableSelfWakeup = false; flexcanConfig->enableIndividMask = false; flexcanConfig->disableSelfReception = false; flexcanConfig->enableListenOnlyMode = false; flexcanConfig->enableDoze = false; flexcanConfig->enablePretendededeNetworking = false; flexcanConfig->enableMemoryErrorControl = true; flexcanConfig->enableNonCorrectableErrorEnterFreeze = true; flexcanConfig->enableTransceiverDelayMeasure = true; flexcanConfig->enableRemoteRequestFrameStored = true; flexcanConfig->payloadEndianness = kFLEXCAN_bigEndian; flexcanConfig.timingConfig = timingConfig;`

Parameters

- pConfig – Pointer to the FlexCAN configuration structure.

void FLEXCAN_SetTimingConfig(CAN_Type *base, const *flexcan_timing_config_t* *pConfig)

Sets the FlexCAN classical CAN protocol timing characteristic.

This function gives user settings to classical CAN or CAN FD nominal phase timing characteristic. The function is for an experienced user. For less experienced users, call the FLEXCAN_SetBitRate() instead.

Note: Calling FLEXCAN_SetTimingConfig() overrides the bit rate set in FLEXCAN_Init() or FLEXCAN_SetBitRate().

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the timing configuration structure.

status_t FLEXCAN_SetBitRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t bitRate_Bps)

Set bit rate of FlexCAN classical CAN frame or CAN FD frame nominal phase.

This function set the bit rate of classical CAN frame or CAN FD frame nominal phase base on FLEXCAN_CalculateImprovedTimingValues() API calculated timing values.

Note: Calling FLEXCAN_SetBitRate() overrides the bit rate set in FLEXCAN_Init().

Parameters

- base – FlexCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- bitRate_Bps – Bit rate in Bps.

Returns

kStatus_Success - Set CAN baud rate (only Nominal phase) successfully.

void FLEXCAN_SetFDTimingConfig(CAN_Type *base, const *flexcan_timing_config_t* *pConfig)

Sets the FlexCAN CANFD data phase timing characteristic.

This function gives user settings to CANFD data phase timing characteristic. The function is for an experienced user. For less experienced users, call the FLEXCAN_SetFDBitRate() to set both Nominal/Data bit Rate instead.

Note: Calling FLEXCAN_SetFDTimingConfig() overrides the data phase bit rate set in FLEXCAN_FDInit()/FLEXCAN_SetFDBitRate().

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the timing configuration structure.

status_t FLEXCAN_SetFDBitRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t bitRateN_Bps, uint32_t bitRateD_Bps)

Set bit rate of FlexCAN FD frame.

This function set the baud rate of FLEXCAN FD base on FLEXCAN_FDCalculateImprovedTimingValues() API calculated timing values.

Parameters

- base – FlexCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- bitRateN_Bps – Nominal bit Rate in Bps.
- bitRateD_Bps – Data bit Rate in Bps.

Returns

kStatus_Success - Set CAN FD bit rate (include Nominal and Data phase) successfully.

void FLEXCAN_SetRxMbGlobalMask(CAN_Type *base, uint32_t mask)

Sets the FlexCAN receive message buffer global mask.

This function sets the global mask for the FlexCAN message buffer in a matching process. The configuration is only effective when the Rx individual mask is disabled in the FLEXCAN_Init().

Parameters

- base – FlexCAN peripheral base address.
- mask – Rx Message Buffer Global Mask value.

void FLEXCAN_SetRxFifoGlobalMask(CAN_Type *base, uint32_t mask)

Sets the FlexCAN receive FIFO global mask.

This function sets the global mask for FlexCAN FIFO in a matching process.

Parameters

- base – FlexCAN peripheral base address.
- mask – Rx Fifo Global Mask value.

void FLEXCAN_SetRxIndividualMask(CAN_Type *base, uint8_t maskIdx, uint32_t mask)

Sets the FlexCAN receive individual mask.

This function sets the individual mask for the FlexCAN matching process. The configuration is only effective when the Rx individual mask is enabled in the FLEXCAN_Init(). If the Rx FIFO is disabled, the individual mask is applied to the corresponding Message Buffer. If the Rx FIFO is enabled, the individual mask for Rx FIFO occupied Message Buffer is applied to the Rx Filter with the same index. Note that only the first 32 individual masks can be used as the Rx FIFO filter mask.

Parameters

- base – FlexCAN peripheral base address.
- maskIdx – The Index of individual Mask.
- mask – Rx Individual Mask value.

void FLEXCAN_SetTxMbConfig(CAN_Type *base, uint8_t mbIdx, bool enable)

Configures a FlexCAN transmit message buffer.

This function aborts the previous transmission, cleans the Message Buffer, and configures it as a Transmit Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- enable – Enable/disable Tx Message Buffer.
 - true: Enable Tx Message Buffer.
 - false: Disable Tx Message Buffer.

void FLEXCAN_SetRxMbConfig(CAN_Type *base, uint8_t mbIdx, const flexcan_rx_mb_config_t *pRxMbConfig, bool enable)

Configures a FlexCAN Receive Message Buffer.

This function cleans a FlexCAN build-in Message Buffer and configures it as a Receive Message Buffer. User should invoke this API when CTRL2[RRS]=1. When CTRL2[RRS]=1, frame's

ID is compared to the IDs of the receive mailboxes with the CODE field configured as kFLEXCAN_RxMbEmpty, kFLEXCAN_RxMbFull or kFLEXCAN_RxMbOverrun. Message buffer will store the remote frame in the same fashion of a data frame. No automatic remote response frame will be generated. User need to setup another message buffer to respond remote request.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pRxMbConfig – Pointer to the FlexCAN Message Buffer configuration structure.
- enable – Enable/disable Rx Message Buffer.
 - true: Enable Rx Message Buffer.
 - false: Disable Rx Message Buffer.

void FLEXCAN_SetFDTxMbConfig(CAN_Type *base, uint8_t mbIdx, bool enable)

Configures a FlexCAN transmit message buffer.

This function aborts the previous transmission, cleans the Message Buffer, and configures it as a Transmit Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- enable – Enable/disable Tx Message Buffer.
 - true: Enable Tx Message Buffer.
 - false: Disable Tx Message Buffer.

void FLEXCAN_SetFDRxMbConfig(CAN_Type *base, uint8_t mbIdx, const *flexcan_rx_mb_config_t* *pRxMbConfig, bool enable)

Configures a FlexCAN Receive Message Buffer.

This function cleans a FlexCAN build-in Message Buffer and configures it as a Receive Message Buffer.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pRxMbConfig – Pointer to the FlexCAN Message Buffer configuration structure.
- enable – Enable/disable Rx Message Buffer.
 - true: Enable Rx Message Buffer.
 - false: Disable Rx Message Buffer.

void FLEXCAN_SetRemoteResponseMbConfig(CAN_Type *base, uint8_t mbIdx, const *flexcan_frame_t* *pFrame)

Configures a FlexCAN Remote Response Message Buffer.

User should invoke this API when CTRL2[RRS]=0. When CTRL2[RRS]=0, frame's ID is compared to the IDs of the receive mailboxes with the CODE field configured as kFLEXCAN_RxMbRanswer. If there is a matching ID, then this mailbox content will be transmitted as response. The received remote request frame is not stored in receive buffer. It is only used to trigger a transmission of a frame in response.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The Message Buffer index.
- pFrame – Pointer to CAN message frame structure for response.

```
void FLEXCAN_SetRxFifoConfig(CAN_Type *base, const flexcan_rx_fifo_config_t *pRxFifoConfig,  
                             bool enable)
```

Configures the FlexCAN Legacy Rx FIFO.

This function configures the FlexCAN Rx FIFO with given configuration.

Note: Legacy Rx FIFO only can receive classic CAN message.

Parameters

- base – FlexCAN peripheral base address.
- pRxFifoConfig – Pointer to the FlexCAN Legacy Rx FIFO configuration structure. Can be NULL when enable parameter is false.
- enable – Enable/disable Legacy Rx FIFO.
 - true: Enable Legacy Rx FIFO.
 - false: Disable Legacy Rx FIFO.

```
void FLEXCAN_SetEnhancedRxFifoConfig(CAN_Type *base, const  
                                     flexcan_enhanced_rx_fifo_config_t *pConfig, bool  
                                     enable)
```

Configures the FlexCAN Enhanced Rx FIFO.

This function configures the Enhanced Rx FIFO with given configuration.

Note: Enhanced Rx FIFO support receive classic CAN or CAN FD messages, Legacy Rx FIFO and Enhanced Rx FIFO cannot be enabled at the same time.

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the FlexCAN Enhanced Rx FIFO configuration structure. Can be NULL when enable parameter is false.
- enable – Enable/disable Enhanced Rx FIFO.
 - true: Enable Enhanced Rx FIFO.
 - false: Disable Enhanced Rx FIFO.

```
void FLEXCAN_SetPNConfig(CAN_Type *base, const flexcan_pn_config_t *pConfig)
```

Configures the FlexCAN Pretended Networking mode.

This function configures the FlexCAN Pretended Networking mode with given configuration.

Parameters

- base – FlexCAN peripheral base address.
- pConfig – Pointer to the FlexCAN Rx FIFO configuration structure.

```
static inline uint64_t FLEXCAN_GetStatusFlags(CAN_Type *base)
```

Gets the FlexCAN module interrupt flags.

This function gets all FlexCAN status flags. The flags are returned as the logical OR value of the enumerators `_flexcan_flags`. To check the specific status, compare the return value with enumerators in `_flexcan_flags`.

Parameters

- `base` – FlexCAN peripheral base address.

Returns

FlexCAN status flags which are ORed by the enumerators in the `_flexcan_flags`.

```
static inline void FLEXCAN_ClearStatusFlags(CAN_Type *base, uint64_t mask)
```

Clears status flags with the provided mask.

This function clears the FlexCAN status flags with a provided mask. An automatically cleared flag can't be cleared by this function.

Parameters

- `base` – FlexCAN peripheral base address.
- `mask` – The status flags to be cleared, it is logical OR value of `_flexcan_flags`.

```
static inline void FLEXCAN_GetBusErrCount(CAN_Type *base, uint8_t *txErrBuf, uint8_t  
                                         *rxErrBuf)
```

Gets the FlexCAN Bus Error Counter value.

This function gets the FlexCAN Bus Error Counter value for both Tx and Rx direction. These values may be needed in the upper layer error handling.

Parameters

- `base` – FlexCAN peripheral base address.
- `txErrBuf` – Buffer to store Tx Error Counter value.
- `rxErrBuf` – Buffer to store Rx Error Counter value.

```
static inline uint64_t FLEXCAN_GetMbStatusFlags(CAN_Type *base, uint64_t mask)
```

Gets the FlexCAN low 64 Message Buffer interrupt flags.

This function gets the interrupt flags of a given Message Buffers.

Parameters

- `base` – FlexCAN peripheral base address.
- `mask` – The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

```
static inline uint64_t FLEXCAN_GetHigh64MbStatusFlags(CAN_Type *base, uint64_t mask)
```

Gets the FlexCAN High 64 Message Buffer interrupt flags.

Valid only if the number of available MBs exceeds 64.

Parameters

- `base` – FlexCAN peripheral base address.
- `mask` – The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

```
static inline void FLEXCAN_ClearMbStatusFlags(CAN_Type *base, uint64_t mask)
```

Clears the FlexCAN low 64 Message Buffer interrupt flags.

This function clears the interrupt flags of a given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

```
static inline void FLEXCAN_ClearHigh64MbStatusFlags(CAN_Type *base, uint64_t mask)
```

Clears the FlexCAN High 64 Message Buffer interrupt flags.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

```
void FLEXCAN_GetMemoryErrorReportStatus(CAN_Type *base,  
                                         flexcan_memory_error_report_status_t  
                                         *errorStatus)
```

Gets the FlexCAN Memory Error Report registers status.

This function gets the FlexCAN Memory Error Report registers status.

Parameters

- base – FlexCAN peripheral base address.
- errorStatus – Pointer to FlexCAN Memory Error Report registers status structure.

```
static inline uint8_t FLEXCAN_GetPNMatchCount(CAN_Type *base)
```

Gets the FlexCAN Number of Matches when in Pretended Networking.

This function gets the number of times a given message has matched the predefined filtering criteria for ID and/or PL before a wakeup event.

Parameters

- base – FlexCAN peripheral base address.

Returns

The number of received wake up messages.

```
static inline uint32_t FLEXCAN_GetEnhancedFifoDataCount(CAN_Type *base)
```

Gets the number of FlexCAN Enhanced Rx FIFO available frames.

This function gets the number of CAN messages stored in the Enhanced Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.

Returns

The number of available CAN messages stored in the Enhanced Rx FIFO.

```
static inline void FLEXCAN_EnableInterrupts(CAN_Type *base, uint64_t mask)
```

Enables FlexCAN interrupts according to the provided mask.

This function enables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see `_flexcan_interrupt_enable`.

Parameters

- base – FlexCAN peripheral base address.

- mask – The interrupts to enable. Logical OR of `_flexcan_interrupt_enable`.

`static inline void FLEXCAN_DisableInterrupts(CAN_Type *base, uint64_t mask)`

Disables FlexCAN interrupts according to the provided mask.

This function disables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see `_flexcan_interrupt_enable`.

Parameters

- base – FlexCAN peripheral base address.
- mask – The interrupts to disable. Logical OR of `_flexcan_interrupt_enable`.

`static inline void FLEXCAN_EnableMbInterrupts(CAN_Type *base, uint64_t mask)`

Enables FlexCAN low 64 Message Buffer interrupts.

This function enables the interrupts of given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

`static inline void FLEXCAN_EnableHigh64MbInterrupts(CAN_Type *base, uint64_t mask)`

Enables FlexCAN high 64 Message Buffer interrupts.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

`static inline void FLEXCAN_DisableMbInterrupts(CAN_Type *base, uint64_t mask)`

Disables FlexCAN low 64 Message Buffer interrupts.

This function disables the interrupts of given Message Buffers.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

`static inline void FLEXCAN_DisableHigh64MbInterrupts(CAN_Type *base, uint64_t mask)`

Disables FlexCAN high 64 Message Buffer interrupts.

Valid only if the number of available MBs exceeds 64.

Parameters

- base – FlexCAN peripheral base address.
- mask – The ORed FlexCAN Message Buffer mask.

`void FLEXCAN_EnableRxFifoDMA(CAN_Type *base, bool enable)`

Enables or disables the FlexCAN Rx FIFO DMA request.

This function enables or disables the DMA feature of FlexCAN build-in Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.
- enable – true to enable, false to disable.

```
static inline uintptr_t FLEXCAN_GetRxFifoHeadAddr(CAN_Type *base)
```

Gets the Rx FIFO Head address.

This function returns the FlexCAN Rx FIFO Head address, which is mainly used for the DMA/eDMA use case.

Parameters

- base – FlexCAN peripheral base address.

Returns

FlexCAN Rx FIFO Head address.

```
static inline status_t FLEXCAN_Enable(CAN_Type *base, bool enable)
```

Enables or disables the FlexCAN module operation.

This function enables or disables the FlexCAN module.

Parameters

- base – FlexCAN base pointer.
- enable – true to enable, false to disable.

Returns

kStatus_Success Enable FlexCAN module successful
kStatus_Timeout Timeout when wait for Low-Power Mode Acknowledge

```
status_t FLEXCAN_WriteTxMb(CAN_Type *base, uint8_t mbIdx, const flexcan_frame_t *pTxFrame)
```

Writes a FlexCAN Message to the Transmit Message Buffer.

This function writes a CAN Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN Message transmit. After that the function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN Message Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

Return values

- kStatus_Success -- Write Tx Message Buffer Successfully.
- kStatus_Fail -- Tx Message Buffer is currently in use.

```
status_t FLEXCAN_ReadRxMb(CAN_Type *base, uint8_t mbIdx, flexcan_frame_t *pRxFrame)
```

Reads a FlexCAN Message from Receive Message Buffer.

This function reads a CAN message from a specified Receive Message Buffer. The function fills a receive CAN message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN Message Buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success -- Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow -- Rx Message Buffer is already overflowed and has been read successfully.

- kStatus_Fail -- Rx Message Buffer is empty.

status_t FLEXCAN_WriteFDTxMb(CAN_Type *base, uint8_t mbIdx, const *flexcan_fd_frame_t* *pTxFrame)

Writes a FlexCAN FD Message to the Transmit Message Buffer.

This function writes a CAN FD Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN FD Message transmit. After that the function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN FD Message Buffer index.
- pTxFrame – Pointer to CAN FD message frame to be sent.

Return values

- kStatus_Success -- Write Tx Message Buffer Successfully.
- kStatus_Fail -- Tx Message Buffer is currently in use.

status_t FLEXCAN_ReadFDRxMb(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pRxFrame)

Reads a FlexCAN FD Message from Receive Message Buffer.

This function reads a CAN FD message from a specified Receive Message Buffer. The function fills a receive CAN FD message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

- base – FlexCAN peripheral base address.
- mbIdx – The FlexCAN FD Message Buffer index.
- pRxFrame – Pointer to CAN FD message frame structure for reception.

Return values

- kStatus_Success -- Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow -- Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail -- Rx Message Buffer is empty.

status_t FLEXCAN_ReadRxFifo(CAN_Type *base, *flexcan_frame_t* *pRxFrame)

Reads a FlexCAN Message from Legacy Rx FIFO.

This function reads a CAN message from the FlexCAN Legacy Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success -- Read Message from Rx FIFO successfully.
- kStatus_Fail -- Rx FIFO is not enabled.

status_t FLEXCAN_ReadEnhancedRxFifo(CAN_Type *base, *flexcan_fd_frame_t* *pRxFrame)

Reads a FlexCAN Message from Enhanced Rx FIFO.

This function reads a CAN or CAN FD message from the FlexCAN Enhanced Rx FIFO.

Parameters

- base – FlexCAN peripheral base address.
- pRxFrame – Pointer to CAN FD message frame structure for reception.

Return values

- kStatus_Success – - Read Message from Rx FIFO successfully.
- kStatus_Fail – - Rx FIFO is not enabled.

status_t FLEXCAN_ReadPNWakeUpMB(CAN_Type *base, uint8_t mbIdx, *flexcan_frame_t* *pRxFrame)

Reads a FlexCAN Message from Wake Up MB.

This function reads a CAN message from the FlexCAN Wake up Message Buffers. There are four Wake up Message Buffers (WMBs) used to store incoming messages in Pretended Networking mode. The WMB index indicates the arrival order. The last message is stored in WMB3.

Parameters

- base – FlexCAN peripheral base address.
- pRxFrame – Pointer to CAN message frame structure for reception.
- mbIdx – The FlexCAN Wake up Message Buffer index. Range in 0x0 ~ 0x3.

Return values

- kStatus_Success – - Read Message from Wake up Message Buffer successfully.
- kStatus_Fail – - Wake up Message Buffer has no valid content.

status_t FLEXCAN_TransferFDSendBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pTxFrame)

Performs a polling send transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN FD Message Buffer index.
- pTxFrame – Pointer to CAN FD message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.
- kStatus_Timeout – - Failed to send frames within specific time.

status_t FLEXCAN_TransferFDReceiveBlocking(CAN_Type *base, uint8_t mbIdx, *flexcan_fd_frame_t* *pRxFrame)

Performs a polling receive transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.

- `mbIdx` – The FlexCAN FD Message Buffer index.
- `pRxFrame` – Pointer to CAN FD message frame structure for reception.

Return values

- `kStatus_Success` – Rx Message Buffer is full and has been read successfully.
- `kStatus_FLEXCAN_RxOverflow` – Rx Message Buffer is already overflowed and has been read successfully.
- `kStatus_Fail` – Rx Message Buffer is empty.
- `kStatus_Timeout` – Failed to receive frames within specific time.

`status_t` FLEXCAN_TransferFDSendNonBlocking(*CAN_Type* *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- `base` – FlexCAN peripheral base address.
- `handle` – FlexCAN handle pointer.
- `pMbXfer` – FlexCAN FD Message Buffer transfer structure. See the `flexcan_mb_transfer_t`.

Return values

- `kStatus_Success` – Start Tx Message Buffer sending process successfully.
- `kStatus_Fail` – Write Tx Message Buffer failed.
- `kStatus_FLEXCAN_TxBusy` – Tx Message Buffer is in use.

`status_t` FLEXCAN_TransferFDReceiveNonBlocking(*CAN_Type* *base, *flexcan_handle_t* *handle, *flexcan_mb_transfer_t* *pMbXfer)

Receives a message using IRQ.

This function receives a message using IRQ. This is non-blocking function, which returns right away. When the message has been received, the receive callback function is called.

Parameters

- `base` – FlexCAN peripheral base address.
- `handle` – FlexCAN handle pointer.
- `pMbXfer` – FlexCAN FD Message Buffer transfer structure. See the `flexcan_mb_transfer_t`.

Return values

- `kStatus_Success` – Start Rx Message Buffer receiving process successfully.
- `kStatus_FLEXCAN_RxBusy` – Rx Message Buffer is in use.

`void` FLEXCAN_TransferFDAbortSend(*CAN_Type* *base, *flexcan_handle_t* *handle, `uint8_t` `mbIdx`)

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- `base` – FlexCAN peripheral base address.
- `handle` – FlexCAN handle pointer.

- mbIdx – The FlexCAN FD Message Buffer index.

`void FLEXCAN_TransferFDAbortReceive(CAN_Type *base, flexcan_handle_t *handle, uint8_t mbIdx)`

Aborts the interrupt driven message receive process.

This function aborts the interrupt driven message receive process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN FD Message Buffer index.

`status_t FLEXCAN_TransferSendBlocking(CAN_Type *base, uint8_t mbIdx, flexcan_frame_t *pTxFrame)`

Performs a polling send transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN Message Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

Return values

- kStatus_Success – - Write Tx Message Buffer Successfully.
- kStatus_Fail – - Tx Message Buffer is currently in use.
- kStatus_Timeout – - Failed to send frames within specific time.

`status_t FLEXCAN_TransferReceiveBlocking(CAN_Type *base, uint8_t mbIdx, flexcan_frame_t *pRxFrame)`

Performs a polling receive transaction on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- mbIdx – The FlexCAN Message Buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – - Rx Message Buffer is full and has been read successfully.
- kStatus_FLEXCAN_RxOverflow – - Rx Message Buffer is already overflowed and has been read successfully.
- kStatus_Fail – - Rx Message Buffer is empty.
- kStatus_Timeout – - Failed to receive frames within specific time.

status_t FLEXCAN_TransferReceiveFifoBlocking(CAN_Type *base, *flexcan_frame_t* *pRxFrame)
Performs a polling receive transaction from Legacy Rx FIFO on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – Read Message from Rx FIFO successfully.
- kStatus_Fail – Rx FIFO is not enabled.
- kStatus_Timeout – Failed to receive frames within specific time.

status_t FLEXCAN_TransferReceiveEnhancedFifoBlocking(CAN_Type *base, *flexcan_fd_frame_t* *pRxFrame)

Performs a polling receive transaction from Enhanced Rx FIFO on the CAN bus.

Note: A transfer handle does not need to be created before calling this API.

Parameters

- base – FlexCAN peripheral base pointer.
- pRxFrame – Pointer to CAN FD message frame structure for reception.

Return values

- kStatus_Success – Read Message from Rx FIFO successfully.
- kStatus_Fail – Rx FIFO is not enabled.
- kStatus_Timeout – Failed to receive frames within specific time.

void FLEXCAN_TransferCreateHandle(CAN_Type *base, *flexcan_handle_t* *handle,
flexcan_transfer_callback_t callback, void *userData)

Initializes the FlexCAN handle.

This function initializes the FlexCAN handle, which can be used for other FlexCAN transactional APIs. Usually, for a specified FlexCAN instance, call this API once to get the initialized handle.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

status_t FLEXCAN_TransferSendNonBlocking(CAN_Type *base, *flexcan_handle_t* *handle,
flexcan_mb_transfer_t *pMbXfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – Start Tx Message Buffer sending process successfully.
- kStatus_Fail – Write Tx Message Buffer failed.
- kStatus_FLEXCAN_TxBusy – Tx Message Buffer is in use.

status_t FLEXCAN_TransferReceiveNonBlocking(CAN_Type *base, flexcan_handle_t *handle, flexcan_mb_transfer_t *pMbXfer)

Receives a message using IRQ.

This function receives a message using IRQ. This is non-blocking function, which returns right away. When the message has been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pMbXfer – FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

- kStatus_Success – Start Rx Message Buffer receiving process successfully.
- kStatus_FLEXCAN_RxBusy – Rx Message Buffer is in use.

status_t FLEXCAN_TransferReceiveFifoNonBlocking(CAN_Type *base, flexcan_handle_t *handle, flexcan_fifo_transfer_t *pFifoXfer)

Receives a message from Rx FIFO using IRQ.

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pFifoXfer – FlexCAN Rx FIFO transfer structure. See the flexcan_fifo_transfer_t.

Return values

- kStatus_Success – Start Rx FIFO receiving process successfully.
- kStatus_FLEXCAN_RxFifoBusy – Rx FIFO is currently in use.

status_t FLEXCAN_TransferGetReceiveFifoCount(CAN_Type *base, flexcan_handle_t *handle, size_t *count)

Gets the Legacy Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- count – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – count is Invalid.
- `kStatus_Success` – Successfully return the count.

`status_t` FLEXCAN_TransferReceiveEnhancedFifoNonBlocking(`CAN_Type` *base, *flexcan_handle_t* *handle, *flexcan_fifo_transfer_t* *pFifoXfer)

Receives a message from Enhanced Rx FIFO using IRQ.

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- pFifoXfer – FlexCAN Rx FIFO transfer structure. See the ref *flexcan_fifo_transfer_t*.

Return values

- `kStatus_Success` – Start Rx FIFO receiving process successfully.
- `kStatus_FLEXCAN_RxFifoBusy` – Rx FIFO is currently in use.

static inline `status_t` FLEXCAN_TransferGetReceiveEnhancedFifoCount(`CAN_Type` *base, *flexcan_handle_t* *handle, `size_t` *count)

Gets the Enhanced Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- count – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – count is Invalid.
- `kStatus_Success` – Successfully return the count.

`uint32_t` FLEXCAN_GetTimeStamp(*flexcan_handle_t* *handle, `uint8_t` mbIdx)

Gets the detail index of Mailbox's Timestamp by handle.

Then function can only be used when calling non-blocking Data transfer (TX/RX) API, After TX/RX data transfer done (User can get the status by handler's callback function), we can get the detail index of Mailbox's timestamp by handle, Detail non-blocking data transfer API (TX/RX) contain. -FLEXCAN_TransferSendNonBlocking -FLEXCAN_TransferFDSendNonBlocking -FLEXCAN_TransferReceiveNonBlocking -FLEXCAN_TransferFDReceiveNonBlocking -FLEXCAN_TransferReceiveFifoNonBlocking

Parameters

- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

Return values

the – index of mailbox 's timestamp stored in the handle.

`void FLEXCAN_TransferAbortSend(CAN_Type *base, flexcan_handle_t *handle, uint8_t mbIdx)`

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

`void FLEXCAN_TransferAbortReceive(CAN_Type *base, flexcan_handle_t *handle, uint8_t mbIdx)`

Aborts the interrupt driven message receive process.

This function aborts the interrupt driven message receive process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- mbIdx – The FlexCAN Message Buffer index.

`void FLEXCAN_TransferAbortReceiveFifo(CAN_Type *base, flexcan_handle_t *handle)`

Aborts the interrupt driven message receive from Rx FIFO process.

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

`void FLEXCAN_TransferAbortReceiveEnhancedFifo(CAN_Type *base, flexcan_handle_t *handle)`

Aborts the interrupt driven message receive from Enhanced Rx FIFO process.

This function aborts the interrupt driven message receive from Enhanced Rx FIFO process.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

`void FLEXCAN_TransferHandleIRQ(CAN_Type *base, flexcan_handle_t *handle)`

FlexCAN IRQ handle function.

This function handles the FlexCAN Error, the Message Buffer, and the Rx FIFO IRQ request.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

`void FLEXCAN_MbHandleIRQ(CAN_Type *base, flexcan_handle_t *handle, uint32_t startMbIdx, uint32_t endMbIdx)`

FlexCAN Message Buffer IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- startMbIdx – First Message Buffer to handle.
- endMbIdx – Last Message Buffer to handle.

void FLEXCAN_EhancedRxFifoHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)
FlexCAN Enhanced Rx FIFO IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_BusoffErrorHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)
FlexCAN Bus Off, Error and Warning IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_PNWakeUpHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)
FlexCAN Pretended Networking Wake-up IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

void FLEXCAN_MemoryErrorHandleIRQ(CAN_Type *base, *flexcan_handle_t* *handle)
FlexCAN Memory Error IRQ handle function.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.

FSL_FLEXCAN_DRIVER_VERSION
FlexCAN driver version.

FlexCAN transfer status.

Values:

enumerator kStatus_FLEXCAN_TxBusy
Tx Message Buffer is Busy.

enumerator kStatus_FLEXCAN_TxIdle
Tx Message Buffer is Idle.

enumerator kStatus_FLEXCAN_TxSwitchToRx
Remote Message is send out and Message buffer changed to Receive one.

enumerator kStatus_FLEXCAN_RxBusy
Rx Message Buffer is Busy.

enumerator kStatus_FLEXCAN_RxIdle
Rx Message Buffer is Idle.

enumerator kStatus_FLEXCAN_RxOverflow
Rx Message Buffer is Overflowed.

enumerator kStatus_FLEXCAN_RxFifoBusy
Rx Message FIFO is Busy.

enumerator kStatus_FLEXCAN_RxFifoIdle
Rx Message FIFO is Idle.

enumerator kStatus_FLEXCAN_RxFifoOverflow
Rx Message FIFO is overflowed.

enumerator kStatus_FLEXCAN_RxFifoWarning
Rx Message FIFO is almost overflowed.

enumerator kStatus_FLEXCAN_RxFifoDisabled
Rx Message FIFO is disabled during reading.

enumerator kStatus_FLEXCAN_ErrorStatus
FlexCAN Module Error and Status.

enumerator kStatus_FLEXCAN_WakeUp
FlexCAN is waken up from STOP mode.

enumerator kStatus_FLEXCAN_UnHandled
UnHandled Interrupt asserted.

enumerator kStatus_FLEXCAN_RxRemote
Rx Remote Message Received in Mail box.

enumerator kStatus_FLEXCAN_RxFifoUnderflow
Enhanced Rx Message FIFO is underflow.

enumerator kStatus_FLEXCAN_MemoryError
FlexCAN Memory Error.

enum _flexcan_frame_format
FlexCAN frame format.

Values:

enumerator kFLEXCAN_FrameFormatStandard
Standard frame format attribute.

enumerator kFLEXCAN_FrameFormatExtend
Extend frame format attribute.

enum _flexcan_frame_type
FlexCAN frame type.

Values:

enumerator kFLEXCAN_FrameTypeData
Data frame type attribute.

enumerator kFLEXCAN_FrameTypeRemote
Remote frame type attribute.

enum _flexcan_clock_source
FlexCAN clock source.

Deprecated:

Do not use the kFLEXCAN_ClkSrcOs. It has been superseded kFLEXCAN_ClkSrc0

Do not use the kFLEXCAN_ClkSrcPeri. It has been superseded kFLEXCAN_ClkSrc1

Values:

enumerator kFLEXCAN_ClkSrcOsc
FlexCAN Protocol Engine clock from Oscillator.

enumerator kFLEXCAN_ClkSrcPeri

FlexCAN Protocol Engine clock from Peripheral Clock.

enumerator kFLEXCAN_ClkSrc0

FlexCAN Protocol Engine clock selected by user as SRC == 0.

enumerator kFLEXCAN_ClkSrc1

FlexCAN Protocol Engine clock selected by user as SRC == 1.

enum _flexcan_wake_up_source

FlexCAN wake up source.

Values:

enumerator kFLEXCAN_WakeupSrcUnfiltered

FlexCAN uses unfiltered Rx input to detect edge.

enumerator kFLEXCAN_WakeupSrcFiltered

FlexCAN uses filtered Rx input to detect edge.

enum _flexcan_rx_fifo_filter_type

FlexCAN Rx Fifo Filter type.

Values:

enumerator kFLEXCAN_RxFifoFilterTypeA

One full ID (standard and extended) per ID Filter element.

enumerator kFLEXCAN_RxFifoFilterTypeB

Two full standard IDs or two partial 14-bit ID slices per ID Filter Table element.

enumerator kFLEXCAN_RxFifoFilterTypeC

Four partial 8-bit Standard or extended ID slices per ID Filter Table element.

enumerator kFLEXCAN_RxFifoFilterTypeD

All frames rejected.

enum _flexcan_mb_size

FlexCAN Message Buffer Payload size.

Values:

enumerator kFLEXCAN_8BperMB

Selects 8 bytes per Message Buffer.

enumerator kFLEXCAN_16BperMB

Selects 16 bytes per Message Buffer.

enumerator kFLEXCAN_32BperMB

Selects 32 bytes per Message Buffer.

enumerator kFLEXCAN_64BperMB

Selects 64 bytes per Message Buffer.

enum _flexcan_fd_frame_length

FlexCAN CAN FD frame supporting data length (available DLC values).

For Tx, when the Data size corresponding to DLC value stored in the MB selected for transmission is larger than the MB Payload size, FlexCAN adds the necessary number of bytes with constant 0xCC pattern to complete the expected DLC. For Rx, when the Data size corresponding to DLC value received from the CAN bus is larger than the MB Payload size, the high order bytes that do not fit the Payload size will lose.

Values:

enumerator kFLEXCAN_0BperFrame
Frame contains 0 valid data bytes.

enumerator kFLEXCAN_1BperFrame
Frame contains 1 valid data bytes.

enumerator kFLEXCAN_2BperFrame
Frame contains 2 valid data bytes.

enumerator kFLEXCAN_3BperFrame
Frame contains 3 valid data bytes.

enumerator kFLEXCAN_4BperFrame
Frame contains 4 valid data bytes.

enumerator kFLEXCAN_5BperFrame
Frame contains 5 valid data bytes.

enumerator kFLEXCAN_6BperFrame
Frame contains 6 valid data bytes.

enumerator kFLEXCAN_7BperFrame
Frame contains 7 valid data bytes.

enumerator kFLEXCAN_8BperFrame
Frame contains 8 valid data bytes.

enumerator kFLEXCAN_12BperFrame
Frame contains 12 valid data bytes.

enumerator kFLEXCAN_16BperFrame
Frame contains 16 valid data bytes.

enumerator kFLEXCAN_20BperFrame
Frame contains 20 valid data bytes.

enumerator kFLEXCAN_24BperFrame
Frame contains 24 valid data bytes.

enumerator kFLEXCAN_32BperFrame
Frame contains 32 valid data bytes.

enumerator kFLEXCAN_48BperFrame
Frame contains 48 valid data bytes.

enumerator kFLEXCAN_64BperFrame
Frame contains 64 valid data bytes.

enum _flexcan_efifo_dma_per_read_length
FlexCAN Enhanced Rx Fifo DMA transfer per read length enumerations.

Values:

enumerator kFLEXCAN_1WordPerRead
Transfer 1 32-bit words (CS).

enumerator kFLEXCAN_2WordPerRead
Transfer 2 32-bit words (CS + ID).

enumerator kFLEXCAN_3WordPerRead
Transfer 3 32-bit words (CS + ID + 1~4 bytes data).

enumerator kFLEXCAN_4WordPerRead

Transfer 4 32-bit words (CS + ID + 5~8 bytes data).

enumerator kFLEXCAN_5WordPerRead

Transfer 5 32-bit words (CS + ID + 9~12 bytes data).

enumerator kFLEXCAN_6WordPerRead

Transfer 6 32-bit words (CS + ID + 13~16 bytes data).

enumerator kFLEXCAN_7WordPerRead

Transfer 7 32-bit words (CS + ID + 17~20 bytes data).

enumerator kFLEXCAN_8WordPerRead

Transfer 8 32-bit words (CS + ID + 21~24 bytes data).

enumerator kFLEXCAN_9WordPerRead

Transfer 9 32-bit words (CS + ID + 25~28 bytes data).

enumerator kFLEXCAN_10WordPerRead

Transfer 10 32-bit words (CS + ID + 29~32 bytes data).

enumerator kFLEXCAN_11WordPerRead

Transfer 11 32-bit words (CS + ID + 33~36 bytes data).

enumerator kFLEXCAN_12WordPerRead

Transfer 12 32-bit words (CS + ID + 37~40 bytes data).

enumerator kFLEXCAN_13WordPerRead

Transfer 13 32-bit words (CS + ID + 41~44 bytes data).

enumerator kFLEXCAN_14WordPerRead

Transfer 14 32-bit words (CS + ID + 45~48 bytes data).

enumerator kFLEXCAN_15WordPerRead

Transfer 15 32-bit words (CS + ID + 49~52 bytes data).

enumerator kFLEXCAN_16WordPerRead

Transfer 16 32-bit words (CS + ID + 53~56 bytes data).

enumerator kFLEXCAN_17WordPerRead

Transfer 17 32-bit words (CS + ID + 57~60 bytes data).

enumerator kFLEXCAN_18WordPerRead

Transfer 18 32-bit words (CS + ID + 61~64 bytes data).

enumerator kFLEXCAN_19WordPerRead

Transfer 19 32-bit words (CS + ID + 64 bytes data + ID HIT).

enum _flexcan_rx_fifo_priority

FlexCAN Enhanced/Legacy Rx FIFO priority.

The matching process starts from the Rx MB(or Enhanced/Legacy Rx FIFO) with higher priority. If no MB(or Enhanced/Legacy Rx FIFO filter) is satisfied, the matching process goes on with the Enhanced/Legacy Rx FIFO(or Rx MB) with lower priority.

Values:

enumerator kFLEXCAN_RxFifoPrioLow

Matching process start from Rx Message Buffer first.

enumerator kFLEXCAN_RxFifoPrioHigh

Matching process start from Enhanced/Legacy Rx FIFO first.

enum _flexcan_interrupt_enable

FlexCAN interrupt enable enumerations.

This provides constants for the FlexCAN interrupt enable enumerations for use in the FlexCAN functions.

Note: FlexCAN Message Buffers and Legacy Rx FIFO interrupts not included in.

Values:

enumerator kFLEXCAN_BusOffInterruptEnable

Bus Off interrupt, use bit 15.

enumerator kFLEXCAN_ErrorInterruptEnable

CAN Error interrupt, use bit 14.

enumerator kFLEXCAN_TxWarningInterruptEnable

Tx Warning interrupt, use bit 11.

enumerator kFLEXCAN_RxWarningInterruptEnable

Rx Warning interrupt, use bit 10.

enumerator kFLEXCAN_WakeUpInterruptEnable

Self Wake Up interrupt, use bit 26.

enumerator kFLEXCAN_FDErrorInterruptEnable

CAN FD Error interrupt, use bit 31.

enumerator kFLEXCAN_PNMatchWakeUpInterruptEnable

PN Match Wake Up interrupt, use high word bit 17.

enumerator kFLEXCAN_PNTimeoutWakeUpInterruptEnable

PN Timeout Wake Up interrupt, use high word bit 16. Enhanced Rx FIFO Underflow interrupt, use high word bit 31.

enumerator kFLEXCAN_ERxFifoUnderflowInterruptEnable

Enhanced Rx FIFO Overflow interrupt, use high word bit 30.

enumerator kFLEXCAN_ERxFifoOverflowInterruptEnable

Enhanced Rx FIFO Watermark interrupt, use high word bit 29.

enumerator kFLEXCAN_ERxFifoWatermarkInterruptEnable

Enhanced Rx FIFO Data Available interrupt, use high word bit 28.

enumerator kFLEXCAN_ERxFifoDataAvlInterruptEnable

enumerator kFLEXCAN_HostAccessNCErrInterruptEnable

Host Access With Non-Correctable Errors interrupt, use high word bit 0.

enumerator kFLEXCAN_FlexCanAccessNCErrInterruptEnable

FlexCAN Access With Non-Correctable Errors interrupt, use high word bit 2.

enumerator kFLEXCAN_HostOrFlexCanCErrInterruptEnable

Host or FlexCAN Access With Correctable Errors interrupt, use high word bit 3.

enum _flexcan_flags

FlexCAN status flags.

This provides constants for the FlexCAN status flags for use in the FlexCAN functions.

Note: The CPU read action clears the bits corresponding to the FLEXCAN_ErrorFlag macro, therefore user need to read status flags and distinguish which error is occur using _flexcan_error_flags enumerations.

Values:

enumerator kFLEXCAN_ErrorOverrunFlag
Error Overrun Status.

enumerator kFLEXCAN_FDErrorIntFlag
CAN FD Error Interrupt Flag.

enumerator kFLEXCAN_BusoffDoneIntFlag
Bus Off process completed Interrupt Flag.

enumerator kFLEXCAN_SynchFlag
CAN Synchronization Status.

enumerator kFLEXCAN_TxWarningIntFlag
Tx Warning Interrupt Flag.

enumerator kFLEXCAN_RxWarningIntFlag
Rx Warning Interrupt Flag.

enumerator kFLEXCAN_IdleFlag
FlexCAN In IDLE Status.

enumerator kFLEXCAN_FaultConfinementFlag
FlexCAN Fault Confinement State.

enumerator kFLEXCAN_TransmittingFlag
FlexCAN In Transmission Status.

enumerator kFLEXCAN_ReceivingFlag
FlexCAN In Reception Status.

enumerator kFLEXCAN_BusOffIntFlag
Bus Off Interrupt Flag.

enumerator kFLEXCAN_ErrorIntFlag
CAN Error Interrupt Flag.

enumerator kFLEXCAN_WakeUpIntFlag
Self Wake-Up Interrupt Flag.

enumerator kFLEXCAN_ErrorFlag

enumerator kFLEXCAN_PNMatchIntFlag
PN Matching Event Interrupt Flag.

enumerator kFLEXCAN_PNTimeoutIntFlag
PN Timeout Event Interrupt Flag.

enumerator kFLEXCAN_ERxFifoUnderflowIntFlag
Enhanced Rx FIFO underflow Interrupt Flag.

enumerator kFLEXCAN_ERxFifoOverflowIntFlag
Enhanced Rx FIFO overflow Interrupt Flag.

enumerator kFLEXCAN_ERxFifoWatermarkIntFlag
Enhanced Rx FIFO watermark Interrupt Flag.

enumerator kFLEXCAN_ERxFifoDataAvlIntFlag

Enhanced Rx FIFO data available Interrupt Flag.

enumerator kFLEXCAN_ERxFifoEmptyFlag

Enhanced Rx FIFO empty status.

enumerator kFLEXCAN_ERxFifoFullFlag

Enhanced Rx FIFO full status.

enumerator kFLEXCAN_HostAccessNonCorrectableErrorIntFlag

Host Access With Non-Correctable Error Interrupt Flag.

enumerator kFLEXCAN_FlexCanAccessNonCorrectableErrorIntFlag

FlexCAN Access With Non-Correctable Error Interrupt Flag.

enumerator kFLEXCAN_CorrectableErrorIntFlag

Correctable Error Interrupt Flag.

enumerator kFLEXCAN_HostAccessNonCorrectableErrorOverrunFlag

Host Access With Non-Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_FlexCanAccessNonCorrectableErrorOverrunFlag

FlexCAN Access With Non-Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_CorrectableErrorOverrunFlag

Correctable Error Interrupt Overrun Flag.

enumerator kFLEXCAN_AllMemoryErrorIntFlag

All Memory Error Interrupt Flags.

enumerator kFLEXCAN_AllMemoryErrorFlag

All Memory Error Flags.

enum _flexcan_error_flags

FlexCAN error status flags.

The FlexCAN Error Status enumerations is used to report current error of the FlexCAN bus. This enumerations should be used with KFLEXCAN_ErrorFlag in _flexcan_flags enumerations to determine which error is generated.

Values:

enumerator kFLEXCAN_FDStuffingError

Stuffing Error.

enumerator kFLEXCAN_FDFormError

Form Error.

enumerator kFLEXCAN_FDCrcError

Cyclic Redundancy Check Error.

enumerator kFLEXCAN_FDBit0Error

Unable to send dominant bit.

enumerator kFLEXCAN_FDBit1Error

Unable to send recessive bit.

enumerator kFLEXCAN_TxErrorWarningFlag

Tx Error Warning Status.

enumerator kFLEXCAN_RxErrorWarningFlag

Rx Error Warning Status.

enumerator kFLEXCAN_StuffingError
Stuffing Error.

enumerator kFLEXCAN_FormError
Form Error.

enumerator kFLEXCAN_CrcError
Cyclic Redundancy Check Error.

enumerator kFLEXCAN_AckError
Received no ACK on transmission.

enumerator kFLEXCAN_Bit0Error
Unable to send dominant bit.

enumerator kFLEXCAN_Bit1Error
Unable to send recessive bit.

FlexCAN Legacy Rx FIFO status flags.

The FlexCAN Legacy Rx FIFO Status enumerations are used to determine the status of the Rx FIFO. Because Rx FIFO occupy the MB0 ~ MB7 (Rx Fifo filter also occupiees more Message Buffer space), Rx FIFO status flags are mapped to the corresponding Message Buffer status flags.

Values:

enumerator kFLEXCAN_RxFifoOverflowFlag
Rx FIFO overflow flag.

enumerator kFLEXCAN_RxFifoWarningFlag
Rx FIFO almost full flag.

enumerator kFLEXCAN_RxFifoFrameAvlFlag
Frames available in Rx FIFO flag.

enum _flexcan_memory_error_type
FlexCAN Memory Error Type.

Values:

enumerator kFLEXCAN_CorrectableError
The memory error is correctable which means on bit error.

enumerator kFLEXCAN_NonCorrectableError
The memory error is non-correctable which means two bit errors.

enum _flexcan_memory_access_type
FlexCAN Memory Access Type.

Values:

enumerator kFLEXCAN_MoveOutFlexCanAccess
The memory error was detected during move-out FlexCAN access.

enumerator kFLEXCAN_MoveInAccess
The memory error was detected during move-in FlexCAN access.

enumerator kFLEXCAN_TxArbitrationAccess
The memory error was detected during Tx Arbitration FlexCAN access.

enumerator kFLEXCAN_RxMatchingAccess
The memory error was detected during Rx Matching FlexCAN access.

enumerator kFLEXCAN_MoveOutHostAccess

The memory error was detected during Rx Matching Host (CPU) access.

enum _flexcan_byte_error_syndrome

FlexCAN Memory Error Byte Syndrome.

Values:

enumerator kFLEXCAN_NoError

No bit error in this byte.

enumerator kFLEXCAN_ParityBits0Error

Parity bit 0 error in this byte.

enumerator kFLEXCAN_ParityBits1Error

Parity bit 1 error in this byte.

enumerator kFLEXCAN_ParityBits2Error

Parity bit 2 error in this byte.

enumerator kFLEXCAN_ParityBits3Error

Parity bit 3 error in this byte.

enumerator kFLEXCAN_ParityBits4Error

Parity bit 4 error in this byte.

enumerator kFLEXCAN_DataBits0Error

Data bit 0 error in this byte.

enumerator kFLEXCAN_DataBits1Error

Data bit 1 error in this byte.

enumerator kFLEXCAN_DataBits2Error

Data bit 2 error in this byte.

enumerator kFLEXCAN_DataBits3Error

Data bit 3 error in this byte.

enumerator kFLEXCAN_DataBits4Error

Data bit 4 error in this byte.

enumerator kFLEXCAN_DataBits5Error

Data bit 5 error in this byte.

enumerator kFLEXCAN_DataBits6Error

Data bit 6 error in this byte.

enumerator kFLEXCAN_DataBits7Error

Data bit 7 error in this byte.

enumerator kFLEXCAN_AllZeroError

All-zeros non-correctable error in this byte.

enumerator kFLEXCAN_AllOneError

All-ones non-correctable error in this byte.

enumerator kFLEXCAN_NonCorrectableErrors

Non-correctable error in this byte.

enum _flexcan_pn_match_source

FlexCAN Pretended Networking match source selection.

Values:

enumerator kFLEXCAN_PNMatSrcID

Message match with ID filtering.

enumerator kFLEXCAN_PNMatSrcIDAndData

Message match with ID filtering and payload filtering.

enum *flexcan_pn_match_mode*

FlexCAN Pretended Networking mode match type.

Values:

enumerator kFLEXCAN_PNMatModeEqual

Match upon ID/Payload contents against an exact target value.

enumerator kFLEXCAN_PNMatModeGreater

Match upon an ID/Payload value greater than or equal to a specified target value.

enumerator kFLEXCAN_PNMatModeSmaller

Match upon an ID/Payload value smaller than or equal to a specified target value.

enumerator kFLEXCAN_PNMatModeRange

Match upon an ID/Payload value inside a range, greater than or equal to a specified lower limit, and smaller than or equal to a specified upper limit

typedef enum *flexcan_frame_format* flexcan_frame_format_t

FlexCAN frame format.

typedef enum *flexcan_frame_type* flexcan_frame_type_t

FlexCAN frame type.

typedef enum *flexcan_clock_source* flexcan_clock_source_t

FlexCAN clock source.

Deprecated:

Do not use the kFLEXCAN_ClkSrcOs. It has been superceded kFLEXCAN_ClkSrc0

Do not use the kFLEXCAN_ClkSrcPeri. It has been superceded kFLEXCAN_ClkSrc1

typedef enum *flexcan_wake_up_source* flexcan_wake_up_source_t

FlexCAN wake up source.

typedef enum *flexcan_rx_fifo_filter_type* flexcan_rx_fifo_filter_type_t

FlexCAN Rx Fifo Filter type.

typedef enum *flexcan_mb_size* flexcan_mb_size_t

FlexCAN Message Buffer Payload size.

typedef enum *flexcan_efifo_dma_per_read_length* flexcan_efifo_dma_per_read_length_t

FlexCAN Enhanced Rx Fifo DMA transfer per read length enumerations.

typedef enum *flexcan_rx_fifo_priority* flexcan_rx_fifo_priority_t

FlexCAN Enhanced/Legacy Rx FIFO priority.

The matching process starts from the Rx MB(or Enhanced/Legacy Rx FIFO) with higher priority. If no MB(or Enhanced/Legacy Rx FIFO filter) is satisfied, the matching process goes on with the Enhanced/Legacy Rx FIFO(or Rx MB) with lower priority.

typedef enum *flexcan_memory_error_type* flexcan_memory_error_type_t

FlexCAN Memory Error Type.

typedef enum *flexcan_memory_access_type* flexcan_memory_access_type_t

FlexCAN Memory Access Type.

typedef enum *_flexcan_byte_error_syndrome* flexcan_byte_error_syndrome_t

FlexCAN Memory Error Byte Syndrome.

typedef struct *_flexcan_memory_error_report_status* flexcan_memory_error_report_status_t

FlexCAN memory error register status structure.

This structure contains the memory access properties that caused a memory error access. It is used as the parameter of FLEXCAN_GetMemoryErrorReportStatus() function. And user can use FLEXCAN_GetMemoryErrorReportStatus to get the status of the last memory error access.

typedef struct *_flexcan_frame* flexcan_frame_t

FlexCAN message frame structure.

typedef struct *_flexcan_fd_frame* flexcan_fd_frame_t

CAN FD message frame structure.

The CAN FD message supporting up to sixty four bytes can be used for a data frame, depending on the length selected for the message buffers. The length should be a enumeration member, see *_flexcan_fd_frame_length*.

typedef struct *_flexcan_timing_config* flexcan_timing_config_t

FlexCAN protocol timing characteristic configuration structure.

typedef struct *_flexcan_config* flexcan_config_t

FlexCAN module configuration structure.

Deprecated:

Do not use the baudRate. It has been superceded bitRate

Do not use the baudRateFD. It has been superceded bitRateFD

typedef struct *_flexcan_rx_mb_config* flexcan_rx_mb_config_t

FlexCAN Receive Message Buffer configuration structure.

This structure is used as the parameter of FLEXCAN_SetRxMbConfig() function. The FLEXCAN_SetRxMbConfig() function is used to configure FlexCAN Receive Message Buffer. The function abort previous receiving process, clean the Message Buffer and activate the Rx Message Buffer using given Message Buffer setting.

typedef enum *_flexcan_pn_match_source* flexcan_pn_match_source_t

FlexCAN Pretended Networking match source selection.

typedef enum *_flexcan_pn_match_mode* flexcan_pn_match_mode_t

FlexCAN Pretended Networking mode match type.

typedef struct *_flexcan_pn_config* flexcan_pn_config_t

FlexCAN Pretended Networking configuration structure.

This structure is used as the parameter of FLEXCAN_SetPNConfig() function. The FLEXCAN_SetPNConfig() function is used to configure FlexCAN Networking work mode.

typedef struct *_flexcan_rx_fifo_config* flexcan_rx_fifo_config_t

FlexCAN Legacy Rx FIFO configuration structure.

typedef struct *_flexcan_enhanced_rx_fifo_std_id_filter* flexcan_enhanced_rx_fifo_std_id_filter_t

FlexCAN Enhanced Rx FIFO Standard ID filter element structure.

typedef struct *_flexcan_enhanced_rx_fifo_ext_id_filter* flexcan_enhanced_rx_fifo_ext_id_filter_t

FlexCAN Enhanced Rx FIFO Extended ID filter element structure.

`typedef struct flexcan_enhanced_rx_fifo_config flexcan_enhanced_rx_fifo_config_t`
FlexCAN Enhanced Rx FIFO configuration structure.

`typedef struct flexcan_mb_transfer flexcan_mb_transfer_t`
FlexCAN Message Buffer transfer.

`typedef struct flexcan_fifo_transfer flexcan_fifo_transfer_t`
FlexCAN Rx FIFO transfer.

`typedef struct flexcan_handle flexcan_handle_t`
FlexCAN handle structure definition.

`typedef void (*flexcan_transfer_callback_t)(CAN_Type *base, flexcan_handle_t *handle, status_t status, uint64_t result, void *userData)`

`FLEXCAN_WAIT_TIMEOUT`

`FLEXCAN_POLLING_TIMEOUT`
Max loops to wait for polling transfer.

`FLEXCAN_MODULE_TIMEOUT`
Max loops to wait for FlexCAN register access complete.

`DLC_LENGTH_DECODE(dlc)`
FlexCAN frame length helper macro.

`FLEXCAN_ID_STD(id)`
FlexCAN Frame ID helper macro.
Standard Frame ID helper macro.

`FLEXCAN_ID_EXT(id)`
Extend Frame ID helper macro.

`FLEXCAN_RX_MB_STD_MASK(id, rtr, ide)`
FlexCAN Rx Message Buffer Mask helper macro.
Standard Rx Message Buffer Mask helper macro.

`FLEXCAN_RX_MB_EXT_MASK(id, rtr, ide)`
Extend Rx Message Buffer Mask helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(id, rtr, ide)`
FlexCAN Legacy Rx FIFO Mask helper macro.
Standard Rx FIFO Mask helper macro Type A helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH(id, rtr, ide)`
Standard Rx FIFO Mask helper macro Type B upper part helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW(id, rtr, ide)`
Standard Rx FIFO Mask helper macro Type B lower part helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(id)`
Standard Rx FIFO Mask helper macro Type C upper part helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(id)`
Standard Rx FIFO Mask helper macro Type C mid-upper part helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(id)`
Standard Rx FIFO Mask helper macro Type C mid-lower part helper macro.

`FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(id)`
Standard Rx FIFO Mask helper macro Type C lower part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)`
Extend Rx FIFO Mask helper macro Type A helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(id, rtr, ide)`
Extend Rx FIFO Mask helper macro Type B upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(id, rtr, ide)`
Extend Rx FIFO Mask helper macro Type B lower part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(id)`
Extend Rx FIFO Mask helper macro Type C upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(id)`
Extend Rx FIFO Mask helper macro Type C mid-upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(id)`
Extend Rx FIFO Mask helper macro Type C mid-lower part helper macro.

`FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)`
Extend Rx FIFO Mask helper macro Type C lower part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_A(id, rtr, ide)`
FlexCAN Rx FIFO Filter helper macro.
Standard Rx FIFO Filter helper macro Type A helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_HIGH(id, rtr, ide)`
Standard Rx FIFO Filter helper macro Type B upper part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_LOW(id, rtr, ide)`
Standard Rx FIFO Filter helper macro Type B lower part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_HIGH(id)`
Standard Rx FIFO Filter helper macro Type C upper part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_HIGH(id)`
Standard Rx FIFO Filter helper macro Type C mid-upper part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_LOW(id)`
Standard Rx FIFO Filter helper macro Type C mid-lower part helper macro.

`FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_LOW(id)`
Standard Rx FIFO Filter helper macro Type C lower part helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_A(id, rtr, ide)`
Extend Rx FIFO Filter helper macro Type A helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_HIGH(id, rtr, ide)`
Extend Rx FIFO Filter helper macro Type B upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_LOW(id, rtr, ide)`
Extend Rx FIFO Filter helper macro Type B lower part helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_HIGH(id)`
Extend Rx FIFO Filter helper macro Type C upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_HIGH(id)`
Extend Rx FIFO Filter helper macro Type C mid-upper part helper macro.

`FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_LOW(id)`
Extend Rx FIFO Filter helper macro Type C mid-lower part helper macro.

FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_LOW(id)

Extend Rx FIFO Filter helper macro Type C lower part helper macro.

ENHANCED_RX_FIFO_FSCH(x)

FlexCAN Enhanced Rx FIFO Filter and Mask helper macro.

RTR_STD_HIGH(x)

RTR_STD_LOW(x)

RTR_EXT(x)

ID_STD_LOW(id)

ID_STD_HIGH(id)

ID_EXT(id)

FLEXCAN_ENHANCED_RX_FIFO_STD_MASK_AND_FILTER(id, rtr, id_mask, rtr_mask)

Standard ID filter element with filter + mask scheme.

**FLEXCAN_ENHANCED_RX_FIFO_STD_FILTER_WITH_RANGE(id_upper, rtr, id_lower,
rtr_mask)**

Standard ID filter element with filter range.

FLEXCAN_ENHANCED_RX_FIFO_STD_TWO_FILTERS(id1, rtr1, id2, rtr2)

Standard ID filter element with two filters without masks.

FLEXCAN_ENHANCED_RX_FIFO_EXT_MASK_AND_FILTER_LOW(id, rtr)

Extended ID filter element with filter + mask scheme low word.

FLEXCAN_ENHANCED_RX_FIFO_EXT_MASK_AND_FILTER_HIGH(id_mask, rtr_mask)

Extended ID filter element with filter + mask scheme high word.

FLEXCAN_ENHANCED_RX_FIFO_EXT_FILTER_WITH_RANGE_LOW(id_upper, rtr)

Extended ID filter element with range scheme low word.

FLEXCAN_ENHANCED_RX_FIFO_EXT_FILTER_WITH_RANGE_HIGH(id_lower, rtr_mask)

Extended ID filter element with range scheme high word.

FLEXCAN_ENHANCED_RX_FIFO_EXT_TWO_FILTERS_LOW(id2, rtr2)

Extended ID filter element with two filters without masks low word.

FLEXCAN_ENHANCED_RX_FIFO_EXT_TWO_FILTERS_HIGH(id1, rtr1)

Extended ID filter element with two filters without masks high word.

FLEXCAN_PN_STD_MASK(id, rtr)

FlexCAN Pretended Networking ID Mask helper macro.

Standard Rx Message Buffer Mask helper macro.

FLEXCAN_PN_EXT_MASK(id, rtr)

Extend Rx Message Buffer Mask helper macro.

FLEXCAN_PN_INT_MASK(x)

FlexCAN interrupt/status flag helper macro.

FLEXCAN_PN_INT_UNMASK(x)

FLEXCAN_PN_STATUS_MASK(x)

FLEXCAN_PN_STATUS_UNMASK(x)

FLEXCAN_EFIFO_INT_MASK(x)

FLEXCAN_EFIFO_INT_UNMASK(x)

FLEXCAN_EFIFO_STATUS_MASK(x)

FLEXCAN_EFIFO_STATUS_UNMASK(x)

FLEXCAN_MECR_INT_MASK(x)

FLEXCAN_MECR_INT_UNMASK(x)

FLEXCAN_MECR_STATUS_MASK(x)

FLEXCAN_MECR_STATUS_UNMASK(x)

FLEXCAN_ERROR_AND_STATUS_INT_FLAG

FLEXCAN_PNWAKE_UP_FLAG

FLEXCAN_WAKE_UP_FLAG

FLEXCAN_MEMORY_ERROR_INT_FLAG

FLEXCAN_MEMORY_ENHANCED_RX_FIFO_INT_FLAG

E_RX_FIFO(base)

FlexCAN Enhanced Rx FIFO base address helper macro.

FLEXCAN_CALLBACK(x)

FlexCAN transfer callback function.

The FlexCAN transfer callback returns a value from the underlying layer. If the status equals to `kStatus_FLEXCAN_ErrorStatus`, the result parameter is the Content of FlexCAN status register which can be used to get the working status(or error status) of FlexCAN module. If the status equals to other FlexCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other FlexCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

struct `_flexcan_memory_error_report_status`

#include <fsl_flexcan.h> FlexCAN memory error register status structure.

This structure contains the memory access properties that caused a memory error access. It is used as the parameter of `FLEXCAN_GetMemoryErrorReportStatus()` function. And user can use `FLEXCAN_GetMemoryErrorReportStatus` to get the status of the last memory error access.

Public Members

flexcan_memory_error_type_t errorType

The type of memory error that giving rise to the report.

flexcan_memory_access_type_t accessType

The type of memory access that giving rise to the memory error.

uint16_t accessAddress

The address where memory error detected.

uint32_t errorData

The raw data word read from memory with error.

struct `_flexcan_frame`

#include <fsl_flexcan.h> FlexCAN message frame structure.

struct __flexcan_fd_frame

#include <fsl_flexcan.h> CAN FD message frame structure.

The CAN FD message supporting up to sixty four bytes can be used for a data frame, depending on the length selected for the message buffers. The length should be a enumeration member, see __flexcan_fd_frame_length.

Public Members

uint32_t idhit

Note: ID HIT offset is changed dynamically according to data length code (DLC), when DLC is 15, they will be located below. Using FLEXCAN_FixEnhancedRxFifoFrameIdHit API is recommended to ensure this idhit value is correct. CAN Enhanced Rx FIFO filter hit id (This value is only used in Enhanced Rx FIFO receive mode).

struct __flexcan_timing_config

#include <fsl_flexcan.h> FlexCAN protocol timing characteristic configuration structure.

Public Members

uint16_t preDivider

Classic CAN or CAN FD nominal phase bit rate prescaler.

uint8_t rJumpwidth

Classic CAN or CAN FD nominal phase Re-sync Jump Width.

uint8_t phaseSeg1

Classic CAN or CAN FD nominal phase Segment 1.

uint8_t phaseSeg2

Classic CAN or CAN FD nominal phase Segment 2.

uint8_t propSeg

Classic CAN or CAN FD nominal phase Propagation Segment.

uint16_t fpreDivider

CAN FD data phase bit rate prescaler.

uint8_t frJumpwidth

CAN FD data phase Re-sync Jump Width.

uint8_t fphaseSeg1

CAN FD data phase Phase Segment 1.

uint8_t fphaseSeg2

CAN FD data phase Phase Segment 2.

uint8_t fpropSeg

CAN FD data phase Propagation Segment.

struct __flexcan_config

#include <fsl_flexcan.h> FlexCAN module configuration structure.

Deprecated:

Do not use the baudRate. It has been superceded bitRate

Do not use the baudRateFD. It has been superceded bitRateFD

Public Members

flexcan_clock_source_t clkSrc

Clock source for FlexCAN Protocol Engine.

flexcan_wake_up_source_t wakeupSrc

Wake up source selection.

uint8_t maxMbNum

The maximum number of Message Buffers used by user.

bool enableLoopBack

Enable or Disable Loop Back Self Test Mode.

bool enableTimerSync

Enable or Disable Timer Synchronization.

bool enableSelfWakeup

Enable or Disable Self Wakeup Mode.

bool enableIndividMask

Enable or Disable Rx Individual Mask and Queue feature.

bool disableSelfReception

Enable or Disable Self Reflection.

bool enableListenOnlyMode

Enable or Disable Listen Only Mode.

bool enableDoze

Enable or Disable Doze Mode.

bool enablePretendedNetworking

Enable or Disable the Pretended Networking mode.

bool enableMemoryErrorControl

Enable or Disable the memory errors detection and correction mechanism.

bool enableNonCorrectableErrorEnterFreeze

Enable or Disable Non-Correctable Errors In FlexCAN Access Put Device In Freeze Mode.

bool enableTransceiverDelayMeasure

Enable or Disable the transceiver delay measurement, when it is enabled, then the secondary sample point position is determined by the sum of the transceiver delay measurement plus the enhanced TDC offset.

bool enableRemoteRequestFrameStored

true: Store Remote Request Frame in the same fashion of data frame. false: Generate an automatic Remote Response Frame.

struct *_flexcan_rx_mb_config*

#include <fsl_flexcan.h> FlexCAN Receive Message Buffer configuration structure.

This structure is used as the parameter of FLEXCAN_SetRxMbConfig() function. The FLEXCAN_SetRxMbConfig() function is used to configure FlexCAN Receive Message Buffer. The function abort previous receiving process, clean the Message Buffer and activate the Rx Message Buffer using given Message Buffer setting.

Public Members

uint32_t id

CAN Message Buffer Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD() macro.

flexcan_frame_format_t format

CAN Frame Identifier format(Standard of Extend).

flexcan_frame_type_t type

CAN Frame Type(Data or Remote for classical CAN only).

struct *_flexcan_pn_config*

#include <fsl_flexcan.h> FlexCAN Pretended Networking configuration structure.

This structure is used as the parameter of FLEXCAN_SetPNConfig() function. The FLEXCAN_SetPNConfig() function is used to configure FlexCAN Networking work mode.

Public Members

bool enableTimeout

Enable or Disable timeout event trigger wakeup.

uint16_t timeoutValue

The timeout value that generates a wakeup event, the counter timer is incremented based on 64 times the CAN Bit Time unit.

bool enableMatch

Enable or Disable match event trigger wakeup.

flexcan_pn_match_source_t matchSrc

Selects the match source (ID and/or data match) to trigger wakeup.

uint8_t matchNum

The number of times a given message must match the predefined ID and/or data before generating a wakeup event, range in 0x1 ~ 0xFF.

flexcan_pn_match_mode_t idMatchMode

The ID match type.

flexcan_pn_match_mode_t dataMatchMode

The data match type.

uint32_t idLower

The ID target values 1 which used either for ID match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in ID match “range detection”.

uint32_t idUpper

The ID target values 2 which used only as the upper limit value in ID match “range detection” or used to store the ID mask in “equal to”.

uint8_t lengthLower

The lower limit for length of data bytes which used only in data match “range detection”. Range in 0x0 ~ 0x8.

uint8_t lengthUpper

The upper limit for length of data bytes which used only in data match “range detection”. Range in 0x0 ~ 0x8.

struct `_flexcan_rx_fifo_config`

#include <fsl_flexcan.h> FlexCAN Legacy Rx FIFO configuration structure.

Public Members

uint32_t *idFilterTable

Pointer to the FlexCAN Legacy Rx FIFO identifier filter table.

uint8_t idFilterNum

The FlexCAN Legacy Rx FIFO Filter elements quantity.

flexcan_rx_fifo_filter_type_t idFilterType

The FlexCAN Legacy Rx FIFO Filter type.

flexcan_rx_fifo_priority_t priority

The FlexCAN Legacy Rx FIFO receive priority.

struct `_flexcan_enhanced_rx_fifo_std_id_filter`

#include <fsl_flexcan.h> FlexCAN Enhanced Rx FIFO Standard ID filter element structure.

Public Members

uint32_t filterType

FlexCAN internal Free-Running Counter Time Stamp.

uint32_t rtr1

CAN FD frame data length code (DLC), range see `_flexcan_fd_frame_length`, When the length <= 8, it equal to the data length, otherwise the number of valid frame data is not equal to the length value. user can use `DLC_LENGTH_DECODE(length)` macro to get the number of valid data bytes.

uint32_t std1

CAN Frame Type(DATA or REMOTE).

uint32_t rtr2

CAN Frame Identifier(STD or EXT format).

uint32_t std2

Substitute Remote request.

struct `_flexcan_enhanced_rx_fifo_ext_id_filter`

#include <fsl_flexcan.h> FlexCAN Enhanced Rx FIFO Extended ID filter element structure.

Public Members

uint32_t filterType

FlexCAN internal Free-Running Counter Time Stamp.

uint32_t rtr1

CAN FD frame data length code (DLC), range see `_flexcan_fd_frame_length`, When the length <= 8, it equal to the data length, otherwise the number of valid frame data is not equal to the length value. user can use `DLC_LENGTH_DECODE(length)` macro to get the number of valid data bytes.

uint32_t std1

CAN Frame Type(DATA or REMOTE).

uint32_t rtr2

CAN Frame Identifier(STD or EXT format).

uint32_t std2

Substitute Remote request.

struct _flexcan_enhanced_rx_fifo_config

#include <fsl_flexcan.h> FlexCAN Enhanced Rx FIFO configuration structure.

Public Members

uint32_t *idFilterTable

Pointer to the FlexCAN Enhanced Rx FIFO identifier filter table, each table member occupies 32 bit word, table size should be equal to idFilterNum. There are two types of Enhanced Rx FIFO filter elements that can be stored in table : extended-ID filter element (1 word, occupies 1 table members) and standard-ID filter element (2 words, occupies 2 table members), the extended-ID filter element needs to be placed in front of the table.

uint8_t idFilterPairNum

idFilterPairNum is the Enhanced Rx FIFO identifier filter element pair numbers, each pair of filter elements occupies 2 words and can consist of one extended ID filter element or two standard ID filter elements.

uint8_t extendIdFilterNum

The number of extended ID filter element items in the FlexCAN enhanced Rx FIFO identifier filter table, each extended-ID filter element occupies 2 words, extendIdFilterNum need less than or equal to idFilterPairNum.

uint8_t fifoWatermark

(fifoWatermark + 1) is the minimum number of CAN messages stored in the Enhanced RX FIFO which can trigger FIFO watermark interrupt or a DMA request.

flexcan_efifo_dma_per_read_length_t dmaPerReadLength

Define the length of each read of the Enhanced RX FIFO element by the DAM, see _flexcan_fd_frame_length.

flexcan_rx_fifo_priority_t priority

The FlexCAN Enhanced Rx FIFO receive priority.

struct _flexcan_mb_transfer

#include <fsl_flexcan.h> FlexCAN Message Buffer transfer.

Public Members

flexcan_frame_t *frame

The buffer of CAN Message to be transfer.

uint8_t mbIdx

The index of Message buffer used to transfer Message.

struct _flexcan_fifo_transfer

#include <fsl_flexcan.h> FlexCAN Rx FIFO transfer.

Public Members

flexcan_fd_frame_t *framefd

The buffer of CAN Message to be received from Enhanced Rx FIFO.

flexcan_frame_t *frame

The buffer of CAN Message to be received from Legacy Rx FIFO.

size_t frameNum

Number of CAN Message need to be received from Legacy or Enhanced Rx FIFO.

struct *_flexcan_handle*

#include <fsl_flexcan.h> FlexCAN handle structure.

Public Members

flexcan_transfer_callback_t callback

Callback function.

void *userData

FlexCAN callback function parameter.

flexcan_frame_t *volatile mbFrameBuf[CAN_WORD1_COUNT]

The buffer for received CAN data from Message Buffers.

flexcan_fd_frame_t *volatile mbFDFrameBuf[CAN_WORD1_COUNT]

The buffer for received CAN FD data from Message Buffers.

flexcan_frame_t *volatile rxFifoFrameBuf

The buffer for received CAN data from Legacy Rx FIFO.

flexcan_fd_frame_t *volatile rxFifoFDFrameBuf

The buffer for received CAN FD data from Enhanced Rx FIFO.

size_t rxFifoFrameNum

The number of CAN messages remaining to be received from Legacy or Enhanced Rx FIFO.

size_t rxFifoTransferTotalNum

Total CAN Message number need to be received from Legacy or Enhanced Rx FIFO.

volatile uint8_t mbState[CAN_WORD1_COUNT]

Message Buffer transfer state.

volatile uint8_t rxFifoState

Rx FIFO transfer state.

volatile uint32_t timestamp[CAN_WORD1_COUNT]

Mailbox transfer timestamp.

struct byteStatus

Public Members

bool byteIsRead

The byte n (0~3) was read or not. The type of error and which bit in byte (n) is affected by the error.

struct ____unnamed34____

Public Members

uint32_t timestamp

FlexCAN internal Free-Running Counter Time Stamp.

uint32_t length

CAN frame data length in bytes (Range: 0~8).

uint32_t type

CAN Frame Type(DATA or REMOTE).

uint32_t format

CAN Frame Identifier(STD or EXT format).

uint32_t __pad0__

Reserved.

uint32_t idhit

CAN Rx FIFO filter hit id(This value is only used in Rx FIFO receive mode).

struct __unnamed36__

Public Members

uint32_t id

CAN Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD() macro.

uint32_t __pad0__

Reserved.

union __unnamed38__

Public Members

struct _flexcan_frame

struct _flexcan_frame

struct __unnamed40__

Public Members

uint32_t dataWord0

CAN Frame payload word0.

uint32_t dataWord1

CAN Frame payload word1.

struct __unnamed42__

Public Members

uint8_t dataByte3

CAN Frame payload byte3.

uint8_t dataByte2

CAN Frame payload byte2.

```
uint8_t dataByte1
    CAN Frame payload byte1.
uint8_t dataByte0
    CAN Frame payload byte0.
uint8_t dataByte7
    CAN Frame payload byte7.
uint8_t dataByte6
    CAN Frame payload byte6.
uint8_t dataByte5
    CAN Frame payload byte5.
uint8_t dataByte4
    CAN Frame payload byte4.
struct __unnamed44__
```

Public Members

```
uint32_t timestamp
    FlexCAN internal Free-Running Counter Time Stamp.
uint32_t length
    CAN FD frame data length code (DLC), range see _flexcan_fd_frame_length, When the
    length <= 8, it equal to the data length, otherwise the number of valid frame data is
    not equal to the length value. user can use DLC_LENGTH_DECODE(length) macro to
    get the number of valid data bytes.
uint32_t type
    CAN Frame Type(DATA only).
uint32_t format
    CAN Frame Identifier(STD or EXT format).
uint32_t srr
    Substitute Remote request.
uint32_t esi
    Error State Indicator.
uint32_t brs
    Bit Rate Switch.
uint32_t edl
    Extended Data Length.
struct __unnamed46__
```

Public Members

```
uint32_t id
    CAN Frame Identifier, should be set using FLEXCAN_ID_EXT() or FLEXCAN_ID_STD()
    macro.
uint32_t __pad0__
    Reserved.
union __unnamed48__
```


Public Members

struct __flexcan_fd_frame

struct __flexcan_fd_frame

struct ____unnamed50____

Public Members

uint32_t dataWord[16]

CAN FD Frame payload, 16 double word maximum.

struct ____unnamed52____

Public Members

uint8_t dataByte3

CAN Frame payload byte3.

uint8_t dataByte2

CAN Frame payload byte2.

uint8_t dataByte1

CAN Frame payload byte1.

uint8_t dataByte0

CAN Frame payload byte0.

uint8_t dataByte7

CAN Frame payload byte7.

uint8_t dataByte6

CAN Frame payload byte6.

uint8_t dataByte5

CAN Frame payload byte5.

uint8_t dataByte4

CAN Frame payload byte4.

union ____unnamed54____

Public Members

struct __flexcan_config

struct __flexcan_config

struct ____unnamed56____

Public Members

uint32_t baudRate

FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.

uint32_t baudRateFD

FlexCAN FD bit rate in bps, for CANFD data phase.

struct ____unnamed58____

Public Members

uint32_t bitRate

FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.

uint32_t bitRateFD

FlexCAN FD bit rate in bps, for CANFD data phase.

union ____unnamed60____

Public Members

struct __flexcan_pn_config

< The data target values 1 which used either for data match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in data match “range detection”.

struct __flexcan_pn_config

struct ____unnamed64____

< The data target values 1 which used either for data match “equal to”, “smaller than”, “greater than” comparisons, or as the lower limit value in data match “range detection”.

Public Members

uint32_t lowerWord0

CAN Frame payload word0.

uint32_t lowerWord1

CAN Frame payload word1.

struct ____unnamed66____

Public Members

uint8_t lowerByte3

CAN Frame payload byte3.

uint8_t lowerByte2

CAN Frame payload byte2.

uint8_t lowerByte1

CAN Frame payload byte1.

uint8_t lowerByte0

CAN Frame payload byte0.

uint8_t lowerByte7

CAN Frame payload byte7.

uint8_t lowerByte6

CAN Frame payload byte6.

uint8_t lowerByte5

CAN Frame payload byte5.

```
uint8_t lowerByte4
    CAN Frame payload byte4.
union __unnamed62__
```

Public Members

```
struct __flexcan_pn_config
    < The data target values 2 which used only as the upper limit value in data match
    “range
    detection” or used to store the data mask in “equal to”.
struct __flexcan_pn_config
struct __unnamed68__
    < The data target values 2 which used only as the upper limit value in data match “range
    detection” or used to store the data mask in “equal to”.
```

Public Members

```
uint32_t upperWord0
    CAN Frame payload word0.
uint32_t upperWord1
    CAN Frame payload word1.
struct __unnamed70__
```

Public Members

```
uint8_t upperByte3
    CAN Frame payload byte3.
uint8_t upperByte2
    CAN Frame payload byte2.
uint8_t upperByte1
    CAN Frame payload byte1.
uint8_t upperByte0
    CAN Frame payload byte0.
uint8_t upperByte7
    CAN Frame payload byte7.
uint8_t upperByte6
    CAN Frame payload byte6.
uint8_t upperByte5
    CAN Frame payload byte5.
uint8_t upperByte4
    CAN Frame payload byte4.
```

2.20 FlexCAN eDMA Driver

```
void FLEXCAN_TransferCreateHandleEDMA(CAN_Type *base, flexcan_edma_handle_t *handle,
                                       flexcan_edma_transfer_callback_t callback, void
                                       *userData, edma_handle_t *rxFifoEdmaHandle)
```

Initializes the FlexCAN handle, which is used in transactional functions.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- callback – The callback function.
- userData – The parameter of the callback function.
- rxFifoEdmaHandle – User-requested DMA handle for Rx FIFO DMA transfer.

```
void FLEXCAN_PrepareTransfConfiguration(CAN_Type *base, flexcan_fifo_transfer_t *pFifoXfer,
                                       edma_transfer_config_t *pEdmaConfig)
```

Prepares the eDMA transfer configuration for FLEXCAN Legacy RX FIFO.

This function prepares the eDMA transfer configuration structure according to FLEXCAN Legacy RX FIFO.

Parameters

- base – FlexCAN peripheral base address.
- pFifoXfer – FlexCAN Rx FIFO EDMA transfer structure, see flexcan_fifo_transfer_t.
- pEdmaConfig – The user configuration structure of type edma_transfer_t.

```
status_t FLEXCAN_StartTransferDatafromRxFIFO(CAN_Type *base, flexcan_edma_handle_t
                                             *handle, edma_transfer_config_t
                                             *pEdmaConfig)
```

Start Transfer Data from the FLEXCAN Legacy Rx FIFO using eDMA.

This function to Update edma transfer configuration and Start eDMA transfer

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- pEdmaConfig – The user configuration structure of type edma_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXCAN_RxFifoBusy – Previous transfer ongoing.

```
status_t FLEXCAN_TransferReceiveFifoEDMA(CAN_Type *base, flexcan_edma_handle_t *handle,
                                          flexcan_fifo_transfer_t *pFifoXfer)
```

Receives the CAN Message from the Legacy Rx FIFO using eDMA.

This function receives the CAN Message using eDMA. This is a non-blocking function, which returns right away. After the CAN Message is received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.

- pFifoXfer – FlexCAN Rx FIFO EDMA transfer structure, see flex-can_fifo_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXCAN_RxFifoBusy – Previous transfer ongoing.

status_t FLEXCAN_TransferGetReceiveFifoCountEMDA(CAN_Type *base, flexcan_edma_handle_t *handle, size_t *count)

Gets the Legacy Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- base – FlexCAN peripheral base address.
- handle – FlexCAN handle pointer.
- count – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXCAN_TransferAbortReceiveFifoEDMA(CAN_Type *base, flexcan_edma_handle_t *handle)

Aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

This function aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.

status_t FLEXCAN_TransferReceiveEnhancedFifoEDMA(CAN_Type *base, flexcan_edma_handle_t *handle, flexcan_fifo_transfer_t *pFifoXfer)

Receives the CAN FD Message from the Enhanced Rx FIFO using eDMA.

This function receives the CAN FD Message using eDMA. This is a non-blocking function, which returns right away. After the CAN Message is received, the receive callback function is called.

Parameters

- base – FlexCAN peripheral base address.
- handle – Pointer to flexcan_edma_handle_t structure.
- pFifoXfer – FlexCAN Rx FIFO EDMA transfer structure, see flex-can_fifo_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXCAN_RxFifoBusy – Previous transfer ongoing.

static inline *status_t* FLEXCAN_TransferGetReceiveEnhancedFifoCountEMDA(CAN_Type *base, flexcan_edma_handle_t *handle, size_t *count)

Gets the Enhanced Rx Fifo transfer status during a interrupt non-blocking receive.

Parameters

- `base` – FlexCAN peripheral base address.
- `handle` – FlexCAN handle pointer.
- `count` – Number of CAN messages receive so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – `count` is Invalid.
- `kStatus_Success` – Successfully return the count.

FSL_FLEXCAN_EDMA_DRIVER_VERSION

FlexCAN EDMA driver version.

```
typedef struct flexcan_edma_handle flexcan_edma_handle_t
```

```
typedef void (*flexcan_edma_transfer_callback_t)(CAN_Type *base, flexcan_edma_handle_t *handle, status_t status, void *userData)
```

FlexCAN transfer callback function.

```
struct flexcan_edma_handle
```

```
#include <fsl_flexcan_edma.h> FlexCAN eDMA handle.
```

Public Members

```
flexcan_edma_transfer_callback_t callback
```

Callback function.

```
void *userData
```

FlexCAN callback function parameter.

```
edma_handle_t *rxFifoEdmaHandle
```

The EDMA handler for Rx FIFO.

```
volatile uint8_t rxFifoState
```

Rx FIFO transfer state.

```
size_t frameNum
```

The number of messages that need to be received.

```
flexcan_fd_frame_t *framefd
```

Point to the buffer of CAN Message to be received from Enhanced Rx FIFO.

2.21 FlexIO: FlexIO Driver

2.22 FlexIO Driver

```
void FLEXIO_GetDefaultConfig(flexio_config_t *userConfig)
```

Gets the default configuration to configure the FlexIO module. The configuration can used directly to call the FLEXIO_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

Parameters

- userConfig – pointer to flexio_config_t structure

void FLEXIO_Init(FLEXIO_Type *base, const flexio_config_t *userConfig)

Configures the FlexIO with a FlexIO configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO_GetDefaultConfig().

Example

```
flexio_config_t config = {  
    .enableFlexio = true,  
    .enableInDoze = false,  
    .enableInDebug = true,  
    .enableFastAccess = false  
};  
FLEXIO_Configure(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- userConfig – pointer to flexio_config_t structure

void FLEXIO_Deinit(FLEXIO_Type *base)

Gates the FlexIO clock. Call this API to stop the FlexIO clock.

Note: After calling this API, call the 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,
    .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_SHIFToNSTAT(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_SHIFThSTAT(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

2.23 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

2.24 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

2.25 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

2.26 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.

2.27 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

2.28 FlexIO SPI Driver

```
void FLEXIO_SPI_MasterInit(FLEXIO_SPI_Type *base, flexio_spi_master_config_t
                           *masterConfig, uint32_t srcClock_Hz)
```

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI master hardware, and configures the FlexIO SPI with FlexIO SPI master configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_MasterGetDefaultConfig().

Example

```
FLEXIO_SPI_Type spiDev = {
    .flexioBase = FLEXIO,
    .SDOPinIndex = 0,
    .SDIPinIndex = 1,
    .SCKPinIndex = 2,
    .CSnPinIndex = 3,
    .shifterIndex = {0,1},
    .timerIndex = {0,1}
};
flexio_spi_master_config_t config = {
    .enableMaster = true,
    .enableInDoze = false,
    .enableInDebug = true,
```

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```
.enableFastAccess = false,
.baudRate_Bps = 500000,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_MasterInit(&spiDev, &config, srcClock_Hz);
```

Note: 1.FlexIO SPI master only support CPOL = 0, which means clock inactive low. 2.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI master communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by $2*2=4$. If FlexIO SPI master communicates with FlexIO SPI slave, the maximum baud rate is FlexIO clock frequency divided by $(1.5+2.5)*2=8$.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- masterConfig – Pointer to the flexio_spi_master_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

void FLEXIO_SPI_MasterDeinit(*FLEXIO_SPI_Type* *base)

Resets the FlexIO SPI timer and shifter config.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_MasterGetDefaultConfig(*flexio_spi_master_config_t* *masterConfig)

Gets the default configuration to configure the FlexIO SPI master. The configuration can be used directly by calling the FLEXIO_SPI_MasterConfigure(). Example:

```
flexio_spi_master_config_t masterConfig;
FLEXIO_SPI_MasterGetDefaultConfig(&masterConfig);
```

Parameters

- masterConfig – Pointer to the flexio_spi_master_config_t structure.

void FLEXIO_SPI_SlaveInit(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_config_t* *slaveConfig)

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI slave hardware configuration, and configures the FlexIO SPI with FlexIO SPI slave configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_SlaveGetDefaultConfig().

Note: 1.Only one timer is needed in the FlexIO SPI slave. As a result, the second timer index is ignored. 2.FlexIO SPI slave only support CPOL = 0, which means clock inactive low. 3.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI slave communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by $3*2=6$. If FlexIO SPI slave communicates with FlexIO SPI master, the maximum baud rate is FlexIO clock frequency divided by $(1.5+2.5)*2=8$. Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
```

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```
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0}
};
flexio_spi_slave_config_t config = {
.enableSlave = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_SlaveInit(&spiDev, &config);
```

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

void FLEXIO_SPI_SlaveDeinit(*FLEXIO_SPI_Type* *base)

Gates the FlexIO clock.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_SlaveGetDefaultConfig(*flexio_spi_slave_config_t* *slaveConfig)

Gets the default configuration to configure the FlexIO SPI slave. The configuration can be used directly for calling the FLEXIO_SPI_SlaveConfigure(). Example:

```
flexio_spi_slave_config_t slaveConfig;
FLEXIO_SPI_SlaveGetDefaultConfig(&slaveConfig);
```

Parameters

- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

uint32_t FLEXIO_SPI_GetStatusFlags(*FLEXIO_SPI_Type* *base)

Gets FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

Returns

status flag; Use the status flag to AND the following flag mask and get the status.

- kFLEXIO_SPI_TxEmptyFlag
- kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_ClearStatusFlags(*FLEXIO_SPI_Type* *base, uint32_t mask)

Clears FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

- **mask** – status flag The parameter can be any combination of the following values:
 - kFLEXIO_SPI_TxEmptyFlag
 - kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_EnableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Enables the FlexIO SPI interrupt.

This function enables the FlexIO SPI interrupt.

Parameters

- **base** – Pointer to the FLEXIO_SPI_Type structure.
- **mask** – interrupt source. The parameter can be any combination of the following values:
 - kFLEXIO_SPI_RxFullInterruptEnable
 - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_DisableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Disables the FlexIO SPI interrupt.

This function disables the FlexIO SPI interrupt.

Parameters

- **base** – Pointer to the FLEXIO_SPI_Type structure.
- **mask** – interrupt source The parameter can be any combination of the following values:
 - kFLEXIO_SPI_RxFullInterruptEnable
 - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_EnableDMA(*FLEXIO_SPI_Type* *base, uint32_t mask, bool enable)

Enables/disables the FlexIO SPI transmit DMA. This function enables/disables the FlexIO SPI Tx DMA, which means that asserting the kFLEXIO_SPI_TxEmptyFlag does/doesn't trigger the DMA request.

Parameters

- **base** – Pointer to the FLEXIO_SPI_Type structure.
- **mask** – SPI DMA source.
- **enable** – True means enable DMA, false means disable DMA.

static inline uint32_t FLEXIO_SPI_GetTxDataRegisterAddress(*FLEXIO_SPI_Type* *base,
flexio_spi_shift_direction_t
direction)

Gets the FlexIO SPI transmit data register address for MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- **base** – Pointer to the FLEXIO_SPI_Type structure.
- **direction** – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI transmit data register address.

```
static inline uint32_t FLEXIO_SPI_GetRxDataRegisterAddress(FLEXIO_SPI_Type *base,  
                                                         flexio_spi_shift_direction_t  
                                                         direction)
```

Gets the FlexIO SPI receive data register address for the MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.
- direction – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI receive data register address.

```
static inline void FLEXIO_SPI_Enable(FLEXIO_SPI_Type *base, bool enable)
```

Enables/disables the FlexIO SPI module operation.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type*.
- enable – True to enable, false does not have any effect.

```
void FLEXIO_SPI_MasterSetBaudRate(FLEXIO_SPI_Type *base, uint32_t baudRate_Bps,  
                                  uint32_t srcClockHz)
```

Sets baud rate for the FlexIO SPI transfer, which is only used for the master.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.
- baudRate_Bps – Baud Rate needed in Hz.
- srcClockHz – SPI source clock frequency in Hz.

```
static inline void FLEXIO_SPI_WriteData(FLEXIO_SPI_Type *base, flexio_spi_shift_direction_t  
                                       direction, uint32_t data)
```

Writes one byte of data, which is sent using the MSB method.

Note: This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.
- direction – Shift direction of MSB first or LSB first.
- data – 8/16/32 bit data.

```
static inline uint32_t FLEXIO_SPI_ReadData(FLEXIO_SPI_Type *base,  
                                           flexio_spi_shift_direction_t direction)
```

Reads 8 bit/16 bit data.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.

- direction – Shift direction of MSB first or LSB first.

Returns

8 bit/16 bit data received.

status_t FLEXIO_SPI_WriteBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, const uint8_t *buffer, size_t size)

Sends a buffer of data bytes.

Note: This function blocks using the polling method until all bytes have been sent.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The data bytes to send.
- size – The number of data bytes to send.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_ReadBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, uint8_t *buffer, size_t size)

Receives a buffer of bytes.

Note: This function blocks using the polling method until all bytes have been received.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The buffer to store the received bytes.
- size – The number of data bytes to be received.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_MasterTransferBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_transfer_t* *xfer)

Receives a buffer of bytes.

Note: This function blocks via polling until all bytes have been received.

Parameters

- base – pointer to FLEXIO_SPI_Type structure
- xfer – FlexIO SPI transfer structure, see flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully create the handle.

- `kStatus_FLEXIO_SPI_Timeout` – The transfer timed out and was aborted.

`void FLEXIO_SPI_FlushShifters(FLEXIO_SPI_Type *base)`

Flush tx/rx shifters.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.

`status_t FLEXIO_SPI_MasterTransferCreateHandle(FLEXIO_SPI_Type *base,
flexio_spi_master_handle_t *handle,
flexio_spi_master_transfer_callback_t
callback, void *userData)`

Initializes the FlexIO SPI Master handle, which is used in transactional functions.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.
- `callback` – The callback function.
- `userData` – The parameter of the callback function.

Return values

- `kStatus_Success` – Successfully create the handle.
- `kStatus_OutOfRange` – The FlexIO type/handle/ISR table out of range.

`status_t FLEXIO_SPI_MasterTransferNonBlocking(FLEXIO_SPI_Type *base,
flexio_spi_master_handle_t *handle,
flexio_spi_transfer_t *xfer)`

Master transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.
- `xfer` – FlexIO SPI transfer structure. See `flexio_spi_transfer_t`.

Return values

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_FLEXIO_SPI_Busy` – SPI is not idle, is running another transfer.

`void FLEXIO_SPI_MasterTransferAbort(FLEXIO_SPI_Type *base, flexio_spi_master_handle_t
*handle)`

Aborts the master data transfer, which used IRQ.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_master_handle_t` structure to store the transfer state.

```
status_t FLEXIO_SPI_MasterTransferGetCount(FLEXIO_SPI_Type *base,  
                                           flexio_spi_master_handle_t *handle, size_t  
                                           *count)
```

Gets the data transfer status which used IRQ.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.
- handle – Pointer to the *flexio_spi_master_handle_t* structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- *kStatus_InvalidArgument* – count is Invalid.
- *kStatus_Success* – Successfully return the count.

```
void FLEXIO_SPI_MasterTransferHandleIRQ(void *spiType, void *spiHandle)
```

FlexIO SPI master IRQ handler function.

Parameters

- spiType – Pointer to the *FLEXIO_SPI_Type* structure.
- spiHandle – Pointer to the *flexio_spi_master_handle_t* structure to store the transfer state.

```
status_t FLEXIO_SPI_SlaveTransferCreateHandle(FLEXIO_SPI_Type *base,  
                                              flexio_spi_slave_handle_t *handle,  
                                              flexio_spi_slave_transfer_callback_t callback,  
                                              void *userData)
```

Initializes the FlexIO SPI Slave handle, which is used in transactional functions.

Parameters

- base – Pointer to the *FLEXIO_SPI_Type* structure.
- handle – Pointer to the *flexio_spi_slave_handle_t* structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- *kStatus_Success* – Successfully create the handle.
- *kStatus_OutOfRange* – The FlexIO type/handle/ISR table out of range.

```
status_t FLEXIO_SPI_SlaveTransferNonBlocking(FLEXIO_SPI_Type *base,  
                                             flexio_spi_slave_handle_t *handle,  
                                             flexio_spi_transfer_t *xfer)
```

Slave transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- handle – Pointer to the *flexio_spi_slave_handle_t* structure to store the transfer state.
- base – Pointer to the *FLEXIO_SPI_Type* structure.
- xfer – FlexIO SPI transfer structure. See *flexio_spi_transfer_t*.

Return values

- `kStatus_Success` – Successfully start a transfer.
- `kStatus_InvalidArgument` – Input argument is invalid.
- `kStatus_FLEXIO_SPI_Busy` – SPI is not idle; it is running another transfer.

```
static inline void FLEXIO_SPI_SlaveTransferAbort(FLEXIO_SPI_Type *base,
                                                flexio_spi_slave_handle_t *handle)
```

Aborts the slave data transfer which used IRQ, share same API with master.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.

```
static inline status_t FLEXIO_SPI_SlaveTransferGetCount(FLEXIO_SPI_Type *base,
                                                        flexio_spi_slave_handle_t *handle,
                                                        size_t *count)
```

Gets the data transfer status which used IRQ, share same API with master.

Parameters

- `base` – Pointer to the `FLEXIO_SPI_Type` structure.
- `handle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.
- `count` – Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – count is Invalid.
- `kStatus_Success` – Successfully return the count.

```
void FLEXIO_SPI_SlaveTransferHandleIRQ(void *spiType, void *spiHandle)
```

FlexIO SPI slave IRQ handler function.

Parameters

- `spiType` – Pointer to the `FLEXIO_SPI_Type` structure.
- `spiHandle` – Pointer to the `flexio_spi_slave_handle_t` structure to store the transfer state.

```
FSL_FLEXIO_SPI_DRIVER_VERSION
```

FlexIO SPI driver version.

Error codes for the FlexIO SPI driver.

Values:

```
enumerator kStatus_FLEXIO_SPI_Busy
```

FlexIO SPI is busy.

```
enumerator kStatus_FLEXIO_SPI_Idle
```

SPI is idle

```
enumerator kStatus_FLEXIO_SPI_Error
```

FlexIO SPI error.

```
enumerator kStatus_FLEXIO_SPI_Timeout
```

FlexIO SPI timeout polling status flags.

enum _flexio_spi_clock_phase

FlexIO SPI clock phase configuration.

Values:

enumerator kFLEXIO_SPI_ClockPhaseFirstEdge

First edge on 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.

2.29 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 `__unnamed262__`

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.

2.30 FLEXSPI: Flexible Serial Peripheral Interface Driver

uint32_t FLEXSPI_GetInstance(FLEXSPI_Type *base)

Get the instance number for FLEXSPI.

Parameters

- base – FLEXSPI base pointer.

status_t FLEXSPI_CheckAndClearError(FLEXSPI_Type *base, uint32_t status)

Check and clear IP command execution errors.

Parameters

- base – FLEXSPI base pointer.
- status – interrupt status.

void FLEXSPI_Init(FLEXSPI_Type *base, const flexspi_config_t *config)

Initializes the FLEXSPI module and internal state.

This function enables the clock for FLEXSPI and also configures the FLEXSPI with the input configure parameters. Users should call this function before any FLEXSPI operations.

Parameters

- base – FLEXSPI peripheral base address.
- config – FLEXSPI configure structure.

void FLEXSPI_GetDefaultConfig(flexspi_config_t *config)

Gets default settings for FLEXSPI.

Parameters

- config – FLEXSPI configuration structure.

void FLEXSPI_Deinit(FLEXSPI_Type *base)

Deinitializes the FLEXSPI module.

Clears the FLEXSPI state and FLEXSPI module registers.

Parameters

- base – FLEXSPI peripheral base address.

void FLEXSPI_UpdateDllValue(FLEXSPI_Type *base, flexspi_device_config_t *config, flexspi_port_t port)

Update FLEXSPI DLL value depending on currently flexspi root clock.

Parameters

- base – FLEXSPI peripheral base address.
- config – Flash configuration parameters.
- port – FLEXSPI Operation port.

void FLEXSPI_SetFlashConfig(FLEXSPI_Type *base, flexspi_device_config_t *config, flexspi_port_t port)

Configures the connected device parameter.

This function configures the connected device relevant parameters, such as the size, command, and so on. The flash configuration value cannot have a default value. The user needs to configure it according to the connected device.

Parameters

- base – FLEXSPI peripheral base address.

- config – Flash configuration parameters.
- port – FLEXSPI Operation port.

void FLEXSPI_SoftwareReset(FLEXSPI_Type *base)

Software reset for the FLEXSPI logic.

This function sets the software reset flags for both AHB and buffer domain and resets both AHB buffer and also IP FIFOs.

Parameters

- base – FLEXSPI peripheral base address.

static inline void FLEXSPI_Enable(FLEXSPI_Type *base, bool enable)

Enables or disables the FLEXSPI module.

Parameters

- base – FLEXSPI peripheral base address.
- enable – True means enable FLEXSPI, false means disable.

void FLEXSPI_UpdateAhbBuffersSettings(FLEXSPI_Type *base, flexspi_ahbBuffers_ctrl_t *ptrAhbBufferCtrl)

Update all AHB buffers' settings, including buffer size, master ID.

Parameters

- base – FLEXSPI peripheral base address.
- ptrAhbBufferCtrl – Pointer to structure flexspi_ahbBuffers_ctrl_t which store all AHB buffers' settings.

static inline void FLEXSPI_EnableInterrupts(FLEXSPI_Type *base, uint32_t mask)

Enables the FLEXSPI interrupts.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

static inline void FLEXSPI_DisableInterrupts(FLEXSPI_Type *base, uint32_t mask)

Disable the FLEXSPI interrupts.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

static inline void FLEXSPI_EnableTxDMA(FLEXSPI_Type *base, bool enable)

Enables or disables FLEXSPI IP Tx FIFO DMA requests.

Parameters

- base – FLEXSPI peripheral base address.
- enable – Enable flag for transmit DMA request. Pass true for enable, false for disable.

static inline void FLEXSPI_EnableRxDMA(FLEXSPI_Type *base, bool enable)

Enables or disables FLEXSPI IP Rx FIFO DMA requests.

Parameters

- base – FLEXSPI peripheral base address.
- enable – Enable flag for receive DMA request. Pass true for enable, false for disable.

```
static inline uint32_t FLEXSPI_GetTxFifoAddress(FLEXSPI_Type *base)
```

Gets FLEXSPI IP tx fifo address for DMA transfer.

Parameters

- base – FLEXSPI peripheral base address.

Return values

The – tx fifo address.

```
static inline uint32_t FLEXSPI_GetRxFifoAddress(FLEXSPI_Type *base)
```

Gets FLEXSPI IP rx fifo address for DMA transfer.

Parameters

- base – FLEXSPI peripheral base address.

Return values

The – rx fifo address.

```
static inline void FLEXSPI_ResetFifos(FLEXSPI_Type *base, bool txFifo, bool rxFifo)
```

Clears the FLEXSPI IP FIFO logic.

Parameters

- base – FLEXSPI peripheral base address.
- txFifo – Pass true to reset TX FIFO.
- rxFifo – Pass true to reset RX FIFO.

```
static inline void FLEXSPI_GetFifoCounts(FLEXSPI_Type *base, size_t *txCount, size_t  
                                         *rxCount)
```

Gets the valid data entries in the FLEXSPI FIFOs.

Parameters

- base – FLEXSPI peripheral base address.
- txCount – **[out]** Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
- rxCount – **[out]** Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

```
static inline uint32_t FLEXSPI_GetInterruptStatusFlags(FLEXSPI_Type *base)
```

Get the FLEXSPI interrupt status flags.

Parameters

- base – FLEXSPI peripheral base address.

Return values

interrupt – status flag, use status flag to AND flexspi_flags_t could get the related status.

```
static inline void FLEXSPI_ClearInterruptStatusFlags(FLEXSPI_Type *base, uint32_t mask)
```

Get the FLEXSPI interrupt status flags.

Parameters

- base – FLEXSPI peripheral base address.
- mask – FLEXSPI interrupt source.

```
static inline flexspi_arb_command_source_t FLEXSPI_GetArbitratorCommandSource(FLEXSPI_Type  
                                                                              *base)
```

Gets the trigger source of current command sequence granted by arbitrator.

Parameters

- base – FLEXSPI peripheral base address.

Return values

trigger – source of current command sequence.

```
static inline flexspi_ip_error_code_t FLEXSPI_GetIPCommandErrorCode(FLEXSPI_Type *base,  
                                                                    uint8_t *index)
```

Gets the error code when IP command error detected.

Parameters

- base – FLEXSPI peripheral base address.
- index – Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error – code when IP command error detected.

```
static inline flexspi_ahb_error_code_t FLEXSPI_GetAHBCommandErrorCode(FLEXSPI_Type  
                                                                    *base, uint8_t  
                                                                    *index)
```

Gets the error code when AHB command error detected.

Parameters

- base – FLEXSPI peripheral base address.
- index – Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error – code when AHB command error detected.

```
static inline bool FLEXSPI_GetBusIdleStatus(FLEXSPI_Type *base)
```

Returns whether the bus is idle.

Parameters

- base – FLEXSPI peripheral base address.

Return values

- true – Bus is idle.
- false – Bus is busy.

```
void FLEXSPI_UpdateRxSampleClock(FLEXSPI_Type *base, flexspi_read_sample_clock_t  
                                clockSource)
```

Update read sample clock source.

Parameters

- base – FLEXSPI peripheral base address.
- clockSource – clockSource of type flexspi_read_sample_clock_t

```
void FLEXSPI_UpdateLUT(FLEXSPI_Type *base, uint32_t index, const uint32_t *cmd, uint32_t  
                      count)
```

Updates the LUT table.

Parameters

- base – FLEXSPI peripheral base address.
- index – From which index start to update. It could be any index of the LUT table, which also allows user to update command content inside a command. Each command consists of up to 8 instructions and occupy 4*32-bit memory.

- `cmd` – Command sequence array.
- `count` – Number of sequences.

`static inline void FLEXSPI_WriteData(FLEXSPI_Type *base, uint32_t data, uint8_t fifoIndex)`
Writes data into FIFO.

Parameters

- `base` – FLEXSPI peripheral base address
- `data` – The data bytes to send
- `fifoIndex` – Destination fifo index.

`static inline uint32_t FLEXSPI_ReadData(FLEXSPI_Type *base, uint8_t fifoIndex)`
Receives data from data FIFO.

Parameters

- `base` – FLEXSPI peripheral base address
- `fifoIndex` – Source fifo index.

Returns

The data in the FIFO.

`status_t FLEXSPI_WriteBlocking(FLEXSPI_Type *base, uint8_t *buffer, size_t size)`
Sends a buffer of data bytes using blocking method.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- `base` – FLEXSPI peripheral base address
- `buffer` – The data bytes to send
- `size` – The number of data bytes to send

Return values

- `kStatus_Success` – write success without error
- `kStatus_FLEXSPI_SequenceExecutionTimeout` – sequence execution timeout
- `kStatus_FLEXSPI_IpCommandSequenceError` – IP command sequence error detected
- `kStatus_FLEXSPI_IpCommandGrantTimeout` – IP command grant timeout detected

`status_t FLEXSPI_ReadBlocking(FLEXSPI_Type *base, uint8_t *buffer, size_t size)`
Receives a buffer of data bytes using a blocking method.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- `base` – FLEXSPI peripheral base address
- `buffer` – The data bytes to send
- `size` – The number of data bytes to receive

Return values

- `kStatus_Success` – read success without error
- `kStatus_FLEXSPI_SequenceExecutionTimeout` – sequence execution timeout
- `kStatus_FLEXSPI_IpCommandSequenceError` – IP command sequence error detected
- `kStatus_FLEXSPI_IpCommandGrantTimeout` – IP command grant timeout detected

`status_t` FLEXSPI_TransferBlocking(FLEXSPI_Type *base, *flexspi_transfer_t* *xfer)

Execute command to transfer a buffer data bytes using a blocking method.

Parameters

- `base` – FLEXSPI peripheral base address
- `xfer` – pointer to the transfer structure.

Return values

- `kStatus_Success` – command transfer success without error
- `kStatus_FLEXSPI_SequenceExecutionTimeout` – sequence execution timeout
- `kStatus_FLEXSPI_IpCommandSequenceError` – IP command sequence error detected
- `kStatus_FLEXSPI_IpCommandGrantTimeout` – IP command grant timeout detected

`void` FLEXSPI_TransferCreateHandle(FLEXSPI_Type *base, *flexspi_handle_t* *handle, *flexspi_transfer_callback_t* callback, `void` *userData)

Initializes the FLEXSPI handle which is used in transactional functions.

Parameters

- `base` – FLEXSPI peripheral base address.
- `handle` – pointer to `flexspi_handle_t` structure to store the transfer state.
- `callback` – pointer to user callback function.
- `userData` – user parameter passed to the callback function.

`status_t` FLEXSPI_TransferNonBlocking(FLEXSPI_Type *base, *flexspi_handle_t* *handle, *flexspi_transfer_t* *xfer)

Performs a interrupt non-blocking transfer on the FLEXSPI bus.

Note: Calling the API returns immediately after transfer initiates. The user needs to call `FLEXSPI_GetTransferCount` to poll the transfer status to check whether the transfer is finished. If the return status is not `kStatus_FLEXSPI_Busy`, the transfer is finished. For `FLEXSPI_Read`, the `dataSize` should be multiple of rx watermark level, or FLEXSPI could not read data properly.

Parameters

- `base` – FLEXSPI peripheral base address.
- `handle` – pointer to `flexspi_handle_t` structure which stores the transfer state.
- `xfer` – pointer to `flexspi_transfer_t` structure.

Return values

- `kStatus_Success` – Successfully start the data transmission.
- `kStatus_FLEXSPI_Busy` – Previous transmission still not finished.

`status_t FLEXSPI_TransferGetCount(FLEXSPI_Type *base, flexspi_handle_t *handle, size_t *count)`

Gets the master transfer status during a interrupt non-blocking transfer.

Parameters

- `base` – FLEXSPI peripheral base address.
- `handle` – pointer to `flexspi_handle_t` structure which stores the transfer state.
- `count` – Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – `count` is Invalid.
- `kStatus_Success` – Successfully return the count.

`void FLEXSPI_TransferAbort(FLEXSPI_Type *base, flexspi_handle_t *handle)`

Aborts an interrupt non-blocking transfer early.

Note: This API can be called at any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- `base` – FLEXSPI peripheral base address.
- `handle` – pointer to `flexspi_handle_t` structure which stores the transfer state

`void FLEXSPI_TransferHandleIRQ(FLEXSPI_Type *base, flexspi_handle_t *handle)`

Master interrupt handler.

Parameters

- `base` – FLEXSPI peripheral base address.
- `handle` – pointer to `flexspi_handle_t` structure.

`FSL_FLEXSPI_DRIVER_VERSION`

FLEXSPI driver version.

Status structure of FLEXSPI.

Values:

enumerator `kStatus_FLEXSPI_Busy`
FLEXSPI is busy

enumerator `kStatus_FLEXSPI_SequenceExecutionTimeout`
Sequence execution timeout error occurred during FLEXSPI transfer.

enumerator `kStatus_FLEXSPI_IpCommandSequenceError`
IP command Sequence execution timeout error occurred during FLEXSPI transfer.

enumerator `kStatus_FLEXSPI_IpCommandGrantTimeout`
IP command grant timeout error occurred during FLEXSPI transfer.

CMD definition of FLEXSPI, use to form LUT instruction, `_flexspi_command`.

Values:

enumerator `kFLEXSPI_Command_STOP`

Stop execution, deassert CS.

enumerator `kFLEXSPI_Command_SDR`

Transmit Command code to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_RADDR_SDR`

Transmit Row Address to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_CADDR_SDR`

Transmit Column Address to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_MODE1_SDR`

Transmit 1-bit Mode bits to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_MODE2_SDR`

Transmit 2-bit Mode bits to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_MODE4_SDR`

Transmit 4-bit Mode bits to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_MODE8_SDR`

Transmit 8-bit Mode bits to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_WRITE_SDR`

Transmit Programming Data to Flash, using SDR mode.

enumerator `kFLEXSPI_Command_READ_SDR`

Receive Read Data from Flash, using SDR mode.

enumerator `kFLEXSPI_Command_LEARN_SDR`

Receive Read Data or Preamble bit from Flash, SDR mode.

enumerator `kFLEXSPI_Command_DATSZ_SDR`

Transmit Read/Program Data size (byte) to Flash, SDR mode.

enumerator `kFLEXSPI_Command_DUMMY_SDR`

Leave data lines undriven by FlexSPI controller.

enumerator `kFLEXSPI_Command_DUMMY_RWDS_SDR`

Leave data lines undriven by FlexSPI controller; dummy cycles decided by RWDS.

enumerator `kFLEXSPI_Command_DDR`

Transmit Command code to Flash, using DDR mode.

enumerator `kFLEXSPI_Command_RADDR_DDR`

Transmit Row Address to Flash, using DDR mode.

enumerator `kFLEXSPI_Command_CADDR_DDR`

Transmit Column Address to Flash, using DDR mode.

enumerator `kFLEXSPI_Command_MODE1_DDR`

Transmit 1-bit Mode bits to Flash, using DDR mode.

enumerator `kFLEXSPI_Command_MODE2_DDR`

Transmit 2-bit Mode bits to Flash, using DDR mode.

```

enumerator kFLEXSPI_Command_MODE4_DDR
    Transmit 4-bit Mode bits to Flash, using DDR mode.
enumerator kFLEXSPI_Command_MODE8_DDR
    Transmit 8-bit Mode bits to Flash, using DDR mode.
enumerator kFLEXSPI_Command_WRITE_DDR
    Transmit Programming Data to Flash, using DDR mode.
enumerator kFLEXSPI_Command_READ_DDR
    Receive Read Data from Flash, using DDR mode.
enumerator kFLEXSPI_Command_LEARN_DDR
    Receive Read Data or Preamble bit from Flash, DDR mode.
enumerator kFLEXSPI_Command_DATSZ_DDR
    Transmit Read/Program Data size (byte) to Flash, DDR mode.
enumerator kFLEXSPI_Command_DUMMY_DDR
    Leave data lines undriven by FlexSPI controller.
enumerator kFLEXSPI_Command_DUMMY_RWDS_DDR
    Leave data lines undriven by FlexSPI controller, dummy cycles decided by RWDS.
enumerator kFLEXSPI_Command_JUMP_ON_CS
    Stop execution, deassert CS and save operand[7:0] as the instruction start pointer for
    next sequence
enum _flexspi_pad
    pad definition of FLEXSPI, use to form LUT instruction.
    Values:
    enumerator kFLEXSPI_1PAD
        Transmit command/address and transmit/receive data only through DATA0/DATA1.
    enumerator kFLEXSPI_2PAD
        Transmit command/address and transmit/receive data only through DATA[1:0].
    enumerator kFLEXSPI_4PAD
        Transmit command/address and transmit/receive data only through DATA[3:0].
    enumerator kFLEXSPI_8PAD
        Transmit command/address and transmit/receive data only through DATA[7:0].
enum _flexspi_flags
    FLEXSPI interrupt status flags.
    Values:
    enumerator kFLEXSPI_SequenceExecutionTimeoutFlag
        Sequence execution timeout.
    enumerator kFLEXSPI_AhbBusErrorFlag
        AHB Bus error flag.
    enumerator kFLEXSPI_SckStoppedBecauseTxEmptyFlag
        SCK is stopped during command sequence because Async TX FIFO empty.
    enumerator kFLEXSPI_SckStoppedBecauseRxFullFlag
        SCK is stopped during command sequence because Async RX FIFO full.
    enumerator kFLEXSPI_IpTxFifoWatermarkEmptyFlag
        IP TX FIFO WaterMark empty.

```

enumerator kFLEXSPI_IpRxFifoWatermarkAvailableFlag
IP RX FIFO WaterMark available.

enumerator kFLEXSPI_AhbCommandSequenceErrorFlag
AHB triggered Command Sequences Error.

enumerator kFLEXSPI_IpCommandSequenceErrorFlag
IP triggered Command Sequences Error.

enumerator kFLEXSPI_AhbCommandGrantTimeoutFlag
AHB triggered Command Sequences Grant Timeout.

enumerator kFLEXSPI_IpCommandGrantTimeoutFlag
IP triggered Command Sequences Grant Timeout.

enumerator kFLEXSPI_IpCommandExecutionDoneFlag
IP triggered Command Sequences Execution finished.

enumerator kFLEXSPI_AllInterruptFlags
All flags.

enum _flexspi_read_sample_clock
FLEXSPI sample clock source selection for Flash Reading.

Values:

enumerator kFLEXSPI_ReadSampleClkLoopbackInternally
Dummy Read strobe generated by FlexSPI Controller and loopback internally.

enumerator kFLEXSPI_ReadSampleClkLoopbackFromDqsPad
Dummy Read strobe generated by FlexSPI Controller and loopback from DQS pad.

enumerator kFLEXSPI_ReadSampleClkLoopbackFromSckPad
SCK output clock and loopback from SCK pad.

enumerator kFLEXSPI_ReadSampleClkExternalInputFromDqsPad
Flash provided Read strobe and input from DQS pad.

enum _flexspi_cs_interval_cycle_unit
FLEXSPI interval unit for flash device select.

Values:

enumerator kFLEXSPI_CsIntervalUnit1SckCycle
Chip selection interval: CSINTERVAL * 1 serial clock cycle.

enumerator kFLEXSPI_CsIntervalUnit256SckCycle
Chip selection interval: CSINTERVAL * 256 serial clock cycle.

enum _flexspi_ahb_write_wait_unit
FLEXSPI AHB wait interval unit for writing.

Values:

enumerator kFLEXSPI_AhbWriteWaitUnit2AhbCycle
AWRWAIT unit is 2 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit8AhbCycle
AWRWAIT unit is 8 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit32AhbCycle
AWRWAIT unit is 32 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit128AhbCycle
AWRWAIT unit is 128 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit512AhbCycle
AWRWAIT unit is 512 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit2048AhbCycle
AWRWAIT unit is 2048 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit8192AhbCycle
AWRWAIT unit is 8192 ahb clock cycle.

enumerator kFLEXSPI_AhbWriteWaitUnit32768AhbCycle
AWRWAIT unit is 32768 ahb clock cycle.

enum _flexspi_ip_error_code

Error Code when IP command Error detected.

Values:

enumerator kFLEXSPI_IpCmdErrorNoError
No error.

enumerator kFLEXSPI_IpCmdErrorJumpOnCsInIpCmd
IP command with JMP_ON_CS instruction used.

enumerator kFLEXSPI_IpCmdErrorUnknownOpCode
Unknown instruction opcode in the sequence.

enumerator kFLEXSPI_IpCmdErrorSdrDummyInDdrSequence
Instruction DUMMY_SDR/DUMMY_RWDS_SDR used in DDR sequence.

enumerator kFLEXSPI_IpCmdErrorDdrDummyInSdrSequence
Instruction DUMMY_DDR/DUMMY_RWDS_DDR used in SDR sequence.

enumerator kFLEXSPI_IpCmdErrorInvalidAddress
Flash access start address exceed the whole flash address range (A1/A2/B1/B2).

enumerator kFLEXSPI_IpCmdErrorSequenceExecutionTimeout
Sequence execution timeout.

enumerator kFLEXSPI_IpCmdErrorFlashBoundaryAcrosss
Flash boundary crossed.

enum _flexspi_ahb_error_code

Error Code when AHB command Error detected.

Values:

enumerator kFLEXSPI_AhbCmdErrorNoError
No error.

enumerator kFLEXSPI_AhbCmdErrorJumpOnCsInWriteCmd
AHB Write command with JMP_ON_CS instruction used in the sequence.

enumerator kFLEXSPI_AhbCmdErrorUnknownOpCode
Unknown instruction opcode in the sequence.

enumerator kFLEXSPI_AhbCmdErrorSdrDummyInDdrSequence
Instruction DUMMY_SDR/DUMMY_RWDS_SDR used in DDR sequence.

enumerator kFLEXSPI_AhbCmdErrorDdrDummyInSdrSequence
Instruction DUMMY_DDR/DUMMY_RWDS_DDR used in SDR sequence.

enumerator kFLEXSPI_AhbCmdSequenceExecutionTimeout
Sequence execution timeout.

enum _flexspi_port

FLEXSPI operation port select.

Values:

enumerator kFLEXSPI_PortA1
Access flash on A1 port.

enumerator kFLEXSPI_PortA2
Access flash on A2 port.

enumerator kFLEXSPI_PortB1
Access flash on B1 port.

enumerator kFLEXSPI_PortB2
Access flash on B2 port.

enumerator kFLEXSPI_PortCount

enum _flexspi_arb_command_source

Trigger source of current command sequence granted by arbitrator.

Values:

enumerator kFLEXSPI_AhbReadCommand

enumerator kFLEXSPI_AhbWriteCommand

enumerator kFLEXSPI_IpCommand

enumerator kFLEXSPI_SuspendedCommand

enum _flexspi_command_type

Command type.

Values:

enumerator kFLEXSPI_Command
FlexSPI operation: Only command, both TX and Rx buffer are ignored.

enumerator kFLEXSPI_Config
FlexSPI operation: Configure device mode, the TX fifo size is fixed in LUT.

enumerator kFLEXSPI_Read

enumerator kFLEXSPI_Write

typedef enum _flexspi_pad flexspi_pad_t

pad definition of FLEXSPI, use to form LUT instruction.

typedef enum _flexspi_flags flexspi_flags_t

FLEXSPI interrupt status flags.

typedef enum _flexspi_read_sample_clock flexspi_read_sample_clock_t

FLEXSPI sample clock source selection for Flash Reading.

typedef enum _flexspi_cs_interval_cycle_unit flexspi_cs_interval_cycle_unit_t

FLEXSPI interval unit for flash device select.

typedef enum _flexspi_ahb_write_wait_unit flexspi_ahb_write_wait_unit_t

FLEXSPI AHB wait interval unit for writing.

```

typedef enum _flexspi_ip_error_code flexspi_ip_error_code_t
    Error Code when IP command Error detected.

typedef enum _flexspi_ahb_error_code flexspi_ahb_error_code_t
    Error Code when AHB command Error detected.

typedef enum _flexspi_port flexspi_port_t
    FLEXSPI operation port select.

typedef enum _flexspi_arb_command_source flexspi_arb_command_source_t
    Trigger source of current command sequence granted by arbitrator.

typedef enum _flexspi_command_type flexspi_command_type_t
    Command type.

typedef struct _flexspi_ahbBuffer_config flexspi_ahbBuffer_config_t

typedef struct _flexspi_ahbBuffers_ctrl flexspi_ahbBuffers_ctrl_t
    Structure to control all AHB buffers.

typedef struct _flexspi_config flexspi_config_t
    FLEXSPI configuration structure.

typedef struct _flexspi_device_config flexspi_device_config_t
    External device configuration items.

typedef struct _flexspi_transfer flexspi_transfer_t
    Transfer structure for FLEXSPI.

typedef struct _flexspi_handle flexspi_handle_t

typedef void (*flexspi_transfer_callback_t)(FLEXSPI_Type *base, flexspi_handle_t *handle,
status_t status, void *userData)
    FLEXSPI transfer callback function.

typedef struct _flexspi_addr_map_config flexspi_addr_map_config_t
    Address mapping configuration structure.

FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNT

FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)
    Formula to form FLEXSPI instructions in LUT table.

struct _flexspi_ahbBuffer_config
    #include <fsl_flexspi.h>

```

Public Members

```

uint8_t priority
    This priority for AHB Master Read which this AHB RX Buffer is assigned.

uint8_t masterIndex
    AHB Master ID the AHB RX Buffer is assigned.

uint16_t bufferSize
    AHB buffer size in byte.

bool enablePrefetch
    AHB Read Prefetch Enable for current AHB RX Buffer corresponding Master, allows
    prefetch disable/enable separately for each master.

struct _flexspi_ahbBuffers_ctrl
    #include <fsl_flexspi.h> Structure to control all AHB buffers.

```


Public Members

flexspi_ahbBuffer_config_t buffer[FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNTn(0)]
Configurations of all AHB buffers.

struct *_flexspi_config*
#include <fsl_flexspi.h> FLEXSPI configuration structure.

Public Members

flexspi_read_sample_clock_t rxSampleClock
Sample Clock source selection for Flash Reading.

bool enableSckFreeRunning
Enable/disable SCK output free-running.

bool enableDoze
Enable/disable doze mode support.

bool enableHalfSpeedAccess
Enable/disable divide by 2 of the clock for half speed commands.

bool enableSameConfigForAll
Enable/disable same configuration for all connected devices when enabled, same configuration in FLASHA1CRx is applied to all.

uint16_t seqTimeoutCycle
Timeout wait cycle for command sequence execution, timeout after ahbGrantTimeoutCycle*1024 serial root clock cycles.

uint8_t ipGrantTimeoutCycle
Timeout wait cycle for IP command grant, timeout after ipGrantTimeoutCycle*1024 AHB clock cycles.

uint8_t txWatermark
FLEXSPI IP transmit watermark value.

uint8_t rxWatermark
FLEXSPI receive watermark value.

struct *_flexspi_device_config*
#include <fsl_flexspi.h> External device configuration items.

Public Members

uint32_t flexspiRootClk
FLEXSPI serial root clock.

bool isSck2Enabled
FLEXSPI use SCK2.

uint32_t flashSize
Flash size in KByte.

bool addressShift
Address shift.

flexspi_cs_interval_cycle_unit_t CSIntervalUnit
CS interval unit, 1 or 256 cycle.

`uint16_t CSInterval`
CS line assert interval, multiply CS interval unit to get the CS line assert interval cycles.

`uint8_t CSHoldTime`
CS line hold time.

`uint8_t CSSetupTime`
CS line setup time.

`uint8_t dataValidTime`
Data valid time for external device.

`uint8_t columnSpace`
Column space size.

`bool enableWordAddress`
If enable word address.

`uint8_t AWRSeqIndex`
Sequence ID for AHB write command.

`uint8_t AWRSeqNumber`
Sequence number for AHB write command.

`uint8_t ARDSeqIndex`
Sequence ID for AHB read command.

`uint8_t ARDSeqNumber`
Sequence number for AHB read command.

flexspi_ahb_write_wait_unit_t AHBWriteWaitUnit
AHB write wait unit.

`uint16_t AHBWriteWaitInterval`
AHB write wait interval, multiply AHB write interval unit to get the AHB write wait cycles.

`bool enableWriteMask`
Enable/Disable FLEXSPI drive DQS pin as write mask when writing to external device.

`struct _flexspi_transfer`
#include <fsl_flexspi.h> Transfer structure for FLEXSPI.

Public Members

`uint32_t deviceAddress`
Operation device address.

flexspi_port_t port
Operation port.

flexspi_command_type_t cmdType
Execution command type.

`uint8_t seqIndex`
Sequence ID for command.

`uint8_t SeqNumber`
Sequence number for command.

`uint32_t *data`
Data buffer.

size_t dataSize

Data size in bytes.

struct _flexspi_handle

#include <fsl_flexspi.h> Transfer handle structure for FLEXSPI.

Public Members

uint32_t state

Internal state for FLEXSPI transfer

uint8_t *data

Data buffer.

size_t dataSize

Remaining Data size in bytes.

size_t transferTotalSize

Total Data size in bytes.

flexspi_transfer_callback_t completionCallback

Callback for users while transfer finish or error occurred

void *userData

FLEXSPI callback function parameter.

struct _flexspi_addr_map_config

#include <fsl_flexspi.h> Address mapping configuration structure.

Public Members

uint32_t addrStart

Remapping start address.

uint32_t addrEnd

Remapping end address.

uint32_t addrOffset

Address offset.

bool remapEnable

Enable address remapping.

struct ahbConfig

Public Members

uint8_t ahbGrantTimeoutCycle

Timeout wait cycle for AHB command grant, timeout after ahbGrantTimeoutCycle*1024 AHB clock cycles.

uint16_t ahbBusTimeoutCycle

Timeout wait cycle for AHB read/write access, timeout after ahbBusTimeoutCycle*1024 AHB clock cycles.

uint8_t resumeWaitCycle

Wait cycle for idle state before suspended command sequence resume, timeout after ahbBusTimeoutCycle AHB clock cycles.

flexspi_ahbBuffer_config_t buffer[FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNTn(0)]
AHB buffer size.

bool enableClearAHBBufferOpt
Enable/disable automatically clean AHB RX Buffer and TX Buffer when FLEXSPI returns STOP mode ACK.

bool enableReadAddressOpt
Enable/disable remove AHB read burst start address alignment limitation. when enable, there is no AHB read burst start address alignment limitation.

bool enableAHBPrefetch
Enable/disable AHB read prefetch feature, when enabled, FLEXSPI will fetch more data than current AHB burst.

bool enableAHBBufferable
Enable/disable AHB bufferable write access support, when enabled, FLEXSPI return before waiting for command execution finished.

bool enableAHBCachable
Enable AHB bus cachable read access support.

2.31 FLEXSPI eDMA Driver

void FLEXSPI_TransferCreateHandleEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_edma_callback_t* callback, void *userData, *edma_handle_t* *txDmaHandle, *edma_handle_t* *rxDmaHandle)

Initializes the FLEXSPI handle for transfer which is used in transactional functions and set the callback.

Parameters

- base – FLEXSPI peripheral base address
- handle – Pointer to *flexspi_edma_handle_t* structure
- callback – FLEXSPI callback, NULL means no callback.
- userData – User callback function data.
- txDmaHandle – User requested DMA handle for TX DMA transfer.
- rxDmaHandle – User requested DMA handle for RX DMA transfer.

void FLEXSPI_TransferUpdateSizeEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_edma_transfer_nsize_t* nsize)

Update FLEXSPI EDMA transfer source data transfer size(SSIZE) and destination data transfer size(DSIZE).

See also:

flexspi_edma_transfer_nsize_t.

Parameters

- base – FLEXSPI peripheral base address
- handle – Pointer to *flexspi_edma_handle_t* structure
- nsize – FLEXSPI DMA transfer data transfer size(SSIZE/DSIZE), by default the size is kFLEXSPI_EDMAAnSize1Bytes(one byte).

status_t FLEXSPI_TransferEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *flexspi_transfer_t* *xfer)

Transfers FLEXSPI data using an eDMA non-blocking method.

This function writes/receives data to/from the FLEXSPI transmit/receive FIFO. This function is non-blocking.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to *flexspi_edma_handle_t* structure
- xfer – FLEXSPI transfer structure.

Return values

- kStatus_FLEXSPI_Busy – FLEXSPI is busy transfer.
- kStatus_InvalidArgument – The watermark configuration is invalid, the watermark should be power of 2 to do successfully EDMA transfer.
- kStatus_Success – FLEXSPI successfully start edma transfer.

void FLEXSPI_TransferAbortEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle)

Aborts the transfer data using eDMA.

This function aborts the transfer data using eDMA.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to *flexspi_edma_handle_t* structure

status_t FLEXSPI_TransferGetTransferCountEDMA(FLEXSPI_Type *base, *flexspi_edma_handle_t* *handle, *size_t* *count)

Gets the transferred counts of transfer.

Parameters

- base – FLEXSPI peripheral base address.
- handle – Pointer to *flexspi_edma_handle_t* structure.
- count – Bytes transfer.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

FSL_FLEXSPI_EDMA_DRIVER_VERSION

FLEXSPI EDMA driver version.

FLEXSPI EDMA driver.

FSL_FLEXSPI_EDMA_DRIVER_VERSION

FLEXSPI EDMA driver.

enum *_flexspi_edma_ntransfer_size*

eDMA transfer configuration

Values:

enumerator kFLEXPSI_EDMAnSize1Bytes

Source/Destination data transfer size is 1 byte every time

```

enumerator kFLEXPSI_EDMA_nSize2Bytes
    Source/Destination data transfer size is 2 bytes every time
enumerator kFLEXPSI_EDMA_nSize4Bytes
    Source/Destination data transfer size is 4 bytes every time
enumerator kFLEXPSI_EDMA_nSize8Bytes
    Source/Destination data transfer size is 8 bytes every time
enumerator kFLEXPSI_EDMA_nSize32Bytes
    Source/Destination data transfer size is 32 bytes every time
enum _flexspi_edma_ntransfer_size
    eDMA transfer configuration
    Values:
enumerator kFLEXPSI_EDMA_nSize1Bytes
    Source/Destination data transfer size is 1 byte every time
enumerator kFLEXPSI_EDMA_nSize2Bytes
    Source/Destination data transfer size is 2 bytes every time
enumerator kFLEXPSI_EDMA_nSize4Bytes
    Source/Destination data transfer size is 4 bytes every time
enumerator kFLEXPSI_EDMA_nSize8Bytes
    Source/Destination data transfer size is 8 bytes every time
enumerator kFLEXPSI_EDMA_nSize32Bytes
    Source/Destination data transfer size is 32 bytes every time
typedef struct _flexspi_edma_handle flexspi_edma_handle_t
typedef void (*flexspi_edma_callback_t)(FLEXSPI_Type *base, flexspi_edma_handle_t *handle,
status_t status, void *userData)
    FLEXSPI eDMA transfer callback function for finish and error.
typedef enum _flexspi_edma_ntransfer_size flexspi_edma_transfer_nsize_t
    eDMA transfer configuration
typedef struct _flexspi_edma_handle flexspi_edma_handle_t
typedef void (*flexspi_edma_callback_t)(FLEXSPI_Type *base, flexspi_edma_handle_t *handle,
status_t status, void *userData)
    FLEXSPI eDMA transfer callback function for finish and error.
typedef enum _flexspi_edma_ntransfer_size flexspi_edma_transfer_nsize_t
    eDMA transfer configuration
struct _flexspi_edma_handle
    #include <fsl_flexspi_edma.h> FLEXSPI DMA transfer handle, users should not touch the con-
    tent of the handle.

```

Public Members

```

edma_handle_t *txDmaHandle
    eDMA handler for FLEXSPI Tx.
edma_handle_t *rxDmaHandle
    eDMA handler for FLEXSPI Rx.

```

`size_t` transferSize

Bytes need to transfer.

flexspi_edma_transfer_nsize_t nsize

eDMA SSIZE/DSIZE in each transfer.

`uint8_t` nbytes

eDMA minor byte transfer count initially configured.

`uint8_t` count

The transfer data count in a DMA request.

`uint32_t` state

Internal state for FLEXSPI eDMA transfer.

flexspi_edma_callback_t completionCallback

A callback function called after the eDMA transfer is finished.

`void *`userData

User callback parameter

2.32 FLEXSPI_FLR: Flexible Serial Peripheral Interface Follower Driver

IO mode enumeration of FLEXSPI FOLLOWER.

Values:

enumerator `kFLEXSPI_SLV_IOMODE_SDRx4`

enumerator `kFLEXSPI_SLV_IOMODE_SDRx8`

enumerator `kFLEXSPI_SLV_IOMODE_DDRx4`

enumerator `kFLEXSPI_SLV_IOMODE_DDRx8`

The read fetch size enumeration of FLEXSPI FOLLOWER.

Values:

enumerator `kFLEXSPI_SLV_Read_Fetch_256Bytes`

enumerator `kFLEXSPI_SLV_Read_Fetch_512Bytes`

enumerator `kFLEXSPI_SLV_Read_Fetch_1KBytes`

enumerator `kFLEXSPI_SLV_Read_Fetch_2KBytes`

The write watermark enumeration of FLEXSPI FOLLOWER.

Values:

enumerator `kFLEXSPI_SLV_Write_Watermark_32Bytes`

enumerator `kFLEXSPI_SLV_Write_Watermark_64Bytes`

enumerator `kFLEXSPI_SLV_Write_Watermark_128Bytes`

enumerator kFLEXSPI_SLV_Write_Watermark_256Bytes

Interrupt status flags of FLEXSPI FOLLOWER.

Values:

enumerator kFLEXSPI_SLV_WriteOverflowFlag

An IO RX FIFO overflow occurred during command/address/write data phase.

enumerator kFLEXSPI_SLV_ReadUnderflowFlag

IO TX FIFO underflow has occurred during a read command.

enumerator kFLEXSPI_SLV_ErrorCommandFlag

An unknown command has been received from the SPI bus.

enumerator kFLEXSPI_SLV_MailInterruptFlag

Mailbox interrupt.

enumerator kFLEXSPI_SLV_AllInterruptFlags

All flags.

typedef struct *flexspi_slv_config* flexspi_slv_config_t

FLEXSPI FOLLOWER configuration structure.

typedef struct *flexspi_slv_handle* flexspi_slv_handle_t

typedef void (*flexspi_slv_callback_t)(FLEXSPI_SLV_Type *base, *flexspi_slv_handle_t* *handle)

FLEXSPI FOLLOWER interrupt callback function.

FSL_FLEXSPI_SLV_DRIVER_VERSION

FLEXSPI FOLLOWER driver version.

FLEXSPI_SLV_CMD_DDR(x)

uint32_t FLEXSPI_SLV_GetInstance(FLEXSPI_SLV_Type *base)

Get the instance number for FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER base pointer.

void FLEXSPI_SLV_Init(FLEXSPI_SLV_Type *base, const *flexspi_slv_config_t* *config)

Initializes the FLEXSPI FOLLOWER module and internal state.

This function enables the clock for FLEXSPI FOLLOWER and also configures the FLEXSPI FOLLOWER with the input configure parameters. Users should call this function before any FLEXSPI FOLLOWER operations.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- config – FLEXSPI FOLLOWER configure structure.

void FLEXSPI_SLV_GetDefaultConfig(*flexspi_slv_config_t* *config)

Gets default settings for FLEXSPI FOLLOWER.

Parameters

- config – FLEXSPI FOLLOWER configuration structure.

void FLEXSPI_SLV_Deinit(FLEXSPI_SLV_Type *base)

Deinitializes the FLEXSPI FOLLOWER module.

Clears the FLEXSPI FOLLOWER state and FLEXSPI FOLLOWER module registers.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

static inline void FLEXSPI_SLV_SoftwareReset(FLEXSPI_SLV_Type *base)

Software reset for the FLEXSPI FOLLOWER logic.

This function does software reset for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

static inline void FLEXSPI_SLV_SetIOMode(FLEXSPI_SLV_Type *base, uint32_t ioMode)

Set IO mode for the FLEXSPI FOLLOWER module.

This function sets the IO mode flags for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- ioMode – Set IO Mode for FLEXSPI FOLLOWER

static inline void FLEXSPI_SLV_UpdateRWCmdBaseRange(FLEXSPI_SLV_Type *base)

Update RW CMD base address and range value for the FLEXSPI FOLLOWER module.

This function updates RW CMD base address and range value for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

static inline void FLEXSPI_SLV_SetRWCmdBaseAddr(FLEXSPI_SLV_Type *base, uint32_t addr1,
uint32_t addr2)

Set RW command base address1 for the FLEXSPI FOLLOWER module.

This function sets the RW command base address1 for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- addr1 – The high 16-bit base address of the RW command0.
- addr2 – The high 16-bit base address of the RW command1.

static inline void FLEXSPI_SLV_SetAddrRange(FLEXSPI_SLV_Type *base, uint32_t index,
uint32_t val)

Set address1/2 range for the FLEXSPI FOLLOWER module.

This function sets the address1/2 range for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- index – The index of RW command, 0 or 1.
- val – The size of the memory range in 1KB units.

static inline void FLEXSPI_SLV_SetReadWatermark(FLEXSPI_SLV_Type *base, uint32_t
rxWatermark, bool enable)

Set read water mark level for the FLEXSPI FOLLOWER module.

This function sets read water mark level for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- val – Read watermark level in bytes

```
static inline void FLEXSPI_SLV_SetReadFetchSize(FLEXSPI_SLV_Type *base, uint32_t rxFetchSize)
```

Sets the maximum read size triggered by a single read command.

This function sets the maximum read size for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- rxFetchSize – The maximum read size triggered by a single read command.

```
static inline void FLEXSPI_SLV_SetWriteWatermark(FLEXSPI_SLV_Type *base, uint32_t txWatermark)
```

Set write water mark level for the FLEXSPI FOLLOWER module.

This function sets write water mark level for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- txWatermark – Write watermark level

```
static inline void FLEXSPI_SLV_MaskChipSelect(FLEXSPI_SLV_Type *base, uint32_t mask)
```

Set CS mask value for the FLEXSPI FOLLOWER module.

This function sets CS mask value for the FLEXSPI FOLLOWER.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- mask – 0 - Not masked, 1 - Masked.

```
static inline void FLEXSPI_SLV_EnableInterrupts(FLEXSPI_SLV_Type *base, uint32_t mask)
```

Enables the FLEXSPI FOLLOWER interrupts.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- mask – FLEXSPI FOLLOWER interrupt source.

```
static inline void FLEXSPI_SLV_DisableInterrupts(FLEXSPI_SLV_Type *base, uint32_t mask)
```

Disable the FLEXSPI FOLLOWER interrupts.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- mask – FLEXSPI FOLLOWER interrupt source.

```
static inline uint32_t FLEXSPI_SLV_GetEnabledInterrupts(FLEXSPI_SLV_Type *base)
```

Get the FLEXSPI FOLLOWER enabled interrupts.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

```
static inline void FLEXSPI_SLV_EnableMailInterrupt(FLEXSPI_SLV_Type *base, bool enable)
```

Enable the FLEXSPI FOLLOWER mailbox interrupts.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- enable – Whether enable the mailbox interrupt.

```
static inline bool FLEXSPI_SLV_GetEnabledMailInterrupt(FLEXSPI_SLV_Type *base)
```

Return whether the FLEXSPI FOLLOWER enables the mailbox interrupt.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

```
static inline void FLEXSPI_SLV_GetOutOfRangeCounts(FLEXSPI_SLV_Type *base, size_t  
                                                    *rdCount, size_t *wrCount)
```

Gets the SPI leader read/write out-of-allowed-range count.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- rdCount – **[out]** Pointer through which the current number in the read out-of-allowed-range counter is returned. Pass NULL if this value is not required.
- wrCount – **[out]** Pointer through which the current number in the write out-of-allowed-range counter is returned Pass NULL if this value is not required.

```
static inline uint32_t FLEXSPI_SLV_GetInterruptStatusFlags(FLEXSPI_SLV_Type *base)
```

Get the FLEXSPI FOLLOWER interrupt status flags.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

Interrupt – status flag, use status flag to AND the bit mask could get the related status.

```
static inline uint32_t FLEXSPI_SLV_GetMailboxData(FLEXSPI_SLV_Type *base, uint32_t index)
```

Get the FLEXSPI FOLLOWER mailbox data.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- index – The index of the mail interrupt register

Returns

Return the FLEXSPI FOLLOWER mailbox data

```
static inline void FLEXSPI_SLV_ClearInterruptStatusFlags(FLEXSPI_SLV_Type *base, uint32_t  
                                                         mask)
```

Clear the FLEXSPI FOLLOWER interrupt status flags.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- mask – FLEXSPI FOLLOWER interrupt source.

```
static inline void FLEXSPI_SLV_ClearMailInterruptFlag(FLEXSPI_SLV_Type *base)
```

Clear the FLEXSPI FOLLOWER mailbox interrupt flag.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

```
static inline bool FLEXSPI_SLV_GetAXIWriteBusyStatus(FLEXSPI_SLV_Type *base)
```

Returns whether the current AXI write leader is busy with a write command.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

- true – The current AXI write leader is busy.
- false – The current AXI write leader is not busy.

static inline bool FLEXSPI_SLV_GetAXIReadIdleStatus(FLEXSPI_SLV_Type *base)

Returns whether the AXI read leader is busy with a read request or else idle with no pending AXI read request.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

- true – The current AXI read leader is idle.
- false – The current AXI read leader is busy.

static inline bool FLEXSPI_SLV_GetRegReadWriteIdleStatus(FLEXSPI_SLV_Type *base)

Returns whether the SPI to read/write register queue is idle.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

- true – The SPI to read/write register queue is idle.
- false – The SPI to read/write register queue is busy.

static inline bool FLEXSPI_SLV_GetSEQIdleStatus(FLEXSPI_SLV_Type *base)

Returns whether the SEQ control logic is idle or else busy with an ongoing SPI request.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

- true – The SEQ control logic is idle.
- false – The SEQ control logic is busy.

static inline bool FLEXSPI_SLV_GetModuleBusyStatus(FLEXSPI_SLV_Type *base)

Returns whether the FLEXSPI FOLLOWER module is busy.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.

Return values

- true – The SEQ control logic is busy.
- false – The SEQ control logic is idle.

static inline void FLEXSPI_SLV_SetReadMemCommand(FLEXSPI_SLV_Type *base, uint32_t index, uint16_t command, uint16_t dummyCycle)

Sets the read memory command.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- index – The read command setting register index.
- command – The read command value.
- dummyCycle – The dummy cycle value of the read command.

```
static inline void FLEXSPI_SLV_SetWriteMemCommand(FLEXSPI_SLV_Type *base, uint32_t
                                                    index, uint32_t command)
```

Sets the write memory command.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- index – The write command setting register index.
- command – The write command value.

```
static inline void FLEXSPI_SLV_SetReadRegCommand(FLEXSPI_SLV_Type *base, uint16_t
                                                    command, uint16_t dummyCycle)
```

Sets the read register command.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address
- command – The read command value.
- dummyCycle – The dummy cycle value of the read command.

```
static inline void FLEXSPI_SLV_SetWriteRegCommand(FLEXSPI_SLV_Type *base, uint32_t
                                                    command)
```

Sets the write register command.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- command – The write register command value.

```
void FLEXSPI_SLV_InterruptCreateHandle(FLEXSPI_SLV_Type *base, flexspi_slv_handle_t
                                        *handle, flexspi_slv_callback_t callback, uint32_t
                                        interruptMask)
```

Initializes the FLEXSPI FOLLOWER handle which is used in transactional functions.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- handle – Pointer to flexspi_slv_handle_t structure to store the interrupt state.
- callback – Pointer to user callback function.
- interruptMask – Interrupt mask to enable during handle creation. Use enumeration values ORed.

```
void FLEXSPI_SLV_HandleIRQ(FLEXSPI_SLV_Type *base, flexspi_slv_handle_t *handle)
```

Master interrupt handler.

Parameters

- base – FLEXSPI FOLLOWER peripheral base address.
- handle – Pointer to flexspi_slv_handle_t structure.

```
uint32_t baseAddr1
```

Read/Write CMD1 Base Address.

```
uint32_t baseAddr2
```

Read/Write CMD2 Base Address.

```
uint32_t addrRange1
```

Read/Write CMD1 Addr Range.

`uint32_t addrRange2`
Read/Write CMD2 Addr Range.

`uint8_t ioMode`
IO mode control - SDRx4, SDRx8, DDRx4, DDRx8.

`uint8_t rxFetchSize`
Specifies the maximum read size triggered by a single read command.

`uint8_t rxWatermark`
Triggers a new AXI read to fetch more data through the IP AXI header.

`uint8_t txWatermark`
Specifies the watermark value. During the write command, if pending write data equals or exceeds the watermark level, it triggers a new AXI write.

`uint16_t readRegCmd`
Read register command.

`uint16_t readRegDummyCycle`
Read register dymmy cycle.

`uint16_t writeRegCmd`
Write register command.

`uint16_t readMemCmd1`
Read memory command1.

`uint16_t readMemDummyCycle1`
Read memory dymmy cycle1.

`uint16_t readMemCmd2`
Read memory command2.

`uint16_t readMemDummyCycle2`
Read memory dymmy cycle2.

`uint16_t writeMemCmd1`
Write memory command1.

`uint16_t writeMemCmd2`
Write memory command2.

`uint32_t intrMask`
Interrupt state for FLEXSPI FOLLOWER.

flexspi_slv_callback_t callback
Callback for users while mailbox received or error occurred.

`struct _flexspi_slv_config`
#include <fsl_flexspi_flr.h> FLEXSPI FOLLOWER configuration structure.

`struct _flexspi_slv_handle`
#include <fsl_flexspi_flr.h> Interrupt handle structure for FLEXSPI FOLLOWER.

2.33 Gpc

`void GPC_AssignCpuDomain(gpc_cpu_slice_t cpu, uint32_t domainMap)`
`static inline void GPC_CM_EnableCpuSleepHold(gpc_cpu_slice_t slice, bool enable)`

```
static inline void GPC_CM_SetNextCpuMode(gpc_cpu_slice_t slice, gpc_cpu_mode_t mode)
```

Set the CPU mode on the next sleep event.

This function configures the CPU mode that the CPU core will transmit to on next sleep event.

Note: This API must be called each time before entering sleep.

Parameters

- slice – GPC CPU slice number.
- mode – The CPU mode that the core will transmit to, refer to “*gpc_cpu_mode_t*”.

```
static inline gpc_cpu_mode_t GPC_CM_GetCurrentCpuMode(gpc_cpu_slice_t slice)
```

Get current CPU mode.

Parameters

- slice – GPC CPU slice number.

Returns

The current CPU mode, in type of *gpc_cpu_mode_t*.

```
static inline gpc_cpu_mode_t GPC_CM_GetPreviousCpuMode(gpc_cpu_slice_t slice)
```

Get previous CPU mode.

Parameters

- slice – GPC CPU slice number.

Returns

The previous CPU mode, in type of *gpc_cpu_mode_t*.

```
void GPC_CM_EnableIrqWakeup(gpc_cpu_slice_t slice, uint32_t irqId, bool enable)
```

Enable IRQ wakeup request.

This function enables the IRQ request which can wakeup the CPU platform.

Parameters

- slice – GPC CPU slice number.
- irqId – ID of the IRQ, accessible range is 0-255.
- enable – Enable the IRQ request or not.

```
static inline void GPC_CM_EnableNonIrqWakeup(gpc_cpu_slice_t slice, uint32_t mask, bool enable)
```

Enable Non-IRQ wakeup request.

This function enables the non-IRQ request which can wakeup the CPU platform.

Parameters

- slice – GPC CPU slice number.
- mask – Non-IRQ type, refer to “*_gpc_cm_non_irq_wakeup_request*”.
- enable – Enable the Non-IRQ request or not.

```
bool GPC_CM_GetIrqWakeupStatus(gpc_cpu_slice_t slice, uint32_t irqId)
```

Get the status of the IRQ wakeup request.

Parameters

- slice – GPC CPU slice number.

- irqId – ID of the IRQ, accessible range is 0-255.

Returns

Indicate the IRQ request is asserted or not.

```
static inline bool GPC_CM_GetNonIrqWakeupStatus(gpc_cpu_slice_t slice, uint32_t mask)
```

Get the status of the Non-IRQ wakeup request.

Parameters

- slice – GPC CPU slice number.
- mask – Non-IRQ type, refer to “_gpc_cm_non_irq_wakeup_request”.

Returns

Indicate the Non-IRQ request is asserted or not.

```
void GPC_CM_EnableCpuModeTransitionStep(gpc_cpu_slice_t slice, gpc_cm_tran_step_t step,  
                                         bool enable)
```

brief Config the cpu mode transition step.

param slice GPC CPU slice number. param step step type, refer to “gpc_cm_tran_step_t”.
param enable Used to control the transition step.

- **true** This step is enabled.
- **false** This step is disabled, GPC will skip this step and not send any request.

```
void GPC_CM_RequestSystemSleepMode(gpc_cpu_slice_t slice, const gpc_cpu_mode_t mode)
```

Request the chip into system sleep mode.

Parameters

- slice – GPC CPU slice number.
- mode – CPU mode. Refer to “gpc_cpu_mode_t”.

```
void GPC_CM_ClearSystemSleepModeRequest(gpc_cpu_slice_t slice, const gpc_cpu_mode_t mode)
```

Clear the system sleep mode request.

Parameters

- slice – GPC CPU slice number.
- mode – CPU mode. Refer to “gpc_cpu_mode_t”.

```
static inline bool GPC_CM_GetSystemSleepModeStatus(gpc_cpu_slice_t slice, uint32_t mask)
```

Get the status of the CPU system sleep mode transition.

Parameters

- slice – GPC CPU slice number.
- mask – System sleep mode transition status mask, refer to “gpc_cm_system_sleep_mode_status_t”.

Returns

Indicate the CPU’s system sleep transition status.

```
void GPC_SS_EnableSystemSleepTransitionStep(GPC_SYS_SLEEP_CTRL_Type *base,  
                                             gpc_ss_tran_step_t step, bool enable)
```

brief Config the system sleep transition step.

param base GPC system sleep controller base address. param step step type, refer to “gpc_ss_tran_step_t”. param enable Used to control the transition step.

- **true** This step is enabled.
- **false** This step is disabled, GPC will skip this step and not send any request.


```
static inline void GPC_SS_SoftwareTriggerPMICStandby(GPC_SYS_SLEEP_CTRL_Type *base,  
                                                    bool enable)
```

Trigger PMIC standby ON/OFF by software.

Parameters

- base – PMIC module base address.
- enable – Trigger on/off PMIC standby.
 - **true** Trigger PMIC standby ON.
 - **false** Trigger PMIC standby OFF.

```
static inline void GPC_SS_SystemSleepTriggerPMICStandby(GPC_SYS_SLEEP_CTRL_Type *base,  
                                                       bool enable)
```

brief Assert the PMIC standby request when system sleep.

Parameters

- base – PMIC module base address.
- enable – Assert PMIC standby request or not.
 - **true** Assert PMIC_STBY_REQ when system sleep is entered.
 - **false** Do not assert PMIC_STBY_REQ when system sleep is entered.

FSL_GPC_RIVER_VERSION

GPC driver version 2.1.0.

`_gpc_cm_non_irq_wakeup_request` GPC Non-IRQ wakeup request.

Values:

enumerator `kGPC_CM_DebugWakeupRequest`

Debug wakeup request.

Values:

enumerator `kGPC_Domain0`

GPC domain 0.

enumerator `kGPC_Domain1`

GPC domain 1.

enumerator `kGPC_Domain2`

GPC domain 2.

enumerator `kGPC_Domain3`

GPC domain 3.

enumerator `kGPC_Domain4`

GPC domain 4.

enumerator `kGPC_Domain5`

GPC domain 5.

enumerator `kGPC_Domain6`

GPC domain 6.

enumerator `kGPC_Domain7`

GPC domain 7.

enumerator kGPC_Domain8
GPC domain 8.

enumerator kGPC_Domain9
GPC domain 9.

enumerator kGPC_Domain10
GPC domain 10.

enumerator kGPC_Domain11
GPC domain 11.

enumerator kGPC_Domain12
GPC domain 12.

enumerator kGPC_Domain13
GPC domain 13.

enumerator kGPC_Domain14
GPC domain 14.

enumerator kGPC_Domain15
GPC domain 15.

enum _gpc_cpu_slice
CPU slice.

Values:

enumerator kGPC_CPU0
CPU slice 0.

enumerator kGPC_CPU1
CPU slice 1.

enum _gpc_cm_tran_step
CPU mode transition step in sleep/wakeup sequence.

Values:

enumerator kGPC_CM_SleepSsar
SSAR (State Save And Restore) sleep step.

enumerator kGPC_CM_SleepLpcg
LPCG (Low Power Clock Gating) sleep step.

enumerator kGPC_CM_SleepPll
PLL sleep step.

enumerator kGPC_CM_SleepIso
ISO (Isolation) sleep step.

enumerator kGPC_CM_SleepReset
Reset sleep step.

enumerator kGPC_CM_SleepPower
Power sleep step.

enumerator kGPC_CM_SleepSYS
System sleep sleep step. Note that this step is controlled by system sleep controller.

enumerator kGPC_CM_WakeupSYS
System sleep wakeup step. Note that this step is controlled by system sleep controller.

enumerator kGPC_CM_WakeupPower

Power wakeup step.

enumerator kGPC_CM_WakeupReset

Reset wakeup step.

enumerator kGPC_CM_WakeupIso

ISO wakeup step.

enumerator kGPC_CM_WakeupPll

PLL wakeup step.

enumerator kGPC_CM_WakeupLpcg

LPCG wakeup step.

enumerator kGPC_CM_WakeupSsar

SSAR wakeup step.

enum _gpc_cpu_mode

CPU mode.

Values:

enumerator kGPC_RunMode

Stay in RUN mode.

enumerator kGPC_WaitMode

Transit to WAIT mode.

enumerator kGPC_StopMode

Transit to STOP mode.

enumerator kGPC_SuspendMode

Transit to SUSPEND mode.

enum _gpc_ss_tran_step

GPC system sleep mode transition steps.

Values:

enumerator kGPC_SS_Step0In

Bias in step.

enumerator kGPC_SS_Step1In

PLDO in step.

enumerator kGPC_SS_Step2In

Bandgap in step.

enumerator kGPC_SS_Step3In

LDO in step.

enumerator kGPC_SS_DcdcIn

DCDC in step.

enumerator kGPC_SS_PmicIn

PMIC in step.

enumerator kGPC_SS_PmicOut

PMIC out step.

enumerator kGPC_SS_DcdcOut

DCDC out step.

enumerator kGPC_SS_Step3Out
LDO out step.

enumerator kGPC_SS_Step2Out
Bandgap out step.

enumerator kGPC_SS_Step1Out
PLDO out step.

enumerator kGPC_SS_Step0Out
Bias out step.

typedef enum *_gpc_cpu_slice* gpc_cpu_slice_t
CPU slice.

typedef enum *_gpc_cm_tran_step* gpc_cm_tran_step_t
CPU mode transition step in sleep/wakeup sequence.

typedef enum *_gpc_cpu_mode* gpc_cpu_mode_t
CPU mode.

typedef enum *_gpc_ss_tran_step* gpc_ss_tran_step_t
GPC system sleep mode transition steps.

GPC_RESERVED_USE_MACRO

GPC_CM_SLEEP_SSAR_CTRL_OFFSET

GPC_CM_SLEEP_LPCG_CTRL_OFFSET

GPC_CM_SLEEP_PLL_CTRL_OFFSET

GPC_CM_SLEEP_ISO_CTRL_OFFSET

GPC_CM_SLEEP_RESET_CTRL_OFFSET

GPC_CM_SLEEP_POWER_CTRL_OFFSET

GPC_CM_WAKEUP_POWER_CTRL_OFFSET

GPC_CM_WAKEUP_RESET_CTRL_OFFSET

GPC_CM_WAKEUP_ISO_CTRL_OFFSET

GPC_CM_WAKEUP_PLL_CTRL_OFFSET

GPC_CM_WAKEUP_LPCG_CTRL_OFFSET

GPC_CM_WAKEUP_SSAR_CTRL_OFFSET

GPC_SS_STEP0_IN_CTRL_OFFSET

GPC_SS_STEP1_IN_CTRL_OFFSET

GPC_SS_STEP2_IN_CTRL_OFFSET

GPC_SS_STEP3_IN_CTRL_OFFSET

GPC_SS_DCDC_IN_CTRL_OFFSET

GPC_SS_PMIC_IN_CTRL_OFFSET

GPC_SS_PMIC_OUT_CTRL_OFFSET

GPC_SS_DCDC_OUT_CTRL_OFFSET

GPC_SS_STEP3_OUT_CTRL_OFFSET
GPC_SS_STEP2_OUT_CTRL_OFFSET
GPC_SS_STEP1_OUT_CTRL_OFFSET
GPC_SS_STEP0_OUT_CTRL_OFFSET
GPC_CM_STEP_REG_OFFSET
GPC_SS_STEP_REG_OFFSET
GPC_STAT(mask, shift)

2.34 GPT: General Purpose Timer

`void GPT_Init(GPT_Type *base, const gpt_config_t *initConfig)`
Initialize GPT to reset state and initialize running mode.

Parameters

- base – GPT peripheral base address.
- initConfig – GPT mode setting configuration.

`void GPT_Deinit(GPT_Type *base)`
Disables the module and gates the GPT clock.

Parameters

- base – GPT peripheral base address.

`void GPT_GetDefaultConfig(gpt_config_t *config)`
Fills in the GPT configuration structure with default settings.
The default values are:

```
config->clockSource = kGPT_ClockSource_Periph;  
config->divider = 1U;  
config->enableRunInStop = true;  
config->enableRunInWait = true;  
config->enableRunInDoze = false;  
config->enableRunInDbg = false;  
config->enableFreeRun = false;  
config->enableMode = true;
```

Parameters

- config – Pointer to the user configuration structure.

`static inline void GPT_SoftwareReset(GPT_Type *base)`
Software reset of GPT module.

Parameters

- base – GPT peripheral base address.

`static inline void GPT_SetClockSource(GPT_Type *base, gpt_clock_source_t gptClkSource)`
Set clock source of GPT.

Parameters

- base – GPT peripheral base address.
- gptClkSource – Clock source (see *gpt_clock_source_t* typedef enumeration).

static inline *gpt_clock_source_t* GPT_GetClockSource(GPT_Type *base)
Get clock source of GPT.

Parameters

- base – GPT peripheral base address.

Returns

clock source (see *gpt_clock_source_t* typedef enumeration).

static inline void GPT_SetClockDivider(GPT_Type *base, uint32_t divider)
Set pre scaler of GPT.

Parameters

- base – GPT peripheral base address.
- divider – Divider of GPT (1-4096).

static inline uint32_t GPT_GetClockDivider(GPT_Type *base)
Get clock divider in GPT module.

Parameters

- base – GPT peripheral base address.

Returns

clock divider in GPT module (1-4096).

static inline void GPT_SetOscClockDivider(GPT_Type *base, uint32_t divider)
OSC 24M pre-scaler before selected by clock source.

Parameters

- base – GPT peripheral base address.
- divider – OSC Divider(1-16).

static inline uint32_t GPT_GetOscClockDivider(GPT_Type *base)
Get OSC 24M clock divider in GPT module.

Parameters

- base – GPT peripheral base address.

Returns

OSC clock divider in GPT module (1-16).

static inline void GPT_StartTimer(GPT_Type *base)
Start GPT timer.

Parameters

- base – GPT peripheral base address.

static inline void GPT_StopTimer(GPT_Type *base)
Stop GPT timer.

Parameters

- base – GPT peripheral base address.

static inline uint32_t GPT_GetCurrentTimerCount(GPT_Type *base)
Reads the current GPT counting value.

Parameters

- base – GPT peripheral base address.

Returns

Current GPT counter value.

```
static inline void GPT_SetInputOperationMode(GPT_Type *base, gpt_input_capture_channel_t
                                             channel, gpt_input_operation_mode_t mode)
```

Set GPT operation mode of input capture channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see `gpt_input_capture_channel_t` typedef enumeration).
- mode – GPT input capture operation mode (see `gpt_input_operation_mode_t` typedef enumeration).

```
static inline gpt_input_operation_mode_t GPT_GetInputOperationMode(GPT_Type *base,
                                                                    gpt_input_capture_channel_t
                                                                    channel)
```

Get GPT operation mode of input capture channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see `gpt_input_capture_channel_t` typedef enumeration).

Returns

GPT input capture operation mode (see `gpt_input_operation_mode_t` typedef enumeration).

```
static inline uint32_t GPT_GetInputCaptureValue(GPT_Type *base, gpt_input_capture_channel_t
                                                channel)
```

Get GPT input capture value of certain channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT capture channel (see `gpt_input_capture_channel_t` typedef enumeration).

Returns

GPT input capture value.

```
static inline void GPT_SetOutputOperationMode(GPT_Type *base,
                                                gpt_output_compare_channel_t channel,
                                                gpt_output_operation_mode_t mode)
```

Set GPT operation mode of output compare channel.

Parameters

- base – GPT peripheral base address.
- channel – GPT output compare channel (see `gpt_output_compare_channel_t` typedef enumeration).
- mode – GPT output operation mode (see `gpt_output_operation_mode_t` typedef enumeration).

```
static inline gpt_output_operation_mode_t GPT_GetOutputOperationMode(GPT_Type *base,
                                                                        gpt_output_compare_channel_t
                                                                        channel)
```

Get GPT operation mode of output compare channel.

Parameters

- base – GPT peripheral base address.

- `channel` – GPT output compare channel (see `gpt_output_compare_channel_t` typedef enumeration).

Returns

GPT output operation mode (see `gpt_output_operation_mode_t` typedef enumeration).

```
static inline void GPT_SetOutputCompareValue(GPT_Type *base, gpt_output_compare_channel_t
                                             channel, uint32_t value)
```

Set GPT output compare value of output compare channel.

Parameters

- `base` – GPT peripheral base address.
- `channel` – GPT output compare channel (see `gpt_output_compare_channel_t` typedef enumeration).
- `value` – GPT output compare value.

```
static inline uint32_t GPT_GetOutputCompareValue(GPT_Type *base,
                                                  gpt_output_compare_channel_t channel)
```

Get GPT output compare value of output compare channel.

Parameters

- `base` – GPT peripheral base address.
- `channel` – GPT output compare channel (see `gpt_output_compare_channel_t` typedef enumeration).

Returns

GPT output compare value.

```
static inline void GPT_ForceOutput(GPT_Type *base, gpt_output_compare_channel_t channel)
```

Force GPT output action on output compare channel, ignoring comparator.

Parameters

- `base` – GPT peripheral base address.
- `channel` – GPT output compare channel (see `gpt_output_compare_channel_t` typedef enumeration).

```
static inline void GPT_EnableInterrupts(GPT_Type *base, uint32_t mask)
```

Enables the selected GPT interrupts.

Parameters

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

```
static inline void GPT_DisableInterrupts(GPT_Type *base, uint32_t mask)
```

Disables the selected GPT interrupts.

Parameters

- `base` – GPT peripheral base address
- `mask` – The interrupts to disable. This is a logical OR of members of the enumeration `gpt_interrupt_enable_t`

```
static inline uint32_t GPT_GetEnabledInterrupts(GPT_Type *base)
```

Gets the enabled GPT interrupts.

Parameters

- `base` – GPT peripheral base address

Returns

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

static inline uint32_t GPT_GetStatusFlags(GPT_Type *base, *gpt_status_flag_t* flags)

Get GPT status flags.

Parameters

- base – GPT peripheral base address.
- flags – GPT status flag mask (see `gpt_status_flag_t` for bit definition).

Returns

GPT status, each bit represents one status flag.

static inline void GPT_ClearStatusFlags(GPT_Type *base, *gpt_status_flag_t* flags)

Clears the GPT status flags.

Parameters

- base – GPT peripheral base address.
- flags – GPT status flag mask (see `gpt_status_flag_t` for bit definition).

FSL_GPT_DRIVER_VERSION

enum `_gpt_clock_source`

List of clock sources.

Note: Actual number of clock sources is SoC dependent

Values:

enumerator `kGPT_ClockSource_Off`

GPT Clock Source Off.

enumerator `kGPT_ClockSource_Periph`

GPT Clock Source from Peripheral Clock.

enumerator `kGPT_ClockSource_HighFreq`

GPT Clock Source from High Frequency Reference Clock.

enumerator `kGPT_ClockSource_Ext`

GPT Clock Source from external pin.

enumerator `kGPT_ClockSource_LowFreq`

GPT Clock Source from Low Frequency Reference Clock.

enumerator `kGPT_ClockSource_Osc`

GPT Clock Source from Crystal oscillator.

enum `_gpt_input_capture_channel`

List of input capture channel number.

Values:

enumerator `kGPT_InputCapture_Channel1`

GPT Input Capture Channel1.

enumerator `kGPT_InputCapture_Channel2`

GPT Input Capture Channel2.

enum _gpt_input_operation_mode

List of input capture operation mode.

Values:

enumerator kGPT_InputOperation_Disabled

Don't capture.

enumerator kGPT_InputOperation_RiseEdge

Capture on rising edge of input pin.

enumerator kGPT_InputOperation_FallEdge

Capture on falling edge of input pin.

enumerator kGPT_InputOperation_BothEdge

Capture on both edges of input pin.

enum _gpt_output_compare_channel

List of output compare channel number.

Values:

enumerator kGPT_OutputCompare_Channel1

Output Compare Channel1.

enumerator kGPT_OutputCompare_Channel2

Output Compare Channel2.

enumerator kGPT_OutputCompare_Channel3

Output Compare Channel3.

enum _gpt_output_operation_mode

List of output compare operation mode.

Values:

enumerator kGPT_OutputOperation_Disconnected

Don't change output pin.

enumerator kGPT_OutputOperation_Toggle

Toggle output pin.

enumerator kGPT_OutputOperation_Clear

Set output pin low.

enumerator kGPT_OutputOperation_Set

Set output pin high.

enumerator kGPT_OutputOperation_Activelow

Generate a active low pulse on output pin.

enum _gpt_interrupt_enable

List of GPT interrupts.

Values:

enumerator kGPT_OutputCompare1InterruptEnable

Output Compare Channel1 interrupt enable

enumerator kGPT_OutputCompare2InterruptEnable

Output Compare Channel2 interrupt enable

enumerator kGPT_OutputCompare3InterruptEnable

Output Compare Channel3 interrupt enable

enumerator kGPT_InputCapture1InterruptEnable

Input Capture Channel1 interrupt enable

enumerator kGPT_InputCapture2InterruptEnable

Input Capture Channel1 interrupt enable

enumerator kGPT_RollOverFlagInterruptEnable

Counter rolled over interrupt enable

enum _gpt_status_flag

Status flag.

Values:

enumerator kGPT_OutputCompare1Flag

Output compare channel 1 event.

enumerator kGPT_OutputCompare2Flag

Output compare channel 2 event.

enumerator kGPT_OutputCompare3Flag

Output compare channel 3 event.

enumerator kGPT_InputCapture1Flag

Input Capture channel 1 event.

enumerator kGPT_InputCapture2Flag

Input Capture channel 2 event.

enumerator kGPT_RollOverFlag

Counter reaches maximum value and rolled over to 0 event.

typedef enum _gpt_clock_source gpt_clock_source_t

List of clock sources.

Note: Actual number of clock sources is SoC dependent

typedef enum _gpt_input_capture_channel gpt_input_capture_channel_t

List of input capture channel number.

typedef enum _gpt_input_operation_mode gpt_input_operation_mode_t

List of input capture operation mode.

typedef enum _gpt_output_compare_channel gpt_output_compare_channel_t

List of output compare channel number.

typedef enum _gpt_output_operation_mode gpt_output_operation_mode_t

List of output compare operation mode.

typedef enum _gpt_interrupt_enable gpt_interrupt_enable_t

List of GPT interrupts.

typedef enum _gpt_status_flag gpt_status_flag_t

Status flag.

typedef struct _gpt_init_config gpt_config_t

Structure to configure the running mode.

struct _gpt_init_config

#include <fsl_gpt.h> Structure to configure the running mode.

Public Members

gpt_clock_source_t clockSource
clock source for GPT module.

uint32_t divider
clock divider (prescaler+1) from clock source to counter.

bool enableFreeRun
true: FreeRun mode, false: Restart mode.

bool enableRunInWait
GPT enabled in wait mode.

bool enableRunInStop
GPT enabled in stop mode.

bool enableRunInDoze
GPT enabled in doze mode.

bool enableRunInDbg
GPT enabled in debug mode.

bool enableMode
true: counter reset to 0 when enabled; false: counter retain its value when enabled.

2.35 I3C: I3C Driver

FSL_I3C_DRIVER_VERSION
I3C driver version.

I3C status return codes.

Values:

enumerator kStatus_I3C_Busy
The master is already performing a transfer.

enumerator kStatus_I3C_Idle
The slave driver is idle.

enumerator kStatus_I3C_Nak
The slave device sent a NAK in response to an address.

enumerator kStatus_I3C_WriteAbort
The slave device sent a NAK in response to a write.

enumerator kStatus_I3C_Term
The master terminates slave read.

enumerator kStatus_I3C_HdrParityError
Parity error from DDR read.

enumerator kStatus_I3C_CrcError
CRC error from DDR read.

enumerator kStatus_I3C_ReadFifoError
Read from M/SRDATAB register when FIFO empty.

enumerator kStatus_I3C_WriteFifoError

Write to M/SWDATAB register when FIFO full.

enumerator kStatus_I3C_MsgError

Message SDR/DDR mismatch or read/write message in wrong state

enumerator kStatus_I3C_InvalidReq

Invalid use of request.

enumerator kStatus_I3C_Timeout

The module has stalled too long in a frame.

enumerator kStatus_I3C_SlaveCountExceed

The I3C slave count has exceed the definition in I3C_MAX_DEVCNT.

enumerator kStatus_I3C_IBIWon

The I3C slave event IBI or MR or HJ won the arbitration on a header address.

enumerator kStatus_I3C_OverrunError

Slave internal from-bus buffer/FIFO overrun.

enumerator kStatus_I3C_UnderrunError

Slave internal to-bus buffer/FIFO underrun

enumerator kStatus_I3C_UnderrunNak

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kStatus_I3C_InvalidStart

Slave invalid start flag

enumerator kStatus_I3C_SdrParityError

SDR parity error

enumerator kStatus_I3C_S0S1Error

S0 or S1 error

enum _i3c_hdr_mode

I3C HDR modes.

Values:

enumerator kI3C_HDRModeNone

enumerator kI3C_HDRModeDDR

enumerator kI3C_HDRModeTSP

enumerator kI3C_HDRModeTSL

typedef enum _i3c_hdr_mode i3c_hdr_mode_t

I3C HDR modes.

typedef struct _i3c_device_info i3c_device_info_t

I3C device information.

I3C_RETRY_TIMES

Max loops to wait for I3C operation status complete.

This is the maximum number of loops to wait for I3C operation status complete. If set to 0, it will wait indefinitely.

I3C_MAX_DEVCNT

I3C_IBI_BUFF_SIZE

```
struct _i3c_device_info
    #include <fsl_i3c.h> I3C device information.
```

Public Members

```
uint8_t dynamicAddr
    Device dynamic address.

uint8_t staticAddr
    Static address.

uint8_t dcr
    Device characteristics register information.

uint8_t bcr
    Bus characteristics register information.

uint16_t vendorID
    Device vendor ID(manufacture ID).

uint32_t partNumber
    Device part number info

uint16_t maxReadLength
    Maximum read length.

uint16_t maxWriteLength
    Maximum write length.

uint8_t hdrMode
    Support hdr mode, could be OR logic in i3c_hdr_mode.
```

2.36 I3C Common Driver

```
typedef struct _i3c_config i3c_config_t
```

Structure with settings to initialize the I3C module, could both initialize master and slave functionality.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C_GetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

```
uint32_t I3C_GetInstance(I3C_Type *base)
    Get which instance current I3C is used.
```

Parameters

- base – The I3C peripheral base address.

```
void I3C_GetDefaultConfig(i3c_config_t *config)
```

Provides a default configuration for the I3C peripheral, the configuration covers both master functionality and slave functionality.

This function provides the following default configuration for I3C:

```

config->enableMaster          = kI3C_MasterCapable;
config->disableTimeout        = false;
config->hKeep                  = kI3C_MasterHighKeeperNone;
config->enableOpenDrainStop    = true;
config->enableOpenDrainHigh    = true;
config->baudRate_Hz.i2cBaud     = 400000U;
config->baudRate_Hz.i3cPushPullBaud = 12500000U;
config->baudRate_Hz.i3cOpenDrainBaud = 2500000U;
config->masterDynamicAddress    = 0x0AU;
config->slowClock_Hz           = 1000000U;
config->enableSlave            = true;
config->vendorID                = 0x11BU;
config->enableRandomPart        = false;
config->partNumber              = 0;
config->dcr                     = 0;
config->bcr = 0;
config->hdrMode                 = (uint8_t)kI3C_HDRModeDDR;
config->nakAllRequest           = false;
config->ignoreS0S1Error         = false;
config->offline                 = false;
config->matchSlaveStartStop     = false;

```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the common I3C driver with `I3C_Init()`.

Parameters

- `config` – **[out]** User provided configuration structure for default values. Refer to `i3c_config_t`.

`void I3C_Init(I3C_Type *base, const i3c_config_t *config, uint32_t sourceClock_Hz)`

Initializes the I3C peripheral. This function enables the peripheral clock and initializes the I3C peripheral as described by the user provided configuration. This will initialize both the master peripheral and slave peripheral so that I3C module could work as pure master, pure slave or secondary master, etc. A software reset is performed prior to configuration.

Parameters

- `base` – The I3C peripheral base address.
- `config` – User provided peripheral configuration. Use `I3C_GetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the I3C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

`struct _i3c_config`

#include <fsl_i3c.h> Structure with settings to initialize the I3C module, could both initialize master and slave functionality.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_GetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

i3c_master_enable_t enableMaster

Enable master mode.

bool disableTimeout

Whether to disable timeout to prevent the ERRWARN.

i3c_master_hkeep_t hKeep
High keeper mode setting.

bool enableOpenDrainStop
Whether to emit open-drain speed STOP.

bool enableOpenDrainHigh
Enable Open-Drain High to be 1 PPBAUD count for i3c messages, or 1 ODBAUD.

i3c_baudrate_hz_t baudRate_Hz
Desired baud rate settings.

uint8_t masterDynamicAddress
Main master dynamic address configuration.

uint32_t maxWriteLength
Maximum write length.

uint32_t maxReadLength
Maximum read length.

bool enableSlave
Whether to enable slave.

uint8_t staticAddr
Static address.

uint16_t vendorID
Device vendor ID(manufacture ID).

uint32_t partNumber
Device part number info

uint8_t dcr
Device characteristics register information.

uint8_t bcr
Bus characteristics register information.

uint8_t hdrMode
Support hdr mode, could be OR logic in enumeration:i3c_hdr_mode_t.

bool nakAllRequest
Whether to reply NAK to all requests except broadcast CCC.

bool ignoreS0S1Error
Whether to ignore S0/S1 error in SDR mode.

bool offline
Whether to wait 60 us of bus quiet or HDR request to ensure slave track SDR mode safely.

bool matchSlaveStartStop
Whether to assert start/stop status only the time slave is addressed.

2.37 I3C Master Driver

`void I3C_MasterGetDefaultConfig(i3c_master_config_t *masterConfig)`

Provides a default configuration for the I3C master peripheral.

This function provides the following default configuration for the I3C master peripheral:

```
masterConfig->enableMaster      = kI3C_MasterOn;
masterConfig->disableTimeout    = false;
masterConfig->hKeep              = kI3C_MasterHighKeeperNone;
masterConfig->enableOpenDrainStop = true;
masterConfig->enableOpenDrainHigh = true;
masterConfig->baudRate_Hz        = 100000U;
masterConfig->busType            = kI3C_TypeI2C;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with `I3C_MasterInit()`.

Parameters

- `masterConfig` – **[out]** User provided configuration structure for default values. Refer to `i3c_master_config_t`.

`void I3C_MasterInit(I3C_Type *base, const i3c_master_config_t *masterConfig, uint32_t sourceClock_Hz)`

Initializes the I3C master peripheral.

This function enables the peripheral clock and initializes the I3C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

Parameters

- `base` – The I3C peripheral base address.
- `masterConfig` – User provided peripheral configuration. Use `I3C_MasterGetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the I3C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

`void I3C_MasterDeinit(I3C_Type *base)`

Deinitializes the I3C master peripheral.

This function disables the I3C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- `base` – The I3C peripheral base address.

`status_t I3C_MasterCheckAndClearError(I3C_Type *base, uint32_t status)`

`status_t I3C_MasterWaitForCtrlDone(I3C_Type *base, bool waitIdle)`

`status_t I3C_CheckForBusyBus(I3C_Type *base)`

`static inline void I3C_MasterEnable(I3C_Type *base, i3c_master_enable_t enable)`

Set I3C module master mode.

Parameters

- `base` – The I3C peripheral base address.
- `enable` – Enable master mode.

```
void I3C_SlaveGetDefaultConfig(i3c_slave_config_t *slaveConfig)
```

Provides a default configuration for the I3C slave peripheral.

This function provides the following default configuration for the I3C slave peripheral:

```
slaveConfig->enableslave = true;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the slave driver with `I3C_SlaveInit()`.

Parameters

- `slaveConfig` – **[out]** User provided configuration structure for default values. Refer to `i3c_slave_config_t`.

```
void I3C_SlaveInit(I3C_Type *base, const i3c_slave_config_t *slaveConfig, uint32_t slowClock_Hz)
```

Initializes the I3C slave peripheral.

This function enables the peripheral clock and initializes the I3C slave peripheral as described by the user provided configuration.

Parameters

- `base` – The I3C peripheral base address.
- `slaveConfig` – User provided peripheral configuration. Use `I3C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- `slowClock_Hz` – Frequency in Hertz of the I3C slow clock. Used to calculate the bus match condition values. If `FSL_FEATURE_I3C_HAS_NO_SCONFIG_BAMATCH` defines as 1, this parameter is useless.

```
void I3C_SlaveDeinit(I3C_Type *base)
```

Deinitializes the I3C slave peripheral.

This function disables the I3C slave peripheral and gates the clock.

Parameters

- `base` – The I3C peripheral base address.

```
static inline void I3C_SlaveEnable(I3C_Type *base, bool isEnabled)
```

Enable/Disable Slave.

Parameters

- `base` – The I3C peripheral base address.
- `isEnabled` – Enable or disable.

```
static inline uint32_t I3C_MasterGetStatusFlags(I3C_Type *base)
```

Gets the I3C master status flags.

A bit mask with the state of all I3C master status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i3c_master_flags`

Parameters

- `base` – The I3C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I3C_MasterClearStatusFlags(I3C_Type *base, uint32_t statusMask)
```

Clears the I3C master status flag state.

The following status register flags can be cleared:

- kI3C_MasterSlaveStartFlag
- kI3C_MasterControlDoneFlag
- kI3C_MasterCompleteFlag
- kI3C_MasterArbitrationWonFlag
- kI3C_MasterSlave2MasterFlag

Attempts to clear other flags has no effect.

See also:

`_i3c_master_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_master_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_MasterGetStatusFlags()`.

```
static inline uint32_t I3C_MasterGetErrorStatusFlags(I3C_Type *base)
```

Gets the I3C master error status flags.

A bit mask with the state of all I3C master error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i3c_master_error_flags`

Parameters

- `base` – The I3C peripheral base address.

Returns

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I3C_MasterClearErrorStatusFlags(I3C_Type *base, uint32_t statusMask)
```

Clears the I3C master error status flag state.

See also:

`_i3c_master_error_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_master_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_MasterGetStatusFlags()`.

`i3c_master_state_t` `I3C_MasterGetState(I3C_Type *base)`

Gets the I3C master state.

Parameters

- `base` – The I3C peripheral base address.

Returns

I3C master state.

`static inline uint32_t` `I3C_SlaveGetStatusFlags(I3C_Type *base)`

Gets the I3C slave status flags.

A bit mask with the state of all I3C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i3c_slave_flags`

Parameters

- `base` – The I3C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

`static inline void` `I3C_SlaveClearStatusFlags(I3C_Type *base, uint32_t statusMask)`

Clears the I3C slave status flag state.

The following status register flags can be cleared:

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`

Attempts to clear other flags has no effect.

See also:

`_i3c_slave_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetStatusFlags()`.

`static inline uint32_t I3C_SlaveGetErrorStatusFlags(I3C_Type *base)`

Gets the I3C slave error status flags.

A bit mask with the state of all I3C slave error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i3c_slave_error_flags`

Parameters

- `base` – The I3C peripheral base address.

Returns

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

`static inline void I3C_SlaveClearErrorStatusFlags(I3C_Type *base, uint32_t statusMask)`

Clears the I3C slave error status flag state.

See also:

`_i3c_slave_error_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_slave_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetErrorStatusFlags()`.

`i3c_slave_activity_state_t I3C_SlaveGetActivityState(I3C_Type *base)`

Gets the I3C slave state.

Parameters

- `base` – The I3C peripheral base address.

Returns

I3C slave activity state, refer `i3c_slave_activity_state_t`.

`status_t I3C_SlaveCheckAndClearError(I3C_Type *base, uint32_t status)`

`static inline void I3C_MasterEnableInterrupts(I3C_Type *base, uint32_t interruptMask)`

Enables the I3C master interrupt requests.

All flags except `kI3C_MasterBetweenFlag` and `kI3C_MasterNackDetectFlag` can be enabled as interrupts.

Parameters

- `base` – The I3C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_i3c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

`static inline void I3C_MasterDisableInterrupts(I3C_Type *base, uint32_t interruptMask)`

Disables the I3C master interrupt requests.

All flags except `kI3C_MasterBetweenFlag` and `kI3C_MasterNackDetectFlag` can be enabled as interrupts.

Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i3c_master_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t I3C_MasterGetEnabledInterrupts(I3C_Type *base)

Returns the set of currently enabled I3C master interrupt requests.

Parameters

- base – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_master_flags` enumerators OR'd together to indicate the set of enabled interrupts.

static inline uint32_t I3C_MasterGetPendingInterrupts(I3C_Type *base)

Returns the set of pending I3C master interrupt requests.

Parameters

- base – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_master_flags` enumerators OR'd together to indicate the set of pending interrupts.

static inline void I3C_SlaveEnableInterrupts(I3C_Type *base, uint32_t interruptMask)

Enables the I3C slave interrupt requests.

Only below flags can be enabled as interrupts.

- kI3C_SlaveBusStartFlag
- kI3C_SlaveMatchedFlag
- kI3C_SlaveBusStopFlag
- kI3C_SlaveRxReadyFlag
- kI3C_SlaveTxReadyFlag
- kI3C_SlaveDynamicAddrChangedFlag
- kI3C_SlaveReceivedCCCFlag
- kI3C_SlaveErrorFlag
- kI3C_SlaveHDRCommandMatchFlag
- kI3C_SlaveCCCHandledFlag
- kI3C_SlaveEventSentFlag

Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline void I3C_SlaveDisableInterrupts(I3C_Type *base, uint32_t interruptMask)

Disables the I3C slave interrupt requests.

Only below flags can be disabled as interrupts.

- kI3C_SlaveBusStartFlag
- kI3C_SlaveMatchedFlag

- kI3C_SlaveBusStopFlag
- kI3C_SlaveRxReadyFlag
- kI3C_SlaveTxReadyFlag
- kI3C_SlaveDynamicAddrChangedFlag
- kI3C_SlaveReceivedCCCFlag
- kI3C_SlaveErrorFlag
- kI3C_SlaveHDRCommandMatchFlag
- kI3C_SlaveCCCHandledFlag
- kI3C_SlaveEventSentFlag

Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t I3C_SlaveGetEnabledInterrupts(I3C_Type *base)

Returns the set of currently enabled I3C slave interrupt requests.

Parameters

- base – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

static inline uint32_t I3C_SlaveGetPendingInterrupts(I3C_Type *base)

Returns the set of pending I3C slave interrupt requests.

Parameters

- base – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of pending interrupts.

static inline void I3C_MasterEnableDMA(I3C_Type *base, bool enableTx, bool enableRx, uint32_t width)

Enables or disables I3C master DMA requests.

Parameters

- base – The I3C peripheral base address.
- enableTx – Enable flag for transmit DMA request. Pass true for enable, false for disable.
- enableRx – Enable flag for receive DMA request. Pass true for enable, false for disable.
- width – DMA read/write unit in bytes.

static inline uint32_t I3C_MasterGetTxFifoAddress(I3C_Type *base, uint32_t width)

Gets I3C master transmit data register address for DMA transfer.

Parameters

- base – The I3C peripheral base address.
- width – DMA read/write unit in bytes.

Returns

The I3C Master Transmit Data Register address.

```
static inline uint32_t I3C_MasterGetRxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C master receive data register address for DMA transfer.

Parameters

- *base* – The I3C peripheral base address.
- *width* – DMA read/write unit in bytes.

Returns

The I3C Master Receive Data Register address.

```
static inline void I3C_SlaveEnableDMA(I3C_Type *base, bool enableTx, bool enableRx, uint32_t width)
```

Enables or disables I3C slave DMA requests.

Parameters

- *base* – The I3C peripheral base address.
- *enableTx* – Enable flag for transmit DMA request. Pass true for enable, false for disable.
- *enableRx* – Enable flag for receive DMA request. Pass true for enable, false for disable.
- *width* – DMA read/write unit in bytes.

```
static inline uint32_t I3C_SlaveGetTxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave transmit data register address for DMA transfer.

Parameters

- *base* – The I3C peripheral base address.
- *width* – DMA read/write unit in bytes.

Returns

The I3C Slave Transmit Data Register address.

```
static inline uint32_t I3C_SlaveGetRxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave receive data register address for DMA transfer.

Parameters

- *base* – The I3C peripheral base address.
- *width* – DMA read/write unit in bytes.

Returns

The I3C Slave Receive Data Register address.

```
static inline void I3C_MasterSetWatermarks(I3C_Type *base, i3c_tx_trigger_level_t txLvl, i3c_rx_trigger_level_t rxLvl, bool flushTx, bool flushRx)
```

Sets the watermarks for I3C master FIFOs.

Parameters

- *base* – The I3C peripheral base address.
- *txLvl* – Transmit FIFO watermark level. The `kI3C_MasterTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches *txLvl*.
- *rxLvl* – Receive FIFO watermark level. The `kI3C_MasterRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches *rxLvl*.

- `flushTx` – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- `flushRx` – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

static inline void I3C_MasterGetFifoCounts(I3C_Type *base, size_t *rxCount, size_t *txCount)

Gets the current number of bytes in the I3C master FIFOs.

Parameters

- `base` – The I3C peripheral base address.
- `txCount` – **[out]** Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
- `rxCount` – **[out]** Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

static inline void I3C_SlaveSetWatermarks(I3C_Type *base, *i3c_tx_trigger_level_t* txLvl, *i3c_rx_trigger_level_t* rxLvl, bool flushTx, bool flushRx)

Sets the watermarks for I3C slave FIFOs.

Parameters

- `base` – The I3C peripheral base address.
- `txLvl` – Transmit FIFO watermark level. The `kI3C_SlaveTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches `txLvl`.
- `rxLvl` – Receive FIFO watermark level. The `kI3C_SlaveRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches `rxLvl`.
- `flushTx` – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- `flushRx` – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

static inline void I3C_SlaveGetFifoCounts(I3C_Type *base, size_t *rxCount, size_t *txCount)

Gets the current number of bytes in the I3C slave FIFOs.

Parameters

- `base` – The I3C peripheral base address.
- `txCount` – **[out]** Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
- `rxCount` – **[out]** Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

void I3C_MasterSetBaudRate(I3C_Type *base, const *i3c_baudrate_hz_t* *baudRate_Hz, uint32_t sourceClock_Hz)

Sets the I3C bus frequency for master transactions.

The I3C master is automatically disabled and re-enabled as necessary to configure the baud rate. Do not call this function during a transfer, or the transfer is aborted.

Parameters

- `base` – The I3C peripheral base address.
- `baudRate_Hz` – Pointer to structure of requested bus frequency in Hertz.
- `sourceClock_Hz` – I3C functional clock frequency in Hertz.

```
static inline bool I3C_MasterGetBusIdleState(I3C_Type *base)
```

Returns whether the bus is idle.

Requires the master mode to be enabled.

Parameters

- `base` – The I3C peripheral base address.

Return values

- `true` – Bus is busy.
- `false` – Bus is idle.

```
status_t I3C_MasterStartWithRxSize(I3C_Type *base, i3c_bus_type_t type, uint8_t address,
                                   i3c_direction_t dir, uint8_t rxSize)
```

Sends a START signal and slave address on the I2C/I3C bus, receive size is also specified in the call.

This function is used to initiate a new master mode transfer. First, the bus state is checked to ensure that another master is not occupying the bus. Then a START signal is transmitted, followed by the 7-bit address specified in the `address` parameter. Note that this function does not actually wait until the START and address are successfully sent on the bus before returning.

Parameters

- `base` – The I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.
- `rxSize` – Read terminate size for the followed read transfer, limit to 255 bytes.

Return values

- `kStatus_Success` – START signal and address were successfully enqueued in the transmit FIFO.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.

```
status_t I3C_MasterStart(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir)
```

Sends a START signal and slave address on the I2C/I3C bus.

This function is used to initiate a new master mode transfer. First, the bus state is checked to ensure that another master is not occupying the bus. Then a START signal is transmitted, followed by the 7-bit address specified in the `address` parameter. Note that this function does not actually wait until the START and address are successfully sent on the bus before returning.

Parameters

- `base` – The I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

- `kStatus_Success` – START signal and address were successfully enqueued in the transmit FIFO.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.

`status_t I3C_MasterRepeatedStartWithRxSize(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir, uint8_t rxSize)`

Sends a repeated START signal and slave address on the I2C/I3C bus, receive size is also specified in the call.

This function is used to send a Repeated START signal when a transfer is already in progress. Like `I3C_MasterStart()`, it also sends the specified 7-bit address. Call this API also configures the read terminate size for the following read transfer. For example, set the `rxSize` = 2, the following read transfer will be terminated after two bytes of data received. Write transfer will not be affected by the `rxSize` configuration.

Note: This function exists primarily to maintain compatible APIs between I3C and I2C drivers, as well as to better document the intent of code that uses these APIs.

Parameters

- `base` – The I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.
- `rxSize` – Read terminate size for the followed read transfer, limit to 255 bytes.

Return values

`kStatus_Success` – Repeated START signal and address were successfully enqueued in the transmit FIFO.

`static inline status_t I3C_MasterRepeatedStart(I3C_Type *base, i3c_bus_type_t type, uint8_t address, i3c_direction_t dir)`

Sends a repeated START signal and slave address on the I2C/I3C bus.

This function is used to send a Repeated START signal when a transfer is already in progress. Like `I3C_MasterStart()`, it also sends the specified 7-bit address.

Note: This function exists primarily to maintain compatible APIs between I3C and I2C drivers, as well as to better document the intent of code that uses these APIs.

Parameters

- `base` – The I3C peripheral base address.
- `type` – The bus type to use in this transaction.
- `address` – 7-bit slave device address, in bits [6:0].
- `dir` – Master transfer direction, either `kI3C_Read` or `kI3C_Write`. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

`kStatus_Success` – Repeated START signal and address were successfully enqueued in the transmit FIFO.

status_t I3C_MasterSend(I3C_Type *base, const void *txBuff, size_t txSize, uint32_t flags)

Performs a polling send transfer on the I2C/I3C bus.

Sends up to *txSize* number of bytes to the previously addressed slave device. The slave may reply with a NAK to any byte in order to terminate the transfer early. If this happens, this function returns *kStatus_I3C_Nak*.

Parameters

- *base* – The I3C peripheral base address.
- *txBuff* – The pointer to the data to be transferred.
- *txSize* – The length in bytes of the data to be transferred.
- *flags* – Bit mask of options for the transfer. See enumeration *_i3c_master_transfer_flags* for available options.

Return values

- *kStatus_Success* – Data was sent successfully.
- *kStatus_I3C_Busy* – Another master is currently utilizing the bus.
- *kStatus_I3C_Timeout* – The module has stalled too long in a frame.
- *kStatus_I3C_Nak* – The slave device sent a NAK in response to an address.
- *kStatus_I3C_WriteAbort* – The slave device sent a NAK in response to a write.
- *kStatus_I3C_MsgError* – Message SDR/DDR mismatch or read/write message in wrong state.
- *kStatus_I3C_WriteFifoError* – Write to M/SWDATAB register when FIFO full.
- *kStatus_I3C_InvalidReq* – Invalid use of request.

status_t I3C_MasterReceive(I3C_Type *base, void *rxBuff, size_t rxSize, uint32_t flags)

Performs a polling receive transfer on the I2C/I3C bus.

Parameters

- *base* – The I3C peripheral base address.
- *rxBuff* – The pointer to the data to be transferred.
- *rxSize* – The length in bytes of the data to be transferred.
- *flags* – Bit mask of options for the transfer. See enumeration *_i3c_master_transfer_flags* for available options.

Return values

- *kStatus_Success* – Data was received successfully.
- *kStatus_I3C_Busy* – Another master is currently utilizing the bus.
- *kStatus_I3C_Timeout* – The module has stalled too long in a frame.
- *kStatus_I3C_Term* – The master terminates slave read.
- *kStatus_I3C_HdrParityError* – Parity error from DDR read.
- *kStatus_I3C_CrcError* – CRC error from DDR read.
- *kStatus_I3C_MsgError* – Message SDR/DDR mismatch or read/write message in wrong state.
- *kStatus_I3C_ReadFifoError* – Read from M/SRDATAB register when FIFO empty.

- `kStatus_I3C_InvalidReq` – Invalid use of request.

`status_t I3C_MasterStop(I3C_Type *base)`

Sends a STOP signal on the I2C/I3C bus.

This function does not return until the STOP signal is seen on the bus, or an error occurs.

Parameters

- `base` – The I3C peripheral base address.

Return values

- `kStatus_Success` – The STOP signal was successfully sent on the bus and the transaction terminated.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I3C_Timeout` – The module has stalled too long in a frame.
- `kStatus_I3C_InvalidReq` – Invalid use of request.

`void I3C_MasterEmitRequest(I3C_Type *base, i3c_bus_request_t masterReq)`

I3C master emit request.

Parameters

- `base` – The I3C peripheral base address.
- `masterReq` – I3C master request of type `i3c_bus_request_t`

`static inline void I3C_MasterEmitIBIResponse(I3C_Type *base, i3c_ibi_response_t ibiResponse)`

I3C master emit request.

Parameters

- `base` – The I3C peripheral base address.
- `ibiResponse` – I3C master emit IBI response of type `i3c_ibi_response_t`

`void I3C_MasterRegisterIBI(I3C_Type *base, i3c_register_ibi_addr_t *ibiRule)`

I3C master register IBI rule.

Parameters

- `base` – The I3C peripheral base address.
- `ibiRule` – Pointer to ibi rule description of type `i3c_register_ibi_addr_t`

`void I3C_MasterGetIBIRules(I3C_Type *base, i3c_register_ibi_addr_t *ibiRule)`

I3C master get IBI rule.

Parameters

- `base` – The I3C peripheral base address.
- `ibiRule` – Pointer to store the read out ibi rule description.

`i3c_ibi_type_t I3C_GetIBIType(I3C_Type *base)`

I3C master get IBI Type.

Parameters

- `base` – The I3C peripheral base address.

Return values

`i3c_ibi_type_t` – Type of `i3c_ibi_type_t`.

```
static inline uint8_t I3C_GetIBIAddress(I3C_Type *base)
```

I3C master get IBI Address.

Parameters

- *base* – The I3C peripheral base address.

Return values

The – 8-bit IBI address.

```
status_t I3C_MasterProcessDAASpecifiedBaudrate(I3C_Type *base, uint8_t *addressList, uint32_t
count, i3c_master_daa_baudrate_t
*daaBaudRate)
```

Performs a DAA in the i3c bus with specified temporary baud rate.

Parameters

- *base* – The I3C peripheral base address.
- *addressList* – The pointer for address list which is used to do DAA.
- *count* – The address count in the address list.
- *daaBaudRate* – The temporary baud rate in DAA process, NULL for using initial setting. The initial setting is set back between the completion of the DAA and the return of this function.

Return values

- *kStatus_Success* – The transaction was started successfully.
- *kStatus_I3C_Busy* – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.
- *kStatus_I3C_SlaveCountExceed* – The I3C slave count has exceed the definition in *I3C_MAX_DEVCNT*.

```
static inline status_t I3C_MasterProcessDAA(I3C_Type *base, uint8_t *addressList, uint32_t
count)
```

Performs a DAA in the i3c bus.

Parameters

- *base* – The I3C peripheral base address.
- *addressList* – The pointer for address list which is used to do DAA.
- *count* – The address count in the address list. The initial setting is set back between the completion of the DAA and the return of this function.

Return values

- *kStatus_Success* – The transaction was started successfully.
- *kStatus_I3C_Busy* – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.
- *kStatus_I3C_SlaveCountExceed* – The I3C slave count has exceed the definition in *I3C_MAX_DEVCNT*.

```
i3c_device_info_t *I3C_MasterGetDeviceListAfterDAA(I3C_Type *base, uint8_t *count)
```

Get device information list after DAA process is done.

Parameters

- *base* – The I3C peripheral base address.
- *count* – **[out]** The pointer to store the available device count.

Returns

Pointer to the *i3c_device_info_t* array.

`void I3C_MasterClearDeviceCount(I3C_Type *base)`

Clear the global device count which represents current devices number on the bus. When user resets all dynamic addresses on the bus, should call this API.

Parameters

- `base` – The I3C peripheral base address.

`status_t I3C_MasterTransferBlocking(I3C_Type *base, i3c_master_transfer_t *transfer)`

Performs a master polling transfer on the I2C/I3C bus.

Note: The API does not return until the transfer succeeds or fails due to error happens during transfer.

Parameters

- `base` – The I3C peripheral base address.
- `transfer` – Pointer to the transfer structure.

Return values

- `kStatus_Success` – Data was received successfully.
- `kStatus_I3C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I3C_IBIWon` – The I3C slave event IBI or MR or HJ won the arbitration on a header address.
- `kStatus_I3C_Timeout` – The module has stalled too long in a frame.
- `kStatus_I3C_Nak` – The slave device sent a NAK in response to an address.
- `kStatus_I3C_WriteAbort` – The slave device sent a NAK in response to a write.
- `kStatus_I3C_Term` – The master terminates slave read.
- `kStatus_I3C_HdrParityError` – Parity error from DDR read.
- `kStatus_I3C_CrcError` – CRC error from DDR read.
- `kStatus_I3C_MsgError` – Message SDR/DDR mismatch or read/write message in wrong state.
- `kStatus_I3C_ReadFifoError` – Read from M/SRDATAB register when FIFO empty.
- `kStatus_I3C_WriteFifoError` – Write to M/SWDATAB register when FIFO full.
- `kStatus_I3C_InvalidReq` – Invalid use of request.

`status_t I3C_SlaveSend(I3C_Type *base, const void *txBuff, size_t txSize)`

Performs a polling send transfer on the I3C bus.

Parameters

- `base` – The I3C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

Returns

Error or success status returned by API.

status_t I3C_SlaveReceive(I3C_Type *base, void *rxBuff, size_t rxSize)

Performs a polling receive transfer on the I3C bus.

Parameters

- base – The I3C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.

Returns

Error or success status returned by API.

void I3C_MasterTransferCreateHandle(I3C_Type *base, *i3c_master_handle_t* *handle, const *i3c_master_transfer_callback_t* *callback, void *userData)

Creates a new handle for the I3C master non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the I3C_MasterTransferAbort() API shall be called.

Note: The function also enables the NVIC IRQ for the input I3C. Need to notice that on some SoCs the I3C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

- base – The I3C peripheral base address.
- handle – **[out]** Pointer to the I3C master driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

status_t I3C_MasterTransferNonBlocking(I3C_Type *base, *i3c_master_handle_t* *handle, *i3c_master_transfer_t* *transfer)

Performs a non-blocking transaction on the I2C/I3C bus.

Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.
- transfer – The pointer to the transfer descriptor.

Return values

- kStatus_Success – The transaction was started successfully.
- kStatus_I3C_Busy – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

status_t I3C_MasterTransferGetCount(I3C_Type *base, *i3c_master_handle_t* *handle, size_t *count)

Returns number of bytes transferred so far.

Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.
- count – **[out]** Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus_Success` –
- `kStatus_NoTransferInProgress` – There is not a non-blocking transaction currently in progress.

`void I3C_MasterTransferAbort(I3C_Type *base, i3c_master_handle_t *handle)`

Terminates a non-blocking I3C master transmission early.

Note: It is not safe to call this function from an IRQ handler that has a higher priority than the I3C peripheral's IRQ priority.

Parameters

- `base` – The I3C peripheral base address.
- `handle` – Pointer to the I3C master driver handle.

Return values

- `kStatus_Success` – A transaction was successfully aborted.
- `kStatus_I3C_Idle` – There is not a non-blocking transaction currently in progress.

`void I3C_MasterTransferHandleIRQ(I3C_Type *base, void *intHandle)`

Reusable routine to handle master interrupts.

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

Parameters

- `base` – The I3C peripheral base address.
- `intHandle` – Pointer to the I3C master driver handle.

`enum _i3c_master_flags`

I3C master peripheral flags.

The following status register flags can be cleared:

- `kI3C_MasterSlaveStartFlag`
- `kI3C_MasterControlDoneFlag`
- `kI3C_MasterCompleteFlag`
- `kI3C_MasterArbitrationWonFlag`
- `kI3C_MasterSlave2MasterFlag`

All flags except `kI3C_MasterBetweenFlag` and `kI3C_MasterNackDetectFlag` can be enabled as interrupts.

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

Values:

enumerator `kI3C_MasterBetweenFlag`

Between messages/DAA's flag

enumerator kI3C_MasterNackDetectFlag
NACK detected flag

enumerator kI3C_MasterSlaveStartFlag
Slave request start flag

enumerator kI3C_MasterControlDoneFlag
Master request complete flag

enumerator kI3C_MasterCompleteFlag
Transfer complete flag

enumerator kI3C_MasterRxReadyFlag
Rx data ready in Rx buffer flag

enumerator kI3C_MasterTxReadyFlag
Tx buffer ready for Tx data flag

enumerator kI3C_MasterArbitrationWonFlag
Header address won arbitration flag

enumerator kI3C_MasterErrorFlag
Error occurred flag

enumerator kI3C_MasterSlave2MasterFlag
Switch from slave to master flag

enumerator kI3C_MasterClearFlags

enum _i3c_master_error_flags
I3C master error flags to indicate the causes.

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

Values:

enumerator kI3C_MasterErrorNackFlag
Slave NACKed the last address

enumerator kI3C_MasterErrorWriteAbortFlag
Slave NACKed the write data

enumerator kI3C_MasterErrorParityFlag
Parity error from DDR read

enumerator kI3C_MasterErrorCrcFlag
CRC error from DDR read

enumerator kI3C_MasterErrorReadFlag
Read from MRDATAB register when FIFO empty

enumerator kI3C_MasterErrorWriteFlag
Write to MWDATAB register when FIFO full

enumerator kI3C_MasterErrorMsgFlag
Message SDR/DDR mismatch or read/write message in wrong state

enumerator kI3C_MasterErrorInvalidReqFlag
Invalid use of request

enumerator kI3C_MasterErrorTimeoutFlag
The module has stalled too long in a frame

enumerator kI3C_MasterAllErrorFlags

All error flags

enum _i3c_master_state

I3C working master state.

Values:

enumerator kI3C_MasterStateIdle

Bus stopped.

enumerator kI3C_MasterStateSlvReq

Bus stopped but slave holding SDA low.

enumerator kI3C_MasterStateMsgSdr

In SDR Message mode from using MWMSG_SDR.

enumerator kI3C_MasterStateNormAct

In normal active SDR mode.

enumerator kI3C_MasterStateDdr

In DDR Message mode.

enumerator kI3C_MasterStateDaa

In ENTDAAs mode.

enumerator kI3C_MasterStateIbiAck

Waiting on IBI ACK/NACK decision.

enumerator kI3C_MasterStateIbiRcv

Receiving IBI.

enum _i3c_master_enable

I3C master enable configuration.

Values:

enumerator kI3C_MasterOff

Master off.

enumerator kI3C_MasterOn

Master on.

enumerator kI3C_MasterCapable

Master capable.

enum _i3c_master_hkeep

I3C high keeper configuration.

Values:

enumerator kI3C_MasterHighKeeperNone

Use PUR to hold SCL high.

enumerator kI3C_MasterHighKeeperWiredIn

Use pin_HK controls.

enumerator kI3C_MasterPassiveSDA

Hi-Z for Bus Free and hold SDA.

enumerator kI3C_MasterPassiveSDASCL

Hi-Z both for Bus Free, and can Hi-Z SDA for hold.

enum _i3c_bus_request

Emits the requested operation when doing in pieces vs. by message.

Values:

enumerator kI3C_RequestNone

No request.

enumerator kI3C_RequestEmitStartAddr

Request to emit start and address on bus.

enumerator kI3C_RequestEmitStop

Request to emit stop on bus.

enumerator kI3C_RequestIbiAckNack

Manual IBI ACK or NACK.

enumerator kI3C_RequestProcessDAA

Process DAA.

enumerator kI3C_RequestForceExit

Request to force exit.

enumerator kI3C_RequestAutoIbi

Hold in stopped state, but Auto-emit START,7E.

enum _i3c_bus_type

Bus type with EmitStartAddr.

Values:

enumerator kI3C_TypeI3CSdr

SDR mode of I3C.

enumerator kI3C_TypeI2C

Standard i2c protocol.

enumerator kI3C_TypeI3CDdr

HDR-DDR mode of I3C.

enum _i3c_ibi_response

IBI response.

Values:

enumerator kI3C_IbiRespAck

ACK with no mandatory byte.

enumerator kI3C_IbiRespNack

NACK.

enumerator kI3C_IbiRespAckMandatory

ACK with mandatory byte.

enumerator kI3C_IbiRespManual

Reserved.

enum _i3c_ibi_type

IBI type.

Values:

enumerator kI3C_IbiNormal

In-band interrupt.

enumerator kI3C_IbiHotJoin
slave hot join.

enumerator kI3C_IbiMasterRequest
slave master ship request.

enum _i3c_ibi_state
IBI state.

Values:

enumerator kI3C_IbiReady
In-band interrupt ready state, ready for user to handle.

enumerator kI3C_IbiDataBuffNeed
In-band interrupt need data buffer for data receive.

enumerator kI3C_IbiAckNackPending
In-band interrupt Ack/Nack pending for decision.

enum _i3c_direction
Direction of master and slave transfers.

Values:

enumerator kI3C_Write
Master transmit.

enumerator kI3C_Read
Master receive.

enum _i3c_tx_trigger_level
Watermark of TX int/dma trigger level.

Values:

enumerator kI3C_TxTriggerOnEmpty
Trigger on empty.

enumerator kI3C_TxTriggerUntilOneQuarterOrLess
Trigger on 1/4 full or less.

enumerator kI3C_TxTriggerUntilOneHalfOrLess
Trigger on 1/2 full or less.

enumerator kI3C_TxTriggerUntilOneLessThanFull
Trigger on 1 less than full or less.

enum _i3c_rx_trigger_level
Watermark of RX int/dma trigger level.

Values:

enumerator kI3C_RxTriggerOnNotEmpty
Trigger on not empty.

enumerator kI3C_RxTriggerUntilOneQuarterOrMore
Trigger on 1/4 full or more.

enumerator kI3C_RxTriggerUntilOneHalfOrMore
Trigger on 1/2 full or more.

enumerator kI3C_RxTriggerUntilThreeQuarterOrMore
Trigger on 3/4 full or more.

enum _i3c_rx_term_ops

I3C master read termination operations.

Values:

enumerator kI3C_RxTermDisable

Master doesn't terminate read, used for CCC transfer.

enumerator kI3C_RxAutoTerm

Master auto terminate read after receiving specified bytes(<=255).

enumerator kI3C_RxTermLastByte

Master terminates read at any time after START, no length limitation.

enum _i3c_start_scl_delay

I3C start SCL delay options.

Values:

enumerator kI3C_NoDelay

No delay.

enumerator kI3C_IncreaseSclHalfPeriod

Increases SCL clock period by 1/2.

enumerator kI3C_IncreaseSclOnePeriod

Increases SCL clock period by 1.

enumerator kI3C_IncreaseSclOneAndHalfPeriod

Increases SCL clock period by 1 1/2

enum _i3c_master_transfer_flags

Transfer option flags.

Note: These enumerations are intended to be OR'd together to form a bit mask of options for the `_i3c_master_transfer::flags` field.

Values:

enumerator kI3C_TransferDefaultFlag

Transfer starts with a start signal, stops with a stop signal.

enumerator kI3C_TransferNoStartFlag

Don't send a start condition, address, and sub address

enumerator kI3C_TransferRepeatedStartFlag

Send a repeated start condition

enumerator kI3C_TransferNoStopFlag

Don't send a stop condition.

enumerator kI3C_TransferWordsFlag

Transfer in words, else transfer in bytes.

enumerator kI3C_TransferDisableRxTermFlag

Disable Rx termination. Note: It's for I3C CCC transfer.

enumerator kI3C_TransferRxAutoTermFlag

Set Rx auto-termination. Note: It's adaptive based on Rx size(<=255 bytes) except in `I3C_MasterReceive`.

enumerator `kI3C_TransferStartWithBroadcastAddr`

Start transfer with 0x7E, then read/write data with device address.

typedef enum `_i3c_master_state` `i3c_master_state_t`

I3C working master state.

typedef enum `_i3c_master_enable` `i3c_master_enable_t`

I3C master enable configuration.

typedef enum `_i3c_master_hkeep` `i3c_master_hkeep_t`

I3C high keeper configuration.

typedef enum `_i3c_bus_request` `i3c_bus_request_t`

Emits the requested operation when doing in pieces vs. by message.

typedef enum `_i3c_bus_type` `i3c_bus_type_t`

Bus type with `EmitStartAddr`.

typedef enum `_i3c_ibi_response` `i3c_ibi_response_t`

IBI response.

typedef enum `_i3c_ibi_type` `i3c_ibi_type_t`

IBI type.

typedef enum `_i3c_ibi_state` `i3c_ibi_state_t`

IBI state.

typedef enum `_i3c_direction` `i3c_direction_t`

Direction of master and slave transfers.

typedef enum `_i3c_tx_trigger_level` `i3c_tx_trigger_level_t`

Watermark of TX int/dma trigger level.

typedef enum `_i3c_rx_trigger_level` `i3c_rx_trigger_level_t`

Watermark of RX int/dma trigger level.

typedef enum `_i3c_rx_term_ops` `i3c_rx_term_ops_t`

I3C master read termination operations.

typedef enum `_i3c_start_scl_delay` `i3c_start_scl_delay_t`

I3C start SCL delay options.

typedef struct `_i3c_register_ibi_addr` `i3c_register_ibi_addr_t`

Structure with setting master IBI rules and slave registry.

typedef struct `_i3c_baudrate` `i3c_baudrate_hz_t`

Structure with I3C baudrate settings.

typedef struct `_i3c_master_daa_baudrate` `i3c_master_daa_baudrate_t`

I3C DAA baud rate configuration.

typedef struct `_i3c_master_config` `i3c_master_config_t`

Structure with settings to initialize the I3C master module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_MasterGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef struct `_i3c_master_transfer` `i3c_master_transfer_t`

typedef struct `_i3c_master_handle` `i3c_master_handle_t`

```
typedef struct _i3c_master_transfer_callback i3c_master_transfer_callback_t
```

i3c master callback functions.

```
typedef void (*i3c_master_isr_t)(I3C_Type *base, void *handle)
```

Typedef for master interrupt handler.

```
struct _i3c_register_ibi_addr
```

#include <fsl_i3c.h> Structure with setting master IBI rules and slave registry.

Public Members

```
uint8_t address[5]
```

Address array for registry.

```
bool i3cFastStart
```

Allow the START header to run as push-pull speed if all dynamic addresses take MSB 0.

```
bool ibiHasPayload
```

Whether the address array has mandatory IBI byte.

```
struct _i3c_baudrate
```

#include <fsl_i3c.h> Structure with I3C baudrate settings.

Public Members

```
uint32_t i2cBaud
```

Desired I2C baud rate in Hertz.

```
uint32_t i3cPushPullBaud
```

Desired I3C push-pull baud rate in Hertz.

```
uint32_t i3cOpenDrainBaud
```

Desired I3C open-drain baud rate in Hertz.

```
struct _i3c_master_daa_baudrate
```

#include <fsl_i3c.h> I3C DAA baud rate configuration.

Public Members

```
uint32_t sourceClock_Hz
```

FCLK, function clock in Hertz.

```
uint32_t i3cPushPullBaud
```

Desired I3C push-pull baud rate in Hertz.

```
uint32_t i3cOpenDrainBaud
```

Desired I3C open-drain baud rate in Hertz.

```
struct _i3c_master_config
```

#include <fsl_i3c.h> Structure with settings to initialize the I3C master module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_MasterGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

i3c_master_enable_t enableMaster

Enable master mode.

bool disableTimeout

Whether to disable timeout to prevent the ERRWARN.

i3c_master_hkeep_t hKeep

High keeper mode setting.

bool enableOpenDrainStop

Whether to emit open-drain speed STOP.

bool enableOpenDrainHigh

Enable Open-Drain High to be 1 PPBAUD count for i3c messages, or 1 ODBAUD.

i3c_baudrate_hz_t baudRate_Hz

Desired baud rate settings.

struct *_i3c_master_transfer_callback*

#include <fsl_i3c.h> i3c master callback functions.

Public Members

void (*slave2Master)(I3C_Type *base, void *userData)

Transfer complete callback

void (*ibiCallback)(I3C_Type *base, *i3c_master_handle_t* *handle, *i3c_ibi_type_t* ibiType, *i3c_ibi_state_t* ibiState)

IBI event callback

void (*transferComplete)(I3C_Type *base, *i3c_master_handle_t* *handle, *status_t* completionStatus, void *userData)

Transfer complete callback

struct *_i3c_master_transfer*

#include <fsl_i3c.h> Non-blocking transfer descriptor structure.

This structure is used to pass transaction parameters to the I3C_MasterTransferNonBlocking() API.

Public Members

uint32_t flags

Bit mask of options for the transfer. See enumeration *_i3c_master_transfer_flags* for available options. Set to 0 or *kI3C_TransferDefaultFlag* for normal transfers.

uint8_t slaveAddress

The 7-bit slave address.

i3c_direction_t direction

Either *kI3C_Read* or *kI3C_Write*.

uint32_t subaddress

Sub address. Transferred MSB first.

size_t subaddressSize

Length of sub address to send in bytes. Maximum size is 4 bytes.

`void *data`
 Pointer to data to transfer.

`size_t dataSize`
 Number of bytes to transfer.

`i3c_bus_type_t busType`
 bus type.

`i3c_ibi_response_t ibiResponse`
 ibi response during transfer.

`struct __i3c_master_handle`
 #include <fsl_i3c.h> Driver handle for master non-blocking APIs.

Note: The contents of this structure are private and subject to change.

Public Members

`uint8_t state`
 Transfer state machine current state.

`uint32_t remainingBytes`
 Remaining byte count in current state.

`i3c_rx_term_ops_t rxTermOps`
 Read termination operation.

`i3c_master_transfer_t transfer`
 Copy of the current transfer info.

`uint8_t ibiAddress`
 Slave address which request IBI.

`uint8_t *ibiBuff`
 Pointer to IBI buffer to keep ibi bytes.

`size_t ibiPayloadSize`
 IBI payload size.

`i3c_ibi_type_t ibiType`
 IBI type.

`i3c_master_transfer_callback_t callback`
 Callback functions pointer.

`void *userData`
 Application data passed to callback.

2.38 I3C Master DMA Driver

```
void I3C_MasterTransferCreateHandleEDMA(I3C_Type *base, i3c_master_edma_handle_t
                                         *handle, const i3c_master_edma_callback_t
                                         *callback, void *userData, edma_handle_t
                                         *rxDmaHandle, edma_handle_t *txDmaHandle)
```

Create a new handle for the I3C master DMA APIs.

The creation of a handle is for use with the DMA APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the `I3C_MasterTransferAbortDMA()` API shall be called.

For devices where the I3C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

Parameters

- *base* – The I3C peripheral base address.
- *handle* – Pointer to the I3C master driver handle.
- *callback* – User provided pointer to the asynchronous callback function.
- *userData* – User provided pointer to the application callback data.
- *rxDmaHandle* – Handle for the DMA receive channel. Created by the user prior to calling this function.
- *txDmaHandle* – Handle for the DMA transmit channel. Created by the user prior to calling this function.

```
status_t I3C_MasterTransferEDMA(I3C_Type *base, i3c_master_edma_handle_t *handle,  
                                i3c_master_transfer_t *transfer)
```

Performs a non-blocking DMA-based transaction on the I3C bus.

The callback specified when the *handle* was created is invoked when the transaction has completed.

Parameters

- *base* – The I3C peripheral base address.
- *handle* – Pointer to the I3C master driver handle.
- *transfer* – The pointer to the transfer descriptor.

Return values

- `kStatus__Success` – The transaction was started successfully.
- `kStatus_I3C_Busy` – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

```
status_t I3C_MasterTransferGetCountEDMA(I3C_Type *base, i3c_master_edma_handle_t *handle,  
                                         size_t *count)
```

Returns number of bytes transferred so far.

Parameters

- *base* – The I3C peripheral base address.
- *handle* – Pointer to the I3C master driver handle.
- *count* – **[out]** Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus__Success` –
- `kStatus__NoTransferInProgress` – There is not a DMA transaction currently in progress.

```
void I3C_MasterTransferAbortEDMA(I3C_Type *base, i3c_master_edma_handle_t *handle)
```

Terminates a non-blocking I3C master transmission early.

Note: It is not safe to call this function from an IRQ handler that has a higher priority than the DMA peripheral's IRQ priority.

Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C master driver handle.

```
void I3C_MasterTransferEDMAHandleIRQ(I3C_Type *base, void *i3cHandle)
```

Reusable routine to handle master interrupts.

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

Parameters

- base – The I3C peripheral base address.
- i3cHandle – Pointer to the I3C master DMA driver handle.

```
typedef struct _i3c_master_edma_handle i3c_master_edma_handle_t
```

```
typedef struct _i3c_master_edma_callback i3c_master_edma_callback_t
```

i3c master callback functions.

```
struct _i3c_master_edma_callback
```

```
#include <fsl_i3c_edma.h> i3c master callback functions.
```

Public Members

```
void (*slave2Master)(I3C_Type *base, void *userData)
```

Target asks for controller request.

```
void (*ibiCallback)(I3C_Type *base, i3c_master_edma_handle_t *handle, i3c_ibi_type_t  
ibiType, i3c_ibi_state_t ibiState)
```

IBI event callback.

```
void (*transferComplete)(I3C_Type *base, i3c_master_edma_handle_t *handle, status_t  
status, void *userData)
```

Transfer complete callback.

```
struct _i3c_master_edma_handle
```

```
#include <fsl_i3c_edma.h> Driver handle for master EDMA APIs.
```

Note: The contents of this structure are private and subject to change.

Public Members

```
I3C_Type *base
```

I3C base pointer.

`uint8_t state`
Transfer state machine current state.

`uint32_t transferCount`
Indicates progress of the transfer

`uint8_t subaddressBuffer[4]`
Saving subaddress command.

`uint8_t subaddressCount`
Saving command count.

`i3c_master_transfer_t transfer`
Copy of the current transfer info.

`i3c_master_edma_callback_t callback`
Callback function pointer.

`void *userData`
Application data passed to callback.

`edma_handle_t *rxDmaHandle`
Handle for receive DMA channel.

`edma_handle_t *txDmaHandle`
Handle for transmit DMA channel.

`bool ibiFlag`
IBIWON flag.

`uint8_t ibiAddress`
Slave address which request IBI.

`uint8_t *ibiBuff`
Pointer to IBI buffer to keep ibi bytes.

`size_t ibiPayloadSize`
IBI payload size.

`i3c_ibi_type_t ibiType`
IBI type.

`status_t result`
Transfer result.

2.39 I3C Slave Driver

`void I3C_SlaveGetDefaultConfig(i3c_slave_config_t *slaveConfig)`
Provides a default configuration for the I3C slave peripheral.

This function provides the following default configuration for the I3C slave peripheral:

```
slaveConfig->enableslave      = true;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the slave driver with `I3C_SlaveInit()`.

Parameters

- `slaveConfig` – **[out]** User provided configuration structure for default values. Refer to `i3c_slave_config_t`.

```
void I3C_SlaveInit(I3C_Type *base, const i3c_slave_config_t *slaveConfig, uint32_t  
slowClock_Hz)
```

Initializes the I3C slave peripheral.

This function enables the peripheral clock and initializes the I3C slave peripheral as described by the user provided configuration.

Parameters

- base – The I3C peripheral base address.
- slaveConfig – User provided peripheral configuration. Use I3C_SlaveGetDefaultConfig() to get a set of defaults that you can override.
- slowClock_Hz – Frequency in Hertz of the I3C slow clock. Used to calculate the bus match condition values. If FSL_FEATURE_I3C_HAS_NO_SCONFIG_BAMATCH defines as 1, this parameter is useless.

```
void I3C_SlaveDeinit(I3C_Type *base)
```

Deinitializes the I3C slave peripheral.

This function disables the I3C slave peripheral and gates the clock.

Parameters

- base – The I3C peripheral base address.

```
static inline void I3C_SlaveEnable(I3C_Type *base, bool isEnabled)
```

Enable/Disable Slave.

Parameters

- base – The I3C peripheral base address.
- isEnabled – Enable or disable.

```
static inline uint32_t I3C_SlaveGetStatusFlags(I3C_Type *base)
```

Gets the I3C slave status flags.

A bit mask with the state of all I3C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

[_i3c_slave_flags](#)

Parameters

- base – The I3C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I3C_SlaveClearStatusFlags(I3C_Type *base, uint32_t statusMask)
```

Clears the I3C slave status flag state.

The following status register flags can be cleared:

- kI3C_SlaveBusStartFlag
- kI3C_SlaveMatchedFlag
- kI3C_SlaveBusStopFlag

Attempts to clear other flags has no effect.

See also:

`_i3c_slave_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i3c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetStatusFlags()`.

`static inline uint32_t I3C_SlaveGetErrorStatusFlags(I3C_Type *base)`

Gets the I3C slave error status flags.

A bit mask with the state of all I3C slave error status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i3c_slave_error_flags`

Parameters

- `base` – The I3C peripheral base address.

Returns

State of the error status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

`static inline void I3C_SlaveClearErrorStatusFlags(I3C_Type *base, uint32_t statusMask)`

Clears the I3C slave error status flag state.

See also:

`_i3c_slave_error_flags`.

Parameters

- `base` – The I3C peripheral base address.
- `statusMask` – A bitmask of error status flags that are to be cleared. The mask is composed of `_i3c_slave_error_flags` enumerators OR'd together. You may pass the result of a previous call to `I3C_SlaveGetErrorStatusFlags()`.

`i3c_slave_activity_state_t I3C_SlaveGetActivityState(I3C_Type *base)`

Gets the I3C slave state.

Parameters

- `base` – The I3C peripheral base address.

Returns

I3C slave activity state, refer `i3c_slave_activity_state_t`.

`status_t I3C_SlaveCheckAndClearError(I3C_Type *base, uint32_t status)`

static inline void I3C_SlaveEnableInterrupts(I3C_Type *base, uint32_t interruptMask)

Enables the I3C slave interrupt requests.

Only below flags can be enabled as interrupts.

- kI3C_SlaveBusStartFlag
- kI3C_SlaveMatchedFlag
- kI3C_SlaveBusStopFlag
- kI3C_SlaveRxReadyFlag
- kI3C_SlaveTxReadyFlag
- kI3C_SlaveDynamicAddrChangedFlag
- kI3C_SlaveReceivedCCCFlag
- kI3C_SlaveErrorFlag
- kI3C_SlaveHDRCommandMatchFlag
- kI3C_SlaveCCCHandledFlag
- kI3C_SlaveEventSentFlag

Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline void I3C_SlaveDisableInterrupts(I3C_Type *base, uint32_t interruptMask)

Disables the I3C slave interrupt requests.

Only below flags can be disabled as interrupts.

- kI3C_SlaveBusStartFlag
- kI3C_SlaveMatchedFlag
- kI3C_SlaveBusStopFlag
- kI3C_SlaveRxReadyFlag
- kI3C_SlaveTxReadyFlag
- kI3C_SlaveDynamicAddrChangedFlag
- kI3C_SlaveReceivedCCCFlag
- kI3C_SlaveErrorFlag
- kI3C_SlaveHDRCommandMatchFlag
- kI3C_SlaveCCCHandledFlag
- kI3C_SlaveEventSentFlag

Parameters

- base – The I3C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i3c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

static inline uint32_t I3C_SlaveGetEnabledInterrupts(I3C_Type *base)

Returns the set of currently enabled I3C slave interrupt requests.

Parameters

- `base` – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
static inline uint32_t I3C_SlaveGetPendingInterrupts(I3C_Type *base)
```

Returns the set of pending I3C slave interrupt requests.

Parameters

- `base` – The I3C peripheral base address.

Returns

A bitmask composed of `_i3c_slave_flags` enumerators OR'd together to indicate the set of pending interrupts.

```
static inline void I3C_SlaveEnableDMA(I3C_Type *base, bool enableTx, bool enableRx, uint32_t width)
```

Enables or disables I3C slave DMA requests.

Parameters

- `base` – The I3C peripheral base address.
- `enableTx` – Enable flag for transmit DMA request. Pass true for enable, false for disable.
- `enableRx` – Enable flag for receive DMA request. Pass true for enable, false for disable.
- `width` – DMA read/write unit in bytes.

```
static inline uint32_t I3C_SlaveGetTxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave transmit data register address for DMA transfer.

Parameters

- `base` – The I3C peripheral base address.
- `width` – DMA read/write unit in bytes.

Returns

The I3C Slave Transmit Data Register address.

```
static inline uint32_t I3C_SlaveGetRxFifoAddress(I3C_Type *base, uint32_t width)
```

Gets I3C slave receive data register address for DMA transfer.

Parameters

- `base` – The I3C peripheral base address.
- `width` – DMA read/write unit in bytes.

Returns

The I3C Slave Receive Data Register address.

```
static inline void I3C_SlaveSetWatermarks(I3C_Type *base, i3c_tx_trigger_level_t txLvl, i3c_rx_trigger_level_t rxLvl, bool flushTx, bool flushRx)
```

Sets the watermarks for I3C slave FIFOs.

Parameters

- `base` – The I3C peripheral base address.
- `txLvl` – Transmit FIFO watermark level. The `kI3C_SlaveTxReadyFlag` flag is set whenever the number of words in the transmit FIFO reaches `txLvl`.

- `rxLvl` – Receive FIFO watermark level. The `kI3C_SlaveRxReadyFlag` flag is set whenever the number of words in the receive FIFO reaches `rxLvl`.
- `flushTx` – true if TX FIFO is to be cleared, otherwise TX FIFO remains unchanged.
- `flushRx` – true if RX FIFO is to be cleared, otherwise RX FIFO remains unchanged.

`static inline void I3C_SlaveGetFifoCounts(I3C_Type *base, size_t *rxCount, size_t *txCount)`

Gets the current number of bytes in the I3C slave FIFOs.

Parameters

- `base` – The I3C peripheral base address.
- `txCount` – **[out]** Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
- `rxCount` – **[out]** Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

`status_t I3C_SlaveSend(I3C_Type *base, const void *txBuff, size_t txSize)`

Performs a polling send transfer on the I3C bus.

Parameters

- `base` – The I3C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

Returns

Error or success status returned by API.

`status_t I3C_SlaveReceive(I3C_Type *base, void *rxBuff, size_t rxSize)`

Performs a polling receive transfer on the I3C bus.

Parameters

- `base` – The I3C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.

Returns

Error or success status returned by API.

`void I3C_SlaveTransferCreateHandle(I3C_Type *base, i3c_slave_handle_t *handle, i3c_slave_transfer_callback_t callback, void *userData)`

Creates a new handle for the I3C slave non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the `I3C_SlaveTransferAbort()` API shall be called.

Note: The function also enables the NVIC IRQ for the input I3C. Need to notice that on some SoCs the I3C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

- `base` – The I3C peripheral base address.
- `handle` – **[out]** Pointer to the I3C slave driver handle.

- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

`status_t I3C_SlaveTransferNonBlocking(I3C_Type *base, i3c_slave_handle_t *handle, uint32_t eventMask)`

Starts accepting slave transfers.

Call this API after calling `I2C_SlaveInit()` and `I3C_SlaveTransferCreateHandle()` to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to `I3C_SlaveTransferCreateHandle()`. The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the `eventMask` parameter to the OR'd combination of `i3c_slave_transfer_event_t` enumerators for the events you wish to receive. The `kI3C_SlaveTransmitEvent` and `kI3C_SlaveReceiveEvent` events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the `kI3C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

Parameters

- `base` – The I3C peripheral base address.
- `handle` – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.
- `eventMask` – Bit mask formed by OR'ing together `i3c_slave_transfer_event_t` enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and `kI3C_SlaveAllEvents` to enable all events.

Return values

- `kStatus_Success` – Slave transfers were successfully started.
- `kStatus_I3C_Busy` – Slave transfers have already been started on this handle.

`status_t I3C_SlaveTransferGetCount(I3C_Type *base, i3c_slave_handle_t *handle, size_t *count)`

Gets the slave transfer status during a non-blocking transfer.

Parameters

- `base` – The I3C peripheral base address.
- `handle` – Pointer to `i2c_slave_handle_t` structure.
- `count` – **[out]** Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

Return values

- `kStatus_Success` –
- `kStatus_NoTransferInProgress` –

`void I3C_SlaveTransferAbort(I3C_Type *base, i3c_slave_handle_t *handle)`

Aborts the slave non-blocking transfers.

Note: This API could be called at any time to stop slave for handling the bus events.

Parameters

- `base` – The I3C peripheral base address.

- handle – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.

Return values

- `kStatus__Success` –
- `kStatus_I3C_Idle` –

`void I3C_SlaveTransferHandleIRQ(I3C_Type *base, void *intHandle)`

Reusable routine to handle slave interrupts.

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

Parameters

- base – The I3C peripheral base address.
- intHandle – Pointer to struct: `_i3c_slave_handle` structure which stores the transfer state.

`enum _i3c_slave_flags`

I3C slave peripheral flags.

The following status register flags can be cleared:

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`

Only below flags can be enabled as interrupts.

- `kI3C_SlaveBusStartFlag`
- `kI3C_SlaveMatchedFlag`
- `kI3C_SlaveBusStopFlag`
- `kI3C_SlaveRxReadyFlag`
- `kI3C_SlaveTxReadyFlag`
- `kI3C_SlaveDynamicAddrChangedFlag`
- `kI3C_SlaveReceivedCCCFlag`
- `kI3C_SlaveErrorFlag`
- `kI3C_SlaveHDRCommandMatchFlag`
- `kI3C_SlaveCCCHandledFlag`
- `kI3C_SlaveEventSentFlag`

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

Values:

enumerator `kI3C_SlaveNotStopFlag`

Slave status not stop flag

enumerator `kI3C_SlaveMessageFlag`

Slave status message, indicating slave is listening to the bus traffic or responding

enumerator `kI3C_SlaveRequiredReadFlag`
Slave status required, either is master doing SDR read from slave, or is IBI pushing out.

enumerator `kI3C_SlaveRequiredWriteFlag`
Slave status request write, master is doing SDR write to slave, except slave in ENTDAAMode

enumerator `kI3C_SlaveBusDAAFlag`
I3C bus is in ENTDAAMode

enumerator `kI3C_SlaveBusHDRModeFlag`
I3C bus is in HDR mode

enumerator `kI3C_SlaveBusStartFlag`
Start/Re-start event is seen since the bus was last cleared

enumerator `kI3C_SlaveMatchedFlag`
Slave address(dynamic/static) matched since last cleared

enumerator `kI3C_SlaveBusStopFlag`
Stop event is seen since the bus was last cleared

enumerator `kI3C_SlaveRxReadyFlag`
Rx data ready in rx buffer flag

enumerator `kI3C_SlaveTxReadyFlag`
Tx buffer ready for Tx data flag

enumerator `kI3C_SlaveDynamicAddrChangedFlag`
Slave dynamic address has been assigned, re-assigned, or lost

enumerator `kI3C_SlaveReceivedCCCFlag`
Slave received Common command code

enumerator `kI3C_SlaveErrorFlag`
Error occurred flag

enumerator `kI3C_SlaveHDRCommandMatchFlag`
High data rate command match

enumerator `kI3C_SlaveCCCHandledFlag`
Slave received Common command code is handled by I3C module

enumerator `kI3C_SlaveEventSentFlag`
Slave IBI/P2P/MR/HJ event has been sent

enumerator `kI3C_SlaveIbiDisableFlag`
Slave in band interrupt is disabled.

enumerator `kI3C_SlaveMasterRequestDisabledFlag`
Slave master request is disabled.

enumerator `kI3C_SlaveHotJoinDisabledFlag`
Slave Hot-Join is disabled.

enumerator `kI3C_SlaveClearFlags`
All flags which are cleared by the driver upon starting a transfer.

enumerator `kI3C_SlaveAllIrqFlags`

enum _i3c_slave_error_flags

I3C slave error flags to indicate the causes.

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

Values:

enumerator kI3C_SlaveErrorOvrerrunFlag

Slave internal from-bus buffer/FIFO overrun.

enumerator kI3C_SlaveErrorUnderrunFlag

Slave internal to-bus buffer/FIFO underrun

enumerator kI3C_SlaveErrorUnderrunNakFlag

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kI3C_SlaveErrorTermFlag

Terminate error from master

enumerator kI3C_SlaveErrorInvalidStartFlag

Slave invalid start flag

enumerator kI3C_SlaveErrorSdrParityFlag

SDR parity error

enumerator kI3C_SlaveErrorHdrParityFlag

HDR parity error

enumerator kI3C_SlaveErrorHdrCRCFlag

HDR-DDR CRC error

enumerator kI3C_SlaveErrorS0S1Flag

S0 or S1 error

enumerator kI3C_SlaveErrorOverreadFlag

Over-read error

enumerator kI3C_SlaveErrorOverwriteFlag

Over-write error

enum _i3c_slave_event

I3C slave.event.

Values:

enumerator kI3C_SlaveEventNormal

Normal mode.

enumerator kI3C_SlaveEventIBI

In band interrupt event.

enumerator kI3C_SlaveEventMasterReq

Master request event.

enumerator kI3C_SlaveEventHotJoinReq

Hot-join event.

enum _i3c_slave_activity_state

I3C slave.activity state.

Values:

enumerator kI3C_SlaveNoLatency

Normal bus operation

enumerator kI3C_SlaveLatency1Ms

1ms of latency.

enumerator kI3C_SlaveLatency100Ms

100ms of latency.

enumerator kI3C_SlaveLatency10S

10s latency.

enum _i3c_slave_transfer_event

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to I3C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

Values:

enumerator kI3C_SlaveAddressMatchEvent

Received the slave address after a start or repeated start.

enumerator kI3C_SlaveTransmitEvent

Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kI3C_SlaveReceiveEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C_SlaveRequiredTransmitEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C_SlaveStartEvent

A start/repeated start was detected.

enumerator kI3C_SlaveHDRCommandMatchEvent

Slave Match HDR Command.

enumerator kI3C_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator kI3C_SlaveRequestSentEvent

Slave request event sent.

enumerator kI3C_SlaveReceivedCCCEvent

Slave received CCC event, need to handle by application.

enumerator kI3C_SlaveAllEvents

Bit mask of all available events.

typedef enum _i3c_slave_event i3c_slave_event_t

I3C slave.event.

typedef enum _i3c_slave_activity_state i3c_slave_activity_state_t

I3C slave.activity state.

```
typedef struct _i3c_slave_config i3c_slave_config_t
```

Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

```
typedef enum _i3c_slave_transfer_event i3c_slave_transfer_event_t
```

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to I3C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

```
typedef struct _i3c_slave_transfer i3c_slave_transfer_t
```

I3C slave transfer structure.

```
typedef struct _i3c_slave_handle i3c_slave_handle_t
```

```
typedef void (*i3c_slave_transfer_callback_t)(I3C_Type *base, i3c_slave_transfer_t *transfer, void *userData)
```

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the I3C_SlaveSetCallback() function after you have created a handle.

Param base

Base address for the I3C instance on which the event occurred.

Param transfer

Pointer to transfer descriptor containing values passed to and/or from the callback.

Param userData

Arbitrary pointer-sized value passed from the application.

```
typedef void (*i3c_slave_isr_t)(I3C_Type *base, void *handle)
```

Typedef for slave interrupt handler.

```
struct _i3c_slave_config
```

#include <fsl_i3c.h> Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the I3C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

bool enableSlave

Whether to enable slave.

uint8_t staticAddr

Static address.

`uint16_t` vendorID
Device vendor ID(manufacture ID).

`uint32_t` partNumber
Device part number info

`uint8_t` dcr
Device characteristics register information.

`uint8_t` bcr
Bus characteristics register information.

`uint8_t` hdrMode
Support hdr mode, could be OR logic in enumeration:`i3c_hdr_mode_t`.

`bool` nakAllRequest
Whether to reply NAK to all requests except broadcast CCC.

`bool` ignoreS0S1Error
Whether to ignore S0/S1 error in SDR mode.

`bool` offline
Whether to wait 60 us of bus quiet or HDR request to ensure slave track SDR mode safely.

`bool` matchSlaveStartStop
Whether to assert start/stop status only the time slave is addressed.

`uint32_t` maxWriteLength
Maximum write length.

`uint32_t` maxReadLength
Maximum read length.

`struct _i3c_slave_transfer`
#include <fsl_i3c.h> I3C slave transfer structure.

Public Members

`uint32_t` event
Reason the callback is being invoked.

`uint8_t *txData`
Transfer buffer

`size_t` txDataSize
Transfer size

`uint8_t *rxData`
Transfer buffer

`size_t` rxDataSize
Transfer size

`status_t` completionStatus
Success or error code describing how the transfer completed. Only applies for `ki3c_slave_completion_event`.

`size_t` transferredCount
Number of bytes actually transferred since start or last repeated start.

struct `_i3c_slave_handle`
#include <fsl_i3c.h> I3C slave handle structure.

Note: The contents of this structure are private and subject to change.

Public Members

i3c_slave_transfer_t transfer
 I3C slave transfer copy.

bool isBusy
 Whether transfer is busy.

bool wasTransmit
 Whether the last transfer was a transmit.

uint32_t eventMask
 Mask of enabled events.

uint32_t transferredCount
 Count of bytes transferred.

i3c_slave_transfer_callback_t callback
 Callback function called at transfer event.

void *userData
 Callback parameter passed to callback.

uint8_t txFifoSize
 Tx Fifo size

2.40 I3C Slave DMA Driver

```
void I3C_SlaveTransferCreateHandleEDMA(I3C_Type *base, i3c_slave_edma_handle_t *handle,
                                       i3c_slave_edma_callback_t callback, void *userData,
                                       edma_handle_t *rxDmaHandle, edma_handle_t
                                       *txDmaHandle)
```

Create a new handle for the I3C slave DMA APIs.

The creation of a handle is for use with the DMA APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the `I3C_SlaveTransferAbortDMA()` API shall be called.

For devices where the I3C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

Parameters

- *base* – The I3C peripheral base address.
- *handle* – Pointer to the I3C slave driver handle.
- *callback* – User provided pointer to the asynchronous callback function.
- *userData* – User provided pointer to the application callback data.
- *rxDmaHandle* – Handle for the DMA receive channel. Created by the user prior to calling this function.

- txDmaHandle – Handle for the DMA transmit channel. Created by the user prior to calling this function.

```
status_t I3C_SlaveTransferEDMA(I3C_Type *base, i3c_slave_edma_handle_t *handle,  
                              i3c_slave_edma_transfer_t *transfer, uint32_t eventMask)
```

Prepares for a non-blocking DMA-based transaction on the I3C bus.

The API will do DMA configuration according to the input transfer descriptor, and the data will be transferred when there's bus master requesting transfer from/to this slave. So the timing of call to this API need be aligned with master application to ensure the transfer is executed as expected. Callback specified when the *handle* was created is invoked when the transaction has completed.

Parameters

- base – The I3C peripheral base address.
- handle – Pointer to the I3C slave driver handle.
- transfer – The pointer to the transfer descriptor.
- eventMask – Bit mask formed by OR'ing together i3c_slave_transfer_event_t enumerators to specify which events to send to the callback. The transmit and receive events is not allowed to be enabled.

Return values

- kStatus_Success – The transaction was started successfully.
- kStatus_I3C_Busy – Either another master is currently utilizing the bus, or another DMA transaction is already in progress.
- kStatus_Fail – The transaction can't be set.

```
void I3C_SlaveTransferAbortEDMA(I3C_Type *base, i3c_slave_edma_handle_t *handle)
```

Abort a slave edma non-blocking transfer in a early time.

Parameters

- base – I3C peripheral base address
- handle – pointer to i3c_slave_edma_handle_t structure

```
void I3C_SlaveTransferEDMAHandleIRQ(I3C_Type *base, void *i3CHandle)
```

Reusable routine to handle slave interrupts.

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

Parameters

- base – The I3C peripheral base address.
- i3CHandle – Pointer to the I3C slave DMA driver handle.

```
typedef struct _i3c_slave_edma_handle i3c_slave_edma_handle_t
```

```
typedef struct _i3c_slave_edma_transfer i3c_slave_edma_transfer_t
```

I3C slave transfer structure.

```
typedef void (*i3c_slave_edma_callback_t)(I3C_Type *base, i3c_slave_edma_transfer_t *transfer,  
void *userData)
```

Slave event callback function pointer type.

This callback is used only for the slave DMA transfer API.

Param base

Base address for the I3C instance on which the event occurred.

Param handle

Pointer to slave DMA transfer handle.

Param transfer

Pointer to transfer descriptor containing values passed to and/or from the callback.

Param userData

Arbitrary pointer-sized value passed from the application.

```
struct __i3c_slave_edma_transfer
```

```
#include <fsl_i3c_edma.h> I3C slave transfer structure.
```

Public Members

```
uint32_t event
```

Reason the callback is being invoked.

```
uint8_t *txData
```

Transfer buffer

```
size_t txDataSize
```

Transfer size

```
uint8_t *rxData
```

Transfer buffer

```
size_t rxDataSize
```

Transfer size

```
status_t completionStatus
```

Success or error code describing how the transfer completed. Only applies for kI3C_SlaveCompletionEvent.

```
struct __i3c_slave_edma_handle
```

```
#include <fsl_i3c_edma.h> I3C slave edma handle structure.
```

Note: The contents of this structure are private and subject to change.

Public Members

```
I3C_Type *base
```

I3C base pointer.

```
i3c_slave_edma_transfer_t transfer
```

I3C slave transfer copy.

```
bool isBusy
```

Whether transfer is busy.

```
bool wasTransmit
```

Whether the last transfer was a transmit.

```
bool isDdrMode
```

Whether this is HDR-DDR transfer.

`uint32_t eventMask`

Mask of enabled events.

`i3c_slave_edma_callback_t callback`

Callback function called at transfer event.

`edma_handle_t *rxDmaHandle`

Handle for receive DMA channel.

`edma_handle_t *txDmaHandle`

Handle for transmit DMA channel.

`void *userData`

Callback parameter passed to callback.

2.41 IEE: Inline Encryption Engine

`FSL_IEE_DRIVER_VERSION`

IEE driver version. Version 2.1.1.

Current version: 2.1.1

Change log:

- Version 2.0.0
 - Initial version
- Version 2.1.0
 - Add region lock function `IEE_LockRegionConfig()` and driver clock control
- Version 2.1.1
 - Fixed MISRA issues.
- Version 2.2.0
 - Add ELE (EdgeLock Enclave) key provisioning feature.

`enum _iee_region`

IEE region.

Values:

enumerator `kIEE_Region0`

IEE region 0

enumerator `kIEE_Region1`

IEE region 1

enumerator `kIEE_Region2`

IEE region 2

enumerator `kIEE_Region3`

IEE region 3

enumerator `kIEE_Region4`

IEE region 4

enumerator `kIEE_Region5`

IEE region 5

```
enumerator kIEE_Region6
    IEE region 6
enumerator kIEE_Region7
    IEE region 7
enum _iee_aes_bypass
    IEE AES enablement/bypass.
    Values:
    enumerator kIEE_AesUseMdField
        AES encryption/decryption enabled
    enumerator kIEE_AesBypass
        AES encryption/decryption bypass
enum _iee_aes_mode
    IEE AES mode.
    Values:
    enumerator kIEE_ModeNone
        AES NONE mode
    enumerator kIEE_ModeAesXTS
        AES XTS mode
    enumerator kIEE_ModeAesCTRWAddress
        AES CTR w address binding mode
    enumerator kIEE_ModeAesCTRWOAddress
        AES CTR w/o address binding mode
    enumerator kIEE_ModeAesCTRkeystream
        AES CTR keystream only
enum _iee_aes_key_size
    IEE AES key size.
    Values:
    enumerator kIEE_AesCTR128XTS256
        AES 128 bits (CTR), 256 bits (XTS)
    enumerator kIEE_AesCTR256XTS512
        AES 256 bits (CTR), 512 bits (XTS)
enum _iee_aes_key_num
    IEE AES key number.
    Values:
    enumerator kIEE_AesKey1
        AES Key 1
    enumerator kIEE_AesKey2
        AES Key 2
typedef enum _iee_region iee_region_t
    IEE region.
typedef enum _iee_aes_bypass iee_aes_bypass_t
    IEE AES enablement/bypass.
```

```
typedef enum _iee_aes_mode iee_aes_mode_t
```

IEE AES mode.

```
typedef enum _iee_aes_key_size iee_aes_key_size_t
```

IEE AES key size.

```
typedef enum _iee_aes_key_num iee_aes_key_num_t
```

IEE AES key number.

```
typedef struct _iee_config iee_config_t
```

IEE configuration structure.

```
void IEE_Init(IEE_Type *base)
```

Resets IEE module to factory default values.

This function performs hardware reset of IEE module. Attributes and keys of all regions are cleared.

Parameters

- base – IEER peripheral address.

```
void IEE_GetDefaultConfig(iee_config_t *config)
```

Loads default values to the IEE configuration structure.

Loads default values to the IEE region configuration structure. The default values are as follows.

```
config->bypass = kIEE_AesUseMdField;
config->mode = kIEE_ModeNone;
config->keySize = kIEE_AesCTR128XTS256;
config->pageOffset = 0U;
```

Parameters

- config – Configuration for the selected IEE region.

```
void IEE_SetRegionConfig(IEE_Type *base, iee_region_t region, iee_config_t *config)
```

Sets the IEE module according to the configuration structure.

This function configures IEE region according to configuration structure.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be configured.
- config – Configuration for the selected IEE region.

```
status_t IEE_SetRegionKey(IEE_Type *base, iee_region_t region, iee_aes_key_num_t keyNum,
                          const uint8_t *key, size_t keySize)
```

Sets the IEE module key.

This function sets specified AES key for the given region.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be configured.
- keyNum – Selection of AES KEY1 or KEY2.
- key – AES key.
- keySize – Size of AES key.

```
static inline uint32_t IEE_GetOffset(uint32_t addressIee, uint32_t addressMemory)
```

Computes IEE offset to be set for specified memory location.

This function calculates offset that must be set for IEE region to access physical memory location.

Parameters

- addressIee – Address of IEE peripheral.
- addressMemory – Address of physical memory location.

```
void IEE_LockRegionConfig(IEE_Type *base, iee_region_t region)
```

Lock the IEE region configuration.

This function locks IEE region registers for Key, Offset and Attribute. Only system reset can clear the Lock bit.

Parameters

- base – IEE peripheral address.
- region – Selection of the IEE region to be locked.

```
struct __iee_config
```

#include <fsl_iee.h> IEE configuration structure.

Public Members

iee_aes_bypass_t bypass

AES encryption/decryption bypass

iee_aes_mode_t mode

AES mode

iee_aes_key_size_t keySize

size of AES key

uint32_t pageOffset

Offset to physical memory location from IEE start address

2.42 Ieer

FSL_IEE_APC_DRIVER_VERSION

IEE_APC driver version. Version 2.0.2.

Current version: 2.0.2

Change log:

- Version 2.0.0
 - Initial version
- Version 2.0.1
 - Fixed MISRA issues.
- Version 2.0.2
 - Update to newer version of implementation in HW.

enum _iee_apc_region

APC IEE regions.

Values:

enumerator kIEE_APC_Region0

APC IEE region 0

enumerator kIEE_APC_Region1

APC IEE region 1

enumerator kIEE_APC_Region2

APC IEE region 2

enumerator kIEE_APC_Region3

APC IEE region 3

enumerator kIEE_APC_Region4

APC IEE region 4

enumerator kIEE_APC_Region5

APC IEE region 5

enumerator kIEE_APC_Region6

APC IEE region 6

enumerator kIEE_APC_Region7

APC IEE region 7

enum _apc_iee_domain

APC IEE domains.

Values:

enumerator kIEE_APC_Domain0

APC IEE region 0

enumerator kIEE_APC_Domain1

APC IEE region 1

typedef enum _iee_apc_region iee_apc_region_t

APC IEE regions.

typedef enum _apc_iee_domain iee_apc_domain_t

APC IEE domains.

void IEE_APC_GlobalEnable(IEE_APC_Type *base)

Enable the APC IEE Region setting.

This function enables IOMUXC LPSR GPR and APC IEE for setting the region.

Parameters

- base – APC IEE peripheral address.

void IEE_APC_GlobalDisable(IEE_APC_Type *base)

Disables the APC IEE Region setting.

This function disables IOMUXC LPSR GPR and APC IEE for setting the region.

Parameters

- base – APC IEE peripheral address.

```
status_t IEE_APC_SetRegionConfig(IEE_APC_Type *base, iee_apc_region_t region, uint32_t
                                startAddr, uint32_t endAddr)
```

Sets the APC IEE Memory Region Descriptors.

This function configures APC IEE Memory Region Descriptor according to region configuration structure.

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be configured.
- startAddr – Start encryption address for the selected APC IEE region.
- endAddr – End encryption address for the selected APC IEE region.

```
status_t IEE_APC_LockRegionConfig(IEE_APC_Type *base, iee_apc_region_t region,
                                  iee_apc_domain_t domain)
```

Lock the LPSR GPR and APC IEE configuration.

This function locks writting to IOMUXC LPSR GPR and APC IEE encryption region setting registers. Only system reset can clear the LPSR GPR and APC IEE-RDC_D0/1 Lock bit

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be locked.
- domain – Core domain ID

```
void IEE_APC_RegionEnable(IEE_APC_Type *base, iee_apc_region_t region)
```

Enable the IEE encryption/decryption and can lock this setting.

This function enables encryption/decryption by writting to IOMUXC LPSR GPR.

Parameters

- base – APC IEE peripheral address.
- region – Selection of the APC IEE region to be enabled.

2.43 IOMUXC: IOMUX Controller

```
enum _iomuxc_mqs_pwm_oversample_rate
```

Values:

```
enumerator kIOMUXC_MqsPwmOverSampleRate32
```

```
enumerator kIOMUXC_MqsPwmOverSampleRate64
```

```
typedef enum _iomuxc_mqs_pwm_oversample_rate iomuxc_mqs_pwm_oversample_rate_t
```

```
IOMUXC_GPIO_EMC_B1_00_SEMC_DATA00
```

```
IOMUXC_GPIO_EMC_B1_00_XBAR1_XBAR_INOUT04
```

```
IOMUXC_GPIO_EMC_B1_00_SINC3_MOD_CLK0
```

```
IOMUXC_GPIO_EMC_B1_00_LPUART3_CTS_B
```

```
IOMUXC_GPIO_EMC_B1_00_NETC_PINMUX_ETH3_TXD03
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IOMUXC_GPIO_EMC_B1_00_GPIO2_IO00
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IOMUXC_GPIO_EMC_B1_00_KPP_ROW03
IOMUXC_GPIO_EMC_B1_00_FLEXIO1_FLEXIO00
IOMUXC_GPIO_EMC_B1_00_NETC_PINMUX_ETH4_TXD03
IOMUXC_GPIO_EMC_B1_00_ECAT_TX_DATA3_0
IOMUXC_GPIO_EMC_B1_00_AHB_SRAMC_DATA00
IOMUXC_GPIO_EMC_B1_01_ECAT_TX_DATA2_0
IOMUXC_GPIO_EMC_B1_01_AHB_SRAMC_DATA01
IOMUXC_GPIO_EMC_B1_01_SEMC_DATA01
IOMUXC_GPIO_EMC_B1_01_XBAR1_XBAR_INOUT05
IOMUXC_GPIO_EMC_B1_01_SINC3_MOD_CLK1
IOMUXC_GPIO_EMC_B1_01_LPUART3_RTS_B
IOMUXC_GPIO_EMC_B1_01_NETC_PINMUX_ETH3_TXD02
IOMUXC_GPIO_EMC_B1_01_GPIO2_IO01
IOMUXC_GPIO_EMC_B1_01_KPP_COL03
IOMUXC_GPIO_EMC_B1_01_FLEXIO1_FLEXIO01
IOMUXC_GPIO_EMC_B1_01_NETC_PINMUX_ETH4_TXD02
IOMUXC_GPIO_EMC_B1_02_SEMC_DATA02
IOMUXC_GPIO_EMC_B1_02_XBAR1_XBAR_INOUT06
IOMUXC_GPIO_EMC_B1_02_SINC3_MOD_CLK2
IOMUXC_GPIO_EMC_B1_02_LPUART3_RX
IOMUXC_GPIO_EMC_B1_02_NETC_PINMUX_ETH3_RX_CLK
IOMUXC_GPIO_EMC_B1_02_GPIO2_IO02
IOMUXC_GPIO_EMC_B1_02_KPP_ROW02
IOMUXC_GPIO_EMC_B1_02_FLEXIO1_FLEXIO02
IOMUXC_GPIO_EMC_B1_02_NETC_PINMUX_ETH4_RX_CLK
IOMUXC_GPIO_EMC_B1_02_ECAT_RX_CLK_0
IOMUXC_GPIO_EMC_B1_02_AHB_SRAMC_DATA02
IOMUXC_GPIO_EMC_B1_03_SEMC_DATA03
IOMUXC_GPIO_EMC_B1_03_XBAR1_XBAR_INOUT07
IOMUXC_GPIO_EMC_B1_03_SINC3_EMCLK00
IOMUXC_GPIO_EMC_B1_03_LPUART3_TX
IOMUXC_GPIO_EMC_B1_03_NETC_PINMUX_ETH3_RXD03
IOMUXC_GPIO_EMC_B1_03_GPIO2_IO03

IOMUXC_GPIO_EMC_B1_03_KPP_COL02
IOMUXC_GPIO_EMC_B1_03_FLEXIO1_FLEXIO03
IOMUXC_GPIO_EMC_B1_03_NETC_PINMUX_ETH4_RXD03
IOMUXC_GPIO_EMC_B1_03_ECAT_RX_DATA3_0
IOMUXC_GPIO_EMC_B1_03_AHB_SRAMC_DATA03
IOMUXC_GPIO_EMC_B1_04_ECAT_RX_DATA2_0
IOMUXC_GPIO_EMC_B1_04_AHB_SRAMC_DATA04
IOMUXC_GPIO_EMC_B1_04_SEMC_DATA04
IOMUXC_GPIO_EMC_B1_04_XBAR1_XBAR_INOUT08
IOMUXC_GPIO_EMC_B1_04_SINC3_EMBIT00
IOMUXC_GPIO_EMC_B1_04_LPUART3_DSR_B
IOMUXC_GPIO_EMC_B1_04_NETC_PINMUX_ETH3_RXD02
IOMUXC_GPIO_EMC_B1_04_GPIO2_IO04
IOMUXC_GPIO_EMC_B1_04_KPP_ROW01
IOMUXC_GPIO_EMC_B1_04_FLEXIO1_FLEXIO04
IOMUXC_GPIO_EMC_B1_04_NETC_PINMUX_ETH4_RXD02
IOMUXC_GPIO_EMC_B1_05_SEMC_DATA05
IOMUXC_GPIO_EMC_B1_05_XBAR1_XBAR_INOUT09
IOMUXC_GPIO_EMC_B1_05_SINC3_EMCLK01
IOMUXC_GPIO_EMC_B1_05_LPUART3_DCD_B
IOMUXC_GPIO_EMC_B1_05_NETC_PINMUX_ETH3_TXD00
IOMUXC_GPIO_EMC_B1_05_GPIO2_IO05
IOMUXC_GPIO_EMC_B1_05_KPP_ROW07
IOMUXC_GPIO_EMC_B1_05_FLEXIO1_FLEXIO05
IOMUXC_GPIO_EMC_B1_05_NETC_PINMUX_ETH4_TXD00
IOMUXC_GPIO_EMC_B1_05_ECAT_TX_DATA0_0
IOMUXC_GPIO_EMC_B1_05_AHB_SRAMC_DATA05
IOMUXC_GPIO_EMC_B1_06_SEMC_DATA06
IOMUXC_GPIO_EMC_B1_06_FLEXPWM4_PWMB03
IOMUXC_GPIO_EMC_B1_06_SINC3_EMBIT01
IOMUXC_GPIO_EMC_B1_06_LPUART3_RI_B
IOMUXC_GPIO_EMC_B1_06_NETC_PINMUX_ETH3_TXD01
IOMUXC_GPIO_EMC_B1_06_GPIO2_IO06

IOMUXC_GPIO_EMC_B1_06_KPP_COL07
IOMUXC_GPIO_EMC_B1_06_FLEXIO1_FLEXIO06
IOMUXC_GPIO_EMC_B1_06_NETC_PINMUX_ETH4_TXD01
IOMUXC_GPIO_EMC_B1_06_ECAT_TX_DATA1_0
IOMUXC_GPIO_EMC_B1_06_AHB_SRAMC_DATA06
IOMUXC_GPIO_EMC_B1_07_ECAT_TX_EN_0
IOMUXC_GPIO_EMC_B1_07_AHB_SRAMC_DATA07
IOMUXC_GPIO_EMC_B1_07_SEMC_DATA07
IOMUXC_GPIO_EMC_B1_07_FLEXPWM4_PWMA03
IOMUXC_GPIO_EMC_B1_07_SINC3_EMCLK02
IOMUXC_GPIO_EMC_B1_07_LPUART3_DTR_B
IOMUXC_GPIO_EMC_B1_07_NETC_PINMUX_ETH3_TX_EN
IOMUXC_GPIO_EMC_B1_07_GPIO2_IO07
IOMUXC_GPIO_EMC_B1_07_KPP_ROW06
IOMUXC_GPIO_EMC_B1_07_FLEXIO1_FLEXIO07
IOMUXC_GPIO_EMC_B1_07_NETC_PINMUX_ETH4_TX_EN
IOMUXC_GPIO_EMC_B1_08_SEMC_DM00
IOMUXC_GPIO_EMC_B1_08_FLEXPWM2_PWMB03
IOMUXC_GPIO_EMC_B1_08_SINC3_EMBIT02
IOMUXC_GPIO_EMC_B1_08_LPUART4_DSR_B
IOMUXC_GPIO_EMC_B1_08_NETC_PINMUX_ETH3_TX_CLK
IOMUXC_GPIO_EMC_B1_08_GPIO2_IO08
IOMUXC_GPIO_EMC_B1_08_KPP_COL06
IOMUXC_GPIO_EMC_B1_08_FLEXIO1_FLEXIO08
IOMUXC_GPIO_EMC_B1_08_NETC_PINMUX_ETH4_TX_CLK
IOMUXC_GPIO_EMC_B1_08_ECAT_TX_CLK_0
IOMUXC_GPIO_EMC_B1_08_AHB_SRAMC_LBB
IOMUXC_GPIO_EMC_B1_09_SEMC_ADDR00
IOMUXC_GPIO_EMC_B1_09_FLEXPWM2_PWMA03
IOMUXC_GPIO_EMC_B1_09_SINC3_EMCLK03
IOMUXC_GPIO_EMC_B1_09_LPUART4_DCD_B
IOMUXC_GPIO_EMC_B1_09_NETC_PINMUX_ETH3_RXD00
IOMUXC_GPIO_EMC_B1_09_GPIO2_IO09

IOMUXC_GPIO_EMC_B1_09_KPP_ROW05
IOMUXC_GPIO_EMC_B1_09_FLEXIO1_FLEXIO09
IOMUXC_GPIO_EMC_B1_09_NETC_PINMUX_ETH4_RXD00
IOMUXC_GPIO_EMC_B1_09_ECAT_RX_DATA0_0
IOMUXC_GPIO_EMC_B1_09_AHB_SRAMC_ADDR00
IOMUXC_GPIO_EMC_B1_10_SEMC_ADDR01
IOMUXC_GPIO_EMC_B1_10_FLEXPWM3_PWMB03
IOMUXC_GPIO_EMC_B1_10_SINC3_EMBIT03
IOMUXC_GPIO_EMC_B1_10_LPUART4_RI_B
IOMUXC_GPIO_EMC_B1_10_NETC_PINMUX_ETH3_RXD01
IOMUXC_GPIO_EMC_B1_10_GPIO2_IO10
IOMUXC_GPIO_EMC_B1_10_KPP_COL05
IOMUXC_GPIO_EMC_B1_10_FLEXIO1_FLEXIO10
IOMUXC_GPIO_EMC_B1_10_NETC_PINMUX_ETH4_RXD01
IOMUXC_GPIO_EMC_B1_10_ECAT_RX_DATA1_0
IOMUXC_GPIO_EMC_B1_10_AHB_SRAMC_ADDR01
IOMUXC_GPIO_EMC_B1_11_ECAT_RX_DV_0
IOMUXC_GPIO_EMC_B1_11_AHB_SRAMC_ADDR02
IOMUXC_GPIO_EMC_B1_11_SEMC_ADDR02
IOMUXC_GPIO_EMC_B1_11_FLEXPWM3_PWMA03
IOMUXC_GPIO_EMC_B1_11_SINC_FILTER_GLUE3_BREAK
IOMUXC_GPIO_EMC_B1_11_LPUART4_DTR_B
IOMUXC_GPIO_EMC_B1_11_NETC_PINMUX_ETH3_RX_DV
IOMUXC_GPIO_EMC_B1_11_GPIO2_IO11
IOMUXC_GPIO_EMC_B1_11_KPP_ROW04
IOMUXC_GPIO_EMC_B1_11_FLEXIO1_FLEXIO11
IOMUXC_GPIO_EMC_B1_11_NETC_PINMUX_ETH4_RX_DV
IOMUXC_GPIO_EMC_B1_12_SEMC_ADDR03
IOMUXC_GPIO_EMC_B1_12_FLEXPWM4_PWMA00
IOMUXC_GPIO_EMC_B1_12_LPUART4_TX
IOMUXC_GPIO_EMC_B1_12_NETC_PINMUX_ETH3_RX_ER
IOMUXC_GPIO_EMC_B1_12_GPIO2_IO12
IOMUXC_GPIO_EMC_B1_12_KPP_COL04

IOMUXC_GPIO_EMC_B1_12_FLEXIO1_FLEXIO12
IOMUXC_GPIO_EMC_B1_12_NETC_PINMUX_ETH4_RX_ER
IOMUXC_GPIO_EMC_B1_12_ECAT_PT0_RX_ER
IOMUXC_GPIO_EMC_B1_12_AHB_SRAMC_ADDR03
IOMUXC_GPIO_EMC_B1_13_SEMC_ADDR04
IOMUXC_GPIO_EMC_B1_13_FLEXPWM4_PWMB00
IOMUXC_GPIO_EMC_B1_13_LPUART4_RX
IOMUXC_GPIO_EMC_B1_13_NETC_PINMUX_ETH2_RX_DV
IOMUXC_GPIO_EMC_B1_13_NETC_PINMUX_ETH3_TX_ER
IOMUXC_GPIO_EMC_B1_13_GPIO2_IO13
IOMUXC_GPIO_EMC_B1_13_KPP_COL01
IOMUXC_GPIO_EMC_B1_13_FLEXIO1_FLEXIO13
IOMUXC_GPIO_EMC_B1_13_NETC_PINMUX_ETH4_TX_ER
IOMUXC_GPIO_EMC_B1_13_QTIMER1_TIMER1
IOMUXC_GPIO_EMC_B1_13_AHB_SRAMC_ADDR04
IOMUXC_GPIO_EMC_B1_14_LPUART4_CTS_B
IOMUXC_GPIO_EMC_B1_14_AHB_SRAMC_ADDR05
IOMUXC_GPIO_EMC_B1_14_SEMC_ADDR05
IOMUXC_GPIO_EMC_B1_14_FLEXPWM4_PWMA01
IOMUXC_GPIO_EMC_B1_14_LPUART5_TX
IOMUXC_GPIO_EMC_B1_14_NETC_PINMUX_ETH2_TX_EN
IOMUXC_GPIO_EMC_B1_14_NETC_ETH3_CRS
IOMUXC_GPIO_EMC_B1_14_GPIO2_IO14
IOMUXC_GPIO_EMC_B1_14_KPP_ROW00
IOMUXC_GPIO_EMC_B1_14_FLEXIO1_FLEXIO14
IOMUXC_GPIO_EMC_B1_14_NETC_ETH4_CRS
IOMUXC_GPIO_EMC_B1_15_SEMC_ADDR06
IOMUXC_GPIO_EMC_B1_15_FLEXPWM4_PWMB01
IOMUXC_GPIO_EMC_B1_15_LPUART5_RX
IOMUXC_GPIO_EMC_B1_15_NETC_PINMUX_ETH2_TX_CLK
IOMUXC_GPIO_EMC_B1_15_NETC_ETH3_COL
IOMUXC_GPIO_EMC_B1_15_GPIO2_IO15
IOMUXC_GPIO_EMC_B1_15_KPP_COL00

IOMUXC_GPIO_EMC_B1_15_FLEXIO1_FLEXIO15
IOMUXC_GPIO_EMC_B1_15_NETC_ETH4_COL
IOMUXC_GPIO_EMC_B1_15_LPUART4_RTS_B
IOMUXC_GPIO_EMC_B1_15_AHB_SRAMC_ADDR06
IOMUXC_GPIO_EMC_B1_16_SEMC_ADDR07
IOMUXC_GPIO_EMC_B1_16_FLEXPWM4_PWMB02
IOMUXC_GPIO_EMC_B1_16_LPUART9_TX
IOMUXC_GPIO_EMC_B1_16_NETC_PINMUX_ETH2_RXD00
IOMUXC_GPIO_EMC_B1_16_NETC_ETH3_SLV_MDC
IOMUXC_GPIO_EMC_B1_16_GPIO2_IO16
IOMUXC_GPIO_EMC_B1_16_NETC_ETH4_SLV_MDC
IOMUXC_GPIO_EMC_B1_16_FLEXIO1_FLEXIO16
IOMUXC_GPIO_EMC_B1_16_NETC_ETH2_SLV_MDC
IOMUXC_GPIO_EMC_B1_16_LPSPI6_PCS2
IOMUXC_GPIO_EMC_B1_16_AHB_SRAMC_ADDR07
IOMUXC_GPIO_EMC_B1_17_LPSPI6_PCS1
IOMUXC_GPIO_EMC_B1_17_AHB_SRAMC_ADDR08
IOMUXC_GPIO_EMC_B1_17_SEMC_ADDR08
IOMUXC_GPIO_EMC_B1_17_FLEXPWM4_PWMA02
IOMUXC_GPIO_EMC_B1_17_LPUART9_RX
IOMUXC_GPIO_EMC_B1_17_NETC_PINMUX_ETH2_RXD01
IOMUXC_GPIO_EMC_B1_17_NETC_ETH3_SLV_MDIO
IOMUXC_GPIO_EMC_B1_17_GPIO2_IO17
IOMUXC_GPIO_EMC_B1_17_NETC_ETH4_SLV_MDIO
IOMUXC_GPIO_EMC_B1_17_FLEXIO1_FLEXIO17
IOMUXC_GPIO_EMC_B1_17_NETC_ETH2_SLV_MDIO
IOMUXC_GPIO_EMC_B1_18_SEMC_ADDR09
IOMUXC_GPIO_EMC_B1_18_FLEXPWM2_PWMA00
IOMUXC_GPIO_EMC_B1_18_QTIMER1_TIMER0
IOMUXC_GPIO_EMC_B1_18_LPSPI6_SCK
IOMUXC_GPIO_EMC_B1_18_NETC_ETH2_CRS
IOMUXC_GPIO_EMC_B1_18_GPIO2_IO18
IOMUXC_GPIO_EMC_B1_18_FLEXIO1_FLEXIO18

IOMUXC_GPIO_EMC_B1_18_NETC_EMDC
IOMUXC_GPIO_EMC_B1_18_AHB_SRAMC_ADDR09
IOMUXC_GPIO_EMC_B1_19_SEMC_ADDR11
IOMUXC_GPIO_EMC_B1_19_FLEXPWM2_PWMB00
IOMUXC_GPIO_EMC_B1_19_QTIMER2_TIMER0
IOMUXC_GPIO_EMC_B1_19_LPSPi6_SDI
IOMUXC_GPIO_EMC_B1_19_NETC_ETH2_COL
IOMUXC_GPIO_EMC_B1_19_GPIO2_IO19
IOMUXC_GPIO_EMC_B1_19_FLEXIO1_FLEXIO19
IOMUXC_GPIO_EMC_B1_19_NETC_EMDIO
IOMUXC_GPIO_EMC_B1_19_AHB_SRAMC_ADDR11
IOMUXC_GPIO_EMC_B1_20_SEMC_ADDR12
IOMUXC_GPIO_EMC_B1_20_FLEXPWM2_PWMA01
IOMUXC_GPIO_EMC_B1_20_QTIMER3_TIMER0
IOMUXC_GPIO_EMC_B1_20_LPSPi6_SDO
IOMUXC_GPIO_EMC_B1_20_NETC_PINMUX_ETH2_TX_ER
IOMUXC_GPIO_EMC_B1_20_GPIO2_IO20
IOMUXC_GPIO_EMC_B1_20_FLEXIO1_FLEXIO20
IOMUXC_GPIO_EMC_B1_20_AHB_SRAMC_ADDR12
IOMUXC_GPIO_EMC_B1_21_FLEXSPI2_BUS2BIT_B_DQS
IOMUXC_GPIO_EMC_B1_21_AHB_SRAMC_ADDR13
IOMUXC_GPIO_EMC_B1_21_SEMC_BA0
IOMUXC_GPIO_EMC_B1_21_FLEXPWM2_PWMB01
IOMUXC_GPIO_EMC_B1_21_QTIMER4_TIMER0
IOMUXC_GPIO_EMC_B1_21_LPSPi6_PCS0
IOMUXC_GPIO_EMC_B1_21_NETC_PINMUX_ETH2_RX_CLK
IOMUXC_GPIO_EMC_B1_21_GPIO2_IO21
IOMUXC_GPIO_EMC_B1_21_FLEXIO1_FLEXIO21
IOMUXC_GPIO_EMC_B1_21_LPUART4_CTS_B
IOMUXC_GPIO_EMC_B1_22_FLEXSPI2_BUS2BIT_B_DATA03
IOMUXC_GPIO_EMC_B1_22_AHB_SRAMC_ADDR14
IOMUXC_GPIO_EMC_B1_22_SEMC_BA1
IOMUXC_GPIO_EMC_B1_22_FLEXPWM2_PWMB02

IOMUXC_GPIO_EMC_B1_22_QTIMER5_TIMER0
IOMUXC_GPIO_EMC_B1_22_LPSPI4_SCK
IOMUXC_GPIO_EMC_B1_22_NETC_PINMUX_ETH2_RXD02
IOMUXC_GPIO_EMC_B1_22_GPIO2_IO22
IOMUXC_GPIO_EMC_B1_22_FLEXIO1_FLEXIO22
IOMUXC_GPIO_EMC_B1_22_LPUART4_RTS_B
IOMUXC_GPIO_EMC_B1_23_SEMC_ADDR10
IOMUXC_GPIO_EMC_B1_23_FLEXPWM2_PWMA02
IOMUXC_GPIO_EMC_B1_23_QTIMER6_TIMER0
IOMUXC_GPIO_EMC_B1_23_LPSPI4_SDI
IOMUXC_GPIO_EMC_B1_23_NETC_PINMUX_ETH2_RXD03
IOMUXC_GPIO_EMC_B1_23_GPIO2_IO23
IOMUXC_GPIO_EMC_B1_23_FLEXIO1_FLEXIO23
IOMUXC_GPIO_EMC_B1_23_FLEXSPI2_BUS2BIT_B_DATA02
IOMUXC_GPIO_EMC_B1_23_AHB_SRAMC_ADDR10
IOMUXC_GPIO_EMC_B1_24_FLEXSPI2_BUS2BIT_B_DATA01
IOMUXC_GPIO_EMC_B1_24_AHB_SRAMC_ADDR15
IOMUXC_GPIO_EMC_B1_24_SEMC_CAS
IOMUXC_GPIO_EMC_B1_24_FLEXPWM1_PWMA00
IOMUXC_GPIO_EMC_B1_24_QTIMER7_TIMER0
IOMUXC_GPIO_EMC_B1_24_LPSPI4_SDO
IOMUXC_GPIO_EMC_B1_24_NETC_PINMUX_ETH2_TXD03
IOMUXC_GPIO_EMC_B1_24_GPIO2_IO24
IOMUXC_GPIO_EMC_B1_24_FLEXIO1_FLEXIO24
IOMUXC_GPIO_EMC_B1_24_NETC_ETH3_SLV_MDC
IOMUXC_GPIO_EMC_B1_25_FLEXSPI2_BUS2BIT_B_DATA00
IOMUXC_GPIO_EMC_B1_25_AHB_SRAMC_ADDR16
IOMUXC_GPIO_EMC_B1_25_SEMC_RAS
IOMUXC_GPIO_EMC_B1_25_FLEXPWM1_PWMB00
IOMUXC_GPIO_EMC_B1_25_QTIMER8_TIMER0
IOMUXC_GPIO_EMC_B1_25_LPSPI4_PCS0
IOMUXC_GPIO_EMC_B1_25_NETC_PINMUX_ETH2_TXD02
IOMUXC_GPIO_EMC_B1_25_GPIO2_IO25

IOMUXC_GPIO_EMC_B1_25_FLEXIO1_FLEXIO25
IOMUXC_GPIO_EMC_B1_25_NETC_ETH3_SLV_MDIO
IOMUXC_GPIO_EMC_B1_26_SEMC_CLK
IOMUXC_GPIO_EMC_B1_26_FLEXPWM1_PWMA01
IOMUXC_GPIO_EMC_B1_26_XBAR1_XBAR_INOUT10
IOMUXC_GPIO_EMC_B1_26_FLEXSPI2_BUS2BIT_A_SS1_B
IOMUXC_GPIO_EMC_B1_26_NETC_PINMUX_ETH2_TXD01
IOMUXC_GPIO_EMC_B1_26_GPIO2_IO26
IOMUXC_GPIO_EMC_B1_26_ECAT_TX_DATA1_1
IOMUXC_GPIO_EMC_B1_26_LPSPI6_SCK
IOMUXC_GPIO_EMC_B1_26_AHB_SRAMC_WE
IOMUXC_GPIO_EMC_B1_27_LPSPI6_SDI
IOMUXC_GPIO_EMC_B1_27_AHB_SRAMC_OEB
IOMUXC_GPIO_EMC_B1_27_SEMC_CKE
IOMUXC_GPIO_EMC_B1_27_FLEXPWM1_PWMB01
IOMUXC_GPIO_EMC_B1_27_XBAR1_XBAR_INOUT11
IOMUXC_GPIO_EMC_B1_27_FLEXSPI2_BUS2BIT_B_SS1_B
IOMUXC_GPIO_EMC_B1_27_NETC_PINMUX_ETH2_TXD00
IOMUXC_GPIO_EMC_B1_27_GPIO2_IO27
IOMUXC_GPIO_EMC_B1_27_ECAT_TX_DATA0_1
IOMUXC_GPIO_EMC_B1_27_LPUART6_RI_B
IOMUXC_GPIO_EMC_B1_28_LPSPI6_SDO
IOMUXC_GPIO_EMC_B1_28_AHB_SRAMC_ADV
IOMUXC_GPIO_EMC_B1_28_SEMC_WE
IOMUXC_GPIO_EMC_B1_28_FLEXPWM1_PWMB02
IOMUXC_GPIO_EMC_B1_28_XBAR1_XBAR_INOUT12
IOMUXC_GPIO_EMC_B1_28_FLEXSPI2_BUS2BIT_B_SS0_B
IOMUXC_GPIO_EMC_B1_28_NETC_PINMUX_ETH2_TX_EN
IOMUXC_GPIO_EMC_B1_28_GPIO2_IO28
IOMUXC_GPIO_EMC_B1_28_ECAT_TX_EN_1
IOMUXC_GPIO_EMC_B1_28_LPUART6_DTR_B
IOMUXC_GPIO_EMC_B1_29_SEMC_CS0
IOMUXC_GPIO_EMC_B1_29_FLEXPWM1_PWMA02

IOMUXC_GPIO_EMC_B1_29_XBAR1_XBAR_INOUT13
IOMUXC_GPIO_EMC_B1_29_FLEXSPI2_BUS2BIT_B_DQS
IOMUXC_GPIO_EMC_B1_29_NETC_PINMUX_ETH2_TX_CLK
IOMUXC_GPIO_EMC_B1_29_GPIO2_IO29
IOMUXC_GPIO_EMC_B1_29_ECAT_TX_CLK_1
IOMUXC_GPIO_EMC_B1_29_LPUART6_DCD_B
IOMUXC_GPIO_EMC_B1_29_LPSPI6_PCS0
IOMUXC_GPIO_EMC_B1_29_AHB_SRAMC_CS0
IOMUXC_GPIO_EMC_B1_30_SEMC_DATA08
IOMUXC_GPIO_EMC_B1_30_FLEXPWM3_PWMA00
IOMUXC_GPIO_EMC_B1_30_XBAR1_XBAR_INOUT14
IOMUXC_GPIO_EMC_B1_30_FLEXSPI2_BUS2BIT_B_DATA03
IOMUXC_GPIO_EMC_B1_30_NETC_PINMUX_ETH2_RXD00
IOMUXC_GPIO_EMC_B1_30_GPIO2_IO30
IOMUXC_GPIO_EMC_B1_30_ECAT_RX_DATA0_1
IOMUXC_GPIO_EMC_B1_30_LPUART6_DSR_B
IOMUXC_GPIO_EMC_B1_30_LPSPI6_PCS1
IOMUXC_GPIO_EMC_B1_30_AHB_SRAMC_DATA08
IOMUXC_GPIO_EMC_B1_31_LPSPI6_PCS2
IOMUXC_GPIO_EMC_B1_31_AHB_SRAMC_DATA09
IOMUXC_GPIO_EMC_B1_31_SEMC_DATA09
IOMUXC_GPIO_EMC_B1_31_FLEXPWM3_PWMB00
IOMUXC_GPIO_EMC_B1_31_LPUART6_TX
IOMUXC_GPIO_EMC_B1_31_FLEXSPI2_BUS2BIT_B_DATA02
IOMUXC_GPIO_EMC_B1_31_NETC_PINMUX_ETH2_RXD01
IOMUXC_GPIO_EMC_B1_31_GPIO2_IO31
IOMUXC_GPIO_EMC_B1_31_ECAT_RX_DATA1_1
IOMUXC_GPIO_EMC_B1_31_LPSPI5_SCK
IOMUXC_GPIO_EMC_B1_32_LPSPI6_PCS3
IOMUXC_GPIO_EMC_B1_32_AHB_SRAMC_DATA10
IOMUXC_GPIO_EMC_B1_32_SEMC_DATA10
IOMUXC_GPIO_EMC_B1_32_FLEXPWM3_PWMA01
IOMUXC_GPIO_EMC_B1_32_LPUART6_RX

IOMUXC_GPIO_EMC_B1_32_FLEXSPI2_BUS2BIT_B_DATA01
IOMUXC_GPIO_EMC_B1_32_NETC_PINMUX_ETH2_RX_DV
IOMUXC_GPIO_EMC_B1_32_GPIO3_IO00
IOMUXC_GPIO_EMC_B1_32_ECAT_RX_DV_1
IOMUXC_GPIO_EMC_B1_32_LPSPi5_SDO
IOMUXC_GPIO_EMC_B1_33_SEMC_DATA11
IOMUXC_GPIO_EMC_B1_33_FLEXPWM3_PWMB01
IOMUXC_GPIO_EMC_B1_33_LPUART6_CTS_B
IOMUXC_GPIO_EMC_B1_33_FLEXSPI2_BUS2BIT_B_DATA00
IOMUXC_GPIO_EMC_B1_33_NETC_PINMUX_ETH2_RX_ER
IOMUXC_GPIO_EMC_B1_33_GPIO3_IO01
IOMUXC_GPIO_EMC_B1_33_ECAT_RX_ER_1
IOMUXC_GPIO_EMC_B1_33_LPSPi5_SDI
IOMUXC_GPIO_EMC_B1_33_NETC_PINMUX_ETH2_RX_CLK
IOMUXC_GPIO_EMC_B1_33_AHB_SRAMC_DATA11
IOMUXC_GPIO_EMC_B1_34_LPSPi5_PCS0
IOMUXC_GPIO_EMC_B1_34_AHB_SRAMC_DATA12
IOMUXC_GPIO_EMC_B1_34_SEMC_DATA12
IOMUXC_GPIO_EMC_B1_34_FLEXPWM3_PWMB02
IOMUXC_GPIO_EMC_B1_34_LPUART6_RTS_B
IOMUXC_GPIO_EMC_B1_34_FLEXSPI2_BUS2BIT_B_SCLK
IOMUXC_GPIO_EMC_B1_34_NETC_PINMUX_ETH2_RXD02
IOMUXC_GPIO_EMC_B1_34_GPIO3_IO02
IOMUXC_GPIO_EMC_B1_34_ECAT_RX_DATA2_1
IOMUXC_GPIO_EMC_B1_34_NETC_PINMUX_ETH0_TXD00
IOMUXC_GPIO_EMC_B1_35_LPSPi5_PCS1
IOMUXC_GPIO_EMC_B1_35_AHB_SRAMC_DATA13
IOMUXC_GPIO_EMC_B1_35_SEMC_DATA13
IOMUXC_GPIO_EMC_B1_35_FLEXPWM3_PWMA02
IOMUXC_GPIO_EMC_B1_35_LPUART5_TX
IOMUXC_GPIO_EMC_B1_35_FLEXSPI2_BUS2BIT_A_DATA00
IOMUXC_GPIO_EMC_B1_35_NETC_PINMUX_ETH2_RXD03
IOMUXC_GPIO_EMC_B1_35_GPIO3_IO03

IOMUXC_GPIO_EMC_B1_35_ECAT_RX_DATA3_1
IOMUXC_GPIO_EMC_B1_35_NETC_PINMUX_ETH0_TXD01
IOMUXC_GPIO_EMC_B1_36_SEMC_DATA14
IOMUXC_GPIO_EMC_B1_36_FLEXPWM1_PWMA00
IOMUXC_GPIO_EMC_B1_36_LPUART5_RX
IOMUXC_GPIO_EMC_B1_36_FLEXSPI2_BUS2BIT_A_DATA01
IOMUXC_GPIO_EMC_B1_36_NETC_PINMUX_ETH2_TXD03
IOMUXC_GPIO_EMC_B1_36_GPIO3_IO04
IOMUXC_GPIO_EMC_B1_36_ECAT_TX_DATA3_1
IOMUXC_GPIO_EMC_B1_36_NETC_PINMUX_ETH0_TX_EN
IOMUXC_GPIO_EMC_B1_36_AHB_SRAMC_DATA14
IOMUXC_GPIO_EMC_B1_37_AHB_SRAMC_DATA15
IOMUXC_GPIO_EMC_B1_37_SEMC_DATA15
IOMUXC_GPIO_EMC_B1_37_FLEXPWM1_PWMB00
IOMUXC_GPIO_EMC_B1_37_LPUART5_CTS_B
IOMUXC_GPIO_EMC_B1_37_FLEXSPI2_BUS2BIT_A_DATA02
IOMUXC_GPIO_EMC_B1_37_NETC_PINMUX_ETH2_TXD02
IOMUXC_GPIO_EMC_B1_37_GPIO3_IO05
IOMUXC_GPIO_EMC_B1_37_ECAT_TX_DATA2_1
IOMUXC_GPIO_EMC_B1_37_NETC_PINMUX_ETH0_TX_CLK
IOMUXC_GPIO_EMC_B1_38_AHB_SRAMC_UBB
IOMUXC_GPIO_EMC_B1_38_SEMC_DM01
IOMUXC_GPIO_EMC_B1_38_FLEXPWM1_PWMB03
IOMUXC_GPIO_EMC_B1_38_LPUART5_RTS_B
IOMUXC_GPIO_EMC_B1_38_FLEXSPI2_BUS2BIT_A_DATA03
IOMUXC_GPIO_EMC_B1_38_NETC_PINMUX_ETH2_RX_CLK
IOMUXC_GPIO_EMC_B1_38_GPIO3_IO06
IOMUXC_GPIO_EMC_B1_38_ECAT_RX_CLK_1
IOMUXC_GPIO_EMC_B1_38_NETC_PINMUX_ETH0_RXD00
IOMUXC_GPIO_EMC_B1_39_SEMC_DQS
IOMUXC_GPIO_EMC_B1_39_FLEXPWM1_PWMA03
IOMUXC_GPIO_EMC_B1_39_XBAR1_XBAR_INOUT15
IOMUXC_GPIO_EMC_B1_39_FLEXSPI2_BUS2BIT_A_SS0_B

IOMUXC_GPIO_EMC_B1_39_NETC_PINMUX_ETH2_TX_ER
IOMUXC_GPIO_EMC_B1_39_GPIO3_IO07
IOMUXC_GPIO_EMC_B1_39_QTIMER2_TIMER1
IOMUXC_GPIO_EMC_B1_39_NETC_PINMUX_ETH0_RXD01
IOMUXC_GPIO_EMC_B1_39_AHB_SRAMC_CS1
IOMUXC_GPIO_EMC_B1_40_SEMC_RDY
IOMUXC_GPIO_EMC_B1_40_NETC_EMDC
IOMUXC_GPIO_EMC_B1_40_NETC_ETH2_SLV_MDC
IOMUXC_GPIO_EMC_B1_40_FLEXSPI2_BUS2BIT_A_DQS
IOMUXC_GPIO_EMC_B1_40_NETC_ETH2_CRS
IOMUXC_GPIO_EMC_B1_40_GPIO3_IO08
IOMUXC_GPIO_EMC_B1_40_QTIMER3_TIMER1
IOMUXC_GPIO_EMC_B1_40_NETC_PINMUX_ETH0_RX_DV
IOMUXC_GPIO_EMC_B1_40_AHB_SRAMC_CS2
IOMUXC_GPIO_EMC_B1_41_AHB_SRAMC_CS3
IOMUXC_GPIO_EMC_B1_41_SEMC_CSX00
IOMUXC_GPIO_EMC_B1_41_NETC_EMDIO
IOMUXC_GPIO_EMC_B1_41_NETC_ETH2_SLV_MDIO
IOMUXC_GPIO_EMC_B1_41_FLEXSPI2_BUS2BIT_A_SCLK
IOMUXC_GPIO_EMC_B1_41_NETC_ETH2_COL
IOMUXC_GPIO_EMC_B1_41_GPIO3_IO09
IOMUXC_GPIO_EMC_B1_41_QTIMER4_TIMER1
IOMUXC_GPIO_EMC_B1_41_NETC_PINMUX_ETH0_RX_ER
IOMUXC_GPIO_EMC_B2_00_SEMC_DATA16
IOMUXC_GPIO_EMC_B2_00_CCM_ENET_REF_CLK_25M
IOMUXC_GPIO_EMC_B2_00_QTIMER5_TIMER1
IOMUXC_GPIO_EMC_B2_00_NETC_EMDC
IOMUXC_GPIO_EMC_B2_00_NETC_PINMUX_ETH0_RX_CLK
IOMUXC_GPIO_EMC_B2_00_GPIO3_IO10
IOMUXC_GPIO_EMC_B2_00_XBAR1_XBAR_INOUT20
IOMUXC_GPIO_EMC_B2_00_LPSPI5_SCK
IOMUXC_GPIO_EMC_B2_00_LPI2C3_SCL
IOMUXC_GPIO_EMC_B2_00_FLEXPWM3_PWMA00

IOMUXC_GPIO_EMC_B2_00_ECAT_RX_CLK_0
IOMUXC_GPIO_EMC_B2_01_SEMC_DATA17
IOMUXC_GPIO_EMC_B2_01_USDHC2_CD_B
IOMUXC_GPIO_EMC_B2_01_QTIMER6_TIMER1
IOMUXC_GPIO_EMC_B2_01_NETC_EMDIO
IOMUXC_GPIO_EMC_B2_01_NETC_PINMUX_ETH0_RXD02
IOMUXC_GPIO_EMC_B2_01_GPIO3_IO11
IOMUXC_GPIO_EMC_B2_01_XBAR1_XBAR_INOUT21
IOMUXC_GPIO_EMC_B2_01_LPSP15_PCS0
IOMUXC_GPIO_EMC_B2_01_LPI2C3_SDA
IOMUXC_GPIO_EMC_B2_01_FLEXPWM3_PWMB00
IOMUXC_GPIO_EMC_B2_01_ECAT_RX_DATA2_0
IOMUXC_GPIO_EMC_B2_02_SEMC_DATA18
IOMUXC_GPIO_EMC_B2_02_USDHC2_WP
IOMUXC_GPIO_EMC_B2_02_QTIMER7_TIMER1
IOMUXC_GPIO_EMC_B2_02_NETC_PINMUX_ETH0_RXD03
IOMUXC_GPIO_EMC_B2_02_GPIO3_IO12
IOMUXC_GPIO_EMC_B2_02_XBAR1_XBAR_INOUT22
IOMUXC_GPIO_EMC_B2_02_LPSP15_SDO
IOMUXC_GPIO_EMC_B2_02_CCM_CLKO1
IOMUXC_GPIO_EMC_B2_02_FLEXPWM3_PWMA01
IOMUXC_GPIO_EMC_B2_02_ECAT_RX_DATA3_0
IOMUXC_GPIO_EMC_B2_03_SEMC_DATA19
IOMUXC_GPIO_EMC_B2_03_USDHC2_VSELECT
IOMUXC_GPIO_EMC_B2_03_QTIMER8_TIMER1
IOMUXC_GPIO_EMC_B2_03_NETC_PINMUX_ETH0_TXD02
IOMUXC_GPIO_EMC_B2_03_GPIO3_IO13
IOMUXC_GPIO_EMC_B2_03_XBAR1_XBAR_INOUT23
IOMUXC_GPIO_EMC_B2_03_LPSP15_SDI
IOMUXC_GPIO_EMC_B2_03_NETC_ETH3_CRS
IOMUXC_GPIO_EMC_B2_03_FLEXPWM3_PWMB01
IOMUXC_GPIO_EMC_B2_03_ECAT_TX_DATA2_0
IOMUXC_GPIO_EMC_B2_04_SEMC_DATA20

IOMUXC_GPIO_EMC_B2_04_USDHC2_RESET_B
IOMUXC_GPIO_EMC_B2_04_SAI2_MCLK
IOMUXC_GPIO_EMC_B2_04_NETC_PINMUX_ETH0_TXD03
IOMUXC_GPIO_EMC_B2_04_GPIO3_IO14
IOMUXC_GPIO_EMC_B2_04_XBAR1_XBAR_INOUT24
IOMUXC_GPIO_EMC_B2_04_LPSP13_SCK
IOMUXC_GPIO_EMC_B2_04_NETC_ETH3_COL
IOMUXC_GPIO_EMC_B2_04_FLEXPWM3_PWMB02
IOMUXC_GPIO_EMC_B2_04_ECAT_TX_DATA3_0
IOMUXC_GPIO_EMC_B2_05_SEMC_DATA21
IOMUXC_GPIO_EMC_B2_05_NETC_ETH4_SLV_MDC
IOMUXC_GPIO_EMC_B2_05_SAI2_RX_SYNC
IOMUXC_GPIO_EMC_B2_05_NETC_PINMUX_ETH0_TXD00
IOMUXC_GPIO_EMC_B2_05_NETC_ETH4_CRS
IOMUXC_GPIO_EMC_B2_05_GPIO3_IO15
IOMUXC_GPIO_EMC_B2_05_XBAR1_XBAR_INOUT25
IOMUXC_GPIO_EMC_B2_05_LPSP13_PCS0
IOMUXC_GPIO_EMC_B2_05_NETC_PINMUX_ETH3_TXD00
IOMUXC_GPIO_EMC_B2_05_FLEXPWM3_PWMA02
IOMUXC_GPIO_EMC_B2_05_ECAT_TX_DATA0_0
IOMUXC_GPIO_EMC_B2_06_SEMC_DATA22
IOMUXC_GPIO_EMC_B2_06_FLEXPWM3_PWMB03
IOMUXC_GPIO_EMC_B2_06_NETC_ETH4_SLV_MDIO
IOMUXC_GPIO_EMC_B2_06_SAI2_RX_BCLK
IOMUXC_GPIO_EMC_B2_06_ECAT_TX_DATA1_0
IOMUXC_GPIO_EMC_B2_06_NETC_PINMUX_ETH0_TXD01
IOMUXC_GPIO_EMC_B2_06_NETC_ETH4_COL
IOMUXC_GPIO_EMC_B2_06_GPIO3_IO16
IOMUXC_GPIO_EMC_B2_06_XBAR1_XBAR_INOUT26
IOMUXC_GPIO_EMC_B2_06_LPSP13_SDO
IOMUXC_GPIO_EMC_B2_06_NETC_PINMUX_ETH3_TXD01
IOMUXC_GPIO_EMC_B2_07_SEMC_DATA23
IOMUXC_GPIO_EMC_B2_07_NETC_PINMUX_ETH4_TX_ER

IOMUXC_GPIO_EMC_B2_07_SAI2_RX_DATA
IOMUXC_GPIO_EMC_B2_07_NETC_PINMUX_ETH0_TX_EN
IOMUXC_GPIO_EMC_B2_07_GPIO3_IO17
IOMUXC_GPIO_EMC_B2_07_XBAR1_XBAR_INOUT27
IOMUXC_GPIO_EMC_B2_07_LPSP13_SDI
IOMUXC_GPIO_EMC_B2_07_NETC_PINMUX_ETH3_TX_EN
IOMUXC_GPIO_EMC_B2_07_FLEXPWM3_PWMA03
IOMUXC_GPIO_EMC_B2_07_ECAT_TX_EN_0
IOMUXC_GPIO_EMC_B2_08_SEMC_DM02
IOMUXC_GPIO_EMC_B2_08_NETC_PINMUX_ETH4_RX_CLK
IOMUXC_GPIO_EMC_B2_08_SAI2_TX_DATA
IOMUXC_GPIO_EMC_B2_08_NETC_PINMUX_ETH0_TX_CLK
IOMUXC_GPIO_EMC_B2_08_GPIO3_IO18
IOMUXC_GPIO_EMC_B2_08_XBAR1_XBAR_INOUT28
IOMUXC_GPIO_EMC_B2_08_LPSP13_PCS3
IOMUXC_GPIO_EMC_B2_08_NETC_PINMUX_ETH3_TX_CLK
IOMUXC_GPIO_EMC_B2_08_CCM_CLKO2
IOMUXC_GPIO_EMC_B2_08_ECAT_TX_CLK_0
IOMUXC_GPIO_EMC_B2_09_QTIMER1_TIMER0
IOMUXC_GPIO_EMC_B2_09_ECAT_RX_DATA0_0
IOMUXC_GPIO_EMC_B2_09_SEMC_DATA24
IOMUXC_GPIO_EMC_B2_09_NETC_PINMUX_ETH4_RXD03
IOMUXC_GPIO_EMC_B2_09_SAI2_TX_BCLK
IOMUXC_GPIO_EMC_B2_09_NETC_PINMUX_ETH0_RXD00
IOMUXC_GPIO_EMC_B2_09_GPIO3_IO19
IOMUXC_GPIO_EMC_B2_09_XBAR1_XBAR_INOUT29
IOMUXC_GPIO_EMC_B2_09_LPSP13_PCS2
IOMUXC_GPIO_EMC_B2_09_NETC_PINMUX_ETH3_RXD00
IOMUXC_GPIO_EMC_B2_10_QTIMER1_TIMER1
IOMUXC_GPIO_EMC_B2_10_ECAT_RX_DATA1_0
IOMUXC_GPIO_EMC_B2_10_SEMC_DATA25
IOMUXC_GPIO_EMC_B2_10_NETC_PINMUX_ETH4_RXD02
IOMUXC_GPIO_EMC_B2_10_SAI2_TX_SYNC

IOMUXC_GPIO_EMC_B2_10_NETC_PINMUX_ETH0_RXD01
IOMUXC_GPIO_EMC_B2_10_GPIO3_IO20
IOMUXC_GPIO_EMC_B2_10_XBAR1_XBAR_INOUT30
IOMUXC_GPIO_EMC_B2_10_LPSPI3_PCS1
IOMUXC_GPIO_EMC_B2_10_NETC_PINMUX_ETH3_RXD01
IOMUXC_GPIO_EMC_B2_11_SEMC_DATA26
IOMUXC_GPIO_EMC_B2_11_NETC_PINMUX_ETH4_TXD03
IOMUXC_GPIO_EMC_B2_11_SPDIF_OUT
IOMUXC_GPIO_EMC_B2_11_NETC_PINMUX_ETH0_RX_DV
IOMUXC_GPIO_EMC_B2_11_LPSPI5_PCS3
IOMUXC_GPIO_EMC_B2_11_GPIO3_IO21
IOMUXC_GPIO_EMC_B2_11_XBAR1_XBAR_INOUT31
IOMUXC_GPIO_EMC_B2_11_SAI3_RX_SYNC
IOMUXC_GPIO_EMC_B2_11_NETC_PINMUX_ETH3_RX_DV
IOMUXC_GPIO_EMC_B2_11_QTIMER1_TIMER2
IOMUXC_GPIO_EMC_B2_11_ECAT_RX_DV_0
IOMUXC_GPIO_EMC_B2_12_SEMC_DATA27
IOMUXC_GPIO_EMC_B2_12_NETC_PINMUX_ETH4_TXD02
IOMUXC_GPIO_EMC_B2_12_SPDIF_IN
IOMUXC_GPIO_EMC_B2_12_NETC_PINMUX_ETH0_RX_ER
IOMUXC_GPIO_EMC_B2_12_LPSPI5_PCS2
IOMUXC_GPIO_EMC_B2_12_GPIO3_IO22
IOMUXC_GPIO_EMC_B2_12_XBAR1_XBAR_INOUT32
IOMUXC_GPIO_EMC_B2_12_SAI3_RX_BCLK
IOMUXC_GPIO_EMC_B2_12_NETC_PINMUX_ETH3_RX_ER
IOMUXC_GPIO_EMC_B2_12_QTIMER1_TIMER3
IOMUXC_GPIO_EMC_B2_12_ECAT_PT0_RX_ER
IOMUXC_GPIO_EMC_B2_13_QTIMER2_TIMER0
IOMUXC_GPIO_EMC_B2_13_ECAT_TX_DATA0_1
IOMUXC_GPIO_EMC_B2_13_SEMC_DATA28
IOMUXC_GPIO_EMC_B2_13_NETC_PINMUX_ETH4_TXD00
IOMUXC_GPIO_EMC_B2_13_LPUART11_TX
IOMUXC_GPIO_EMC_B2_13_NETC_PINMUX_ETH0_TXD03

IOMUXC_GPIO_EMC_B2_13_LPSP15_PCS1
IOMUXC_GPIO_EMC_B2_13_GPIO3_IO23
IOMUXC_GPIO_EMC_B2_13_XBAR1_XBAR_INOUT33
IOMUXC_GPIO_EMC_B2_13_SAI3_RX_DATA
IOMUXC_GPIO_EMC_B2_13_NETC_PINMUX_ETH3_TXD03
IOMUXC_GPIO_EMC_B2_14_SEMC_DATA29
IOMUXC_GPIO_EMC_B2_14_NETC_PINMUX_ETH4_TXD01
IOMUXC_GPIO_EMC_B2_14_LPUART11_RX
IOMUXC_GPIO_EMC_B2_14_NETC_PINMUX_ETH0_TXD02
IOMUXC_GPIO_EMC_B2_14_LPUART5_DSR_B
IOMUXC_GPIO_EMC_B2_14_GPIO3_IO24
IOMUXC_GPIO_EMC_B2_14_XBAR1_XBAR_INOUT34
IOMUXC_GPIO_EMC_B2_14_SAI3_TX_DATA
IOMUXC_GPIO_EMC_B2_14_NETC_PINMUX_ETH3_TXD02
IOMUXC_GPIO_EMC_B2_14_QTIMER2_TIMER1
IOMUXC_GPIO_EMC_B2_14_ECAT_TX_DATA1_1
IOMUXC_GPIO_EMC_B2_15_SEMC_DATA30
IOMUXC_GPIO_EMC_B2_15_NETC_PINMUX_ETH4_TX_EN
IOMUXC_GPIO_EMC_B2_15_LPUART11_CTS_B
IOMUXC_GPIO_EMC_B2_15_NETC_PINMUX_ETH0_RX_CLK
IOMUXC_GPIO_EMC_B2_15_LPUART5_DCD_B
IOMUXC_GPIO_EMC_B2_15_GPIO3_IO25
IOMUXC_GPIO_EMC_B2_15_XBAR1_XBAR_INOUT35
IOMUXC_GPIO_EMC_B2_15_SAI3_TX_BCLK
IOMUXC_GPIO_EMC_B2_15_NETC_PINMUX_ETH3_RX_CLK
IOMUXC_GPIO_EMC_B2_15_QTIMER2_TIMER2
IOMUXC_GPIO_EMC_B2_15_ECAT_TX_EN_1
IOMUXC_GPIO_EMC_B2_16_QTIMER2_TIMER3
IOMUXC_GPIO_EMC_B2_16_ECAT_TX_CLK_1
IOMUXC_GPIO_EMC_B2_16_SEMC_DATA31
IOMUXC_GPIO_EMC_B2_16_NETC_PINMUX_ETH4_TX_CLK
IOMUXC_GPIO_EMC_B2_16_LPUART11_RTS_B
IOMUXC_GPIO_EMC_B2_16_NETC_PINMUX_ETH0_RXD02

IOMUXC_GPIO_EMC_B2_16_LPUART5_DTR_B
IOMUXC_GPIO_EMC_B2_16_GPIO3_IO26
IOMUXC_GPIO_EMC_B2_16_XBAR1_XBAR_INOUT14
IOMUXC_GPIO_EMC_B2_16_SAI3_TX_SYNC
IOMUXC_GPIO_EMC_B2_16_NETC_PINMUX_ETH3_RXD02
IOMUXC_GPIO_EMC_B2_17_SEMC_DM03
IOMUXC_GPIO_EMC_B2_17_NETC_PINMUX_ETH4_RXD00
IOMUXC_GPIO_EMC_B2_17_LPUART5_TX
IOMUXC_GPIO_EMC_B2_17_NETC_PINMUX_ETH0_RXD03
IOMUXC_GPIO_EMC_B2_17_GPIO3_IO27
IOMUXC_GPIO_EMC_B2_17_XBAR1_XBAR_INOUT15
IOMUXC_GPIO_EMC_B2_17_SAI3_MCLK
IOMUXC_GPIO_EMC_B2_17_NETC_PINMUX_ETH3_RXD03
IOMUXC_GPIO_EMC_B2_17_QTIMER3_TIMER0
IOMUXC_GPIO_EMC_B2_17_ECAT_RX_DATA0_1
IOMUXC_GPIO_EMC_B2_18_SEMC_DQS4
IOMUXC_GPIO_EMC_B2_18_NETC_PINMUX_ETH4_RXD01
IOMUXC_GPIO_EMC_B2_18_LPUART5_RX
IOMUXC_GPIO_EMC_B2_18_NETC_PINMUX_ETH0_TX_ER
IOMUXC_GPIO_EMC_B2_18_GPIO3_IO28
IOMUXC_GPIO_EMC_B2_18_XBAR1_XBAR_INOUT16
IOMUXC_GPIO_EMC_B2_18_EWM_EWM_OUT_B
IOMUXC_GPIO_EMC_B2_18_NETC_PINMUX_ETH3_TX_ER
IOMUXC_GPIO_EMC_B2_18_QTIMER3_TIMER1
IOMUXC_GPIO_EMC_B2_18_ECAT_RX_DATA1_1
IOMUXC_GPIO_EMC_B2_19_QTIMER3_TIMER2
IOMUXC_GPIO_EMC_B2_19_ECAT_RX_DV_1
IOMUXC_GPIO_EMC_B2_19_SEMC_CLKX00
IOMUXC_GPIO_EMC_B2_19_NETC_PINMUX_ETH4_RX_DV
IOMUXC_GPIO_EMC_B2_19_LPUART5_CTS_B
IOMUXC_GPIO_EMC_B2_19_NETC_ETH0_CRS
IOMUXC_GPIO_EMC_B2_19_NETC_EMDC
IOMUXC_GPIO_EMC_B2_19_GPIO3_IO29

IOMUXC_GPIO_EMC_B2_19_XBAR1_XBAR_INOUT36
IOMUXC_GPIO_EMC_B2_19_LPI2C3_SCL
IOMUXC_GPIO_EMC_B2_19_NETC_ETH3_SLV_MDC
IOMUXC_GPIO_EMC_B2_20_QTIMER3_TIMER3
IOMUXC_GPIO_EMC_B2_20_ECAT_RX_ER_1
IOMUXC_GPIO_EMC_B2_20_SEMC_CLKX01
IOMUXC_GPIO_EMC_B2_20_NETC_PINMUX_ETH4_RX_ER
IOMUXC_GPIO_EMC_B2_20_LPUART5_RTS_B
IOMUXC_GPIO_EMC_B2_20_NETC_ETH0_COL
IOMUXC_GPIO_EMC_B2_20_NETC_EMDIO
IOMUXC_GPIO_EMC_B2_20_GPIO3_IO30
IOMUXC_GPIO_EMC_B2_20_XBAR1_XBAR_INOUT37
IOMUXC_GPIO_EMC_B2_20_LPI2C3_SDA
IOMUXC_GPIO_EMC_B2_20_NETC_ETH3_SLV_MDIO
IOMUXC_GPIO_AD_00_CAN2_TX
IOMUXC_GPIO_AD_00_MIC_CLK
IOMUXC_GPIO_AD_00_GPT2_CAPTURE1
IOMUXC_GPIO_AD_00_FLEXPWM1_PWMA00
IOMUXC_GPIO_AD_00_GPIO4_IO00
IOMUXC_GPIO_AD_00_SINC1_MOD_CLK0
IOMUXC_GPIO_AD_00_FLEXIO2_FLEXIO00
IOMUXC_GPIO_AD_00_QTIMER4_TIMER0
IOMUXC_GPIO_AD_01_CAN2_RX
IOMUXC_GPIO_AD_01_MIC_BITSTREAM00
IOMUXC_GPIO_AD_01_GPT2_CAPTURE2
IOMUXC_GPIO_AD_01_FLEXPWM1_PWMB00
IOMUXC_GPIO_AD_01_GPIO4_IO01
IOMUXC_GPIO_AD_01_SINC1_MOD_CLK1
IOMUXC_GPIO_AD_01_FLEXIO2_FLEXIO01
IOMUXC_GPIO_AD_01_QTIMER4_TIMER1
IOMUXC_GPIO_AD_02_MIC_BITSTREAM01
IOMUXC_GPIO_AD_02_GPT2_COMPARE1
IOMUXC_GPIO_AD_02_FLEXPWM1_PWMA01

IOMUXC_GPIO_AD_02_GPIO4_IO02
IOMUXC_GPIO_AD_02_SINC1_MOD_CLK2
IOMUXC_GPIO_AD_02_FLEXIO2_FLEXIO02
IOMUXC_GPIO_AD_02_QTIMER4_TIMER2
IOMUXC_GPIO_AD_03_MIC_BITSTREAM02
IOMUXC_GPIO_AD_03_GPT2_COMPARE2
IOMUXC_GPIO_AD_03_FLEXPWM1_PWMB01
IOMUXC_GPIO_AD_03_GPIO4_IO03
IOMUXC_GPIO_AD_03_SINC1_EMCLK00
IOMUXC_GPIO_AD_03_FLEXIO2_FLEXIO03
IOMUXC_GPIO_AD_03_QTIMER4_TIMER3
IOMUXC_GPIO_AD_04_MIC_BITSTREAM03
IOMUXC_GPIO_AD_04_GPT2_COMPARE3
IOMUXC_GPIO_AD_04_FLEXPWM1_PWMB02
IOMUXC_GPIO_AD_04_GPIO4_IO04
IOMUXC_GPIO_AD_04_SINC1_EMBIT00
IOMUXC_GPIO_AD_04_FLEXIO2_FLEXIO04
IOMUXC_GPIO_AD_04_QTIMER5_TIMER0
IOMUXC_GPIO_AD_05_GPT2_CLK
IOMUXC_GPIO_AD_05_FLEXPWM1_PWMA02
IOMUXC_GPIO_AD_05_GPIO4_IO05
IOMUXC_GPIO_AD_05_SINC1_EMCLK01
IOMUXC_GPIO_AD_05_CCM_ENET_REF_CLK_25M
IOMUXC_GPIO_AD_05_FLEXIO2_FLEXIO05
IOMUXC_GPIO_AD_05_QTIMER5_TIMER1
IOMUXC_GPIO_AD_06_USB_OTG2_OC
IOMUXC_GPIO_AD_06_CAN3_TX
IOMUXC_GPIO_AD_06_FLEXPWM1_PWMX00
IOMUXC_GPIO_AD_06_GPIO4_IO06
IOMUXC_GPIO_AD_06_SINC1_EMBIT01
IOMUXC_GPIO_AD_06_FLEXIO2_FLEXIO06
IOMUXC_GPIO_AD_06_QTIMER5_TIMER2
IOMUXC_GPIO_AD_07_USB_OTG2_PWR

IOMUXC_GPIO_AD_07_CAN3_RX
IOMUXC_GPIO_AD_07_FLEXPWM1_PWMX01
IOMUXC_GPIO_AD_07_GPIO4_IO07
IOMUXC_GPIO_AD_07_SINC1_EMCLK02
IOMUXC_GPIO_AD_07_FLEXIO2_FLEXIO07
IOMUXC_GPIO_AD_07_QTIMER5_TIMER3
IOMUXC_GPIO_AD_08_USBPHY2_OTG_ID
IOMUXC_GPIO_AD_08_LPI2C5_SCL
IOMUXC_GPIO_AD_08_FLEXPWM1_PWMX02
IOMUXC_GPIO_AD_08_GPIO4_IO08
IOMUXC_GPIO_AD_08_SINC1_EMBIT02
IOMUXC_GPIO_AD_08_FLEXIO2_FLEXIO08
IOMUXC_GPIO_AD_08_QTIMER6_TIMER0
IOMUXC_GPIO_AD_09_USBPHY1_OTG_ID
IOMUXC_GPIO_AD_09_LPI2C5_SDA
IOMUXC_GPIO_AD_09_FLEXPWM1_PWMX03
IOMUXC_GPIO_AD_09_GPIO4_IO09
IOMUXC_GPIO_AD_09_SINC1_EMCLK03
IOMUXC_GPIO_AD_09_FLEXIO2_FLEXIO09
IOMUXC_GPIO_AD_09_QTIMER6_TIMER1
IOMUXC_GPIO_AD_10_USB_OTG1_PWR
IOMUXC_GPIO_AD_10_FLEXPWM2_PWMX00
IOMUXC_GPIO_AD_10_GPIO4_IO10
IOMUXC_GPIO_AD_10_SINC1_EMBIT03
IOMUXC_GPIO_AD_10_FLEXIO2_FLEXIO10
IOMUXC_GPIO_AD_10_QTIMER6_TIMER2
IOMUXC_GPIO_AD_11_USB_OTG1_OC
IOMUXC_GPIO_AD_11_FLEXPWM2_PWMX01
IOMUXC_GPIO_AD_11_GPIO4_IO11
IOMUXC_GPIO_AD_11_SINC_FILTER_GLUE1_BREAK
IOMUXC_GPIO_AD_11_FLEXIO2_FLEXIO11
IOMUXC_GPIO_AD_11_QTIMER6_TIMER3
IOMUXC_GPIO_AD_12_SPDIF_LOCK

IOMUXC_GPIO_AD_12_LPI2C5_SCLS
IOMUXC_GPIO_AD_12_GPT1_CAPTURE1
IOMUXC_GPIO_AD_12_KPP_ROW07
IOMUXC_GPIO_AD_12_FLEXPWM2_PWMX02
IOMUXC_GPIO_AD_12_GPIO4_IO12
IOMUXC_GPIO_AD_12_XBAR1_XBAR_INOUT18
IOMUXC_GPIO_AD_12_EWM_EWM_OUT_B
IOMUXC_GPIO_AD_12_FLEXIO2_FLEXIO12
IOMUXC_GPIO_AD_13_SPDIF_SR_CLK
IOMUXC_GPIO_AD_13_LPI2C5_SDAS
IOMUXC_GPIO_AD_13_GPT1_CAPTURE2
IOMUXC_GPIO_AD_13_KPP_COL07
IOMUXC_GPIO_AD_13_FLEXPWM2_PWMX03
IOMUXC_GPIO_AD_13_GPIO4_IO13
IOMUXC_GPIO_AD_13_LPUART3_TX
IOMUXC_GPIO_AD_13_USDHC2_CD_B
IOMUXC_GPIO_AD_13_FLEXIO2_FLEXIO13
IOMUXC_GPIO_AD_14_SPDIF_EXT_CLK
IOMUXC_GPIO_AD_14_LPI2C5_HREQ
IOMUXC_GPIO_AD_14_GPT1_COMPARE1
IOMUXC_GPIO_AD_14_KPP_ROW06
IOMUXC_GPIO_AD_14_FLEXPWM3_PWMX00
IOMUXC_GPIO_AD_14_GPIO4_IO14
IOMUXC_GPIO_AD_14_LPUART3_RX
IOMUXC_GPIO_AD_14_USDHC2_WP
IOMUXC_GPIO_AD_14_FLEXIO2_FLEXIO14
IOMUXC_GPIO_AD_15_ECAT_CLK_ECAT_CLK25
IOMUXC_GPIO_AD_15_SPDIF_IN
IOMUXC_GPIO_AD_15_LPUART10_TX
IOMUXC_GPIO_AD_15_GPT1_COMPARE2
IOMUXC_GPIO_AD_15_KPP_COL06
IOMUXC_GPIO_AD_15_FLEXPWM3_PWMX01
IOMUXC_GPIO_AD_15_GPIO4_IO15

IOMUXC_GPIO_AD_15_LPUART3_CTS_B
IOMUXC_GPIO_AD_15_LPSPI3_PCS1
IOMUXC_GPIO_AD_15_FLEXIO2_FLEXIO15
IOMUXC_GPIO_AD_15_CAN1_TX
IOMUXC_GPIO_AD_16_SPDIF_OUT
IOMUXC_GPIO_AD_16_LPUART10_RX
IOMUXC_GPIO_AD_16_GPT1_COMPARE3
IOMUXC_GPIO_AD_16_KPP_ROW05
IOMUXC_GPIO_AD_16_FLEXPWM3_PWMX02
IOMUXC_GPIO_AD_16_GPIO4_IO16
IOMUXC_GPIO_AD_16_LPUART3_RTS_B
IOMUXC_GPIO_AD_16_LPSPI3_SCK
IOMUXC_GPIO_AD_16_FLEXIO2_FLEXIO16
IOMUXC_GPIO_AD_16_CAN1_RX
IOMUXC_GPIO_AD_16_ECAT_LINK_0
IOMUXC_GPIO_AD_17_SAI4_MCLK
IOMUXC_GPIO_AD_17_ACMP1_CMPO
IOMUXC_GPIO_AD_17_GPT1_CLK
IOMUXC_GPIO_AD_17_KPP_COL05
IOMUXC_GPIO_AD_17_FLEXPWM3_PWMX03
IOMUXC_GPIO_AD_17_GPIO4_IO17
IOMUXC_GPIO_AD_17_I3C2_PUR
IOMUXC_GPIO_AD_17_LPSPI3_PCS0
IOMUXC_GPIO_AD_17_FLEXIO2_FLEXIO17
IOMUXC_GPIO_AD_17_LPI2C3_HREQ
IOMUXC_GPIO_AD_17_ECAT_LINK_1
IOMUXC_GPIO_AD_18_ECAT_PROM_CLK
IOMUXC_GPIO_AD_18_SAI4_RX_SYNC
IOMUXC_GPIO_AD_18_ACMP2_CMPO
IOMUXC_GPIO_AD_18_LPUART5_RI_B
IOMUXC_GPIO_AD_18_KPP_ROW04
IOMUXC_GPIO_AD_18_FLEXPWM4_PWMX00
IOMUXC_GPIO_AD_18_GPIO4_IO18

IOMUXC_GPIO_AD_18_I3C2_SCL
IOMUXC_GPIO_AD_18_LPSPI3_SDO
IOMUXC_GPIO_AD_18_FLEXIO2_FLEXIO18
IOMUXC_GPIO_AD_18_LPI2C3_SCL
IOMUXC_GPIO_AD_19_SAI4_RX_BCLK
IOMUXC_GPIO_AD_19_ACMP3_CMPO
IOMUXC_GPIO_AD_19_XBAR1_XBAR_INOUT19
IOMUXC_GPIO_AD_19_KPP_COL04
IOMUXC_GPIO_AD_19_FLEXPWM4_PWMX01
IOMUXC_GPIO_AD_19_GPIO4_IO19
IOMUXC_GPIO_AD_19_I3C2_SDA
IOMUXC_GPIO_AD_19_LPSPI3_SDI
IOMUXC_GPIO_AD_19_FLEXIO2_FLEXIO19
IOMUXC_GPIO_AD_19_LPI2C3_SDA
IOMUXC_GPIO_AD_19_ECAT_PROM_DATA
IOMUXC_GPIO_AD_20_SAI4_RX_DATA00
IOMUXC_GPIO_AD_20_ACMP4_CMPO
IOMUXC_GPIO_AD_20_LPIT2_TRIGGER00
IOMUXC_GPIO_AD_20_SINC1_EMCLK00
IOMUXC_GPIO_AD_20_FLEXPWM4_PWMX02
IOMUXC_GPIO_AD_20_GPIO4_IO20
IOMUXC_GPIO_AD_20_NETC_TMR_TRIG1
IOMUXC_GPIO_AD_20_NETC_1588_CLK
IOMUXC_GPIO_AD_20_FLEXIO2_FLEXIO20
IOMUXC_GPIO_AD_21_SAI4_TX_DATA00
IOMUXC_GPIO_AD_21_LPIT2_TRIGGER01
IOMUXC_GPIO_AD_21_SINC1_EMBIT00
IOMUXC_GPIO_AD_21_FLEXPWM4_PWMX03
IOMUXC_GPIO_AD_21_GPIO4_IO21
IOMUXC_GPIO_AD_21_NETC_TMR_TRIG2
IOMUXC_GPIO_AD_21_NETC_TMR_GCLK
IOMUXC_GPIO_AD_21_FLEXIO2_FLEXIO21
IOMUXC_GPIO_AD_21_ECAT_LED_RUN

IOMUXC_GPIO_AD_22_ECAT_LED_ERR
IOMUXC_GPIO_AD_22_SAI4_TX_BCLK
IOMUXC_GPIO_AD_22_LPIT2_TRIGGER02
IOMUXC_GPIO_AD_22_SINC1_EMCLK01
IOMUXC_GPIO_AD_22_GPIO4_IO22
IOMUXC_GPIO_AD_22_NETC_TMR_ALARM1
IOMUXC_GPIO_AD_22_FLEXIO2_FLEXIO22
IOMUXC_GPIO_AD_23_SAI4_TX_SYNC
IOMUXC_GPIO_AD_23_LPIT2_TRIGGER03
IOMUXC_GPIO_AD_23_SINC1_EMBIT01
IOMUXC_GPIO_AD_23_GPIO4_IO23
IOMUXC_GPIO_AD_23_NETC_TMR_ALARM2
IOMUXC_GPIO_AD_23_FLEXIO2_FLEXIO23
IOMUXC_GPIO_AD_23_ECAT_LED_STATE_RUN
IOMUXC_GPIO_AD_24_LPUART6_TX
IOMUXC_GPIO_AD_24_LPI2C4_SCL
IOMUXC_GPIO_AD_24_SINC2_MOD_CLK1
IOMUXC_GPIO_AD_24_FLEXPWM2_PWMA00
IOMUXC_GPIO_AD_24_GPIO4_IO24
IOMUXC_GPIO_AD_24_NETC_TMR_TRIG1
IOMUXC_GPIO_AD_24_FLEXIO2_FLEXIO24
IOMUXC_GPIO_AD_24_ECAT_LINK_ACT00
IOMUXC_GPIO_AD_25_ECAT_LINK_ACT01
IOMUXC_GPIO_AD_25_LPUART6_RX
IOMUXC_GPIO_AD_25_LPI2C4_SDA
IOMUXC_GPIO_AD_25_LPSPI5_PCS3
IOMUXC_GPIO_AD_25_SINC2_MOD_CLK2
IOMUXC_GPIO_AD_25_FLEXPWM2_PWMB00
IOMUXC_GPIO_AD_25_GPIO4_IO25
IOMUXC_GPIO_AD_25_NETC_TMR_TRIG2
IOMUXC_GPIO_AD_25_FLEXIO2_FLEXIO25
IOMUXC_GPIO_AD_26_LPUART6_CTS_B
IOMUXC_GPIO_AD_26_LPUART5_TX

IOMUXC_GPIO_AD_26_LPSP15_PCS2
IOMUXC_GPIO_AD_26_SINC2_EMCLK00
IOMUXC_GPIO_AD_26_FLEXPWM2_PWMA01
IOMUXC_GPIO_AD_26_GPIO4_IO26
IOMUXC_GPIO_AD_26_KPP_ROW00
IOMUXC_GPIO_AD_26_NETC_TMR_PP1
IOMUXC_GPIO_AD_26_FLEXIO2_FLEXIO26
IOMUXC_GPIO_AD_26_USDHC2_CD_B
IOMUXC_GPIO_AD_26_MIC_BITSTREAM02
IOMUXC_GPIO_AD_27_LPUART6_RTS_B
IOMUXC_GPIO_AD_27_LPUART5_RX
IOMUXC_GPIO_AD_27_LPSP15_PCS1
IOMUXC_GPIO_AD_27_SINC2_EMBIT00
IOMUXC_GPIO_AD_27_FLEXPWM2_PWMB01
IOMUXC_GPIO_AD_27_GPIO4_IO27
IOMUXC_GPIO_AD_27_KPP_COL00
IOMUXC_GPIO_AD_27_NETC_TMR_PP2
IOMUXC_GPIO_AD_27_FLEXIO2_FLEXIO27
IOMUXC_GPIO_AD_27_USDHC2_WP
IOMUXC_GPIO_AD_27_MIC_CLK
IOMUXC_GPIO_AD_28_MIC_BITSTREAM00
IOMUXC_GPIO_AD_28_LPSP15_SCK
IOMUXC_GPIO_AD_28_I3C1_PUR
IOMUXC_GPIO_AD_28_SINC2_EMCLK01
IOMUXC_GPIO_AD_28_FLEXPWM2_PWMB02
IOMUXC_GPIO_AD_28_GPIO4_IO28
IOMUXC_GPIO_AD_28_KPP_ROW03
IOMUXC_GPIO_AD_28_NETC_TMR_PP3
IOMUXC_GPIO_AD_28_FLEXIO2_FLEXIO28
IOMUXC_GPIO_AD_28_USDHC2_RESET_B
IOMUXC_GPIO_AD_29_LPSP15_PCS0
IOMUXC_GPIO_AD_29_USDHC2_CD_B
IOMUXC_GPIO_AD_29_SINC2_EMBIT01

IOMUXC_GPIO_AD_29_FLEXPWM2_PWMA02
IOMUXC_GPIO_AD_29_GPIO4_IO29
IOMUXC_GPIO_AD_29_KPP_COL03
IOMUXC_GPIO_AD_29_EWM_EWM_OUT_B
IOMUXC_GPIO_AD_29_FLEXIO2_FLEXIO29
IOMUXC_GPIO_AD_29_USDHC2_VSELECT
IOMUXC_GPIO_AD_29_MIC_BITSTREAM01
IOMUXC_GPIO_AD_30_LPSPI5_SDO
IOMUXC_GPIO_AD_30_USB_OTG2_OC
IOMUXC_GPIO_AD_30_CAN2_TX
IOMUXC_GPIO_AD_30_SINC2_EMCLK02
IOMUXC_GPIO_AD_30_LPUART8_TX
IOMUXC_GPIO_AD_30_GPIO4_IO30
IOMUXC_GPIO_AD_30_KPP_ROW02
IOMUXC_GPIO_AD_30_NETC_EMDC
IOMUXC_GPIO_AD_30_FLEXIO2_FLEXIO30
IOMUXC_GPIO_AD_30_XBAR1_XBAR_INOUT24
IOMUXC_GPIO_AD_30_ECAT_MCLK
IOMUXC_GPIO_AD_31_LPSPI5_SDI
IOMUXC_GPIO_AD_31_USB_OTG2_PWR
IOMUXC_GPIO_AD_31_CAN2_RX
IOMUXC_GPIO_AD_31_SINC2_EMBIT02
IOMUXC_GPIO_AD_31_LPUART8_RX
IOMUXC_GPIO_AD_31_GPIO4_IO31
IOMUXC_GPIO_AD_31_KPP_COL02
IOMUXC_GPIO_AD_31_NETC_EMDIO
IOMUXC_GPIO_AD_31_FLEXIO2_FLEXIO31
IOMUXC_GPIO_AD_31_XBAR1_XBAR_INOUT25
IOMUXC_GPIO_AD_31_ECAT_MDIO
IOMUXC_GPIO_AD_32_MIC_BITSTREAM03
IOMUXC_GPIO_AD_32_LPI2C5_SCL
IOMUXC_GPIO_AD_32_USBPHY2_OTG_ID
IOMUXC_GPIO_AD_32_GPC_PMIC_RDY

IOMUXC_GPIO_AD_32_SINC2_EMCLK03
IOMUXC_GPIO_AD_32_USDHC1_CD_B
IOMUXC_GPIO_AD_32_GPIO5_IO00
IOMUXC_GPIO_AD_32_KPP_ROW01
IOMUXC_GPIO_AD_32_NETC_TMR_TRIG1
IOMUXC_GPIO_AD_32_LPUART10_TX
IOMUXC_GPIO_AD_33_LPI2C5_SDA
IOMUXC_GPIO_AD_33_USBPHY1_OTG_ID
IOMUXC_GPIO_AD_33_XBAR1_XBAR_INOUT17
IOMUXC_GPIO_AD_33_SINC2_EMBIT03
IOMUXC_GPIO_AD_33_USDHC1_WP
IOMUXC_GPIO_AD_33_GPIO5_IO01
IOMUXC_GPIO_AD_33_KPP_COL01
IOMUXC_GPIO_AD_33_NETC_TMR_TRIG2
IOMUXC_GPIO_AD_33_LPUART10_RX
IOMUXC_GPIO_AD_34_I3C2_SCL
IOMUXC_GPIO_AD_34_USB_OTG1_PWR
IOMUXC_GPIO_AD_34_XBAR1_XBAR_INOUT18
IOMUXC_GPIO_AD_34_SINC_FILTER_GLUE2_BREAK
IOMUXC_GPIO_AD_34_USDHC1_VSELECT
IOMUXC_GPIO_AD_34_GPIO5_IO02
IOMUXC_GPIO_AD_34_NETC_TMR_ALARM1
IOMUXC_GPIO_AD_34_LPUART10_CTS_B
IOMUXC_GPIO_AD_35_I3C2_SDA
IOMUXC_GPIO_AD_35_USB_OTG1_OC
IOMUXC_GPIO_AD_35_XBAR1_XBAR_INOUT19
IOMUXC_GPIO_AD_35_SINC2_MOD_CLK0
IOMUXC_GPIO_AD_35_USDHC1_RESET_B
IOMUXC_GPIO_AD_35_GPIO5_IO03
IOMUXC_GPIO_AD_35_NETC_TMR_ALARM2
IOMUXC_GPIO_AD_35_LPUART10_RTS_B
IOMUXC_GPIO_SD_B1_00_USDHC1_CMD
IOMUXC_GPIO_SD_B1_00_SINC1_EMCLK02

IOMUXC_GPIO_SD_B1_00_XBAR1_XBAR_INOUT20
IOMUXC_GPIO_SD_B1_00_LPTMR2_ALT1
IOMUXC_GPIO_SD_B1_00_XSPI_SLV_CS
IOMUXC_GPIO_SD_B1_00_GPIO5_IO04
IOMUXC_GPIO_SD_B1_00_LPSP13_PCS0
IOMUXC_GPIO_SD_B1_00_KPP_ROW07
IOMUXC_GPIO_SD_B1_00_CCM_CLKO1
IOMUXC_GPIO_SD_B1_01_USDHC1_CLK
IOMUXC_GPIO_SD_B1_01_SINC1_EMBIT02
IOMUXC_GPIO_SD_B1_01_XBAR1_XBAR_INOUT21
IOMUXC_GPIO_SD_B1_01_LPTMR2_ALT2
IOMUXC_GPIO_SD_B1_01_XSPI_SLV_CLK
IOMUXC_GPIO_SD_B1_01_GPIO5_IO05
IOMUXC_GPIO_SD_B1_01_LPSP13_SCK
IOMUXC_GPIO_SD_B1_01_KPP_COL07
IOMUXC_GPIO_SD_B1_01_CCM_CLKO2
IOMUXC_GPIO_SD_B1_02_ECAT_RESET_OUT
IOMUXC_GPIO_SD_B1_02_USDHC1_DATA0
IOMUXC_GPIO_SD_B1_02_SINC1_EMCLK03
IOMUXC_GPIO_SD_B1_02_XBAR1_XBAR_INOUT22
IOMUXC_GPIO_SD_B1_02_LPTMR2_ALT3
IOMUXC_GPIO_SD_B1_02_XSPI_SLV_DATA04
IOMUXC_GPIO_SD_B1_02_GPIO5_IO06
IOMUXC_GPIO_SD_B1_02_LPSP13_SDO
IOMUXC_GPIO_SD_B1_02_KPP_ROW06
IOMUXC_GPIO_SD_B1_02_FLEXSPI1_BUS2BIT_A_SS1_B
IOMUXC_GPIO_SD_B1_03_USDHC1_DATA1
IOMUXC_GPIO_SD_B1_03_SINC1_EMBIT03
IOMUXC_GPIO_SD_B1_03_XBAR1_XBAR_INOUT23
IOMUXC_GPIO_SD_B1_03_LPTMR3_ALT1
IOMUXC_GPIO_SD_B1_03_XSPI_SLV_DATA05
IOMUXC_GPIO_SD_B1_03_GPIO5_IO07
IOMUXC_GPIO_SD_B1_03_LPSP13_SDI

IOMUXC_GPIO_SD_B1_03_KPP_COL06
IOMUXC_GPIO_SD_B1_03_FLEXSPI1_BUS2BIT_B_SS1_B
IOMUXC_GPIO_SD_B1_04_USDHC1_DATA2
IOMUXC_GPIO_SD_B1_04_SINC_FILTER_GLUE1_BREAK
IOMUXC_GPIO_SD_B1_04_SINC2_EMCLK02
IOMUXC_GPIO_SD_B1_04_LPTMR3_ALT2
IOMUXC_GPIO_SD_B1_04_XSPI_SLV_DATA06
IOMUXC_GPIO_SD_B1_04_GPIO5_IO08
IOMUXC_GPIO_SD_B1_04_LPSPI3_PCS1
IOMUXC_GPIO_SD_B1_04_FLEXSPI1_BUS2BIT_B_SS0_B
IOMUXC_GPIO_SD_B1_04_FLEXSPI1_BUS2BIT_A_SS1_B
IOMUXC_GPIO_SD_B1_05_USDHC1_DATA3
IOMUXC_GPIO_SD_B1_05_SINC2_EMBIT02
IOMUXC_GPIO_SD_B1_05_LPTMR3_ALT3
IOMUXC_GPIO_SD_B1_05_XSPI_SLV_DATA07
IOMUXC_GPIO_SD_B1_05_GPIO5_IO09
IOMUXC_GPIO_SD_B1_05_LPSPI3_PCS2
IOMUXC_GPIO_SD_B1_05_FLEXSPI1_BUS2BIT_B_SS0_B
IOMUXC_GPIO_SD_B2_00_MIC_BITSTREAM00
IOMUXC_GPIO_SD_B2_00_USDHC2_DATA3
IOMUXC_GPIO_SD_B2_00_FLEXSPI1_BUS2BIT_B_DATA04
IOMUXC_GPIO_SD_B2_00_XSPI_SLV_DATA04
IOMUXC_GPIO_SD_B2_00_XBAR1_XBAR_INOUT17
IOMUXC_GPIO_SD_B2_00_KPP_ROW01
IOMUXC_GPIO_SD_B2_00_GPIO5_IO10
IOMUXC_GPIO_SD_B2_00_LPSPI3_PCS3
IOMUXC_GPIO_SD_B2_00_NETC_1588_CLK
IOMUXC_GPIO_SD_B2_00_LPUART8_TX
IOMUXC_GPIO_SD_B2_01_USDHC2_DATA2
IOMUXC_GPIO_SD_B2_01_FLEXSPI1_BUS2BIT_B_DATA05
IOMUXC_GPIO_SD_B2_01_XSPI_SLV_DATA05
IOMUXC_GPIO_SD_B2_01_QTIMER6_TIMER0
IOMUXC_GPIO_SD_B2_01_KPP_COL01

IOMUXC_GPIO_SD_B2_01_GPIO5_IO11
IOMUXC_GPIO_SD_B2_01_NETC_TMR_GCLK
IOMUXC_GPIO_SD_B2_01_LPUART8_RX
IOMUXC_GPIO_SD_B2_01_MIC_BITSTREAM01
IOMUXC_GPIO_SD_B2_02_MIC_BITSTREAM02
IOMUXC_GPIO_SD_B2_02_USDHC2_DATA1
IOMUXC_GPIO_SD_B2_02_FLEXSPI1_BUS2BIT_B_DATA06
IOMUXC_GPIO_SD_B2_02_XSPI_SLV_DATA06
IOMUXC_GPIO_SD_B2_02_QTIMER6_TIMER1
IOMUXC_GPIO_SD_B2_02_KPP_ROW00
IOMUXC_GPIO_SD_B2_02_GPIO5_IO12
IOMUXC_GPIO_SD_B2_02_NETC_TMR_ALARM1
IOMUXC_GPIO_SD_B2_02_LPUART8_CTS_B
IOMUXC_GPIO_SD_B2_03_MIC_BITSTREAM03
IOMUXC_GPIO_SD_B2_03_USDHC2_DATA0
IOMUXC_GPIO_SD_B2_03_FLEXSPI1_BUS2BIT_B_DATA07
IOMUXC_GPIO_SD_B2_03_XSPI_SLV_DATA07
IOMUXC_GPIO_SD_B2_03_QTIMER6_TIMER2
IOMUXC_GPIO_SD_B2_03_KPP_COL00
IOMUXC_GPIO_SD_B2_03_GPIO5_IO13
IOMUXC_GPIO_SD_B2_03_NETC_TMR_ALARM2
IOMUXC_GPIO_SD_B2_03_LPUART8_RTS_B
IOMUXC_GPIO_SD_B2_04_USDHC2_CLK
IOMUXC_GPIO_SD_B2_04_FLEXSPI1_BUS2BIT_B_SS1_B
IOMUXC_GPIO_SD_B2_04_QTIMER7_TIMER0
IOMUXC_GPIO_SD_B2_04_KPP_ROW03
IOMUXC_GPIO_SD_B2_04_GPIO5_IO14
IOMUXC_GPIO_SD_B2_04_LPUART5_RI_B
IOMUXC_GPIO_SD_B2_04_NETC_TMR_PP1
IOMUXC_GPIO_SD_B2_04_MIC_CLK
IOMUXC_GPIO_SD_B2_05_USDHC2_CMD
IOMUXC_GPIO_SD_B2_05_FLEXSPI1_BUS2BIT_B_DQS
IOMUXC_GPIO_SD_B2_05_XSPI_SLV_DQS

IOMUXC_GPIO_SD_B2_05_QTIMER7_TIMER1
IOMUXC_GPIO_SD_B2_05_LPSPI4_PCS3
IOMUXC_GPIO_SD_B2_05_GPIO5_IO15
IOMUXC_GPIO_SD_B2_05_LPUART5_DTR_B
IOMUXC_GPIO_SD_B2_05_NETC_TMR_PP2
IOMUXC_GPIO_SD_B2_06_USDHC2_RESET_B
IOMUXC_GPIO_SD_B2_06_FLEXSPI1_BUS2BIT_B_SS0_B
IOMUXC_GPIO_SD_B2_06_XSPI_SLV_CS
IOMUXC_GPIO_SD_B2_06_QTIMER7_TIMER2
IOMUXC_GPIO_SD_B2_06_LPSPI4_PCS2
IOMUXC_GPIO_SD_B2_06_GPIO5_IO16
IOMUXC_GPIO_SD_B2_06_LPUART5_CTS_B
IOMUXC_GPIO_SD_B2_06_NETC_TMR_PP3
IOMUXC_GPIO_SD_B2_07_USDHC2_STROBE
IOMUXC_GPIO_SD_B2_07_FLEXSPI1_BUS2BIT_B_SCLK
IOMUXC_GPIO_SD_B2_07_XSPI_SLV_CLK
IOMUXC_GPIO_SD_B2_07_QTIMER7_TIMER3
IOMUXC_GPIO_SD_B2_07_LPSPI4_PCS1
IOMUXC_GPIO_SD_B2_07_GPIO5_IO17
IOMUXC_GPIO_SD_B2_07_LPUART5_RTS_B
IOMUXC_GPIO_SD_B2_07_NETC_TMR_ALARM1
IOMUXC_GPIO_SD_B2_08_USDHC2_DATA4
IOMUXC_GPIO_SD_B2_08_FLEXSPI1_BUS2BIT_B_DATA00
IOMUXC_GPIO_SD_B2_08_XSPI_SLV_DATA00
IOMUXC_GPIO_SD_B2_08_QTIMER8_TIMER0
IOMUXC_GPIO_SD_B2_08_LPSPI4_SCK
IOMUXC_GPIO_SD_B2_08_GPIO5_IO18
IOMUXC_GPIO_SD_B2_08_LPUART5_TX
IOMUXC_GPIO_SD_B2_08_NETC_TMR_ALARM2
IOMUXC_GPIO_SD_B2_08_NETC_TMR_PP2
IOMUXC_GPIO_SD_B2_09_USDHC2_DATA5
IOMUXC_GPIO_SD_B2_09_FLEXSPI1_BUS2BIT_B_DATA01
IOMUXC_GPIO_SD_B2_09_XSPI_SLV_DATA01

IOMUXC_GPIO_SD_B2_09_QTIMER8_TIMER1
IOMUXC_GPIO_SD_B2_09_LPSPI4_PCS0
IOMUXC_GPIO_SD_B2_09_GPIO5_IO19
IOMUXC_GPIO_SD_B2_09_LPUART5_RX
IOMUXC_GPIO_SD_B2_09_NETC_TMR_PP1
IOMUXC_GPIO_SD_B2_10_NETC_EMDIO
IOMUXC_GPIO_SD_B2_10_ECAT_MDIO
IOMUXC_GPIO_SD_B2_10_USDHC2_DATA6
IOMUXC_GPIO_SD_B2_10_FLEXSPI1_BUS2BIT_B_DATA02
IOMUXC_GPIO_SD_B2_10_XSPI_SLV_DATA02
IOMUXC_GPIO_SD_B2_10_QTIMER8_TIMER2
IOMUXC_GPIO_SD_B2_10_LPSPI4_SDO
IOMUXC_GPIO_SD_B2_10_GPIO5_IO20
IOMUXC_GPIO_SD_B2_10_LPUART5_DCD_B
IOMUXC_GPIO_SD_B2_10_NETC_TMR_TRIG2
IOMUXC_GPIO_SD_B2_10_NETC_TMR_PP3
IOMUXC_GPIO_SD_B2_11_USDHC2_DATA7
IOMUXC_GPIO_SD_B2_11_FLEXSPI1_BUS2BIT_B_DATA03
IOMUXC_GPIO_SD_B2_11_XSPI_SLV_DATA03
IOMUXC_GPIO_SD_B2_11_QTIMER8_TIMER3
IOMUXC_GPIO_SD_B2_11_LPSPI4_SDI
IOMUXC_GPIO_SD_B2_11_GPIO5_IO21
IOMUXC_GPIO_SD_B2_11_LPUART5_DSR_B
IOMUXC_GPIO_SD_B2_11_SFA_ATX_CLK_OUT
IOMUXC_GPIO_SD_B2_11_NETC_TMR_TRIG1
IOMUXC_GPIO_SD_B2_11_NETC_EMDC
IOMUXC_GPIO_SD_B2_11_ECAT_MCLK
IOMUXC_GPIO_SD_B2_12_DUMMY_FLEXSPI1_BUS2BIT_A_DQS
IOMUXC_GPIO_SD_B2_12_DUMMY_FLEXSPI1_BUS2BIT_B_DQS
IOMUXC_GPIO_SD_B2_12_DUMMY_GPIO5_IO22
IOMUXC_GPIO_B1_00_NETC_PINMUX_ETH1_TXD00
IOMUXC_GPIO_B1_00_ADC2_CONV_D00
IOMUXC_GPIO_B1_00_SEMC_CSX01

IOMUXC_GPIO_B1_00_QTIMER1_TIMER0
IOMUXC_GPIO_B1_00_XBAR1_XBAR_INOUT26
IOMUXC_GPIO_B1_00_GPIO6_IO00
IOMUXC_GPIO_B1_00_TPM5_CH00
IOMUXC_GPIO_B1_00_NETC_PINMUX_ETH4_TXD00
IOMUXC_GPIO_B1_01_NETC_PINMUX_ETH1_TXD01
IOMUXC_GPIO_B1_01_ADC2_CONV_D01
IOMUXC_GPIO_B1_01_SEMC_CSX02
IOMUXC_GPIO_B1_01_QTIMER1_TIMER1
IOMUXC_GPIO_B1_01_XBAR1_XBAR_INOUT27
IOMUXC_GPIO_B1_01_GPIO6_IO01
IOMUXC_GPIO_B1_01_TPM5_CH01
IOMUXC_GPIO_B1_01_NETC_PINMUX_ETH4_TXD01
IOMUXC_GPIO_B1_01_SAI4_RX_DATA00
IOMUXC_GPIO_B1_02_NETC_PINMUX_ETH1_TX_EN
IOMUXC_GPIO_B1_02_ADC2_CONV_D02
IOMUXC_GPIO_B1_02_LPI2C6_SCL
IOMUXC_GPIO_B1_02_QTIMER1_TIMER2
IOMUXC_GPIO_B1_02_XBAR1_XBAR_INOUT28
IOMUXC_GPIO_B1_02_GPIO6_IO02
IOMUXC_GPIO_B1_02_TPM5_CH02
IOMUXC_GPIO_B1_02_FLEXSPI1_BUS2BIT_B_SS1_B
IOMUXC_GPIO_B1_02_NETC_PINMUX_ETH4_TX_EN
IOMUXC_GPIO_B1_02_LPUART11_TX
IOMUXC_GPIO_B1_02_SAI4_RX_DATA01
IOMUXC_GPIO_B1_03_NETC_PINMUX_ETH1_TX_CLK
IOMUXC_GPIO_B1_03_ADC2_CONV_D03
IOMUXC_GPIO_B1_03_LPI2C6_SDA
IOMUXC_GPIO_B1_03_QTIMER2_TIMER0
IOMUXC_GPIO_B1_03_XBAR1_XBAR_INOUT29
IOMUXC_GPIO_B1_03_GPIO6_IO03
IOMUXC_GPIO_B1_03_TPM5_CH03
IOMUXC_GPIO_B1_03_FLEXSPI1_BUS2BIT_B_DQS

IOMUXC_GPIO_B1_03_NETC_PINMUX_ETH4_TX_CLK
IOMUXC_GPIO_B1_03_LPUART11_RX
IOMUXC_GPIO_B1_03_SAI4_RX_DATA02
IOMUXC_GPIO_B1_04_NETC_PINMUX_ETH1_RXD00
IOMUXC_GPIO_B1_04_ADC2_CONV_D04
IOMUXC_GPIO_B1_04_LPUART9_RX
IOMUXC_GPIO_B1_04_QTIMER2_TIMER1
IOMUXC_GPIO_B1_04_XBAR1_XBAR_INOUT30
IOMUXC_GPIO_B1_04_GPIO6_IO04
IOMUXC_GPIO_B1_04_TPM5_EXTCLK
IOMUXC_GPIO_B1_04_FLEXSPI1_BUS2BIT_B_SS0_B
IOMUXC_GPIO_B1_04_NETC_PINMUX_ETH4_RXD00
IOMUXC_GPIO_B1_04_SAI4_RX_DATA03
IOMUXC_GPIO_B1_05_NETC_PINMUX_ETH1_RXD01
IOMUXC_GPIO_B1_05_ADC2_CONV_D05
IOMUXC_GPIO_B1_05_LPUART9_CTS_B
IOMUXC_GPIO_B1_05_QTIMER2_TIMER2
IOMUXC_GPIO_B1_05_XBAR1_XBAR_INOUT31
IOMUXC_GPIO_B1_05_GPIO6_IO05
IOMUXC_GPIO_B1_05_TPM6_EXTCLK
IOMUXC_GPIO_B1_05_FLEXSPI1_BUS2BIT_B_SCLK
IOMUXC_GPIO_B1_05_NETC_PINMUX_ETH4_RXD01
IOMUXC_GPIO_B1_05_SAI4_MCLK
IOMUXC_GPIO_B1_06_NETC_PINMUX_ETH1_RX_DV
IOMUXC_GPIO_B1_06_ADC2_CONV_D06
IOMUXC_GPIO_B1_06_LPUART9_TX
IOMUXC_GPIO_B1_06_QTIMER3_TIMER0
IOMUXC_GPIO_B1_06_XBAR1_XBAR_INOUT32
IOMUXC_GPIO_B1_06_GPIO6_IO06
IOMUXC_GPIO_B1_06_TPM6_CH00
IOMUXC_GPIO_B1_06_FLEXSPI1_BUS2BIT_B_DATA07
IOMUXC_GPIO_B1_06_NETC_PINMUX_ETH4_RX_DV
IOMUXC_GPIO_B1_06_SAI4_RX_BCLK

IOMUXC_GPIO_B1_07_NETC_PINMUX_ETH1_TXD02
IOMUXC_GPIO_B1_07_ADC2_CONV_D07
IOMUXC_GPIO_B1_07_LPUART9_RTS_B
IOMUXC_GPIO_B1_07_QTIMER3_TIMER1
IOMUXC_GPIO_B1_07_XBAR1_XBAR_INOUT33
IOMUXC_GPIO_B1_07_GPIO6_IO07
IOMUXC_GPIO_B1_07_TPM6_CH01
IOMUXC_GPIO_B1_07_FLEXSPI1_BUS2BIT_B_DATA06
IOMUXC_GPIO_B1_07_NETC_PINMUX_ETH4_TXD02
IOMUXC_GPIO_B1_07_LPSPI6_SDI
IOMUXC_GPIO_B1_07_SAI4_RX_SYNC
IOMUXC_GPIO_B1_08_SAI4_TX_BCLK
IOMUXC_GPIO_B1_08_NETC_PINMUX_ETH1_TXD03
IOMUXC_GPIO_B1_08_ADC2_CONV_RDY_CLK
IOMUXC_GPIO_B1_08_USDHC1_CD_B
IOMUXC_GPIO_B1_08_QTIMER3_TIMER2
IOMUXC_GPIO_B1_08_XBAR1_XBAR_INOUT36
IOMUXC_GPIO_B1_08_GPIO6_IO08
IOMUXC_GPIO_B1_08_TPM6_CH02
IOMUXC_GPIO_B1_08_FLEXSPI1_BUS2BIT_B_DATA05
IOMUXC_GPIO_B1_08_NETC_PINMUX_ETH4_TXD03
IOMUXC_GPIO_B1_08_LPSPI6_SDO
IOMUXC_GPIO_B1_09_NETC_PINMUX_ETH1_RXD02
IOMUXC_GPIO_B1_09_USDHC1_WP
IOMUXC_GPIO_B1_09_QTIMER4_TIMER0
IOMUXC_GPIO_B1_09_XBAR1_XBAR_INOUT37
IOMUXC_GPIO_B1_09_GPIO6_IO09
IOMUXC_GPIO_B1_09_TPM6_CH03
IOMUXC_GPIO_B1_09_FLEXSPI1_BUS2BIT_B_DATA04
IOMUXC_GPIO_B1_09_NETC_PINMUX_ETH4_RXD02
IOMUXC_GPIO_B1_09_LPSPI6_PCS1
IOMUXC_GPIO_B1_09_SAI4_TX_SYNC
IOMUXC_GPIO_B1_10_NETC_PINMUX_ETH1_RXD03

IOMUXC_GPIO_B1_10_USDHC1_RESET_B
IOMUXC_GPIO_B1_10_QTIMER4_TIMER1
IOMUXC_GPIO_B1_10_XBAR1_XBAR_INOUT34
IOMUXC_GPIO_B1_10_GPIO6_IO10
IOMUXC_GPIO_B1_10_FLEXSPI1_BUS2BIT_B_DATA03
IOMUXC_GPIO_B1_10_NETC_PINMUX_ETH4_RXD03
IOMUXC_GPIO_B1_10_LPSPI6_PCS2
IOMUXC_GPIO_B1_10_SAI4_TX_DATA00
IOMUXC_GPIO_B1_11_NETC_PINMUX_ETH1_RX_CLK
IOMUXC_GPIO_B1_11_QTIMER4_TIMER2
IOMUXC_GPIO_B1_11_XBAR1_XBAR_INOUT35
IOMUXC_GPIO_B1_11_GPIO6_IO11
IOMUXC_GPIO_B1_11_FLEXSPI1_BUS2BIT_B_DATA02
IOMUXC_GPIO_B1_11_NETC_PINMUX_ETH4_RX_CLK
IOMUXC_GPIO_B1_11_LPSPI6_PCS3
IOMUXC_GPIO_B1_11_SAI4_TX_DATA01
IOMUXC_GPIO_B1_12_SAI4_TX_DATA02
IOMUXC_GPIO_B1_12_NETC_PINMUX_ETH1_RX_ER
IOMUXC_GPIO_B1_12_NETC_EMDIO
IOMUXC_GPIO_B1_12_GPIO6_IO12
IOMUXC_GPIO_B1_12_FLEXSPI1_BUS2BIT_B_DATA01
IOMUXC_GPIO_B1_12_NETC_PINMUX_ETH4_RX_ER
IOMUXC_GPIO_B1_12_LPSPI6_PCS0
IOMUXC_GPIO_B1_13_NETC_PINMUX_ETH1_TX_ER
IOMUXC_GPIO_B1_13_NETC_EMDC
IOMUXC_GPIO_B1_13_USDHC1_VSELECT
IOMUXC_GPIO_B1_13_CCM_ENET_REF_CLK_25M
IOMUXC_GPIO_B1_13_GPIO6_IO13
IOMUXC_GPIO_B1_13_FLEXSPI1_BUS2BIT_B_DATA00
IOMUXC_GPIO_B1_13_NETC_PINMUX_ETH4_TX_ER
IOMUXC_GPIO_B1_13_LPSPI6_SCK
IOMUXC_GPIO_B1_13_SAI4_TX_DATA03
IOMUXC_GPIO_B2_00_NETC_ETH2_SLV_MDIO

IOMUXC_GPIO_B2_00_ECAT_CLK_ECAT_CLK25
IOMUXC_GPIO_B2_00_NETC_ETH1_CRS
IOMUXC_GPIO_B2_00_SEMC_CSX03
IOMUXC_GPIO_B2_00_LPIT3_TRIGGER00
IOMUXC_GPIO_B2_00_SAI4_MCLK
IOMUXC_GPIO_B2_00_GPIO6_IO14
IOMUXC_GPIO_B2_00_NETC_ETH4_CRS
IOMUXC_GPIO_B2_00_LPSPI6_SDI
IOMUXC_GPIO_B2_01_NETC_ETH2_SLV_MDC
IOMUXC_GPIO_B2_01_NETC_PINMUX_ETH2_RX_ER
IOMUXC_GPIO_B2_01_ECAT_RX_ER_1
IOMUXC_GPIO_B2_01_NETC_ETH1_COL
IOMUXC_GPIO_B2_01_LPIT3_TRIGGER01
IOMUXC_GPIO_B2_01_SAI4_TX_BCLK
IOMUXC_GPIO_B2_01_GPIO6_IO15
IOMUXC_GPIO_B2_01_FLEXSPI1_BUS2BIT_A_SS1_B
IOMUXC_GPIO_B2_01_NETC_ETH4_COL
IOMUXC_GPIO_B2_01_LPSPI6_SDO
IOMUXC_GPIO_B2_02_EWM_EWM_OUT_B
IOMUXC_GPIO_B2_02_NETC_PINMUX_ETH2_RXD02
IOMUXC_GPIO_B2_02_ECAT_RX_DATA2_1
IOMUXC_GPIO_B2_02_LPIT3_TRIGGER02
IOMUXC_GPIO_B2_02_NETC_EMDIO
IOMUXC_GPIO_B2_02_SAI4_TX_SYNC
IOMUXC_GPIO_B2_02_GPIO6_IO16
IOMUXC_GPIO_B2_02_FLEXSPI1_BUS2BIT_B_SCLK
IOMUXC_GPIO_B2_02_CCM_ENET_REF_CLK_25M
IOMUXC_GPIO_B2_03_XSPI_SLV_DATA04
IOMUXC_GPIO_B2_03_NETC_PINMUX_ETH2_RXD03
IOMUXC_GPIO_B2_03_ECAT_RX_DATA3_1
IOMUXC_GPIO_B2_03_LPIT3_TRIGGER03
IOMUXC_GPIO_B2_03_NETC_EMDC
IOMUXC_GPIO_B2_03_SAI4_TX_DATA00

IOMUXC_GPIO_B2_03_GPIO6_IO17
IOMUXC_GPIO_B2_03_FLEXSPI1_BUS2BIT_A_DATA04
IOMUXC_GPIO_B2_04_XSPI_SLV_DATA05
IOMUXC_GPIO_B2_04_NETC_PINMUX_ETH2_TXD02
IOMUXC_GPIO_B2_04_ECAT_TX_DATA2_1
IOMUXC_GPIO_B2_04_SINC1_MOD_CLK0
IOMUXC_GPIO_B2_04_SINC2_MOD_CLK0
IOMUXC_GPIO_B2_04_SINC3_MOD_CLK0
IOMUXC_GPIO_B2_04_SAI4_RX_SYNC
IOMUXC_GPIO_B2_04_GPIO6_IO18
IOMUXC_GPIO_B2_04_FLEXSPI1_BUS2BIT_A_DATA05
IOMUXC_GPIO_B2_04_TPM3_EXTCLK
IOMUXC_GPIO_B2_05_XSPI_SLV_DATA06
IOMUXC_GPIO_B2_05_NETC_PINMUX_ETH2_TXD03
IOMUXC_GPIO_B2_05_ECAT_TX_DATA3_1
IOMUXC_GPIO_B2_05_SINC1_MOD_CLK1
IOMUXC_GPIO_B2_05_SINC2_MOD_CLK1
IOMUXC_GPIO_B2_05_SINC3_MOD_CLK1
IOMUXC_GPIO_B2_05_SAI4_RX_BCLK
IOMUXC_GPIO_B2_05_GPIO6_IO19
IOMUXC_GPIO_B2_05_MIC_CLK
IOMUXC_GPIO_B2_05_FLEXSPI1_BUS2BIT_A_DATA06
IOMUXC_GPIO_B2_05_TPM3_CH00
IOMUXC_GPIO_B2_06_XSPI_SLV_DATA07
IOMUXC_GPIO_B2_06_NETC_PINMUX_ETH2_TXD00
IOMUXC_GPIO_B2_06_ECAT_TX_DATA0_1
IOMUXC_GPIO_B2_06_SINC1_MOD_CLK2
IOMUXC_GPIO_B2_06_SINC2_MOD_CLK2
IOMUXC_GPIO_B2_06_SINC3_MOD_CLK2
IOMUXC_GPIO_B2_06_LPUART6_DSR_B
IOMUXC_GPIO_B2_06_SAI4_RX_DATA00
IOMUXC_GPIO_B2_06_GPIO6_IO20
IOMUXC_GPIO_B2_06_FLEXSPI1_BUS2BIT_A_DATA07

IOMUXC_GPIO_B2_06_TPM3_CH01
IOMUXC_GPIO_B2_06_LPUART11_TX
IOMUXC_GPIO_B2_07_XSPI_SLV_DQS
IOMUXC_GPIO_B2_07_NETC_PINMUX_ETH2_TXD01
IOMUXC_GPIO_B2_07_ECAT_TX_DATA1_1
IOMUXC_GPIO_B2_07_QTIMER5_TIMER0
IOMUXC_GPIO_B2_07_LPUART6_DCD_B
IOMUXC_GPIO_B2_07_SAI4_TX_DATA01
IOMUXC_GPIO_B2_07_GPIO6_IO21
IOMUXC_GPIO_B2_07_SAI4_RX_DATA01
IOMUXC_GPIO_B2_07_FLEXSPI1_BUS2BIT_A_DQS
IOMUXC_GPIO_B2_07_TPM3_CH02
IOMUXC_GPIO_B2_07_LPUART11_RX
IOMUXC_GPIO_B2_08_XSPI_SLV_CLK
IOMUXC_GPIO_B2_08_NETC_PINMUX_ETH2_TX_EN
IOMUXC_GPIO_B2_08_ECAT_TX_EN_1
IOMUXC_GPIO_B2_08_QTIMER5_TIMER1
IOMUXC_GPIO_B2_08_SINC2_EMCLK02
IOMUXC_GPIO_B2_08_LPUART6_RI_B
IOMUXC_GPIO_B2_08_GPIO6_IO22
IOMUXC_GPIO_B2_08_LPI2C6_SCL
IOMUXC_GPIO_B2_08_FLEXSPI1_BUS2BIT_A_SCLK
IOMUXC_GPIO_B2_08_TPM3_CH03
IOMUXC_GPIO_B2_08_SPDIF_IN
IOMUXC_GPIO_B2_09_XSPI_SLV_CS
IOMUXC_GPIO_B2_09_NETC_PINMUX_ETH2_TX_CLK
IOMUXC_GPIO_B2_09_ECAT_TX_CLK_1
IOMUXC_GPIO_B2_09_QTIMER5_TIMER2
IOMUXC_GPIO_B2_09_SINC2_EMBIT02
IOMUXC_GPIO_B2_09_LPUART6_DTR_B
IOMUXC_GPIO_B2_09_GPIO6_IO23
IOMUXC_GPIO_B2_09_LPI2C6_SDA
IOMUXC_GPIO_B2_09_FLEXSPI1_BUS2BIT_A_SS0_B

IOMUXC_GPIO_B2_09_TPM4_EXTCLK
IOMUXC_GPIO_B2_09_SPDIF_OUT
IOMUXC_GPIO_B2_10_XSPI_SLV_DATA00
IOMUXC_GPIO_B2_10_NETC_PINMUX_ETH2_RXD00
IOMUXC_GPIO_B2_10_ECAT_RX_DATA0_1
IOMUXC_GPIO_B2_10_MIC_BITSTREAM00
IOMUXC_GPIO_B2_10_SINC2_EMCLK03
IOMUXC_GPIO_B2_10_CAN3_TX
IOMUXC_GPIO_B2_10_LPUART8_CTS_B
IOMUXC_GPIO_B2_10_LPUART6_TX
IOMUXC_GPIO_B2_10_GPIO6_IO24
IOMUXC_GPIO_B2_10_LPI2C4_SCL
IOMUXC_GPIO_B2_10_FLEXSPI1_BUS2BIT_A_DATA00
IOMUXC_GPIO_B2_10_TPM4_CH00
IOMUXC_GPIO_B2_10_LPSPI4_SCK
IOMUXC_GPIO_B2_11_XSPI_SLV_DATA01
IOMUXC_GPIO_B2_11_NETC_PINMUX_ETH2_RXD01
IOMUXC_GPIO_B2_11_ECAT_RX_DATA1_1
IOMUXC_GPIO_B2_11_MIC_BITSTREAM01
IOMUXC_GPIO_B2_11_SINC2_EMBIT03
IOMUXC_GPIO_B2_11_CAN3_RX
IOMUXC_GPIO_B2_11_LPUART8_RTS_B
IOMUXC_GPIO_B2_11_LPUART6_RX
IOMUXC_GPIO_B2_11_GPIO6_IO25
IOMUXC_GPIO_B2_11_LPI2C4_SDA
IOMUXC_GPIO_B2_11_FLEXSPI1_BUS2BIT_A_DATA01
IOMUXC_GPIO_B2_11_TPM4_CH01
IOMUXC_GPIO_B2_11_LPSPI4_SDI
IOMUXC_GPIO_B2_12_MIC_BITSTREAM02
IOMUXC_GPIO_B2_12_SINC_FILTER_GLUE2_BREAK
IOMUXC_GPIO_B2_12_LPUART8_TX
IOMUXC_GPIO_B2_12_LPUART6_CTS_B
IOMUXC_GPIO_B2_12_GPIO6_IO26

IOMUXC_GPIO_B2_12_CAN3_TX
IOMUXC_GPIO_B2_12_FLEXSPI1_BUS2BIT_A_DATA02
IOMUXC_GPIO_B2_12_TPM4_CH02
IOMUXC_GPIO_B2_12_LPSPI4_SDO
IOMUXC_GPIO_B2_12_XSPI_SLV_DATA02
IOMUXC_GPIO_B2_12_NETC_PINMUX_ETH2_RX_DV
IOMUXC_GPIO_B2_12_ECAT_RX_DV_1
IOMUXC_GPIO_B2_13_MIC_BITSTREAM03
IOMUXC_GPIO_B2_13_SINC2_EMCLK00
IOMUXC_GPIO_B2_13_LPUART8_RX
IOMUXC_GPIO_B2_13_LPUART6_RTS_B
IOMUXC_GPIO_B2_13_GPIO6_IO27
IOMUXC_GPIO_B2_13_CAN3_RX
IOMUXC_GPIO_B2_13_FLEXSPI1_BUS2BIT_A_DATA03
IOMUXC_GPIO_B2_13_TPM4_CH03
IOMUXC_GPIO_B2_13_LPSPI4_PCS0
IOMUXC_GPIO_B2_13_XSPI_SLV_DATA03
IOMUXC_GPIO_B2_13_NETC_PINMUX_ETH2_RX_CLK
IOMUXC_GPIO_B2_13_ECAT_RX_CLK_1
IOMUXC_GPIO_AON_00_SRC_BOOT_MODE00
IOMUXC_GPIO_AON_00_CAN1_TX
IOMUXC_GPIO_AON_00_LPTMR1_ALT1
IOMUXC_GPIO_AON_00_GPIO1_IO00
IOMUXC_GPIO_AON_00_LPUART2_TX
IOMUXC_GPIO_AON_00_TPM1_EXTCLK
IOMUXC_GPIO_AON_01_SRC_BOOT_MODE01
IOMUXC_GPIO_AON_01_CAN1_RX
IOMUXC_GPIO_AON_01_LPTMR1_ALT2
IOMUXC_GPIO_AON_01_GPIO1_IO01
IOMUXC_GPIO_AON_01_LPUART2_RX
IOMUXC_GPIO_AON_01_TPM1_CH00
IOMUXC_GPIO_AON_02_SRC_BOOT_MODE02
IOMUXC_GPIO_AON_02_CAN3_TX

IOMUXC_GPIO_AON_02_LPSPI2_PCS3
IOMUXC_GPIO_AON_02_LPSPI2_SDO
IOMUXC_GPIO_AON_02_LPTMR1_ALT3
IOMUXC_GPIO_AON_02_GPIO1_IO02
IOMUXC_GPIO_AON_02_LPUART2_RTS_B
IOMUXC_GPIO_AON_02_TPM1_CH01
IOMUXC_GPIO_AON_02_ECAT_CLK_ECAT_CLK25
IOMUXC_GPIO_AON_03_CAN3_RX
IOMUXC_GPIO_AON_03_LPSPI1_PCS1
IOMUXC_GPIO_AON_03_LPSPI2_SDI
IOMUXC_GPIO_AON_03_LPSPI1_PCS3
IOMUXC_GPIO_AON_03_GPIO1_IO03
IOMUXC_GPIO_AON_03_LPUART2_CTS_B
IOMUXC_GPIO_AON_03_TPM1_CH02
IOMUXC_GPIO_AON_03_ECAT_LED_STATE_RUN
IOMUXC_GPIO_AON_04_ECAT_LED_RUN
IOMUXC_GPIO_AON_04_LPSPI1_SCK
IOMUXC_GPIO_AON_04_SAI1_TX_DATA00
IOMUXC_GPIO_AON_04_SAI1_RX_DATA01
IOMUXC_GPIO_AON_04_GPIO1_IO04
IOMUXC_GPIO_AON_04_LPUART7_CTS_B
IOMUXC_GPIO_AON_04_TPM1_CH03
IOMUXC_GPIO_AON_05_LPSPI1_PCS0
IOMUXC_GPIO_AON_05_SAI1_TX_SYNC
IOMUXC_GPIO_AON_05_GPIO1_IO05
IOMUXC_GPIO_AON_05_LPUART7_RTS_B
IOMUXC_GPIO_AON_05_NMI_GLUE_NMI
IOMUXC_GPIO_AON_05_ECAT_LED_ERR
IOMUXC_GPIO_AON_06_LPSPI1_SDO
IOMUXC_GPIO_AON_06_I3C1_PUR
IOMUXC_GPIO_AON_06_SAI1_TX_BCLK
IOMUXC_GPIO_AON_06_LPI2C1_SDA
IOMUXC_GPIO_AON_06_GPIO1_IO06

IOMUXC_GPIO_AON_06_CAN1_TX
IOMUXC_GPIO_AON_06_ECAT_SDA
IOMUXC_GPIO_AON_07_ECAT_SCL
IOMUXC_GPIO_AON_07_LPSPI1_SDI
IOMUXC_GPIO_AON_07_SAI1_MCLK
IOMUXC_GPIO_AON_07_LPI2C1_SCL
IOMUXC_GPIO_AON_07_GPIO1_IO07
IOMUXC_GPIO_AON_07_CAN1_RX
IOMUXC_GPIO_AON_08_LPUART1_TX
IOMUXC_GPIO_AON_08_S400_TX
IOMUXC_GPIO_AON_08_SAI1_RX_DATA00
IOMUXC_GPIO_AON_08_SAI1_TX_DATA01
IOMUXC_GPIO_AON_08_GPIO1_IO08
IOMUXC_GPIO_AON_08_LPI2C1_SDA
IOMUXC_GPIO_AON_08_LPSPI1_PCS1
IOMUXC_GPIO_AON_08_ECAT_LINK_ACT00
IOMUXC_GPIO_AON_09_LPUART1_RX
IOMUXC_GPIO_AON_09_S400_RX
IOMUXC_GPIO_AON_09_SAI1_RX_BCLK
IOMUXC_GPIO_AON_09_LPIT1_TRIGGER00
IOMUXC_GPIO_AON_09_GPIO1_IO09
IOMUXC_GPIO_AON_09_LPI2C1_SCL
IOMUXC_GPIO_AON_09_LPSPI1_PCS2
IOMUXC_GPIO_AON_09_ECAT_LINK_ACT01
IOMUXC_GPIO_AON_10_JTAG_MUX_TRSTB
IOMUXC_GPIO_AON_10_LPSPI2_PCS0
IOMUXC_GPIO_AON_10_SAI1_RX_SYNC
IOMUXC_GPIO_AON_10_LPIT1_TRIGGER01
IOMUXC_GPIO_AON_10_TPM2_EXTCLK
IOMUXC_GPIO_AON_10_GPIO1_IO10
IOMUXC_GPIO_AON_10_LPI2C1_SCLS
IOMUXC_GPIO_AON_11_JTAG_MUX_TDO
IOMUXC_GPIO_AON_11_LPUART1_CTS_B

IOMUXC_GPIO_AON_11_LPIT1_TRIGGER02
IOMUXC_GPIO_AON_11_TPM2_CH00
IOMUXC_GPIO_AON_11_GPIO1_IO11
IOMUXC_GPIO_AON_11_LPI2C1_SDAS
IOMUXC_GPIO_AON_12_JTAG_MUX_TDI
IOMUXC_GPIO_AON_12_LPUART1_RTS_B
IOMUXC_GPIO_AON_12_LPIT1_TRIGGER03
IOMUXC_GPIO_AON_12_TPM2_CH01
IOMUXC_GPIO_AON_12_GPIO1_IO12
IOMUXC_GPIO_AON_12_LPI2C1_HREQ
IOMUXC_GPIO_AON_12_LPSPI1_SCK
IOMUXC_GPIO_AON_13_JTAG_MUX_TCK
IOMUXC_GPIO_AON_13_LPUART12_CTS_B
IOMUXC_GPIO_AON_13_LPUART1_DSR_B
IOMUXC_GPIO_AON_13_TPM2_CH02
IOMUXC_GPIO_AON_13_GPIO1_IO13
IOMUXC_GPIO_AON_13_LPTMR1_ALT1
IOMUXC_GPIO_AON_13_LPSPI1_PCS0
IOMUXC_GPIO_AON_14_JTAG_MUX_TMS
IOMUXC_GPIO_AON_14_LPUART12_RTS_B
IOMUXC_GPIO_AON_14_LPUART1_DCD_B
IOMUXC_GPIO_AON_14_TPM2_CH03
IOMUXC_GPIO_AON_14_GPIO1_IO14
IOMUXC_GPIO_AON_14_LPTMR1_ALT2
IOMUXC_GPIO_AON_14_LPSPI1_SDO
IOMUXC_GPIO_AON_15_FLEXSPI2_BUS2BIT_B_DATA03
IOMUXC_GPIO_AON_15_LPSPI2_PCS1
IOMUXC_GPIO_AON_15_LPUART12_TX
IOMUXC_GPIO_AON_15_LPUART1_RI_B
IOMUXC_GPIO_AON_15_LPI2C2_SDA
IOMUXC_GPIO_AON_15_GPIO1_IO15
IOMUXC_GPIO_AON_15_LPTMR1_ALT3
IOMUXC_GPIO_AON_15_LPSPI1_SDI

IOMUXC_GPIO_AON_15_I3C1_SDA
IOMUXC_GPIO_AON_16_FLEXSPI2_BUS2BIT_B_DATA02
IOMUXC_GPIO_AON_16_LPSPI2_PCS0
IOMUXC_GPIO_AON_16_LPUART12_RX
IOMUXC_GPIO_AON_16_LPUART1_DTR_B
IOMUXC_GPIO_AON_16_LPI2C2_SCL
IOMUXC_GPIO_AON_16_GPIO1_IO16
IOMUXC_GPIO_AON_16_CAN1_TX
IOMUXC_GPIO_AON_16_LPUART7_CTS_B
IOMUXC_GPIO_AON_16_I3C1_SCL
IOMUXC_GPIO_AON_17_FLEXSPI2_BUS2BIT_B_DATA01
IOMUXC_GPIO_AON_17_LPSPI2_SDI
IOMUXC_GPIO_AON_17_LPUART7_TX
IOMUXC_GPIO_AON_17_LPI2C2_SDA
IOMUXC_GPIO_AON_17_LPUART1_DSR_B
IOMUXC_GPIO_AON_17_GPIO1_IO17
IOMUXC_GPIO_AON_17_CAN1_RX
IOMUXC_GPIO_AON_18_FLEXSPI2_BUS2BIT_B_DATA00
IOMUXC_GPIO_AON_18_LPSPI2_SDO
IOMUXC_GPIO_AON_18_LPUART7_RX
IOMUXC_GPIO_AON_18_LPI2C2_SCL
IOMUXC_GPIO_AON_18_LPUART1_DCD_B
IOMUXC_GPIO_AON_18_GPIO1_IO18
IOMUXC_GPIO_AON_18_CAN3_TX
IOMUXC_GPIO_AON_19_FLEXSPI2_BUS2BIT_B_SCLK
IOMUXC_GPIO_AON_19_LPSPI2_SCK
IOMUXC_GPIO_AON_19_FLEXSPI2_BUS2BIT_A_SS1_B
IOMUXC_GPIO_AON_19_LPUART1_CTS_B
IOMUXC_GPIO_AON_19_GPIO1_IO19
IOMUXC_GPIO_AON_19_CAN3_RX
IOMUXC_GPIO_AON_19_LPUART7_RTS_B
IOMUXC_GPIO_AON_19_LPUART12_TX
IOMUXC_GPIO_AON_19_ADC1_CONV_D00

IOMUXC_GPIO_AON_20_FLEXSPI2_BUS2BIT_B_DQS
IOMUXC_GPIO_AON_20_FLEXSPI2_BUS2BIT_A_SS1_B
IOMUXC_GPIO_AON_20_LPI2C1_SDA
IOMUXC_GPIO_AON_20_I3C1_SDA
IOMUXC_GPIO_AON_20_LPUART1_RTS_B
IOMUXC_GPIO_AON_20_GPIO1_IO20
IOMUXC_GPIO_AON_20_LPUART12_RX
IOMUXC_GPIO_AON_20_ADC1_CONV_D01
IOMUXC_GPIO_AON_21_ADC1_CONV_D02
IOMUXC_GPIO_AON_21_FLEXSPI2_BUS2BIT_B_SS0_B
IOMUXC_GPIO_AON_21_LPSPI2_PCS1
IOMUXC_GPIO_AON_21_LPI2C1_SCL
IOMUXC_GPIO_AON_21_I3C1_SCL
IOMUXC_GPIO_AON_21_SAI1_TX_DATA00
IOMUXC_GPIO_AON_21_GPIO1_IO21
IOMUXC_GPIO_AON_21_FLEXSPI2_BUS2BIT_A_DQS
IOMUXC_GPIO_AON_21_SAI1_RX_DATA01
IOMUXC_GPIO_AON_22_CCMSRCGPC_CCMOBS1
IOMUXC_GPIO_AON_22_ADC1_CONV_D03
IOMUXC_GPIO_AON_22_FLEXSPI2_BUS2BIT_A_SS0_B
IOMUXC_GPIO_AON_22_LPI2C2_SDA
IOMUXC_GPIO_AON_22_LPUART7_TX
IOMUXC_GPIO_AON_22_LPUART12_CTS_B
IOMUXC_GPIO_AON_22_SAI1_TX_SYNC
IOMUXC_GPIO_AON_22_GPIO1_IO22
IOMUXC_GPIO_AON_22_LPSPI2_SCK
IOMUXC_GPIO_AON_23_FLEXSPI2_BUS2BIT_A_SCLK
IOMUXC_GPIO_AON_23_LPI2C2_SCL
IOMUXC_GPIO_AON_23_LPUART7_RX
IOMUXC_GPIO_AON_23_LPUART12_RTS_B
IOMUXC_GPIO_AON_23_SAI1_TX_BCLK
IOMUXC_GPIO_AON_23_GPIO1_IO23
IOMUXC_GPIO_AON_23_LPSPI2_SDO

IOMUXC_GPIO_AON_23_CCMSRCGPC_CCMOBS2
IOMUXC_GPIO_AON_23_ADC1_CONV_D04
IOMUXC_GPIO_AON_24_ADC1_CONV_D05
IOMUXC_GPIO_AON_24_FLEXSPI2_BUS2BIT_A_DATA00
IOMUXC_GPIO_AON_24_LPI2C1_SDA
IOMUXC_GPIO_AON_24_LPUART2_RTS_B
IOMUXC_GPIO_AON_24_LPUART7_CTS_B
IOMUXC_GPIO_AON_24_SAI1_MCLK
IOMUXC_GPIO_AON_24_GPIO1_IO24
IOMUXC_GPIO_AON_24_LPSPI2_SDI
IOMUXC_GPIO_AON_25_ADC1_CONV_D06
IOMUXC_GPIO_AON_25_FLEXSPI2_BUS2BIT_A_DATA01
IOMUXC_GPIO_AON_25_LPI2C1_SCL
IOMUXC_GPIO_AON_25_LPUART2_CTS_B
IOMUXC_GPIO_AON_25_LPUART7_RTS_B
IOMUXC_GPIO_AON_25_SAI1_RX_DATA00
IOMUXC_GPIO_AON_25_GPIO1_IO25
IOMUXC_GPIO_AON_25_LPSPI2_PCS0
IOMUXC_GPIO_AON_25_SAI1_TX_DATA01
IOMUXC_GPIO_AON_26_FLEXSPI2_BUS2BIT_A_DATA02
IOMUXC_GPIO_AON_26_LPSPI2_PCS2
IOMUXC_GPIO_AON_26_LPUART2_TX
IOMUXC_GPIO_AON_26_SAI1_RX_BCLK
IOMUXC_GPIO_AON_26_GPIO1_IO26
IOMUXC_GPIO_AON_26_ADC1_CONV_D07
IOMUXC_GPIO_AON_27_ADC1_CONV_RDY_CLK
IOMUXC_GPIO_AON_27_FLEXSPI2_BUS2BIT_A_DATA03
IOMUXC_GPIO_AON_27_LPSPI2_PCS3
IOMUXC_GPIO_AON_27_LPUART2_RX
IOMUXC_GPIO_AON_27_SAI1_RX_SYNC
IOMUXC_GPIO_AON_27_GPIO1_IO27
IOMUXC_GPIO_AON_27_EWM_EWM_OUT_B
IOMUXC_GPIO_AON_28_DUMMY_FLEXSPI2_BUS2BIT_A_DQS

IOMUXC_GPIO_AON_28_DUMMY_FLEXSPI2_BUS2BIT_B_DQS

IOMUXC_GPIO_AON_28_DUMMY_GPIO1_IO28

IOMUXC_GPR_SAIMCLK_LOWBITMASK

IOMUXC_GPR_SAIMCLK_HIGHBITMASK

```
static inline void IOMUXC_SetPinMux(uint32_t muxRegister, uint32_t muxMode, uint32_t
                                inputRegister, uint32_t inputDaisy, uint32_t
                                configRegister, uint32_t inputOnfield)
```

Sets the IOMUXC pin mux mode.

This is an example to set the PTA6 as the lpuart0_tx:

```
IOMUXC_SetPinMux(IOMUXC_PTA6_LPUART0_TX, 0);
```

This is an example to set the PTA0 as GPIOA0:

```
IOMUXC_SetPinMux(IOMUXC_PTA0_GPIOA0, 0);
```

Note: The first five parameters can be filled with the pin function ID macros.

Parameters

- muxRegister – The pin mux register.
- muxMode – The pin mux mode.
- inputRegister – The select input register.
- inputDaisy – The input daisy.
- configRegister – The config register.
- inputOnfield – Software input on field.

```
static inline void IOMUXC_SetPinConfig(uint32_t muxRegister, uint32_t muxMode, uint32_t
                                inputRegister, uint32_t inputDaisy, uint32_t
                                configRegister, uint32_t configValue)
```

Sets the IOMUXC pin configuration.

This is an example to set pin configuration for IOMUXC_PTA3_LPI2C0_SCLS:

```
IOMUXC_SetPinConfig(IOMUXC_PTA3_LPI2C0_SCLS,IOMUXC_SW_PAD_CTL_PAD_PUS_
↪MASK|IOMUXC_SW_PAD_CTL_PAD_PUS(2U))
```

Note: The previous five parameters can be filled with the pin function ID macros.

Parameters

- muxRegister – The pin mux register.
- muxMode – The pin mux mode.
- inputRegister – The select input register.
- inputDaisy – The input daisy.
- configRegister – The config register.

- configValue – The pin config value.

FSL_IOMUXC_DRIVER_VERSION

IOMUXC driver version 2.0.0.

FSL_COMPONENT_ID

2.44 KPP: KeyPad Port Driver

void KPP_Init(KPP_Type *base, *kpp_config_t* *configure)

KPP initialize. This function ungates the KPP clock and initializes KPP. This function must be called before calling any other KPP driver functions.

Parameters

- base – KPP peripheral base address.
- configure – The KPP configuration structure pointer.

void KPP_Deinit(KPP_Type *base)

Deinitializes the KPP module and gates the clock. This function gates the KPP clock. As a result, the KPP module doesn't work after calling this function.

Parameters

- base – KPP peripheral base address.

static inline void KPP_EnableInterrupts(KPP_Type *base, uint16_t mask)

Enable the interrupt.

Parameters

- base – KPP peripheral base address.
- mask – KPP interrupts to enable. This is a logical OR of the enumeration :: *kpp_interrupt_enable_t*.

static inline void KPP_DisableInterrupts(KPP_Type *base, uint16_t mask)

Disable the interrupt.

Parameters

- base – KPP peripheral base address.
- mask – KPP interrupts to disable. This is a logical OR of the enumeration :: *kpp_interrupt_enable_t*.

static inline uint16_t KPP_GetStatusFlag(KPP_Type *base)

Gets the KPP interrupt event status.

Parameters

- base – KPP peripheral base address.

Returns

The status of the KPP. Application can use the enum type in the "kpp_interrupt_enable_t" to get the right status of the related event.

static inline void KPP_ClearStatusFlag(KPP_Type *base, uint16_t mask)

Clears KPP status flag.

Parameters

- base – KPP peripheral base address.

- mask – KPP mask to be cleared. This is a logical OR of the enumeration :: `kpp_interrupt_enable_t`.

static inline void KPP_SetSynchronizeChain(KPP_Type *base, uint16_t mask)

Set KPP synchronization chain.

Parameters

- base – KPP peripheral base address.
- mask – KPP mask to be cleared. This is a logical OR of the enumeration :: `kpp_sync_operation_t`.

void KPP_keyPressScanning(KPP_Type *base, uint8_t *data, uint32_t clockSrc_Hz)

Keypad press scanning.

This function will scanning all columns and rows. so all scanning data will be stored in the data pointer.

Parameters

- base – KPP peripheral base address.
- data – KPP key press scanning data. The data buffer should be prepared with length at least equal to `KPP_KEYPAD_COLUMNNUM_MAX * KPP_KEYPAD_ROWNUM_MAX`. the data pointer is recommended to be a array like `uint8_t data[KPP_KEYPAD_COLUMNNUM_MAX]`. for example the `data[2] = 4`, that means in column 1 row 2 has a key press event.
- clockSrc_Hz – Source clock.

FSL_KPP_DRIVER_VERSION

KPP driver version.

enum _kpp_interrupt_enable

List of interrupts supported by the peripheral. This enumeration uses one-hot encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

Values:

enumerator kKPP_keyDepressInterrupt

Keypad depress interrupt source

enumerator kKPP_keyReleaseInterrupt

Keypad release interrupt source

enum _kpp_sync_operation

Lists of KPP synchronize chain operation.

Values:

enumerator kKPP_ClearKeyDepressSyncChain

Keypad depress interrupt status.

enumerator kKPP_SetKeyReleasesSyncChain

Keypad release interrupt status.

typedef enum _kpp_interrupt_enable kpp_interrupt_enable_t

List of interrupts supported by the peripheral. This enumeration uses one-hot encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

typedef enum _kpp_sync_operation kpp_sync_operation_t

Lists of KPP synchronize chain operation.

```
typedef struct _kpp_config kpp_config_t
```

Lists of KPP status.

```
KPP_KEYPAD_COLUMNNUM_MAX
```

```
KPP_KEYPAD_ROWNUM_MAX
```

```
struct _kpp_config
```

#include <fsl_kpp.h> Lists of KPP status.

Public Members

```
uint8_t activeRow
```

The row number: bit 7 ~ 0 represents the row 7 ~ 0.

```
uint8_t activeColumn
```

The column number: bit 7 ~ 0 represents the column 7 ~ 0.

```
uint16_t interrupt
```

KPP interrupt source. A logical OR of “kpp_interrupt_enable_t”.

2.45 Common Driver

```
FSL_COMMON_DRIVER_VERSION
```

common driver version.

```
DEBUG_CONSOLE_DEVICE_TYPE_NONE
```

No debug console.

```
DEBUG_CONSOLE_DEVICE_TYPE_UART
```

Debug console based on UART.

```
DEBUG_CONSOLE_DEVICE_TYPE_LPUART
```

Debug console based on LPUART.

```
DEBUG_CONSOLE_DEVICE_TYPE_LPSCI
```

Debug console based on LPSCI.

```
DEBUG_CONSOLE_DEVICE_TYPE_USBCDC
```

Debug console based on USBCDC.

```
DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM
```

Debug console based on FLEXCOMM.

```
DEBUG_CONSOLE_DEVICE_TYPE_IUART
```

Debug console based on i.MX UART.

```
DEBUG_CONSOLE_DEVICE_TYPE_VUSART
```

Debug console based on LPC_VUSART.

```
DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART
```

Debug console based on LPC_USART.

```
DEBUG_CONSOLE_DEVICE_TYPE_SWO
```

Debug console based on SWO.

```
DEBUG_CONSOLE_DEVICE_TYPE_QSCI
```

Debug console based on QSCI.

MIN(*a*, *b*)

Computes the minimum of *a* and *b*.

MAX(*a*, *b*)

Computes the maximum of *a* and *b*.

UINT16_MAX

Max value of uint16_t type.

UINT32_MAX

Max value of uint32_t type.

SDK_ATOMIC_LOCAL_ADD(addr, val)

Add value *val* from the variable at address *address*.

SDK_ATOMIC_LOCAL_SUB(addr, val)

Subtract value *val* to the variable at address *address*.

SDK_ATOMIC_LOCAL_SET(addr, bits)

Set the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR(addr, bits)

Clear the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_TOGGLE(addr, bits)

Toggle the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR_AND_SET(addr, clearBits, setBits)

For the variable at address *address*, clear the bits specifiled by *clearBits* and set the bits specifiled by *setBits*.

SDK_ATOMIC_LOCAL_COMPARE_AND_SET(addr, expected, newValue)

For the variable at address *address*, check whether the value equal to *expected*. If value same as *expected* then update *newValue* to address and return **true** , else return **false** .

SDK_ATOMIC_LOCAL_TEST_AND_SET(addr, newValue)

For the variable at address *address*, set as *newValue* value and return old value.

USEC_TO_COUNT(us, clockFreqInHz)

Macro to convert a microsecond period to raw count value

COUNT_TO_USEC(count, clockFreqInHz)

Macro to convert a raw count value to microsecond

MSEC_TO_COUNT(ms, clockFreqInHz)

Macro to convert a millisecond period to raw count value

COUNT_TO_MSEC(count, clockFreqInHz)

Macro to convert a raw count value to millisecond

SDK_ISR_EXIT_BARRIER

SDK_L1DCACHE_ALIGN(var)

Macro to define a variable with L1 d-cache line size alignment

SDK_SIZEALIGN(var, alignbytes)

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value

CACHE_LINE_DATA

enum _status_groups

Status group numbers.

Values:

enumerator kStatusGroup_Generic

Group number for generic status codes.

enumerator kStatusGroup_FLASH

Group number for FLASH status codes.

enumerator kStatusGroup_LPSPI

Group number for LPSPI status codes.

enumerator kStatusGroup_FLEXIO_SPI

Group number for FLEXIO SPI status codes.

enumerator kStatusGroup_DSPI

Group number for DSPI status codes.

enumerator kStatusGroup_FLEXIO_UART

Group number for FLEXIO UART status codes.

enumerator kStatusGroup_FLEXIO_I2C

Group number for FLEXIO I2C status codes.

enumerator kStatusGroup_LPI2C

Group number for LPI2C status codes.

enumerator kStatusGroup_UART

Group number for UART status codes.

enumerator kStatusGroup_I2C

Group number for 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_CODEC
Group number for codec status codes.

enumerator kStatusGroup_ASRC
Group number for codec status ASRC.

enumerator kStatusGroup_OTFAD
Group number for codec status codes.

enumerator kStatusGroup_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 will be fallthrough warning with compiler flag -Wextra or -Wimplicit-fallthrough=n when using armgcc. To suppress this warning, “SUPPRESS_FALL_THROUGH_WARNING();” need to be added at the end of each case section which misses “break;”statement.

MSDK_REG_SECURE_ADDR(x)

Convert the register address to the one used in secure mode.

MSDK_REG_NONSECURE_ADDR(x)

Convert the register address to the one used in non-secure mode.

MSDK_INVALID_IRQ_HANDLER

Invalid IRQ handler address.

2.46 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_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.
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 returns 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

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enum _lpadc_status_flags

Define hardware flags of the module.

Values:

enumerator kLPADC_ResultFIFO0OverflowFlag

Indicates that more data has been written to the Result FIFO 0 than it can hold.

enumerator kLPADC_ResultFIFO0ReadyFlag

Indicates when the number of valid datawords in the result FIFO 0 is greater than the setting watermark level.

enumerator kLPADC_TriggerExceptionFlag

Indicates that a trigger exception event has occurred.

enumerator kLPADC_TriggerCompletionFlag

Indicates that a trigger completion event has occurred.

enumerator kLPADC_CalibrationReadyFlag

Indicates that the calibration process is done.

enumerator kLPADC_ActiveFlag

Indicates that the ADC is in active state.

enumerator kLPADC_ResultFIFOOverflowFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowFlag as instead.

enumerator kLPADC_ResultFIFOReadyFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0ReadyFlag as instead.

enum _lpadc_interrupt_enable

Define interrupt switchers of the module.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_ResultFIFO0OverflowInterruptEnable

Configures ADC to generate overflow interrupt requests when FOF0 flag is asserted.

enumerator kLPADC_FIFO0WatermarkInterruptEnable

Configures ADC to generate watermark interrupt requests when RDY0 flag is asserted.

enumerator kLPADC_ResultFIFOOverflowInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowInterruptEnable as instead.

enumerator kLPADC_FIFOWatermarkInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_FIFO0WatermarkInterruptEnable as instead.

enumerator kLPADC_TriggerExceptionInterruptEnable

Configures ADC to generate trigger exception interrupt.

enumerator kLPADC_Trigger0CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 0 completion.

enumerator kLPADC_Trigger1CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 1 completion.

enumerator kLPADC_Trigger2CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 2 completion.

enumerator kLPADC_Trigger3CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 3 completion.

enumerator kLPADC_Trigger4CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 4 completion.

enumerator kLPADC_Trigger5CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 5 completion.

enumerator kLPADC_Trigger6CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 6 completion.

enumerator kLPADC_Trigger7CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 7 completion.

enumerator kLPADC_Trigger8CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 8 completion.

enumerator kLPADC_Trigger9CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 9 completion.

enumerator kLPADC_Trigger10CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 10 completion.

enumerator kLPADC_Trigger11CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 11 completion.

enumerator kLPADC_Trigger12CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 12 completion.

enumerator kLPADC_Trigger13CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 13 completion.

enumerator kLPADC_Trigger14CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 14 completion.

enumerator kLPADC_Trigger15CompletionInterruptEnable
Configures ADC to generate interrupt when trigger 15 completion.

enum _lpadc_trigger_status_flags

The enumerator of lpadc trigger status flags, including interrupted flags and completed flags.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_Trigger0InterruptedFlag
Trigger 0 is interrupted by a high priority exception.

enumerator kLPADC_Trigger1InterruptedFlag
Trigger 1 is interrupted by a high priority exception.

enumerator kLPADC_Trigger2InterruptedFlag
Trigger 2 is interrupted by a high priority exception.

enumerator kLPADC_Trigger3InterruptedFlag
Trigger 3 is interrupted by a high priority exception.

enumerator kLPADC_Trigger4InterruptedFlag
Trigger 4 is interrupted by a high priority exception.

enumerator kLPADC_Trigger5InterruptedFlag
Trigger 5 is interrupted by a high priority exception.

enumerator kLPADC_Trigger6InterruptedFlag
Trigger 6 is interrupted by a high priority exception.

enumerator kLPADC_Trigger7InterruptedFlag

Trigger 7 is interrupted by a high priority exception.

enumerator kLPADC_Trigger8InterruptedFlag

Trigger 8 is interrupted by a high priority exception.

enumerator kLPADC_Trigger9InterruptedFlag

Trigger 9 is interrupted by a high priority exception.

enumerator kLPADC_Trigger10InterruptedFlag

Trigger 10 is interrupted by a high priority exception.

enumerator kLPADC_Trigger11InterruptedFlag

Trigger 11 is interrupted by a high priority exception.

enumerator kLPADC_Trigger12InterruptedFlag

Trigger 12 is interrupted by a high priority exception.

enumerator kLPADC_Trigger13InterruptedFlag

Trigger 13 is interrupted by a high priority exception.

enumerator kLPADC_Trigger14InterruptedFlag

Trigger 14 is interrupted by a high priority exception.

enumerator kLPADC_Trigger15InterruptedFlag

Trigger 15 is interrupted by a high priority exception.

enumerator kLPADC_Trigger0CompletedFlag

Trigger 0 is completed and trigger 0 has enabled completion interrupts.

enumerator kLPADC_Trigger1CompletedFlag

Trigger 1 is completed and trigger 1 has enabled completion interrupts.

enumerator kLPADC_Trigger2CompletedFlag

Trigger 2 is completed and trigger 2 has enabled completion interrupts.

enumerator kLPADC_Trigger3CompletedFlag

Trigger 3 is completed and trigger 3 has enabled completion interrupts.

enumerator kLPADC_Trigger4CompletedFlag

Trigger 4 is completed and trigger 4 has enabled completion interrupts.

enumerator kLPADC_Trigger5CompletedFlag

Trigger 5 is completed and trigger 5 has enabled completion interrupts.

enumerator kLPADC_Trigger6CompletedFlag

Trigger 6 is completed and trigger 6 has enabled completion interrupts.

enumerator kLPADC_Trigger7CompletedFlag

Trigger 7 is completed and trigger 7 has enabled completion interrupts.

enumerator kLPADC_Trigger8CompletedFlag

Trigger 8 is completed and trigger 8 has enabled completion interrupts.

enumerator kLPADC_Trigger9CompletedFlag

Trigger 9 is completed and trigger 9 has enabled completion interrupts.

enumerator kLPADC_Trigger10CompletedFlag

Trigger 10 is completed and trigger 10 has enabled completion interrupts.

enumerator kLPADC_Trigger11CompletedFlag

Trigger 11 is completed and trigger 11 has enabled completion interrupts.

enumerator kLPADC_Trigger12CompletedFlag

Trigger 12 is completed and trigger 12 has enabled completion interrupts.

enumerator kLPADC_Trigger13CompletedFlag

Trigger 13 is completed and trigger 13 has enabled completion interrupts.

enumerator kLPADC_Trigger14CompletedFlag

Trigger 14 is completed and trigger 14 has enabled completion interrupts.

enumerator kLPADC_Trigger15CompletedFlag

Trigger 15 is completed and trigger 15 has enabled completion interrupts.

enum __lpadc_sample_scale_mode

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

Values:

enumerator kLPADC_SamplePartScale

Use divided input voltage signal. (For scale select, please refer to the reference manual).

enumerator kLPADC_SampleFullScale

Full scale (Factor of 1).

enum __lpadc_sample_channel_mode

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

Values:

enumerator kLPADC_SampleChannelSingleEndSideA

Single-end mode, only A-side channel is converted.

enumerator kLPADC_SampleChannelSingleEndSideB

Single-end mode, only B-side channel is converted.

enumerator kLPADC_SampleChannelDiffBothSideAB

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDiffBothSideBA

Differential mode, the ADC result is (CHnB-CHnA).

enumerator kLPADC_SampleChannelDiffBothSide

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC_SampleChannelDualSingleEndBothSide

Dual-Single-Ended Mode. Both A side and B side channels are converted independently.

enum __lpadc_hardware_average_mode

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

Values:

enumerator kLPADC__HardwareAverageCount1

Single conversion.

enumerator kLPADC__HardwareAverageCount2

2 conversions averaged.

enumerator kLPADC__HardwareAverageCount4

4 conversions averaged.

enumerator kLPADC__HardwareAverageCount8

8 conversions averaged.

enumerator kLPADC__HardwareAverageCount16

16 conversions averaged.

enumerator kLPADC__HardwareAverageCount32

32 conversions averaged.

enumerator kLPADC__HardwareAverageCount64

64 conversions averaged.

enumerator kLPADC__HardwareAverageCount128

128 conversions averaged.

enum _lpadc_sample_time_mode

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

Values:

enumerator kLPADC__SampleTimeADCK3

3 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK5

5 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK7

7 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK11

11 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK19

19 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK35

35 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK67

69 ADCK cycles total sample time.

enumerator kLPADC__SampleTimeADCK131

131 ADCK cycles total sample time.

enum _lpadc_hardware_compare_mode

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

Values:

enumerator kLPADC__HardwareCompareDisabled

Compare disabled.

enumerator kLPADC__HardwareCompareStoreOnTrue

Compare enabled. Store on true.

enumerator kLPADC__HardwareCompareRepeatUntilTrue

Compare enabled. Repeat channel acquisition until true.

enum _lpadc_conversion_resolution_mode

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to lpadc_sample_channel_mode_t

Values:

enumerator kLPADC__ConversionResolutionStandard

Standard resolution. Single-ended 12-bit conversion, Differential 13-bit conversion with 2's complement output.

enumerator kLPADC__ConversionResolutionHigh

High resolution. Single-ended 16-bit conversion; Differential 16-bit conversion with 2's complement output.

enum _lpadc_conversion_average_mode

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

Values:

enumerator kLPADC__ConversionAverage1

Single conversion.

enumerator kLPADC__ConversionAverage2

2 conversions averaged.

enumerator kLPADC__ConversionAverage4

4 conversions averaged.

enumerator kLPADC__ConversionAverage8

8 conversions averaged.

enumerator kLPADC__ConversionAverage16

16 conversions averaged.

enumerator kLPADC__ConversionAverage32

32 conversions averaged.

enumerator kLPADC_ConversionAverage64
64 conversions averaged.

enumerator kLPADC_ConversionAverage128
128 conversions averaged.

enum _lpadc_reference_voltage_mode

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

Values:

enumerator kLPADC_ReferenceVoltageAlt1
Option 1 setting.

enumerator kLPADC_ReferenceVoltageAlt2
Option 2 setting.

enumerator kLPADC_ReferenceVoltageAlt3
Option 3 setting.

enum _lpadc_power_level_mode

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

Values:

enumerator kLPADC_PowerLevelAlt1
Lowest power setting.

enumerator kLPADC_PowerLevelAlt2
Next lowest power setting.

enumerator kLPADC_PowerLevelAlt3
...

enumerator kLPADC_PowerLevelAlt4
Highest power setting.

enum _lpadc_offset_calibration_mode

Define enumeration of offset calibration mode.

Values:

enumerator kLPADC_OffsetCalibration12bitMode
12 bit offset calibration mode.

enumerator kLPADC_OffsetCalibration16bitMode
16 bit offset calibration mode.

enum _lpadc_trigger_priority_policy

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

Values:

enumerator `kLPADC_ConvPreemptImmediatelyNotAutoResumed`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion is not automatically resumed or restarted.

enumerator `kLPADC_ConvPreemptSoftlyNotAutoResumed`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion is not resumed or restarted.

enumerator `kLPADC_ConvPreemptImmediatelyAutoRestarted`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptSoftlyAutoRestarted`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptImmediatelyAutoResumed`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be resumed.

enumerator `kLPADC_ConvPreemptSoftlyAutoResumed`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will be automatically be resumed.

enumerator `kLPADC_TriggerPriorityPreemptImmediately`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityPreemptSoftly`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityExceptionDisabled`

High priority trigger exception disabled.

typedef enum *lpadc_sample_scale_mode* `lpadc_sample_scale_mode_t`

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

`typedef enum _lpadc_sample_channel_mode` `lpadc_sample_channel_mode_t`

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

`typedef enum _lpadc_hardware_average_mode` `lpadc_hardware_average_mode_t`

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

`typedef enum _lpadc_sample_time_mode` `lpadc_sample_time_mode_t`

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

`typedef enum _lpadc_hardware_compare_mode` `lpadc_hardware_compare_mode_t`

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

`typedef enum _lpadc_conversion_resolution_mode` `lpadc_conversion_resolution_mode_t`

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to `lpadc_sample_channel_mode_t`

`typedef enum _lpadc_conversion_average_mode` `lpadc_conversion_average_mode_t`

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

`typedef enum _lpadc_reference_voltage_mode` `lpadc_reference_voltage_source_t`

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

`typedef enum _lpadc_power_level_mode` `lpadc_power_level_mode_t`

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

`typedef enum _lpadc_offset_calibration_mode` `lpadc_offset_calibration_mode_t`

Define enumeration of offset calibration mode.

```
typedef enum lpadc_trigger_priority_policy lpadc_trigger_priority_policy_t
```

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

```
typedef struct lpadc_calibration_value lpadc_calibration_value_t
```

A structure of calibration value.

```
LPADC_CONVERSION_COMPLETE_TIMEOUT
```

Max loops to wait for LPADC conversion complete.

When doing calibration, driver will wait for the completion of conversion. This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

```
LPADC_CALIBRATION_READY_TIMEOUT
```

Max loops to wait for LPADC calibration ready.

Before doing calibration, driver will wait for the calibration ready. This parameter defines how many loops to check the calibration ready. If defined as 0, driver will wait forever until ready.

```
LPADC_GAIN_CAL_READY_TIMEOUT
```

Max loops to wait for LPADC gain calibration GAIN_CAL ready.

Before doing calibration, driver will wait for the gain calibration GAIN_CAL ready. This parameter defines how many loops to check the gain calibration GAIN_CAL ready. If defined as 0, driver will wait forever until ready.

```
LPADC_GET_ACTIVE_COMMAND_STATUS(statusVal)
```

Define the MACRO function to get command status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

```
LPADC_GET_ACTIVE_TRIGGER_STATUE(statusVal)
```

Define the MACRO function to get trigger status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

```
void LPADC_Init(ADC_Type *base, const lpadc_config_t *config)
```

Initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.
- config – Pointer to configuration structure. See “*lpadc_config_t*”.

```
void LPADC_GetDefaultConfig(lpadc_config_t *config)
```

Gets an available pre-defined settings for initial configuration.

This function initializes the converter configuration structure with an available settings. The default values are:

```
config->enableInDozeMode      = true;
config->enableAnalogPreliminary = false;
config->powerUpDelay           = 0x80;
config->referenceVoltageSource  = kLPADC_ReferenceVoltageAlt1;
config->powerLevelMode         = kLPADC_PowerLevelAlt1;
config->triggerPriorityPolicy    = kLPADC_TriggerPriorityPreemptImmediately;
```

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```
config->enableConvPause    = false;
config->convPauseDelay      = 0U;
config->FIFOWatermark       = 0U;
```

Parameters

- config – Pointer to configuration structure.

```
void LPADC_Deinit(ADC_Type *base)
```

De-initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.

```
static inline void LPADC_Enable(ADC_Type *base, bool enable)
```

Switch on/off the LPADC module.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the module.

```
static inline void LPADC_DoResetFIFO(ADC_Type *base)
```

Do reset the conversion FIFO.

Parameters

- base – LPADC peripheral base address.

```
static inline void LPADC_DoResetConfig(ADC_Type *base)
```

Do reset the module's configuration.

Reset all ADC internal logic and registers, except the Control Register (ADCx_CTRL).

Parameters

- base – LPADC peripheral base address.

```
static inline uint32_t LPADC_GetStatusFlags(ADC_Type *base)
```

Get status flags.

Parameters

- base – LPADC peripheral base address.

Returns

status flags' mask. See to `_lpadc_status_flags`.

```
static inline void LPADC_ClearStatusFlags(ADC_Type *base, uint32_t mask)
```

Clear status flags.

Only the flags can be cleared by writing ADCx_STATUS register would be cleared by this API.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for flags to be cleared. See to `_lpadc_status_flags`.

```
static inline uint32_t LPADC_GetTriggerStatusFlags(ADC_Type *base)
```

Get trigger status flags to indicate which trigger sequences have been completed or interrupted by a high priority trigger exception.

Parameters

- base – LPADC peripheral base address.

Returns

The OR'ed value of `_lpadc_trigger_status_flags`.

```
static inline void LPADC_ClearTriggerStatusFlags(ADC_Type *base, uint32_t mask)
```

Clear trigger status flags.

Parameters

- base – LPADC peripheral base address.
- mask – The mask of trigger status flags to be cleared, should be the OR'ed value of `_lpadc_trigger_status_flags`.

```
static inline void LPADC_EnableInterrupts(ADC_Type *base, uint32_t mask)
```

Enable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.

```
static inline void LPADC_DisableInterrupts(ADC_Type *base, uint32_t mask)
```

Disable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.

```
static inline void LPADC_EnableFIFOWatermarkDMA(ADC_Type *base, bool enable)
```

Switch on/off the DMA trigger for FIFO watermark event.

Parameters

- base – LPADC peripheral base address.
- enable – Switcher to the event.

```
static inline uint32_t LPADC_GetConvResultCount(ADC_Type *base)
```

Get the count of result kept in conversion FIFO.

Parameters

- base – LPADC peripheral base address.

Returns

The count of result kept in conversion FIFO.

```
bool LPADC_GetConvResult(ADC_Type *base, lpadc_conv_result_t *result)
```

Get the result in conversion FIFO.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

Returns

Status whether FIFO entry is valid.

```
void LPADC_GetConvResultBlocking(ADC_Type *base, lpadc_conv_result_t *result)
```

Get the result in conversion FIFO using blocking method.

Parameters

- base – LPADC peripheral base address.

- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

```
void LPADC_SetConvTriggerConfig(ADC_Type *base, uint32_t triggerId, const  
                                lpadc_conv_trigger_config_t *config)
```

Configure the conversion trigger source.

Each programmable trigger can launch the conversion command in command buffer.

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- config – Pointer to configuration structure. See to `lpadc_conv_trigger_config_t`.

```
void LPADC_GetDefaultConvTriggerConfig(lpadc_conv_trigger_config_t *config)
```

Gets an available pre-defined settings for trigger's configuration.

This function initializes the trigger's configuration structure with an available settings. The default values are:

```
config->targetCommandId    = 0U;  
config->delayPower         = 0U;  
config->priority           = 0U;  
config->channelAFIFOSelect = 0U;  
config->channelBFIFOSelect = 0U;  
config->enableHardwareTrigger = false;
```

Parameters

- config – Pointer to configuration structure.

```
static inline void LPADC_DoSoftwareTrigger(ADC_Type *base, uint32_t triggerIdMask)
```

Do software trigger to conversion command.

Parameters

- base – LPADC peripheral base address.
- triggerIdMask – Mask value for software trigger indexes, which count from zero.

```
static inline void LPADC_EnableHardwareTriggerCommandSelection(ADC_Type *base, uint32_t  
                                                                triggerId, bool enable)
```

Enable hardware trigger command selection.

This function will use the hardware trigger command from ADC_ETC. The trigger command is then defined by ADC hardware trigger command selection field in ADC_ETC->TRIGx_CHAINy_z_n[CSEL].

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- enable – True to enable or false to disable.

```
void LPADC_SetConvCommandConfig(ADC_Type *base, uint32_t commandId, const  
                                lpadc_conv_command_config_t *config)
```

Configure conversion command.

Note: The number of compare value register on different chips is different, that is mean in some chips, some command buffers do not have the compare functionality.

Parameters

- `base` – LPADC peripheral base address.
- `commandId` – ID for command in command buffer. Typically, the available value range is 1 - 15.
- `config` – Pointer to configuration structure. See to `lpadc_conv_command_config_t`.

`void LPADC_GetDefaultConvCommandConfig(lpadc_conv_command_config_t *config)`

Gets an available pre-defined settings for conversion command's configuration.

This function initializes the conversion command's configuration structure with an available settings. The default values are:

```
config->sampleScaleMode      = kLPADC_SampleFullScale;
config->channelBScaleMode    = kLPADC_SampleFullScale;
config->sampleChannelMode    = kLPADC_SampleChannelSingleEndSideA;
config->channelNumber        = 0U;
config->channelBNumber       = 0U;
config->chainedNextCommandNumber = 0U;
config->enableAutoChannelIncrement = false;
config->loopCount            = 0U;
config->hardwareAverageMode   = kLPADC_HardwareAverageCount1;
config->sampleTimeMode       = kLPADC_SampleTimeADCK3;
config->hardwareCompareMode   = kLPADC_HardwareCompareDisabled;
config->hardwareCompareValueHigh = 0U;
config->hardwareCompareValueLow  = 0U;
config->conversionResolutionMode = kLPADC_ConversionResolutionStandard;
config->enableWaitTrigger      = false;
config->enableChannelB        = false;
```

Parameters

- `config` – Pointer to configuration structure.

`void LPADC_EnableCalibration(ADC_Type *base, bool enable)`

Enable the calibration function.

When CALOFS is set, the ADC is configured to perform a calibration function anytime the ADC executes a conversion. Any channel selected is ignored and the value returned in the RESFIFO is a signed value between -31 and 31. -32 is not a valid and is never a returned value. Software should copy the lower 6-bits of the conversion result stored in the RESFIFO after a completed calibration conversion to the OFSTRIM field. The OFSTRIM field is used in normal operation for offset correction.

Parameters

- `base` – LPADC peripheral base address.
- `enable` – switcher to the calibration function.

`static inline void LPADC_SetOffsetValue(ADC_Type *base, uint32_t value)`

Set proper offset value to trim ADC.

To minimize the offset during normal operation, software should read the conversion result from the RESFIFO calibration operation and write the lower 6 bits to the OFSTRIM register.

Parameters

- base – LPADC peripheral base address.
- value – Setting offset value.

status_t LPADC_DoAutoCalibration(ADC_Type *base)

Do auto calibration.

Calibration function should be executed before using converter in application. It used the software trigger and a dummy conversion, get the offset and write them into the OFSTRIM register. It called some of functional API including: -LPADC_EnableCalibration(...) -LPADC_LPADC_SetOffsetValue(...) -LPADC_SetConvCommandConfig(...) -LPADC_SetConvTriggerConfig(...)

Parameters

- base – LPADC peripheral base address.
- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

static inline void LPADC_EnableOffsetCalibration(ADC_Type *base, bool enable)

Enable the offset calibration function.

Parameters

- base – LPADC peripheral base address.
- enable – switcher to the calibration function.

static inline void LPADC_SetOffsetCalibrationMode(ADC_Type *base,
lpadc_offset_calibration_mode_t mode)

Set offset calibration mode.

Parameters

- base – LPADC peripheral base address.
- mode – set offset calibration mode.see to *lpadc_offset_calibration_mode_t*.

status_t LPADC_DoOffsetCalibration(ADC_Type *base)

Do offset calibration.

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_PrepareAutoCalibration(ADC_Type *base)

Prepare auto calibration, LPADC_FinishAutoCalibration has to be called before using the LPADC. LPADC_DoAutoCalibration has been split in two API to avoid to be stuck too long in the function.

Parameters

- base – LPADC peripheral base address.

status_t LPADC_FinishAutoCalibration(ADC_Type *base)

Finish auto calibration start with LPADC_PrepareAutoCalibration.

Note: This feature is used for LPADC with CTRL[CALOFSMODE].

Parameters

- base – LPADC peripheral base address.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

void LPADC_GetCalibrationValue(ADC_Type *base, *lpadc_calibration_value_t* *ptrCalibrationValue)

Get calibration value into the memory which is defined by invoker.

Note: Please note the ADC will be disabled temporary.

Note: This function should be used after finish calibration.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to *lpadc_calibration_value_t* structure, this memory block should be always powered on even in low power modes.

status_t LPADC_SetCalibrationValue(ADC_Type *base, const *lpadc_calibration_value_t* *ptrCalibrationValue)

Set calibration value into ADC calibration registers.

Note: Please note the ADC will be disabled temporary.

Parameters

- base – LPADC peripheral base address.
- ptrCalibrationValue – Pointer to *lpadc_calibration_value_t* structure which contains ADC's calibration value.

Return values

- kStatus_Success – Successfully configured.
- kStatus_Timeout – Timeout occurs while waiting completion.

FSL_LPADC_DRIVER_VERSION

LPADC driver version 2.9.3.

struct *lpadc_config_t*

#include <fsl_lpadc.h> LPADC global configuration.

This structure would used to keep the settings for initialization.

Public Members

bool enableInternalClock

Enables the internally generated clock source. The clock source is used in clock selection logic at the chip level and is optionally used for the ADC clock source.

bool enableVref1LowVoltage

If voltage reference option1 input is below 1.8V, it should be “true”. If voltage reference option1 input is above 1.8V, it should be “false”.

bool enableInDozeMode

Control system transition to Stop and Wait power modes while ADC is converting. When enabled in Doze mode, immediate entries to Wait or Stop are allowed. When disabled, the ADC will wait for the current averaging iteration/FIFO storage to complete before acknowledging stop or wait mode entry.

lpadc_conversion_average_mode_t conversionAverageMode

Auto-Calibration Averages.

bool enableAnalogPreliminary

ADC analog circuits are pre-enabled and ready to execute conversions without startup delays(at the cost of higher DC current consumption).

uint32_t powerUpDelay

When the analog circuits are not pre-enabled, the ADC analog circuits are only powered while the ADC is active and there is a counted delay defined by this field after an initial trigger transitions the ADC from its Idle state to allow time for the analog circuits to stabilize. The startup delay count of (powerUpDelay * 4) ADCK cycles must result in a longer delay than the analog startup time.

lpadc_reference_voltage_source_t referenceVoltageSource

Selects the voltage reference high used for conversions.

lpadc_power_level_mode_t powerLevelMode

Power Configuration Selection.

lpadc_trigger_priority_policy_t triggerPriorityPolicy

Control how higher priority triggers are handled, see to *lpadc_trigger_priority_policy_t*.

bool enableConvPause

Enables the ADC pausing function. When enabled, a programmable delay is inserted during command execution sequencing between LOOP iterations, between commands in a sequence, and between conversions when command is executing in “Compare Until True” configuration.

uint32_t convPauseDelay

Controls the duration of pausing during command execution sequencing. The pause delay is a count of (convPauseDelay*4) ADCK cycles. Only available when ADC pausing function is enabled. The available value range is in 9-bit.

uint32_t FIFOWatermark

FIFOWatermark is a programmable threshold setting. When the number of datawords stored in the ADC Result FIFO is greater than the value in this field, the ready flag would be asserted to indicate stored data has reached the programmable threshold.

struct lpadc_conv_command_config_t

#include <fsl_lpadc.h> Define structure to keep the configuration for conversion command.

Public Members

lpadc_sample_scale_mode_t sampleScaleMode

Sample scale mode.

lpadc_sample_scale_mode_t channelBScaleMode

Alternate 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.

2.48 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.

2.49 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.

2.50 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.

2.51 LPI2C Slave Driver

```
void LPI2C_SlaveGetDefaultConfig(lpi2c_slave_config_t *slaveConfig)
```

Provides a default configuration for the LPI2C slave peripheral.

This function provides the following default configuration for the LPI2C slave peripheral:

```
slaveConfig->enableSlave      = true;
slaveConfig->address0         = 0U;
slaveConfig->address1         = 0U;
slaveConfig->addressMatchMode = kLPI2C_MatchAddress0;
slaveConfig->filterDozeEnable = true;
slaveConfig->filterEnable     = true;
slaveConfig->enableGeneralCall = false;
slaveConfig->sclStall.enableAck = false;
slaveConfig->sclStall.enableTx  = true;
slaveConfig->sclStall.enableRx  = true;
```

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```

slaveConfig->sclStall.enableAddress    = true;
slaveConfig->ignoreAck                 = false;
slaveConfig->enableReceivedAddressRead = false;
slaveConfig->sdaGlitchFilterWidth_ns   = 0;
slaveConfig->sclGlitchFilterWidth_ns   = 0;
slaveConfig->dataValidDelay_ns         = 0;
slaveConfig->clockHoldTime_ns          = 0;

```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with `LPI2C_SlaveInit()`. Be sure to override at least the *address0* member of the configuration structure with the desired slave address.

Parameters

- `slaveConfig` – **[out]** User provided configuration structure that is set to default values. Refer to `lpi2c_slave_config_t`.

```
void LPI2C_SlaveInit(LPI2C_Type *base, const lpi2c_slave_config_t *slaveConfig, uint32_t
                    sourceClock_Hz)
```

Initializes the LPI2C slave peripheral.

This function enables the peripheral clock and initializes the LPI2C slave peripheral as described by the user provided configuration.

Parameters

- `base` – The LPI2C peripheral base address.
- `slaveConfig` – User provided peripheral configuration. Use `LPI2C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- `sourceClock_Hz` – Frequency in Hertz of the LPI2C functional clock. Used to calculate the filter widths, data valid delay, and clock hold time.

```
void LPI2C_SlaveDeinit(LPI2C_Type *base)
```

Deinitializes the LPI2C slave peripheral.

This function disables the LPI2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- `base` – The LPI2C peripheral base address.

```
static inline void LPI2C_SlaveReset(LPI2C_Type *base)
```

Performs a software reset of the LPI2C slave peripheral.

Parameters

- `base` – The LPI2C peripheral base address.

```
static inline void LPI2C_SlaveEnable(LPI2C_Type *base, bool enable)
```

Enables or disables the LPI2C module as slave.

Parameters

- `base` – The LPI2C peripheral base address.
- `enable` – Pass true to enable or false to disable the specified LPI2C as slave.

```
static inline uint32_t LPI2C_SlaveGetStatusFlags(LPI2C_Type *base)
```

Gets the LPI2C slave status flags.

A bit mask with the state of all LPI2C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_lpi2c_slave_flags`

Parameters

- `base` – The LPI2C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void LPI2C_SlaveClearStatusFlags(LPI2C_Type *base, uint32_t statusMask)
```

Clears the LPI2C status flag state.

The following status register flags can be cleared:

- `kLPI2C_SlaveRepeatedStartDetectFlag`
- `kLPI2C_SlaveStopDetectFlag`
- `kLPI2C_SlaveBitErrFlag`
- `kLPI2C_SlaveFifoErrFlag`

Attempts to clear other flags has no effect.

See also:

`_lpi2c_slave_flags`.

Parameters

- `base` – The LPI2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_lpi2c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `LPI2C_SlaveGetStatusFlags()`.

```
static inline void LPI2C_SlaveEnableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Enables the LPI2C slave interrupt requests.

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

Parameters

- `base` – The LPI2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to enable. See `_lpi2c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline void LPI2C_SlaveDisableInterrupts(LPI2C_Type *base, uint32_t interruptMask)
```

Disables the LPI2C slave interrupt requests.

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

Parameters

- `base` – The LPI2C peripheral base address.
- `interruptMask` – Bit mask of interrupts to disable. See `_lpi2c_slave_flags` for the set of constants that should be OR'd together to form the bit mask.

```
static inline uint32_t LPI2C_SlaveGetEnabledInterrupts(LPI2C_Type *base)
```

Returns the set of currently enabled LPI2C slave interrupt requests.

Parameters

- base – The LPI2C peripheral base address.

Returns

A bitmask composed of `_lpi2c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

```
static inline void LPI2C_SlaveEnableDMA(LPI2C_Type *base, bool enableAddressValid, bool enableRx, bool enableTx)
```

Enables or disables the LPI2C slave peripheral DMA requests.

Parameters

- base – The LPI2C peripheral base address.
- enableAddressValid – Enable flag for the address valid DMA request. Pass true for enable, false for disable. The address valid DMA request is shared with the receive data DMA request.
- enableRx – Enable flag for the receive data DMA request. Pass true for enable, false for disable.
- enableTx – Enable flag for the transmit data DMA request. Pass true for enable, false for disable.

```
static inline bool LPI2C_SlaveGetBusIdleState(LPI2C_Type *base)
```

Returns whether the bus is idle.

Requires the slave mode to be enabled.

Parameters

- base – The LPI2C peripheral base address.

Return values

- true – Bus is busy.
- false – Bus is idle.

```
static inline void LPI2C_SlaveTransmitAck(LPI2C_Type *base, bool ackOrNack)
```

Transmits either an ACK or NAK on the I2C bus in response to a byte from the master.

Use this function to send an ACK or NAK when the `kLPI2C_SlaveTransmitAckFlag` is asserted. This only happens if you enable the `sclStall.enableAck` field of the `lpi2c_slave_config_t` configuration structure used to initialize the slave peripheral.

Parameters

- base – The LPI2C peripheral base address.
- ackOrNack – Pass true for an ACK or false for a NAK.

```
static inline void LPI2C_SlaveEnableAckStall(LPI2C_Type *base, bool enable)
```

Enables or disables ACKSTALL.

When enables ACKSTALL, software can transmit either an ACK or NAK on the I2C bus in response to a byte from the master.

Parameters

- base – The LPI2C peripheral base address.
- enable – True will enable ACKSTALL, false will disable ACKSTALL.

static inline uint32_t LPI2C_SlaveGetReceivedAddress(LPI2C_Type *base)

Returns the slave address sent by the I2C master.

This function should only be called if the kLPI2C_SlaveAddressValidFlag is asserted.

Parameters

- base – The LPI2C peripheral base address.

Returns

The 8-bit address matched by the LPI2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

status_t LPI2C_SlaveSend(LPI2C_Type *base, void *txBuff, size_t txSize, size_t *actualTxSize)

Performs a polling send transfer on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- actualTxSize – **[out]**

Returns

Error or success status returned by API.

status_t LPI2C_SlaveReceive(LPI2C_Type *base, void *rxBuff, size_t rxSize, size_t *actualRxSize)

Performs a polling receive transfer on the I2C bus.

Parameters

- base – The LPI2C peripheral base address.
- rxBuff – The pointer to the data to be transferred.
- rxSize – The length in bytes of the data to be transferred.
- actualRxSize – **[out]**

Returns

Error or success status returned by API.

void LPI2C_SlaveTransferCreateHandle(LPI2C_Type *base, lpi2c_slave_handle_t *handle, lpi2c_slave_transfer_callback_t callback, void *userData)

Creates a new handle for the LPI2C slave non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the LPI2C_SlaveTransferAbort() API shall be called.

Note: The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

- base – The LPI2C peripheral base address.
- handle – **[out]** Pointer to the LPI2C slave driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

```
status_t LPI2C_SlaveTransferNonBlocking(LPI2C_Type *base, lpi2c_slave_handle_t *handle,
                                         uint32_t eventMask)
```

Starts accepting slave transfers.

Call this API after calling I2C_SlaveInit() and LPI2C_SlaveTransferCreateHandle() to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to LPI2C_SlaveTransferCreateHandle(). The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of *lpi2c_slave_transfer_event_t* enumerators for the events you wish to receive. The *kLPI2C_SlaveTransmitEvent* and *kLPI2C_SlaveReceiveEvent* events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the *kLPI2C_SlaveAllEvents* constant is provided as a convenient way to enable all events.

Parameters

- *base* – The LPI2C peripheral base address.
- *handle* – Pointer to *lpi2c_slave_handle_t* structure which stores the transfer state.
- *eventMask* – Bit mask formed by OR'ing together *lpi2c_slave_transfer_event_t* enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and *kLPI2C_SlaveAllEvents* to enable all events.

Return values

- *kStatus_Success* – Slave transfers were successfully started.
- *kStatus_LPI2C_Busy* – Slave transfers have already been started on this handle.

```
status_t LPI2C_SlaveTransferGetCount(LPI2C_Type *base, lpi2c_slave_handle_t *handle, size_t
                                     *count)
```

Gets the slave transfer status during a non-blocking transfer.

Parameters

- *base* – The LPI2C peripheral base address.
- *handle* – Pointer to *i2c_slave_handle_t* structure.
- *count* – **[out]** Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

Return values

- *kStatus_Success* –
- *kStatus_NoTransferInProgress* –

```
void LPI2C_SlaveTransferAbort(LPI2C_Type *base, lpi2c_slave_handle_t *handle)
```

Aborts the slave non-blocking transfers.

Note: This API could be called at any time to stop slave for handling the bus events.

Parameters

- *base* – The LPI2C peripheral base address.

- *handle* – Pointer to `lpi2c_slave_handle_t` structure which stores the transfer state.

`void LPI2C_SlaveTransferHandleIRQ(LPI2C_Type *base, lpi2c_slave_handle_t *handle)`

Reusable routine to handle slave interrupts.

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

Parameters

- *base* – The LPI2C peripheral base address.
- *handle* – Pointer to `lpi2c_slave_handle_t` structure which stores the transfer state.

`enum _lpi2c_slave_flags`

LPI2C slave peripheral flags.

The following status register flags can be cleared:

- `kLPI2C_SlaveRepeatedStartDetectFlag`
- `kLPI2C_SlaveStopDetectFlag`
- `kLPI2C_SlaveBitErrFlag`
- `kLPI2C_SlaveFifoErrFlag`

All flags except `kLPI2C_SlaveBusyFlag` and `kLPI2C_SlaveBusBusyFlag` can be enabled as interrupts.

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

Values:

enumerator `kLPI2C_SlaveTxReadyFlag`

Transmit data flag

enumerator `kLPI2C_SlaveRxReadyFlag`

Receive data flag

enumerator `kLPI2C_SlaveAddressValidFlag`

Address valid flag

enumerator `kLPI2C_SlaveTransmitAckFlag`

Transmit ACK flag

enumerator `kLPI2C_SlaveRepeatedStartDetectFlag`

Repeated start detect flag

enumerator `kLPI2C_SlaveStopDetectFlag`

Stop detect flag

enumerator `kLPI2C_SlaveBitErrFlag`

Bit error flag

enumerator `kLPI2C_SlaveFifoErrFlag`

FIFO error flag

enumerator `kLPI2C_SlaveAddressMatch0Flag`

Address match 0 flag

enumerator kLPI2C_SlaveAddressMatch1Flag

Address match 1 flag

enumerator kLPI2C_SlaveGeneralCallFlag

General call flag

enumerator kLPI2C_SlaveBusyFlag

Master busy flag

enumerator kLPI2C_SlaveBusBusyFlag

Bus busy flag

enumerator kLPI2C_SlaveClearFlags

All flags which are cleared by the driver upon starting a transfer.

enumerator kLPI2C_SlaveIrqFlags

IRQ sources enabled by the non-blocking transactional API.

enumerator kLPI2C_SlaveErrorFlags

Errors to check for.

enum _lpi2c_slave_address_match

LPI2C slave address match options.

Values:

enumerator kLPI2C_MatchAddress0

Match only address 0.

enumerator kLPI2C_MatchAddress0OrAddress1

Match either address 0 or address 1.

enumerator kLPI2C_MatchAddress0ThroughAddress1

Match a range of slave addresses from address 0 through address 1.

enum _lpi2c_slave_transfer_event

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

Values:

enumerator kLPI2C_SlaveAddressMatchEvent

Received the slave address after a start or repeated start.

enumerator kLPI2C_SlaveTransmitEvent

Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kLPI2C_SlaveReceiveEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kLPI2C_SlaveTransmitAckEvent

Callback needs to either transmit an ACK or NACK.

enumerator kLPI2C_SlaveRepeatedStartEvent

A repeated start was detected.

enumerator kLPI2C_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator kLPI2C_SlaveAllEvents

Bit mask of all available events.

typedef enum *_lpi2c_slave_address_match* lpi2c_slave_address_match_t

LPI2C slave address match options.

typedef struct *_lpi2c_slave_config* lpi2c_slave_config_t

Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum *_lpi2c_slave_transfer_event* lpi2c_slave_transfer_event_t

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to LPI2C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

typedef struct *_lpi2c_slave_transfer* lpi2c_slave_transfer_t

LPI2C slave transfer structure.

typedef struct *_lpi2c_slave_handle* lpi2c_slave_handle_t

LPI2C slave handle structure.

typedef void (*lpi2c_slave_transfer_callback_t)(LPI2C_Type *base, *lpi2c_slave_transfer_t* *transfer, void *userData)

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the LPI2C_SlaveSetCallback() function after you have created a handle.

Param base

Base address for the LPI2C instance on which the event occurred.

Param transfer

Pointer to transfer descriptor containing values passed to and/or from the callback.

Param userData

Arbitrary pointer-sized value passed from the application.

struct *_lpi2c_slave_config*

#include <fsl_lpi2c.h> Structure with settings to initialize the LPI2C slave module.

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the LPI2C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

`bool enableSlave`
Enable slave mode.

`uint8_t address0`
Slave's 7-bit address.

`uint8_t address1`
Alternate slave 7-bit address.

`lpi2c_slave_address_match_t addressMatchMode`
Address matching options.

`bool filterDozeEnable`
Enable digital glitch filter in doze mode.

`bool filterEnable`
Enable digital glitch filter.

`bool enableGeneralCall`
Enable general call address matching.

`struct _lpi2c_slave_config sclStall`
SCL stall enable options.

`bool ignoreAck`
Continue transfers after a NACK is detected.

`bool enableReceivedAddressRead`
Enable reading the address received address as the first byte of data.

`uint32_t sdaGlitchFilterWidth_ns`
Width in nanoseconds of the digital filter on the SDA signal. Set to 0 to disable.

`uint32_t sclGlitchFilterWidth_ns`
Width in nanoseconds of the digital filter on the SCL signal. Set to 0 to disable.

`uint32_t dataValidDelay_ns`
Width in nanoseconds of the data valid delay.

`uint32_t clockHoldTime_ns`
Width in nanoseconds of the clock hold time.

`struct _lpi2c_slave_transfer`
#include <fsl_lpi2c.h> LPI2C slave transfer structure.

Public Members

`lpi2c_slave_transfer_event_t event`
Reason the callback is being invoked.

`uint8_t receivedAddress`
Matching address send by master.

`uint8_t *data`
Transfer buffer

`size_t dataSize`
Transfer size

status_t completionStatus

Success or error code describing how the transfer completed. Only applies for kLPI2C_SlaveCompletionEvent.

size_t transferredCount

Number of bytes actually transferred since start or last repeated start.

struct *_lpi2c_slave_handle*

#include <fsl_lpi2c.h> LPI2C slave handle structure.

Note: The contents of this structure are private and subject to change.

Public Members

lpi2c_slave_transfer_t transfer

LPI2C slave transfer copy.

bool isBusy

Whether transfer is busy.

bool wasTransmit

Whether the last transfer was a transmit.

uint32_t eventMask

Mask of enabled events.

uint32_t transferredCount

Count of bytes transferred.

lpi2c_slave_transfer_callback_t callback

Callback function called at transfer event.

void *userData

Callback parameter passed to callback.

struct sclStall

Public Members

bool enableAck

Enables SCL clock stretching during slave-transmit address byte(s) and slave-receiver address and data byte(s) to allow software to write the Transmit ACK Register before the ACK or NACK is transmitted. Clock stretching occurs when transmitting the 9th bit. When enableAckSCLStall is enabled, there is no need to set either enableRxDatasCLStall or enableAddressSCLStall.

bool enableTx

Enables SCL clock stretching when the transmit data flag is set during a slave-transmit transfer.

bool enableRx

Enables SCL clock stretching when receive data flag is set during a slave-receive transfer.

bool enableAddress

Enables SCL clock stretching when the address valid flag is asserted.

2.52 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

2.53 LPSPI: Low Power Serial Peripheral Interface

2.54 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_MasterByteSwap` you 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.

2.55 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

2.56 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

FSL_LPTMR_DRIVER_VERSION

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

2.57 LPUART: Low Power Universal Asynchronous Receiver/Transmitter Driver

2.58 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

```
void LPUART_Deinit(LPUART_Type *base)
```

Deinitializes a LPUART instance.

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

- base – LPUART peripheral base address.

```
void LPUART_GetDefaultConfig(lpuart_config_t *config)
```

Gets the default configuration structure.

This function initializes the LPUART configuration structure to a default value. The default values are: lpuartConfig->baudRate_Bps = 115200U; lpuartConfig->parityMode = kLPUART_ParityDisabled; lpuartConfig->dataBitsCount = kLPUART_EightDataBits; lpuartConfig->isMsb = false; lpuartConfig->stopBitCount = kLPUART_OneStopBit; lpuartConfig->txFifoWatermark = 0; lpuartConfig->rxFifoWatermark = 1; lpuartConfig->rxIdleType = kLPUART_IdleTypeStartBit; lpuartConfig->rxIdleConfig = kLPUART_IdleCharacter1; lpuartConfig->enableTx = false; lpuartConfig->enableRx = false;

Parameters

- config – Pointer to a configuration structure.

```
status_t LPUART_SetBaudRate(LPUART_Type *base, uint32_t baudRate_Bps, uint32_t
                             srcClock_Hz)
```

Sets the LPUART instance baudrate.

This function configures the LPUART module baudrate. This function is used to update the LPUART module baudrate after the LPUART module is initialized by the LPUART_Init.

```
LPUART_SetBaudRate(LPUART1, 115200U, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- baudRate_Bps – LPUART baudrate to be set.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not supported in the current clock source.
- kStatus_Success – Set baudrate succeeded.

```
void LPUART_Enable9bitMode(LPUART_Type *base, bool enable)
```

Enable 9-bit data mode for LPUART.

This function set the 9-bit mode for LPUART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – LPUART peripheral base address.
- enable – true to enable, 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 be 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 __unnamed85__

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 __unnamed87__

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 __unnamed89__

Public Members

uint8_t *volatile rxData

Address of remaining data to receive.

uint16_t *volatile rxData16

Address of remaining data to receive.

union __unnamed91__

Public Members

uint8_t *rxRingBuffer

Start address of the receiver ring buffer.

uint16_t *rxRingBuffer16

Start address of the receiver ring buffer.

2.59 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

2.60 MECC: internal error correction code

`void MECC_Init(MECC_Type *base, mecc_config_t *config)`

MECC module initialization function.

Parameters

- `base` – MECC base address.
- `config` – pointer to the MECC configuration structure.

`void MECC_Deinit(MECC_Type *base)`

Deinitializes the MECC.

Parameters

- `base` – MECC base address.

`void MECC_GetDefaultConfig(mecc_config_t *config)`

Sets the MECC configuration structure to default values.

Parameters

- `config` – pointer to the MECC configuration structure.

`static inline uint32_t MECC_GetStatusFlags(MECC_Type *base)`

Gets MECC status flags.

Parameters

- `base` – MECC peripheral base address.

Returns

MECC status flags.

`static inline void MECC_ClearStatusFlags(MECC_Type *base, uint32_t mask)`

MECC module clear interrupt status.

Parameters

- `base` – MECC base address.
- `mask` – status to clear.

`static inline void MECC_EnableInterruptStatus(MECC_Type *base, uint32_t mask)`

MECC module enable interrupt status.

Parameters

- `base` – MECC base address.
- `mask` – status to enable.

`static inline void MECC_DisableInterruptStatus(MECC_Type *base, uint32_t mask)`

MECC module disable interrupt status.

Parameters

- `base` – MECC base address.
- `mask` – status to disable.

`static inline void MECC_EnableInterrupts(MECC_Type *base, uint32_t mask)`

MECC module enable interrupt.

Parameters

- `base` – MECC base address.
- `mask` – The interrupts to enable.

static inline void MECC_DisableInterrupts(MECC_Type *base, uint32_t mask)
MECC module disable interrupt.

Parameters

- base – MECC base address.
- mask – The interrupts to disable.

status_t MECC_ErrorInjection(MECC_Type *base, uint32_t lowerrordata, uint32_t
higherrordata, uint8_t eccdata, uint8_t banknumber)
MECC module error injection.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2:
ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i =
0,1,2,3,4,....

Parameters

- base – MECC base address.
- lowerrordata – low 32 bits data.
- higherrordata – high 32 bits data.
- eccdata – ecc code.
- banknumber – ocram bank number.

Return values

kStatus_Success. –

status_t MECC_GetSingleErrorInfo(MECC_Type *base, *mecc_single_error_info_t* *info, uint8_t
banknumber)
MECC module get single error information.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2:
ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i =
0,1,2,3,4,....

Parameters

- base – MECC base address.
- info – single error information.
- banknumber – ocram bank number.

Return values

- kStatus_Success. –
- kStatus_MECC_BankMiss. –

status_t MECC_GetMultiErrorInfo(MECC_Type *base, *mecc_multi_error_info_t* *info, uint8_t
banknumber)
MECC module get multiple error information.

Bank0: ocram_base_address+0x20*i Bank1: ocram_base_address+0x20*i+0x8 Bank2:
ocram_base_address+0x20*i+0x10 Bank3: ocram_base_address+0x20*i+0x18 i =
0,1,2,3,4,....

Parameters

- base – MECC base address.

- info – multiple error information.
- banknumber – ocram bank number.

Return values

- kStatus__Success. –
- kStatus__MECC__BankMiss. –

static inline uint32_t MECC_GetPendingFlags(MECC_Type *base)

Get pending flags for OCRAM wait and pipeline enable.

Parameters

- base – MECC base address.

Returns

Pending flags, should be the OR'ed value of mecc_pending_flag_t.

FSL_MECC_DRIVER_VERSION

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Error codes for the MECC driver.

Values:

enumerator kStatus__MECC__BankMiss

Ocram bank miss

MECC interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the MECC interrupt configurations.

Values:

enumerator kMECC__SingleError0InterruptEnable

Single Bit Error On Ocram Bank0 interrupt enable.

enumerator kMECC__SingleError1InterruptEnable

Single Bit Error On Ocram Bank1 interrupt enable

enumerator kMECC__SingleError2InterruptEnable

Single Bit Error On Ocram Bank2 interrupt enable

enumerator kMECC__SingleError3InterruptEnable

Single Bit Error On Ocram Bank3 interrupt enable

enumerator kMECC__MultiError0InterruptEnable

Multiple Bits Error On Ocram Bank0 interrupt enable

enumerator kMECC__MultiError1InterruptEnable

Multiple Bits Error On Ocram Bank1 interrupt enable

enumerator kMECC__MultiError2InterruptEnable

Multiple Bits Error On Ocram Bank2 interrupt enable

enumerator kMECC__MultiError3InterruptEnable

Multiple Bits Error On Ocram Bank3 interrupt enable

enumerator kMECC__StrobeError0InterruptEnable

AXI Strobe Error On Ocram Bank0 interrupt enable

enumerator kMECC__StrobeError1InterruptEnable

AXI Strobe Error On Ocram Bank1 interrupt enable

enumerator kMECC_StrobeError2InterruptEnable
AXI Strobe Error On Ocram Bank2 interrupt enable

enumerator kMECC_StrobeError3InterruptEnable
AXI Strobe Error On Ocram Bank3 interrupt enable

enumerator kMECC_AccessError0InterruptEnable
Ocram Access Error On Bank0 interrupt enable

enumerator kMECC_AccessError1InterruptEnable
Ocram Access Error On Bank1 interrupt enable

enumerator kMECC_AccessError2InterruptEnable
Ocram Access Error On Bank2 interrupt enable

enumerator kMECC_AccessError3InterruptEnable
Ocram Access Error On Bank3 interrupt enable

enumerator kMECC_AllInterruptsEnable
all interrupts enable

MECC interrupt status configuration structure, default settings all disabled.

This structure contains the settings for all of the MECC interrupt status configurations.

Values:

enumerator kMECC_SingleError0InterruptStatusEnable
Single Bit Error On Ocram Bank0 interrupt status enable.

enumerator kMECC_SingleError1InterruptStatusEnable
Single Bit Error On Ocram Bank1 interrupt status enable

enumerator kMECC_SingleError2InterruptStatusEnable
Single Bit Error On Ocram Bank2 interrupt status enable

enumerator kMECC_SingleError3InterruptStatusEnable
Single Bit Error On Ocram Bank3 interrupt status enable

enumerator kMECC_MultiError0InterruptStatusEnable
Multiple Bits Error On Ocram Bank0 interrupt status enable

enumerator kMECC_MultiError1InterruptStatusEnable
Multiple Bits Error On Ocram Bank1 interrupt status enable

enumerator kMECC_MultiError2InterruptStatusEnable
Multiple Bits Error On Ocram Bank2 interrupt status enable

enumerator kMECC_MultiError3InterruptStatusEnable
Multiple Bits Error On Ocram Bank3 interrupt status enable

enumerator kMECC_StrobeError0InterruptStatusEnable
AXI Strobe Error On Ocram Bank0 interrupt status enable

enumerator kMECC_StrobeError1InterruptStatusEnable
AXI Strobe Error On Ocram Bank1 interrupt status enable

enumerator kMECC_StrobeError2InterruptStatusEnable
AXI Strobe Error On Ocram Bank2 interrupt status enable

enumerator kMECC_StrobeError3InterruptStatusEnable
AXI Strobe Error On Ocram Bank3 interrupt status enable

enumerator kMECC_AccessError0InterruptStatusEnable
Ocram Access Error On Bank0 interrupt status enable

enumerator kMECC_AccessError1InterruptStatusEnable
Ocram Access Error On Bank1 interrupt status enable

enumerator kMECC_AccessError2InterruptStatusEnable
Ocram Access Error On Bank2 interrupt status enable

enumerator kMECC_AccessError3InterruptStatusEnable
Ocram Access Error On Bank3 interrupt status enable

enumerator kMECC_AllInterruptsStatusEnable
all interrupts enable

MECC status flags.

This provides constants for the MECC status flags for use in the MECC functions.

Values:

enumerator kMECC_SingleError0InterruptFlag
Single Bit Error On Ocram Bank0 interrupt flag

enumerator kMECC_SingleError1InterruptFlag
Single Bit Error On Ocram Bank1 interrupt flag

enumerator kMECC_SingleError2InterruptFlag
Single Bit Error On Ocram Bank2 interrupt flag

enumerator kMECC_SingleError3InterruptFlag
Single Bit Error On Ocram Bank3 interrupt flag

enumerator kMECC_MultiError0InterruptFlag
Multiple Bits Error On Ocram Bank0 interrupt flag

enumerator kMECC_MultiError1InterruptFlag
Multiple Bits Error On Ocram Bank1 interrupt flag

enumerator kMECC_MultiError2InterruptFlag
Multiple Bits Error On Ocram Bank2 interrupt flag

enumerator kMECC_MultiError3InterruptFlag
Multiple Bits Error On Ocram Bank3 interrupt flag

enumerator kMECC_StrobeError0InterruptFlag
AXI Strobe Error On Ocram Bank0 interrupt flag

enumerator kMECC_StrobeError1InterruptFlag
AXI Strobe Error On Ocram Bank1 interrupt flag

enumerator kMECC_StrobeError2InterruptFlag
AXI Strobe Error On Ocram Bank2 interrupt flag

enumerator kMECC_StrobeError3InterruptFlag
AXI Strobe Error On Ocram Bank3 interrupt flag

enumerator kMECC_AccessError0InterruptFlag
Ocram Access Error On Bank0 interrupt flag

enumerator kMECC_AccessError1InterruptFlag
Ocram Access Error On Bank1 interrupt flag

enumerator kMECC_AccessError2InterruptFlag
Ocram Access Error On Bank2 interrupt flag

enumerator kMECC_AccessError3InterruptFlag
Ocram Access Error On Bank3 interrupt flag

enumerator kMECC_AllInterruptsFlag
all interrupts interrupt flag

MECC ocram bank number.

Values:

enumerator kMECC_OcramBank0
ocram bank number 0: ocram_base_address+0x20*i

enumerator kMECC_OcramBank1
ocram bank number 1: ocram_base_address+0x20*i+0x8

enumerator kMECC_OcramBank2
ocram bank number 2: ocram_base_address+0x20*i+0x10

enumerator kMECC_OcramBank3
ocram bank number 3: ocram_base_address+0x20*i+0x18

enum _mecc_pending_flag

Pending flags for OCRAM wait and pipeline enable. .

Values:

enumerator kMECC_ReadDataWaitPendingFlag
Indicate an update pending status for read data wait.

enumerator kMECC_ReadAddrPipelinePendingFlag
Indicate an update pending status for read address pipeline.

enumerator kMECC_WriteDataPipelinePendingFlag
Indicate an update pending status for write data pipeline.

enumerator kMECC_WriteAddrPipelinePendingFlag
Indicate an update pending status for write address pipeline.

enumerator kMECC_AllPendingFlags
Indicate all pending status flags.

typedef struct *_mecc_config* mecc_config_t
MECC user configuration.

Note: Ocram1StartAddress, Ocram1EndAddress, Ocram2StartAddress, Ocram2EndAddress are removed since 2.1.0 version; This changes will cause compile error for applications which use MECC driver before 2.1.0 version; To resolve compile error please use *startAddress* and *endAddress* as instead.

typedef struct *_mecc_single_error_info* mecc_single_error_info_t
MECC ocram single error information, including single error address, ECC code, error data and error bit position.

typedef struct *_mecc_multi_error_info* mecc_multi_error_info_t
MECC ocram multiple error information, including multiple error address, ECC code, error data.

```
struct _mecc_config
#include <fsl_mecc.h> MECC user configuration.
```

Note: Ocram1StartAddress, Ocram1EndAddress, Ocram2StartAddress, Ocram2EndAddress are removed since 2.1.0 version; This changes will cause compile error for applications which use MECC driver before 2.1.0 version; To resolve compile error please use *startAddress* and *endAddress* as instead.

Public Members

bool enableMecc
Enable the MECC function.

uint32_t startAddress
Start address of corresponding OCRAM memory region to enable ECC.

uint32_t endAddress
end address of corresponding OCRAM memory region to enable ECC.

bool enableReadDataWait
uint32_t Ocram1StartAddress; Ocram 1 start address, deprecated since 2.1.0
uint32_t Ocram1EndAddress; Ocram 1 end address, deprecated since 2.1.0
uint32_t Ocram2StartAddress; Ocram 2 start address, deprecated since 2.1.0.
uint32_t Ocram2EndAddress; Ocram 2 end address, deprecated since 2.1.0 If enabled, 1-cycle wait state will be inserted into each read access:

- **true** Enable read data wait;
- **false** Disable read data wait.

bool enableReadAddrPipeline
If enabled, the read address will be registered before can be applied to memory cell:

- **true** Enable Read address pipeline;
- **false** Disable Read address pipeline.

bool enableWriteDataPipeline
If enabled, the write data will be registered before can be applied to memory cell:

- **true** Enable write data pipeline;
- **false** Disable write data pipeline.

bool enableWriteAddrPipeline
If enabled, write address will be registered before can be applied to memory cell:

- **true** Enable write address pipeline;
- **false** Disable write address pipeline.

```
struct _mecc_single_error_info
#include <fsl_mecc.h> MECC ocram single error information, including single error address,
ECC code, error data and error bit position.
```

Public Members

uint32_t singleErrorAddress
Single error address on Ocram bank n

uint32_t singleErrorDataLow

Single error low 32 bits uncorrected read data on Ocram bank n

uint32_t singleErrorDataHigh

Single error high 32 bits uncorrected read data on Ocram bank n

uint32_t singleErrorPosLow

Single error bit position of low 32 bits read data on Ocram bank n

uint32_t singleErrorPosHigh

Single error bit position of high 32 bits read data on Ocram bank n

uint8_t singleErrorEccCode

Single error ECC code on Ocram bank n

struct _mecc_multi_error_info

#include <fsl_mecc.h> MECC ocram multiple error information, including multiple error address, ECC code, error data.

Public Members

uint32_t multiErrorAddress

Multiple error address on Ocram bank n

uint32_t multiErrorDataLow

Multiple error low 32 bits read data on Ocram bank n

uint32_t multiErrorDataHigh

Multiple error high 32 bits read data on Ocram bank n

uint8_t multiErrorEccCode

Multiple error ECC code on Ocram bank n

2.61 MSGINTR: Message Unit

2.62 MSGINTR Driver

2.63 MU: Messaging Unit

uint32_t MU_GetInstance(MU_Type *base)

Get the MU instance index.

Parameters

- base – MU peripheral base address.

Returns

MU instance index.

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 `MU1_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)

brief 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 MU1_BUSY_POLL_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus_Timeout.

return status_t retval kStatus_Success Flags were set successfully. retval kStatus_Timeout Timeout occurred while waiting for flags to update.

Parameters

- base – MU peripheral base address.
- flags – The 3-bit MU flags to set.

static inline uint32_t MU_GetFlags(MU_Type *base)

Gets the current value of the 3-bit MU flags set by the other side.

This function gets the current 3-bit MU flags on the current side.

Parameters

- base – MU peripheral base address.

Returns

flags Current value of the 3-bit flags.

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);
}

```

If there are more than 4 general purpose interrupts, use `MU_GetGeneralPurposeStatusFlags`.

Parameters

- base – MU peripheral base address.

Returns

Bit mask of the MU status flags, see `_mu_status_flags`.

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 flags)

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);

```

If there are more than 4 general purpose interrupts, use `MU_ClearGeneralPurposeStatusFlags`.

Parameters

- base – MU peripheral base address.
- flags – Bit mask of the MU status flags. See `_mu_status_flags`. Only the following flags can be cleared by software, other flags are cleared by hardware:
 - `kMU_GenInt0Flag`
 - `kMU_GenInt1Flag`
 - `kMU_GenInt2Flag`
 - `kMU_GenInt3Flag`
 - `kMU_MuResetInterruptFlag`

- #kMU_OtherSideEnterRunInterruptFlag
- #kMU_OtherSideEnterHaltInterruptFlag
- #kMU_OtherSideEnterWaitInterruptFlag
- #kMU_OtherSideEnterStopInterruptFlag
- #kMU_OtherSideEnterPowerDownInterruptFlag
- #kMU_ResetAssertInterruptFlag
- #kMU_HardwareResetInterruptFlag

static inline void MU_EnableInterrupts(MU_Type *base, uint32_t interrupts)

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);

If there are more than 4 general purpose interrupts, use `MU_EnableGeneralPurposeInterrupts`.

Parameters

- base – MU peripheral base address.
- interrupts – Bit mask of the MU interrupts. See `_mu_interrupt_enable`.

static inline void MU_DisableInterrupts(MU_Type *base, uint32_t interrupts)

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);

If there are more than 4 general purpose interrupts, use `MU_DisableGeneralPurposeInterrupts`.

Parameters

- base – MU peripheral base address.
- interrupts – Bit mask of the MU interrupts. See `_mu_interrupt_enable`.

status_t MU_TriggerInterrupts(MU_Type *base, uint32_t interrupts)

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.
}
```

If there are more than 4 general purpose interrupts, use `MU_TriggerGeneralPurposeInterrupts`.

Parameters

- base – MU peripheral base address.
- interrupts – 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_EnableGeneralPurposeInterrupts(MU_Type *base, uint32_t interrupts)`

Enables the MU general purpose interrupts.

This function enables the MU general purpose interrupts. The interrupts to enable should be passed in as bit mask of `mu_general_purpose_interrupt_t`. The function `MU_EnableInterrupts` only support general interrupt 0~3, this function supports all general interrupts.

For example, to enable general purpose interrupt 0 and 3, use like this:

```
MU_EnableGeneralPurposeInterrupts(MU, kMU_GeneralPurposeInterrupt0 | kMU_
↳ GeneralPurposeInterrupt3);
```

Parameters

- base – MU peripheral base address.
- interrupts – Bit mask of the MU general purpose interrupts, see `mu_general_purpose_interrupt_t`.

`static inline void MU_DisableGeneralPurposeInterrupts(MU_Type *base, uint32_t interrupts)`

Disables the MU general purpose interrupts.

This function disables the MU general purpose interrupts. The interrupts to disable should be passed in as bit mask of `mu_general_purpose_interrupt_t`. The function `MU_DisableInterrupts` only support general interrupt 0~3, this function supports all general interrupts.

For example, to disable general purpose interrupt 0 and 3, use like this:

```
MU_EnableGeneralPurposeInterrupts(MU, kMU_GeneralPurposeInterrupt0 | kMU_
↳ GeneralPurposeInterrupt3);
```

Parameters

- base – MU peripheral base address.
- interrupts – Bit mask of the MU general purpose interrupts. see `mu_general_purpose_interrupt_t`.

`static inline uint32_t MU_GetGeneralPurposeStatusFlags(MU_Type *base)`

Gets the MU general purpose interrupt status flags.

This function returns the bit mask of the MU general purpose interrupt status flags. `MU_GetStatusFlags` can only get general purpose interrupt status 0~3, this function can get all general purpose interrupts status.

This example shows to check whether general purpose interrupt 0 and 3 happened.

```
uint32_t flags;
flags = MU_GetGeneralPurposeStatusFlags(base);
if (kMU_GeneralPurposeInterrupt0 & flags)
{
}
```

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```
if (kMU_GeneralPurposeInterrupt3 & flags)
{
}
```

Parameters

- base – MU peripheral base address.

Returns

Bit mask of the MU general purpose interrupt status flags.

```
static inline void MU_ClearGeneralPurposeStatusFlags(MU_Type *base, uint32_t flags)
```

Clear the MU general purpose interrupt status flags.

This function clears the specific MU general purpose interrupt status flags. The flags to clear should be passed in as bit mask. `mu_general_purpose_interrupt_t_mu_status_flags`.

Example to clear general purpose interrupt 0 and general interrupt 1 pending flags.

```
MU_ClearGeneralPurposeStatusFlags(base, kMU_GeneralPurposeInterrupt0 | kMU_
↳ GeneralPurposeInterrupt1);
```

Parameters

- base – MU peripheral base address.
- flags – Bit mask of the MU general purpose interrupt status flags. See `mu_general_purpose_interrupt_t`.

```
static inline uint32_t MU_GetRxStatusFlags(MU_Type *base)
```

Return the RX status flags in reverse numerical order.

This function return the RX status flags in reverse order. Note: RFn bits of SR[3-0](mu status register) are mapped in ascending numerical order: RF0 -> SR[0] RF1 -> SR[1] RF2 -> SR[2] RF3 -> SR[3] This function will return these bits in reverse numerical order(RF3->RF1) to comply with `MU_GetRxStatusFlags()` of mu driver. See `MU_GetRxStatusFlags()` from `drivers/mu/fsl_mu.h`

```
status_reg = MU_GetRxStatusFlags(base);
```

Parameters

- base – MU peripheral base address.

Returns

MU RX status flags in reverse order

```
status_t MU_TriggerGeneralPurposeInterrupts(MU_Type *base, uint32_t interrupts)
```

Triggers general purpose interrupts to the other core.

This function triggers the specific general purpose interrupts to the other core. The interrupts to trigger are passed in as bit mask. See `mu_general_purpose_interrupt_t`. 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.

```
status_t status;
status = MU_TriggerGeneralPurposeInterrupts(base, kMU_GeneralPurposeInterrupt0 | kMU_
↳ GeneralPurposeInterrupt2);

if (kStatus_Success != status)
{
```

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```
}  
    Previous general purpose interrupt 0 or general purpose interrupt 2  
    has not been processed by the other core.
```

Parameters

- base – MU peripheral base address.
- interrupts – Bit mask of the interrupts to trigger. See `mu_general_purpose_interrupt_t`.

Return values

- `kStatus_Success` – Interrupts have been triggered successfully.
- `kStatus_Fail` – Previous interrupts have not been accepted.

```
void MU_BootOtherCore(MU_Type *base, mu_core_boot_mode_t mode)
```

Boots the other core.

This function boots the other core with a boot configuration.

Parameters

- base – MU peripheral base address.
- mode – The other core boot mode.

```
void MU_HoldOtherCoreReset(MU_Type *base)
```

Holds the other core reset.

This function causes the other core to be held in reset following any reset event.

Parameters

- base – MU peripheral base address.

```
static inline status_t MU_ResetBothSides(MU_Type *base)
```

Resets the MU for both A side and B side.

This function resets the MU for both A side and B side. Before reset, it is recommended to interrupt processor B, because this function may affect the ongoing processor B programs.

If `MU1_BUSY_POLL_COUNT` is defined and non-zero, the function will timeout after the specified number of polling iterations if waiting for the other side to come out of reset takes too long.

Note: For some platforms, only MU side A could use this function, check reference manual for details.

Parameters

- base – MU peripheral base address.

Return values

- `kStatus_Success` – The MU was reset successfully.
- `kStatus_Timeout` – Timeout occurred while waiting for the other side to come out of reset.

Returns

`status_t`

```
status_t MU_HardwareResetOtherCore(MU_Type *base, bool waitReset, bool holdReset,
                                     mu_core_boot_mode_t bootMode)
```

Hardware reset the other core.

This function resets the other core, the other core could mask the hardware reset by calling MU_MaskHardwareReset. The hardware reset mask feature is only available for some platforms. This function could be used together with MU_BootOtherCore to control the other core reset workflow.

If MU1_BUSY_POLL_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus_Timeout if waiting for the other core to enter or exit reset takes too long.

Example 1: Reset the other core, and no hold reset

```
MU_HardwareResetOtherCore(MU_A, true, false, bootMode);
```

In this example, the core at MU side B will reset with the specified boot mode.

Example 2: Reset the other core and hold it, then boot the other core later. Here the other core enters reset, and the reset is hold

```
MU_HardwareResetOtherCore(MU_A, true, true, modeDontCare);
```

Current core boot the other core when necessary.

```
MU_BootOtherCore(MU_A, bootMode);
```

Note: The feature waitReset, holdReset, and bootMode might be not supported for some platforms. waitReset is only available for platforms that FSL_FEATURE_MU_NO_CORE_STATUS not defined as 1 and FSL_FEATURE_MU_HAS_RESET_ASSERT_INT not defined as 0. holdReset is only available for platforms that FSL_FEATURE_MU_HAS_RSTH not defined as 0. bootMode is only available for platforms that FSL_FEATURE_MU_HAS_BOOT not defined as 0.

Parameters

- base – MU peripheral base address.
- waitReset – Wait the other core enters reset. Only work when there is CSSR0[RAIP].
 - true: Wait until the other core enters reset, if the other core has masked the hardware reset, then this function will be blocked.
 - false: Don't wait the reset.
- holdReset – Hold the other core reset or not. Only work when there is CCR0[RSTH].
 - true: Hold the other core in reset, this function returns directly when the other core enters reset.
 - false: Don't hold the other core in reset, this function waits until the other core out of reset.
- bootMode – Boot mode of the other core, if holdReset is true, this parameter is useless.

Return values

- kStatus_Success – The other core was reset successfully.

- kStatus_Timeout – Timeout occurred while waiting for the other core to enter or exit reset.

Returns

status_t

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_RxFullPendingFlag

Any RX full flag is pending.

enumerator kMU_TxEmptyPendingFlag

Any TX empty flag is pending.

enumerator kMU_GenIntPendingFlag

Any general interrupt flag is pending.

enumerator kMU_EventPendingFlag

MU event pending.

enumerator kMU_FlagsUpdatingFlag

MU flags update is on-going.

enumerator kMU_MuInResetFlag

MU of any side is in reset.

enumerator kMU_MuResetInterruptFlag

The other side initializes MU reset.

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_MuResetInterruptEnable

The other side initializes MU reset.

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 index.

Values:

enumerator kMU_MsgReg0

Message register 0.

enumerator kMU_MsgReg1

Message register 1.

enumerator kMU_MsgReg2

Message register 2.

enumerator kMU_MsgReg3

Message register 3.

enum _mu_general_purpose_interrupt

MU general purpose interrupts.

Values:

enumerator kMU_GeneralPurposeInterrupt0

General purpose interrupt 0

enumerator kMU_GeneralPurposeInterrupt1

General purpose interrupt 1

enumerator kMU_GeneralPurposeInterrupt2

General purpose interrupt 2

enumerator kMU_GeneralPurposeInterrupt3

General purpose interrupt 3

typedef enum _mu_msg_reg_index mu_msg_reg_index_t

MU message register index.

typedef enum _mu_general_purpose_interrupt mu_general_purpose_interrupt_t

MU general purpose interrupts.

MU_CORE_INTR(intr)

MU_MISC_INTR(intr)

MU_TX_INTR(intr)

MU_RX_INTR(intr)

MU_GI_INTR(intr)

MU_GET_CORE_INTR(intrs)

MU_GET_TX_INTR(intrs)

MU_GET_RX_INTR(intrs)

MU_GET_GI_INTR(intrs)

MU_CORE_FLAG(flag)

MU_STAT_FLAG(flag)

MU_TX_FLAG(flag)

MU_RX_FLAG(flag)

MU_GI_FLAG(flag)

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)

MU1_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.

2.64 NETC driver

Status code for the NETC module.

Values:

enumerator kStatus_NETC_RxFrameEmpty

Rx BD ring empty.

enumerator kStatus_NETC_RxTsrResp

Rx timestamp reference response

enumerator kStatus_NETC_RxFrameError

Rx frame error.

enumerator kStatus_NETC_TxFrameOverLen

Tx frame over length.

enumerator kStatus_NETC_LackOfResource

Lack of resources to configure certain features.

enumerator kStatus_NETC_Unsupported

Unsupported operation/feature.

enumerator kStatus_NETC_RxHRZeroFrame

Rx frame host reason is zero

enumerator kStatus_NETC_RxHRNotZeroFrame

Rx frame host reason is not zero

enumerator kStatus_NETC_NotFound

No entry found in hardware tables

enumerator kStatus_NETC_EntryExists

An entry already exists in hardware tables

enum __netc_ep_event

Defines the common interrupt event for callback use.

Values:

enumerator kNETC_EPRxEvent

EP Rx interrupt event.

enumerator kNETC_EPTxEvent

EP Tx interrupt event.

enum __netc_ep_tx_status

Status for the transmit buffer descriptor.

Values:

enumerator kNETC_EPTxSuccess

Success transmission.

enumerator kNETC_EPTxProgramErr

Error exists in either the Tx BD, the Tx ring registers, or both.

enumerator kNETC_EPTxTsdDrop

The time defined in TX_START expired before frame could be transmitted.

enumerator kNETC_EPTxFrameSizeErr

Frame size error.

enumerator kNETC_EPTxNullAddr

Null address.

enumerator kNETC_EPTxInvalidLength

Invalid frame/buffer/chain length.

enumerator kNETC_EPTxSrcMacSpoofingDetect

Source MAC address spoofing detected.

enumerator kNETC_EPTxPortRestDrop

Frame dropped due to port reset.

enumerator kNETC_EPTxPortDisableDrop

Frame dropped due to port disable.

enumerator kNETC_EPTxVlanTpidDrop

VLAN TPID not allowed.

enumerator kNETC_EPTxSmsParamErr

Programming error in buffer descriptor used for direct switch enqueue.

enumerator kNETC_EPTxFrameGateErr

Frame too large for time gating window.

enumerator kNETC_EPTxAxiReadErr

AXI read error.

enumerator kNETC_EPTxAxiWriteErr

AXI write error.

enumerator kNETC_EPTxMultiBitECCErr

Frame not transmitted(dropped) due to a multi-bit ECC error detected.

enumerator kNETC_EPTxParityErr

Parity error.

enumerator kNETC_EPTxSwCongestion

Frame dropped due to switch congestion.

enum __netc_vlan_tpid_select

Ethernet VLAN Tag protocol identifier.

Values:

enumerator kNETC_StanCvlan

0x8100.

enumerator kNETC_StanSvlan

0x88A8.

enumerator kNETC_CustomVlan1

CVLANR1[ETYPE]

enumerator kNETC_CustomVlan2

CVLANR2[ETYPE]

enum __netc_packet_type

Ethernet packet type enumerator.

Values:

enumerator kNETC_PacketUnicast

enumerator kNETC_PacketMulticast

enumerator kNETC_PacketBroadcast

enum __netc_host_reason

Host reason.

Values:

enumerator kNETC_RegularFrame

enumerator kNETC_IngressMirror

enumerator kNETC_MACLearning

enumerator kNETC_TimestampResp

enumerator kNETC_SoftwareDefHR0

enumerator kNETC_SoftwareDefHR1

enumerator kNETC_SoftwareDefHR2

enumerator kNETC_SoftwareDefHR3

enumerator kNETC_SoftwareDefHR4

enumerator kNETC_SoftwareDefHR5

enumerator kNETC_SoftwareDefHR6

enumerator kNETC_SoftwareDefHR7

enum *_netc_msix_vector_ctrl*

MSIX vector control field.

Values:

enumerator *kNETC_MsixIntrMaskBit*

MSIX vector control interrupt mask bit.

enum *_netc_tx_ext_flags*

METC Extension Transmit Buffer Descriptor Extension flags field.

Values:

enumerator *kNETC_TxExtVlanInsert*

Enable VLAN insert.

enumerator *kNETC_TxExtTwoStepTs*

Enable two-step timestamp offload.

typedef enum *_netc_ep_event* *netc_ep_event_t*

Defines the common interrupt event for callback use.

typedef enum *_netc_ep_tx_status* *netc_ep_tx_status_t*

Status for the transmit buffer descriptor.

typedef struct *_netc_vlan* *netc_vlan_t*

VLAN tag struct.

typedef enum *_netc_vlan_tpid_select* *netc_vlan_tpid_select_t*

Ethernet VLAN Tag protocol identifier.

typedef enum *_netc_packet_type* *netc_packet_type_t*

Ethernet packet type enumerator.

typedef enum *_netc_host_reason* *netc_host_reason_t*

Host reason.

typedef struct *_ep_buffer_struct* *netc_buffer_struct_t*

Buffer structure. Driver can send/receive one frame spread across multiple buffers.

typedef struct *_ep_frame_struct* *netc_frame_struct_t*

Frame structure for single Tx/Rx frame.

typedef struct *_netc_frame_attr_struct* *netc_frame_attr_t*

Frame attribute struct.

typedef struct *_netc_tx_frame_info_struct* *netc_tx_frame_info_t*

Frame attribute structure.

typedef enum *_netc_msix_vector_ctrl* *netc_msix_vector_ctrl_t*

MSIX vector control field.

typedef struct *_netc_msix_entry* *netc_msix_entry_t*

NETC MSIX entry structure.

typedef enum *_netc_tx_ext_flags* *netc_tx_ext_flags_t*

METC Extension Transmit Buffer Descriptor Extension flags field.

FSL_NETC_DRIVER_VERSION

Driver Version.

NETC_ADDR_LOW_32BIT(x)

Macro to divides an address into a low 32 bits and a possible high 32 bits.

NETC_ADDR_HIGH_32BIT(x)

struct __netc_vlan

#include <fsl_netc.h> VLAN tag struct.

Public Members

uint32_t vid

Vlan Identifier.

uint32_t dei

Drop Eligible indicator.

uint32_t pcp

Priority.

uint32_t tpid

Tag protocol identifier.

struct __ep_buffer_struct

#include <fsl_netc.h> Buffer structure. Driver can send/receive one frame spread across multiple buffers.

Public Members

void *buffer

Buffer address.

uint16_t length

Buffer data length.

struct __ep_frame_struct

#include <fsl_netc.h> Frame structure for single Tx/Rx frame.

Public Members

netc_buffer_struct_t *buffArray

Buffer array. Tx: [in]App sets, Rx: [in/out]App sets prepared array, driver sets back received buffers array.

uint16_t length

Buffer array length. Tx: [in]App sets, Rx: [in/out]App sets prepared array length, driver sets back received buffers array length.

struct __netc_frame_attr_struct

#include <fsl_netc.h> Frame attribute struct.

Public Members

bool isTsAvail

Rx frame timestamp is available or not.

bool isVlanExtracted

Rx frame VLAN header is available or not.

uint32_t timestamp

The timestamp of this Rx frame.

struct *_netc_tx_frame_info_struct*
 #include <fsl_netc.h> Frame attribute structure.

Public Members

bool isTsAvail
 Tx frame timestamp is available or not.

uint32_t timestamp
 The timestamp of this Tx frame, valid when isTsAvail is true.

void *context
 Private context provided by the user.

netc_ep_tx_status_t status
 Transmit status.

struct *_netc_msix_entry*
 #include <fsl_netc.h> NETC MSIX entry structure.

Public Members

uint64_t msgAddr
 Message address.

uint32_t msgData
 Message data.

uint32_t control
 Vector control, *netc_msix_vector_ctrl_t*.

2.65 Abbreviation in NETC driver

2.66 API layer

2.67 NETC Endpoint (EP) Driver

2.68 Endpoint (EP) Generic Configuration

typedef struct *_ep_handle* *ep_handle_t*
 Endpoint handle.

typedef *status_t* (**ep_reclaim_cb_t*)(*ep_handle_t* *handle, uint8_t ring, *netc_tx_frame_info_t* *frameInfo, void *userData)
 Callback for reclaimed tx frames.

typedef void (**ep_rx_alloc_cb_t*)(*ep_handle_t* *handle, uint8_t ring, uint32_t length, void *userData)
 Defines the EP Rx memory buffer alloc function pointer.

typedef void (**ep_rx_free_cb_t*)(*ep_handle_t* *handle, uint8_t ring, void *address, void *userData)
 Defines the EP Rx memory buffer free function pointer.

```
typedef status_t (*ep_get_link_status_cb_t)(ep_handle_t *handle, uint8_t *link)
```

Callback for getting link status.

```
typedef status_t (*ep_get_link_speed_cb_t)(ep_handle_t *handle, netc_hw_mii_speed_t *speed,
netc_hw_mii_duplex_t *duplex)
```

Callback for getting link speed.

```
typedef status_t (*ep_preinit_vsi_cb_t)(netc_enetc_hw_t *hw, netc_hw_si_idx_t si)
```

Callback for vsi pre-init.

```
typedef struct _ep_config ep_config_t
```

Configuration for the endpoint handle.

```
typedef struct _ep_config_const ep_config_const_t
```

Configuration constant in handle.

```
status_t EP_Init(ep_handle_t *handle, uint8_t *macAddr, const ep_config_t *config, const
netc_bdr_config_t *bdrConfig)
```

Initialize the endpoint with specified station interface.

Each station interface needs to call this API. In the case of a virtual station interface it's necessary that the physical station interface has been initialized beforehand.

Parameters

- handle –
- macAddr – Primary MAC address
- config – The user configuration
- bdrConfig – Array of buffer configurations (for each queue/ring)

Returns

status_t

```
status_t EP_Deinit(ep_handle_t *handle)
```

De-initialize the endpoint.

Parameters

- handle –

Returns

status_t

```
status_t EP_GetDefaultConfig(ep_config_t *config)
```

Get the default configuration.

Parameters

- config –

Returns

status_t

```
status_t EP_Up(ep_handle_t *handle, netc_hw_mii_speed_t speed, netc_hw_mii_duplex_t duplex)
```

Enable MAC transmission/reception To be called when the PHY link is up.

Parameters

- handle –
- speed –
- duplex –

Returns

status_t

status_t EP_Down(*ep_handle_t* *handle)

Disable MAC transmission/reception To be called when the PHY link is down.

Note: Must ensure all active Tx rings finish current transmission before call this API.

Parameters

- handle –

Returns

status_t

status_t EP_SetPrimaryMacAddr(*ep_handle_t* *handle, *uint8_t* *macAddr)

Set the Primary MAC address.

Parameters

- handle –
- macAddr –

Returns

status_t

static inline void EP_SetPortSpeed(*ep_handle_t* *handle, *uint16_t* pSpeed)

Set EP port speed.

Parameters

- handle –
- pSpeed –

struct *_ep_config*

#include <fsl_enetc_endpoint.h> Configuration for the endpoint handle.

Public Members

netc_hw_si_idx_t si

Station interface index.

netc_hw_enetc_si_config_t siConfig

Station interface configuration.

uint8_t txPrioToTC[8]

Tx BD ring priority to Tx traffic class queue index mapping, range in TC0 ~ TC7.

netc_port_tx_tc_config_t txTcCfg[8]

Tx traffic class related configuration, valid only on ENETC 0.

netc_ep_psfpcfg_t psfpCfg

PSFP configuration, cover the ISI key construction profile and port ingress stream identification configuration.

bool enOuterAsInner

Enable use outer VLAN tag as the inner tag if only one tag is found.

netc_enetc_native_vlan_config_t rxOuterVLANCfg

Port outer native VLAN config.

netc_enetc_native_vlan_config_t rxInnerVLANCfg

Port inner native VLAN config.

netc_enetc_parser_config_t parserCfg
ENETC parser configuration.

uint32_t pauseOnThr
ENETC Port pause ON threshold value, value 0 means disables pause generation.

uint32_t pauseOffThr
ENETC Port pause OFF threshold value, value 0 means disables pause generation.

netc_msix_entry_t *msixEntry
MSIX table entry array.

uint8_t entryNum
MSIX entry number.

uint8_t cmdBdEntryIdx
MSIX entry index of command BD ring interrupt.

uint8_t siComEntryIdx
MSIX entry index of PSI-VSI communication interrupt.

uint8_t timerSyncEntryIdx
MSIX entry index of timer synchronous state change interrupt.

ep_reclaim_cb_t reclaimCallback
Callback for reclaimed Tx frames.

void *userData
User data, return in callback.

bool rxCacheMaintain
Enable/Disable Rx buffer cache maintain in driver.

bool txCacheMaintain
Enable/Disable Tx buffer cache maintain in driver.

bool rxZeroCopy
Enable/Disable zero-copy receive mode.

ep_rx_alloc_cb_t rxBuffAlloc
Callback function to alloc memory, must be provided for zero-copy Rx.

ep_rx_free_cb_t rxBuffFree
Callback function to free memory, must be provided for zero-copy Rx.

ep_preinit_vsi_cb_t preinitVsi
Callback function to pre-init VSI

netc_cmd_bdr_config_t cmdBdrConfig
Command BD ring configuration.

struct __ep_config_const
#include <fsl_net_endpoint.h> Configuration constant in handle.

Public Members

netc_hw_si_idx_t si
Station interface index.

uint32_t rxRingUse
Number of Rx Rings to be used, when enable Rx ring group, this equal to the sum of all Rx group rings.

uint32_t txRingUse

Number of Tx Rings to be used, note that when SI is Switch management ENETC SI, the number not include Tx ring 0.

uint32_t rxBdrGroupNum

Rx BD ring group number, range in 0 ~ 2.

uint32_t ringPerBdrGroup

The ring number in every Rx BD ring group, range in 1 ~ 8, active when rxBdrGroupNum not equal zero.

bool rxCacheMaintain

Enable/Disable Rx buffer cache maintain in driver.

bool txCacheMaintain

Enable/Disable Tx buffer cache maintain in driver.

bool rxZeroCopy

Enable/Disable zero-copy receive mode.

uint8_t entryNum

MSIX entry number.

ep_reclaim_cb_t reclaimCallback

Callback for reclaimed Tx frames.

void *userData

User data, return in callback.

ep_rx_alloc_cb_t rxBuffAlloc

Callback function to alloc memory, must be provided for zero-copy Rx.

ep_rx_free_cb_t rxBuffFree

Callback function to free memory, must be provided for zero-copy Rx.

struct _ep_handle

#include <fsl_enetc_endpoint.h> Handle for the endpoint Private internal data.

Public Members

netc_enetc_hw_t hw

Hardware register map resource.

netc_enetc_cap_t capability

ENETC capability.

ep_config_const_t cfg

Endpoint configuration constant.

netc_rx_bdr_t rxBdRing[1]

Receive buffer descriptor ring.

netc_tx_bdr_t txBdRing[1]

Transmit buffer descriptor ring.

netc_cmd_bdr_t cmdBdRing

Command BD ring handle for endpoint.

uint8_t unicastHashCount[64]

Unicast hash index collisions counter.

```

uint8_t multicastHashCount[64]
    Multicast hash index collisions counter.
uint8_t vlanHashCount[64]
    VLAN hash index collisions counter.
uint8_t macFilterCount[64]
    mac address filter index collisions counter.
uint8_t vlanFilterCount[64]
    vlan address filter index collisions counter.
ep_get_link_status_cb_t getLinkStatus
    Callback to get link status
ep_get_link_speed_cb_t getLinkSpeed
    Callback to get link speed
uint16_t vsiBitMapNotifyLinkStatus
    VSI bit map for link status notify
uint16_t vsiBitMapNotifyLinkSpeed
    VSI bit map for link speed notify
struct port

Public Members

netc_port_ethmac_t ethMac
    Ethernet MAC configuration.
netc_port_common_t common
    Port common configuration.
bool enableTg
    Enable port time gate scheduling.
bool enPseudoMacTxPad
    Enable pseudo MAC Port Transmit Padding, will pad the frame to a minimum of 60
    bytes and append 4 octets of FCS.

```

2.69 Endpoint (EP) data path

```

typedef struct _netc_ep_ipf_config netc_ep_ipf_config_t
    Port Ingress Filter config.
typedef struct _netc_ep_psfp_config netc_ep_psfp_config_t
    PSFP config.
struct _netc_ep_ipf_config
    #include <fsl_netc_endpoint.h> Port Ingress Filter config.

```

Public Members

```

netc_ipf_config_t dosCfg
    Configuration for L2/3 DOS.

```

netc_port_ipf_config_t portConfig

Configuration for port connected to enetc peripheral.

struct __netc_ep_psf_config

#include <fsl_netc_endpoint.h> PSFP config.

2.70 Endpoint (EP) Interrupt Module

enum __ep_interrupt_flag

Interrupt enable/disable flags.

The value of the enumerator is not necessary match the bit in register. All interrupts in Endpoint are merged into this enum except the BDR specific interrupt. TODO SITMRIER

Values:

enumerator kNETC_EPPSIResetInterruptEnable

enumerator kNETC_EPPSIMsgRxInterruptEnable

typedef enum __ep_interrupt_flag ep_interrupt_flag_t

Interrupt enable/disable flags.

The value of the enumerator is not necessary match the bit in register. All interrupts in Endpoint are merged into this enum except the BDR specific interrupt. TODO SITMRIER

static inline void EP_CleanTxIntrFlags(*ep_handle_t* *handle, uint16_t txFrameIntrMask, uint16_t txThresIntrMask)

Clean the SI transmit interrupt flags.

Parameters

- handle – The EP handle.
- txFrameIntrMask – IPV value to be mapped, bit x represents ring x.
- txThresIntrMask – The Rx BD ring index to be mapped, bit x represents ring x.

static inline void EP_CleanRxIntrFlags(*ep_handle_t* *handle, uint32_t rxIntrMask)

Clean the SI receive interrupt flags.

Parameters

- handle – The EP handle.
- rxIntrMask – Rx interrupt bit mask, bit x represents ring x.

status_t EP_MsixSetGlobalMask(*ep_handle_t* *handle, bool mask)

Set the global MSIX mask status.

This function masks/unmasks global MSIX message. Mask - All of the vectors are masked, regardless of their per-entry mask bit states. Unmask - Each entry's mask status determines whether the vector is masked or not.

Parameters

- handle – The EP handle
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

status_t EP_MsixSetEntryMask(*ep_handle_t* *handle, uint8_t entryIdx, bool mask)

Set the MSIX entry mask status for specified entry.

This function masks/unmasks MSIX message for specified entry.

Parameters

- handle – The EP handle
- entryIdx – The entry index in the table.
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

status_t EP_MsixGetPendingStatus(*ep_handle_t* *handle, uint8_t pbaIdx, uint64_t *status)

Get the MSIX pending status in MSIX PBA table.

This function is to get the entry pending status from MSIX PBA table. If interrupt occurs but masked by vector control of entry, pending bit in PBA will be set.

Parameters

- handle – The EP handle
- pbaIdx – The index of PBA array with 64-bit unit.
- status – Pending status bit mask, bit n for entry n.

Returns

status_t

2.71 Endpoint (EP) Table Management Module

status_t EP_CmdBDRInit(*ep_handle_t* *handle, const *netc_cmd_bdr_config_t* *config)

Initialize endpoint command BD ring.

Parameters

- handle –
- config – The command BD ring configuration

Returns

status_t

status_t EP_CmdBDRDeinit(*ep_handle_t* *handle)

Deinit endpoint command BD ring.

Parameters

- handle –

Returns

status_t

2.72 Endpoint (EP) PSI/VSI

void EP_PsiEnableInterrupt(*ep_handle_t* *handle, uint32_t mask, bool enable)

PSI enables/disables specified interrupt.

Parameters

- *handle* – The EP handle.
- *mask* – The interrupt mask, refer to `netc_psi_msg_flags_t` which should be OR'd together.
- *enable* – Enable/Disable the interrupt.

`uint32_t EP_PsiGetStatus(ep_handle_t *handle)`

PSI gets interrupt event flag status.

Parameters

- *handle* – The EP handle.

Returns

The interrupt mask, refer to `netc_psi_msg_flags_t` which should be OR'd together.

`void EP_PsiClearStatus(ep_handle_t *handle, uint32_t mask)`

PSI clears interrupt event flag.

Parameters

- *handle* – The EP handle.
- *mask* – The interrupt mask, refer to `netc_psi_msg_flags_t` which should be OR'd together.

`status_t EP_PsiSendMsg(ep_handle_t *handle, uint16_t msg, netc_vsi_number_t vsi)`

PSI sends message to specified VSI(s)

Parameters

- *handle* – The EP handle.
- *msg* – The message to be sent.
- *vsi* – The VSI number.

Returns

`status_t`

`bool EP_PsiCheckTxBusy(ep_handle_t *handle, netc_vsi_number_t vsi)`

PSI checks Tx busy flag which should be cleaned when VSI receive the message data.

Parameters

- *handle* – The EP handle.
- *vsi* – The VSI number.

Returns

The busy status of specified VSI.

`status_t EP_PsiSetRxBuffer(ep_handle_t *handle, netc_vsi_number_t vsi, uint64_t buffAddr)`

PSI sets Rx buffer to receive message from specified VSI.

Note: The buffer memory size should be big enough for the message data from VSI

Parameters

- *handle* – The EP handle.
- *vsi* – The VSI number.
- *buffAddr* – The buffer address to store message data from VSI.

status_t EP_PsiGetRxMsg(*ep_handle_t* *handle, *netc_vsi_number_t* vsi, *netc_psi_rx_msg_t* *msgInfo)

PSI gets Rx message from specified VSI.

Parameters

- handle – The EP handle.
- vsi – The VSI number.
- msgInfo – The Rx message information.

void EP_VsiEnableInterrupt(*ep_handle_t* *handle, uint32_t mask, bool enable)

Enable VSI interrupt.

Parameters

- handle – The EP handle.
- mask – The interrupt mask, see *netc_vsi_msg_flags_t* which should be OR'd together.
- enable – Enable/Disable interrupt.

uint32_t EP_VsiGetStatus(*ep_handle_t* *handle)

Get VSI interrupt status.

Parameters

- handle – The EP handle.

Returns

A bitmask composed of *netc_vsi_msg_flags_t* enumerators OR'd together.

void EP_VsiClearStatus(*ep_handle_t* *handle, uint32_t mask)

Clear VSI interrupt status.

Parameters

- handle – The EP handle.
- mask – The interrupt mask, see *netc_vsi_msg_flags_t* which should be OR'd together.

status_t EP_VsiSendMsg(*ep_handle_t* *handle, uint64_t msgAddr, uint32_t msgLen)

VSI sends message to PSI.

Parameters

- handle – The EP handle.
- msgAddr – Address to store message ready to be sent, must be 64 bytes aligned.
- msgLen – The message length, must be 32 bytes aligned.

Returns

status_t

void EP_VsiCheckTxStatus(*ep_handle_t* *handle, *netc_vsi_msg_tx_status_t* *status)

Check VSI Tx status.

Parameters

- handle – The EP handle.
- status – The VSI Tx status structure.

status_t EP_VsiReceiveMsg(*ep_handle_t* *handle, uint16_t *msg)

VSI receives message from PSI.

Parameters

- handle – The EP handle.
- msg – The message from PSI.

Returns

status_t

2.73 Endpoint (EP) Ingress data path configuration

static inline *status_t* EP_RxParserConfig(*ep_handle_t* *handle, *netc_port_parser_config_t* *config)

Configure Parser in Receive Data Path.

Parameters

- handle –
- config –

Returns

status_t

static inline *status_t* EP_RxVlanCInit(*ep_handle_t* *handle, const *netc_vlan_classify_config_t* *config)

Configure the customer vlan type.

Parameters

- handle –
- config –

Returns

status_t

static inline *status_t* EP_RxVlanCConfigPort(*ep_handle_t* *handle, *netc_port_vlan_classify_config_t* *config)

Configure the Accepted Vlan.

Parameters

- handle –
- config –

Returns

status_t

status_t EP_RxIPFInit(*ep_handle_t* *handle, *netc_ep_ipf_config_t* *config)

Enable / Disable Ingress Port Filtering.

Applied for both Switch and ENETC

Parameters

- handle –
- config – IPF general features

Returns

status_t

static inline uint32_t EP_RxIPFGetTableRemainWordNum(*ep_handle_t* *handle)

Get remaining available word number (words size is 6 bytes) of the ingress Port Filter Table.

Note: This is a ternary match table, and the entries can vary in size, from 2 to 14 words.

Parameters

- handle –

Returns

uint32_t

status_t EP_RxIPFAddTableEntry(*ep_handle_t* *handle, *netc_tb_ipf_config_t* *config, uint32_t *entryID)

Add an entry for the ingress Port Filter Table.

This function do an add & query with return hardware id which can be used as future query / delete / update.

Parameters

- handle –
- config – IPF instance configuration
- entryID – The table entry ID read out

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxIPFUpdateTableEntry(*ep_handle_t* *handle, uint32_t entryID, *netc_tb_ipf_cfg_t* *cfg)

Update entry in the ingress Port Filter Table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxIPFDeleteTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete an entry for the ingress Port Filter Table.

Parameters

- handle –
- entryID – The table entry ID

Returns

status_t

status_t EP_RxIPFResetMatchCounter(*ep_handle_t* *handle, uint32_t entryID)

Reset the counter of an ingress port filter entry.

Parameters

- handle –
- entryID – The table entry ID

Returns

status_t

status_t EP_RxIPFGetMatchedCount(*ep_handle_t* *handle, uint32_t entryID, uint64_t *count)

Get the matched count for entry in IPF.

Parameters

- handle –
- entryID – The table entry ID
- count – A count of how many times this entry has been matched.

Returns

status_t

static inline status_t EP_RxPSFPInit(*ep_handle_t* *handle, const *netc_ep_psfp_config_t* *config)

Init the ENETC PSFP, include.

Parameters

- handle –
- config –

Returns

status_t

static inline uint32_t EP_RxPSFPGetISITableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number (entry size is 24 bytes) of stream identification table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Filter, table.

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddISITableEntry(*ep_handle_t* *handle, *netc_tb_isi_config_t* *config, uint32_t *entryID)

Add an entry into the stream identification table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPDeISITableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete an entry in the stream identification table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t EP_RxPSFPGetISTableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number of ingress stream table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddISTableEntry(*ep_handle_t* *handle, *netc_tb_is_config_t* *config)

Add an entry into the ingress stream table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPUpdateISTableEntry(*ep_handle_t* *handle, *netc_tb_is_config_t* *config)

Update an entry in the ingress stream table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPDelISTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete an entry in the stream identification table.

Parameters

- handle –
- entryID –

Returns

status_t

static inline uint32_t EP_RxPSFPGetISFTableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number (entry size is 24 bytes) of ingress stream filter table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification table.

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddISFTableEntry(*ep_handle_t* *handle, *netc_tb_isf_config_t* *config,
uint32_t *entryID)

Add an entry into the ingress stream filter table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPUpdateISFTableEntry(*ep_handle_t* *handle, uint32_t entryID,
netc_tb_isf_cfg_t *cfg)

Update an entry into the ingress stream filter table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPDelISFTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Del an entry into the stream filter table.

Parameters

- handle –
- entryID –

Returns

status_t

static inline uint32_t EP_RxPSFPGetRPTableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number of Rate Policer table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddRPTableEntry(*ep_handle_t* *handle, *netc_tb_rp_config_t* *config)

Add entry to Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPUpdateRPTableEntry(*ep_handle_t* *handle, *netc_tb_rp_config_t* *config)

Update entry in Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPAddOrUpdateRPTableEntry(*ep_handle_t* *handle, *netc_tb_rp_config_t* *config)

Add or update entry in Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPDelRPTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete entry in the Rate Policer table.

Parameters

- handle –
- entryID –

Returns

status_t

status_t EP_RxPSFPGetRPStatistic(*ep_handle_t* *handle, uint32_t entryID, *netc_tb_rp_stse_t* *statis)

Get statistic of specified Rate Policer entry.

Parameters

- handle –
- entryID –
- statis –

Returns

status_t

Returns

See *netc_cmd_error_t*

static inline uint32_t EP_RxPSFPGetISCTableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number of ingress stream count table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddISCTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Add entry in ingress stream count table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxPSFPGetISCStatistic(*ep_handle_t* *handle, uint32_t entryID, *netc_tb_isc_stse_t* *statistic)

Get ingress stream count statistic.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxPSFPRestISCSStatistic(*ep_handle_t* *handle, uint32_t entryID)

Reset the count of the ingress stream count.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See *netc_cmd_error_t*

static inline uint32_t EP_RxPSFPGetSGITableRemainEntryNum(*ep_handle_t* *handle)

Get remaining available entry number of stream gate instance table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddSGITableEntry(*ep_handle_t* *handle, *netc_tb_sgi_config_t* *config)

Add entry in stream gate instance table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxPSFPUdateSGITableEntry(*ep_handle_t* *handle, *netc_tb_sgi_config_t* *config)

Update entry in stream gate instance table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxPSFPDeSGITableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete entry in stream gate instance table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPGetSGIState(*ep_handle_t* *handle, uint32_t entryID, *netc_tb_sgi_sgise_t* *state)

Get state of the stream gate instance for specified entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t EP_RxPSFPGetSGCLTableRemainWordNum(*ep_handle_t* *handle)

Get remaining available words number of Stream Gate Control List table.

Note: This is a dynamic bounded index table, and number of words required for a stream gate control list is $1+N/2$ where N is number of gate time slots in the stream gate control list. The remaining word should be greater than the want added entry size

Parameters

- handle –

Returns

uint32_t

status_t EP_RxPSFPAddSGCLTableEntry(*ep_handle_t* *handle, *netc_tb_sgcl_gcl_t* *config)

Add entry into Stream Gate Control List Table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPDelSGCLTableEntry(*ep_handle_t* *handle, uint32_t entryID)

Delete entry of Stream Gate Control List Table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxPSFPGetSGCLGateList(*ep_handle_t* *handle, *netc_tb_sgcl_gcl_t* *gcl, uint32_t length)

Get Stream Gate Control List Table entry gate control list.

Parameters

- handle –
- gcl –
- length –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxPSFPGetSGCLState(*ep_handle_t* *handle, uint32_t entryID, *netc_tb_sgcl_sgclse_t* *state)

Get state (ref count) for Stream Gate Control List table entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxL2MFInit(*ep_handle_t* *handle, *netc_si_l2mf_config_t* *config)

Init the L2 MAC Filter for a specified SI.

Parameters

- handle – EP handle
- config – The L2 MAC Filter configuration

Returns

status_t

status_t EP_RxL2MFAddHashEntry(*ep_handle_t* *handle, *netc_packet_type_t* type, uint8_t *macAddr)

Add entry into the MAC address hash filter with given MAC address Hardware layer will not maintain the counter of the hash filter. API layer shall cover this requirement.

Parameters

- handle – EP handle
- type – Unicast or multicast MAC address
- macAddr – MAC address to be added in filter table

Returns

status_t

status_t EP_RxL2MFDelHashEntry(*ep_handle_t* *handle, *netc_packet_type_t* type, uint8_t *macAddr)

Delete entry into the MAC address hash filter with given MAC address Hardware layer will not maintain the counter of the hash filter. API layer shall cover this requirement.

Parameters

- handle – EP handle
- type – Unicast or multicast MAC address
- macAddr – MAC address to be deleted from filter table

Returns

status_t

status_t EP_RxL2MFAddEMTableEntry(*ep_handle_t* *handle, uint32_t idx, uint8_t *macAddr)

Add entry into the MAC filter exact match table.

The entry is associated to the current Station Interface

Parameters

- handle –
- idx – Index in the entry table
- macAddr – MAC address for filter

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxL2MFDeleEMTableEntry(*ep_handle_t* *handle, uint32_t idx)

Delete entry into the MAC filter exact match table.

Parameters

- handle – EP handle
- idx – Index in the entry table

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_RxL2VFInit(*ep_handle_t* *handle, *netc_si_l2vf_config_t* *config)

For VLAN filter, use inner vlan tag or outer vlan tag.

Parameters

- handle –
- config –

Returns

status_t

status_t EP_RxL2VFAddHashEntry(*ep_handle_t* *handle, uint16_t vlanId)

Add entry into the VLAN hash filter with given MAC address Hardware layer will not maintain the counter of the hash filter. API layer shall cover this requirement.

Parameters

- handle –
- vlanId – VLAN identifier for filter

Returns

status_t

status_t EP_RxL2VFDelHashEntry(*ep_handle_t* *handle, uint16_t vlanId)

Delete entry into the VLAN hash filter with given MAC address Hardware layer will not maintain the counter of the hash filter. API layer shall cover this requirement.

Parameters

- handle –
- vlanId – VLAN identifier for filter

Returns

status_t

status_t EP_RxL2VFAddEMTableEntry(*ep_handle_t* *handle, uint32_t idx, uint16_t vlanId, *netc_vlan_tpid_select_t* tpid)

Add entry into the MAC filter exact match table.

The entry is associated to the current Station Interface

Parameters

- handle –
- idx – Index in the entry table
- vlanId – VLAN identifier
- tpid – VLAN TPID

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t EP_RxL2VFDeleMTableEntry(*ep_handle_t* *handle, uint32_t idx)

Delete entry into the VLAN filter exact match table.

Parameters

- handle –
- idx – Index in the entry table

Returns

status_t

Returns

See *netc_cmd_error_t*

static inline *status_t* EP_RxMapVlanToIpv(*ep_handle_t* *handle, *netc_vlan_t* vlan, uint8_t ipv)

Set the received Frame vlan to IPV mapping.

Parameters

- handle –
- vlan – Frame VLAN tag.
- ipv – The IPV value to be mapped.

Returns

status_t

static inline *status_t* EP_RxMapIpvToRing(*ep_handle_t* *handle, uint8_t ipv, uint8_t ring)

Set the IPV to Rx ring mapping.

Parameters

- handle –

- `ipv` – IPV value to be mapped.
- `ring` – The Rx BD ring index to be mapped.

Returns`status_t`

```
static inline status_t EP_RxSetDefaultBDRGroup(ep_handle_t *handle,  
                                              netc_hw_enetc_si_rxr_group groupIdX)
```

Set the default used receive Rx BD ring group.

Note: The IPV mapped ring index is the relative index inside the default used group.

Parameters

- `handle` –
- `groupIdX` – The default Rx group index.

Returns`status_t`

2.74 Endpoint (EP) Statistic Module

```
enum _ep_flags
```

Status/interrupt detect flags merged to same set of enum. TODO SITMRIDR.

Values:

```
enumerator kNETC_EPTimerSyncedFlag
```

```
enumerator kNETC_EPICMBlockedFlag
```

```
enumerator kNETC_EPWakeOnLANActiveFlag
```

```
typedef enum _ep_flags ep_flags_t
```

Status/interrupt detect flags merged to same set of enum. TODO SITMRIDR.

```
static inline status_t EP_GetPortDiscardStatistic(ep_handle_t *handle, bool useTx,  
                                                  netc_port_discard_statistic_t *statistic)
```

Get the ENETC port discard statistic and reason.

Get the discarded count of frames and its reasons.

Parameters

- `handle` –
- `useTx` – true - Tx port. false - Rx port.
- `statistic` – pointer to the statistic data

Returns`status_t`

```
static inline status_t EP_ClearPortDiscardReason(ep_handle_t *handle, bool useTx, uint32_t  
                                                  reason0, uint32_t reason1)
```

Clean the EP Port Rx discard reason. Set the related bits to 1 to clear the specific reasons.

Parameters

- `handle` –

- useTx – true - Tx port. false - Rx port.
- reason0 –
- reason1 –

Returns

status_t

static inline uint32_t EP_GetPortTGSLStatus(*ep_handle_t* *handle)

Get EP port time gate scheduling gate list status.

Parameters

- handle –

Returns

Port status flags which are ORed by the enumerators in the netc_port_tgsl_status_t

2.75 Endpoint (EP) Egress data path configuration

status_t EP_TxTGSCfgAdminGcl(*ep_handle_t* *handle, *netc_tb_tgs_gcl_t* *config)

Config the Time Gate Scheduling entry admin gate control list.

This function is used to program the Enhanced Scheduled Transmisson. (IEEE802.1Qbv)

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t EP_TxPortTGSEnable(*ep_handle_t* *handle, bool enable, uint8_t gateState)

Enable the EP port time gate scheduling.

Parameters

- handle –
- enable –
- gateState –

Returns

status_t

status_t EP_TxtTGSGetOperGcl(*ep_handle_t* *handle, *netc_tb_tgs_gcl_t* *gcl, uint32_t length)

Get Time Gate Scheduling entry operation gate control list.

This function is used to read the Enhanced Scheduled Transmisson. (IEEE802.1Qbv)

Parameters

- handle –
- gcl –
- length –

Returns

status_t

Returns

See `netc_cmd_error_t`

```
status_t EP_TxTrafficClassConfig(ep_handle_t *handle, netc_hw_tc_idx_t tcIdx, const  
                                netc_port_tx_tc_config_t *config)
```

Config the TC (traffic class) property.

Parameters

- `handle` –
- `tcIdx` –
- `config` –

Returns

`status_t`

```
static inline void EP_TxTcConfigPreemption(ep_handle_t *handle, netc_hw_tc_idx_t tcIdx, const  
                                           bool enable)
```

Config Preemption for each port TC (traffic class)

Parameters

- `handle` –
- `tcIdx` –
- `enable` –

```
static inline void EP_TxGetTcPreemption(ep_handle_t *handle, netc_hw_tc_idx_t tcIdx, bool  
                                       *enabled)
```

Get Preemption configuration for each port TC (traffic class)

Parameters

- `handle` –
- `tcIdx` –
- `enabled` –

```
static inline void EP_TxPortEthMacConfigPreemption(ep_handle_t *handle, const  
                                                  netc_port_preemption_config *config)
```

Configure Preemption control configuration for an ethernet MAC.

Parameters

- `handle` –
- `config` –

```
static inline void EP_TxPortGetEthMacPreemption(ep_handle_t *handle,  
                                              netc_port_preemption_config *config,  
                                              netc_port_phy_mac_preemption_status_t  
                                              *status)
```

Get Preemption configuration from ethernet MAC port.

Parameters

- `handle` –
- `config` –
- `status` –

2.76 Endpoint (EP) Transmit/Receive

enum `_ep_rx_flags`

Values:

enumerator `kEP_RX_RSS_VALID`

Request timestamp.

enumerator `kEP_RX_VLAN_VALID`

Specify frame departure time.

enumerator `kEP_RX_TIMESTAMP_VALID`

Enable port masquerading.

enum `_ep_tx_opt_flags`

Values:

enumerator `kEP_TX_OPT_REQ_TS`

Request timestamp (IEEE 1588 PTP two-step timestamp).

enumerator `kEP_TX_OPT_VLAN_INSERT`

Enable VLAN insert.

enumerator `kEP_TX_OPT_START_TIME`

Specify frame departure time.

typedef enum `_ep_rx_flags` `ep_rx_flags_t`

typedef enum `_ep_tx_opt_flags` `ep_tx_opt_flags`

typedef struct `_ep_tx_offload` `netc_tx_offload_t`

typedef struct `_ep_tx_opt` `ep_tx_opt`

`status_t` `EP_SendFrameCommon`(`ep_handle_t` *handle, `netc_tx_bdr_t` *txBdRing, `uint8_t` hwRing, `netc_frame_struct_t` *frame, `void` *context, `netc_tx_bd_t` *txDesc, `bool` txCacheMaintain)

Common part for transfer regular frame or Switch management frame.

Note: This function is internal used. Please use `EP_SendFrame()` or `SWT_SendFrame()` API to send frames.

Parameters

- handle –
- txBdRing – The Transmit buffer descriptor ring handle
- hwRing – The hardware Tx ring index
- frame – The frame descriptor pointer
- context – Private context provided back by `ep_reclaim_cb_t`
- txDesc – Point to the Transmits BD Description array.
- txCacheMaintain – Enable/Disable Tx buffer Cache Maintain.

Return values

`status_t` –

```
status_t EP_SendFrame(ep_handle_t *handle, uint8_t ring, netc_frame_struct_t *frame, void
                    *context, ep_tx_opt *opt)
```

Transmits a frame for specified ring. This API is zero-copy and requires the ep_reclaim_cb_t to be called to free the transmitted frame.

Parameters

- handle –
- ring – The ring index
- frame – The frame descriptor pointer
- context – Private context provided back by ep_reclaim_cb_t
- opt – Additional tx options. If NULL, default is tx timestamping enabled, no start time and no masquerading.

Return values

status_t –

```
static inline void EP_WaitUntilTxComplete(ep_handle_t *handle, uint8_t ring)
```

Wait until the EP Tx ring has completed the transfer.

Note: Only call after EP_SendFrame() to do a no-interrupt transfer

Parameters

- handle –
- ring – The ring index

```
netc_tx_frame_info_t *EP_ReclaimTxDescCommon(ep_handle_t *handle, netc_tx_bdr_t *txBdRing,
                                             uint8_t hwRing, bool enCallback)
```

Common part of Reclaim tx descriptors for regular frame or Switch management frame.

Note: This function is internal used. Please use EP_ReclaimTxDescriptor() or SWT_ReclaimTxDescriptor() API to Reclaim tx descriptors.

Parameters

- handle –
- txBdRing – The Transmit buffer descriptor ring handle
- hwRing – The hardware Tx ring index
- enCallback – Enable/Disable call the Tx Reclaim callback functions.

```
void EP_ReclaimTxDescriptor(ep_handle_t *handle, uint8_t ring)
```

Reclaim tx descriptors. This function is used to update the tx descriptor status and get the tx timestamp. For each reclaimed transmit frame the ep_reclaim_cb_t is called.

This is called after being notified of a transmit completion from ISR. It runs until there are no more frames to be reclaimed in the BD ring.

Parameters

- handle –
- ring – The ring index

```
status_t EP_ReceiveFrameCommon(ep_handle_t *handle, netc_rx_bdr_t *rxBdRing, uint8_t ring,
                               netc_frame_struct_t *frame, netc_frame_attr_t *attr, bool
                               rxCacheMaintain)
```

Common part of receives one frame with zero copy from specified ring.

Note: This function is internal used. Please use EP_ReceiveFrame() or SWT_ReceiveFrame() API.

Parameters

- handle –
- rxBdRing – Rx BD ring handle
- ring – Ring index
- frame – Frame buffer point
- attr – Frame attribute pointer
- rxCacheMaintain – Enable/Disable Rx buffer Cache maintain

Returns

status_t

```
status_t EP_ReceiveFrame(ep_handle_t *handle, uint8_t ring, netc_frame_struct_t *frame,
                        netc_frame_attr_t *attr)
```

Receives one frame with zero copy from specified ring.

Note: The sufficient rx frame data structure MUST be provided by application.

Parameters

- handle –
- ring – The ring index
- frame – The frame descriptor pointer
- attr – Frame attribute pointer

Returns

kStatus_Success Successfully receive a regular frame

Returns

kStatus_NETC_RxHRNotZeroFrame Frame in Rx BD ring is management frame, need call SWT_ReceiveFrame()

Returns

kStatus_NETC_RxTsrResp Frame in Rx BD ring is Transmit Timestamp Reference Response messages, need call SWT_GetTimestampRefResp() to get Transmit Timestamp Reference Response

Returns

kStatus_NETC_RxFrameEmpty Rx BD ring is empty

Returns

kStatus_NETC_RxFrameError Frame in Rx BD ring has error, need be dropped

Returns

kStatus_InvalidArgument Rx BD ring index is out of range

Returns

kStatus_NETC_LackOfResource Application provided buffer is not enough

void EP_DropFrame(*ep_handle_t* *handle, *netc_rx_bdr_t* *rxBdRing, uint8_t ring)
Drop one frame.

Note: This function is internal used.

Parameters

- handle –
- rxBdRing – Rx BD ring handle
- ring – Ring index

status_t EP_ReceiveFrameCopyCommon(*ep_handle_t* *handle, *netc_rx_bdr_t* *rxBdRing, uint8_t ring, void *buffer, uint32_t length, *netc_frame_attr_t* *attr, bool rxCacheMaintain)

Common part of receive regular frame or Switch management frame which will be copied in the provided buffer.

Note: This function is internal used. Please use EP_ReceiveFrameCopy() or SWT_ReceiveFrameCopy() API.

Parameters

- handle –
- rxBdRing – Rx BD ring handle
- ring – Ring index
- buffer – Buffer address
- length – Buffer length
- attr – Frame attribute pointer
- rxCacheMaintain – Enable/Disable Rx buffer Cache maintain

Returns

status_t

status_t EP_ReceiveFrameCopy(*ep_handle_t* *handle, uint8_t ring, void *buffer, uint32_t length, *netc_frame_attr_t* *attr)

Receives one frame which will be copied in the provided buffer from specified ring.

Note: The buffer size MUST be queried using EP_GetRxFrameSize() beforehand.

Parameters

- handle –
- ring – Ring index
- buffer – Buffer address
- length – Buffer length
- attr – Frame attribute pointer

Returns

kStatus_Success Successfully receive a regular frame

Returns

kStatus_InvalidArgument Rx BD ring index is out of range

status_t EP_GetRxFramSizeCommon(*ep_handle_t* *handle, *netc_rx_bdr_t* *rxBdRing, *uint32_t* *length)

Common part of get pending frame size API for regular frame or Switch management frame.

Note: This function is internal used. Please use EP_GetRxFramSize() or SWT_GetRxFramSize() API.

Parameters

- handle –
- rxBdRing – Rx BD ring handle
- length – The length of the valid frame received.

Returns

status_t

status_t EP_GetRxFramSize(*ep_handle_t* *handle, *uint8_t* ring, *uint32_t* *length)

Gets the size of the pending frame in the specified receive ring buffer.

Note: Frame size without FCS

Parameters

- handle – The ENET handler structure. This is the same handler pointer used in the ENET_Init.
- ring – The ring index
- length – The length of the valid frame received.

Returns

kStatus_Success Successfully get the length of a regular frame

Returns

kStatus_NETC_RxHRNotZeroFrame Frame in Rx BD ring is management frame, need call SWT_GetRxFramSize() to get frame size

Returns

kStatus_NETC_RxTsrResp Frame in Rx BD ring is Transmit Timestamp Reference Response messages, need call SWT_GetTimestampRefResp() to get Transmit Timestamp Reference Response

Returns

kStatus_NETC_RxFramEmpty Rx BD ring is empty

Returns

kStatus_NETC_RxFramError Frame in Rx BD ring has error, need be dropped

Returns

kStatus_InvalidArgument Rx BD ring index is out of range

struct __ep_tx_offload

#include <fsl_netc_endpoint.h>

Public Members

`bool lso`
Large send offload.

`bool l4Checksum`
L4 checksum offload.

`bool ipv4Checksum`
IPv4 checksum offload.

`uint32_t lsoMaxSegSize`
Large send offload maximum segment size.

`uint32_t l4Type`
L4 type. 1-UDP, 2-TCP.

`uint32_t l3Type`
L3 type. 0-IPv4, 1-IPv6.

`uint32_t l3HeaderSize`
L3 IP header size in units of 32-bit words.

`uint32_t l3Start`
Offset of the IPv4/IPv6 header in units of bytes.

`struct _ep_tx_opt`
#include <fsl_netc_endpoint.h>

Public Members

`uint32_t flags`
A bitmask of `ep_tx_opt_flags`

`uint32_t timestamp`
Departure timestamp, used if `KEP_TX_OPT_START_TIME` is set

`netc_enetc_vlan_tag_t vlan`
VLAN tag which will be inserted, used if `KEP_TX_OPT_VLAN_INSERT` is set

2.77 Hardware layer

`enum _netc_hw_enetc_idx`
ENETC index enumerator.

Values:

enumerator `kNETC_ENETC0`
ENETC hardware 0

enumerator `kNETC_ENETC1`
ENETC hardware 0

`enum _netc_hw_switch_idx`
SWITCH index enumerator.

Values:

enumerator `kNETC_SWITCH0`
SWITCH hardware 0

enum _netc_hw_port_idx

Port Resource for the NETC module.

Values:

enumerator kNETC_ENETC0Port

MAC port for ENETC0

enumerator kNETC_ENETC1Port

Pseudo MAC port for ENETC1

enumerator kNETC_SWITCH0Port0

MAC port0 for SWITCH

enumerator kNETC_SWITCH0Port1

MAC port1 for SWITCH

enumerator kNETC_SWITCH0Port2

MAC port2 for SWITCH

enumerator kNETC_SWITCH0Port3

MAC port3 for SWITCH

enumerator kNETC_SWITCH0Port4

Pseudo port4 for SWITCH

enum _netc_hw_tc_idx

Traffic class enumerator.

Values:

enumerator kNETC_TxTC0

Traffic class 0

enumerator kNETC_TxTC1

Traffic class 1

enumerator kNETC_TxTC2

Traffic class 2

enumerator kNETC_TxTC3

Traffic class 3

enumerator kNETC_TxTC4

Traffic class 4

enumerator kNETC_TxTC5

Traffic class 5

enumerator kNETC_TxTC6

Traffic class 6

enumerator kNETC_TxTC7

Traffic class 7

enum _netc_hw_bdr_idx

Enumeration for the ENETC SI BDR identifier.

Values:

enumerator kNETC_BDR0

enumerator kNETC_BDR1

enumerator kNETC_BDR2
enumerator kNETC_BDR3
enumerator kNETC_BDR4
enumerator kNETC_BDR5
enumerator kNETC_BDR6
enumerator kNETC_BDR7
enumerator kNETC_BDR8
enumerator kNETC_BDR9
enumerator kNETC_BDR10
enumerator kNETC_BDR11
enumerator kNETC_BDR12
enumerator kNETC_BDR13

enum _netc_hw_swt_cbdr_idx

Switch command BD ring index enumerator.

Values:

enumerator kNETC_SWTCBDR0
 Switch command BD ring 0
enumerator kNETC_SWTCBDR1
 Switch command BD ring 1

enum _netc_hw_class_queue_idx

Enumerator for ETM class queue identifier.

Values:

enumerator kNETC_ClassQueue0
 ETM Class Queue 0
enumerator kNETC_ClassQueue1
 ETM Class Queue 1
enumerator kNETC_ClassQueue2
 ETM Class Queue 2
enumerator kNETC_ClassQueue3
 ETM Class Queue 3
enumerator kNETC_ClassQueue4
 ETM Class Queue 4
enumerator kNETC_ClassQueue5
 ETM Class Queue 5
enumerator kNETC_ClassQueue6
 ETM Class Queue 6
enumerator kNETC_ClassQueue7
 ETM Class Queue 7

enum _netc_hw_congestion_group_idx

Enumerator for the ETM congestion group.

Values:

enumerator kNETC_CongGroup0

enumerator kNETC_CongGroup1

enum _netc_hw_mii_mode

Defines the MII/RGMII mode for data interface between the MAC and the PHY.

Values:

enumerator kNETC_XgmiiMode

XGMII mode for data interface.

enumerator kNETC_MiiMode

MII mode for data interface.

enumerator kNETC_GmiiMode

GMII mode for data interface.

enumerator kNETC_RmiiMode

RMII mode for data interface.

enumerator kNETC_RgmiiMode

RGMII mode for data interface.

enumerator kNETC_SgmiiMode

SGMII mode for data interface.

enum _netc_hw_mii_speed

Defines the speed for the *MII data interface.

Values:

enumerator kNETC_MiiSpeed10M

Speed 10 Mbps.

enumerator kNETC_MiiSpeed100M

Speed 100 Mbps.

enumerator kNETC_MiiSpeed1000M

Speed 1000 Mbps.

enumerator kNETC_MiiSpeed2500M

Speed 2500 Mbps.

enumerator kNETC_MiiSpeed5G

Speed 5Gbps.

enumerator kNETC_MiiSpeed10G

Speed 10Gbps Mbps.

enum _netc_hw_mii_duplex

Defines the half or full duplex for the MII data interface.

Values:

enumerator kNETC_MiiHalfDuplex

Half duplex mode.

enumerator kNETC_MiiFullDuplex

Full duplex mode.

typedef enum *_netc_hw_enetc_idx* netc_hw_enetc_idx_t
ENETC index enumerator.

typedef enum *_netc_hw_switch_idx* netc_hw_switch_idx_t
SWITCH index enumerator.

typedef enum *_netc_hw_port_idx* netc_hw_port_idx_t
Port Resource for the NETC module.

typedef enum *_netc_hw_tc_idx* netc_hw_tc_idx_t
Traffic class enumerator.

typedef enum *_netc_hw_bdr_idx* netc_hw_bdr_idx_t
Enumeration for the ENETC SI BDR identifier.

typedef enum *_netc_hw_swt_cbdr_idx* netc_hw_swt_cbdr_idx_t
Switch command BD ring index enumerator.

typedef enum *_netc_hw_classs_queue_idx* netc_hw_etm_class_queue_idx_t
Enumerator for ETM class queue identifier.

typedef enum *_netc_hw_congestion_group_idx* netc_hw_congestion_group_idx_t
Enumerator for the ETM congestion group.

typedef enum *_netc_hw_mii_mode* netc_hw_mii_mode_t
Defines the MII/RGMII mode for data interface between the MAC and the PHY.

typedef enum *_netc_hw_mii_speed* netc_hw_mii_speed_t
Defines the speed for the *MII data interface.

typedef enum *_netc_hw_mii_duplex* netc_hw_mii_duplex_t
Defines the half or full duplex for the MII data interface.

typedef struct *_netc_psfp_kc_profile* netc_isi_kc_rule_t
NETC PSFP kc profile configuration, the key size (not include the spmp and portp) is up to 16 bytes.

typedef struct *_netc_vlan_classify_config* netc_vlan_classify_config_t
NETC Vlan classification config.

typedef struct *_netc_qos_classify_profile* netc_qos_classify_profile_t
NETC Qos Classification profile file (vlan PCP/DEI to IPV/DR map)

typedef struct *_netc_ipf_config* netc_ipf_config_t
NETC Ingress Filter config.

typedef struct *_netc_func* netc_func_t
Register groups for the PCIe function.

typedef struct *_netc_port_hw* netc_port_hw_t
Register groups for the Port/Link hardware.

typedef struct *_netc_enetc_hw* netc_enetc_hw_t
Register group for the ENETC peripheral hardware.

typedef struct *_netc_timer_hw* netc_timer_hw_t
Register group for the Timer peripheral hardware.

typedef struct *_netc_mdio_hw* netc_mdio_hw_t
Register group for both EMDIO and port external MDIO.

getSiInstance(si)

Get SI information from netc_hw_si_idx_t.

The ENETC instance of this SI.

getSiNum(si)

The SI number in the ENETC.

getSiIdx(si)

The actual index in the netc_hw_si_idx_t.

NETC_MSIX_TABLE_OFFSET

MSIX table address offset.

NETC_MSIX_TABLE_PBA_OFFSET

MSIX PBA address offset.

NETC_NANOSECOND_ONE_SECOND

Nanosecond in one second.

struct __netc_psfpc_profile

#include <fsl_net.h> NETC PSFP profile configuration, the key size (not include the spmp and portp) is up to 16 bytes.

Public Members

bool etp

2 Byte Ethertype field present in the key

bool sqtp

1 Byte Sequence Tag present in the key

bool ipcpp

inner VLAN header's PCP field present in the key

bool ividp

inner VLAN ID present in the key

bool opcpp

outer VLAN header's PCP field present in the key

bool ovidp

outer VLAN ID present in the key

bool smacp

6 bytes of source MAC address present in the key

bool dmacp

6 bytes of destination MAC address present in the key

bool spmp

switch port masquerading flag present in the key

bool portp

source port present in the key

bool valid

Key Construction is valid

struct __netc_vlan_classify_config

#include <fsl_net.h> NETC Vlan classification config.

Public Members

`bool enableCustom1`
Enable/Disable custom0 ether type

`uint16_t custom1EtherType`
Ethertype

`bool enableCustom2`
Enable/Disable custom0 ether type

`uint16_t custom2EtherType`
Ethertype

`uint16_t preStandRTAGType`
802.1CB draft 2.0 R-TAG Ethertype value. PSRTAGETR. Only applicable for switch

`struct __netc_qos_classify__profile`
#include <fsl_netc.h> NETC Qos Classification profile file (vlan PCP/DEI to IPV/DR map)

Public Members

`uint8_t ipv[16]`
Index is created from PCP (3 bits) + DEI (1 bit) field. Value is the mapped IPV for Qos.

`uint8_t dr[16]`
Index is created from PCP (3 bits) + DEI (1 bit) field. Value is the mapped DR for QoS.

`struct __netc_ipf_config`
#include <fsl_netc.h> NETC Ingress Filter config.

Public Members

`bool l2DiscardMCSmac`
DOSL2CR. Discard received frames with Multicast SMAC address

`bool l2DiscardSmacEquDmac`
DOSL2CR. Discard received frames with SMAC = DMAC

`bool l3DiscardSipEquDip`
DOSL3CR. Discard IPV3/IPV6 source address == destination address

`struct __netc_func`
#include <fsl_netc_hw.h> Register groups for the PCIe function.

`struct __netc_port_hw`
#include <fsl_netc_hw.h> Register groups for the Port/Link hardware.

Public Members

`NETC_PORT_Type *port`
Port Address

`struct __netc_enetc_hw`
#include <fsl_netc_hw.h> Register group for the ENETC peripheral hardware.

Public Members

netc_func_t func
PCIE function register

NETC_ENETC_Type *base
Base register of ENETC module

NETC_SW_ENETC_Type *common
Common register of ENETC module

netc_port_hw_t portGroup
Port register group

ENETC_GLOBAL_Type *global
Global NETC address

ENETC_SI_Type *si
Station Interface for the P/V SI

netc_msix_entry_t *msixTable
MSIX table address

struct _netc_timer_hw
#include <fsl_netc_hw.h> Register group for the Timer peripheral hardware.

Public Members

ENETC_PCI_TYPE0_Type *func
PCIE function register

ENETC_PF_TMR_Type *base
Base register address for timer module

ENETC_GLOBAL_Type *global
Global NETC register address

netc_msix_entry_t *msixTable
MSIX table address

struct _netc_mdio_hw
#include <fsl_netc_hw.h> Register group for both EMDIO and port external MDIO.

Public Members

__IO uint32_t EMDIO_CFG
External MDIO configuration register, offset: 0x1C00

__IO uint32_t EMDIO_CTL
External MDIO interface control register, offset: 0x1C04

__IO uint32_t EMDIO_DATA
External MDIO interface data register, offset: 0x1C08

__IO uint32_t EMDIO_ADDR
External MDIO register address register, offset: 0x1C0C

__IO uint32_t EMDIO_STAT
External MDIO status register, offset: 0x1C10

__IO uint32_t PHY_STATUS_CFG
PHY status configuration register, offset: 0x1C20

__IO uint32_t PHY_STATUS_CTL
PHY status control register, offset: 0x1C24

__IO uint32_t PHY_STATUS_DATA
PHY status data register, offset: 0x1C28

__IO uint32_t PHY_STATUS_ADDR
PHY status register address register, offset: 0x1C2C

__IO uint32_t PHY_STATUS_EVENT
PHY status event register, offset: 0x1C30

__IO uint32_t PHY_STATUS_MASK
PHY status mask register, offset: 0x1C34

struct payload

Public Members

uint8_t lbMask
Payload Last Byte Mask

uint8_t fbMask
Payload First Byte Mask

uint8_t byteOffset
Payload Byte Offset where field extraction begins

uint8_t numBytes
Specify the size (numBytes + 1) of the payload key field

uint8_t pfp
Payload field Present

union __unnamed212__

Public Members

ENETC_PCI_TYPE0_Type *pf
PSI function

ENETC_VF_PCI_TYPE0_Type *vf
VSI function

union __unnamed214__

Public Members

NETC_ETH_LINK_Type *eth
MAC Port Address

2.78 Hardware Common Functions

```
static inline uint16_t EP_IncreaseIndex(uint16_t index, uint32_t max)
```

```
uint16_t NETC_SIGetVsiIndex(netc_vsi_number_t vsi)
```

Get the VSI index.

Parameters

- vsi – The VSI number.

```
static inline void NETC_IPFInit(NETC_SW_ENETC_Type *base, const netc_ipf_config_t *config)
```

Set layer2/3 Dos configuration.

Parameters

- base –
- config –

```
void NETC_PSFpKcProfileInit(NETC_SW_ENETC_Type *base, const netc_isi_kc_rule_t *rule, bool  
enKcPair1)
```

Initialize the Ingress Stream Identification Key construction rule profiles.

Parameters

- base –
- rule –
- enKcPair1 –

Returns

void

```
void NETC_RxVlanCInit(NETC_SW_ENETC_Type *base, const netc_vlan_classify_config_t  
*config, bool enRtag)
```

Initialize the customer vlan type.

Parameters

- base –
- config –
- enRtag –

Returns

void

```
void NETC_RxQoSInit(NETC_SW_ENETC_Type *base, const netc_qos_classify_profile_t *profile,  
bool enProfile1)
```

Initialize the ingress QoS classification.

Parameters

- base –
- profile –
- enProfile1 –

2.79 Hardware ENETC

typedef struct *_netc_enetc_vlan_tag_t* netc_enetc_vlan_tag_t

ENETC Port outer/inner VLAN tag.

typedef struct *_netc_enetc_discard_statistic* netc_enetc_port_discard_statistic_t

PORT discard count statistic.

typedef struct *_netc_enetc_native_vlan_config_t* netc_enetc_native_vlan_config_t

ENETC Port outer/inner native VLAN config.

typedef struct *_netc_enetc_parser_config_t* netc_enetc_parser_config_t

ENETC parser configuration.

typedef struct *_netc_enetc_cap* netc_enetc_cap_t

ENETC capability.

static inline bool NETC_EnetcHasManagement(NETC_ENETC_Type *base)

Check whether ENETC has switch management capability.

Parameters

- base – NETC peripheral base address.

Returns

true or false

void NETC_EnetcGetCapability(NETC_ENETC_Type *base, *netc_enetc_cap_t* *capability)

Get ENETC capability.

Parameters

- base – NETC peripheral base address.
- capability – Pointer to capability structure.

void NETC_EnetcSetSIMacAddr(NETC_ENETC_Type *base, uint8_t si, uint8_t *macAddr)

Set MAC address for specified VSI of ENETC.

Parameters

- base –
- macAddr –

status_t NETC_EnetcConfigureSI(NETC_ENETC_Type *base, uint8_t si, const
netc_hw_enetc_si_config_t *psConfig)

Configure SI.

Parameters

- base – ENETC peripheral base address.
- si – The SI number
- psConfig – The SI configuration

Returns

status_t

status_t NETC_EnetcSetMsixEntryNum(NETC_ENETC_Type *base, uint8_t si, uint32_t msixNum)

Set SI MSIX table entry number.

Parameters

- base – ENETC peripheral base address.
- si – The SI number.
- msixNum – The MSIX table entry number.

Returns

status_t

static inline void NETC__EnetcEnableSI(NETC_ENETC_Type *base, uint8_t si, bool enable)

Enable/Disable specified SI.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- enable – Enable/Disable SI from ENETC layer.

void NETC__EnetcGetPortDiscardStatistic(NETC_ENETC_Type *base,
netc_enetc_port_discard_statistic_t *statistic)

Get ENETC discard statistic data.

Parameters

- base – ENETC peripheral base address.
- statistic – Statistic data.

void NETC__EnetcEnablePromiscuous(NETC_ENETC_Type *base, uint8_t si, bool enableUCPromis,
bool enableMCPromis)

Enable MAC promiscuous mode.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- enableUCPromis – Enable unicast frame promiscuous.
- enableMCPromis – Enable multicast frame promiscuous.

void NETC__EnetcConfigureVlanFilter(NETC_ENETC_Type *base, uint8_t si, netc_si_l2vf_config_t
*config)

Configure VLAN filter.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- config – Enable untagged VLAN frame promiscuous.

void NETC__EnetcAddMacAddrHash(NETC_ENETC_Type *base, uint8_t si, netc_packet_type_t
type, uint8_t hashIndex)

Add the hash filter for the MAC address.

Hardware layer will not maintain the counter of the hash filter. API layer shall cover this requirement.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- type – Unicast or multicast frame type.
- hashIndex – The calculated hash index of MAC address.

```
void NETC__EnetcDelMacAddrHash(NETC_ENETC_Type *base, uint8_t si, netc_packet_type_t type,
                               uint8_t hashIndex)
```

Remove the hash filter for the MAC address.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- type – Unicast or multicast frame type.
- hashIndex – The calculated hash index of MAC address.

```
void NETC__EnetcAddVlanHash(NETC_ENETC_Type *base, uint8_t si, uint8_t hashIndex)
```

Add the hash filter for the VLAN.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- hashIndex – The calculated hash index of MAC address.

```
void NETC__EnetcDelVlanHash(NETC_ENETC_Type *base, uint8_t si, uint8_t hashIndex)
```

Remove the hash filter for the VLAN.

Parameters

- base – ENETC peripheral base address.
- si – SI index.
- hashIndex – The calculated hash index of MAC address.

```
static inline status_t NETC__EnetcPortEnableTSD(NETC_ENETC_Type *base, netc_hw_tc_idx_t
                                                tcIdx, bool isEnabled)
```

Enable / Disable ENETC Port Time Specific Departure (TSD) feature.

It can't work with QBV CBS

Parameters

- base –
- tcIdx –
- isEnabled –

Returns

status_t

```
static inline void NETC__EnetcPortSetNativeVLAN(NETC_ENETC_Type *base, const
                                                netc_enetc_native_vlan_config_t *config, bool
                                                isOuter)
```

Set ENETC Rx native outer/inner VLAN.

It is used for classification when untagged frames are received by the port.

Parameters

- base –
- config –
- isOuter –

```
static inline void NETC__EnetcSetParser(NETC_ENETC_Type *base, const
                                     netc_enetc_parser_config_t *config)
```

Set ENETC Parser configuration.

PARCSCR and PARCE0CR - PARCE3CR.

Parameters

- base –
- config –

```
static inline void NETC__EnetcEnableWakeOnLan(NETC_ENETC_Type *base, bool isEnabled)
Enable / Disable ENETC Wake-on-LAN mode.
```

Only available on ENETC 0

Parameters

- base –
- isEnabled –

Returns

status_t

```
struct __netc_enetc_vlan_tag_t
#include <fsl_netc.h> ENETC Port outer/inner VLAN tag.
```

Public Members

```
uint16_t pcp
    Priority code point
uint16_t dei
    Drop eligible indicator
uint16_t vid
    VLAN identifier
netc_vlan_tpid_select_t tpid
    Tag protocol identifier
```

```
struct __netc_enetc_discard_statistic
#include <fsl_netc.h> PORT discard count statistic.
```

Public Members

```
uint32_t ingressDR[4]
    Discard count for port ingress congestion different DR
uint32_t broadcastReject
    Broadcast frame drops count due to all SI enable broadcast reject
uint32_t smacPruning
    Frames discard count due to port MAC source address pruning
uint32_t unicastMacFilt
    Unicast frame discard count due to port MAC filtering
uint32_t multicastMacFilt
    Multicast frame discard count due to MAC filtering
```

uint32_t unicastVlanFilt
 Unicast frame discard count due to VLAN filtering

uint32_t multicastVlanFilt
 Multicast frame discard count due to VLAN filtering

uint32_t broadcastVlanFilt
 Broadcast frame discard count due to VLAN filtering

struct __netc_enetc_native_vlan_config_t
 #include <fsl_netc.h> ENETC Port outer/inner native VLAN config.

Public Members

bool enUnderZeroVid
 Enable use the port default VLAN VID when the VID in the packet's is zero

bool enUnderNoVlan
 Enable use the port default VLAN VID when the VLAN tag is not present

netc_enetc_vlan_tag_t vlanTag
 Port native outer/inner VLAN tag, valid when enUnderZeroVid or enUnderNoVlan is true

struct __netc_enetc_parser_config_t
 #include <fsl_netc.h> ENETC parser configuration.

Public Members

bool disL3Checksum
 Disable Layer 3 IPv4 Header checksum validation.

bool disL4Checksum
 Disable Layer 4 TCP and UDP checksum validation.

struct __netc_enetc_cap
 #include <fsl_netc_hw_enetc.h> ENETC capability.

Public Members

bool funcSafety
 Support for safety capability.

bool wol
 Support for Wake-on-LAN in low-power mode.

bool rss
 Support for RSS.

bool tsd
 Support for time specific departure.

bool rfs
 Support for RFS.

uint32_t ipvNum
 IPV number.

`uint32_t vsiNum`
VSI number.

`uint32_t msixNum`
MSIX table vector/entry number.

`uint32_t tcsNum`
Traffic class number.

`uint16_t uchNum`
Unicast hash entry number.

`uint16_t mchNum`
Multicast hash entry number.

`uint16_t rxBdrNum`
Rx BD ring number.

`uint16_t txBdrNum`
Tx BD ring number.

`struct custEtype`

Public Members

`uint16_t etype`
Custom Ethertype value. Upon detecting this ether type the associated code point will be mapped to the parse summary as a Non IP code point.

`bool en`
Enables the detection and mapping.

`uint8_t cp`
This value is mapped to the parse summary as a Non IP code point.

2.80 Hardware Port

`enum __netc_port_tgsl_status`
Port time gate scheduling gate list status.

Values:

`enumerator kNETC_OperListActive`
Port operational gate control list is active.

`enumerator kNETC_AdminListPending`
Administrative gate control list is pending (configured but not installed yet).

`enum __netc_port_discard_tpye`
Port Tx/Rx discard counter in the datapath processing pipeline or bridge forwarding processing function.

Values:

`enumerator kNETC_RxDiscard`
Discarded frames in the receive port datapath processing pipeline.

`enumerator kNETC_TxDiscard`
Discarded frames in the egress datapath processing pipeline, only for switch.

enumerator kNETC_BridgeDiscard

Discarded frames in the bridge forwarding processing function, only for switch.

enum __netc_port_tpidlist

Defines Port TPID acceptance.

Values:

enumerator kNETC_OuterStanCvlan

Accept outer Standard C-VLAN 0x8100.

enumerator kNETC_OuterStanSvlan

Accept outer Standard S-VLAN 0x88A8.

enumerator kNETC_OuterCustomVlan1

Accept outer Custom VLAN as defined by CVLANR1[ETYPE].

enumerator kNETC_OuterCustomVlan2

Accept outer Custom VLAN as defined by CVLANR2[ETYPE].

enumerator kNETC_InnerStanCvlan

Accept inner Standard C-VLAN 0x8100.

enumerator kNETC_InnerStanSvlan

Accept inner Standard S-VLAN 0x88A8.

enumerator kNETC_InnerCustomVlan1

Accept inner Custom VLAN as defined by CVLANR1[ETYPE].

enumerator kNETC_InnerCustomVlan2

Accept inner Custom VLAN as defined by CVLANR2[ETYPE].

enum __netc_port_ts_select

Defines port timestamp selection.

Values:

enumerator kNETC_SyncTime

Synchronized time.

enumerator kNETC_FreeRunningTime

Free running time.

enum __netc_hw_preemption_mode

Port MAC preemption mode.

Values:

enumerator kNETC_PreemptDisable

Frame preemption is not enabled

enumerator kNETC_PreemptOn64B

Frame preemption is enabled, but transmit only preempts frames on 64B boundaries

enumerator kNETC_PreemptOn4B

Frame preemption is enabled, but transmit only preempts frames on 4B boundaries

enum __netc_hw_raf_size

Port MAC Remote Additional Fragment Size.

Values:

enumerator kNETC_RafSize64

Additional Fragment Size of 64 octets

enumerator kNETC_RafSize128
Additional Fragment Size of 128 octets

enumerator kNETC_RafSize256
Additional Fragment Size of 256 octets

enumerator kNETC_RafSize512
Additional Fragment Size of 512 octets

enum __netc_tc_sdu_type
Type of PDU/SDU (Protocol/Service Data Unit).

Note: Overhead values which adding to the transmitted frame of Length are specified by Port SDU config as follows:

- PPDU = add rxPpduBco/txPpduBco + rxMacsecBco/txMacsecBco bytes
 - MPDU = add rxMacsecBco/txMacsecBco bytes
 - MSDU = minus 16B (12B MAC Header + 4B FCS)
-

Values:

enumerator kNETC_PDU
Physical Layer PDU, Preamble, IFG, SFD along with MPDU. Not supported if cut-through frames are expected

enumerator kNETC_MPDU
MAC PDU, MAC Header, MSDU and FCS

enumerator kNETC_MSDU
MAC SDU, MPDU minus 12B MAC Header and 4B FCS. Not supported if cut-through frames are expected

enum __netc_port_sg_ogc_mode
Defines the Port's Stream Gate Open Gate Check mode.

Values:

enumerator kNETC_SGCheckSFD
Check whether frame SFD is within the open gate interval.

enumerator kNETC_SGCheckEntire
Check whether the entire frame is within the open gate interval.

enum __netc_port_intr_flags

Values:

enumerator kNETC_TxEmptyFlag
Tx FIFO empty flag.

enumerator kNETC_RxEmptyFlag
Rx FIFO empty flag.

enumerator kNETC_TxOverflowFlag
Tx overflow flag.

enumerator kNETC_TxUnderflowFlag
Tx underflow flag.

enumerator kNETC_RxOverflowFlag
Rx overflow flag.

enumerator `kNETC_MagicPacketFlag`

Magic packet detection indication flag.

enumerator `kNETC_TxClkStopFlag`

Tx clock stop detection flag.

enumerator `kNETC_RxClkStopFlag`

Rx clock stop detection flag.

enumerator `kNETC_SpeedDuplexChangeFlag`

Speed/Duplex Change flag

enumerator `kNETC_MacMergeSMDErrFlag`

MAC merge frame SMD error received event flag

enumerator `kNETC_MacMergeAssemblyErrFlag`

MAC merge frame assembly error event flag

enum `_netc_port_loopback_mode_t`

Defines the port MAC frame loopback mode.

Values:

enumerator `kNETC_PortLpbWithExtTxClk`

Port MAC frame loopback with external Tx clock.

enumerator `kNETC_PortLpbWithIntTxClk`

Port MAC frame loopback with internal Tx clock.

typedef enum `_netc_port_tgsl_status` `netc_port_tgsl_status_t`

Port time gate scheduling gate list status.

typedef enum `_netc_port_discard_tpye` `netc_port_discard_tpye_t`

Port Tx/Rx discard counter in the datapath processing pipeline or bridge forwarding processing function.

typedef enum `_netc_port_tpidlist` `netc_port_tpidlist_t`

Defines Port TPID acceptance.

typedef enum `_netc_port_ts_select` `netc_port_ts_select_t`

Defines port timestamp selection.

typedef struct `_netc_port_qos_mode` `netc_port_qos_mode_t`

Port Qos mode.

typedef struct `_netc_port_parser_config` `netc_port_parser_config_t`

Port Parser config.

typedef struct `_netc_port_tg_config` `netc_port_tg_config_t`

Port time gate config.

typedef struct `_netc_port_tg_preemption_config` `netc_port_tg_preemption_config`

Port time gate config when used with Frame Preemption.

typedef enum `_netc_hw_preemption_mode` `netc_hw_preemption_mode_t`

Port MAC preemption mode.

typedef enum `_netc_hw_raf_size` `netc_hw_raf_size_t`

Port MAC Remote Additional Fragment Size.

typedef struct `_netc_port_preemption_config` `netc_port_preemption_config`

Frame Preemption Portconfig.

```
typedef struct _netc_port_tc_cbs_config netc_port_tc_cbs_config_t
```

Configuration for the Credit Based Shaped for port TC.

Note: The 802.1Qav bandwidth availability parameters is calculated as follows:

- idleSlope (bits) = portTxRate * bwWeight / 100
 - sendSlope (bits) = portTxRate * (100 - bwWeight) / 100
 - lowCredit (bits) = tcMaxFrameSize * (100 - bwWeight) / 100
 - hiCredit (bits) calculation formula depends on the traffic class, Please refer to the Reference manual.
 - hiCredit (credits) = (enetClockFrequency / portTxRate) * 100 * hiCredit (bits)
-

```
typedef enum _netc_tc_sdu_type netc_tc_sdu_type_t
```

Type of PDU/SDU (Protocol/Service Data Unit).

Note: Overhead values which adding to the transmitted frame of Length are specified by Port SDU config as follows:

- PPDU = add rxPpduBco/txPpduBco + rxMacsecBco/txMacsecBco bytes
 - MPDU = add rxMacsecBco/txMacsecBco bytes
 - MSDU = minus 16B (12B MAC Header + 4B FCS)
-

```
typedef struct _netc_port_tc_sdu_config netc_port_tc_sdu_config_t
```

```
typedef struct _netc_port_tx_tc_config netc_port_tx_tc_config_t
```

Configuration for the port Tx Traffic Class.

```
typedef struct _netc_port_discard_statistic netc_port_discard_statistic_t
```

Switch or ENETC port Tx/Rx/Bridge discard statistic / reason.

```
typedef struct _netc_port_vlan_classify_config netc_port_vlan_classify_config_t
```

Port accepted Vlan classification config.

```
typedef struct _netc_port_qos_classify_configs netc_port_qos_classify_config_t
```

Port Qos Classification Config.

```
typedef struct _netc_port_ipf_config_t netc_port_ipf_config_t
```

Port Ingress Filter Config.

```
typedef struct _netc_port_psf_psi_config netc_port_psf_psi_config
```

PSFP port config.

Port ingress stream identification config

Note: The first stream identification find IS_EID has higher precedence value than the second, and the priority of the IS_EID found by the IPF is specified by the IPF entry RRR bit. The possible orderings are as follows

- RRR = 00b : IPF > enKC0 > enKC1 > defaultISEID
 - RRR = 01b : enKC0 > IPF > enKC1 > defaultISEID
 - RRR = 10b : enKC0 > enKC1 > IPF > defaultISEID
-

```
typedef struct _netc_port_ethmac netc_port_ethmac_t
```

```
typedef enum _netc_port_sg_ogc_mode netc_port_sg_ogc_mode_t
```

Defines the Port's Stream Gate Open Gate Check mode.

```
typedef struct _netc_port_common netc_port_common_t
```

Port common configuration.

```
typedef enum _netc_port_intr_flags netc_port_intr_flags_t
```

```
typedef enum _netc_port_loopback_mode_t netc_port_loopback_mode_t
```

Defines the port MAC frame loopback mode.

```
status_t NETC_PortConfig(NETC_PORT_Type *base, const netc_port_common_t *config)
```

Configure specified PORT.

Parameters

- base – NETC port module base address.
- config – Port configuration structure.

Returns

status_t

```
void NETC_PortSetMacAddr(NETC_PORT_Type *base, const uint8_t *macAddr)
```

Set the MAC address.

Parameters

- handle –
- macAddr –

```
bool NETC_PortIsPseudo(NETC_PORT_Type *base)
```

Check whether this port a pseudo MAC port.

Parameters

- base – PORT peripheral base address.

```
void NETC_PortGetDiscardStatistic(NETC_PORT_Type *base, netc_port_discard_tpye_t  
discardType, netc_port_discard_statistic_t *statistic)
```

Get specified PORT discard counter.

Parameters

- base – NETC port module base address.
- discardType – Port discard type.
- statistic – pointer to the statistic data

```
void NETC_PortClearDiscardReason(NETC_PORT_Type *base, netc_port_discard_tpye_t  
discardType, uint32_t reason0, uint32_t reason1)
```

Clean the Port Rx discard reason. Set the related bits to 1 to clear the specific reasons.

Parameters

- base – NETC port module base address.
- discardType – Port discard type.
- reason0 –
- reason1 –

```
static inline uint32_t NETC_PortGetTGSLStatus(NETC_PORT_Type *base)
```

Get port time gate scheduling gate list status.

Parameters

- base – NETC port module base address.

Returns

Port status flags which are ORed by the enumerators in the `netc_port_tgsl_status_t`

`void NETC_PortEthMacGracefulStop(NETC_PORT_Type *base)`

Do graceful stop for Port Ethernet MAC receive/transmit.

Parameters

- base – NETC port module base address.

`static inline void NETC_PortSetSpeed(NETC_PORT_Type *base, uint16_t pSpeed)`

Set port speed.

Parameters

- base – NETC port module base address.
- pSpeed – Transmit Port Speed = 10Mbps * (pSpeed+1), Used by ETS, Qbu and to determine if cut-through is permissible.

`NETC_PORT_MIN_FRAME_SIZE`

The port supported minimum/maximum frame size.

`NETC_PORT_MAX_FRAME_SIZE`

`struct __netc_port_qos_mode`

#include <fsl_netc.h> Port Qos mode.

Public Members

`uint8_t qosVlanMap`

Transmit QoS to VLAN PCP Mapping Profile index, only active on switch port

`uint8_t vlanQosMap`

Receive VLAN PCP/DE to QoS Mapping Profile index, only active on switch port

`uint8_t defaultIpv`

Port default IPV

`uint8_t defaultDr`

Port default DR

`bool enVlanInfo`

Enable use VLAN info to determine IPV and DR (base on VLANIPVMPaR0/1 and VLAN-DRMPaR)

`bool vlanTagSelect`

True: Outer VLAN, False: Inner VLAN. Active when enVlanInfo is true

`struct __netc_port_parser_config`

#include <fsl_netc.h> Port Parser config.

Public Members

`uint8_t l2PloadCount`

L2 payload fields size in bytes

`bool enableL3Parser`

Enable/Disable parser for L3

uint8_t l3PayloadCount
L3 payload fields size in bytes

bool enableL4Parser
Enable/Disable parser for L4

uint8_t l4PayloadCount
L4 payload fields size in bytes

struct _netc_port_tg_config
#include <fsl_netc.h> Port time gate config.

Public Members

uint16_t advOffset
Advance time offset in ns.

uint32_t holdSkew
Hold-Skew in ns, not effective on ports connected to a pseudo-MAC

struct _netc_port_tg_preemption_config
#include <fsl_netc.h> Port time gate config when used with Frame Preemption.

Public Members

uint16_t holdAdvance
the amount of time in ns prior to the Set-And-Hold-MAC time slot for asserting a Hold request. Used with frame Preemption.

uint16_t releaseAdvance
the amount of time in ns prior to the Set-And-Release-MAC time slot for asserting a Release request. Used with Frame Preemption.

struct _netc_port_preemption_config
#include <fsl_netc.h> Frame Preemption Portconfig.

Public Members

bool enMergeVerify
Enable verify the merged preemption frame, need to enable when preemptMode is not zero

uint8_t mergeVerifyTime
The nominal wait time between verification attempts in milliseconds, range in 1 ~ 128

netc_hw_preemption_mode_t preemptMode
When set to not zero, PMAC frames may be preempted by EMAC frames

netc_hw_raf_size_t raf_size
Additional Fragment Size. Indicates the smallest sized fragments that can be sent on Tx

bool PreemptionActive
Local preemption active. Indicates whether preemption is active for this port. This bit will be set if preemption is both enabled and has completed the verification process

```
struct __netc_port_tc_cbs_config
#include <fsl_netc.h> Configuration for the Credit Based Shaped for port TC.
```

Note: The 802.1Qav bandwidth availability parameters is is calculated as follows:

- $\text{idleSlope (bits)} = \text{portTxRate} * \text{bwWeight} / 100$
 - $\text{sendSlope (bits)} = \text{portTxRate} * (100 - \text{bwWeight}) / 100$
 - $\text{lowCredit (bits)} = \text{tcMaxFrameSize} * (100 - \text{bwWeight}) / 100$
 - hiCredit (bits) calculation formula depends on the traffic class, Please refer to the Reference manual.
 - $\text{hiCredit (credits)} = (\text{enetClockFrequency} / \text{portTxRate}) * 100 * \text{hiCredit (bits)}$
-

Public Members

uint8_t bwWeight

Percentage units of the port transmit rate and the credit-based shaper (range from 0 ~ 100), the sum of all traffic class credit-based shaper's bandwidth cannot exceed 100

uint32_t hiCredit

The maximum allowed accumulation of credits when conflicting transfers occur, in credit units $((\text{enetClockFrequency} / \text{portTxRate}) * 100)$

```
struct __netc_port_tc_sdu_config
#include <fsl_netc.h>
```

Public Members

bool enTxMaxSduCheck

Enable Tx Max SDU check for Store and Forward frames, the frame which greater than maxSduSized will be discarded, Cut-Through frames will always perform Max SDU check

netc_tc_sdu_type_t sduType

Specifies the type of PDU/SDU whose length is being validated as seen on the link

uint16_t maxSduSized

Transmit Maximum SDU size in bytes, the dequeued frame will be discarded when it SDU size exceeds this value

```
struct __netc_port_tx_tc_config
#include <fsl_netc.h> Configuration for the port Tx Traffic Class.
```

Public Members

bool enPreemption

Frames from traffic class are transmitted on the preemptable MAC, not supported on internal port (ENETC 1 port and Switch port 4)

bool enTcGate

Enable the traffic class gate when no gate control list is operational, or when time gate scheduling is disabled.

bool enableTsd

Enable Time Specific Departure traffic class, only applicable to ENETC

bool enableCbs

Enable Credit based shaper for traffic class

netc_port_tc_cbs_config_t cbsCfg

Configure transmit traffic class credit based shaper (PTC0CBSR0/PTC0CBSR1) if enableCbs set to true

struct __netc_port_discard_statistic

#include <fsl_netc.h> Switch or ENETC port Tx/Rx/Bridge discard statistic / reason.

Public Members

uint32_t count

Count of discarded frames. PRXDCR, PTXDCR or BPDCR.

uint32_t reason0

Discard Reason. Find bit detail from PT/RXDCRR0 or BPDCRR0.

uint32_t reason1

Discard Reason. Find bit detail from PT/RXDCRR1 or BPDCRR1.

struct __netc_port_vlan_classify_config

#include <fsl_netc.h> Port accepted Vlan classification config.

Public Members

uint8_t innerMask

Bitmap identifying which TPIDs are acceptable as Inner VLAN tag. See PTAR

uint8_t outerMask

Bitmap identifying which TPIDs are acceptable as Outer VLAN tag. See PTAR

struct __netc_port_qos_classify_configs

#include <fsl_netc.h> Port Qos Classification Config.

Public Members

uint8_t vlanQosMap

Receive VLAN PCP/DE to QoS Mapping Profile index

uint8_t defaultIpv

Port default IPV

uint8_t defaultDr

Port default DR

bool enVlanInfo

Enable use VLAN info to determine IPV and DR, base on VLAN to IPV map (VLANIPVMPaR0/1) and VLAN to DR map (VLANDRMPaR)

bool vlanTagSelect

True: Use received Outer VLAN, False: Use received Inner VLAN. Active when enVlanInfo is true

struct __netc_port_ipf_config_t

#include <fsl_netc.h> Port Ingress Filter Config.

Public Members

`bool enL2Dos`
Enable port L2 Ethernet DoS Protection

`bool enL3Dos`
Enable port L3 IP DoS Protection

`bool enIPFTable`
Enable port IPF lookup

`struct _netc_port_psfpi_si_config`
#include <fsl_net.h> PSFP port config.
Port ingress stream identification config

Note: The first stream identification find IS_EID has higher precedence value than the second, and the priority of the IS_EID found by the IPF is specified by the IPF entry RRR bit. The possible orderings are as follows

- RRR = 00b : IPF > enKC0 > enKC1 > defaultISEID
 - RRR = 01b : enKC0 > IPF > enKC1 > defaultISEID
 - RRR = 10b : enKC0 > enKC1 > IPF > defaultISEID
-

Public Members

`uint16_t defaultISEID`
Default Ingress Stream Entry ID, has lower precedence value than ISI entry and IPF entry defined IS_EID. 0xFFFF means NULL

`bool enKC1`
Enable do the second stream identification with key construction rule 1 or rule 3

`bool enKC0`
Enable do the first stream identification with key construction rule 0 or rule 2

`bool kcPair`
Indicates which Key Construction pair to use for this port, false - user pair0. true - use pair1 only applicable for Switch

`struct _netc_port_ethmac`
#include <fsl_net.h>

Public Members

`bool enableRevMii`
Enable RevMII mode.

`netc_port_ts_select_t txTsSelect`
Tx timestamp clock source.

`bool isTsPointPhy`
True: Timestamp is captured based on PHY SFD detect pulse on Rx and Tx for 2-step timestamping. False: Based on SFD detect at boundary of MAC merge layer and pins/protocol gaskets.

netc_hw_mii_mode_t miiMode

MII mode.

netc_hw_mii_speed_t miiSpeed

MII Speed.

netc_hw_mii_duplex_t miiDuplex

MII duplex.

bool enTxPad

Enable ETH MAC Tx Padding, which will pad the frame to a minimum of 60 bytes and append 4 octets of FCS.

uint8_t rxMinFrameSize

Receive Minimum Frame Length size in bytes, range in 18 ~ 64, received frames shorter than 18B are discarded silently. Both for express MAC and preemptable MAC.

uint16_t rxMaxFrameSize

Receive Maximum Frame Length size in bytes, up to 2000, received frames that exceed this stated maximum are truncated. Both for express MAC and preemptable MAC.

netc_port_preemption_config PreemptionConfig

Frame Preemption configuration

bool rgmiiClkStop

True: RGMII transmit clock is stoppable during low power idle. False: It's not stoppable.

bool enableHalfDuplexFlowCtrl

Enable/Disable half-duplex flow control.

uint16_t maxBackPressOn

Maximum amount of time backpressure can stay asserted before stopping to prevent excess defer on link partner, in byte times.

uint16_t minBackPressOff

Minimum amount of time backpressure will stay off after reaching the ON max, before backpressure can reassert after checking if `icm_pause_notification` is still or again asserted, in byte times.

uint32_t txWakeupTimeCycleEEE

Energy Efficient Ethernet feature. Defines the number of NETC cycles (which represents time) required by the PHY to wait before transmitting a new frame after the application has indicated it wants to end the low power state.

uint32_t txSleepTimeCycleEEE

Energy Efficient Ethernet feature. Defines the number of NETC cycles (which represents time) where Tx is idle before mac transmits low power EEE. A value of 0 does not activate low power EEE transmission.

struct *_netc_port_common*

#include <fsl_netc.h> Port common configuration.

Public Members

netc_port_vlan_classify_config_t acceptTpid

Port acceptable VLAN tpid configure.

netc_port_ts_select_t rxTsSelect

Eth MAC Rx or pseudo MAC Tx timestamp clock source

`uint16_t pSpeed`

Transmit Port Speed = 10Mbps * (pSpeed+1), Used by ETS, Qbu and to determine if cut-through is permissible

`uint8_t rxMacsecBco`

Port receive MACSec byte count overhead which due to MACSec encapsulation

`uint8_t rxPpduBco`

Port receive PPDU Byte count overhead which includes IPG, SFD and Preamble

`uint8_t txMacsecBco`

Port transmit MACSec byte count overhead which due to MACSec encapsulation

`uint8_t txPpduBco`

Port transmit PPDU Byte count overhead which includes IPG, SFD and Preamble

`netc_port_sg_ogc_mode_t ogcMode`

Stream Gate Open Gate Check mode, 0b is check whether SFD is within the open gate interval, 1b is check whether the entire frame is within the open gate interval

`uint32_t pDelay`

Link propagation delay in ns

`uint8_t macAddr[6]`

Port MAC address, used for Switch egress frame modification action or ENETC SIO primary MAC address

`netc_port_qos_classify_config_t qosMode`

Port Rx Qos Classification config

`netc_port_ipf_config_t ipfCfg`

Port ingress port filter configuration

`netc_port_tg_config_t timeGate`

Port Tx time gate config

`netc_port_parser_config_t parser`

Port Rx Parser config

2.81 Hardware Port MAC

`enum __netc_port_phy_mac_type`

Defines the Ethernet MAC physical port type.

Values:

`enumerator kNETC_ExpressMAC`

The MAC which handles express traffic when frame preemption is enabled or handles all traffic when frame preemption is disabled.

`enumerator kNETC_PreemptableMAC`

The MAC which handles preemptive traffic when frame preemption is enabled.

`enum __netc_port_preemption_verify_status`

Defines the state of the mac merge sublayer with respect to verification as defined in IEEE Std 802.3br-2016.

Values:

enumerator `kNETC_VerifyDisable`

Verification is disabled

enumerator `kNETC_VerifyInProgress`

Verification is in progress

enumerator `kNETC_VerifySuccess`

Verification was successful

enumerator `kNETC_VerifyFaile`

Verification failed

enumerator `kNETC_VerifyUndefined`

Verification is in an undefined state

typedef enum *netc_port_phy_mac_type* netc_port_phy_mac_type_t

Defines the Ethernet MAC physical port type.

typedef enum *netc_port_preemption_verify_status* netc_port_preemption_verify_status_t

Defines the state of the mac merge sublayer with respect to verification as defined in IEEE Std 802.3br-2016.

typedef struct *netc_port_phy_mac_preemption_status* netc_port_phy_mac_preemption_status_t

Port MAC preemption Status.

typedef struct *netc_port_phy_mac_traffic_statistic* netc_port_phy_mac_traffic_statistic_t

Ethernet MAC physical port traffic (Tx/Rx) statistics counters, when enable frame preemption, one physical MAC will be divided into a pMAC and a eMAC and statistics counters will also have two groups.

typedef struct *netc_port_phy_mac_discard_statistic* netc_port_phy_mac_discard_statistic_t

Ethernet MAC physical port frame discard/errors status statistics counters, when enable frame preemption, one physical MAC will be divided into a pMAC and a eMAC and statistics counters will also have two groups.

typedef struct *netc_port_phy_mac_preemption_statistic*

netc_port_phy_mac_preemption_statistic_t

Ethernet physical MAC port preemption (Tx/Rx) related statistics counters.

typedef struct *netc_port_pseudo_mac_traffic_statistic* netc_port_pseudo_mac_traffic_statistic_t

Ethernet pseudo MAC port traffic (Tx/Rx) statistics counters.

uint32_t NETC_GetPortMacInterruptFlags(NETC_ETH_LINK_Type *base,
netc_port_phy_mac_type_t macType)

Get port MAC interrupt flags.

Parameters

- base – NETC ETH link base register.
- mac – MAC type.

void NETC_ClearPortMacInterruptFlags(NETC_ETH_LINK_Type *base, netc_port_phy_mac_type_t
macType, uint32_t mask)

Clear port MAC interrupt flags.

Parameters

- base – NETC ETH link base register.
- mac – MAC type.
- mask – Bit mask of interrupts to enable. See `netc_port_intr_flags_t` for the set of constants that should be OR'd together to form the bit mask.

```
void NETC_EnablePortMacInterrupts(NETC_ETH_LINK_Type *base, netc_port_phy_mac_type_t
                                macType, uint32_t mask, bool enable)
```

Enable/Disable port MAC interrupts.

Parameters

- base – NETC ETH link base register.
- mac – MAC type.
- mask – Bit mask of interrupts to enable. See `netc_port_intr_flags_t` for the set of constants that should be OR'd together to form the bit mask.
- enable – Enable/Disable interrupts.

```
status_t NETC_PortEnableLoopback(NETC_ETH_LINK_Type *base, netc_port_loopback_mode_t
                                loopMode, bool enable)
```

Enable/Disable Loopback for specified MAC.

Parameters

- base –
- loopMode –
- enable –

Returns

`status_t`

```
static inline netc_hw_mii_mode_t NETC_PortGetMIIMode(NETC_ETH_LINK_Type *base)
```

Get ethernet MAC port MII mode.

Parameters

- base – Ethernet MAC port peripheral base address.

Returns

`netc_hw_mii_mode_t`

```
status_t NETC_PortSetMII(NETC_ETH_LINK_Type *base, netc_hw_mii_mode_t miiMode,
                        netc_hw_mii_speed_t speed, netc_hw_mii_duplex_t duplex)
```

Configure ethernet MAC interface mode, speed and duplex for specified PORT.

Parameters

- base – Ethernet MAC port peripheral base address.
- miiMode – The Ethernet MAC MII mode.
- speed – The Ethernet MAC speed.
- duplex – The Ethernet MAC duplex.

Returns

`status_t`

```
status_t NETC_PortSetMaxFrameSize(NETC_ETH_LINK_Type *base, uint16_t size)
```

Set the maximum supported received frame size.

Parameters

- base – Ethernet MAC port peripheral base address.
- size – Maximum frame size to set.

Returns

`status_t`

```
status_t NETC_PortConfigEthMac(NETC_ETH_LINK_Type *base, const netc_port_ethmac_t
                               *config)
```

Configure ethernet MAC for specified PORT. Set the MII mode, speed/duplex, reverse mode, etc.

Parameters

- base – Ethernet MAC port peripheral base address.
- config – The Ethernet MAC configuration.

Returns

status_t

```
static inline void NETC_PortConfigEthMacPreemption(NETC_ETH_LINK_Type *base, const
                                                    netc_port_preemption_config *config)
```

Configure ethernet MAC for Frame preemption on specified PORT.

Parameters

- base – Ethernet MAC port peripheral base address.
- config – The Ethernet MAC configuration.

Returns

status_t

```
static inline void NETC_PortSoftwareResetEthMac(NETC_ETH_LINK_Type *base)
```

Do software reset for Ethernet MAC.

Note: This can reset all statistic counters.

Parameters

- base – PORT MAC peripheral base address.

```
static inline void NETC_PortGetPhyMacPreemptionStatus(NETC_ETH_LINK_Type *base,
                                                       netc_port_phy_mac_preemption_status_t
                                                       *status)
```

Get Ethernet MAC preemption status.

Parameters

- base – PORT MAC peripheral base address.
- status – Point to the buffer which store status.

```
static inline void NETC_PortGetPhyMacPreemptionControl(NETC_ETH_LINK_Type *base,
                                                         netc_port_preemption_config *config)
```

Get Ethernet MAC preemption control parameters.

Parameters

- base – PORT MAC peripheral base address.
- config – Pointer to the NETC port preemption configuration.

```
void NETC_PortGetPhyMacTxStatistic(NETC_ETH_LINK_Type *base, netc_port_phy_mac_type_t
                                   macType, netc_port_phy_mac_traffic_statistic_t *statistic)
```

Get Ethernet MAC Tx Traffic Statistics .

Parameters

- base – PORT MAC peripheral base address.
- macType – Express MAC or Preemptable MAC.

- status – Point to the buffer which store statistics.

```
void NETC_PortGetPhyMacRxStatistic(NETC_ETH_LINK_Type *base, netc_port_phy_mac_type_t
                                macType, netc_port_phy_mac_traffic_statistic_t *statistic)
```

Get Ethernet MAC Rx Traffic Statistics .

Parameters

- base – PORT MAC peripheral base address.
- macType – Express MAC or Preemptable MAC.
- status – Point to the buffer which store statistics.

```
void NETC_PortGetPhyMacDiscardStatistic(NETC_ETH_LINK_Type *base,
                                       netc_port_phy_mac_type_t macType,
                                       netc_port_phy_mac_discard_statistic_t *statistic)
```

Get Ethernet MAC Rx/Tx Drops/Errors Statistics .

Parameters

- base – PORT MAC peripheral base address.
- macType – Express MAC or Preemptable MAC.
- status – Point to the buffer which store statistics.

```
void NETC_PortGetPhyMacPreemptionStatistic(NETC_ETH_LINK_Type *base,
                                           netc_port_phy_mac_preemption_statistic_t
                                           *statistic)
```

Get Ethernet Preemptable MAC preemption Statistics .

Parameters

- base – PORT MAC peripheral base address.
- status – Point to the buffer which store statistics.

```
status_t NETC_PortConfigTxIpgPreamble(NETC_ETH_LINK_Type *base, uint8_t preambleCnt,
                                       uint8_t ipgLen)
```

Configure the port MAC flexible preamble and IPG length.

Parameters

- base – PORT MAC peripheral base address.
- preambleCnt – Flexible Preamble Count. Valid values are 1 to 7(default).
- ipgLen – Transmit inter-packet gap value. Valid values are 4 to 24(default) with 12 being default.

Returns

status_t

```
struct _netc_port_phy_mac_preemption_status
#include <fsl_netc.h> Port MAC preemption Status.
```

Public Members

bool mergeActive

Transmit preemption is active or not

netc_port_preemption_verify_status_t verifyStatus

Transmit preemption is active or not

struct _netc_port_phy_mac_traffic_statistic

#include <fsl_netc.h> Ethernet MAC physical port traffic (Tx/Rx) statistics counters, when enable frame preemption, one physical MAC will be divided into a pMAC and a eMAC and statistics counters will also have two groups.

Public Members

uint64_t totalOctet

Count of MAC received/transmitted good/error Ethernet octets.

uint64_t validOctet

Count of MAC received/transmitted good Ethernet octets.

uint64_t pauseFrame

Count of MAC received/transmitted valid PAUSE frames.

uint64_t validFrame

Count of MAC received/transmitted valid frames.

uint64_t vlanFrame

Count of MAC received/transmitted valid VLAN tagged frames.

uint64_t unicastFrame

Count of MAC received/transmitted valid unicast frames.

uint64_t multicastFrame

Count of MAC received/transmitted valid multicast frames.

uint64_t broadcastFrame

Count of MAC received/transmitted valid broadcast frames.

uint64_t totalPacket

Count of MAC received/transmitted good/error packets.

uint64_t rxMinPacket

Count of MAC received min to 63-octet packets.

uint64_t total64BPacket

Count of MAC received/transmitted 64 octet packets.

uint64_t total65To127BPacket

Count of MAC received/transmitted 65 to 127 octet packets.

uint64_t total128To255BPacket

Count of MAC received/transmitted 128 to 255 octet packets.

uint64_t total256To511BPacket

Count of MAC received/transmitted 256 to 511 octet packets.

uint64_t total511To1023BPacket

Count of MAC received/transmitted 512 to 1023 octet packets.

uint64_t total1024To1522BPacket

Count of MAC received/transmitted 1024 to 1522 octet packets.

uint64_t total1523ToMaxBPacket

Count of MAC received/transmitted 1523 to Max octet packets.

uint64_t controlPacket

Count of MAC received/transmitted control packets.

struct _netc_port_phy_mac_discard_statistic

#include <fsl_netc.h> Ethernet MAC physical port frame discard/errors status statistics counters, when enable frame preemption, one physical MAC will be divided into a pMAC and a eMAC and statistics counters will also have two groups.

Public Members

uint64_t rxError

Count of MAC received error frames.

uint64_t rxUndersized

Count of MAC received undersized frames.

uint64_t rxOversized

Count of MAC received oversized frames.

uint64_t rxErrorFCS

Count of MAC received check sequence (FCS) error frames.

uint64_t rxFragment

Count of MAC frames which is shorter than the MIN length and received with a wrong FCS/CRC.

uint64_t rxJabber

Count of MAC frames which is larger than the MAX length and received with a wrong FCS/CRC.

uint64_t rxDiscard

Count of MAC drops frame.

uint64_t rxDiscardNoTruncated

Count of MAC non-truncated drops frame.

uint64_t txErrorFCS

Count of MAC transmitted bad FCS frames.

uint64_t txUndersized

Count of MAC transmitted less than 64B with good FCS frames.

struct _netc_port_phy_mac_preemption_statistic

#include <fsl_netc.h> Ethernet physical MAC port preemption (Tx/Rx) related statistics counters.

Public Members

uint32_t rxReassembledFrame

Count of MAC frames that were successfully reassembled and delivered to the MAC.

uint32_t rxReassembledError

Count of MAC frames with reassembly errors.

uint32_t rxMPacket

Count of the number of additional mPackets received due to preemption.

uint32_t rxSMDError

Count of received MAC frames / MAC frame fragments rejected due to unknown SMD.

uint32_t txPreemptionReq

Count of the number of tx preemption HOLD requests.

uint32_t txMPacket

Count of the number of additional mPackets transmitted due to preemption.

struct __netc_port_pseudo_mac_traffic_statistic

#include <fsl_netc.h> Ethernet pseudo MAC port traffic (Tx/Rx) statistics counters.

Public Members

uint64_t totalOctet

Count of MAC received/transmitted octets.

uint64_t unicastFrame

Count of MAC received/transmitted unicast frames.

uint64_t multicastFrame

Count of MAC received/transmitted multicast frames.

uint64_t broadcastFrame

Count of MAC received/transmitted broadcast frames .

2.82 Hardware Port Rx

static inline void NETC_PortSetParser(NETC_PORT_Type *base, const *netc_port_parser_config_t* *config)

Set port Parser.

Parameters

- base – PORT peripheral base address.
- config – The port Parser configuration.

static inline void NETC_PortSetVlanClassify(NETC_PORT_Type *base, const *netc_port_vlan_classify_config_t* *config)

Set port acceptable VLAN.

Parameters

- base – PORT peripheral base address.
- config – The port acceptable vlan classification configuration.

static inline *status_t* NETC_PortSetQosClassify(NETC_PORT_Type *base, const *netc_port_qos_classify_config_t* *config)

Set port Qos Classification.

Parameters

- base – PORT peripheral base address.
- config – The port QoS classification configuration.

Returns

status_t

static inline void NETC_PortSetIPF(NETC_PORT_Type *base, const *netc_port_ipf_config_t* *config)

Set port ingress filter.

Parameters

- base – PORT peripheral base address.

- config – The port ingress filter configuration.

```
static inline void NETC_PortSetISI(NETC_PORT_Type *base, const netc_port_psfpi_config_t *config)
```

Set port Ingress stream identification.

Parameters

- base – PORT peripheral base address.
- config – The port Ingress stream identification configuration.

2.83 Hardware Port Tx

```
static inline status_t NETC_PortConfigTGS(NETC_PORT_Type *base, const netc_port_tg_config_t *config)
```

Configure the port time gating Scheduling.

Parameters

- base –
- config –

Returns

status_t

```
status_t NETC_PortConfigTcCBS(NETC_PORT_Type *base, netc_hw_tc_idx_t tcIdx, const netc_port_tc_cbs_config_t *config)
```

Config the Credit-Based Shaper (CBS) for specified Port Traffic Class.

Parameters

- base –
- tcIdx –
- config –

Returns

status_t

```
static inline status_t NETC_PortConfigTcMaxSDU(NETC_PORT_Type *base, netc_hw_tc_idx_t tcIdx, const netc_port_tc_sdu_config_t *config)
```

Config the max Transmit max SDU for specified Port Traffic Class.

Parameters

- base –
- tcIdx –
- config –

Returns

status_t

```
static inline status_t NETC_PortGetTcMaxSDU(NETC_PORT_Type *base, netc_hw_tc_idx_t tcIdx, netc_port_tc_sdu_config_t *config)
```

Read the max Transmit max SDU for specified Port Traffic Class.

Parameters

- base –
- tcIdx –

- config –

Returns

status_t

static inline void NETC_PortConfigTcPreemption(NETC_PORT_Type *base, *netc_hw_tc_idx_t* tcIdx, const bool enable)

Config Frame Preemption for specified Port Traffic Class.

Parameters

- base – NETC PORT base peripheral address
- tcIdx – traffic class index
- enable – enable/disable feature on traffic class

static inline void NETC_PortGetTcPreemption(NETC_PORT_Type *base, *netc_hw_tc_idx_t* tcIdx, bool *enabled)

Get Frame Preemption configuration for specified Port Traffic Class.

Parameters

- base – NETC PORT base peripheral address
- tcIdx – traffic class index
- enabled – port tx traffic class enabled flag

static inline void NETC_PortGetTGSFPCConfig(NETC_PORT_Type *base, *netc_port_tg_preemption_config* *config)

Get the port time gating Scheduling configuration specific for when used with Frame Preemption.

Parameters

- base – NETC PORT base peripheral address
- config –

2.84 Hardware Station Interface(SI)

NETC_SI_TXDESCRIP_RD_FL(n)

Defines for read format.

NETC_SI_TXDESCRIP_RD_TSE_MASK

NETC_SI_TXDESCRIP_RD_TXSTART(n)

NETC_SI_TXDESCRIP_RD_L3START(n)

NETC_SI_TXDESCRIP_RD_IPCS(n)

NETC_SI_TXDESCRIP_RD_L3HDRSIZE(n)

NETC_SI_TXDESCRIP_RD_L3T(n)

NETC_SI_TXDESCRIP_RD_L4T(n)

NETC_SI_TXDESCRIP_RD_L4CS(n)

NETC_SI_TXDESCRIP_RD_LSO(n)

NETC_SI_TXDESCRIP_RD_LSO_MASK

enum _netc_hw_enetc_si_vlan_type

VLAN Ethertypes.

Values:

enumerator kNETC_ENETC_StanCVlan

Standard C-VLAN 0x8100.

enumerator kNETC_ENETC_StanSVlan

Standard S-VLAN 0x88A8.

enumerator kNETC_ENETC_CustomVlan1

Custom VLAN as defined by CVLANR1[ETYPE].

enumerator kNETC_ENETC_CustomVlan2

Custom VLAN as defined by CVLANR2[ETYPE].

enum _netc_hw_enetc_si_rxr_group

SI receive BD ring group index.

Values:

enumerator kNETC_SiBDRGroupOne

SI Rx BD ring group index one.

enumerator kNETC_SiBDRGroupTwo

SI Rx BD ring group index two.

enum _netc_tx_bdr_flags

Status/Interrupts flags for the TX BDR. Each flag get its own bit thus it support bit AND/OR operation.

Values:

enumerator kNETC_TxBDRSystemBusErrorFlag

enumerator kNETC_TxBDRBusyFlag

enumerator kNETC_TxBDRStatusFlagsMask

enum _netc_rx_bdr_flags

Status/Interrupts flags for the RX BDR. Each flag get its own bit thus it support bit AND/OR operation.

Values:

enumerator kNETC_RxBDRSystemBusErrorFlag

enumerator kNETC_RxBDREmptyFlag

enum _netc_psi_msg_flags_t

PSI message interrupt type.

Values:

enumerator kNETC_PsiRxMsgFromVsi1Flag

Message receive interrupt enable, initiated by VSI1.

enumerator kNETC_PsiRxMsgFromVsi2Flag

Message receive interrupt enable, initiated by VSI2.

enumerator kNETC_PsiFLRFromVsi1Flag

Function level reset interrupt enable, initiated by VSI1.

enum `_netc_vsi_msg_flags`

VSI message interrupt flags.

Values:

enumerator `kNETC_VsiMsgTxFlag`

Message sent to PSI has completed and response received.

enumerator `kNETC_VsiMsgRxFlag`

Message received from PSI.

enum `_netc_vsi_number`

VSI number bit map, VSI1 starts from bit1.

Values:

enumerator `kNETC_Vsi1`

enumerator `kNETC_Vsi2`

enum `_enetc_si_bdr_priority`

ENETC Station Interface BD Ring priority enumeration.

Values:

enumerator `kNETC_SIBdrPriorityLowest`

enumerator `kNETC_SIBdrPriority0`

enumerator `kNETC_SIBdrPriority1`

enumerator `kNETC_SIBdrPriority2`

enumerator `kNETC_SIBdrPriority3`

enumerator `kNETC_SIBdrPriority4`

enumerator `kNETC_SIBdrPriority5`

enumerator `kNETC_SIBdrPriority6`

enumerator `kNETC_SIBdrPriority7`

enumerator `kNETC_SIBdrPriorityHighest`

typedef enum `_netc_hw_enetc_si_vlan_type` `netc_hw_enetc_si_vlan_type`

VLAN Ethertypes.

typedef enum `_netc_hw_enetc_si_rxr_group` `netc_hw_enetc_si_rxr_group`

SI receive BD ring group index.

typedef struct `_netc_hw_enetc_si_config` `netc_hw_enetc_si_config_t`

Station Interface configuration.

typedef struct `_netc_si_l2mf_config` `netc_si_l2mf_config_t`

L2 Mac Filter Configuration for SI.

typedef struct `_netc_si_l2vf_config` `netc_si_l2vf_config_t`

L2 VLAN Filter Configuration for SI.

typedef struct `_netc_si_discard_statistic` `netc_si_discard_statistic_t`

SI frame drop statistic struct.

typedef struct `_netc_si_traffic_statistic` `netc_si_traffic_statistic_t`

SI traffic statistic struct.

```
typedef struct _netc_si_config netc_si_config_t
    SI Configuration.

typedef union _netc_tx_bd netc_tx_bd_t
    Transmit Buffer Descriptor format.
    A union type cover the BD used as Standard/Extended/WriteBack format.

typedef union _netc_rx_bd netc_rx_bd_t
    Receive Buffer Descriptor format.

typedef struct _netc_tx_bdr_config netc_tx_bdr_config_t
    Configuration for the SI Tx Buffer Descriptor Ring Configuration.

typedef struct _netc_tx_bdr netc_tx_bdr_t
    Transmit BD ring handler data structure.

typedef enum _netc_tx_bdr_flags netc_tx_bdr_flags_t
    Status/Interrupts flags for the TX BDR. Each flag get its own bit thus it support bit AND/OR
    operation.

typedef struct _netc_rx_bdr_config netc_rx_bdr_config_t
    Configuration for the SI Rx Buffer Descriptor Ring Configuration.

typedef struct _netc_rx_bdr netc_rx_bdr_t
    Receive BD ring handler data structure.

typedef enum _netc_rx_bdr_flags netc_rx_bdr_flags_t
    Status/Interrupts flags for the RX BDR. Each flag get its own bit thus it support bit AND/OR
    operation.

typedef struct _netc_bdr_config netc_bdr_config_t
    Configuration for the buffer descriptors ring.

typedef enum _netc_psi_msg_flags_t netc_psi_msg_flags_t
    PSI message interrupt type.

typedef enum _netc_vsi_msg_flags netc_vsi_msg_flags_t
    VSI message interrupt flags.

typedef enum _netc_vsi_number netc_vsi_number_t
    VSI number bit map, VSI1 starts from bit1.

typedef struct _netc_psi_rx_msg netc_psi_rx_msg_t
    PSI receive message information.

typedef struct _netc_vsi_msg_tx_status netc_vsi_msg_tx_status_t
    VSI message transmit status.

typedef enum _enetc_si_bdr_priority enetc_si_bdr_priority_t
    ENETC Station Interface BD Ring priority enumeration.

static inline void NETC_ClearTxDescriptor(netc_tx_bd_t *txDesc)

static inline void NETC_CopyTxDescriptor(netc_tx_bd_t *txDescDst, netc_tx_bd_t *txDescSrc)

static inline void NETC_SIEnable(ENETC_SI_Type *base, bool enable)
    Enable the Station Interface(SI)
```

Parameters

- base –

```
static inline void NETC_SIRxRingEnable(ENETC_SI_Type *base, uint8_t ring, bool enable)
```

Enable the specified Rx BD ring.

Parameters

- base –
- ring – The ring index.
- enable – Enable/Disable the ring.

```
static inline void NETC_SIEnablePromisc(ENETC_SI_Type *base, netc_packet_type_t type, bool enable)
```

Enable/Disable unicast/multicast/boardcast promisc mode for specified SI.

Parameters

- base –
- type –
- enable –

```
static inline void NETC_SISetTxProducer(ENETC_SI_Type *base, uint8_t ring, uint16_t producer)
```

Set producer index of specified Tx BD ring.

Parameters

- base – SI base address.
- ring – BD ring index.
- producer – The producer index of specified ring.

```
static inline uint16_t NETC_SIGetTxConsumer(ENETC_SI_Type *base, uint8_t ring)
```

Get consumer index of specified Tx BD ring.

Parameters

- base – SI base address.
- ring – BD ring index.

Returns

consumer The consumer index of specified ring.

```
static inline void NETC_SISetRxConsumer(ENETC_SI_Type *base, uint8_t ring, uint16_t consumer)
```

Set consumer index of specified Rx BD ring.

Parameters

- base – SI base address.
- ring – BD ring index.
- consumer – The consumer index of specified ring.

```
static inline uint16_t NETC_SIGetRxProducer(ENETC_SI_Type *base, uint8_t ring)
```

Get producer index of specified Rx BD ring.

Parameters

- base – SI base address.
- ring – BD ring index.

Returns

producer The producer index of specified ring.

```
status_t NETC_SIconfigTxBDR(ENETC_SI_Type *base, uint8_t ring, const netc_tx_bdr_config_t *bdrConfig)
```

Configure the Transmit Buffer Descriptor Ring for specified SI.

Parameters

- base – SI base address.
- ring – BD ring index.
- bdrConfig – The BD ring configuration.

Returns

status_t

```
status_t NETC_SIconfigRxBDR(ENETC_SI_Type *base, uint8_t ring, const netc_rx_bdr_config_t *bdrConfig)
```

Configure the Rx Buffer Descriptor Ring for specified SI.

Parameters

- base – SI base address.
- ring – BD ring index.
- bdrConfig – The BD ring configuration.

Returns

status_t

```
static inline void NETC_SIMapVlanToIpv(ENETC_SI_Type *base, uint8_t pcpDei, uint8_t ipv)
```

Enable the mapping of VLAN to IPV.

Parameters

- base – SI base address.
- pcpDei – The VLAN tag pcp dei value (use NETC_VLAN_PCP_DEI_VALUE macro).
- ipv – The IPV value for this VLAN mapping.

```
static inline void NETC_SIEnableVlanToIpv(ENETC_SI_Type *base, bool enable)
```

Enable the mapping of VLAN to IPV.

Parameters

- base – SI base address.
- enable – Whether enable mapping.

Returns

status_t

```
static inline void NETC_SIMapIpvToRing(ENETC_SI_Type *base, uint8_t ipv, uint8_t ring)
```

Set the IPV to ring mapping.

Parameters

- base – SI base address.
- ipv – IPV value to be mapped.
- ring – The Rx BD ring index to be mapped.

Returns

status_t


```
static inline void NETC_SISetRxBDRGroup(ENETC_SI_Type *base, uint8_t groupNum, uint8_t
                                       ringPerGroup)
```

Set the group of Rx BD ring.

Parameters

- base – SI base address.
- groupNum – Total group number.
- ringPerGroup – Rings per group.

Returns

status_t

```
static inline void NETC_SISetDefaultRxBDRGroup(ENETC_SI_Type *base,
                                              netc_hw_enetc_si_rxr_group groupId)
```

Set the default used receive Rx BD ring group.

Note: The IPV mapped ring index is the relative index inside the default used group.

Parameters

- base – SI base address.
- groupNum – The default Rx group index.

Returns

status_t

```
static inline void NETC_SICleanTxIntrFlags(ENETC_SI_Type *base, uint16_t txFrameIntrMask,
                                           uint16_t txThresIntrMask)
```

Clean the SI transmit interrupt flags.

Parameters

- base – SI base address.
- txFrameIntrMask – IPV value to be mapped, bit x represents ring x.
- txThresIntrMask – The Rx BD ring index to be mapped, bit x represents ring x.

```
static inline void NETC_SICleanRxIntrFlags(ENETC_SI_Type *base, uint32_t rxIntrMask)
```

Clean the SI receive interrupt flags.

Parameters

- base – SI base address.
- rxIntrMask – Rx interrupt bit mask, bit x represents ring x.

```
void NETC_SIPsiEnableInterrupt(ENETC_SI_Type *base, uint32_t mask, bool enable)
```

PSI enables/disables specified interrupt.

Parameters

- base – SI base address.
- mask – The interrupt mask, refer to netc_psi_msg_flags_t which should be OR'd together.
- enable – Enable/Disable the interrupt.

static inline uint32_t NETC_SIPsiGetStatus(ENETC_SI_Type *base)

PSI gets interrupt event flag status.

Parameters

- base – SI base address.

Returns

The interrupt mask, refer to netc_psi_msg_flags_t which should be OR'd together.

static inline void NETC_SIPsiClearStatus(ENETC_SI_Type *base, uint32_t mask)

PSI clears interrupt event flag.

Parameters

- base – SI base address.
- mask – The interrupt mask, refer to netc_psi_msg_flags_t which should be OR'd together.

status_t NETC_SIPsiSendMsg(ENETC_SI_Type *base, uint16_t msg, netc_vsi_number_t vsi)

PSI sends message to specified VSI(s)

Parameters

- base – SI base address.
- msg – The message to be sent.
- vsi – The VSI number.

Returns

status_t

static inline bool NETC_SIPsiCheckTxBusy(ENETC_SI_Type *base, netc_vsi_number_t vsi)

PSI checks Tx busy flag which should be cleaned when VSI receive the message data.

Parameters

- base – SI base address.
- vsi – The VSI number.

Returns

The busy status of specified VSI.

status_t NETC_SIPsiSetRxBuffer(ENETC_SI_Type *base, netc_vsi_number_t vsi, uint64_t buffAddr)

PSI sets Rx buffer to receive message from specified VSI.

Note: The buffer memory size should be big enough for the message data from VSI

Parameters

- base – SI base address.
- vsi – The VSI number.
- buffAddr – The buffer address to store message data from VSI, must be 64 bytes aligned.

Returns

status_t

```
status_t NETC_SIPsiGetRxMsg(ENETC_SI_Type *base, netc_vsi_number_t vsi, netc_psi_rx_msg_t *msgInfo)
```

PSI gets Rx message from specified VSI.

Parameters

- base – SI base address.
- vsi – The VSI number.
- msgInfo – The Rx message information.

```
void NETC_SIVsiEnableInterrupt(ENETC_SI_Type *base, uint32_t mask, bool enable)
```

Enable VSI interrupt.

Parameters

- base – SI base address.
- mask – The interrupt mask, see *netc_vsi_msg_flags_t* which should be OR'd together.
- enable – Enable/Disable interrupt.

```
static inline uint32_t NETC_SIVsiGetStatus(ENETC_SI_Type *base)
```

Get VSI interrupt status.

Parameters

- base – SI base address.

Returns

A bitmask composed of *netc_vsi_msg_flags_t* enumerators OR'd together.

```
static inline void NETC_SIVsiClearStatus(ENETC_SI_Type *base, uint32_t mask)
```

Clear VSI interrupt status.

Parameters

- base – SI base address.
- mask – The interrupt mask, see *netc_vsi_msg_flags_t* which should be OR'd together.

```
status_t NETC_SIVsiSendMsg(ENETC_SI_Type *base, uint64_t msgAddr, uint32_t msgLen)
```

VSI sends message to PSI.

Parameters

- base – SI base address.
- msgAddr – Address to store message ready to be sent, must be 64 bytes aligned.
- msgLen – The message length, must be 32 bytes aligned.

Returns

status_t

```
void NETC_SIVsiCheckTxStatus(ENETC_SI_Type *base, netc_vsi_msg_tx_status_t *status)
```

Check VSI Tx status.

Parameters

- base – SI base address.
- status – The VSI Tx status structure.

`status_t` NETC_SIVsiReceiveMsg(ENETC_SI_Type *base, uint16_t *msg)

VSI receives message from PSI.

Parameters

- base – SI base address.
- msg – The message from PSI.

Returns

`status_t`

`void` NETC_SIGetDiscardStatistic(ENETC_SI_Type *base, *netc_si_discard_statistic_t* *statistic)

Get the discard statistic from SI layer.

Parameters

- base – SI base address.
- statistic – The statistic data.

`void` NETC_SIGetTrafficStatistic(ENETC_SI_Type *base, *netc_si_traffic_statistic_t* *statistic)

Get the traffic statistic from SI layer.

Parameters

- base – SI base address.
- statistic – The statistic data.

`NETC_VLAN_PCP_DEI_VALUE`(pcp, dei)

Macro to cover VLAN PCP, DEI value to internal used pcpDei value.

`struct` `_netc_hw_enetc_si_config`

#include <fsl_enetc.h> Station Interface configuration.

Public Members

`uint32_t` bandWeight

Station interface traffic class bandwidth weight

`uint32_t` vlanCtrl

VLAN Ethertypes can be inserted by the SI driver, set with OR of `netc_hw_enetc_si_vlan_type`.

`uint32_t` antiSpoofEnable

Anti-spoofing enable

`uint32_t` vlanInsertEnable

Software SI-based VLAN Insertion enable, avtive when `enSIBaseVlan` is true

`uint32_t` vlanExtractEnable

SI-based VLAN removed from frame enable, avtive when `enSIBaseVlan` is true

`uint32_t` sourcePruneEnable

Source pruning enable

`uint32_t` rxRingUse

Number of Rx Rings to be used, when enable Rx ring group, this equal to the sum of all Rx group rings.

`uint32_t` txRingUse

Number of Tx Rings to be used, note that when SI is Switch management ENETC SI, the number not include Tx ring 0.

uint32_t valnToIpvEnable

Enable the VLAN PCP/DEI value (use NETC_VLAN_PCP_DEI_VALUE marco) to internal priority value mapping.

uint32_t rxBdrGroupNum

Rx BD ring group number, range in 0 ~ 2.

uint32_t ringPerBdrGroup

The ring number in every Rx BD ring group, range in 1 ~ 8, active when rxBdrGroupNum not equal zero.

netc_hw_enetc_si_rxr_group defaultRxBdrGroup

The selected Rx BD ring group, active when rxBdrGroupNum not equal zero.

uint8_t vlanToIpvMap[16]

Frame VLAN pcp|dei to IPV mapping, active when valnToIpvEnable is true.

uint8_t ipvToRingMap[8]

BD ring used within the default Rx BD ring group for IPV n, active when rxBdrGroupNum not equal zero.

uint8_t vsiTcToTC[8]

Maps the VSI traffic class to transmit traffic class, done after the ENETC txPrio to TC mapping, only available for VSI.

bool enSIBaseVlan

Enable use SI-based VLAN information.

netc_enetc_vlan_tag_t siBaseVlan

SI-based VLAN information, active when enSIBaseVlan is true.

struct _netc_si_l2mf_config

#include <fsl_netc.h> L2 Mac Filter Configuration for SI.

Public Members

bool macUCPromis

Enable/Disable MAC unicast promiscuous.

bool macMCPromis

Enable/Disable MAC multicast promiscuous.

bool rejectUC

Reject Unicast.

bool rejectMC

Reject Multicast.

bool rejectBC

Reject Broadcast.

struct _netc_si_l2vf_config

#include <fsl_netc.h> L2 VLAN Filter Configuration for SI.

Public Members

bool acceptUntagged

Accept/Reject untagged frame.

bool enPromis

Enable/Disable VLAN promiscuous.

bool useOuterVlanTag

Use outer/inner VLAN tag for filtering.

struct _netc_si_discard_statistic

#include <fsl_netc.h> SI frame drop statistic struct.

Public Members

uint32_t programError

Due to programming error (non-existing BD ring or non-existing group, or SI disabled or BD ring disabled).

uint32_t busError

Due to system bus error.

uint32_t lackBD[14]

Due to lack of Rx BDs available.

struct _netc_si_traffic_statistic

#include <fsl_netc.h> SI traffic statistic struct.

struct _netc_si_config

#include <fsl_netc.h> SI Configuration.

Public Members

uint32_t tcBWWeight

SI traffic class bandwidth weight.

union _netc_tx_bd

#include <fsl_netc.h> Transmit Buffer Descriptor format.

A union type cover the BD used as Standard/Extended/WriteBack format.

Public Members

struct _netc_tx_bd standard

struct _netc_tx_bd ext

struct _netc_tx_bd writeback

uint64_t dword[2]

union _netc_rx_bd

#include <fsl_netc.h> Receive Buffer Descriptor format.

Public Members

struct _netc_rx_bd standard

struct _netc_rx_bd writeback

struct _netc_rx_bd ext

struct _netc_tx_bdr_config

#include <fsl_netc.h> Configuration for the SI Tx Buffer Descriptor Ring Configuration.

Public Members

uint32_t len

Size of BD ring which shall be multiple of 8 BD.

netc_tx_bd_t *bdArray

BDR base address which shall be 128 bytes aligned.

netc_tx_frame_info_t *dirtyArray

Tx cleanup ring.

bool enIntr

Enable/Disable completion interrupt.

bool enThresIntr

Enable/Disable threshold interrupt.

bool enCoalIntr

Enable/Disable interrupt coalescing.

uint32_t intrThreshold

Interrupt coalescing packet threshold.

uint32_t intrTimerThres

Interrupt coalescing timer threshold, specified in NETC clock cycles.

uint8_t msixEntryIdx

MSIX entry index of Tx ring interrupt.

bool isVlanInsert

Enable/Disable VLAN insert offload.

bool isUserCRC

Enable/Disable user provided the CRC32 - FCS at end of frame.

uint8_t wrrWeight

Weight used for arbitration when rings have same priority.

uint8_t priority

Priority of the Tx BDR.

struct __netc_tx_bdr

#include <fsl_netc.h> Transmit BD ring handler data structure.

Public Members

netc_tx_bd_t *bdBase

Tx BDR base address.

netc_tx_frame_info_t *dirtyBase

Tx cleanup ring base address.

uint16_t producerIndex

Current index for transmit.

uint16_t cleanIndex

Current index for tx cleaning.

uint32_t len

Length of this BD ring.

struct __netc_rx_bdr_config

#include <fsl_netc.h> Configuration for the SI Rx Buffer Descriptor Ring Configuration.

Public Members

`bool extendDescEn`

False - Use 16Bytes standard BD. True - Use 32Bytes extended BD.

`netc_rx_bd_t *bdArray`

BD ring base address which shall be 128 bytes aligned.

`uint32_t len`

BD ring length in the unit of 16Bytes standard BD. Shall be multiple of 8/16 for standard/extended BD.

`uint64_t *buffAddrArray`

Rx buffers array with BD length(half of BD length if use extended BD).

`uint16_t buffSize`

Size of all Rx buffers in this BD ring.

`bool enThresIntr`

Enable/Disable threshold interrupt.

`bool enCoalIntr`

Enable/Disable interrupt coalescing.

`uint32_t intrThreshold`

Interrupt coalescing packet threshold.

`uint32_t intrTimerThres`

Interrupt coalescing timer threshold, specified in NETC clock cycles.

`uint8_t msixEntryIdx`

MSIX entry index of Rx ring interrupt.

`bool disVlanPresent`

Disable/Enable VLAN in BD.

`bool enVlanExtract`

Enable/Disable VLAN extract.

`bool isKeepCRC`

Whether user provided the CRC32 - FCS at end of frame.

`bool congestionMode`

False - lossy. True - lossless.

`bool enHeaderAlign`

Enable/disable +2B alignment to frame.

`struct _netc_rx_bdr`

#include <fsl_netc.h> Receive BD ring handler data structure.

Public Members

`netc_rx_bd_t *bdBase`

Rx BDR base address.

`bool extendDesc`

Use extended buffer descriptor.

`uint16_t index`

Current index for read.

uint32_t len

Length of this BD ring, unit of 16Bytes standard BD.

uint64_t *buffArray

Rx buffers array of this ring.

uint32_t buffSize

Rx buffers size for all BDs in this ring.

struct __netc_bdr_config

#include <fsl_netc.h> Configuration for the buffer descriptors ring.

Public Members

netc_rx_bdr_config_t *rxBdrConfig

Receive buffer ring configuration array.

netc_tx_bdr_config_t *txBdrConfig

Transmit buffer ring configuration array.

struct __netc_psi_rx_msg

#include <fsl_netc.h> PSI receive message information.

Public Members

uint8_t *msgBuff

The buffer address application set before receiving message.

uint32_t msgLen

Received message length.

struct __netc_vsi_msg_tx_status

#include <fsl_netc.h> VSI message transmit status.

Public Members

bool txBusy

The VSI Tx busy flag, become idle when the PSI receive and clear the related status.

bool isTxErr

Tx error flag.

uint16_t msgCode

The error code or user-defined content.

struct standard

Public Members

uint64_t addr

Address of the buffer. Little Endian.

uint16_t bufLen

Length of buffer specifying effective number of bytes.

uint16_t frameLen

Length of Frame.

uint32_t flags

Flags qualified setting.

uint32_t enableInterrupt

Whether enable interrupt on complete of BD.

uint32_t isExtended

Extended BD format flag.

uint32_t isFinal

Final BD flag.

struct ext

Public Members

uint32_t timestamp

IEEE1588 PTP one-step timestamp.

uint32_t __pad0__

Ignore 2-bit MSB.

uint16_t tpid

VLAN TPID type, see netc_vlan_tpid_select_t.

uint16_t vid

VLAN ID.

uint16_t dei

VLAN DEI.

uint16_t pcp

VLAN PCP.

uint8_t eFlags

Tx extension flags.

uint8_t isFinal

Final BD flag.

struct writeback

Public Members

uint32_t timestamp

Timestamp write back.

uint32_t status

Status.

uint32_t written

Write-back flag.

struct standard

Public Members

uint64_t addr

Software write address.

struct writeback

Public Members

uint16_t internetChecksum
Internet Checksum.

uint16_t parserSummary
Parser Summary.

uint16_t bufLen
Length of received buffer.

uint16_t vid
VLAN ID.

uint16_t dei
VLAN DEI.

uint16_t pcpc
VLAN PCP.

uint8_t tpid
VLAN TPID.

uint8_t hr
Host Reason.

uint8_t flags
Rx information flags.

uint8_t error
Rx error code.

uint8_t isReady
Received data ready flag.

uint8_t isFinal
Final BD flag.

union ____unnamed206____

Public Members

struct __netc_rx_bd

uint32_t rssHashSwt
RSS hash while not used as switch management port.

struct ____unnamed208____

Public Members

uint32_t srcPort
Source port received from switch management port.

uint32_t rssHash
RSS Hash high field value.

struct ext

Public Members

uint32_t timestamp
Rx Timestamp.

2.85 Hardware Switch

enum __netc_swt_port_bitmap

The switch port bitmap.

Values:

enumerator kNETC_SWTPort0Bit

Switch port0 bitmap

enumerator kNETC_SWTPort1Bit

Switch port1 bitmap

enumerator kNETC_SWTPort2Bit

Switch port2 bitmap

enumerator kNETC_SWTPort3Bit

Switch port3 bitmap

enumerator kNETC_SWTPort4Bit

Switch port4 (internal port) bitmap

enum __netc_swt_imr_dest_port

The switch ingress mirror destination port.

Values:

enumerator kNETC_SWTPort0

Switch port0

enumerator kNETC_SWTPort1

Switch port1

enumerator kNETC_SWTPort2

Switch port2

enumerator kNETC_SWTPort3

Switch port3

enumerator kNETC_SWTPort4

Switch port4

enumerator kNETC_SWTMPort

Switch management port

enum __netc_swt_mac_forward_mode

The switch MAC forwarding options.

Values:

enumerator kNETC_NoFDBLookUp

No FDB lookup is performed, the frame is flooded.

enumerator kNETC_FDBLookUpWithFlood

FDB lookup is performed, and if there is no match, the frame is flooded to the port bitmap in VLAN filter entry.

enumerator kNETC_FDBLookUpWithDiscard

FDB lookup is performed, and if there is no match, the frame is discarded.

enum _netc_swt_mac_learn_mode

The switch MAC learning options.

Values:

enumerator kNETC_DisableMACLearn

Disable MAC learning. SMAC FDB lookup is by-passed.

enumerator kNETC_HardwareMACLearn

Hardware MAC learning is enabled.

enumerator kNETC_SeSoftwareMACLearn

Software MAC learning secure. FDB lookup based on FID and SMAC is performed and if an entry is not found, the frame is redirected to the switch management port.

enumerator kNETC_UnseSoftwareMACLearn

Software MAC learning unsecure. FDB lookup based on FID and SMAC is performed and if an entry is not found, the frame is copied to the switch management port.

enumerator kNETC_DisableMACLearnWithSMAC

Disable MAC learning with SMAC validation. FDB lookup based on FID and SMAC is performed and if an entry is not found, the frame is discarded.

enum _netc_swt_port_tx_vlan_act

Switch transmit Bridge Port VLAN Tag Action.

Values:

enumerator kNETC_NoTxVlanModify

No egress VLAN modification performed

enumerator kNETC_TxDelOuterVlan

Delete outer VLAN tag

enumerator kNETC_TxReplOuterVlanVid

Replace outer VLAN tag's VID with 0; frame to be transmitted as a priority tag frame

enum _netc_swt_port_stg_mode

Switch port spanning tree group work mode.

Values:

enumerator kNETC_DiscardFrame

Tx or RX Frames on this port with current spanning tree group ID will be discarded

enumerator kNETC_LearnWithoutFowrad

RX Frames on this port with current spanning tree group ID will do Learn SMAC, but do not forward, Tx Frame will be discarded

enumerator kNETC_ForwardFrame

RX Frames on this port with current spanning tree group ID will do both MAC learning and forwarding, Tx Frame will be forwarded.

typedef enum _netc_swt_port_bitmap netc_swt_port_bitmap_t

The switch port bitmap.

typedef enum _netc_swt_imr_dest_port netc_swt_imr_dest_port_t

The switch ingress mirror destination port.

typedef enum _netc_swt_mac_forward_mode netc_swt_mac_forward_mode_t

The switch MAC forwarding options.

```
typedef enum _netc_swt_mac_learn_mode netc_swt_mac_learn_mode_t
```

The switch MAC learning options.

```
typedef enum _netc_swt_port_tx_vlan_act netc_swt_port_tx_vlan_act_t
```

Switch transmit Bridge Port VLAN Tag Action.

```
typedef enum _netc_swt_port_stg_mode netc_swt_port_stg_mode_t
```

Switch port spanning tree group work mode.

```
typedef struct _etc_swt_imr_config netc_swt_imr_config_t
```

Switch Ingress mirror destination config.

```
typedef struct _netc_swt_port_config netc_swt_port_bridge_config_t
```

Switch port bridge configuration.

```
typedef struct _netc_swt_port_fm_config netc_swt_port_fm_config_t
```

Switch Port level Frame Modification configuration (PPCPDEIMR and PQOSMR[QVMP])

```
typedef struct _netc_swt_default_vlan_filter netc_swt_default_vlan_filter_t
```

Switch VLAN filter hash table default entry configuration, which determines the default entry when not found in VLAN filter lookup.

```
typedef struct _netc_swt_bridge_config netc_swt_bridge_config_t
```

Bridge config.

```
typedef struct _netc_swt_psf_config netc_swt_psf_config_t
```

Switch PSFP configuration.

```
typedef struct _netc_qos_classify_config netc_swt_qos_classify_config_t
```

Switch Qos Classification configuration (include two profiles)

```
typedef struct _netc_swt_qos_to_vlan_config netc_swt_qos_to_vlan_config_t
```

Switch QoS to PCP mapping and PCP to PCP mapping configuration when egress packet modification the VLAN tag.

```
typedef struct _netc_switch_inuse_fdb_statistic netc_switch_inuse_fdb_statistic_t
```

Switch static/dynamic FDB entries in-use statistic.

```
typedef struct _netc_swt_port_sr_config netc_swt_port_sr_config_t
```

Port seamless redundancy configuration.

```
struct _etc_swt_imr_config
```

#include <fsl_net.h> Switch Ingress mirror destination config.

Public Members

```
bool enMirror
```

Enable ingress mirroring

```
netc_swt_imr_dest_port_t destPort
```

Port where ingress mirrored frames are sent

```
uint8_t dr
```

Mirrored packet's DR (drop resilience)

```
uint8_t ipv
```

Mirrored packet's IPV (internal priority value)

```
uint8_t efmLengthChange
```

Egress Frame Modification Frame Length change in 2s complement notation, Valid if efmEntryID is not null

uint16_t efmEntryID

Egress Frame Modification Entry Id, note 0xFFFF is a Null Frame Modification Entry,
Only applicable if destPort != kNETC_SWTMPort

struct __netc_swt_port_config

#include <fsl_netc.h> Switch port bridge configuration.

Public Members

netc_swt_port_tx_vlan_act_t txVlanAction

Only applies for the frame outer VLAN tag's VID is equal to the port default VID

bool isRxVlanAware

Receive VLAN Aware Mode

bool acceptUntag

Accept untagged frame

bool acceptPriorityTag

Accept priority tagged frame (VID = 0)

bool acceptSingleTag

Accept single tagged frame

bool acceptDoubleTag

Accept double tagged frame (outer and inner)

bool enSrcPortPrun

Enable/Disable received frame be transmitted to same port it was received

bool enMacStationMove

Enable/Disable received frame which ingress port not match the FDB entry Destination
Port Bitmap

bool enBcastStormCtrl

Enable/Disable Storm control for broadcast frames

bool enMcastStormCtrl

Enable/Disable Storm control for multicast frames

bool enUnMcastStormCtrl

Enable/Disable Storm control for unknown multicast frames

bool enUnUcastStormCtrl

Enable/Disable Storm control for unknown unicast frames

uint32_t bcastRpEntryID

Broadcast rate policer entry ID. Valid if enBroadStormCtrl = true

uint32_t mcastEntryID

Known multicast rate policer entry ID. Valid if enBroadStormCtrl = true

uint32_t unMcastRpEntryID

Unknown multicast policer entry ID. Valid if enUnMultiStormCtrl = true

uint32_t unUcastRpEntryID

Unknown unicast rate policer entry ID. Valid if enUnUniStormCtrl = true

uint16_t maxDynaFDBEntry

The maximum number of dynamic entries in the FDB table, 0 means no limit

```
struct _netc_swt_port_fm_config
#include <fsl_netc.h> Switch Port level Frame Modification configuration (PPCPDEIMR and PQOSMR[QVMP])
```

Public Members

bool ignoreFMMiscfg
Enable/Disable ignore the Frame Modification Misconfiguration Action

bool enEgressPcpMap
Enable egress frame modification of outer VLAN tag's PCP value is mapped to a new value based on egressPcpMap, used for Frame Modification VLAN Outer PCP action

bool enIngressPcpMap
Enable ingress frame modification of outer VLAN tag's PCP value is mapped to a new value based on egressPcpMap, used for Frame Modification VLAN Outer PCP action

bool enUpdateVlanDei
Enable update DR value in the outer VLAN based on DEnDEI field, used for egress Frame Modification Outer DEI action

uint8_t drToDeiMap
Mapping of internal QoS's DR value n to VLAN DEI, The 4 bits correspond to the DR3 ~ DR0, and 1 means DRn mapping to DEI 1, 0 means DRn mapping to DEI 0

uint8_t egressPcpMap
Egress PCP to PCP Mapping Profile instance, active when enEgressPcpMap is true

uint8_t ingressPcpMap
Ingress PCP to PCP Mapping Profile instance, active when enIngressPcpMap is true

uint8_t qosVlanMap
Transmit QoS to VLAN PCP Mapping Profile index, used for egress Frame Modification VLAN Add/Replace Action

```
struct _netc_swt_default_vlan_filter
#include <fsl_netc.h> Switch VLAN filter hash table default entry configuration, which determines the default entry when not found in VLAN filter lookup.
```

Public Members

bool enIPMFlood
Enable IP Multicast Flooding

bool enIPMFilter
Enable IP Multicast Filtering

uint8_t stgID
Spanning Tree Group Member ID, range in 0 ~ 15

uint8_t portMembership
The bit 0 ~ 4 correspond to the 5 ports, When bit set (0b1), means the port is a member of this VLAN. Port membership is used for source/destination pruning

bool enUseFilterID
Enable use the specified filterID as FID, otherwise will use the frame VID

uint16_t filterID
Used as a key value to do FDB table and the L2 IPV4 Multicast Filter table lookup. Valid if enUseFilterID is true

netc_swt_mac_forward_mode_t mfo

MAC forwarding options

netc_swt_mac_learn_mode_t mlo

MAC learning options

uint16_t baseETEID

Base Egress Treatment Entry ID

uint8_t etaPortBitmap

Egress Treatment Applicability Port. Valid if baseETEID is not null.

struct *_netc_swt_bridge_config*

#include <fsl_net.h> Bridge config.

Public Members

netc_swt_default_vlan_filter_t dVFCfg

Default VLAN filter entry configuration when not found in VLAN filter lookup

struct *_netc_swt_psfpcfg*

#include <fsl_net.h> Switch PSFP configuration.

Public Members

netc_isi_kc_rule_t kcRule[4]

Key construction rules

struct *_netc_qos_classify_config*

#include <fsl_net.h> Switch Qos Classification configuration (include two profiles)

struct *_netc_swt_qos_to_vlan_config*

#include <fsl_net.h> Switch QoS to PCP mapping and PCP to PCP mapping configuration when egress packet modification the VLAN tag.

struct *fsl_net*

#include <fsl_net.h>

Public Members

uint8_t qos[32]

Index is created from IPV (3 bits) + DR (2 bits) field. Value is the mapped PCP for VLAN tag.

uint8_t pcp[8]

Index is created from outer PCP (3 bits) field. Value is the mapped PCP for VLAN tag.

struct *_netc_switch_inuse_fdb_statistic*

#include <fsl_net.h> Switch static/dynamic FDB entries in-use statistic.

Public Members

uint16_t camEntries

Number of FDB entries in-use in the CAM.

uint16_t staticEntries

Number of static FDB entries in-use (both hash-based and CAM-based entries).

uint16_t dynamicEntries

Number of dynamic FDB entries in-use (hash-based and CAM-based entries).

uint16_t dynamicEntriesHWM

High water mark of dynamic entries in-use in the FDB table.

struct __netc_swt_port_sr_config

#include <fsl_netc.h> Port seamless redundancy configuration.

struct defaultVlan

Public Members

uint32_t vid

Vlan Identifier.

uint32_t dei

Drop eligible indicator

uint32_t pcp

Priority code point.

uint32_t tpid

Tag protocol identifier, 0 = Standard C-VLAN 0x8100, 1 = Standard S-VLAN 0x88A8.

2.86 Hardware Table Access Functions

enum __netc_tb_index

Table index.

Values:

enumerator kNETC_TGSTable

Time Gate Scheduling table index

enumerator kNETC_RPTable

Rate Policer table index

enumerator kNETC_IPFTable

Ingress Port filter table index

enumerator kNETC_FDBTable

FDB table index

enumerator kNETC_L2MCFTable

L2 IPV4 Multicast Filter table index

enumerator kNETC_VFTable

VLAN Filter table index

enumerator kNETC_ECQTable

ETM Class Queue table index

enumerator kNETC_ECSTable

ETM Class Scheduler table index

enumerator kNETC_ISITable
Ingress Stream Identification table index

enumerator kNETC_ISTable
Ingress Stream table index

enumerator kNETC_ISFTable
Ingress Stream Filter table index

enumerator kNETC_ETTable
Egress Treatment table index

enumerator kNETC_ISGTable
Ingress Sequence Generation table index

enumerator kNETC_ESRTable
Egress Sequence Recovery table index

enumerator kNETC_SGITable
Stream Gate Instance table index

enumerator kNETC_SGCLTable
Stream Gate Control List table index

enumerator kNETC_ISCTable
Ingress Stream Count table index

enumerator kNETC_ECTable
Egress Count table index

enumerator kNETC_FMTTable
Frame Modification table index

enumerator kNETC_BPTable
Buffer Pool table index

enumerator kNETC_SBPTable
Shared Buffer Pool table index

enumerator kNETC_ECGTable
ETM Class Group table index

enumerator kNETC_FMDTable
Frame Modification Data table index

enum __netc_tb_cmd
Table management command operations.

Values:

enumerator kNETC_DeleteEntry
Delete operation

enumerator kNETC_UpdateEntry
Update operation

enumerator kNETC_QueryEntry
Query operation

enumerator kNETC_QueryAndDeleteEntry
Query operation followed by a delete operation

enumerator kNETC_QueryAndUpdateEntry

Query operation followed by a update operation

enumerator kNETC_AddEntry

Add operation

enumerator kNETC_AddOrUpdateEntry

If the entry exists, is update operation, if not exist, is the Add operation

enumerator kNETC_AddAndQueryEntry

Add operation followed by a query operation

enumerator kNETC_AddQueryAndUpdateEntry

Add operation followed by a query operation, Then, if the entry existed prior to the Add operation of this command, the Update operation will be performed.

enum _netc_tb_access_mode

Table Access Method.

Values:

enumerator kNETC_EntryIDMatch

Entry ID Match

enumerator kNETC_ExactKeyMatch

Exact Match Key Element Match

enumerator kNETC_Search

Search with search criteria

enumerator kNETC_TernaryKeyMatch

Ternary Match Key Element Match

enum _netc_cbd_version

NTMP version.

Values:

enumerator kNETC_NtmpV1_0

NTMP Version 1.0

enumerator kNETC_NtmpV2_0

NTMP Version 2.0

enum _netc_cmd_error

Table command response error status.

Values:

enumerator kNETC_FormatError

Format error : 1. Illegal class or command. 2. Invalid SF bit setting. 3. LENGTH is zero for long format. 4. LENGTH is too small for buffer size.

enumerator kNETC_SizeError

Size error : 1. Invalid table index, out of range. 2. Table overflow, no additional entries available.

enumerator kNETC_AccessError

Access violation error, the entity is not allowed to perform the task requested

enumerator kNETC_ClassError

Class specific error

enumerator kNETC_IntegrityError

Integrity error; the command did not execute due to a data integrity error (ECC on internal memory or AXI read/write error)

enumerator kNETC_InvTableID

Invalid table ID

enumerator kNETC_InvAccMethod

Invalid Access method

enumerator kNETC_TableIdxOutOfRange

Table index out of range

enumerator kNETC_DBNotEnough

Request data buffer size or response data buffer size is not sufficient

enumerator kNETC_InvCmd

Invalid command

enumerator kNETC_ReqDBError

Request Data buffer error

enumerator kNETC_MultiBitError

Multi-bit ECC or parity error observed during command processing

enumerator kNETC_HashEntryLimit

Exceeded hash entry limit

enumerator kNETC_HashChainLimit

Exceeded maximum hash collision chain limit and the CAM if present is full

enumerator kNETC_InvHWGenEntryID

Invalid ENTRY_ID for ENTRY_ID generated by hardware

enumerator kNETC_SrchResDBNotEnough

Search command filled the response data buffer before completing the command

enumerator kNETC_CmdIdxTableWithITM

Command for index table before OSR[ITM_STATE]=0

enumerator kNETC_InvQueryAction

Invalid Query action

enumerator kNETC_InvTableAccPrivilege

Invalid table access privilege

enumerator kNETC_ReadSysBusErr

System Bus Read Error

enumerator kNETC_WriteSysBusErr

System Bus Write Error

enumerator kNETC_ClientErr

Client encountered a fault

enumerator kNETC_TGSCmdIssue

Command issued when time gating function is disabled for the port.

enumerator kNETC_TGSUpdateExistList

Update action attempted on an existing admin gate control list. (should delete admin gate control list first before creating a new admin list)

enumerator kNETC_TGSUpdateOverLength

Update action attempted exceeds TGSTCAPR[MAX_GCL_LEN]

enumerator kNETC_TGSUpdateOverSize

Update action attempted exceeds TGSTCAPR[NUM_WORDS].

enumerator kNETC_TGSEntryNotEnough

Insufficient resources to perform the requested operation (not enough free time gate list entries)

enumerator kNETC_TGSUpdateNSList

Update action attempted with ADMIN_CYCLE_TIME, ADMIN_TIME_INTERVAL_GE_i or truncated ADMIN_TIME_INTERVAL_GE_n due ADMIN_CYCLE_TIME specified is not sufficient to transmit 64 byte of frame data + header overhead.

enumerator kNETC_TGSUpdateEarlierStartTime

Update action attempted with ADMIN_BASE_TIME specified s more than one second in the past from tcs advance time.

enumerator kNETC_TGSUpdateOverflowCycle

Update action attempted with ADMIN_CYCLE_TIME + ADMIN_CYCLE_TIME_EXT is greater than $2^{32}-1$.

enumerator kNETC_TGSQueryBeforeListActive

Query action issued when config change occurred. Retry query.

enumerator kNETC_TGSUpdateInvGateValue

Update action attempted with ADMIN_HR_CB_GE_i set to an invalid value

enumerator kNETC_RPSDUTypeOutOfRange

SDU_TYPE specified in entry CFGE_DATA is out of range

enumerator kNETC_IPFInvHR

HR value not valid. Only checked if command issued from the Switch and FLTFA=0x2 or FLTFA=0x3

enumerator kNETC_IPFEntryNotFit

Entry being added does not fit in table

enumerator kNETC_IPFWithoutSTSE

CFGE_DATA update without STSE_DATA update

enumerator kNETC_IPFInvRPP

RPR set to a reserved value. Only checked if FLTA=0x2.

enumerator kNETC_IPFFLTATGTOutOfRange

FLTA_TGT is outside valid range and not NULL. Only checked if FLTA>0x0

enumerator kNETC_IPFInvSwtFLTA

FLTA=0x3 when command issued from the Switch.

enumerator kNETC_IPFInvEnetcFLTA

FLTFA>0x1 when command issued from an ENETC PF.

enumerator kNETC_FDBReachPortLimit

Failed to add or update and entry because the Port BPCR[DYN_LIMIT] has been reached

enumerator kNETC_FDBReachSwtLimit

Failed to add entry because the Switch FDBHTMCR[DYN_LIMIT] has been reached.

enumerator kNETC_FDBInvEPORT

EPORT value not valid. Only checked if (OETEID=0x1 OR CTD=0x1)

- enumerator kNETC_FDBETEIDOutRange
ET_EID is out of range and not NULL. Only checked if OETEID>0x0
- enumerator kNETC_FDBParityErr
Parity error encountered when adding guaranteed entry
- enumerator kNETC_L2MCFInvEPORT
EPORT value not valid. Only checked if (OETEID=0x1 OR CTD=0x1)
- enumerator kNETC_L2MCFETEIDOutRange
ET_EID is not NULL or within the valid range. Only checked if OETEID>0x0.
- enumerator kNETC_L2MCFInvKEYTYPE
KEY_TYPE value not valid
- enumerator kNETC_VFBASEETEIDOutRange
BASE_ET_EID is out of range or MLO is not valid.
- enumerator kNETC_ECQCQ2CGMAPOutRange
CQ2CG_MAP value out-of-range in update command.
- enumerator kNETC_ISIPortIDOutRange
Port ID specified in KEYE_DATA is out of range.
- enumerator kNETC_ISIInvISEID
IS_EID in invalid.
- enumerator kNETC_ISInvOpt
Option specified in one or more of the following fields is not valid – FA, CTD or ISQA, SDU_TYPE.
- enumerator kNETC_ISInvID
One or more of following : 1. Entry IDs are not in valid range or Entry ID is not Null. 2. Check valid ranges specified for these Entry IDs in Ingress Stream table entry – RP_EID, SGI_EID, ISQ_EID, ET_EID or EPORT. 3. ET_EID is checked if (FA =010b .. 101b) & (OETEID!=0). 4. EPORT is checked if (FA = 010b .. 101b) & (OETEID= 0x1 OR CTD= 0x1). 5. HR is chkd if FA = 001b, 100b, or 101b. HR specified cannot be 0x0
- enumerator kNETC_ISInvFMEID
FM_EID format or index is out of range : 1. FM_EID format option type is invalid. 2. FM_EID format is option 1 and the Index is out of range and not Null, or FM_EID format is option 2 and VUDA or SQTA is out of range.
- enumerator kNETC_ISFInvISEID
IS_EID in KEYE_DATA is invalid.
- enumerator kNETC_ISFInvCFGE
Any of the following in CFGE_DATA is invalid : 1. One or more of following Entry IDs are not in valid range or Entry ID specified is not Null. Checks are performed for following Entry IDs CFGE DATA – RP_EID, SGI_EID, ISC_EID. 2. SDU_TYPE is invalid
- enumerator kNETC_ETInvOpt
Command option specified is invalid or not supported. ESQA is not 00 or 10 (others are reserved), or ECA > 1 (reserved).
- enumerator kNETC_ETInvFMEID
FM_EID format or index is out of range. Check performed is as follows : 1. EFM_EID format option type is invalid, or EFM_EID format is option 1 and the Index is out of range and not Null, or EFM_EID format is option 2 and VUDA or SQTA is out of range . 2. the Egress Counter Table index EC_EID is out of range. 3. The Egress Sequence Actions Target Entry ID ESQA_TGT_EID is out of range

enumerator kNETC_ISGInvQSTAG

SG_TAG specified is not valid

enumerator kNETC_SGISGCLEIDOutOfRange

SGCL_EID specified in out of range for Add or Update operation.

enumerator kNETC_SGIIInvSDUTYPE

SDU_TYPE is specified is invalid for Add or Update operation.

enumerator kNETC_SGISGCLEIDNotAlloc

Either the SGCL_EID specified as admin gate control list in Add or Update operation has not been allocated or SGCL_EID is not the first entry in gate control list or the reference count in SGCL entry is not 0.

enumerator kNETC_SGIIInvSGCLEID

SGCL_EID specified for Update operation is in invalid.

enumerator kNETC_SGIIInvADMINBASETIME

ADMIN_BASE_TIME specified for Add or Update operation is more than 2^{30} ns in the past.

enumerator kNETC_SGIIInvCYCLETIME

Cumulated time value of CYCLE_TIME in Stream gate Control list plus CYCLE_TIME_EXT specified in Add or Update operation is $\geq 2^{30}$ ns or CYCLE_TIME specified is 0.

enumerator kNETC_SGCLOverLength

Number words required for the LIST_LENGTH specified for the Add operation exceeds the number of words allocated for SGCL table

enumerator kNETC_SGCLTimeIntervalZero

TIME_INTERVAL_GE_N specified in Add operation is 0. Note that upper 2 bits of TIME_INTERVAL_GE_N are ignored, TIME_INTERVAL_GE_N[29:0] must not be 0.

enumerator kNETC_SGCLTimeIntervalOverflow

Cumulated time value of TIME_INTERVAL_GE_N[29:0] for the gate list specified in Add operation is $\geq 2^{30}$ ns.

enumerator kNETC_FMInvEMEID

FM_EID format is invalid

enumerator kNETC_FMOptOutOfRange

Following fields specified are out of range - MAC_HDR_ACT, VLAN_HDR_ACT, SQT_ACT, OUTER_PCP_DEI_ACT, PLD_ACT.

enumerator kNETC_FMFMDOutOfRange

FMD_EID, FMD_BYTES specified is out of range. When FMD_EID is not set to Null, valid range is $FMD\_EID[15:0] * 24 + FMD\_BYTES \leq (FMDITCAPR[Num\_Words] * 24)$.

enumerator kNETC_BPSBPEIDOutOfRange

SBP_EN is 1 and SBP_EID value is out-of-range in update command

enum __netc_fm_vlan_ud_act

Frame Modification VLAN Update/Delete Action.

Note: Misconfiguration error if replace or delete action is specified and if VLAN tag is not present in frame.

Values:

enumerator kNETC_NoUDVlanAction

No Update/Delete VLAN action

enumerator kNETC_ReplVlanPcpAndDei

Replace outer VLAN's PCP/DEI based on the port's PPCPDEIMR. The tag's original VID and TPID are preserved

enumerator kNETC_DelVlan

Delete outer VLAN Tag

enum __netc_fm_sqt_act

Frame Modification Sequence Tag Action.

Note: Must be set to 000b for Ingress frame modification, otherwise misconfiguration error.

Values:

enumerator kNETC_NoSqtAction

No SQT action

enumerator kNETC_ReomveRTag

Remove R-TAG/draft 2.0 R-TAG/HSR tag, If R-TAG/HSR tag not present, misconfiguration error.

enum __netc_fm_vlan_ar_act

Frame Modification VLAN Add/Replace Action.

Note: For ingress frame modificaion with 00b or 01b, use the ingress port to select PCP and DEI from the Bridge port default VLAN register (BPDVR). For egress frame modification with 00b or 01b, use the internal QoS associated with the frame (IPV, DR) to access the QoS to PCP mapping profile (PQOSMR[QVMP] , QOSVLANMPaR0/1/2/3) to set the new PCP value. Use internal DR associated with frame to access the DR to DEI mapping profile (PPCPDEIMR[DRnDEI]) to set the new DEI value.

Values:

enumerator kNETC_AddCVlanPcpAndDei

Add outer VLAN with VID and PCP/DEI updated as described above. TPID=0x8100

enumerator kNETC_AddSVlanPcpAndDei

Add outer VLAN with VID and PCP/DEI updated as described above. TPID=0x88A8

enumerator kNETC_ReplVidOnly

Replace VLAN with VID. The tag's original PCP, DEI and TPID are preserved

enumerator kNETC_ReplVidPcpAndDei

Replace VLAN with VID and PCP/DEI updated by port's PPCPDEIMR. The tag's original TPID is preserved

enum __netc_tb_eteid_access_mode

Define FDB/L2MCF/IS table entry access the primary Egress Treatment table entry group mode.

Note: The FDB/L2 IPv4 Multicast filter table has precedence over any assignment made via the Ingress Stream table. For Mult port mode, the index to access the Egress Treatment table is computed by adding an offset to the base index of the Egress Treatment group. That offset is derived from the applicability bitmap as follows: starting from the lowest

significant bit of the bitmap, the first encountered bit set to 1, corresponds to offset 0, and so on. This continues till the destination port location in the bitmap is reached

Values:

enumerator kNETC_NoETAccess

No Egress Treatment table access

enumerator kNETC_SinglePortETAccess

Only frame sent to a special port (define in ePort) can access a single Egress Treatment table entry, the applicability bitmap specified by FDB/L2MCF/IS ePort field

enumerator kNETC_MulitPortPackedETAccess

Only frames sent to a special set of ports (ports set to 1 in ePortBitmap) can access the Egress Treatment table, the applicability bitmap = IS ePortBitmap field or FDB/L2MCF portBitmap field

enumerator kNETC_MulitPortAbsETAccess

Frames sent to all of ports can access the Egress Treatment table, means the applicability bitmap is set with 1 for all ports

enum _netc_tb_ipf_update_action

Ingress Port Filter Table Update Actions.

Values:

enumerator kNETC_IPFCfgEUpdate

Configuration Element Update

enumerator kNETC_IPFStsEUpdate

Statistics Element Update

enum _netc_tb_ipf_attr_mask

Ingress Port Filter frame attribute mask.

Values:

enumerator kNETC_IPFSwtPortMasMask

Switch port masquerading Mask

enumerator kNETC_IPFEthernetMask

Ethernet type Mask

enumerator kNETC_IPFOuterVlanMask

Outer VLAN Mask

enumerator kNETC_IPFInnerVlanMask

Inner VLAN Mask

enumerator kNETC_IPFSeqTagMask

Sequence Tag Code Mask

enumerator kNETC_IPFIpHeaderMask

IP Header Mask

enumerator kNETC_IPFIpVersionMask

IP Version Mask

enumerator kNETC_IPFIpExtMask

IPv4 option / IPv6 extension Mask

enumerator kNETC_IPFL4HeaderMask

L4 Code Mask

enumerator kNETC_IPFWakeOnLanMask
Wake-on-LAN Magic Packet Mask

enum __netc_tb_ipf_seq_tag
Ingress Port Filter frame attribute Sequence Tag Code.

Values:

enumerator kNETC_IPFNoRtag
R-TAG/HSR tag is not present

enumerator kNETC_IPFDraftRtag
802.1CB draft 2.0 R-TAG is present

enumerator kNETC_IPFRtag
802.1CB R-TAG is present

enumerator kNETC_IPFHsrTag
HSR Tag is present

enum __netc_tb_ipf_l4_header
Ingress Port Filter frame attribute L4 Header Code.

Values:

enumerator kNETC_IPFOtherL4
The L4 Header is considered as other L4 if it is not one of the following L4 Headers

enumerator kNETC_IPFTcp
TCP header is present

enumerator kNETC_IPFUdp
UDP header is present

enumerator kNETC_IPFSctp
SCTP header is present

enum __netc_tb_ipf_forward_action
Ingress port filter forwarding Action.

Values:

enumerator kNETC_IPFForwardDiscard
Frame be discard

enumerator kNETC_IPFForwardPermit
Frame be permit

enumerator kNETC_IPFRedirectToMgmtPort
Redirect frame to switch management port without any frame modification, Switch only

enumerator kNETC_IPFCopyToMgmtPort
Copy frame to switch management port without any frame modification, Switch only

enum __netc_tb_ipf_filter_action
Ingress port filter Filter Action.

Values:

enumerator kNETC_IPFNoAction
No action

enumerator kNETC_IPFWWithRatePolicer

Rate action with the Rate Policer Entry ID (RP_EID) set to the value configured in the fltaTgt field

enumerator kNETC_IPFWWithIngressStream

Ingress stream identification action where the Ingress Stream Entry ID (IS_EID) is set to the value configured in the fltaTgt field

enumerator kNETC_IPFWWithL2Filtering

Setting a pre L2 filtering SI bitmap (set to the value configured in the fltaTgt) that will be used by the L2 filtering function to determine the final SI bitmap, ENETC only

enum _netc_tb_isi_key_type

Stream identification table key type.

Values:

enumerator kNETC_KCRule0

Use key construction rule 0 (ISIDKC0CR0)

enumerator kNETC_KCRule1

Use key construction rule 1 (ISIDKC1CR0)

enumerator kNETC_KCRule2

Use key construction rule 2 (ISIDKC2CR0). Only for SWITCH

enumerator kNETC_KCRule3

Use key construction rule 3 (ISIDKC3CR0). Only for SWITCH

enum _netc_tb_is_isq_action

Ingress Stream table Ingress Sequence Action.

Values:

enumerator kNETC_ISNotPerformFRER

Not perform Frame FRER sequence generation function

enumerator kNETC_ISPerformFRER

Perform Frame FRER sequence generation function

enum _netc_tb_is_forward_action

Ingress Stream table forwarding Action.

Values:

enumerator kNETC_ISDiscard

Frame be discard

enumerator kNETC_ISRedirectToMgmtPort

Frame be Re-direct frame to switch management port, Switch only

enumerator kNETC_ISAllow

Frame is allow without setting the pre L2 filtering SI bitmap, ENETC only

enumerator kNETC_ISAllowWithSImap

Frame is allow with setting the pre L2 filtering SI bitmap to the value configured in the SI_MAP field, ENETC only

enumerator kNETC_ISSStreamForward

Frame is forwarded to the port(s) specified in the EGRESS_PORT_BITMAP field, Switch only

enumerator kNETC_ISBridgeForward

Frame is do 802.1Q Bridge forwarding (VLAN processing and L2 forwarding), Switch only

enumerator kNETC_ISCopyToMgmtPortAndStream

Copy frame to switch management port with specified HR and stream forwarding, Switch only

enumerator kNETC_ISCopyToMgmtPortAndBridge

Copy frame to switch management port with specified HR and Bridge forwarding, Switch only

enum __netc_tb_is_ctd_mode

Ingress Stream table Cut-Through Disable mode.

Values:

enumerator kNETC_ISNoCTD

Do not override cut-through state

enumerator kNETC_ISSinglePortCTD

Disable cut-through for the outgoing port specified in the cfge ePort field

enumerator kNETC_ISAllPortCTD

Disable cut-through for all ports specified in cfge portBitmap field

enum __netc_tb_rp_update_action

Rate Policer Table Update Actions.

Values:

enumerator kNETC_RPCfgEUpdate

Configuration Element Update

enumerator kNETC_RPFfeEUpdate

Functional Enable Element Update

enumerator kNETC_RPPsEUpdate

Policer State Element Update Element Update

enumerator kNETC_RPStsEUpdate

Statistics Element Update

enum __netc_tb_sgi_update_action

Stream Gate Instance table Update Actions.

Values:

enumerator kNETC_SGIAcfEUpdate

Admin Configuration Element

enumerator kNETC_SGICfgEUpdate

Configuration Element Update

enumerator kNETC_SGISgisEUpdate

Stream Gate Instance State Element Update

enum __netc_tb_sgi_state

Stream Gate Instance State.

Values:

enumerator kNETC_GSNotOper

Gate instance is not operational or Gate instance and lists are not valid

enumerator kNETC_GSUseDefaultParam

Gate instance is operational but no stream gate control list specified, use default Gate Instance parameters

enumerator kNETC_GSUseDefUntilAdminAct

Use default Gate Instance parameters until administrative stream gate control list takes effect

enumerator kNETC_GSUseOperUntilAdminAct

Use Operational stream gate control list until new administrative stream gate control list takes effect

enumerator kNETC_GSUseOperList

Operational stream gate control list is in effect

enum __netc_tb_fm_layer2_act

Frame Modification table Layer 2 Actions.

Note: This field must be set to 0 for traffic destined to a pseudo link. This field must be set to 0 for any device with ASIL-B safety requirements.

Values:

enumerator kNETC_UseL2HeaderAct

L2 actions are specified in L2 header action fields macHdrAct, vlanHdrAct and sqtAct

enumerator kNETC_UseSpecPayload

The entire L2 PDU is replaced with fmdBytes of data specified in fmdEID, not applicable for ingress frame modifications

enum __netc_tb_fm_mac_header_act

Frame Modification table Layer 2 Header MAC Actions.

Note: Ingress frame modifications only support kNETC_NoAction or kNETC_ReplDmac.

Values:

enumerator kNETC_NoMacAction

No Mac header action

enumerator kNETC_ReplSmac

Replace SMAC with the contents of the port's PMAR0/1 register, The port is specified by smacPort field

enumerator kNETC_ReplSmacAndDmacAct1

Replace SMAC and DMAC, The content of SMAC is the same as kNETC_ReplaceSMAC, the DMAC is specified by dmac[6] field

enumerator kNETC_ReplSmacAndDmacAct2

Replace SMAC and DMAC, The content of SMAC is the same as kNETC_ReplaceSMAC, the DMAC is specified by frame's SMAC

enumerator kNETC_ReplDmac

Replace DMAC with specified dmac[6] field value

enumerator kNETC_SwapDmacAndSmac

Swap DMAC and SMAC

enum _netc_tb_fm_vlan_header_act

Frame Modification table Layer 2 VLAN Actions.

Note: For use Delete or Replace action, if no outer VLAN header is present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

Values:

enumerator kNETC_NoVlanAction

No VLAN header action

enumerator kNETC_DelOuterVlan

Delete outer VLAN header

enumerator kNETC_AddOuterVlan

Add outer VLAN header (new VLAN data will be inserted in the outer position), the VID, PCP, DEI and TPID values are specified by outerVidAct, outerPcpAct, outerDeiAct and outerTpidAct field

enumerator kNETC_ReplOuterVlan

Replace outer VLAN header, the VID, PCP, DEI and TPID values are specified by outerVidAct, outerPcpAct, outerDeiAct and outerTpidAct field

enum _netc_tb_fm_outer_vid_act

Frame Modification table Layer 2 outer VLAN VID Actions.

Note: For use kNETC_UseFrameVID action, if no outer VLAN header is present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

Values:

enumerator kNETC_UseFrameVid

Use the VID from the valid outer VLAN header of the received frame

enumerator kNETC_UseSpecVid

Use the VID specified in the outerVlanID field

enum _netc_tb_fm_outer_tpid_act

Frame Modification table Outer TPID action.

Note: For use kNETC_UseFrameTpid action, If outer VLAN header not present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

Values:

enumerator kNETC_UseFrameTpid

Use TPID from outer VLAN header

enumerator kNETC_UseStdCVlan

Set TPID to Standard C-VLAN 0x8100

enumerator kNETC_UseStdSVlan

Set TPID to Standard S-VLAN 0x88A8

enumerator kNETC_UseCustomCVlan

Set TPID to Custom C-VLAN as defined by CVLANR1[ETYPE]

enumerator kNETC_UseCustomSVlan

Set TPID to Custom S-VLAN as defined by CVLANR2[ETYPE]

enum __netc_tb_fm_outer_pcp_act

Frame Modification table Outer PCP action.

Note: For use kNETC_UseFramePcp/kNETC_UseFramePcpMap action, If outer VLAN header not present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

Values:

enumerator kNETC_UseFramePcp

Use PCP from frame outer VLAN header

enumerator kNETC_UseSpecPcp

Use the PCP specified in the outerVlanPcp field

enumerator kNETC_UseFramePcpMap

The PCP is mapping from frame outer VLAN PCP (do mapping according to the PCP to PCP mapping profile which specified in PPCPDEIMR[IPCPMP/EPCMPMP])

enumerator kNETC_UseQosMap

The PCP is mapping from internal QoS (IPV, DR) (do mapping according to the QoS to PCP mapping profile which specified in QOSVLANMPaR0/1/2/3), not applicable for ingress frame modifications

enum __netc_tb_fm_outer_dei_act

Frame Modification table Outer DEI action.

Note: For use kNETC_UseFrameDei action, If outer VLAN header not present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

Values:

enumerator kNETC_UseFrameDei

Use DEI from frame outer VLAN header

enumerator kNETC_UseSpecDei

Use the DEI specified in the outerVlanDei field

enumerator kNETC_UseDrMap

The DEI is mapping from internal DR (do mapping according to the DR to DEI mapping profile which specified in PPCPDEIMR[DRnDEI], not applicable for ingress frame modifications

enum __netc_tb_fm_payload_act

Frame Modification table Payload Actions.

Note: This field must be set to 0 for traffic destined to a pseudo link. This field must be set to 0 for any device with ASIL-B safety requirements.

Values:

enumerator kNETC_NoAction

No Action

enumerator kNETC_ReplAllEthPld

Remove entire Ethernet payload and insert with fmdBytes of data specified in fmdEID

enumerator kNETC_ReplPldWithOffset

Replace fmdBytes of raw data in the Ethernet payload starting at pldOffset, data specified in fmdEID

enum __netc_tb_fdb_update_action

FDB table Update Actions.

Values:

enumerator kNETC_FDBCfgEUpdate

Configuration Element Update

enumerator kNETC_FDBActEUpdate

Activity Element Update

enum __netc_tb_fdb_ctd_mode

FDB table Cut-Through Disable mode.

Values:

enumerator kNETC_FDBNoCTD

Do not override cut-through state

enumerator kNETC_FDBSinglePortCTD

Disable cut-through for the outgoing port specified in the cfge ePort field

enumerator kNETC_FDBAllPortCTD

Disable cut-through for all ports specified in cfge portBitmap field

enum __netc_tb_fdb_sc_keye_mc

FDB table search criteria Key Element Match Criteria.

Values:

enumerator kNETC_FDBKeyeMacthAny

Match any Key Element Criteria

enumerator kNETC_FDBKeyeMacthFID

Match Key Element FID

enumerator kNETC_FDBKeyeMacthMacMulticast

Match Key Element MAC Multicast bit (MAC_ADDR most significant byte's least significant bit)

enumerator kNETC_FDBKeyeMacthBoth

Match both FID field and MAC Multicast bit

enum __netc_tb_fdb_sc_cfge_mc

FDB table search criteria Configuration Element Match Criteria.

Values:

enumerator kNETC_FDBCfgeMacthAny

Match any Configuration Element Criteria

enumerator kNETC_FDBCfgeMacthDynamic

Match Configuration Element dynamic field

enumerator kNETC_FDBCfgeMacthPortBitmap

Match Configuration Element portBitmap field

enumerator kNETC_FDBCfgeMacthBoth

Match both dynamic field and portBitmap

enum _netc_tb_fdb_sc_acte_mc

FDB table search criteria Activity Element Match Criteria.

Values:

enumerator kNETC_FDBActeMacthAny

Match any Activity Element Criteria

enumerator kNETC_FDBActeMatchExact

Exact match with Activity Element

enum _netc_tb_l2mcf_key_type

L2 IPV4 Multicast Filter table key type.

Values:

enumerator kNETC_IPv4ASMKey

Key consists of a filtering ID (FID) and destination multicast IPv4 address

enumerator kNETC_IPv4SSMKey

Key consists of a filtering ID (FID), IPv4 source address and multicast IPv4 destination address

enum _etc_tb_l2mcf_sc_keye_mc

L2 IPV4 Multicast Filter table search criteria Key Element Match Criteria.

Values:

enumerator kNETC_L2MCFKeyeMacthAny

Match any Key Element Criteria

enumerator kNETC_L2MCFKeyeMacthFID

Match Key Element FID

enum _etc_tb_l2mcf_sc_cfge_mc

L2 IPV4 Multicast Filter table search criteria Configuration Element Match Criteria.

Values:

enumerator kNETC_L2MCFCfgeMacthAny

Match any Configuration Element Criteria

enumerator kNETC_L2MCFCfgeMacthDynamic

Match Configuration Element dynamic field

enumerator kNETC_L2MCFCfgeMacthPortBitmap

Match Configuration Element portBitmap field

enumerator kNETC_L2MCFCfgeMacthBoth

Match both dynamic field and portBitmap

enum _etc_tb_l2mcf_sc_acte_mc

FDB table search criteria Activity Element Match Criteria.

Values:

enumerator kNETC_L2MCFActeMacthAny

Match any Activity Element Criteria

enumerator kNETC_L2MCFActeMatchExact

Exact match with Activity Element

enum `_netc_tb_iseqg_sqttag`

Sequence Tag Type.

Values:

enumerator `kNETC_SqDraftRTag`

802.1CB draft 2.0 R-TAG.

enumerator `kNETC_SqRTag`

802.1CB R-TAG.

enumerator `kNETC_SqHsrTag`

HSR Tag.

enum `_netc_tb_iseqg_update_action`

Ingress Sequence Generation Table Update Actions.

Values:

enumerator `kNETC_ISEQGCfgEUpdate`

Configuration Element Update

enumerator `kNETC_ISEQSGsEUpdate`

Sequence Generation Element Update

enum `_netc_tb_eseqr_sqttag`

Egress Sequence Recovery table Sequence Tag Type.

Values:

enumerator `kNETC_AcceptAnyTag`

Accept any incoming tag type (802.1CB draft 2.0 R-TAG, 802.1CB R-TAG or HSR Tag)

enumerator `kNETC_AcceptDraftRTag`

802.1CB draft 2.0 R-TAG.

enumerator `kNETC_AcceptRTag`

802.1CB R-TAG.

enumerator `kNETC_AcceptHsrTag`

HSR Tag.

enum `_netc_tb_tgs_entry_id`

Time Gate Scheduling table entry ID for switch and ENETC.

Values:

enumerator `kNETC_TGSSwtPort0`

Switch PORT 0 entry ID

enumerator `kNETC_TGSSwtPort1`

Switch PORT 1 entry ID

enumerator `kNETC_TGSSwtPort2`

Switch PORT 2 entry ID

enumerator `kNETC_TGSSwtPort3`

Switch PORT 3 entry ID

enumerator `kNETC_TGSSwtPort4`

Switch PORT 4 entry ID

enumerator `kNETC_TGSEnetc0Port`

ENETC 0 port entry ID

enumerator kNETC_TGSEnetc1Port
ENETC 1 port entry ID

enum __netc_tb_tgs_gate_type
Administrative gate operation type.

Values:

enumerator kNETC_SetGateStates
HoldRequest is unchanged

enumerator kNETC_SetAndHoldMac
HoldRequest is set to value hold, only active when enable preemption

enumerator kNETC_SetAndReleaseMac
HoldRequest is set to value release, only active when enable preemption

enum __netc_tb_et_efm_mode
Egress Frame Modification entry mode.

Values:

enumerator kNETC_NormalMode
Egress Frame Modification entry use normal/Default mode

enumerator kNETC_L2Act1
Egress Frame Modification entry l2Act = kNETC_UseSpecPayload

enumerator kNETC_PldAct1
Egress Frame Modification entry pldAct = kNETC_ReplAllEthPld

enum __netc_tb_et_esq_act
Egress Sequence Actions.

Values:

enumerator kNETC_NoEsqAction
No Egress Sequence Action required

enumerator kNETC_HasEsqAction
Has Egress Sequence Recovery action

enum __netc_tb_et_ec_act
Egress Counter Action.

Values:

enumerator kNETC_NoEcCounter
Do not increment egress frame counter

enumerator kNETC_HasEcCounter
Increment egress frame counter

enum __netc_tb_etmq_update_action
ETM Class Queue table Update Actions.

Values:

enumerator kNETC_CQCfgEUpdate
Configuration Element Update

enumerator kNETC_CQStsEUpdate
Statistics Element Update, all counters (except FRM_CNT) within the Statistics Element are reset

enum `_netc_tb_etmcs_entry_id`

ETM Class Scheduler table entry ID.

Values:

enumerator `kNETC_CSSwtPort0`

CS Switch PORT 0 entry ID

enumerator `kNETC_CSSwtPort1`

CS Switch PORT 1 entry ID

enumerator `kNETC_CSSwtPort2`

CS Switch PORT 2 entry ID

enumerator `kNETC_CSSwtPort3`

CS Switch PORT 3 entry ID

enumerator `kNETC_CSSwtPort4`

CS Switch PORT 4 entry ID

enum `_netc_tb_etmcs_ca_assg`

ETM Class Scheduler table Class queue assignment to scheduler inputs mode.

Values:

enumerator `kNETC_CQ7AssignToSchedIn15`

CQ 7 assignment to scheduler input 15, means all CQ use strict priority

enumerator `kNETC_CQ7AssignToSchedIn14`

CQ 7 assignment to scheduler input 14

enumerator `kNETC_CQ7AssignToSchedIn13`

CQ 7 assignment to scheduler input 13

enumerator `kNETC_CQ7AssignToSchedIn12`

CQ 7 assignment to scheduler input 12

enumerator `kNETC_CQ7AssignToSchedIn11`

CQ 7 assignment to scheduler input 11

enumerator `kNETC_CQ7AssignToSchedIn10`

CQ 7 assignment to scheduler input 10

enumerator `kNETC_CQ7AssignToSchedIn9`

CQ 7 assignment to scheduler input 9

enumerator `kNETC_CQ7AssignToSchedIn8`

CQ 7 assignment to scheduler input 8

enumerator `kNETC_CQ7AssignToSchedIn7`

CQ 7 assignment to scheduler input 7, means all CQ use weighted fair

enum `_netc_tb_bp_fc_cfg`

Buffer Pool Flow Control (FC) Configuration.

Values:

enumerator `kNETC_FlowCtrlDisable`

Flow Control disabled

enumerator `kNETC_FlowCtrlWithBP`

Flow Control enabled using only buffer pool FC state.

enumerator `kNETC_FlowCtrlWithSBP`

Flow Control enabled using only shared buffer pool FC state.

enumerator `kNETC_FlowCtrlWithBPAndSBP`

Flow Control enabled using both buffer pool and shared buffer pool FC state, only both 1 trigger the Flow Control ON

typedef enum `_netc_tb_index` `netc_tb_index_t`

Table index.

typedef enum `_netc_tb_cmd` `netc_tb_cmd_t`

Table management command operations.

typedef enum `_netc_tb_access_mode` `netc_tb_access_mode_t`

Table Access Method.

typedef enum `_netc_cbd_version` `netc_cbd_version_t`

NTMP version.

typedef enum `_netc_cmd_error` `netc_cmd_error_t`

Table command response error status.

typedef union `_netc_cmd_bd` `netc_cmd_bd_t`

The Switch/SI command BD data structure.

typedef struct `_netc_cmd_bdr_config` `netc_cmd_bdr_config_t`

Configuration for the Switch/SI command BD Ring Configuration.

typedef struct `_netc_cmd_bdr` `netc_cmd_bdr_t`

The Switch/SI command BD ring handle data structure.

typedef struct `_netc_tb_common_header` `netc_tb_common_header_t`

Table request data buffer common header.

typedef enum `_netc_fm_vlan_ud_act` `netc_fm_vlan_ud_act_t`

Frame Modification VLAN Update/Delete Action.

Note: Misconfiguration error if replace or delete action is specified and if VLAN tag is not present in frame.

typedef enum `_netc_fm_sqt_act` `netc_fm_sqt_act_t`

Frame Modification Sequence Tag Action.

Note: Must be set to 000b for Ingress frame modification, otherwise misconfiguration error..

typedef enum `_netc_fm_vlan_ar_act` `netc_fm_vlan_ar_act_t`

Frame Modification VLAN Add/Replace Action.

Note: For ingress frame modification with 00b or 01b, use the ingress port to select PCP and DEI from the Bridge port default VLAN register (BPDVR). For egress frame modification with 00b or 01b, use the internal QoS associated with the frame (IPV, DR) to access the QoS to PCP mapping profile (PQOSMR[QVMP] , QOSVLANMPaR0/1/2/3) to set the new PCP value. Use internal DR associated with frame to access the DR to DEI mapping profile (PPCPDEIMR[DRnDEI]) to set the new DEI value.

typedef enum *_netc_tb_eteid_access_mode* netc_tb_eteid_access_mode_t

Define FDB/L2MCF/IS table entry access the primary Egress Treatment table entry group mode.

Note: The FDB/L2 IPv4 Multicast filter table has precedence over any assignment made via the Ingress Stream table. For Mult port mode, the index to access the Egress Treatment table is computed by adding an offset to the base index of the Egress Treatment group. That offset is derived from the applicability bitmap as follows: starting from the lowest significant bit of the bitmap, the first encountered bit set to 1, corresponds to offset 0, and so on. This continues till the destination port location in the bitmap is reached

typedef enum *_netc_tb_ipf_update_action* netc_tb_ipf_update_action_t

Ingress Port Filter Table Update Actions.

typedef enum *_netc_tb_ipf_attr_mask* netc_tb_ipf_attr_mask_t

Ingress Port Filter frame attribute mask.

typedef enum *_netc_tb_ipf_seq_tag* netc_tb_ipf_seq_tag_t

Ingress Port Filter frame attribute Sequence Tag Code.

typedef enum *_netc_tb_ipf_l4_header* netc_tb_ipf_l4_header_t

Ingress Port Filter frame attribute L4 Header Code.

typedef struct *_netc_tb_ipf_keye* netc_tb_ipf_keye_t

Ingress Port Filter key element.

typedef enum *_netc_tb_ipf_forward_action* netc_tb_ipf_forward_action_t

Ingress port filter forwarding Action.

typedef enum *_netc_tb_ipf_filter_action* netc_tb_ipf_filter_action_t

Ingress port filter Filter Action.

typedef struct *_netc_tb_ipf_cfge* netc_tb_ipf_cfge_t

Ingress port filter config element.

typedef struct *_netc_tb_ipf_stse* netc_tb_ipf_stse_t

Ingress port filter statistic element.

typedef struct *_netc_tb_ipf_req_data* netc_tb_ipf_req_data_t

Ingress port filter table entry config.

typedef struct *_netc_tb_ipf_rsp_data* netc_tb_ipf_rsp_data_t

Ingress port filter table response data.

typedef struct *_netc_tb_ipf_data* netc_tb_ipf_data_t

Ingress Port filter table data buffer.

typedef struct *_netc_tb_ipf_config* netc_tb_ipf_config_t

Ingress Port filter entry config.

typedef enum *_netc_tb_isi_key_type* netc_tb_isi_key_type

Stream identification table key type.

typedef struct *_netc_tb_isi_keye* netc_tb_isi_keye_t

Stream identification table key element.

typedef struct *_netc_tb_isi_cfge* netc_tb_isi_cfge_t

Stream identification table config element.

typedef struct *_netc_tb_isi_req_data* netc_tb_isi_req_data_t

Stream identification table request data buffer.

```
typedef struct _netc_tb_isi_rsp_data netc_tb_isi_rsp_data_t
    Stream identification table request response data buffer.

typedef struct _netc_tb_isi_data netc_tb_isi_data_t
    Stream identification table data buffer.

typedef struct _netc_tb_isi_config netc_tb_isi_config_t
    Stream identification table entry config.

typedef enum _netc_tb_is_isq_action netc_tb_is_isq_action_t
    Ingress Stream table Ingress Sequence Action.

typedef enum _netc_tb_is_forward_action netc_tb_is_forward_action_t
    Ingress Stream table forwarding Action.

typedef enum _netc_tb_is_ctd_mode netc_tb_is_ctd_mode_t
    Ingress Stream table Cut-Through Disable mode.

typedef netc_tb_eteid_access_mode_t netc_tb_is_eteid_mode_t
    Ingress Stream table Override ET_EID mode.

typedef struct _netc_tb_is_cfge netc_tb_is_cfge_t
    Ingress Stream table config element.

typedef struct _netc_tb_is_req_data netc_tb_is_req_data_t
    Ingress Stream table request data buffer.

typedef struct _netc_tb_is_rsp_data netc_tb_is_rsp_data_t
    Ingress Stream table request response data buffer.

typedef struct _netc_tb_is_data netc_tb_is_data_t
    Ingress Stream table data buffer.

typedef struct _netc_tb_is_config netc_tb_is_config_t
    Ingress Stream table entry config.

typedef struct _netc_tb_isf_keye netc_tb_isf_keye_t
    Ingress Stream Filter table key element.

typedef struct _netc_tb_isf_cfge netc_tb_isf_cfge_t
    Ingress Stream Filter table config element.

typedef struct _netc_tb_isf_req_data netc_tb_isf_req_data_t
    Ingress Stream Filter table request data buffer.

typedef struct _netc_tb_isf_rsp_data netc_tb_isf_rsp_data_t
    Ingress Stream Filter table request response data buffer.

typedef struct _netc_tb_isf_data netc_tb_isf_data_t
    Ingress Stream Filter table data buffer.

typedef struct _netc_tb_isf_config netc_tb_isf_config_t
    Ingress Stream Filter table entry config.

typedef enum _netc_tb_rp_update_action netc_tb_rp_update_action_t
    Rate Policer Table Update Actions.

typedef netc_tc_sdu_type_t netc_tb_rp_sdu_type_t
    Rate Policer Table Protocol/Service Data Unit Type.

typedef struct _netc_tb_rp_cfge netc_tb_rp_cfge_t
    Rate Policer table config element.
```



```
typedef struct _netc_tb_rp_fee netc_tb_rp_fee_t
    Rate Policer table Function Enable element.
typedef struct _netc_tb_rp_pse netc_tb_rp_pse_t
    Rate Policer table Policer State element.
typedef struct _netc_tb_rp_stse netc_tb_rp_stse_t
    Rate Policer table statistic element.
typedef struct _netc_tb_rp_req_data netc_tb_rp_req_data_t
    Rate Policer table request data buffer.
typedef struct _netc_tb_rp_rsp_data netc_tb_rp_rsp_data_t
    Rate Policer table request response data buffer.
typedef struct _netc_tb_rp_data netc_tb_rp_data_t
    Rate Policer table data buffer.
typedef struct _netc_tb_rp_config netc_tb_rp_config_t
    Rate Policer table entry config.
typedef struct _netc_tb_isc_stse netc_tb_isc_stse_t
    Ingress Stream Count table statistic element.
typedef struct _netc_tb_isc_req_data netc_tb_isc_req_data_t
    Ingress Stream Count table request data buffer.
typedef struct _netc_tb_isc_rsp_data netc_tb_isc_rsp_data_t
    Ingress Stream Count table request response data buffer.
typedef struct _netc_tb_isc_data netc_tb_isc_data_t
    Ingress Stream Count table data buffer.
typedef enum _netc_tb_sgi_update_action netc_tb_sgi_update_action_t
    Stream Gate Instance table Update Actions.
typedef netc_tc_sdu_type_t netc_tb_sgi_sdu_type_t
    Stream Gate Instance table Protocol/Service Data Unit Type.
typedef enum _netc_tb_sgi_state netc_tb_sgi_state_t
    Stream Gate Instance State.
typedef struct _netc_tb_sgi_cfge netc_tb_sgi_cfge_t
    Stream Gate Instance table config element.
typedef struct _netc_tb_sgi_acfge netc_tb_sgi_acfge_t
    Stream Gate Instance table Admin Configuration element.
typedef struct _netc_tb_sgi_icfge netc_tb_sgi_icfge_t
    Stream Gate Instance table Initial Configuration element.
typedef struct _netc_tb_sgi_sgise netc_tb_sgi_sgise_t
    Stream Gate Instance table stream gate instance state element.
typedef struct _netc_tb_sgi_req_data netc_tb_sgi_req_data_t
    Stream Gate Instance table request data buffer.
typedef struct _netc_tb_sgi_rsp_data netc_tb_sgi_rsp_data_t
    Stream Gate Instance table request response data buffer.
typedef struct _netc_tb_sgi_data netc_tb_sgi_data_t
    Stream Gate Instance table data buffer.
```

```
typedef struct _netc_tb_sgi_config netc_tb_sgi_config_t
```

Stream Gate Instance table entry config.

```
typedef struct _netc_sgcl_gate_entry netc_sgcl_gate_entry_t
```

Defines the Stream Gate Control entry structure.

```
typedef struct _netc_tb_sgcl_cfge netc_tb_sgcl_cfge_t
```

Stream Gate Control List table config element.

```
typedef struct _netc_tb_sgcl_sgclse netc_tb_sgcl_sgclse_t
```

Stream Gate Control List table Stream Gate Control List State element.

```
typedef struct _netc_tb_sgcl_req_data netc_tb_sgcl_req_data_t
```

Stream Gate Control List table request data buffer.

```
typedef struct _netc_tb_sgcl_rsp_data netc_tb_sgcl_rsp_data_t
```

Stream Gate Control List table request response data buffer.

```
typedef struct _netc_tb_sgcl_data netc_tb_sgcl_data_t
```

Stream Gate Control List table data buffer.

```
typedef struct _netc_tb_sgcl_gcl netc_tb_sgcl_gcl_t
```

Stream Gate Control List table entry gate control list structure.

```
typedef enum _netc_tb_fm_layer2_act netc_tb_fm_layer2_act_t
```

Frame Modification table Layer 2 Actions.

Note: This field must be set to 0 for traffic destined to a pseudo link. This field must be set to 0 for any device with ASIL-B safety requirements.

```
typedef enum _netc_tb_fm_mac_header_act netc_tb_fm_mac_header_act_t
```

Frame Modification table Layer 2 Header MAC Actions.

Note: Ingress frame modifications only support kNETC_NoAction or kNETC_ReplDmac.

```
typedef enum _netc_tb_fm_vlan_header_act netc_tb_fm_vlan_header_act_t
```

Frame Modification table Layer 2 VLAN Actions.

Note: For use Delete or Replace action, if no outer VLAN header is present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

```
typedef enum _netc_tb_fm_outer_vid_act netc_tb_fm_outer_vid_act_t
```

Frame Modification table Layer 2 outer VLAN VID Actions.

Note: For use kNETC_UseFrameVID action, if no outer VLAN header is present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

```
typedef netc_fm_sqt_act_t netc_tb_fm_sqt_act_t
```

Frame Modification table Sequence Tag Action.

Note: For use kNETC_ReomveTag action, If R-TAG/draft 2.0 R-TAG/HSR tag not present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

```
typedef enum _netc_tb_fm_outer_tpid_act netc_tb_fm_outer_tpid_act_t
```

Frame Modification table Outer TPID action.

Note: For use kNETC_UseFrameTpid action, If outer VLAN header not present, then a mis-configuration event will be generated and handled according to the port's PFMCR register.

```
typedef enum _netc_tb_fm_outer_pcp_act netc_tb_fm_outer_pcp_act_t
```

Frame Modification table Outer PCP action.

Note: For use kNETC_UseFramePcp/kNETC_UseFramePcpMap action, If outer VLAN header not present, then a misconfiguration event will be generated and handled according to the port's PFMCR register.

```
typedef enum _netc_tb_fm_outer_dei_act netc_tb_fm_outer_dei_act_t
```

Frame Modification table Outer DEI action.

Note: For use kNETC_UseFrameDei action, If outer VLAN header not present, then a mis-configuration event will be generated and handled according to the port's PFMCR register.

```
typedef enum _netc_tb_fm_payload_act netc_tb_fm_payload_act_t
```

Frame Modification table Payload Actions.

Note: This field must be set to 0 for traffic destined to a pseudo link. This field must be set to 0 for any device with ASIL-B safety requirements.

```
typedef struct _netc_tb_fm_cfge netc_tb_fm_cfge_t
```

Frame Modification table config element.

```
typedef struct _netc_tb_fm_req_data netc_tb_fm_req_data_t
```

Frame Modification table request data buffer.

```
typedef struct _netc_tb_fm_rsp_data netc_tb_fm_rsp_data_t
```

Frame Modification table request response data buffer.

```
typedef struct _netc_tb_fm_data netc_tb_fm_data_t
```

Frame Modification table data buffer.

```
typedef struct _netc_tb_fm_config netc_tb_fm_config_t
```

Frame Modification table entry config.

```
typedef struct _netc_tb_fmd_req_data netc_tb_fmd_req_data_t
```

Frame Modification Data table request data buffer.

```
typedef struct _netc_tb_fmd_rsp_data netc_tb_fmd_rsp_data_t
```

Frame Modification Data table request response data buffer.

```
typedef struct _netc_tb_fmd_data netc_tb_fmd_data_t
```

Frame Modification Data table data buffer.

```
typedef struct _netc_tb_fmd_update_config netc_tb_fmd_update_config_t
```

Frame Modification data table entry update config.

```
typedef struct _netc_tb_fmd_query_buffer netc_tb_fmd_query_buffer_t
```

Frame Modification data table entry query data buffer.

```
typedef struct _netc_tb_vf_keye netc_tb_vf_keye_t
    Vlan Filter table key element.

typedef struct _netc_tb_vf_cfge netc_tb_vf_cfge_t
    Vlan Filter table config element.

typedef struct _netc_tb_vf_search_criteria netc_tb_vf_search_criteria_t
    Vlan Filter table search criteria format.

typedef struct _netc_tb_vf_req_data netc_tb_vf_req_data_t
    Vlan Filter table request data buffer.

typedef struct _netc_tb_vf_rsp_data netc_tb_vf_rsp_data_t
    Vlan Filter table request response data buffer.

typedef struct _netc_tb_vf_data netc_tb_vf_data_t
    Vlan Filter table data buffer.

typedef struct _netc_tb_vf_config netc_tb_vf_config_t
    Vlan Filter table entry config.

typedef enum _netc_tb_fdb_update_action netc_tb_fdb_update_action_t
    FDB table Update Actions.

typedef netc_tb_eteid_access_mode_t netc_tb_fdb_eteid_mode_t
    FDB table entry defined the egress packet processing actions (will cover the actions which
    specified in the Egress Treatment table )

typedef enum _netc_tb_fdb_ctd_mode netc_tb_fdb_ctd_mode_t
    FDB table Cut-Through Disable mode.

typedef struct _netc_tb_fdb_keye netc_tb_fdb_keye_t

typedef struct _netc_tb_fdb_cfge netc_tb_fdb_cfge_t
    FDB table configuration element.

typedef struct _netc_tb_fdb_acte netc_tb_fdb_acte_t
    FDB table Activity element.

typedef enum _netc_tb_fdb_sc_keye_mc netc_tb_fdb_sc_keye_mc_t
    FDB table search criteria Key Element Match Criteria.

typedef enum _netc_tb_fdb_sc_cfge_mc netc_tb_fdb_sc_cfge_mc_t
    FDB table search criteria Configuration Element Match Criteria.

typedef enum _netc_tb_fdb_sc_acte_mc netc_tb_fdb_sc_acte_mc_t
    FDB table search criteria Activity Element Match Criteria.

typedef struct _netc_tb_fdb_search_criteria netc_tb_fdb_search_criteria_t
    FDB table search criteria format.

typedef struct _netc_tb_fdb_req_data netc_tb_fdb_req_data_t
    FDB table request data buffer.

typedef struct _netc_tb_fdb_rsp_data netc_tb_fdb_rsp_data_t
    FDB table request response data buffer.

typedef struct _netc_tb_fdb_data netc_tb_fdb_data_t
    FDB table data buffer.

typedef struct _netc_tb_fdb_config netc_tb_fdb_config_t
    FDB table entry config.
```

typedef enum *_netc_tb_l2mcf_key_type* netc_tb_l2mcf_key_type_t

L2 IPV4 Multicast Filter table key type.

typedef struct *_netc_tb_l2mcf_keye* netc_tb_l2mcf_keye_t

L2 IPV4 Multicast Filter table key element.

typedef enum *_etc_tb_l2mcf_sc_keye_mc* etc_tb_l2mcf_sc_keye_mc_t

L2 IPV4 Multicast Filter table search criteria Key Element Match Criteria.

typedef enum *_etc_tb_l2mcf_sc_cfge_mc* etc_tb_l2mcf_sc_cfge_mc_t

L2 IPV4 Multicast Filter table search criteria Configuration Element Match Criteria.

typedef enum *_etc_tb_l2mcf_sc_acte_mc* etc_tb_l2mcf_sc_acte_mc_t

FDB table search criteria Activity Element Match Criteria.

typedef *netc_tb_fdb_cfge_t* netc_tb_l2mcf_cfge_t

L2 IPV4 Multicast Filter table config element.

typedef *netc_tb_fdb_acte_t* netc_tb_l2mcf_acte_t

L2 IPV4 Multicast Filter table activity lement.

typedef struct *_etc_tb_l2mcf_search_criteria* netc_tb_l2mcf_search_criteria_t

L2 IPV4 Multicast Filter table search criteria format.

typedef struct *_netc_tb_l2mcf_req_data* netc_tb_l2mcf_req_data_t

L2 IPV4 Multicast Filter table request data buffer.

typedef struct *_netc_tb_l2mcf_rsp_data* netc_tb_l2mcf_rsp_data_t

L2 IPV4 Multicast Filter table request response data buffer.

typedef struct *_netc_tb_l2mcf_data* netc_tb_l2mcf_data_t

L2 IPV4 Multicast Filter table data buffer.

typedef struct *_netc_tb_l2mcf_config* netc_tb_l2mcf_config_t

L2 IPV4 Multicast Filter table entry config.

typedef enum *_netc_tb_iseqg_sqtg* netc_tb_iseqg_sqtg_t

Sequence Tag Type.

typedef struct *_netc_tb_iseqg_cfge* netc_tb_iseqg_cfge_t

Ingress Sequence Generation table config element.

typedef struct *_netc_tb_iseqg_sgse* netc_tb_iseqg_sgse_t

Ingress Sequence Generation table Sequence generation state element.

typedef struct *_netc_tb_iseqg_req_data* netc_tb_iseqg_req_data_t

Ingress Sequence Generation table request data buffer.

typedef struct *_netc_tb_iseqg_rsp_data* netc_tb_iseqg_rsp_data_t

Ingress Sequence Generation table request response data buffer.

typedef struct *_netc_tb_iseqg_data* netc_tb_iseqg_data_t

Ingress Sequence Generation table data buffer.

typedef struct *_netc_tb_iseqg_config* netc_tb_iseqg_config_t

Ingress Sequence Generation table entry config.

typedef enum *_netc_tb_iseqg_update_action* netc_tb_iseqg_update_action_t

Ingress Sequence Generation Table Update Actions.

typedef enum *_netc_tb_eseqr_sqtg* netc_tb_eseqr_sqtg_t

Egress Sequence Recovery table Sequence Tag Type.

```
typedef struct _netc_tb_eseqr_cfge netc_tb_eseqr_cfge_t
    Egress Sequence Recovery table config element.
typedef struct _netc_tb_eseqr_stse netc_tb_eseqr_stse_t
    Egress Sequence Recovery table statistic element.
typedef struct _netc_tb_eseqr_srse netc_tb_eseqr_srse_t
    Egress Sequence Recovery table sequence recovery state element.
typedef struct _netc_tb_eseqr_req_data netc_tb_eseqr_req_data_t
    Egress Sequence Recovery table request data buffer.
typedef struct _netc_tb_eseqr_rsp_data netc_tb_eseqr_rsp_data_t
    Egress Sequence Recovery table request response data buffer.
typedef struct _netc_tb_eseqr_data netc_tb_eseqr_data_t
    Egress Sequence Recovery table data buffer.
typedef struct _netc_tb_eseqr_config netc_tb_eseqr_config_t
    Egress Sequence Recovery table entry config.
typedef enum _netc_tb_tgs_entry_id netc_tb_tgs_entry_id_t
    Time Gate Scheduling table entry ID for switch and ENETC.
typedef enum _netc_tb_tgs_gate_type netc_tb_tgs_gate_type_t
    Administrative gate operation type.
typedef struct _netc_tgs_gate_entry netc_tgs_gate_entry_t
    Defines the Time Gate Scheduling gate control entry structure.
typedef struct _netc_tb_tgs_cfge netc_tb_tgs_cfge_t
    Time Gate Scheduling table config element.
typedef struct _netc_tb_tgs_olse netc_tb_tgs_olse_t
    Time Gate Scheduling table statistic element.
typedef struct _netc_tb_tgs_req_data netc_tb_tgs_req_data_t
    Time Gate Scheduling table request data buffer.
typedef struct _netc_tb_tgs_rsp_data netc_tb_tgs_rsp_data_t
    Time Gate Scheduling table request response data buffer.
typedef struct _netc_tb_tgs_data netc_tb_tgs_data_t
    Time Gate Scheduling table data buffer, set with max size.
typedef struct _netc_tb_tgs_gcl netc_tb_tgs_gcl_t
    Time Gate Scheduling table entry gate control list structure.
typedef enum _netc_tb_et_efm_mode netc_tb_et_efm_mode_t
    Egress Frame Modification entry mode.
typedef enum _netc_tb_et_esq_act netc_tb_et_esq_act_t
    Egress Sequence Actions.
typedef enum _netc_tb_et_ec_act netc_tb_et_ec_act_t
    Egress Counter Action.
typedef struct _netc_tb_et_cfge netc_tb_et_cfge_t
    Egress Treatment table config element.
typedef struct _netc_tb_et_req_data netc_tb_et_req_data_t
    Egress Treatment table request data buffer.
```

```
typedef struct _netc_tb_et_rsp_data netc_tb_et_rsp_data_t
    Egress Treatment table request response data buffer.
typedef struct _netc_tb_et_data netc_tb_et_data_t
    Egress Treatment table data buffer.
typedef struct _netc_tb_et_config netc_tb_et_config_t
    Egress Treatment table entry config.
typedef enum _netc_tb_etmcq_update_action netc_tb_etmcq_update_action_t
    ETM Class Queue table Update Actions.
typedef struct _netc_tb_etmcq_cfge netc_tb_etmcq_cfge_t
    ETM Class Queue table config element.
typedef struct _netc_tb_etmcq_stse netc_tb_etmcq_stse_t
    ETM Class Queue table statistic element.
typedef struct _netc_tb_etmcq_req_data netc_tb_etmcq_req_data_t
    ETM Class Queue table request data buffer.
typedef struct _netc_tb_etmcq_rsp_data netc_tb_etmcq_rsp_data_t
    ETM Class Queue table request response data buffer.
typedef struct _netc_tb_etmcq_data netc_tb_etmcq_data_t
    ETM Class Queue table data buffer.
typedef struct _netc_tb_etmcq_config netc_tb_etmcq_config_t
    ETM Class Queue table entry config.
typedef enum _netc_tb_etmcs_entry_id netc_tb_etmcs_entry_id_t
    ETM Class Scheduler table entry ID.
typedef enum _netc_tb_etmcs_ca_assg netc_tb_etmcs_ca_assg_t
    ETM Class Scheduler table Class queue assignment to scheduler inputs mode.
typedef struct _netc_tb_etmcs_cfge netc_tb_etmcs_cfge_t
    ETM Class Scheduler table config element.
typedef struct _netc_tb_etmcs_req_data netc_tb_etmcs_req_data_t
    ETM Class Scheduler table request data buffer.
typedef struct _netc_tb_etmcs_rsp_data netc_tb_etmcs_rsp_data_t
    ETM Class Scheduler table request response data buffer.
typedef struct _netc_tb_etmcs_data netc_tb_etmcs_data_t
    ETM Class Scheduler table data buffer.
typedef struct _netc_tb_etmcs_config netc_tb_etmcs_config_t
    ETM Class Scheduler table entry config.
typedef struct _netc_tb_etmcg_cfge netc_tb_etmcg_cfge_t
    ETM Congestion Group table config element.
typedef struct _netc_tb_etmcg_stse netc_tb_etmcg_stse_t
    ETM Congestion Group table statistic element.
typedef struct _netc_tb_etmcg_req_data netc_tb_etmcg_req_data_t
    ETM Congestion Group table request data buffer.
typedef struct _netc_tb_etmcg_rsp_data netc_tb_etmcg_rsp_data_t
    ETM Congestion Group table request response data buffer.
```

```
typedef struct _netc_tb_etmcg_data netc_tb_etmcg_data_t
    ETM Congestion Group table data buffer.
typedef struct _netc_tb_etmcg_config netc_tb_etmcg_config_t
    ETM Congestion Group table entry config.
typedef struct _netc_tb_ec_stse netc_tb_ec_stse_t
    Egress Count table statistic element.
typedef struct _netc_tb_ec_req_data netc_tb_ec_req_data_t
    Egress Count table request data buffer.
typedef struct _netc_tb_ec_rsp_data netc_tb_ec_rsp_data_t
    Egress Count table request response data buffer.
typedef struct _netc_tb_ec_data netc_tb_ec_data_t
    Egress Count table data buffer.
typedef enum _netc_tb_bp_fc_cfg netc_tb_bp_fc_cfg_t
    Buffer Pool Flow Control (FC) Configuration.
typedef struct _netc_tb_bp_cfge netc_tb_bp_cfge_t
    Buffer Pool table config element.
typedef struct _netc_tb_bp_bpse netc_tb_bp_bpse_t
    Buffer Pool table State Element Data.
typedef struct _netc_tb_bp_req_data netc_tb_bp_req_data_t
    Buffer Pool table request data buffer.
typedef struct _netc_tb_bp_rsp_data netc_tb_bp_rsp_data_t
    Buffer Pool table request response data buffer.
typedef struct _netc_tb_bp_data netc_tb_bp_data_t
    Buffer Pool table data buffer.
typedef struct _netc_tb_bp_config netc_tb_bp_config_t
    Buffer Pool table entry config.
typedef struct _netc_tb_sbp_cfge netc_tb_sbp_cfge_t
    Shared Buffer Pool table config element.
typedef struct _netc_tb_sbp_sbpse netc_tb_sbp_sbpse_t
    Shared Buffer Pool table State Element Data.
typedef struct _netc_tb_sbp_req_data netc_tb_sbp_req_data_t
    Shared Buffer Pool table request data buffer.
typedef struct _netc_tb_sbp_rsp_data netc_tb_sbp_rsp_data_t
    Shared Buffer Pool table request response data buffer.
typedef struct _netc_tb_sbp_data netc_tb_sbp_data_t
    Shared Buffer Pool table data buffer.
typedef struct _netc_tb_sbp_config netc_tb_sbp_config_t
    Shared Buffer Pool table entry config.
typedef union _netc_tb_data_buffer netc_tb_data_buffer_t
    Table common data buffer.
typedef struct _netc_cbdr_hw netc_cbdr_hw_t
    Register group for SI/Switch command bd ring.
```



```
typedef struct _netc_cbdr_handle netc_cbdr_handle_t
```

Handle for common part of EP/Switch NTMP.

```
status_t NETC_CmdBDRInit(netc_cbdr_hw_t *base, const netc_cmd_bdr_config_t *config)
```

Initialize the command BD ring.

Parameters

- base –
- config –

Returns

kStatus_Success

Returns

kStatus_Fail

```
status_t NETC_CmdBDRDeinit(netc_cbdr_hw_t *base)
```

Deinitialize the command BD ring.

Parameters

- base –

Returns

kStatus_Success

```
status_t NETC_CmdBDSendCommand(netc_cbdr_hw_t *base, netc_cmd_bdr_t *cbdr,  
                                netc_cmd_bd_t *cbd, netc_cbd_version_t version)
```

Send the Command Buffer Descriptor to operate on a NTMP table.

Parameters

- base –
- cbdr –
- cbd –
- version –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t NETC_AddIPFTableEntry(netc_cbdr_handle_t *handle, netc_tb_ipf_config_t *config,  
                               uint32_t *entryID)
```

Add entry into the ingress Port Filter Table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t NETC_UpdateIPFTableEntry(netc_cbdr_handle_t *handle, uint32_t entryID,  
                                   netc_tb_ipf_cfge_t *cfg)
```

Update entry in the ingress Port Filter Table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QueryIPFTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID,
netc_tb_ipf_config_t *config)

Query entry in the ingress Port Filter Table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_DelIPFTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Delete an entry in the ingress Port Filter Table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_ResetIPFMatchCounter(*netc_cldr_handle_t* *handle, uint32_t entryID)

Reset the counter of an ingress port filter Table entry.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_GetIPFMatchedCount(*netc_cldr_handle_t* *handle, uint32_t entryID, uint64_t
*count)

Get the matched count of an ingress port filter Table entry.

Parameters

- handle –
- entryID –

- count –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_AddISITableEntry(*netc_cldr_handle_t* *handle, *netc_tb_isi_config_t* *config, uint32_t *entryID)

Add entry into Ingress Stream Identification table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_DeISITableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Delete an entry in Ingress stream identification table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QueryISITableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID, *netc_tb_isi_config_t* *config)

Query Ingress Stream Identification table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QueryISITableEntryWithKey(*netc_cldr_handle_t* *handle, *netc_tb_isi_keye_t* *keye, *netc_tb_isi_rsp_data_t* *rsp)

Query Ingress Stream Identification table with key.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC__AddOrUpdateISTableEntry(*netc_cldr_handle_t* *handle, *netc_tb_is_config_t* *config, bool isAdd)

Add or update entry in Ingress Stream table.

Parameters

- handle –
- config –
- isAdd –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC__QueryISTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID, *netc_tb_is_config_t* *config)

Query Ingress Stream table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC__DelISTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Delete an entry in Ingress stream table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC__AddISFTableEntry(*netc_cldr_handle_t* *handle, *netc_tb_isf_config_t* *config, uint32_t *entryID)

Add entry into ingress stream filter table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_UpdateISFTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID,
netc_tb_isf_cfg_t *cfg)

Update entry into ingress stream filter table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_DelISFTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Delete an entry in Ingress stream filter table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QueryISFTableEntry(*netc_cldr_handle_t* *handle, *netc_tb_isf_keye_t* *keye,
netc_tb_isf_rsp_data_t *rsp)

Query entry from the Ingress stream filter table.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_AddISCTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Add entry in ingress stream count table.

Parameters

- handle –
- entryID –

Returns

status_t

status_t NETC_GetISCStatistic(*netc_cbd_r_handle_t* *handle, uint32_t entryID, *netc_tb_isc_stse_t* *statistic)

Get ingress stream count statistic.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t NETC_ResetISCStatistic(*netc_cbd_r_handle_t* *handle, uint32_t entryID)

Reset the count of the ingress stream count.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t NETC_AddOrUpdateSGITableEntry(*netc_cbd_r_handle_t* *handle, *netc_tb_sgi_config_t* *config, bool isAdd)

Add or update entry in stream gate instance table.

Parameters

- handle –
- config –
- isAdd –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t NETC_ResetIRXOEXSGITableEntry(*netc_cbd_r_handle_t* *handle, uint32_t entryID)

Reset IRX and OEX flags in stream gate instance entry.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t NETC_DelSGITableEntry(*netc_cbd_r_handle_t* *handle, uint32_t entryID)

Delete entry in the stream gate instance table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_GetSGIState(*netc_cldr_handle_t* *handle, uint32_t entryID, *netc_tb_sgi_sgise_t* *statis)

Get statistic of specified stream gate instance table entry.

Parameters

- handle –
- entryID –
- statis –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QuerySGITableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID, *netc_tb_sgi_config_t* *config)

Query entry from the stream gate instance table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_AddSGCLTableEntry(*netc_cldr_handle_t* *handle, *netc_tb_sgcl_gcl_t* *config)

Add entry into Stream Gate Control List Table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_DelSGCLTableEntry(*netc_cldr_handle_t* *handle, uint32_t entryID)

Delete entry of Stream Gate Control List Table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_GetSGCLGateList(*netc_cbdr_handle_t* *handle, *netc_tb_sgcl_gcl_t* *gcl, uint32_t length)

Get Stream Gate Control List Table entry gate control list.

Parameters

- handle –
- gcl –
- length –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_GetSGCLState(*netc_cbdr_handle_t* *handle, uint32_t entryID, *netc_tb_sgcl_sgclse_t* *state)

Get state (ref count) for Stream Gate Control List table entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_QueryRPTableEntry(*netc_cbdr_handle_t* *handle, uint32_t entryID, *netc_tb_rp_rsp_data_t* *rsp)

Query entry from the Rate Policer table.

Parameters

- handle –
- entryID –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_AddOrUpdateRPTableEntry(*netc_cbdr_handle_t* *handle, *netc_tb_rp_config_t* *config, *netc_tb_cmd_t* cmd)

Add or update entry in Rate Policer table.

Parameters

- handle –
- config –

- cmd –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_DelRPTableEntry(*netc_cbdr_handle_t* *handle, uint32_t entryID)

Delete entry in the Rate Policer table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_GetRPStatistic(*netc_cbdr_handle_t* *handle, uint32_t entryID, *netc_tb_rp_stse_t* *statis)

Get statistic of specified Rate Policer table entry.

Parameters

- handle –
- entryID –
- statis –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_ResetMRRPTableEntry(*netc_cbdr_handle_t* *handle, uint32_t entryID)

Reset mark red parameter of specified Rate Policer table entry.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t NETC_ConfigTGSAdminList(*netc_cbdr_handle_t* *handle, *netc_tb_tgs_gcl_t* *config)

Config the QBV (Time Gate Scheduling)

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

`status_t` NETC_GetTGSOperationList(*netc_cldr_handle_t* *handle, *netc_tb_tgs_gcl_t* *gcl, *uint32_t* length)

Get time gate table operation list.

Parameters

- handle –
- gcl –
- length –

Returns

`status_t`

Returns

See `netc_cmd_error_t`

NETC_FD_EID_ENCODE_OPTION_0(entryId)

Frame Modification Entry ID encode options.

Note: `sqta` should be `netc_fm_sqt_act_t` type, `vuda` should be `netc_fm_vlan_ud_act_t` type and `vara` should be `netc_fm_vlan_ar_act_t` type.

NETC_FD_EID_ENCODE_OPTION_1(sqta, vuda)

NETC_FD_EID_ENCODE_OPTION_2(vara, vid)

NETC_ISI_VLAN_FRAME_KEY(valid, pcp, vid)

2 Bytes VLAN field which may added to the frame Key

NETC_TB_SGCL_MAX_ENTRY

Stream Gate Control List Table maximum gate control list length.

NETC_TB_FMD_UPDATE_CONFIG_LENGTH(x)

TFrame Modification Data table update config Data Buffer length, x is the number of update data bytes.

NETC_TB_TGS_MAX_ENTRY

Time Gate Scheduling Table maximum gate control list length (TGSTCAPR[MAX_GCL_LEN])

NETC_TB_ETM_CQ_ENTRY_ID(portID, cqID)

ETM Class Queue table entry ID macro, `cqID` is represents the Class Queue ID ,rang in 0 ~ 7, `portID` is Switch ID, rang in 0 ~ 4.

NETC_TB_ETM_CG_ENTRY_ID(portID, cgID)

ETM Congestion Group table entry ID macro, `cgID` is represents the Congestion Group ID ,rang in 0 ~ 7, `portID` is Switch ID, rang in 0 ~ 4.

NETC_TB_BP_THRESH(mant, exp)

Buffer pool and shared buffer pool threshold macro, the threshold = $MANT * 2^{EXP}$, `uint` is internal memory words (avergae of 20 bytes each)

`union _netc_cmd_bd`

`#include <fsl_netc.h>` The Switch/SI command BD data structure.

Public Members

`struct _netc_cmd_bd` req

`struct _netc_cmd_bd` resp

struct *_netc_cmd_bd* generic

struct *_netc_cmd_bdr_config*

#include <fsl_netc.h> Configuration for the Switch/SI command BD Ring Configuration.

Public Members

netc_cmd_bd_t *bdBase

BDR base address which shall be 128 bytes aligned

uint16_t bdLength

Size of BD ring which shall be multiple of 8 BD

bool enCompInt

Enable/Disable command BD completion interrupt

struct *_netc_cmd_bdr*

#include <fsl_netc.h> The Switch/SI command BD ring handle data structure.

Public Members

netc_cmd_bd_t *bdBase

BDR base address which shall be 128 bytes aligned

uint16_t bdLength

Size of BD ring

uint16_t producerIndex

Current index for execution.

uint16_t cleanIndex

Current index for cleaning.

bool bdrEnable

Current command BD ring is enable or not.

struct *_netc_tb_common_header*

#include <fsl_netc.h> Table request data buffer common header.

Public Members

uint32_t updateActions

Update Actions

uint32_t queryActions

Query Actions

struct *_netc_tb_ipf_keye*

#include <fsl_netc.h> Ingress Port Filter key element.

Public Members

uint16_t precedence

Precedence value of an entry

struct *_netc_tb_ipf_keye* frameAttr

Frame Attribute flags

`uint16_t frameAttrMask`
Frame attribute mask, set with OR of `netc_tb_ipf_attr_mask_t`

`uint16_t dscp`
Differentiated Services Code Point

`uint16_t dscpMask`
Differentiated Services Code Point Mask

`uint16_t srcPort`
Source Port ID

`uint16_t srcPortMask`
Source Port ID Mask

`uint16_t outerVlanTCI`
Outer VLAN Tag Control Information

`uint16_t outerVlanTCIMask`
Outer VLAN Tag Control Information Mask

`uint8_t dmac[6]`
Destination MAC Address

`uint8_t dmacMask[6]`
Destination MAC Address Mask

`uint8_t smac[6]`
Source MAC Address

`uint8_t smacMask[6]`
Source MAC Address Mask

`uint16_t innerVlanTCI`
Inner VLAN Tag Control Information

`uint16_t innerVlanTCIMask`
Inner VLAN Tag Control Information Mask

`uint16_t etherType`
2-byte EtherType

`uint16_t etherTypeMask`
EtherType Mask

`uint8_t IPProtocol`
IP Protocol

`uint8_t IPProtocolMask`
IP Protocol Mask

`uint8_t srcIPAddr[16]`
IP Source Address, Bits 127-0: IPv6 source address, Bits 127-96: IPv4 source address

`uint8_t srcIPAddrMask[16]`
IP Source Address Mask

`uint16_t l4SrcPort`
L4 Source Port

`uint16_t l4SrcPortMask`
L4 Source Port Mask

uint8_t destIPAddr[16]
 IP Destination Address, Bits 127-0: IPv6 source address, Bits 127-96: IPv4 source address

uint8_t destIPAddrMask[16]
 IP Destination Address Mask

uint16_t l4DestPort
 L4 Destination Port

uint16_t l4DestPortMask
 L4 Destination Port Mask

struct __netc__tb_ipf_cfge
 #include <fsl_netc.h> Ingress port filter config element.

Public Members

uint32_t ipv
 Internal Priority Value

uint32_t oipv
 Overwrite IPV

uint32_t dr
 Drop Resilience

uint32_t odr
 Overwrite DR

netc__tb_ipf_forward_action_t fltfa
 Filter Forwarding action.

uint32_t imire
 Ingress Mirroring Enable

uint32_t wolte
 Wake-onLAN trigger enable

netc__tb_ipf_filter_action_t flta
 Filter Action.

uint32_t rpr
 Relative Precedent Resolution

uint32_t ctd
 Cut through disable.

netc__host_reason_t hr
 Host Reason metadata when frame is redirected/copied to the switch management port

uint32_t timecape
 Timestamp capture enable

uint32_t fltaTgt
 Target for selected switch forwarding action or filter action

struct __netc__tb_ipf_stse
 #include <fsl_netc.h> Ingress port filter statistic element.

Public Members

uint32_t matchCount[2]

A count of how many times this entry has been matched.

struct __netc_tb_ipf_req_data

#include <fsl_netc.h> Ingress port filter table entry config.

struct __netc_tb_ipf_rsp_data

#include <fsl_netc.h> Ingress port filter table response data.

Public Members

uint32_t entryID

Present only for commands which perform a query

netc_tb_ipf_keye_t keye

Present only for commands which perform a query

netc_tb_ipf_stse_t stse

Present only for commands which perform a query

netc_tb_ipf_cfge_t cfge

Present only for commands which perform a query

struct __netc_tb_ipf_data

#include <fsl_netc.h> Ingress Port filter table data buffer.

struct __netc_tb_ipf_config

#include <fsl_netc.h> Ingress Port filter entry config.

struct __netc_tb_isi_keye

#include <fsl_netc.h> Stream identification table key element.

Public Members

netc_tb_isi_key_type keyType

Define the key type used for the current isi entry

uint8_t srcPortID

Source Port ID, used when kc portp filed is 1. Only for SWITCH

uint8_t spm

Source Port Masquerading, used when kc spm filed is 1. Only for SWITCH

uint8_t framekey[16]

Frame portion of the key.

struct __netc_tb_isi_cfge

#include <fsl_netc.h> Stream identification table config element.

Public Members

uint32_t iSEID

Ingress stream entry ID, 0xFFFFFFFF means NULL

struct __netc_tb_isi_req_data

#include <fsl_netc.h> Stream identification table request data buffer.

struct __netc_tb_isi_rsp_data

#include <fsl_netc.h> Stream identification table request response data buffer.

Public Members

uint32_t entryID

Only present for query command

netc_tb_isi_keye_t keye

Only present for query command

netc_tb_isi_cfge_t cfge

Only present for query command

struct __netc_tb_isi_data

#include <fsl_netc.h> Stream identification table data buffer.

struct __netc_tb_isi_config

#include <fsl_netc.h> Stream identification table entry config.

struct __netc_tb_is_cfge

#include <fsl_netc.h> Ingress Stream table config element.

Public Members

uint32_t sfe

Stream Filtering Enable

uint32_t ipv

Internal Priority Value, active when opiv is set to 1

uint32_t oipv

Override internal priority value

uint32_t dr

Drop Resilience, active when odr is set to 1

uint32_t odr

Overwrite DR

uint32_t imire

Ingress Mirroring Enable, not applicable to ENETC

uint32_t timecape

Timestamp Capture Enable, not applicable to ENETC

uint32_t sppd

Source Port Pruning Disable, not applicable to ENETC

netc_tb_is_isq_action_t isqa

Ingress Sequence Action, not applicable to ENETC

uint32_t orp

Override Rate Policer ID

uint32_t osgi

Override stream gate instance entry id (default is NULL)

netc_host_reason_t hr

Host Reason when frame is redirected (fa = 01b) to the switch management port or copied to the switch management port (fa = 100b or 101b), value specified has to be a software defined Host Reason (8-15).

netc_tb_is_forward_action_t fa

Forward Option

netc_tc_sdu_type_t sduType
Service Data Unit Type to user for MSDU

uint32_t msdu
Maximum Service Data Unit

uint32_t ifmeLenChange
Ingress Frame Modification Entry Frame Length Change, specified in unit of bytes using a 2's complement notation

uint32_t eport
Egress Port which need do egress packet processing, active when oeteid is set to 1, not applicable to ENETC

netc_tb_is_oeteid_mode_t oETEID
Override ET_EID (Egress Treatment table entry, which specified egress packet processing actions)

netc_tb_is_ctd_mode_t ctd
Cut-Through Disable mode, valid if fa = 010b ~ 101b

uint32_t isqEID
Ingress Sequence Generation Entry ID, Valid when isqa is set to 1. 0xFFFF_FFFF is NULL. Not applicable to ENETC

uint32_t rpEID
Rate Policer Entry ID, Valid when orp =1. 0xFFFF_FFFF is NULL

uint32_t sgiEID
Stream Gate Instance Entry ID, Valid when osgi =1. 0xFFFF_FFFF is NULL

uint32_t ifmEID
Ingress Frame Modification Entry ID. 0xFFFF_FFFF is NULL

uint32_t etEID
Base Egress Treatment Entry ID for primary Egress Treatment group, Valid alid if fa = 010b ~ 101b. 0xFFFF_FFFF is NULL. Not applicable to ENETC

uint32_t iscEID
Ingress Stream counter Index. 0xFFFF_FFFF is NULL.

uint32_t ePortBitmap
Egress Port bitmap, identifies the ports to which the frame is to be forwarding or ET applicability port bitmap when oETEID = 10b. Not applicable to ENETC

uint32_t siMap
Station Interface Map, only valid for ENETC function when fa field is set to 10b

struct __netc_tb_is_req_data
#include <fsl_netc.h> Ingress Stream table request data buffer.

Public Members

netc_tb_is_cfge_t cfge
Only perform for update or add command

struct __netc_tb_is_rsp_data
#include <fsl_netc.h> Ingress Stream table request response data buffer.

Public Members

uint32_t entryID
Only perform for query command

netc_tb_is_cfge_t cfge
Only perform for query command

struct *_netc_tb_is_data*
#include <fsl_netc.h> Ingress Stream table data buffer.

struct *_netc_tb_is_config*
#include <fsl_netc.h> Ingress Stream table entry config.

struct *_netc_tb_isf_keye*
#include <fsl_netc.h> Ingress Stream Filter table key element.

Public Members

uint32_t isEID
Ingress Stream Entry ID

uint8_t pcp
Priority Code Point, Outer VLAN TAG PCP of the received frame

struct *_netc_tb_isf_cfge*
#include <fsl_netc.h> Ingress Stream Filter table config element.

Public Members

uint32_t ipv
Internal Priority Value, active when opiv is set to 1

uint32_t oipv
Override internal priority value

uint32_t dr
Drop Resilience, active when odr is set to 1

uint32_t odr
Overwrite DR

uint32_t imire
Ingress Mirroring Enable, not applicable to ENETC

uint32_t timecape
Timestamp Capture Enable, not applicable to ENETC

uint32_t osgi
Override stream gate instance entry id

uint32_t ctd
Cut-Through Disable, will disable cut-through for all destined ports when set 1, not applicable to ENETC

uint32_t orp
Override Rate Policer (instance) ID

netc_tc_sdu_type_t sduType
Service Data Unit Type to user for MSDU

uint32_t msdu

Maximum Service Data Unit

uint32_t rpEID

Rate Policer Entry ID, Valid when orp =1. 0xFFFF_FFFF is NULL

uint32_t sgiEID

Stream Gate Instance Entry ID, Valid when osgi =1. 0xFFFF_FFFF is NULL

uint32_t iscEID

Ingress Stream counter Index. 0xFFFF_FFFF is NULL.

struct __netc__tb_isf_req_data

#include <fsl_netc.h> Ingress Stream Filter table request data buffer.

Public Members

netc_tb_isf_cfge_t cfge

Only perform for update or add command

struct __netc__tb_isf_rsp_data

#include <fsl_netc.h> Ingress Stream Filter table request response data buffer.

Public Members

uint32_t entryID

Only perform for query command

netc_tb_isf_keye_t keye

Only perform for query command

netc_tb_isf_cfge_t cfge

Only perform for query command

struct __netc__tb_isf_data

#include <fsl_netc.h> Ingress Stream Filter table data buffer.

struct __netc__tb_isf_config

#include <fsl_netc.h> Ingress Stream Filter table entry config.

struct __netc__tb_rp_cfge

#include <fsl_netc.h> Rate Policer table config element.

Public Members

uint32_t cir

Committed information Rate

uint32_t cbs

Committed Burst Size

uint32_t eir

Excess information Rate

uint32_t ebs

Excess Burst Size

uint32_t mren

Mark All Frames Red Enable, Not valid when ndor=1

uint32_t doy
Drop on Yellow enable

uint32_t cm
Color mode, 0b = Color blind, 1b = Color aware

uint32_t cf
Coupling flag, enables coupling the Committed (C) bucket and Excess (E) bucket

uint32_t ndor
No drop on red

netc_tb_rp_sdu_type_t sduType
Service Data Unit Type

uint32_t ____pad0____
Reserved

struct __netc__tb__rp__fee
#include <fsl_netc.h> Rate Policer table Function Enable element.

Public Members

uint8_t fen
Function Enable

uint8_t ____pad0____
Reserved

struct __netc__tb__rp__pse
#include <fsl_netc.h> Rate Policer table Policer State element.

Public Members

uint8_t mr
Mark Red Flag

uint8_t res0
Reserved

struct __netc__tb__rp__stse
#include <fsl_netc.h> Rate Policer table statistic element.

Public Members

uint32_t byteCount[2]
Number of bytes received by the rate policer instance

uint32_t dropFrames[2]
Number of frames dropped by the rate policer instance

uint32_t dr0GrnFrames[2]
Number of frames marked green with DR=0 by the rate policer instance

uint32_t dr1GrnFrames[2]
Number of frames marked green with DR=1 by the rate policer instance

uint32_t dr2GrnFrames[2]
Number of frames marked yellow with DR=2 by the rate policer instance

uint32_t remarkYlwFrames[2]

Number of frames re-marked from green to yellow by the rate policer instance

uint32_t dr3RedFrames[2]

Number of frames marked red with DR=3 by the rate policer instance

uint32_t remarkRedFrames[2]

Number of frames re-marked from green or yellow to red by the rate policer instance

uint32_t lts

Last timestamp

uint32_t bci

Committed token bucket contents, integer portion (31 bits)

uint32_t bcs

Committed token bucket sign bit (1 bit)

uint32_t bcf

Committed token bucket contents, fractional portion (31 bits)

uint32_t bei

Excess token bucket contents, integer portion (32 bits)

uint32_t bef

Excess token bucket contents, fractional portion (31 bits)

uint32_t bes

Committed token bucket sign bit

struct __netc__tb_rp_req_data

#include <fsl_netc.h> Rate Policer table request data buffer.

struct __netc__tb_rp_rsp_data

#include <fsl_netc.h> Rate Policer table request response data buffer.

Public Members

uint32_t entryID

Present only for commands which perform a query

netc__tb_rp_stse_t stse

Present only for commands which perform a query

struct __netc__tb_rp_data

#include <fsl_netc.h> Rate Policer table data buffer.

struct __netc__tb_rp_config

#include <fsl_netc.h> Rate Policer table entry config.

struct __netc__tb_isc_stse

#include <fsl_netc.h> Ingress Stream Count table statistic element.

Public Members

uint32_t rxCount

Receive Count

uint32_t msduDropCount

MSDU Drop Count

uint32_t policerDropCount

Policer Drop Count

uint32_t sgDropCount

Stream Gating Drop Count

struct __netc__tb__isc_req_data

#include <fsl_netc.h> Ingress Stream Count table request data buffer.

struct __netc__tb__isc_rsp_data

#include <fsl_netc.h> Ingress Stream Count table request response data buffer.

struct __netc__tb__isc_data

#include <fsl_netc.h> Ingress Stream Count table data buffer.

struct __netc__tb__sgi_cfge

#include <fsl_netc.h> Stream Gate Instance table config element.

Public Members

uint8_t oexen

Octets Exceeded (Gate Closed Due To Octets Exceeded function) Enable

uint8_t irxen

Invalid Receive (Gate Closed Due To Invalid Rx) Enable

netc__tb__sgi_sdu_type_t sduType

The type of PDU/SDU for Interval Octets Maximum check for Gate Entry

struct __netc__tb__sgi_acfge

#include <fsl_netc.h> Stream Gate Instance table Admin Configuration element.

Public Members

uint32_t adminSgclEID

Administrative Stream Gate Control List Entry ID, 0xFFFFFFFF is NULL

uint32_t adminBaseTime[2]

Admin Base Time

uint32_t adminCycleTimeExt

Admin Cycle Time Extension

struct __netc__tb__sgi_icfge

#include <fsl_netc.h> Stream Gate Instance table Initial Configuration element.

Public Members

uint8_t ipv

Internal Priority Value (IPV), Valid if oipv is 1

uint8_t oipv

Override frame IPV, otherwise the IPV value is determined by the stream gate control list entry

uint8_t gst

Specifies Gate State before the administrative stream gate control list takes affect, 0b = Closed; 1b = Open

uint8_t ctd

Specifies Cut Through disable status before the administrative stream gate control list takes affect , Not applicable to ENETC function

struct __netc__tb__sgi__sgise

#include <fsl_netc.h> Stream Gate Instance table stream gate instance state element.

Public Members

uint32_t operSgclEID

Operational Stream Gate Control List Entry ID

uint32_t configChangeTime[2]

Configuration Change Time

uint32_t operBaseTime[2]

Operational Base Time

uint32_t operCycleTimeExt

Oper Cycle Time Extension

uint32_t oex

Octets Exceeded Flag

uint32_t irx

Invalid Receive Flag

netc__tb__sgi__state_t state

Current Gate Instance State

struct __netc__tb__sgi__req__data

#include <fsl_netc.h> Stream Gate Instance table request data buffer.

struct __netc__tb__sgi__rsp__data

#include <fsl_netc.h> Stream Gate Instance table request response data buffer.

struct __netc__tb__sgi__data

#include <fsl_netc.h> Stream Gate Instance table data buffer.

struct __netc__tb__sgi__config

#include <fsl_netc.h> Stream Gate Instance table entry config.

struct __netc__sgcl__gate__entry

#include <fsl_netc.h> Defines the Stream Gate Control entry structure.

Public Members

uint32_t timeInterval

Time Interval for Gate Entry

uint32_t iom

Interval Octets Maximum for Gate Entry, specifies the maximum bytes (octets) allowed to pass (open), valid if iomen = 1

uint32_t ipv

Internal Priority Value for Gate Entry

uint32_t oipv

Override Internal Priority Value for Gate Entry

uint32_t ctd

Cut Through Disable for Gate Entry

uint32_t iomen

Interval Octet Maximum Enabled for Gate Entry, 0b = Don't track count, 1b = Track count

uint32_t gtst

Gate State for Gate Entry, 0b = Closed; 1b = Open

struct _netc_tb_sgcl_cfge

#include <fsl_netc.h> Stream Gate Control List table config element.

Public Members

uint32_t cycleTime

Cycle Time

uint8_t listLength

List Length

uint16_t extOipv

Extension (means the stream gate control list ends and before cycleTime restarts) Override Internal Priority Value

uint16_t extIpv

List Extension Internal Priority Value, valid if extOipv = 1

uint16_t extCtd

Extension Cut Through Disabled, 0b = No action, 1b = Disabled

uint16_t extGtst

Extension Gate State, 0b = closed, 1b = Open

struct _netc_tb_sgcl_sgclse

#include <fsl_netc.h> Stream Gate Control List table Stream Gate Control List State element.

Public Members

uint8_t refCount

Reference Count, 1 indicates that the gate control list is an administrative or an operational gate control list in a stream gate instance

struct _netc_tb_sgcl_req_data

#include <fsl_netc.h> Stream Gate Control List table request data buffer.

struct _netc_tb_sgcl_rsp_data

#include <fsl_netc.h> Stream Gate Control List table request response data buffer.

struct _netc_tb_sgcl_data

#include <fsl_netc.h> Stream Gate Control List table data buffer.

struct _netc_tb_sgcl_gcl

#include <fsl_netc.h> Stream Gate Control List table entry gate control list structure.

Public Members

uint16_t extOipv

Extension (means the stream gate control list ends and before cycleTime restarts) Override Internal Priority Value

```

uint16_t extIpv
    List Extension Internal Priority Value, valid if extOipv = 1
uint16_t extCtd
    Extension Cut Through Disabled, 0b = No action, 1b = Disabled
uint16_t extGtst
    Extension Gate State, 0b = closed, 1b = Open
uint32_t cycleTime
    Cycle Time
uint32_t numEntries
    Control List entry numbers
netc_sgcl_gate_entry_t *gcList
    Pointer to stream gate control list array
struct _netc_tb_fm_cfge
    #include <fsl_netc.h> Frame Modification table config element.

```

Public Members

```

netc_tb_fm_layer2_act_t l2Act
    Layer 2 Actions
netc_tb_fm_mac_header_act_t macHdrAct
    Layer 2 Header MAC Actions
netc_tb_fm_vlan_header_act_t vlanHdrAct
    Layer 2 VLAN Actions
netc_tb_fm_outer_vid_act_t outerVidAct
    Outer VID Actions
netc_tb_fm_sqt_act_t sqtAct
    Sequence Tag Action, Not applicable for ingress frame modifications
uint16_t smacPort
    Source MAC Address Register Port, valid if macHdrAct=010b,011b,100b
uint8_t dmac[6]
    Destination MAC Address, valid if macHdrAct = 011b,101b
uint32_t outerVlanID
    Outer VLAN VID, valid if outerVidAct = 01b
uint32_t outerVlanPcp
    Outer VLAN PCP, valid if outerPcpAct = 01b
uint32_t outerVlanDei
    Outer VLAN DEI, valid if outerDeiAct = 01b
netc_tb_fm_outer_tpid_act_t outerTpidAct
    Outer TPID action
netc_tb_fm_outer_pcp_act_t outerPcpAct
    Outer PCP action
netc_tb_fm_outer_dei_act_t outerDeiAct
    Outer DEI action

```


netc_tb_fm_payload_act_t pldAct

Payload Actions, Not applicable for ingress frame modifications

uint8_t pldOffset

Payload Offset, valid if outerPldAct = 010b

uint16_t fmdBytes

Frame Modification Bytes, valid if outerPldAct = 001b,010b or l2Act = 1b

uint32_t fmdEID

Frame Modification Data Entry ID, valid if outerPldAct = 001b,010b or l2Act = 1b.
0xFFFF is null pointer

struct __netc_tb_fm_req_data

#include <fsl_netc.h> Frame Modification table request data buffer.

struct __netc_tb_fm_rsp_data

#include <fsl_netc.h> Frame Modification table request response data buffer.

struct __netc_tb_fm_data

#include <fsl_netc.h> Frame Modification table data buffer.

struct __netc_tb_fm_config

#include <fsl_netc.h> Frame Modification table entry config.

struct __netc_tb_fmd_req_data

#include <fsl_netc.h> Frame Modification Data table request data buffer.

Public Members

uint8_t cfge[]

Configuration Element Data size is variable

struct __netc_tb_fmd_rsp_data

#include <fsl_netc.h> Frame Modification Data table request response data buffer.

Public Members

uint8_t cfge[]

Configuration Element Data size is variable

struct __netc_tb_fmd_data

#include <fsl_netc.h> Frame Modification Data table data buffer.

struct __netc_tb_fmd_update_config

#include <fsl_netc.h> Frame Modification data table entry update config.

Public Members

uint32_t res

Hold for request->commonHeader

uint8_t cfge[]

Configuration Element Data size is variable

struct __netc_tb_fmd_query_buffer

#include <fsl_netc.h> Frame Modification data table entry query data buffer.

Public Members

uint32_t entryID
EntryID of the queried entry

uint8_t cfge[]
Configuration Element Data size is variable

struct __netc__tb_vf_keye
#include <fsl_netc.h> Vlan Filter table key element.

struct __netc__tb_vf_cfge
#include <fsl_netc.h> Vlan Filter table config element.

Public Members

uint32_t portMembership
Port Membership Bitmap

uint32_t stgID
Spanning Tree Group Member ID

uint32_t fid
Filtering ID

uint32_t mlo
MAC Learning Options

uint32_t mfo
MAC Forwarding Options

uint32_t ipmfe
IP Multicast Filtering Enable

uint32_t ipmfle
IP Multicast Flooding Enable

uint32_t etaPortBitmap
Egress Treatment Applicability Port Bitmap for the secondary Egress Treatment group

uint32_t baseETEID
Base Egress Treatment Entry ID for the secondary Egress Treatment group

struct __netc__tb_vf_search_criteria
#include <fsl_netc.h> Vlan Filter table search criteria format.

Public Members

uint32_t resumeEntryId
Resume Entry ID, when starting a search, pass the NULL Entry ID.

struct __netc__tb_vf_req_data
#include <fsl_netc.h> Vlan Filter table request data buffer.

Public Members

netc__tb_vf_cfge_t cfge
Present only for update or add commands

struct __netc__tb_vf_rsp_data
#include <fsl_netc.h> Vlan Filter table request response data buffer.

Public Members

uint32_t status

Present only for query command with search access method

uint32_t entryID

Present only for query command

netc_tb_vf_keye_t keye

Present only for query command

netc_tb_vf_cfge_t cfge

Present only for query command

struct _netc_tb_vf_data

#include <fsl_netc.h> Vlan Filter table data buffer.

struct _netc_tb_vf_config

#include <fsl_netc.h> Vlan Filter table entry config.

struct _netc_tb_fdb_keye

#include <fsl_netc.h>

Public Members

uint8_t macAddr[6]

Destination MAC address of the frame for MAC forwarding lookups and the source MAC address of the frame for MAC learning lookups

uint32_t fid

Filtering ID, is obtained from an ingress lookup into the VLAN Filter table

struct _netc_tb_fdb_cfge

#include <fsl_netc.h> FDB table configuration element.

Public Members

uint32_t portBitmap

Forwarding destination Port Bitmap and ET applicability port bitmap when oETEID = 10b

netc_tb_fdb_oeteid_mode_t oETEID

Override ET_EID option

uint32_t ePort

Egress Ports, active when oETEid = 01b or ctd = 01b

uint32_t iMirE

Ingress Mirroring Enable

netc_tb_fdb_ctd_mode_t ctd

Cut-Through Disable

uint32_t dynamic

Static or Dynamic Entry, 0b = Static entry, 1b = Dynamic entry

uint32_t timeCapE

Timestamp Capture Enable when set

uint32_t etEID

Base egress treatment table entry id for primary Egress Treatment group, is valid if the oETEID field is set to value other than kNETC_FDBNoEPP. 0xFFFFFFFF is NULL.

struct __netc__tb_fdb_acte

#include <fsl_netc.h> FDB table Activity element.

Public Members

uint8_t actCnt

Activity Counter

uint8_t actFlag

Activity Flag

struct __netc__tb_fdb_search_criteria

#include <fsl_netc.h> FDB table search criteria format.

Public Members

uint32_t resumeEntryId

Resume Entry ID, pass the NULL Entry ID when starting a search

netc_tb_fdb_keye_t keye

Key Element data which used to match against the table entries

netc_tb_fdb_cfge_t cfge

Configuration Element data which used to match against the table entries

struct __netc__tb_fdb_req_data

#include <fsl_netc.h> FDB table request data buffer.

Public Members

netc_tb_common_header_t commonHeader

Define update actions (use *netc_tb_fdb_update_action_t*) and query actions

netc_tb_fdb_cfge_t cfge

Present only for commands which perform an update or add

struct __netc__tb_fdb_rsp_data

#include <fsl_netc.h> FDB table request response data buffer.

Public Members

uint32_t status

RESUME_ENTRY_ID, valid only in responses for commands which use the Search Access Method

uint32_t entryID

Present only for query command

netc_tb_fdb_keye_t keye

Present only for query command

netc_tb_fdb_cfge_t cfge

Present only for query command

netc_tb_fdb_acte_t acte

Present only for query command

struct __netc_tb_fdb_data

#include <fsl_netc.h> FDB table data buffer.

struct __netc_tb_fdb_config

#include <fsl_netc.h> FDB table entry config.

struct __netc_tb_l2mcf_keye

#include <fsl_netc.h> L2 IPV4 Multicast Filter table key element.

Public Members

netc_tb_l2mcf_key_type_t keyType

Key Type

uint32_t fid

Filtering ID

uint32_t ipv4DestAddr

IPv4 Destination Address

uint32_t ipv4SrcAddr

IPv4 Source Address

struct __etc_tb_l2mcf_search_criteria

#include <fsl_netc.h> L2 IPV4 Multicast Filter table search criteria format.

Public Members

uint32_t resumeEntryId

Resume Entry ID, pass the NULL Entry ID when starting a search

netc_tb_l2mcf_keye_t keye

Key Element data which used to match against the table entries

netc_tb_l2mcf_cfge_t cfge

Configuration Element data which used to match against the table entries

struct __netc_tb_l2mcf_req_data

#include <fsl_netc.h> L2 IPV4 Multicast Filter table request data buffer.

struct __netc_tb_l2mcf_rsp_data

#include <fsl_netc.h> L2 IPV4 Multicast Filter table request response data buffer.

struct __netc_tb_l2mcf_data

#include <fsl_netc.h> L2 IPV4 Multicast Filter table data buffer.

struct __netc_tb_l2mcf_config

#include <fsl_netc.h> L2 IPV4 Multicast Filter table entry config.

struct __netc_tb_iseqg_cfge

#include <fsl_netc.h> Ingress Sequence Generation table config element.

Public Members

netc_tb_iseqg_sqt *t* sqTag

Sequence Tag Type.

uint8_t __pad0__

Reserved.

struct __netc_tb_iseqg_sgse

#include <fsl_netc.h> Ingress Sequence Generation table Sequence generation state element.

Public Members

uint16_t sqgNum

Sequence Generation Number

struct __netc_tb_iseqg_req_data

#include <fsl_netc.h> Ingress Sequence Generation table request data buffer.

struct __netc_tb_iseqg_rsp_data

#include <fsl_netc.h> Ingress Sequence Generation table request response data buffer.

struct __netc_tb_iseqg_data

#include <fsl_netc.h> Ingress Sequence Generation table data buffer.

struct __netc_tb_iseqg_config

#include <fsl_netc.h> Ingress Sequence Generation table entry config.

struct __netc_tb_eseqr_cfge

#include <fsl_netc.h> Egress Sequence Recovery table config element.

Public Members

netc_tb_eseqr_sqt *t* sqTag

Sequence Tag, specify the expected sequence tag type in the frame

uint32_t sqrTnsq

Sequence Recovery Take No Sequence

uint32_t sqrAlg

Sequence Recovery Algorithm, 0b = Vector algorithm, 1b = Match algorithm

uint32_t sqrType

Sequence Recovery Function type, 0b = Sequence recovery function, 1b = Individual recovery function

uint32_t sqrHl

Sequence Recovery History Length, valid if *sqrAlg* = 0b

uint32_t sqrFwl

Sequence Recovery Future Window Length, valid if *sqrAlg* = 0b

uint32_t sqrTp

Sequence Timeout Period, the unit is 1.048576 milliseconds

struct __netc_tb_eseqr_stse

#include <fsl_netc.h> Egress Sequence Recovery table statistic element.

Public Members

uint32_t inOrderPackets[2]

In Order Packets

uint32_t outOfOrderPackets[2]

Out of Order Packets

uint32_t roguePackets[2]

Rogue Packets

uint32_t duplicatePackets[2]

Duplicate Packets

uint32_t lostPackets[2]

Lost Packets

uint32_t taglessPackets[2]

Tag-Less Packets

uint32_t esqrResetCounts

Sequence Recovery Resets

struct __netc__tb__eseqr__srse

#include <fsl_net.c.h> Egress Sequence Recovery table sequence recovery state element.

Public Members

uint32_t sqrNum

Sequence Recovery Number

uint32_t takeAny

Take Any

uint32_t lce

Lost Count Enable

uint32_t sqrTs

Sequence Recovery Timestamp

uint32_t sqrHistory[4]

Recovery History bit vector, each bit corresponding to sequence numbers, bit 1 means a packet with that sequence number has been previously received

struct __netc__tb__eseqr__req__data

#include <fsl_net.c.h> Egress Sequence Recovery table request data buffer.

struct __netc__tb__eseqr__rsp__data

#include <fsl_net.c.h> Egress Sequence Recovery table request response data buffer.

struct __netc__tb__eseqr__data

#include <fsl_net.c.h> Egress Sequence Recovery table data buffer.

struct __netc__tb__eseqr__config

#include <fsl_net.c.h> Egress Sequence Recovery table entry config.

struct __netc__tgs__gate__entry

#include <fsl_net.c.h> Defines the Time Gate Scheduling gate control entry structure.

Public Members

uint32_t interval
Entry Time Interval

struct _netc_tb_tgs_cfge
#include <fsl_netc.h> Time Gate Scheduling table config element.

Public Members

uint64_t adminBaseTime
Administrative Base Time
uint32_t adminCycleTime
Administrative Cycle Time
uint32_t adminCycleTimeExt
Administrative Cycle Time Extension
uint32_t adminControlListLength
Administrative Control List Length
netc_tgs_gate_entry_t adminGcl[]
Administrative Gate control list

struct _netc_tb_tgs_olse
#include <fsl_netc.h> Time Gate Scheduling table statistic element.

Public Members

uint64_t configChangeTime
The time at which this operational gate control list became active
uint64_t configChangeError
Count of error configuration changes
uint64_t operBaseTime
Operational Base Time
uint32_t operCycleTime
Operational Cycle Time
uint32_t operCycleTimeExt
Operational Cycle Time Extension
uint32_t operControlListLength
Operational Control List Length
netc_tgs_gate_entry_t operGcl[]
Operational Gate control list

struct _netc_tb_tgs_req_data
#include <fsl_netc.h> Time Gate Scheduling table request data buffer.

Public Members

netc_tb_tgs_cfge_t cfge
Present only for commands which perform a update

struct _netc_tb_tgs_rsp_data
#include <fsl_netc.h> Time Gate Scheduling table request response data buffer.

Public Members

uint32_t entryID

Present only for commands which perform a query

netc_tb_tgs_cfge_t cfge

Present only for commands which perform a query

netc_tb_tgs_olse_t olse

Present only for commands which perform a query

struct *_netc_tb_tgs_data*

#include <fsl_netc.h> Time Gate Scheduling table data buffer, set with max size.

struct *_netc_tb_tgs_gcl*

#include <fsl_netc.h> Time Gate Scheduling table entry gate control list structure.

Public Members

uint64_t baseTime

Base Time

uint32_t cycleTime

Cycle Time

uint32_t extTime

Cycle Time Extension

uint32_t numEntries

Control List entry numbers

netc_tgs_gate_entry_t *gcList

Pointer to time gate control list array

struct *_netc_tb_et_cfge*

#include <fsl_netc.h> Egress Treatment table config element.

Public Members

netc_tb_et_efm_mode_t efmMode

Egress Frame Modification mode

netc_tb_et_esq_act_t esqa

Egress Sequence Actions

netc_tb_et_ec_act_t eca

Egress Counter Action

uint8_t __pad1__

Reserve for data align

uint8_t efmLenChange

Egress Frame Modification Length Change, specified in units of bytes using a 2's complement notation

uint16_t efmDataLen

Egress Frame Modification Data Length

uint32_t efmEID

Egress Frame Modification Entry Id

uint32_t ecEID

Egress Count Table Entry ID

uint32_t esqaTgtEID

Egress Sequence Actions Target Entry ID, active when esqa = 10b

struct __netc__tb__et__req__data

#include <fsl_netc.h> Egress Treatment table request data buffer.

struct __netc__tb__et__rsp__data

#include <fsl_netc.h> Egress Treatment table request response data buffer.

struct __netc__tb__et__data

#include <fsl_netc.h> Egress Treatment table data buffer.

struct __netc__tb__et__config

#include <fsl_netc.h> Egress Treatment table entry config.

struct __netc__tb__etmcq__cfge

#include <fsl_netc.h> ETM Class Queue table config element.

Public Members

netc_hw_etm_class_queue_idx_t cq2cgMap

Class Queue to Congestion Group Mapping

struct __netc__tb__etmcq__stse

#include <fsl_netc.h> ETM Class Queue table statistic element.

Public Members

uint32_t rejByteCnt[2]

Reject Byte Count

uint32_t rejFrameCnt[2]

Reject Frame Count

uint32_t deqByteCnt[2]

Dequeue Byte Count

uint32_t deqFrameCnt[2]

Dequeue Frame Count

uint32_t dropByteCnt[2]

Dropped Frames, Memory Lost

uint32_t dropFrameCnt[2]

Dropped Frames, Memory Recovered

uint32_t frmCnt

Frame Count

struct __netc__tb__etmcq__req__data

#include <fsl_netc.h> ETM Class Queue table request data buffer.

struct __netc__tb__etmcq__rsp__data

#include <fsl_netc.h> ETM Class Queue table request response data buffer.

struct __netc__tb__etmcq__data

#include <fsl_netc.h> ETM Class Queue table data buffer.

struct __netc_tb_etmcq_config
#include <fsl_netc.h> ETM Class Queue table entry config.

Public Members

uint32_t entryID
Need use NETC_TB_ETM_CQ_ENTRY_ID macro to create entry ID

struct __netc_tb_etmcs_cfge
#include <fsl_netc.h> ETM Class Scheduler table config element.

Public Members

netc_tb_etmcs_ca_assg_t cqAssg
Class Queue Assignment, input 0 to 7 are weighted fair whereby input 8 to 15 are strict priority

uint32_t oal
Overread accounting length

struct __netc_tb_etmcs_cfge wbfsWeight[8]
Weight for scheduler input 0 ~ 7, effective weight is: $(2^x)/(1-(y/64))$

struct __netc_tb_etmcs_req_data
#include <fsl_netc.h> ETM Class Scheduler table request data buffer.

Public Members

netc_tb_etmcs_entry_id_t entryID
One class scheduler entry per port

struct __netc_tb_etmcs_rsp_data
#include <fsl_netc.h> ETM Class Scheduler table request response data buffer.

struct __netc_tb_etmcs_data
#include <fsl_netc.h> ETM Class Scheduler table data buffer.

struct __netc_tb_etmcs_config
#include <fsl_netc.h> ETM Class Scheduler table entry config.

Public Members

netc_tb_etmcs_entry_id_t entryID
One class scheduler entry per port

struct __netc_tb_etmcs_cfge
#include <fsl_netc.h> ETM Congestion Group table config element.

Public Members

uint16_t tdDr0En
Tail drop enable for DR0 Frame

uint16_t tdDr1En
Tail drop enable for DR1 Frame

uint16_t tdDr2En
Tail drop enable for DR2 Frame

uint16_t tdDr3En
Tail drop enable for DR3 Frame

uint16_t oal
Overhead accounting length, 2's complement value (range -2048 to +2047)

struct __netc__tb__etmcbg_cfge tdDRThresh[4]
Tail Drop Threshold ($TA * 2^{Tn}$) for DR0 ~ DR3 Frames, valid if tdDrnEn = 1b

struct __netc__tb__etmcbg_stse
#include <fsl_netcbg.h> ETM Congestion Group table statistic element.

Public Members

uint32_t byteCount[2]
Number of bytes currently in use in all class queues that are members of this group.

struct __netc__tb__etmcbg_req_data
#include <fsl_netcbg.h> ETM Congestion Group table request data buffer.

struct __netc__tb__etmcbg_rsp_data
#include <fsl_netcbg.h> ETM Congestion Group table request response data buffer.

struct __netc__tb__etmcbg_data
#include <fsl_netcbg.h> ETM Congestion Group table data buffer.

struct __netc__tb__etmcbg_config
#include <fsl_netcbg.h> ETM Congestion Group table entry config.

Public Members

uint32_t entryID
Need use NETC_TB_ETM_CG_ENTRY_ID macro to create entry ID

struct __netc__tb__ec_stse
#include <fsl_netcbg.h> Egress Count table statistic element.

Public Members

uint32_t enqFrmCnt[2]
Enqueued Frame Count

uint32_t rejFrmCnt[2]
Rejected Frame Count

struct __netc__tb__ec_req_data
#include <fsl_netcbg.h> Egress Count table request data buffer.

struct __netc__tb__ec_rsp_data
#include <fsl_netcbg.h> Egress Count table request response data buffer.

struct __netc__tb__ec_data
#include <fsl_netcbg.h> Egress Count table data buffer.

struct __netc__tb__bp_cfge
#include <fsl_netcbg.h> Buffer Pool table config element.

Public Members

bool sbpEn
Shared Buffer Pool Enable, set true means a shared buffer pool is associated with this buffer pool

netc_tb_bp_fc_cfg_t gcCfg
Flow Control (FC) Configuration

uint8_t pfcVector
Priority Flow Control (PFC) Vector; not support in NETC 3.0 and 3.1 version

uint16_t maxThresh
Maximum Threshold, value 0 means disable maximum threshold checking, use NETC_TB_BP_THRESH macro to set this value

uint16_t fcOnThresh
Flow Control On Threshold, If the buffer pool usage crosses this threshold, and if fcOnThresh is greater than fcOffThresh, the flow control state of the buffer pool is set to 1, use NETC_TB_BP_THRESH macro to set this value.

uint16_t fcOffThresh
Flow Control Off Threshold, If buffer pool usage drops to this threshold or below, the flow control state of the buffer pool is set to 0, , use NETC_TB_BP_THRESH macro to set this value

uint32_t sbpThresh
Shared Buffer Pool Threshold, use NETC_TB_BP_THRESH macro to set this value

uint32_t sbpEid
Shared Buffer Pool Entry ID, valid if sbpEn is true

uint32_t fcPorts
Flow Control Port bitmap, indicates which ports are to be flow controlled for this buffer pool

struct _netc_tb_bp_bpse
#include <fsl_netc.h> Buffer Pool table State Element Data.

Public Members

uint32_t amountUsed
Amount Used, number of internal memory words (average of 20 bytes each) currently in use in this buffer pool.

uint32_t amountUsedHWM
Amount Used High Watermark, value sticks at the highest AMOUNT_USED seen since the last watermark reset

uint32_t fcState
Flow Control (FC) State, ON (1) or OFF (0)

uint32_t bpd
Buffer Pool Disabled, 1 means the buffer pool has been disabled due to an uncorrectable ECC error

struct _netc_tb_bp_req_data
#include <fsl_netc.h> Buffer Pool table request data buffer.

struct _netc_tb_bp_rsp_data
#include <fsl_netc.h> Buffer Pool table request response data buffer.

```
struct __netc_tb_bp_data
    #include <fsl_netc.h> Buffer Pool table data buffer.
```

```
struct __netc_tb_bp_config
    #include <fsl_netc.h> Buffer Pool table entry config.
```

Public Members

```
uint32_t entryID
    Buffer pool ID, range in 0 ~ (SWT_GetBPTableEntryNum() - 1)
netc_tb_bp_cfge_t cfge
    Buffer Pool table config element
```

```
struct __netc_tb_sbp_cfge
    #include <fsl_netc.h> Shared Buffer Pool table config element.
```

Public Members

```
uint32_t maxThresh
    Maximum Threshold, If shared buffer pool usage is greater than or equal to this threshold, use NETC_TB_BP_THRESH macro to set this value
```

```
uint16_t fcOnThresh
    Flow Control On Threshold, If the shared buffer pool usage crosses this threshold, and if fcOnThresh is greater than fcOffThresh, the flow control state of the buffer pool is set to 1, use NETC_TB_BP_THRESH macro to set this value.
```

```
uint16_t fcOffThresh
    Flow Control Off Threshold, If shared buffer pool usage drops to this threshold or below, the flow control state of the buffer pool is set to 0, use NETC_TB_BP_THRESH macro to set this value
```

```
struct __netc_tb_sbp_sbpse
    #include <fsl_netc.h> Shared Buffer Pool table State Element Data.
```

Public Members

```
uint32_t amountUsed
    Amount Used, number of internal memory words (average of 20 bytes each) currently in use in this buffer pool.
```

```
uint32_t amountUsedHWM
    Amount Used High Watermark, value sticks at the highest AMOUNT_USED seen since the last watermark reset
```

```
uint32_t fcState
    Flow Control (FC) State, ON (1) or OFF (0)
```

```
struct __netc_tb_sbp_req_data
    #include <fsl_netc.h> Shared Buffer Pool table request data buffer.
```

```
struct __netc_tb_sbp_rsp_data
    #include <fsl_netc.h> Shared Buffer Pool table request response data buffer.
```

```
struct __netc_tb_sbp_data
    #include <fsl_netc.h> Shared Buffer Pool table data buffer.
```

```
struct __netc_tb_sbp_config
    #include <fsl_netc.h> Shared Buffer Pool table entry config.
```

Public Members

uint32_t entryID

Shared Buffer pool ID, range in 0 ~ (SWT_GetSBPTableEntryNum() - 1)

netc_tb_sbp_cfge_t cfge

Shared Buffer Pool table config element

union __netc_tb_data_buffer

#include <fsl_net.h> Table common data buffer.

Public Members

netc_tb_tgs_data_t tgs

Time Gate Scheduling table data buffer

netc_tb_rp_data_t rp

Rate Policer table data buffer

netc_tb_ipf_data_t ipf

Ingress Port filter table data buffer

netc_tb_fdb_data_t fdb

FDB table data buffer

netc_tb_l2mcf_data_t l2mcf

L2 IPV4 Multicast Filter table data buffer

netc_tb_vf_data_t vf

VLAN Filter table data buffer

netc_tb_isi_data_t isi

Ingress Stream Identification table data buffer

netc_tb_is_data_t is

Ingress Stream table data buffer

netc_tb_isf_data_t isf

Ingress Stream Filter table data buffer

netc_tb_isc_data_t isc

Ingress Stream Count table data buffer

netc_tb_sgi_data_t sgi

Stream Gate Instance table data buffer

netc_tb_sgcl_data_t sgcl

Stream Gate Control List table data buffer

netc_tb_fm_data_t fm

Frame Modification table data buffer

netc_tb_fmd_data_t fmd

Frame Modification Data table data buffer

netc_tb_et_data_t et

Egress Treatment table data buffer

netc_tb_ec_data_t ec

Egress Count table data buffer

netc_tb_etmcq_data_t eq
ETM Class Queue table data buffer

netc_tb_etmcs_data_t cs
ETM Class Scheduler table data buffer

netc_tb_etmcg_data_t cg
ETM Class Group table data buffer

netc_tb_iseqg_data_t iseqg
Ingress Sequence Generation table data buffer

netc_tb_eseqr_data_t eseqr
Egress Sequence Recovery table data buffer

netc_tb_bp_data_t bp
Buffer Pool table data buffer

netc_tb_sbp_data_t sbp
Shared Buffer Pool table data buffer

struct *_netc_cbdr_hw*
#include <fsl_netc_hw.h> Register group for SI/Switch command bd ring.

Public Members

__IO uint32_t CBDRMR
Command BDR mode register.

__I uint32_t CBDRSR
Command BDR status register.

__IO uint32_t CBDRBAR0
Command BDR base address register 0

__IO uint32_t CBDRBAR1
Command BDR base address register 1

__IO uint32_t CBDRPIR
Command BDR producer index register

__IO uint32_t CBDRCIR
Command BDR consumer index register

__IO uint32_t CBDRLNR
Command BDR length register

struct *_netc_cbdr_handle*
#include <fsl_netc_hw.h> Handle for common part of EP/Switch NTMP.

Public Members

netc_cbdr_hw_t *base
Point to hardware command bd ring register group.

netc_cmd_bdr_t *cmdr
Point to command BD ring handle.

netc_tb_data_buffer_t *buffer
Point to table common data buffer.

struct req

Public Members

uint64_t addr
The request and response data buffers address

struct ____unnamed104____

Public Members

uint32_t resLength
The length of the Response Data Buffer

uint32_t reqLength
The length of the Request Data Buffer

struct ____unnamed106____

Public Members

netc_tb_cmd_t cmd
Access table entry command, see *netc_tb_cmd_t* .

netc_tb_access_mode_t accessType
Access table entry method, see *netc_tb_access_mode_t*.

uint32_t ____pad1____
RSS Hash high field value.

uint32_t version
Protocol Version.

uint32_t enCompInt
Command Completion Interrupt.

uint32_t resReady
Response Ready.

struct ____unnamed108____

Public Members

uint32_t npf
NTMP Protocol Format.

struct resp

struct ____unnamed110____

Public Members

uint32_t numMatched
Number of Entries Matched.

uint32_t error
Error status.

uint32_t resReady
Response Ready.

struct generic

Public Members

uint64_t addr

Data.

uint32_t en

Enable entry.

uint32_t siBitMap

Station interfaces 15-0 for which this filter applies.

uint32_t index

The index refers to an entry location within a table.

uint32_t length

NA

uint32_t cmd

Command.

uint32_t ____pad2____

< Class of command.

uint32_t status

Status.

uint32_t ci

Completion interrupt.

uint32_t sf

Short format.

struct frameAttr

Public Members

uint16_t swtPortMas

Switch port masquerading, applicable only if the incoming port is designated as a switch management port

uint16_t ethernet

Ethernet type Present

uint16_t outerVlan

Outer VLAN Present

uint16_t innerVlan

Inner VLAN Present

netc_tb_ipf_seq_tag_t seqTag

Sequence Tag Code

uint16_t ipHeader

IP Header Present

uint16_t ipVersion

0b = IPv4, 1b = IPv6

uint16_t ipExt

IPv4 option / IPv6 extension present

```
netc_tb_ipf_l4_header_t l4Header
    L4 Header code
uint16_t wakeOnLan
    Wake-on-LAN Magic Packet Present
struct payload
```

Public Members

```
uint8_t data
    Payload Byte n
uint8_t mask
    Payload Byte n Mask
union ____unnamed114____
```

Public Members

```
netc_tb_ipf_keye_t keye
uint32_t entryID
uint32_t sCriteria
union ____unnamed116____
```

Public Members

```
netc_tb_ipf_req_data_t request
netc_tb_ipf_rsp_data_t response
union ____unnamed118____
```

Public Members

```
uint32_t entryID
uint32_t sCriteria
netc_tb_isi_keye_t keye
union ____unnamed120____
```

Public Members

```
netc_tb_isi_req_data_t request
netc_tb_isi_rsp_data_t response
union ____unnamed122____
```

Public Members

netc_tb_is_req_data_t request

netc_tb_is_rsp_data_t response

union ____unnamed124____

Public Members

uint32_t entryID

uint32_t sCriteria

netc_tb_isf_keye_t keye

union ____unnamed126____

Public Members

netc_tb_isf_req_data_t request

netc_tb_isf_rsp_data_t response

union ____unnamed128____

Public Members

netc_tb_rp_cfge_t cfge

Present only for commands which perform an update or add

struct __netc_tb_rp_req_data

struct ____unnamed130____

Public Members

netc_tb_rp_fee_t fee

Present only for commands which perform an update or add

union ____unnamed132____

Public Members

netc_tb_rp_cfge_t cfge

Present only for commands which perform a query

struct __netc_tb_rp_rsp_data

struct __netc_tb_rp_rsp_data

struct ____unnamed134____

Public Members*netc_tb_rp_fee_t* fee

Present only for commands which perform a query

struct ____unnamed136____

Public Members*netc_tb_rp_pse_t* pse

Present only for commands which perform a query

union ____unnamed138____

Public Members*netc_tb_rp_req_data_t* request*netc_tb_rp_rsp_data_t* response

union ____unnamed140____

Public Members*netc_tb_isc_req_data_t* request*netc_tb_isc_rsp_data_t* response

union ____unnamed142____

Public Members*netc_tb_sgi_sgise_t* sgise

struct __netc__tb__sgi__rsp__data

struct ____unnamed144____

union ____unnamed146____

Public Members*netc_tb_sgi_req_data_t* request*netc_tb_sgi_rsp_data_t* response

union ____unnamed148____

Public Members*netc_tb_sgcl_req_data_t* request*netc_tb_sgcl_rsp_data_t* response

struct __netc__tb__sgcl__data

struct ____unnamed150____

union ____unnamed152____

Public Members

netc_tb_fm_req_data_t request

netc_tb_fm_rsp_data_t response

union `__unnamed154__`

Public Members

netc_tb_fmd_req_data_t request

netc_tb_fmd_rsp_data_t response

union `__unnamed156__`

Public Members

uint32_t entryID

netc_tb_vf_search_criteria_t sCriteria

Active when access method is kNETC_Search

netc_tb_vf_keye_t keye

union `__unnamed158__`

Public Members

netc_tb_vf_req_data_t request

netc_tb_vf_rsp_data_t response

struct `__unnamed160__`

Public Members

netc_tb_fdb_acte_t acte

Activity Element data which used to match against the table entries

netc_tb_fdb_sc_keye_mc_t keyeMc

Key Element data match criteria

netc_tb_fdb_sc_cfge_mc_t cfgeMc

Configuration Element data match criteria

netc_tb_fdb_sc_acte_mc_t acteMc

Activity Element data match criteria

union `__unnamed162__`

Public Members

uint32_t entryID

Active when access method is kNETC_EntryIDMatch

netc_tb_fdb_keye_t keye

Active when access method is kNETC_ExactKeyMatch

netc_tb_fdb_search_criteria_t sCriteria

Active when access method is kNETC_Search

union ____unnamed164____

Public Members

netc_tb_fdb_req_data_t request

netc_tb_fdb_rsp_data_t response

struct ____unnamed166____

Public Members

netc_tb_l2mcf_acte_t acte

Activity Element data which used to match against the table entries

etc_tb_l2mcf_sc_keye_mc_t keyeMc

Key Element data match criteria

etc_tb_l2mcf_sc_cfge_mc_t cfgeMc

Configuration Element data match criteria

etc_tb_l2mcf_sc_acte_mc_t acteMc

Activity Element data match criteria

union ____unnamed168____

Public Members

uint32_t entryID

netc_tb_l2mcf_search_criteria_t sCriteria

netc_tb_l2mcf_keye_t keye

union ____unnamed170____

Public Members

netc_tb_l2mcf_req_data_t request

netc_tb_l2mcf_rsp_data_t response

union ____unnamed172____

Public Members

netc_tb_iseqg_req_data_t request

netc_tb_iseqg_rsp_data_t response

union ____unnamed174____

Public Members

netc_tb_eseqr_req_data_t request

netc_tb_eseqr_rsp_data_t response

union ____unnamed176____

Public Members

struct __netc_tgs_gate_entry

uint32_t gate

Entry Gate Mask

struct ____unnamed178____

Public Members

uint32_t tcGateState

Traffic Class Gate States for Gate Entry, 8 bits for 8 Traffic Class , 0b means Gate closed, 1b means Gate open

netc_tb_tgs_gate_type_t operType

Gate operation type (IEEE 802.1Q-2018) field for gate control list entry i

union ____unnamed180____

Public Members

netc_tb_tgs_req_data_t request

netc_tb_tgs_rsp_data_t response

struct __netc_tb_tgs_data

struct ____unnamed182____

union ____unnamed184____

Public Members

netc_tb_et_req_data_t request

netc_tb_et_rsp_data_t response

union ____unnamed186____

Public Members

netc_tb_etmcq_req_data_t request

netc_tb_etmcq_rsp_data_t response

struct wbfWeight

Public Members

uint8_t xCode
Weight code x value

uint8_t yCode
Weight code y value

union __unnamed189__

Public Members

netc_tb_etmcs_req_data_t request

netc_tb_etmcs_rsp_data_t response

struct tdDRThresh

Public Members

uint16_t tn
TA

uint16_t ta
Tn

union __unnamed192__

Public Members

netc_tb_etmcg_req_data_t request

netc_tb_etmcg_rsp_data_t response

union __unnamed194__

Public Members

netc_tb_ec_req_data_t request

netc_tb_ec_rsp_data_t response

union __unnamed196__

Public Members

netc_tb_bp_req_data_t request

netc_tb_bp_rsp_data_t response

union __unnamed198__

Public Members

netc_tb_sbp_req_data_t request

netc_tb_sbp_rsp_data_t response

2.87 NETC MDIO Driver

2.88 MDIO initialization module

```
enum _netc_mdio_type
    Enumeration for the MAC port MDIO type.
    Values:
    enumerator kNETC_EMdio
        Bound handle to EMDIO access, submodule of NETC.
    enumerator kNETC_InternalMdio
        Bound handle to MAC port internal MDIO access, submodule of EP/Switch.
    enumerator kNETC_ExternalMdio
        Bound handle to MAC port external MDIO access, submodule of EP/Switch.
typedef enum _netc_mdio_type netc_mdio_type_t
    Enumeration for the MAC port MDIO type.
typedef struct _netc_mdio netc_mdio_t
    Structure to choose MDIO entity(Internal/external MDIO for specified EP/Switch port)
typedef struct _netc_mdio_handle netc_mdio_handle_t
    MDIO handle.
typedef struct _netc_mdio_config netc_mdio_config_t
    MDIO configuration structure.
status_t NETC_MDIOInit(netc_mdio_handle_t *handle, netc_mdio_config_t *config)
    Initialize the MDIO.
```

Note: The EMDIO can be used independently. The port internal/external MDIO is a part of EP/Switch, should be initialized and used after EP/Switch is enabled.

Parameters

- handle – MDIO handle.
- config – MDIO configuration.

Returns

status_t

```
struct _netc_mdio
    #include <fsl_netc_mdio.h> Structure to choose MDIO entity(Internal/external MDIO for
    specified EP/Switch port)
```

Public Members

```
netc_mdio_type_t type
    Internal or external MAC port MDIO.
netc_hw_eth_port_idx_t port
    MDIO port index, only meaningful when port MDIO type is used.
```

```
struct _netc_mdio_handle
    #include <fsl_netc_mdio.h> MDIO handle.
```

Public Members

netc_mdio_t mdio
MDIO identifier.

struct *__netc_mdio_config*
#include <fsl_netc_mdio.h> MDIO configuration structure.

Public Members

netc_mdio_t mdio
MDIO identifier.

uint32_t srcClockHz
MDIO reference clock for MDC frequency calculation.

bool isNegativeDriven
MDIO driven at positive(false)/negative(true) of MDC edge.

bool isPreambleDisable
Enable/Disable generation of MDIO preamble.

2.89 MDIO PHY status module

typedef struct *netc_mdio_phy_status* *netc_mdio_phy_status_t*
PHY auto status check configuration structure.

status_t NETC_MDIOSetPhyStatusCheck(*netc_mdio_handle_t* *handle, *netc_mdio_phy_status_t* *config)

Setup the mechanism to check PHY status automatically This is a hardware mechanism to read specified PHY register in a configured time interval instead of polling the PHY in software.

Parameters

- handle – MDIO handle.
- config – The configuration of the PHY status automatical check.

Returns

status_t

void NETC_MDIOPhyStatusGetFlags(*netc_mdio_handle_t* *handle, uint16_t *low2HighMask, uint16_t *high2LowMask)

Get the PHY register bit status transition interrupt flag(s).

Parameters

- handle – MDIO handle.
- low2HighMask – The interrupt flag of a 0->1 transition on a corresponding bit of PHY register.
- high2LowMask – The interrupt flag of a 1->0 transition on a corresponding bit of PHY register.

void NETC_MDIOPhyStatusClearFlags(*netc_mdio_handle_t* *handle, uint16_t low2HighMask, uint16_t high2LowMask)

Clear the PHY register bit status transition interrupt flag(s).

Parameters

- handle – MDIO handle.
- low2HighMask – Clear the interrupt flag of a 0->1 transition on a corresponding bit of PHY register.
- high2LowMask – Clear the interrupt flag of a 1->0 transition on a corresponding bit of PHY register.

struct `_netc_mdio_phy_status`

#include <fsl_netcdm.h> PHY auto status check configuration structure.

Public Members

uint16_t interval

PHY status read interval in units of 1-2 ms. A value of 0 indicates disable.

bool isC45Used

PHY status read with Clause 22/45 MDIO access.

uint8_t phyOrPortAddr

MDIO PHY address(Clause 22) / port address(Clause 45).

uint8_t regiOrDevAddr

MDIO register address(Clause 22) / device address(Clause 45).

uint16_t c45RegiAddr

MDIO register address(Clause 45).

uint16_t enableIntrHigh2Low

Bit high-to-low event interrupt enable.

uint16_t enableIntrLow2High

Bit low-to-high event interrupt enable.

2.90 MDIO write/read module

status_t NETC_MDIOWrite(*netc_mdio_handle_t* *handle, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

IEEE802.3 Clause 22 MDIO write data.

Parameters

- handle – MDIO handle.
- phyAddr – The PHY address.
- regAddr – The PHY register address.
- data – The data written to PHY.

Returns

status_t

status_t NETC_MDIORead(*netc_mdio_handle_t* *handle, uint8_t phyAddr, uint8_t regAddr, uint16_t *pData)

IEEE802.3 Clause 22 MDIO read data.

Parameters

- handle – MDIO handle.
- phyAddr – The PHY address.

- regAddr – The PHY register address.
- pData – The received data from PHY.

Returns

status_t

status_t NETC_MDIOC45Write(*netc_mdio_handle_t* *handle, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t data)

IEEE802.3 Clause 45 MDIO write data.

Parameters

- handle – MDIO handle.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.
- data – The data written to PHY.

Returns

status_t

status_t NETC_MDIOC45Read(*netc_mdio_handle_t* *handle, uint8_t portAddr, uint8_t devAddr, uint16_t regAddr, uint16_t *pData)

IEEE802.3 Clause 45 MDIO read data.

Parameters

- handle – MDIO handle.
- portAddr – The MDIO port address(PHY address).
- devAddr – The device address.
- regAddr – The PHY register address.
- pData – The received data from PHY.

Returns

status_t

2.91 NETC SWITCH (SWT) Driver

2.92 Switch (SWT) data path

2.93 Switch (SWT) Generic Configuration

```
typedef struct _swt_handle swt_handle_t
```

```
typedef struct _swt_transfer_config swt_transfer_config_t
```

```
typedef status_t (*swt_reclaim_cb_t)(swt_handle_t *handle, netc_tx_frame_info_t *frameInfo, void *userData)
```

Callback for reclaimed tx frames.

```
typedef void (*swt_rx_alloc_cb_t)(swt_handle_t *handle, uint32_t length, void *userData)
```

Defines the Switch Rx memory buffer alloc function pointer.

`typedef void (*swt_rx_free_cb_t)(swt_handle_t *handle, void *address, void *userData)`

Defines the Switch Rx memory buffer free function pointer.

`typedef struct _swt_config swt_config_t`

Configuration structure for Switch.

`typedef struct _swt_config_const swt_config_const_t`

Configuration constant structure for Switch in handle.

`status_t SWT_Init(swt_handle_t *handle, const swt_config_t *config)`

Init SWITCH.

Parameters

- handle –
- config – The user configuration

Returns

status_t

`status_t SWT_Deinit(swt_handle_t *handle)`

Deinit switch.

Parameters

- handle –

Returns

status_t

`status_t SWT_GetDefaultConfig(swt_config_t *config)`

Get default configuration for switch.

Parameters

- config –

Returns

status_t

`status_t SWT_SetEthPortMII(swt_handle_t *handle, uint8_t ethPort, netc_hw_mii_speed_t speed, netc_hw_mii_duplex_t duplex)`

Set MII speed and duplex for switch ethernet port.

Parameters

- handle –
- ethPort –
- speed –
- duplex –

Returns

status_t

`static inline void SWT_SetPortSpeed(swt_handle_t *handle, netc_hw_port_idx_t portIdx, uint16_t pSpeed)`

Set switch port speed.

Parameters

- handle –
- portIdx –
- pSpeed –

status_t SWT_PortStop(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx)

Stop Switch Port receive/transmit (disable both ETH and port)

Parameters

- handle –
- portIdx –

Returns

status_t

status_t SWT_SetPortMaxFrameSize(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *uint16_t* size)

Set switch port maximum supported received frame size.

Parameters

- handle –
- portIdx –
- size –

Returns

status_t

struct __swt_config

#include <fsl_netc_switch.h> Configuration structure for Switch.

Public Members

netc_hw_switch_idx_t switchIdx

Switch index

struct __swt_config ports[5]

The common configuration required for all ports

uint16_t dynFDBLimit

Maximum number of entries which can be dynamically learned by FDB table, a value of 0 implies no limit.

netc_swt_psfpcfg_t psfpCfg

The switch PSFP configuration, cover the ISI key construction profiles configuration

netc_ipf_cfg_t ipfCfg

The switch ingress port filter configuration

netc_vlan_classify_cfg_t vlanCfg

The switch ingress vlan classify configuration

netc_swt_qos_classify_cfg_t rxqosCfg

The switch ingress VLAN to QoS mapping configuration

netc_swt_qos_to_vlan_cfg_t txqosCfg

The switch egress QoS to VLAN mapping configuration

netc_swt_imr_cfg_t imrCfg

The switch Ingress mirror configuration

netc_swt_bridge_cfg_t bridgeCfg

The switch bridge configuration

```

uint8_t cmdRingUse
    Number of command BD rings to be used
netc_cmd_bdr_config_t cmdBdrCfg[2]
    The switch command BD rings configuration
netc_msix_entry_t *msixEntry
    MSIX table entry array.
uint8_t entryNum
    MSIX entry number.
uint8_t cmdBdrEntryIdx[2]
    MSIX entry index of command BD ring interrupt.
uint8_t timeCaptureEntryIdx
    MSIX entry index of time capture interrupt.
struct __swt_config_const
    #include <fsl_netc_switch.h> Configuration constant structure for Switch in handle.

```

Public Members

```

uint8_t cmdRingUse
    Number of command BD rings to be used
uint8_t entryNum
    MSIX entry number.
bool rxCacheMaintain
    Enable/Disable Rx buffer cache maintain in driver.
bool txCacheMaintain
    Enable/Disable Tx buffer cache maintain in driver.
bool enUseMgmtRxBdRing
    Enable/Disable use Switch management Rx BD ring.
bool rxZeroCopy
    Enable zero-copy receive mode.
swt_rx_alloc_cb_t rxBuffAlloc
    Callback function to alloc memory, must be provided for zero-copy Rx.
swt_rx_free_cb_t rxBuffFree
    Callback function to free memory, must be provided for zero-copy Rx.
swt_reclaim_cb_t reclaimCallback
    Callback for reclaimed Tx Switch management frames.
void *userData
    User data, return in callback.
struct __swt_handle
    #include <fsl_netc_switch.h> Handle for SWITCH.

```

Public Members

```

netc_switch_hw_t hw
    Hardware register map resource.

```


swt_config_const_t cfg

Switch configuration constant.

netc_cmd_bdr_t cmdBdRing[2]

Command BD ring handle for switch.

ep_handle_t *epHandle

The EP handle to send/receive management frame.

netc_rx_bdr_t mgmtRxBdRing

Management Receive BD ring for frames with Host Reason filed not zero.

netc_tx_bdr_t mgmtTxBdRing

Management Transmit BD ring for Direct Switch Enqueue frames.

struct ports

Public Members

netc_port_ethmac_t ethMac

Ethernet MAC configuration, vaild only on port 0 ~ 3

netc_port_common_t commonCfg

Port common configuration

netc_swt_port_bridge_config_t bridgeCfg

Port bridge configuration

netc_swt_port_fm_config_t fmCfg

Port Frame Modification configuration

netc_port_tx_tc_config_t txTcCfg[8]

Port Tx traffic class related configuration, vaild only on port 0 ~ 3

uint8_t ipvToTC[8]

Port IPV to Tx traffic class queue index mapping, value means TC index, range in 0 ~ 7

uint8_t ipvToBP[8]

Port IPV to buffer pool ID mapping, value means BP ID, range in 0 ~ (SWT_GetBPTableEntryNum() - 1)

netc_port_psfpi_config_t isiCfg

Port Ingress stream identification

bool enMirror

Enable/Disable Ingress Mirroring on this port

uint8_t lanID

The HSR's LANID this port belong to

bool inCutThrough

Enable/Disable Ingress Cut Through on this port, vaild only on port 0 ~ 3

bool outCutThrough

Enable/Disable Egress Cut Through on this port, vaild only on port 0 ~ 3

bool enableTg

Enable port time gate scheduling.

bool enTxRx

Enable port transmit/receive path, if disabled, the tx/rx of the mac corresponding to the port will also be closed.

2.94 Switch (SWT) Interrupt Module

status_t SWT_MsixSetGlobalMask(*swt_handle_t* *handle, bool mask)

Set the global MSIX mask status.

This function masks/unmasks global MSIX message. Mask - All of the vectors are masked, regardless of their per-entry mask bit states. Unmask - Each entry's mask status determines whether the vector is masked or not.

Parameters

- handle – The EP handle
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

status_t SWT_MsixSetEntryMask(*swt_handle_t* *handle, uint8_t entryIdx, bool mask)

Set the MSIX entry mask status for specified entry.

This function masks/unmasks MSIX message for specified entry.

Parameters

- handle – SWT handle.
- entryIdx – The entry index in the table.
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

status_t SWT_MsixGetPendingStatus(*swt_handle_t* *handle, uint8_t pbaIdx, uint64_t *status)

Get the MSIX pending status in MSIX PBA table.

This function is to get the entry pending status from MSIX PBA table. If interrupt occurs but masked by vector control of entry, pending bit in PBA will be set.

Parameters

- handle – SWT handle.
- pbaIdx – The index of PBA array with 64-bit unit.
- status – Pending status bit mask, bit n for entry n.

Returns

status_t

2.95 Switch (SWT) management

status_t SWT_BridgeInit(*swt_handle_t* *handle, const *netc_swt_bridge_config_t* *config)

Config the Bridge.

Cover configuration below

- Vlan filter table default VFHTDRCR0-2

Not Cover

- Port specific Vlan config
- Port Storm Control BPSCR0/R1
- FDB entry

- Vlan Filter Table entry
- Multicast filter entry

Parameters

- handle –
- config –

Returns

status_t

status_t SWT_BridgeConfigPort(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, const *netc_swt_port_bridge_config_t* *config)

Config bridge port vlan Tx/Rx.

Cover configuration below

- Port specific Vlan config
- Port Storm Control BPSCR0/R1

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

status_t SWT_BridgeConfigPortDefaultVid(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *uint16_t* vid)

Config bridge port default VID.

Parameters

- handle –
- portIdx –
- vid –

Returns

status_t

static inline *uint32_t* SWT_BridgeGetVFTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number (entry size is 24 bytes) of bridge vlan filter table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, Ingress Stream Filter, FDB, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_BridgeAddVFTableEntry(*swt_handle_t* *handle, *netc_tb_vf_config_t* *config, *uint32_t* *entryID)

Add entry into bridge vlan filter table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeUpdateVFTableEntry(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_vf_cfge_t *cfg)

Update entry in bridge vlan filter table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeQueryVFTableEntry(*swt_handle_t* *handle, netc_tb_vf_keye_t *keye,
netc_tb_vf_rsp_data_t *rsp)

Query an entry in bridge VF Table.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeDelVFTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry in bridge vlan filter table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeSearchVFTableEntry(*swt_handle_t* *handle, netc_tb_vf_search_criteria_t
*sCriteria, netc_tb_vf_rsp_data_t *rsp)

Search entry in bridge vlan filter table.

Note: Only support search and return one entry at a time.

Parameters

- handle –
- sCriteria –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_BridgeGetFDBTableRemainEntryNum(*swt_handle_t* *handle)
Get remaining available entry number (entry size is 24 bytes) of bridge FDB table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, Ingress Stream Filter, VLAN Filter, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_BridgeAddFDBTableEntry(*swt_handle_t* *handle, *netc_tb_fdb_config_t* *config,
uint32_t *entryID)

Add entry into bridge FDB table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeUpdateFDBTableEntry(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_fdb_cfg_t *cfg)

Update entry in bridge FDB table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_BridgeQueryFDBTableEntry(swt_handle_t *handle, netc_tb_fdb_keye_t *keye,  
                                     netc_tb_fdb_rsp_data_t *rsp)
```

Query an entry in bridge FDB Table.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_BridgeSearchFDBTableEntry(swt_handle_t *handle, netc_tb_fdb_search_criteria_t  
                                       *sCriteria, netc_tb_fdb_rsp_data_t *rsp)
```

Search entry in bridge FDB table.

Note: Only support search and return one entry at a time.

Parameters

- handle –
- sCriteria –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_BridgeDelFDBTableEntry(swt_handle_t *handle, uint32_t entryID)
```

Delete an entry in bridge FDB Table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_BridgeGetFDBActivityState(swt_handle_t *handle, uint32_t entryID,  
                                       netc_tb_fdb_acte_t *state)
```

Get the activity data for FDB table entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_BridgeGetL2MCFTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number (entry size is 24 bytes) of bridge L2 IPV4 multicast filter table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, Ingress Stream Filter, VLAN Filter, FDB table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_BridgeAddL2MCFTableEntry(*swt_handle_t* *handle, *netc_tb_l2mcf_config_t* *config, uint32_t *entryID)

Add entry into Bridge L2 IPV4 multicast filter table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeUpdateL2MCFTableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_l2mcf_cfg_t* *cfg)

Update entry in bridge L2 IPV4 multicast filter table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeSearchL2MCFTableEntry(*swt_handle_t* *handle, *netc_tb_l2mcf_search_criteria_t* *sCriteria, *netc_tb_l2mcf_rsp_data_t* *rsp)

Search entry in bridge L2 IPV4 multicast filter table.

Note: Only support search and return one entry at a time.

Parameters

- handle –

- sCriteria –
- rsp –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeGetL2MCFActivityState(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_l2mcf_acte_t *state)

Get the activity data for bridge L2 IPV4 multicast filter table entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_BridgeDelL2MCFTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry in bridge L2 IPV4 multicast filter table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline status_t SWT_FMConfigPort(*swt_handle_t* *handle, netc_hw_port_idx_t portIdx,
const netc_swt_port_fm_config_t *config)

Config Port level Frame Modification.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

static inline uint32_t SWT_FMGetTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of Frame Modification table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

```
static inline uint32_t SWT_FMGetTableMaxEntryNum(swt_handle_t *handle)
```

Get maximum entry number of Frame Modification table.

Parameters

- handle –

Returns

uint32_t

```
status_t SWT_FMAddTableEntry(swt_handle_t *handle, netc_tb_fm_config_t *config)
```

Add entry into the Frame Modification table.

Add entry of the frame modification table. Frame modification can be encoded into the table id directly or provided as index of the table entry. refer to the frame modification entry definition.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_FMUpdateTableEntry(swt_handle_t *handle, netc_tb_fm_config_t *config)
```

Update entry in the Frame Modification table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_FMDelTableEntry(swt_handle_t *handle, uint32_t entryID)
```

Delete table entry in Frame Modification Table.

The provided ID must be table index. Error return if the id is action encoded id.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_FMQueryTableEntry(swt_handle_t *handle, uint32_t entryID, netc_tb_fm_config_t *config)
```

Query table entry in Frame Modification Table.

The provided ID must be table index. Error return if the id is action encoded id.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_FMDGetTableWordsNum(*swt_handle_t* *handle)

Get word number (word size is 24 bytes) of Frame Modification data table.

Note: This is a static bounded index table, when update or query table, should satisfied: numBytes + ENTRY_ID <= 24 * wordNumber .

Parameters

- handle –

Returns

uint32_t

status_t SWT_FMDUpdateTableEntry(*swt_handle_t* *handle, *netc_tb_fmd_update_config_t* *config, uint32_t length)

Update Frame Modification data table contents.

Parameters

- handle –
- config –
- length –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FMDQueryTableEntry(*swt_handle_t* *handle, *netc_tb_fmd_query_buffer_t* *query, uint32_t length)

Query Frame Modification data table contents.

Parameters

- handle –
- query –
- length –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_FRERGetISEQGTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of ingress Sequence Generation table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t SWT_FRERAddISEQGTableEntry(*swt_handle_t* *handle, *netc_tb_iseqg_config_t* *config)

Add entry into FRER sequence number generation table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERUpdateISEQGTableEntry(*swt_handle_t* *handle, *netc_tb_iseqg_config_t* *config)

Update entry in FRER sequence number generation table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERResetSEQGTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Reset sequence number generation in FRER sequence generation entry.

Parameters

- handle –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERDelISEQGTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry in FRER sequence number generation table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERGetISEQGState(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_iseqg_sgse_t *state)

Get the Sequence generation number form sequence generation table for specified entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_FRERGetESEQRTableEntryNum(*swt_handle_t* *handle)

Get the number of entries assigned to FRER sequence number recovery table.

Note: This is a static bounded index table, so all entries in the table are available for SWT_FRERConfigESEQRTableEntry() API

Parameters

- handle –

Returns

uint32_t

status_t SWT_FRERConfigESEQRTableEntry(*swt_handle_t* *handle, *netc_tb_eseqr_config_t*
*config)

Config FRER sequence number recovery table entry.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERQueryESEQRTableEntry(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_eseqr_stse_t *statistic, netc_tb_eseqr_cfge_t
*config, netc_tb_eseqr_srse_t *state)

Query FRER sequence recovery table entry.

Parameters

- handle –
- entryID –
- statistic –
- config –

- state –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_FRERGetESEQRStatistic(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_eseqr_stse_t *statistic, netc_tb_eseqr_srse_t
*state)

Get FRER sequence recorvery table state and statistic.

Parameters

- handle –
- entryID –
- statistic –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_GetBPTableEntryNum(*swt_handle_t* *handle)

Get Buffer Pool table entry number.

Note: This is a static bounded index table, so all entries in the table are available for SWT_UpdateBPTableEntry() API

Parameters

- handle –

Returns

uint32_t

status_t SWT_UpdateBPTableEntry(*swt_handle_t* *handle, netc_tb_bp_config_t *config)

Update Buffer Pool table entry.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_GetBPEntryState(*swt_handle_t* *handle, uint32_t entryID, netc_tb_bp_bpse_t
*state)

Get Buffer Pool table entry State.

Parameters

- handle –
- entryID –

- state –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_GetSBPTableEntryNum(*swt_handle_t* *handle)

Get Shared Buffer Pool table entry number.

Note: This is a static bounded index table, so all entries in the table are available for SWT_UpdateSBPTableEntry() API

Parameters

- handle –

Returns

uint32_t

status_t SWT_UpdateSBPTableEntry(*swt_handle_t* *handle, *netc_tb_sbp_config_t* *config)

Update Shared Buffer Pool table entry.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_GetSBPEntryState(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_sbp_sbpse_t* *state)

Get Shared Buffer Pool table entry State.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

2.96 Switch (SWT) Table Management Module

status_t SWT_CmdBDRInit(*swt_handle_t* *handle, *netc_hw_swt_cbdr_idx_t* ring, const *netc_cmd_bdr_config_t* *config)

Init SWITCH command BD ring.

Parameters

- handle –

- ring – Command BD ring index
- config – The user configuration

Returns

status_t

status_t SWT_CmdBDRDeinit(*swt_handle_t* *handle, *netc_hw_swt_cbd_r_idx_t* ring)

Deinit switch command BD ring.

Parameters

- handle –
- ring – Command BD ring index

Returns

status_t

2.97 Switch (SWT) Ingress data path configuration

status_t SWT_RxMirrorConfig(*swt_handle_t* *handle, const *netc_swt_imr_config_t* *config)

Configure switch ingress mirror.

Parameters

- handle –
- config –

Returns

status_t

static inline status_t SWT_RxParserConfig(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, const *netc_port_parser_config_t* *config)

Configure Parser in Receive Data Path.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

static inline status_t SWT_RxVlanCInit(*swt_handle_t* *handle, const *netc_vlan_classify_config_t* *config)

Configure the customer vlan type.

Parameters

- handle –
- config –

Returns

status_t

static inline status_t SWT_RxVlanCConfigPort(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *netc_port_vlan_classify_config_t* *config)

Configure the Accepted Vlan for PORT.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

```
static inline status_t SWT_RxQosCInit(swt_handle_t *handle, const  
                                     netc_swt_qos_classify_config_t *config)
```

Init the ingress QoS classification for Switch.

Parameters

- handle –
- config –

Returns

status_t

```
static inline status_t SWT_RxQosCConfigPort(swt_handle_t *handle, netc_hw_port_idx_t  
                                             portIdx, netc_port_qos_classify_config_t *config)
```

Configure the QoS Classification for Switch Port.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

```
static inline status_t SWT_RxIPFInit(swt_handle_t *handle, const netc_ipf_config_t *config)
```

Enable/Disable Ingress Port Filtering.

Applied for both Switch and ENETC

Parameters

- handle –
- config –

Returns

status_t

```
static inline status_t SWT_RxIPFConfigPort(swt_handle_t *handle, netc_hw_port_idx_t portIdx,  
                                           const netc_port_ipf_config_t *config)
```

Config the IPF for specified Port.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

static inline uint32_t SWT_RxIPFGetTableRemainWordNum(*swt_handle_t* *handle)

Get remaining available word number (words size is 6 bytes) of the ingress Port Filter Table.

Note: This is a ternary match table, and the entries can vary in size, from 2 to 14 words.

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxIPFAddTableEntry(*swt_handle_t* *handle, *netc_tb_ipf_config_t* *config, uint32_t *entryID)

Add an entry for the ingress Port Filter Table.

This function do an add & query with return hardware id which can be used as future query / delete / update.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t SWT_RxIPFUpdateTableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_ipf_cfg_t* *cfg)

Update entry in the ingress Port Filter Table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t SWT_RxIPFQueryTableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_ipf_config_t* *config)

Query an entry for the ingress Port Filter Table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxIPFDeleteEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete an entry for the ingress Port Filter Table.

Parameters

- handle –
- entryID –

Returns*status_t***Returns**

See netc_cmd_error_t

status_t SWT_RxIPFResetMatchCounter(*swt_handle_t* *handle, uint32_t entryID)

Reset the counter of an ingress port filter entry.

Parameters

- handle –
- entryID –

Returns*status_t***Returns**

See netc_cmd_error_t

status_t SWT_RxIPFGetMatchedCount(*swt_handle_t* *handle, uint32_t entryID, uint64_t *count)

Get the matched count for entry in IPF.

Parameters

- handle –
- entryID –
- count –

Returns*status_t***Returns**

See netc_cmd_error_t

static inline *status_t* SWT_RxPSFPInit(*swt_handle_t* *handle, const *netc_swt_psfp_config_t* *config)

Init the Switch PSFP Cover configuration below.

- ISI key construction profiles (ISIDKC0CR0 - ISIDKC3CR0)

Not Cover

- Port specific isi config

Parameters

- handle –
- config –

Returns*status_t*

```
static inline status_t SWT_RxPSFPConfigPortISI(swt_handle_t *handle, netc_hw_port_idx_t
                                              portIdx, const netc_port_psfp_isi_config
                                              *config)
```

Configure Ingress stream identification for specified port.

Parameters

- handle –
- portIdx –
- config –

Returns

status_t

```
static inline uint32_t SWT_RxPSFPGetISITableRemainEntryNum(swt_handle_t *handle)
    Get remaining available entry number (entry size is 24 bytes) of stream identification table.
```

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Filter, VLAN Filter, FDB, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

```
status_t SWT_RxPSFPAddISITableEntry(swt_handle_t *handle, netc_tb_isi_config_t *config,
                                     uint32_t *entryID)
```

Add an entry into the stream identification table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_RxPSFPQueryISITableEntry(swt_handle_t *handle, uint32_t entryID,
                                       netc_tb_isi_config_t *config)
```

Query an entry in ingress stream identification table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

```
status_t SWT_RxPSFPQueryISITableEntryWithKey(swt_handle_t *handle, netc_tb_isi_keye_t
                                              *keye, netc_tb_isi_rsp_data_t *rsp)
```

Query an entry in ingress stream identification table using key match.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

status_t SWT_RxPSFPDelISTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete an entry in the stream identification table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_RxPSFPGetISTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of ingress stream table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPAddISTableEntry(*swt_handle_t* *handle, *netc_tb_is_config_t* *config)

Add an entry into the ingress stream table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPUpdateISTableEntry(*swt_handle_t* *handle, *netc_tb_is_config_t* *config)

Updtae an entry in the ingress stream table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPQueryISTableEntry(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_is_config_t *config)

Query an entry in ingress stream table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPDelISTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete an entry in the stream identification table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_RxPSFPGetISFTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number (entry size is 24 bytes) of ingress stream filter table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, VLAN Filter, FDB, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

static inline uint32_t SWT_RxPSFPGetISFTableMaxEntryNum(*swt_handle_t* *handle)

Get maximum available entry number (entry size is 24 bytes) of ingress stream filter table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, VLAN Filter, FDB, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPAddISFTableEntry(*swt_handle_t* *handle, netc_tb_isf_config_t *config,
uint32_t *entryID)

Add an entry into the ingress stream filter table.

Parameters

- handle –
- config –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPUpdateISFTableEntry(*swt_handle_t* *handle, uint32_t entryID,
netc_tb_isf_cfge_t *cfg)

Update an entry in the ingress stream filter table.

Parameters

- handle –
- entryID –
- cfg –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPDelISFTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete an entry in the ingress stream filter table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_RxPSFPGetRPTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of Rate Policer table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

static inline uint32_t SWT_RxPSFPGetRPTableMaxEntryNum(*swt_handle_t* *handle)

Get maximum available entry number (entry size is 24 bytes) of Rate Policer table.

Note: This is a Exact Match hash table, and it shares the remaining available entries with Ingress Stream Identification, VLAN Filter, FDB, L2 IPV4 Multicast Filter table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPAddRPTableEntry(*swt_handle_t* *handle, *netc_tb_rp_config_t* *config)

Add entry to Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPUpdateRPTableEntry(*swt_handle_t* *handle, *netc_tb_rp_config_t* *config)

Update entry in Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPAddOrUpdateRPTableEntry(*swt_handle_t* *handle, *netc_tb_rp_config_t* *config)

Add or update entry in Rate Policer table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPDelRPTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry in the Rate Policer table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPQueryRPTableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_rp_rsp_data_t* *rsp)

Query entry in the stream Rate Policer table.

Parameters

- handle –
- entryID –
- rsp –

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPGetRPStatistic(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_rp_stse_t* *statis)

Get statistic of specified Rate Policer entry.

Parameters

- handle –
- entryID –
- statis –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPRestMRRPTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Reset mark red parameter of specified Rate Policer entry.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_RxPSFPGetISCTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of ingress stream count table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPQueryISFTableEntry(*swt_handle_t* *handle, *netc_tb_isf_keye_t* *keye, *netc_tb_isf_rsp_data_t* *rsp)

Query entry from the Ingress Stream Filter table.

Parameters

- handle –
- keye –
- rsp –

Returns

status_t

status_t SWT_RxPSFPAddISCTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Add entry in ingress stream count table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPGetISCStatistic(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_isc_stse_t* *statistic)

Get ingress stream count statistic.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPResetISCStatistic(*swt_handle_t* *handle, uint32_t entryID)

Reset the count of the ingress stream count.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_RxPSFPGetSGITableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of stream gate instance table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

static inline uint32_t SWT_RxPSFPGetSGITableMaxEntryNum(*swt_handle_t* *handle)

Get maximum entry number of stream gate instance table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPAddSGITableEntry(*swt_handle_t* *handle, *netc_tb_sgi_config_t* *config)

Add entry in stream gate instance table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPResetIRXOEXSGITableEntry(*swt_handle_t* *handle, uint32_t entryID)

Reset IRX and OEX flag in stream gate instance entry.

Parameters

- handle –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPUpdateSGITableEntry(*swt_handle_t* *handle, *netc_tb_sgi_config_t* *config)

Update entry in stream gate instance table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPDelSGITableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry in stream gate instance table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPGetSGIState(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_sgi_sgise_t* *state)

Get state of the stream gate instance for specified entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See *netc_cmd_error_t*

status_t SWT_RxPSFPQuerySGITableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_sgi_config_t* *config)

Query entry in the stream gate instance table.

Parameters

- handle –
- entryID –
- config –

Returns

See *netc_cmd_error_t*

static inline uint32_t SWT_RxPSFPGetSGCLTableRemainWordNum(*swt_handle_t* *handle)

Get remaining available words number of Stream Gate Control List table.

Note: This is a dynamic bounded index table, and number of words required for a stream gate control list is $1+N/2$ where N is number of gate time slots in the stream gate control list. The remaining word should be greater than the want added entry size

Parameters

- handle –

Returns

uint32_t

static inline uint32_t SWT_RxPSFPGetSGCLTableMaxWordNum(*swt_handle_t* *handle)

Get maximum words number of Stream Gate Control List table.

Parameters

- handle –

Returns

uint32_t

status_t SWT_RxPSFPAddSGCLTableEntry(*swt_handle_t* *handle, *netc_tb_sgcl_gcl_t* *config)

Add entry into Stream Gate Control List Table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPDelSGCLTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry of Stream Gate Control List Table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPGetSGCLGateList(*swt_handle_t* *handle, *netc_tb_sgcl_gcl_t* *gcl, uint32_t length)

Get Stream Gate Control List Table entry gate control list.

Parameters

- handle –
- gcl –
- length –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_RxPSFPGetSGCLState(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_sgcl_sgclse_t* *state)

Get state (ref count) for Stream Gate Control List table entry.

Parameters

- handle –
- entryID –
- state –

Returns

status_t

Returns

See netc_cmd_error_t

2.98 Switch (SWT) Statistic Module

static inline status_t SWT_GetCutThroughForwardStatistic(*swt_handle_t* *handle, uint32_t *statistic)

Get Switch cut through forwarding count.

Get the Cut-through frames counter of frames forwarded to at least one egress port.

Parameters

- handle –
- statistic – pointer to the statistic count data

Returns

kStatus_Success

status_t SWT_GetETMCongestionGroupStatistic(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_etmcg_stse_t* *statistic)

Get statistic of the congestion group.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_GetETMClassQueueStatistic(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_etmcq_stse_t* *statistic)

Get the statistic for the class queue in specified switch port.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See netc_cmd_error_t

static inline uint32_t SWT_GetECEntNum(*swt_handle_t* *handle)

Get egress count table entry number.

Note: This is a static bounded index table, so all entries in the table are available for SWT_GetECStatistic()/SWT_ResetECStatistic() API

Parameters

- handle –

Returns

uint32_t

status_t SWT_GetECStatistic(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_ec_stse_t* *statistic)

Get statistic for specified egress count table entry.

Parameters

- handle –
- entryID –
- statistic –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT__ResetECStatistic(*swt_handle_t* *handle, uint32_t entryID)

Reset statistic for specified egress count table entry.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

static inline status_t SWT__GetPortDiscardStatistic(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *netc_port_discard_tpye_t* discardType, *netc_port_discard_statistic_t* *statistic)

Get the port discard statistic and reason.

Get the discarded count of frames and its reasons.

Parameters

- handle –
- portIdx – port index
- discardType – Port discard type.
- statistic – pointer to the statistic data

Returns

kStatus_Success

static inline status_t SWT__ClearPortDiscardReason(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *netc_port_discard_tpye_t* discardType, uint32_t reason0, uint32_t reason1)

Clean the Port Rx discard reason. Set the related bits to 1 to clear the specific reasons.

Parameters

- handle –
- portIdx – port index
- discardType – Port discard type.
- reason0 –
- reason1 –

Returns

kStatus_Success

static inline status_t SWT__GetFDBInUseEntriesNumber(*swt_handle_t* *handle, *netc_switch_inuse_fdb_statistic_t* *statistic)

Clean the Port Rx discard reason. Set the related bits to 1 to clear the specific reasons.

Parameters

- handle –
- statistic –

Returns

kStatus_Success

```
static inline uint32_t SWT_GetPortTGSLStatus(swt_handle_t *handle, netc_hw_port_idx_t portIdx)
```

Get Switch port time gate scheduling gate list status.

Parameters

- handle –
- portIdx – port index

Returns

Port status flags which are ORed by the enumerators in the `netc_port_tgsl_status_t`

```
static inline status_t SWT_SetPortIPV2QMR(swt_handle_t *handle, netc_hw_port_idx_t portIdx, const uint8_t *ipvToTC)
```

Set IPV to queue mapping on Switch port.

Parameters

- handle –
- portIdx – port index
- ipvToTC[] – queue number of each ipv value

Returns

kStatus_Success

```
static inline status_t SWT_EnablePortMacStationMove(swt_handle_t *handle, netc_hw_port_idx_t portIdx, bool enable)
```

Enable MAC station move on Switch port.

Parameters

- handle –
- portIdx – port index
- enable – Allow MAC station move

Returns

kStatus_Success

2.99 Switch (SWT) Egress data path configuration

```
static inline status_t SWT_TxSDUConfigPort(swt_handle_t *handle, netc_hw_port_idx_t portIdx, netc_hw_tc_idx_t tcIdx, const netc_port_tc_sdu_config_t *config)
```

Configure the transmit maximum SDU for port Traffic Class.

Parameters

- handle –
- portIdx –
- tcIdx –
- config –

Returns

status_t

```
static inline status_t SWT_TxCBSConfigPort(swt_handle_t *handle, netc_hw_port_idx_t portIdx,
                                           netc_hw_tc_idx_t tcIdx, const
                                           netc_port_tc_cbs_config_t *config)
```

Configure the Credit Based Shaper for port Traffic Class.

Parameters

- handle –
- portIdx –
- tcIdx –
- config –

Returns

status_t

```
status_t SWT_TxTGSConfigAdminGcl(swt_handle_t *handle, netc_tb_tgs_gcl_t *config)
```

Config the Time Gate Scheduling entry admin gate control list.

This function is used to program the Enhanced Scheduled Transmisson. (IEEE802.1Qbv)

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_TxtTGSCGetOperGcl(swt_handle_t *handle, netc_tb_tgs_gcl_t *gcl, uint32_t length)
```

Get Time Gate Scheduling entry operation gate control list.

This function is used to read the Enhanced Scheduled Transmisson. (IEEE802.1Qbv)

Parameters

- handle –
- gcl –
- length –

Returns

status_t

Returns

See netc_cmd_error_t

```
status_t SWT_TxTrafficClassConfig(swt_handle_t *handle, netc_hw_port_idx_t portIdx,
                                  netc_hw_tc_idx_t tcIdx, const netc_port_tx_tc_config_t
                                  *config)
```

Config the TC (traffic class) property.

Parameters

- handle –
- portIdx –
- tcIdx –
- config –

Returns

status_t

status_t SWT_TxPortTGSEnable(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, bool enable, uint8_t gateState)

Enable the switch port time gate scheduling.

Parameters

- handle –
- portIdx –
- enable –
- gateState –

Returns

status_t

static inline uint32_t SWT_TxEPPGetETTableRemainEntryNum(*swt_handle_t* *handle)

Get remaining available entry number of egress treatment table.

Note: This is a dynamic bounded index table, the remaining entry can't be zero before add entry into it

Parameters

- handle –

Returns

uint32_t

status_t SWT_TxEPPAddETTableEntry(*swt_handle_t* *handle, *netc_tb_et_config_t* *config)

Add entry in the egress treatment table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxEPPUpdateETTableEntry(*swt_handle_t* *handle, *netc_tb_et_config_t* *config)

Update entry in the egress treatment table.

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxEPPQueryETTableEntry(*swt_handle_t* *handle, uint32_t entryID, *netc_tb_et_config_t* *config)

Query an entry in the egress treatment table.

Parameters

- handle –
- entryID –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxEPPDeletTableEntry(*swt_handle_t* *handle, uint32_t entryID)

Delete entry for the egress treatment table.

Parameters

- handle –
- entryID –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxEPPQosToVlanConfig(*swt_handle_t* *handle, const
netc_swt_qos_to_vlan_config_t *config)

Configure switch egress QOS to VLAN map classification.

Parameters

- handle –
- config –

Returns

status_t

status_t SWT_TxETMConfigClassScheduler(*swt_handle_t* *handle, netc_tb_etmcs_config_t
*config)

Configure the WBFS and Strict priority for each PORT by using ETM Class Scheduler table.

Note: There is one class queue scheduler per switch port, and there is limitation between TSD and class queue scheduler configuration

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxETMConfigClassQueue(*swt_handle_t* *handle, netc_tb_etmcq_config_t *config)

Configure the class queue to congestion group map by using ETM class queue table.

Note: The number of class queue table entry is equal to the number of class queues in the switch

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

status_t SWT_TxETMConfigCongestionGroup(*swt_handle_t* *handle, *netc_tb_etmcg_config_t* *config)

Config congestion group map by using ETM congestion group table.

Note: The number of congestion groups table entry is equal to the number of class queues in the switch

Parameters

- handle –
- config –

Returns

status_t

Returns

See netc_cmd_error_t

static inline void SWT_TxTcConfigPreemption(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *netc_hw_tc_idx_t* tcIdx, const bool enable)

Config Preemption for each port TC (traffic class)

Parameters

- handle –
- portIdx –
- tcIdx –
- enable –

static inline void SWT_TxGetTcPreemption(*swt_handle_t* *handle, *netc_hw_port_idx_t* portIdx, *netc_hw_tc_idx_t* tcIdx, bool *enabled)

Get Preemption configuration for each port TC (traffic class)

Parameters

- handle –
- portIdx –
- tcIdx –
- enabled –

```
static inline void SWT_TxPortEthMacConfigPreemption(swt_handle_t *handle,
                                                    netc_hw_port_idx_t portIdx, const
                                                    netc_port_preemption_config *config)
```

Configure Preemption control configuration for an ethernet MAC.

Parameters

- handle –
- portIdx –
- config –

```
static inline void SWT_TxPortGetEthMacPreemption(swt_handle_t *handle, netc_hw_port_idx_t
                                                  portIdx, netc_port_preemption_config
                                                  *config,
                                                  netc_port_phy_mac_preemption_status_t
                                                  *status)
```

Get Preemption control configuration from ethernet MAC port.

Parameters

- handle –
- portIdx –
- config –

2.100 Switch (SWT) Transmit/Receive

```
enum _swt_mgmt_tx_opt_flags
```

Switch management Tx Option flags.

Values:

```
enumerator kSWT_TX_OPT_VLAN_INSERT
```

Enable VLAN insert, only active when use Switch Port masquerading Tx option.

```
enumerator kSWT_TX_OPT_OFFLOAD
```

Tx offload.

```
typedef union _swt_mgmt_tx_arg_t swt_mgmt_tx_arg_t
```

Switch management Tx parameter.

```
typedef enum _swt_mgmt_tx_opt_flags swt_mgmt_tx_opt_flags
```

Switch management Tx Option flags.

```
typedef struct _swt_tx_opt swt_tx_opt
```

```
status_t SWT_ManagementTxRxConfig(swt_handle_t *handle, ep_handle_t *epHandle, const
                                  swt_transfer_config_t *txRxConfig)
```

Set the EP handle used by switch frame management.

Parameters

- handle –
- epHandle – The EP handle
- txRxConfig – Switch transfer config

Return values

status_t –

```
status_t SWT_SendFrame(swt_handle_t *handle, netc_frame_struct_t *frame, void *context,  
                      swt_tx_opt *opt)
```

Transmits a frame on management port.

Parameters

- handle – The SWT handle
- frame – The frame descriptor pointer
- context – Private context provided back on reclaim
- opt – Tx options.

Return values

status_t –

```
static inline void SWT_WaitUntilTxComplete(swt_handle_t *handle, bool enMasquerade,  
                                           uint8_t ring)
```

Wait until the EP Tx ring has completed the transfer.

Note: Only call after EP_SendFrame() to do a no-interrupt transfer

Parameters

- handle –
- ring – Tx ring.

```
void SWT_ReclaimTxDescriptor(swt_handle_t *handle, uint8_t ring)
```

Reclaim tx descriptors. This function is used to update the tx descriptor status. For each reclaimed transmit frame the *ep_reclaim_cb_t* is called.

This is called after being notified of a transmit completion from ISR. It runs until there are no more frames to be reclaimed in the BD ring.

Parameters

- handle –
- ring – Tx ring.

```
status_t SWT_ReceiveFrame(swt_handle_t *handle, netc_frame_struct_t *frame,  
                          netc_frame_attr_t *attr)
```

Receives management frames (host reason not zero) with zero copy.

Parameters

- handle –
- frame – The frame descriptor pointer
- attr – Frame attribute pointer

Returns

kStatus_Success Successfully receive a management (host reason not zero) frame

Returns

kStatus_NETC_RxHRZeroFrame Frame in Rx BD ring is regular frame, need call EP_ReceiveFrame()

Returns

kStatus_NETC_RxTsrResp Frame in Rx BD ring is Transmit Timestamp Reference Response messages, need call SWT_GetTimestampRefResp() to get Transmit Timestamp Reference Response

Returns

kStatus_NETC_RxFrameEmpty Rx BD ring is empty

Returns

kStatus_NETC_RxFrameError Frame in Rx BD ring has error, need be dropped

Returns

kStatus_InvalidArgument No Rx BD ring is available

Returns

kStatus_NETC_LackOfResource Application provided buffer is not enough

status_t SWT_ReceiveFrameCopy(*swt_handle_t* *handle, void *buffer, uint32_t length,
netc_frame_attr_t *attr)

Receives management frame (host reason not zero) which will be copied in the provided buffer.

Note: The buffer size MUST be queried using SWT_GetRxFrameSize() beforehand.

Parameters

- handle –
- buffer – Buffer address
- length – Buffer length
- attr – Frame attribute pointer

Returns

kStatus_Success Successfully receive a management (host reason not zero) frame

Returns

kStatus_InvalidArgument No Rx BD ring is available

status_t SWT_GetRxFrameSize(*swt_handle_t* *handle, uint32_t *length)

brief Gets the size of the pending frame in the specified receive ring buffer.

Note: Frame size without FCS, and the size will be zero when Rx BD is Timestamp Reference Response message.

Parameters

- handle – The ENET handler structure. This is the same handler pointer used in the ENET_Init.
- length – The length of the valid frame received.

Returns

kStatus_Success Successfully get the length of a management (host reason not zero) frame

Returns

kStatus_NETC_RxHRZeroFrame Frame in Rx BD ring is regular frame, need call EP_GetRxFrameSize() to get frame size

Returns

kStatus_NETC_RxTsrResp Frame in Rx BD ring is Transmit Timestamp Reference Response messages, need call SWT_GetTimestampRefResp() to get Transmit Timestamp Reference Response

Returns

kStatus_NETC_RxFrameEmpty Rx BD ring is empty

Returns

kStatus_NETC_RxFrameError Frame in Rx BD ring has error, need be dropped

Returns

kStatus_InvalidArgument No Rx BD ring is available

union __swt_mgmt_tx_arg_t

#include <fsl_netc_switch.h> Switch management Tx parameter.

Public Members

uint8_t ring

Tx ring index, use for Switch Port masquerading Tx option

struct __swt_mgmt_tx_arg_t

struct __swt_tx_opt

#include <fsl_netc_switch.h>

Public Members

uint8_t ring

Tx ring index.

uint32_t flags

A bitmask of @swt_mgmt_tx_opt_flags.

netc_enetc_vlan_tag_t vlan

VLAN tag which will be inserted, used if enVlanInsert is set.

netc_tx_offload_t offload

Offload parameters.

struct __swt_transfer_config

#include <fsl_netc_switch.h> Transfer configuration structure for Switch.

Note: When need use Switch/EP receive APIs, recommended enable mgmtRxBdrConfig to use special MgmtRxBdRing rings to receive these host reason not-zero frames

Public Members

bool rxCacheMaintain

Enable/Disable Rx buffer cache maintain in driver.

bool txCacheMaintain

Enable/Disable Tx buffer cache maintain in driver.

bool rxZeroCopy

Enable zero-copy receive mode.

swt_rx_alloc_cb_t rxBuffAlloc

Callback function to alloc memory, must be provided for zero-copy Rx.

swt_rx_free_cb_t rxBuffFree

Callback function to free memory, must be provided for zero-copy Rx.

`bool enUseMgmtRxBdRing`

Enable/Disable use Switch management Rx BD ring, if disabled, the Switch/EP receive APIs (SWT_GetRxFrameSize()/SWT_ReceiveFrameCopy()/SWT_GetTimestampRefResp()/SWT_ReceiveF will use EP Rx BD ring 0 to receive frames.

`netc_rx_bdr_config_t` `mgmtRxBdrConfig`

Switch management Rx BD ring configuration.

`bool enUseMgmtTxBdRing`

Enable/Disable use Switch management Tx BD ring, if disabled, can't use Switch transfer API (SWT_SendFrame()) to send frames.

`netc_tx_bdr_config_t` `mgmtTxBdrConfig`

Switch management Rx BD ring configuration.

`swt_reclaim_cb_t` `reclaimCallback`

Callback for reclaimed Tx Switch management frames.

`void *userData`

User data, return in callback.

`struct __unnamed217__`

Public Members

`uint8_t` `ipv`

Internal Priority Value, use for Direct Switch Enqueue Tx option

`uint8_t` `dr`

Discard Resilience, use for Direct Switch Enqueue Tx option

2.101 NETC Timer Driver

2.102 Timer adjustment module

`void NETC_TimerGetTime(ENETC_PF_TMR_Type *base, uint64_t *nanosecond)`

Get the timer's current or default time.

Parameters

- `base` – NETC timer base address.
- `nanosecond` – Time in nanosecond.

`void NETC_TimerGetCurrentTime(netc_timer_handle_t *handle, uint64_t *nanosecond)`

Get the timer's current time.

Parameters

- `handle` – NETC timer handle.
- `nanosecond` – Time in nanosecond.

`void NETC_TimerGetFreeRunningTime(netc_timer_handle_t *handle, uint64_t *nanosecond)`

Get the timer's freerunning time.

Parameters

- `handle` – NETC timer handle.
- `nanosecond` – Time in nanosecond.

void NETC_TimerAddOffset(*netc_timer_handle_t* *handle, int64_t nanosecond)

Correct the current timer.

Note: Need stop all mechanisms based on 1588 timers during call this API. To take time gate scheduling as example, if the port is enabled with TGS and it contains an operational list, user need to call SWT_TxPortTGSEnable()/SWT_TxPortTGSEnable() to disable the port time gate before call this API, and re-enable and configure the port TGS after the execution of this API.

Parameters

- handle – NETC timer handle.
- nanosecond – Time in nanosecond.

void NETC_TimerAdjustFreq(*netc_timer_handle_t* *handle, int32_t ppb)

Adjust the timer frequency.

Parameters

- handle – NETC timer handle.
- ppb – Parts per billion.

void NETC_TimerGetFrtSrtTime(*netc_timer_handle_t* *handle, uint64_t *frt, uint64_t *srt)

Get the free running and synchronized current time with an atomic read.

Parameters

- handle – NETC timer handle.
- frt – The free-running time in nanosecond.
- srt – The synchronized current time in nanosecond.

2.103 Timer initialization module

enum _netc_timer_irq_flags

Timer interrupt flags.

Values:

enumerator kNETC_TimerFiper1IrqFlag

Periodic pulse 1 interrupt.

enumerator kNETC_TimerFiper2IrqFlag

Periodic pulse 2 interrupt.

enumerator kNETC_TimerFiper3IrqFlag

Periodic pulse 3 interrupt.

enumerator kNETC_TimerAlarm1IrqFlag

Alarm 1 interrupt.

enumerator kNETC_TimerAlarm2IrqFlag

Alarm 2 interrupt.

enumerator kNETC_TimerExtTrig1ThresholdIrqFlag

External trigger 1 timestamp FIFO threshold hit interrupt.

enumerator kNETC_TimerExtTrig2ThresholdIrqFlag
External trigger 2 timestamp FIFO threshold hit interrupt.

enumerator kNETC_TimerExtTrig1TsAvailIrqFlag
External trigger 1 new timestamp available interrupt.

enumerator kNETC_TimerExtTrig2TsAvailIrqFlag
External trigger 2 new timestamp available interrupt.

enumerator kNETC_TimerExtTrig1OverflowIrqFlag
External trigger 1 timestamp FIFO overflow interrupt.

enumerator kNETC_TimerExtTrig2OverflowIrqFlag
External trigger 2 timestamp FIFO overflow interrupt.

enum _netc_timer_ref_clk
Enumeration for NETC timer reference clock.

Values:

enumerator kNETC_TimerExtRefClk

enumerator kNETC_TimerSystemClk

typedef enum _netc_timer_irq_flags netc_timer_irq_flags_t
Timer interrupt flags.

typedef struct _netc_timer_handle netc_timer_handle_t

typedef enum _netc_timer_ref_clk netc_timer_ref_clk_t
Enumeration for NETC timer reference clock.

typedef struct _netc_timer_config netc_timer_config_t
Structure to configure timer.

status_t NETC_TimerInit(*netc_timer_handle_t* *handle, const *netc_timer_config_t* *config)
Initialize the NETC PTP1588 timer.

Parameters

- handle – NETC timer handle.
- config – The configuration of the timer.

Returns

status_t

void NETC_TimerDeinit(*netc_timer_handle_t* *handle)
Deinitialize the NETC PTP1588 timer.

Parameters

- handle – NETC timer handle.

void NETC_TimerInitHandle(*netc_timer_handle_t* *handle)
Initialize a NETC PTP1588 timer handle.

Parameters

- handle – NETC timer handle.

void NETC_TimerEnable(*netc_timer_handle_t* *handle, bool enable)
Enable/Disable the NETC PTP1588 timer.

Parameters

- handle – NETC timer handle.

- enable – Whether enable the PTP1588 timer.

struct `_netc_timer_handle`

#include <fsl_netc_timer.h> Timer handler structure.

Public Members

`netc_timer_hw_t` hw

Hardware register map resource.

`uint32_t` timerFreq

Timer clock frequency(Hz).

`uint8_t` entryNum

MSIX entry number.

struct `_netc_timer_config`

#include <fsl_netc_timer.h> Structure to configure timer.

Public Members

`bool` clkOutputPhase

True: Inverted divided clock is output, False: Non-inverted divided clock is output.

`bool` clkInputPhase

True: Inverted frequency tuned timer input clock, False: Non-inverted frequency tuned timer input clock.

`bool` enableTimer

True: Enable 1588 timer, False: Disable 1588 timer, use default counter.

`netc_timer_ref_clk_t` clockSelect

Timer reference clock.

`uint32_t` refClkHz

Timer reference clock frequency in Hz.

`int32_t` defaultPpb

Default ppb.

`netc_msix_entry_t*` msixEntry

MSIX table entry array.

`uint8_t` entryNum

MSIX entry number.

2.104 Local time synchronization module

enum `_netc_timer_alarm_index`

Enumeration for NETC timer alarm index.

Values:

enumerator `kNETC_TimerAlarm1`

enumerator `kNETC_TimerAlarm2`

enum *_netc_timer_fiper_index*

Enumeration for NETC timer FIPER index.

Values:

enumerator *kNETC_TimerFiper1*

enumerator *kNETC_TimerFiper2*

enumerator *kNETC_TimerFiper3*

typedef enum *_netc_timer_alarm_index* *netc_timer_alarm_index_t*

Enumeration for NETC timer alarm index.

typedef struct *_netc_timer_alarm_t* *netc_timer_alarm_t*

Structure to configure timer alarm.

typedef enum *_netc_timer_fiper_index* *netc_timer_fiper_index_t*

Enumeration for NETC timer FIPER index.

typedef struct *_netc_timer_fiper_config* *netc_timer_fiper_config_t*

Structure to configure timer FIPER.

typedef struct *_netc_timer_fiper* *netc_timer_fiper_t*

Structure to set and start timer FIPER.

typedef struct *_netc_timer_ext_pulse_trig* *netc_timer_ext_trig_t*

Structure to configure external pulse trigger timestamp.

void NETC_TimerConfigureAlarm(*netc_timer_handle_t* *handle, *netc_timer_alarm_index_t* alarmId, const *netc_timer_alarm_t* *alarm)

Configure the timer alarm feature.

Parameters

- handle – NETC timer handle.
- alarmId – The alarm index.
- alarm – The timer alarm configuration structure.

void NETC_TimerStartAlarm(*netc_timer_handle_t* *handle, *netc_timer_alarm_index_t* alarmId, uint64_t nanosecond)

Start the alarm with specified time after alarm feature is configured This function can generate a pulse on a GPIO and/or an interrupt at specified future time. It also can trigger FIPER at specified time.

Parameters

- handle – NETC timer handle.
- alarmId – The alarm index.
- nanosecond – The time in nanosecond to generate alarm pulse.

void NETC_TimerStopAlarm(*netc_timer_handle_t* *handle, *netc_timer_alarm_index_t* alarmId)

Stop the alarm before/after it's fired This function can deactivate alarm.

Parameters

- handle – NETC timer handle.
- alarmId – The alarm index.

```
void NETC_TimerConfigureFIPER(netc_timer_handle_t *handle, const netc_timer_fiper_config_t
                             *config)
```

Configure the timer FIPER feature.

Parameters

- handle – NETC timer handle.
- config – The timer FIPER configuration structure.

```
void NETC_TimerStartFIPER(netc_timer_handle_t *handle, netc_timer_fiper_index_t fiperId,
                          const netc_timer_fiper_t *fiper)
```

Start the timer FIPER to generate pulse This function can generate a periodic(Fixed Period-FIPER) pulse on a GPIO pin and/or an interrupt to the host.

Parameters

- handle – NETC timer handle.
- fiperId – The timer FIPER index.
- fiper – The timer FIPER configuration structure.

```
void NETC_TimerStopFIPER(netc_timer_handle_t *handle, netc_timer_fiper_index_t fiperId)
```

Stop the timer FIPER to generate pulse.

Parameters

- handle – NETC timer handle.
- fiperId – The timer FIPER index.

```
void NETC_TimerConfigureExtPulseTrig(netc_timer_handle_t *handle,
                                     netc_timer_exttrig_index_t extTrigId, const
                                     netc_timer_ext_trig_t *extTrig)
```

Configure the external pulse trigger timestamp capture.

Parameters

- handle – NETC timer handle.
- extTrigId – The timer FIPER index.
- extTrig – The external pulse trigger configuration structure.

```
status_t NETC_TimerSetTsFifoThreshold(netc_timer_handle_t *handle, uint8_t threshold)
```

Set timestamp FIFO threshold of the external pulse trigger timestamp capture.

Parameters

- handle – NETC timer handle.
- threshold – Timestamp FIFO threshold.

Returns

status_t

```
status_t NETC_TimerReadExtPulseCaptureTime(netc_timer_handle_t *handle,
                                             netc_timer_exttrig_index_t extTrigId, uint64_t
                                             *nanosecond)
```

Read the timestamp captured by external pulse trigger in FIFO.

Parameters

- handle – NETC timer handle.
- extTrigId – The timer FIPER index.
- nanosecond – Timestamp in nanosecond.

Returns

status_t

```
static inline void NETC_TimerClearInterruptStatus(netc_timer_handle_t *handle, uint32_t flags)
```

Clear timer interrupt flags.

Parameters

- handle – NETC timer handle.
- flags – Timer interrupt flags. This is a logical OR of enumeration :: *netc_timer_irq_flags_t*.

```
status_t NETC_TimerMsixSetGlobalMask(netc_timer_handle_t *handle, bool mask)
```

Set the global MSIX mask status.

This function masks/unmasks global MSIX message. Mask - All of the vectors are masked, regardless of their per-entry mask bit states. Unmask - Each entry's mask status determines whether the vector is masked or not.

Parameters

- handle – The timer handle
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

```
status_t NETC_TimerMsixSetEntryMask(netc_timer_handle_t *handle, uint8_t entryIdx, bool mask)
```

Set the MSIX entry mask status for specified entry.

This function masks/unmasks MSIX message for specified entry.

Parameters

- handle – NETC timer handle.
- entryIdx – The entry index in the table.
- mask – The mask state. True: Mask, False: Unmask.

Returns

status_t

```
status_t NETC_TimerMsixGetPendingStatus(netc_timer_handle_t *handle, uint8_t pbaIdx, uint64_t *status)
```

Get the MSIX pending status in MSIX PBA table.

This function is to get the entry pending status from MSIX PBA table. If interrupt occurs but masked by vector control of entry, pending bit in PBA will be set.

Parameters

- handle – NETC timer handle.
- pbaIdx – The index of PBA array with 64-bit unit.
- status – Pending status bit mask, bit n for entry n.

Returns

status_t

```
struct __netc_timer_alarm_t
```

#include <fsl_netc_timer.h> Structure to configure timer alarm.

Public Members

bool enableInterrupt

Enable/Disable ALARM interrupt enable.

bool polarity

True: Active low output, False: Active high output.

bool pulseGenSync

True: ALARM output asserted synchronous to timer generated clock, False: ALARM output asserted immediately.

uint8_t pulseWidth

Pulse width in number of timer generated clocks the alarm will be active for.

struct _netc_timer_fiper_config

#include <fsl_netc_timer.h> Structure to configure timer FIPER.

Public Members

bool startCondition

True: FIPER is enabled through timer enable and alarm getting set, False: FIPER is enabled through timer enable.

bool fiper1Loopback

True: FIPER1 pulse is looped back into Trigger1 input, False: Trigger1 input is based upon normal external trigger input.

bool fiper2Loopback

True: FIPER2 pulse is looped back into Trigger2 input, False: Trigger2 input is based upon normal external trigger input.

uint16_t prescale

Output FIPER pulse clock is generated by dividing the timer input clock by this number. Must be an even value.

struct _netc_timer_fiper

#include <fsl_netc_timer.h> Structure to set and start timer FIPER.

Public Members

bool enableInterrupt

Enable/Disable FIPER interrupt interrupt.

bool pulseGenSync

True: FIPER output asserted synchronous to timer generated clock, False: FIPER output asserted immediately.

uint8_t pulseWidth

FIPER pulse width.

uint32_t pulsePeriod

Interval of FIPER pulses.

struct _netc_timer_ext_pulse_trig

#include <fsl_netc_timer.h> Structure to configure external pulse trigger timestamp.

Public Members

`bool` polarity

Time stamp on the falling(true)/rising(false) edge of the external trigger.

`bool` enableFifoOverflowInterrupt

Enable/Disable FIFO Overflow interrupt.

`bool` enableFifoThresholdHitInterrupt

Enable/Disable FIFO Threshold Hit interrupt.

`bool` enableTsAvailInterrupt

Enable/Disable timestamp capture interrupt.

2.105 OTFAD: On The Fly AES-128 Decryption Driver

`void` OTFAD_GetDefaultConfig(*otfad_config_t* *config)

OTFAD module initialization function.

Parameters

- config – OTFAD configuration.

AT_QUICKACCESS_SECTION_CODE (void OTFAD_Init(OTFAD_Type *base,
const *otfad_config_t* *config))

OTFAD module initialization function.

Parameters

- base – OTFAD base address.
- config – OTFAD configuration.

AT_QUICKACCESS_SECTION_CODE (void OTFAD_Deinit(OTFAD_Type *base))

Deinitializes the OTFAD.

`static inline uint32_t` OTFAD_GetOperateMode(OTFAD_Type *base)

OTFAD module get operate mode.

Parameters

- base – OTFAD base address.

`static inline uint32_t` OTFAD_GetStatus(OTFAD_Type *base)

OTFAD module get status.

Parameters

- base – OTFAD base address.

status_t OTFAD_SetEncryptionConfig(OTFAD_Type *base, const *otfad_encryption_config_t*
*config)

OTFAD module set encryption configuration.

Note: if enable keyblob process, the first 256 bytes external memory is use for keyblob data, so this region shouldn't be in OTFAD region.

Parameters

- base – OTFAD base address.
- config – encryption configuration.

status_t OTFAD_GetEncryptionConfig(OTFAD_Type *base, *otfad_encryption_config_t* *config)
OTFAD module get encryption configuration.

Note: if enable keyblob process, the first 256 bytes external memory is use for keyblob data, so this region shouldn't be in OTFAD region.

Parameters

- base – OTFAD base address.
- config – encryption configuration.

status_t OTFAD_HitDetermination(OTFAD_Type *base, uint32_t address, uint8_t *contextIndex)
OTFAD module do hit determination.

Parameters

- base – OTFAD base address.
- address – the physical address space assigned to the QuadSPI(FlexSPI) module.
- contextIndex – hitted context region index.

Returns

status, such as kStatus_Success or kStatus_OTFAD_ResRegAccessMode.

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Driver version.

Status codes for the OTFAD driver.

Values:

enumerator kStatus_OTFAD_ResRegAccessMode
Restricted register mode

enumerator kStatus_OTFAD_AddressError
End address less than start address

enumerator kStatus_OTFAD_RegionOverlap
the OTFAD does not support any form of memory region overlap, for system accesses that hit in multiple contexts or no contexts, the fetched data is simply bypassed

enumerator kStatus_OTFAD_RegionMiss
For accesses that hit in a single context, but not the selected one

OTFAD context type.

Values:

enumerator kOTFAD_Context_0
context 0

enumerator kOTFAD_Context_1
context 1

enumerator kOTFAD_Context_2
context 2

enumerator kOTFAD_Context_3
context 3

OTFAD operate mode.

Values:

enumerator kOTFAD_NRM

Normal Mode

enumerator kOTFAD_SVM

Security Violation Mode

enumerator kOTFAD_LDM

Logically Disabled Mode

typedef struct *_otfad_encryption_config* otfad_encryption_config_t
OTFAD encryption configuration structure.

typedef struct *_otfad_config* otfad_config_t
OTFAD configuration structure.

struct *_otfad_encryption_config*
#include <fsl_otfad.h> OTFAD encryption configuration structure.

Public Members

bool valid

The context is valid or not

bool AESdecryption

AES decryption enable

uint8_t readOnly

read write attribute for the entire set of context registers

uint8_t contextIndex

OTFAD context index

uint32_t startAddr

Start address

uint32_t endAddr

End address

uint32_t key[4]

Encryption key

uint32_t counter[2]

Encryption counter

struct *_otfad_config*
#include <fsl_otfad.h> OTFAD configuration structure.

Public Members

bool forceSVM

Force entry into SVM after a write

bool forceLDM

Force entry into LDM after a write

`bool restrictedRegAccess`
Restricted register access enable

`bool enableOTFAD`
OTFAD has decryption enabled

2.106 PDM: Microphone Interface

2.107 PDM Driver

`void PDM_Init(PDM_Type *base, const pdm_config_t *config)`

Initializes the PDM peripheral.

Un gates the PDM clock, resets the module, and configures PDM with a configuration structure. The configuration structure can be custom filled or set with default values by `PDM_GetDefaultConfig()`.

Note: This API should be called at the beginning of the application to use the PDM driver. Otherwise, accessing the PDM module can cause a hard fault because the clock is not enabled.

Parameters

- `base` – PDM base pointer
- `config` – PDM configuration structure.

`void PDM_Deinit(PDM_Type *base)`

De-initializes the PDM peripheral.

This API gates the PDM clock. The PDM module can't operate unless `PDM_Init` is called to enable the clock.

Parameters

- `base` – PDM base pointer

`static inline void PDM_Reset(PDM_Type *base)`

Resets the PDM module.

Parameters

- `base` – PDM base pointer

`static inline void PDM_Enable(PDM_Type *base, bool enable)`

Enables/disables PDM interface.

Parameters

- `base` – PDM base pointer
- `enable` – True means PDM interface is enabled, false means PDM interface is disabled.

`static inline void PDM_EnableDebugMode(PDM_Type *base, bool enable)`

Enables/disables debug mode for PDM. The PDM interface cannot enter debug mode once in Disable/Low Leakage or Low Power mode.

Parameters

- `base` – PDM base pointer

- enable – True means PDM interface enter debug mode, false means PDM interface in normal mode.

static inline void PDM_EnableInDebugMode(PDM_Type *base, bool enable)

Enables/disables PDM interface in debug mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is enabled debug mode, false means PDM interface is disabled after after completing the current frame in debug mode.

static inline void PDM_EnterLowLeakageMode(PDM_Type *base, bool enable)

Enables/disables PDM interface disable/Low Leakage mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is in disable/low leakage mode, False means PDM interface is in normal mode.

static inline void PDM_EnableChannel(PDM_Type *base, uint8_t channel, bool enable)

Enables/disables the PDM channel.

Parameters

- base – PDM base pointer
- channel – PDM channel number need to enable or disable.
- enable – True means enable PDM channel, false means disable.

void PDM_SetChannelConfig(PDM_Type *base, uint32_t channel, const *pdm_channel_config_t* *config)

PDM one channel configurations.

Parameters

- base – PDM base pointer
- config – PDM channel configurations.
- channel – channel number. after completing the current frame in debug mode.

status_t PDM_SetSampleRateConfig(PDM_Type *base, uint32_t sourceClock_HZ, uint32_t sampleRate_HZ)

PDM set sample rate.

Note: This function is depend on the configuration of the PDM and PDM channel, so the correct call sequence is

```
PDM_Init(base, pdmConfig)
PDM_SetChannelConfig(base, channel, &channelConfig)
PDM_SetSampleRateConfig(base, source, sampleRate)
```

Parameters

- base – PDM base pointer
- sourceClock_HZ – PDM source clock frequency.
- sampleRate_HZ – PDM sample rate.

status_t PDM_SetSampleRate(PDM_Type *base, uint32_t enableChannelMask,
 pdm_df_quality_mode_t qualityMode, uint8_t osr, uint32_t clkDiv)
PDM set sample rate.

Deprecated:

Do not use this function. It has been superceded by PDM_SetSampleRateConfig

Parameters

- base – PDM base pointer
- enableChannelMask – PDM channel enable mask.
- qualityMode – quality mode.
- osr – cic oversample rate
- clkDiv – clock divider

uint32_t PDM_GetInstance(PDM_Type *base)
Get the instance number for PDM.

Parameters

- base – PDM base pointer.

static inline uint32_t PDM_GetStatus(PDM_Type *base)

Gets the PDM internal status flag. Use the Status Mask in `_pdm_internal_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

PDM status flag value.

static inline uint32_t PDM_GetFifoStatus(PDM_Type *base)

Gets the PDM FIFO status flag. Use the Status Mask in `_pdm_fifo_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

FIFO status.

static inline uint32_t PDM_GetRangeStatus(PDM_Type *base)

Gets the PDM Range status flag. Use the Status Mask in `_pdm_range_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

output status.

static inline void PDM_ClearStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer

- mask – State mask. It can be a combination of the status between kPDM_StatusFrequencyLow and kPDM_StatusCh7FifoDataAvaliable.

static inline void PDM_ClearFIFOStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status in _pdm_fifo_status.

static inline void PDM_ClearRangeStatus(PDM_Type *base, uint32_t mask)

Clears the PDM range status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status in _pdm_range_status.

void PDM_EnableInterrupts(PDM_Type *base, uint32_t mask)

Enables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kPDM_ErrorInterruptEnable
 - kPDM_FIFOInterruptEnable

static inline void PDM_DisableInterrupts(PDM_Type *base, uint32_t mask)

Disables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kPDM_ErrorInterruptEnable
 - kPDM_FIFOInterruptEnable

static inline void PDM_EnableDMA(PDM_Type *base, bool enable)

Enables/disables the PDM DMA requests.

Parameters

- base – PDM base pointer
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t PDM_GetDataRegisterAddress(PDM_Type *base, uint32_t channel)

Gets the PDM data register address.

This API is used to provide a transfer address for the PDM DMA transfer configuration.

Parameters

- base – PDM base pointer.
- channel – Which data channel used.

Returns

data register address.

```
void PDM_ReadFifo(PDM_Type *base, uint32_t startChannel, uint32_t channelNums, void  
                 *buffer, size_t size, uint32_t dataWidth)
```

PDM read fifo.

Note: : This function support 16 bit only for IP version that only supports 16bit.

Parameters

- base – PDM base pointer.
- startChannel – start channel number.
- channelNums – total enabled channelnums.
- buffer – received buffer address.
- size – number of samples to read.
- dataWidth – sample width.

```
void PDM_SetChannelGain(PDM_Type *base, uint32_t channel, pdm_df_output_gain_t gain)
```

Set the PDM channel gain.

Please note for different quality mode, the valid gain value is different, reference RM for detail.

Parameters

- base – PDM base pointer.
- channel – PDM channel index.
- gain – channel gain, the register gain value range is 0 - 15.

```
void PDM_SetHwvadConfig(PDM_Type *base, const pdm_hwvad_config_t *config)
```

Configure voice activity detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector configure structure pointer .

```
static inline void PDM_ForceHwvadOutputDisable(PDM_Type *base, bool enable)
```

PDM hwvad force output disable.

Parameters

- base – PDM base pointer
- enable – true is output force disable, false is output not force.

```
static inline void PDM_ResetHwvad(PDM_Type *base)
```

PDM hwvad reset. It will reset VADNDATA register and will clean all internal buffers, should be called when the PDM isn't running.

Parameters

- base – PDM base pointer

```
static inline void PDM_EnableHwvad(PDM_Type *base, bool enable)
```

Enable/Disable Voice activity detector. Should be called when the PDM isn't running.

Parameters

- base – PDM base pointer.
- enable – True means enable voice activity detector, false means disable.

static inline void PDM_EnableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Enables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kPDM_HWVADErrorInterruptEnable
 - kPDM_HWVADInterruptEnable

static inline void PDM_DisableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Disables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kPDM_HWVADErrorInterruptEnable
 - kPDM_HWVADInterruptEnable

static inline void PDM_ClearHwvadInterruptStatusFlags(PDM_Type *base, uint32_t mask)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer
- mask – State mask, reference `_pdm_hwvad_int_status`.

static inline uint32_t PDM_GetHwvadInterruptStatusFlags(PDM_Type *base)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer

Returns

status, reference `_pdm_hwvad_int_status`

static inline uint32_t PDM_GetHwvadInitialFlag(PDM_Type *base)

Get the PDM voice activity detector initial flags.

Parameters

- base – PDM base pointer

Returns

initial flag.

static inline void PDM_EnableHwvadSignalFilter(PDM_Type *base, bool enable)

Enables/disables voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enable – True means enable signal filter; false means disable.

void PDM_SetHwvadSignalFilterConfig(PDM_Type *base, bool enableMaxBlock, uint32_t signalGain)

Configure voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enableMaxBlock – If signal maximum block enabled.
- signalGain – Gain value for the signal energy.

void PDM_SetHwvadNoiseFilterConfig(PDM_Type *base, const *pdm_hwvad_noise_filter_t* *config)
Configure voice activity detector noise filter.

Parameters

- base – PDM base pointer
- config – Voice activity detector noise filter configure structure pointer .

static inline void PDM_EnableHwvadZeroCrossDetector(PDM_Type *base, bool enable)
Enables/disables voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- enable – True means enable zero cross detector, false means disable.

void PDM_SetHwvadZeroCrossDetectorConfig(PDM_Type *base, const
pdm_hwvad_zero_cross_detector_t *config)
Configure voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector zero cross detector configure structure pointer .

static inline uint16_t PDM_GetNoiseData(PDM_Type *base)
Reads noise data.

Parameters

- base – PDM base pointer.

Returns

Data in PDM noise data register.

static inline void PDM_SetHwvadInternalFilterStatus(PDM_Type *base,
pdm_hwvad_filter_status_t status)

set hwvad internal filter status . Note: filter initial status should be asserted for two more cycles, then set it to normal operation.

Parameters

- base – PDM base pointer.
- status – internal filter status.

void PDM_SetHwvadInEnvelopeBasedMode(PDM_Type *base, const *pdm_hwvad_config_t*
*hwvadConfig, const *pdm_hwvad_noise_filter_t*
*noiseConfig, const
pdm_hwvad_zero_cross_detector_t *zcdConfig,
uint32_t signalGain)

set HWVAD in envelope based mode . Recommend configurations,

```
static const pdm_hwvad_config_t hwvadConfig = {
    .channel          = 0,
    .initializeTime   = 10U,
    .cicOverSampleRate = 0U,
    .inputGain        = 0U,
    .frameTime        = 10U,
    .cutOffFreq       = kPDM_HwvadHpfBypassed,
    .enableFrameEnergy = false,
    .enablePreFilter   = true,
};

static const pdm_hwvad_noise_filter_t noiseFilterConfig = {
    .enableAutoNoiseFilter = false,
    .enableNoiseMin        = true,
    .enableNoiseDecimation = true,
    .noiseFilterAdjustment = 0U,
    .noiseGain              = 7U,
    .enableNoiseDetectOR    = true,
};
```

Parameters

- base – PDM base pointer.
- hwvadConfig – internal filter status.
- noiseConfig – Voice activity detector noise filter configure structure pointer.
- zcdConfig – Voice activity detector zero cross detector configure structure pointer .
- signalGain – signal gain value.

```
void PDM_SetHwvadInEnergyBasedMode(PDM_Type *base, const pdm_hwvad_config_t
                                   *hwvadConfig, const pdm_hwvad_noise_filter_t
                                   *noiseConfig, const pdm_hwvad_zero_cross_detector_t
                                   *zcdConfig, uint32_t signalGain)
```

brief set HWVAD in energy based mode . Recommend configurations, code static const pdm_hwvad_config_t hwvadConfig = { .channel = 0, .initializeTime = 10U, .cicOverSampleRate = 0U, .inputGain = 0U, .frameTime = 10U, .cutOffFreq = kPDM_HwvadHpfBypassed, .enableFrameEnergy = true, .enablePreFilter = true, };

static const pdm_hwvad_noise_filter_t noiseFilterConfig = { .enableAutoNoiseFilter = true, .enableNoiseMin = false, .enableNoiseDecimation = false, .noiseFilterAdjustment = 0U, .noiseGain = 7U, .enableNoiseDetectOR = false, }; code param base PDM base pointer. param hwvadConfig internal filter status. param noiseConfig Voice activity detector noise filter configure structure pointer. param zcdConfig Voice activity detector zero cross detector configure structure pointer . param signalGain signal gain value, signal gain value should be properly according to application.

```
void PDM_EnableHwvadInterruptCallback(PDM_Type *base, pdm_hwvad_callback_t vadCallback,
                                     void *userData, bool enable)
```

Enable/Disable hwvad callback.

This function enable/disable the hwvad interrupt for the selected PDM peripheral.

Parameters

- base – Base address of the PDM peripheral.
- vadCallback – callback Pointer to store callback function, should be NULL when disable.
- userData – user data.

- enable – true is enable, false is disable.

Return values

None. –

```
void PDM_TransferCreateHandle(PDM_Type *base, pdm_handle_t *handle,  
                             pdm_transfer_callback_t callback, void *userData)
```

Initializes the PDM handle.

This function initializes the handle for the PDM transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

```
status_t PDM_TransferSetChannelConfig(PDM_Type *base, pdm_handle_t *handle, uint32_t  
                                     channel, const pdm_channel_config_t *config, uint32_t  
                                     format)
```

PDM set channel transfer config.

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- channel – PDM channel.
- config – channel config.
- format – data format, support data width configurations, _pdm_data_width.

Return values

kStatus_PDM_ChannelConfig_Failed – or kStatus_Success.

```
status_t PDM_TransferReceiveNonBlocking(PDM_Type *base, pdm_handle_t *handle,  
                                       pdm_transfer_t *xfer)
```

Performs an interrupt non-blocking receive transfer on PDM.

Note: This API returns immediately after the transfer initiates. Call the PDM_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_PDM_Busy, the transfer is finished.

Parameters

- base – PDM base pointer
- handle – Pointer to the pdm_handle_t structure which stores the transfer state.
- xfer – Pointer to the pdm_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_PDM_Busy – Previous receive still not finished.

void PDM_TransferAbortReceive(PDM_Type *base, *pdm_handle_t* *handle)
Aborts the current IRQ receive.

Note: This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – PDM base pointer
- handle – Pointer to the *pdm_handle_t* structure which stores the transfer state.

void PDM_TransferHandleIRQ(PDM_Type *base, *pdm_handle_t* *handle)
Tx interrupt handler.

Parameters

- base – PDM base pointer.
- handle – Pointer to the *pdm_handle_t* structure.

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PDM return status.

Values:

enumerator kStatus_PDM_Busy
PDM is busy.

enumerator kStatus_PDM_CLK_LOW
PDM clock frequency low

enumerator kStatus_PDM_FIFO_ERROR
PDM FIFO underrun or overflow

enumerator kStatus_PDM_QueueFull
PDM FIFO underrun or overflow

enumerator kStatus_PDM_Idle
PDM is idle

enumerator kStatus_PDM_Output_ERROR
PDM is output error

enumerator kStatus_PDM_ChannelConfig_Failed
PDM channel config failed

enumerator kStatus_PDM_HWVAD_VoiceDetected
PDM hwvad voice detected

enumerator kStatus_PDM_HWVAD_Error
PDM hwvad error

enum __pdm_interrupt_enable
The PDM interrupt enable flag.

Values:

enumerator kPDM_ErrorInterruptEnable
PDM channel error interrupt enable.

enumerator kPDM_FIFOInterruptEnable
PDM channel FIFO interrupt

enum __pdm_internal_status
The PDM status.

Values:

enumerator kPDM_StatusDfBusyFlag
Decimation filter is busy processing data

enumerator kPDM_StatusFrequencyLow
Mic app clock frequency not high enough

enumerator kPDM_StatusCh0FifoDataAvaliable
channel 0 fifo data reached watermark level

enumerator kPDM_StatusCh1FifoDataAvaliable
channel 1 fifo data reached watermark level

enumerator kPDM_StatusCh2FifoDataAvaliable
channel 2 fifo data reached watermark level

enumerator kPDM_StatusCh3FifoDataAvaliable
channel 3 fifo data reached watermark level

enum __pdm_channel_enable_mask
PDM channel enable mask.

Values:

enumerator kPDM_EnableChannel0
channgel 0 enable mask

enumerator kPDM_EnableChannel1
channgel 1 enable mask

enumerator kPDM_EnableChannel2
channgel 2 enable mask

enumerator kPDM_EnableChannel3
channgel 3 enable mask

enumerator kPDM_EnableChannelAll

enum __pdm_fifo_status
The PDM fifo status.

Values:

enumerator kPDM_FifoStatusUnderflowCh0
channel0 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh1
channel1 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh2
channel2 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh3
channel3 fifo status underflow

enumerator kPDM_FifoStatusOverflowCh0
channel0 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh1
channel1 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh2
channel2 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh3
channel3 fifo status overflow

enum __pdm_range_status
The PDM output status.

Values:

enumerator kPDM_RangeStatusUnderFlowCh0
channel0 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh1
channel1 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh2
channel2 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh3
channel3 range status underflow

enumerator kPDM_RangeStatusOverFlowCh0
channel0 range status overflow

enumerator kPDM_RangeStatusOverFlowCh1
channel1 range status overflow

enumerator kPDM_RangeStatusOverFlowCh2
channel2 range status overflow

enumerator kPDM_RangeStatusOverFlowCh3
channel3 range status overflow

enum __pdm_dc_removal
PDM DC removal configurations.

Values:

enumerator kPDM_DcRemovalCutOff20Hz
DC removal cut off 20HZ

enumerator kPDM_DcRemovalCutOff13Hz
DC removal cut off 13.3HZ

enumerator kPDM_DcRemovalCutOff40Hz
DC removal cut off 40HZ

enumerator kPDM_DcRemovalBypass
DC removal bypass

enum __pdm_df_quality_mode
PDM decimation filter quality mode.

Values:

enumerator kPDM_QualityModeMedium
quality mode memdium

enumerator kPDM_QualityModeHigh
quality mode high

enumerator kPDM_QualityModeLow
quality mode low

enumerator kPDM_QualityModeVeryLow0
quality mode very low0

enumerator kPDM_QualityModeVeryLow1
quality mode very low1

enumerator kPDM_QualityModeVeryLow2
quality mode very low2

enum __pdm_qulaity_mode_k_factor
PDM quality mode K factor.

Values:

enumerator kPDM_QualityModeHighKFactor
high quality mode K factor = 1 / 2

enumerator kPDM_QualityModeMediumKFactor
medium/very low0 quality mode K factor = 2 / 2

enumerator kPDM_QualityModeLowKFactor
low/very low1 quality mode K factor = 4 / 2

enumerator kPDM_QualityModeVeryLow2KFactor
very low2 quality mode K factor = 8 / 2

enum __pdm_df_output_gain
PDM decimation filter output gain.

Values:

enumerator kPDM_DfOutputGain0
Decimation filter output gain 0

enumerator kPDM_DfOutputGain1
Decimation filter output gain 1

enumerator kPDM_DfOutputGain2
Decimation filter output gain 2

enumerator kPDM_DfOutputGain3
Decimation filter output gain 3

enumerator kPDM_DfOutputGain4
Decimation filter output gain 4

enumerator kPDM_DfOutputGain5
Decimation filter output gain 5

enumerator kPDM_DfOutputGain6
Decimation filter output gain 6

enumerator kPDM_DfOutputGain7
Decimation filter output gain 7

enumerator kPDM_DfOutputGain8
Decimation filter output gain 8

enumerator kPDM_DfOutputGain9
Decimation filter output gain 9

enumerator kPDM_DfOutputGain10
Decimation filter output gain 10

enumerator kPDM_DfOutputGain11
Decimation filter output gain 11

enumerator kPDM_DfOutputGain12
Decimation filter output gain 12

enumerator kPDM_DfOutputGain13
Decimation filter output gain 13

enumerator kPDM_DfOutputGain14
Decimation filter output gain 14

enumerator kPDM_DfOutputGain15
Decimation filter output gain 15

enum __pdm_data_width
PDM data width.
Values:

enumerator kPDM_DataWwidth24
PDM data width 24bit

enumerator kPDM_DataWwidth32
PDM data width 32bit

enum __pdm_hwvad_interrupt_enable
PDM voice activity detector interrupt type.
Values:

enumerator kPDM_HwvadErrorInterruptEnable
PDM channel HWVAD error interrupt enable.

enumerator kPDM_HwvadInterruptEnable
PDM channel HWVAD interrupt

enum __pdm_hwvad_int_status
The PDM hwvad interrupt status flag.
Values:

enumerator kPDM_HwvadStatusInputSaturation
HWVAD saturation condition

enumerator kPDM_HwvadStatusVoiceDetectFlag
HWVAD voice detect interrupt triggered

enum __pdm_hwvad_hpf_config
High pass filter configure cut-off frequency.
Values:

enumerator kPDM_HwvadHpfBypassed
High-pass filter bypass


```
enumerator kPDM_HwvadHpfCutOffFreq1750Hz
    High-pass filter cut off frequency 1750HZ
enumerator kPDM_HwvadHpfCutOffFreq215Hz
    High-pass filter cut off frequency 215HZ
enumerator kPDM_HwvadHpfCutOffFreq102Hz
    High-pass filter cut off frequency 102HZ
enum __pdm_hwvad_filter_status
    HWVAD internal filter status.
    Values:
enumerator kPDM_HwvadInternalFilterNormalOperation
    internal filter ready for normal operation
enumerator kPDM_HwvadInternalFilterInitial
    interla filter are initial
enum __pdm_hwvad_zcd_result
    PDM voice activity detector zero cross detector result.
    Values:
enumerator kPDM_HwvadResultOREnergyBasedDetection
    zero cross detector result will be OR with energy based detection
enumerator kPDM_HwvadResultANDEnergyBasedDetection
    zero cross detector result will be AND with energy based detection
typedef enum __pdm_dc_removal pdm_dc_removal_t
    PDM DC remover configurations.
typedef enum __pdm_df_quality_mode pdm_df_quality_mode_t
    PDM decimation filter quality mode.
typedef enum __pdm_df_output_gain pdm_df_output_gain_t
    PDM decimation filter output gain.
typedef struct __pdm_channel_config pdm_channel_config_t
    PDM channel configurations.
typedef struct __pdm_config pdm_config_t
    PDM user configuration structure.
typedef enum __pdm_hwvad_hpf_config pdm_hwvad_hpf_config_t
    High pass filter configure cut-off frequency.
typedef enum __pdm_hwvad_filter_status pdm_hwvad_filter_status_t
    HWVAD internal filter status.
typedef struct __pdm_hwvad_config pdm_hwvad_config_t
    PDM voice activity detector user configuration structure.
typedef struct __pdm_hwvad_noise_filter pdm_hwvad_noise_filter_t
    PDM voice activity detector noise filter user configuration structure.
typedef enum __pdm_hwvad_zcd_result pdm_hwvad_zcd_result_t
    PDM voice activity detector zero cross detector result.
typedef struct __pdm_hwvad_zero_cross_detector pdm_hwvad_zero_cross_detector_t
    PDM voice activity detector zero cross detector configuration structure.
```

```
typedef struct _pdm_transfer pdm_transfer_t
```

PDM SDMA transfer structure.

```
typedef struct _pdm_handle pdm_handle_t
```

PDM handle.

```
typedef void (*pdm_transfer_callback_t)(PDM_Type *base, pdm_handle_t *handle, status_t status, void *userData)
```

PDM transfer callback prototype.

```
typedef void (*pdm_hwvad_callback_t)(status_t status, void *userData)
```

PDM HWVAD callback prototype.

```
typedef struct _pdm_hwvad_notification pdm_hwvad_notification_t
```

PDM HWVAD notification structure.

```
PDM_XFER_QUEUE_SIZE
```

PDM XFER QUEUE SIZE.

```
struct __pdm_channel_config
```

#include <fsl_pdm.h> PDM channel configurations.

Public Members

pdm_dc_removal_t outputCutOffFreq

PDM output DC remover cut off frequency

pdm_df_output_gain_t gain

Decimation Filter Output Gain

```
struct __pdm_config
```

#include <fsl_pdm.h> PDM user configuration structure.

Public Members

bool enableDoze

This module will enter disable/low leakage mode if DOZEN is active with ipg_doze is asserted

bool enableFilterBypass

Switchable bypass path for the decimation filter

uint8_t fifoWatermark

Watermark value for FIFO

pdm_df_quality_mode_t qualityMode

Quality mode

uint8_t cicOverSampleRate

CIC filter over sampling rate

```
struct __pdm_hwvad_config
```

#include <fsl_pdm.h> PDM voice activity detector user configuration structure.

Public Members

uint8_t channel

Which channel uses voice activity detector

`uint8_t initializeTime`
Number of frames or samples to initialize voice activity detector.

`uint8_t cicOverSampleRate`
CIC filter over sampling rate

`uint8_t inputGain`
Voice activity detector input gain

`uint32_t frameTime`
Voice activity frame time

`pdm_hwvad_hpf_config_t cutOffFreq`
High pass filter cut off frequency

`bool enableFrameEnergy`
If frame energy enabled, true means enable

`bool enablePreFilter`
If pre-filter enabled

`struct __pdm_hwvad_noise_filter`
#include <fsl_pdm.h> PDM voice activity detector noise filter user configuration structure.

Public Members

`bool enableAutoNoiseFilter`
If noise filter automatically activated, true means enable

`bool enableNoiseMin`
If Noise minimum block enabled, true means enabled

`bool enableNoiseDecimation`
If enable noise input decimation

`bool enableNoiseDetectOR`
Enables a OR logic in the output of minimum noise estimator block

`uint32_t noiseFilterAdjustment`
The adjustment value of the noise filter

`uint32_t noiseGain`
Gain value for the noise energy or envelope estimated

`struct __pdm_hwvad_zero_cross_detector`
#include <fsl_pdm.h> PDM voice activity detector zero cross detector configuration structure.

Public Members

`bool enableAutoThreshold`
If ZCD auto-threshold enabled, true means enabled.

`pdm_hwvad_zcd_result_t zcdAnd`
Is ZCD result is AND'ed with energy-based detection, false means OR'ed

`uint32_t threshold`
The adjustment value of the noise filter

uint32_t adjustmentThreshold

Gain value for the noise energy or envelope estimated

struct __pdm_transfer

#include <fsl_pdm.h> PDM SDMA transfer structure.

Public Members

volatile uint8_t *data

Data start address to transfer.

volatile size_t dataSize

Total Transfer bytes size.

struct __pdm_hwvad_notification

#include <fsl_pdm.h> PDM HWVAD notification structure.

struct __pdm_handle

#include <fsl_pdm.h> PDM handle structure.

Public Members

uint32_t state

Transfer status

pdm_transfer_callback_t callback

Callback function called at transfer event

void *userData

Callback parameter passed to callback function

pdm_transfer_t pdmQueue[(4U)]

Transfer queue storing queued transfer

size_t transferSize[(4U)]

Data bytes need to transfer

volatile uint8_t queueUser

Index for user to queue transfer

volatile uint8_t queueDriver

Index for driver to get the transfer data and size

uint32_t format

data format

uint8_t watermark

Watermark value

uint8_t startChannel

end channel

uint8_t channelNums

Enabled channel number

2.108 PDM EDMA Driver

```
void PDM_TransferInstallEDMATCDMemory(pdm_edma_handle_t *handle, void *tcdAddr, size_t  
tcdNum)
```

Install EDMA descriptor memory.

Parameters

- handle – Pointer to EDMA channel transfer handle.
- tcdAddr – EDMA head descriptor address.
- tcdNum – EDMA link descriptor address.

```
void PDM_TransferCreateHandleEDMA(PDM_Type *base, pdm_edma_handle_t *handle,  
pdm_edma_callback_t callback, void *userData,  
edma_handle_t *dmaHandle)
```

Initializes the PDM Rx eDMA handle.

This function initializes the PDM slave DMA handle, which can be used for other PDM master transactional APIs. Usually, for a specified PDM instance, call this API once to get the initialized handle.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

```
void PDM_TransferSetMultiChannelInterleaveType(pdm_edma_handle_t *handle,  
pdm_edma_multi_channel_interleave_t  
multiChannelInterleaveType)
```

Initializes the multi PDM channel interleave type.

This function initializes the PDM DMA handle member `interleaveType`, it shall be called only when application would like to use type `kPDM_EDMAMultiChannelInterleavePerChannelBlock`, since the default `interleaveType` is `kPDM_EDMAMultiChannelInterleavePerChannelSample` always

Parameters

- handle – PDM eDMA handle pointer.
- multiChannelInterleaveType – Multi channel interleave type.

```
void PDM_TransferSetChannelConfigEDMA(PDM_Type *base, pdm_edma_handle_t *handle,  
uint32_t channel, const pdm_channel_config_t  
*config)
```

Configures the PDM channel.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.
- channel – channel index.
- config – pdm channel configurations.

status_t PDM_TransferReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, *pdm_edma_transfer_t* *xfer)

Performs a non-blocking PDM receive using eDMA.

Mcaro MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL can control whether PDM is enabled internally or externally.

- a. Scatter gather case: This funcio support dynamic scatter gather and staic scatter gather, a. for the dynamic scatter gather case: Application should call PDM_TransferReceiveEDMA function continuously to make sure new receive request is submit before the previous one finish. b. for the static scatter gather case: Application should use the link transfer feature and make sure a loop link transfer is provided, such as:

```
pdm_edma_transfer_t pdmXfer[2] =
{
    {
        .data = s_buffer,
        .dataSize = BUFFER_SIZE,
        .linkTransfer = &pdmXfer[1],
    },
    {
        .data = &s_buffer[BUFFER_SIZE],
        .dataSize = BUFFER_SIZE,
        .linkTransfer = &pdmXfer[0]
    },
};
```

- b. Multi channel case: This function support receive multi pdm channel data, for example, if two channel is requested,

```
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↳ENABLE_CHANNEL_0, &channelConfig);
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↳ENABLE_CHANNEL_1, &channelConfig);
PDM_TransferReceiveEDMA(DEMO_PDM, &s_pdmRxHandle_0, pdmXfer);
```

The output data will be formatted as below if handle->interleaveType =

Note: This interface returns immediately after the transfer initiates. Call the PDM_GetReceiveRemainingBytes to poll the transfer status and check whether the PDM transfer is finished.

void PDM_TransferTerminateReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Terminate all PDM receive.

This function will clear all transfer slots buffered in the pdm queue. If users only want to abort the current transfer slot, please call PDM_TransferAbortReceiveEDMA.

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.

void PDM_TransferAbortReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Aborts a PDM receive using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call PDM_TransferTerminateReceiveEDMA.

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.

status_t PDM_TransferGetReceiveCountEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, size_t *count)

Gets byte count received by PDM.

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.
- count – Bytes count received by PDM.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

FSL_PDM_EDMA_DRIVER_VERSION

Version 2.6.5

enum __pdm_edma_multi_channel_interleave

pdm multi channel interleave type

Values:

enumerator kPDM_EDMA_MultiChannelInterleavePerChannelSample

enumerator kPDM_EDMA_MultiChannelInterleavePerChannelBlock

typedef struct *_pdm_edma_handle* pdm_edma_handle_t

PDM edma handler.

typedef enum *_pdm_edma_multi_channel_interleave* pdm_edma_multi_channel_interleave_t

pdm multi channel interleave type

typedef struct *_pdm_edma_transfer* pdm_edma_transfer_t

PDM edma transfer.

typedef void (*pdm_edma_callback_t)(PDM_Type *base, *pdm_edma_handle_t* *handle, *status_t* status, void *userData)

PDM eDMA transfer callback function for finish and error.

MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL

the PDM enable position When calling PDM_TransferReceiveEDMA

struct __pdm_edma_transfer

#include <fsl_pdm_edma.h> PDM edma transfer.

Public Members

volatile uint8_t *data

Data start address to transfer.

volatile size_t dataSize
Total Transfer bytes size.

struct *_pdm_edma_transfer* *linkTransfer
linked transfer configurations

struct *_pdm_edma_handle*
#include <fsl_pdm_edma.h> PDM DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaHandle
DMA handler for PDM send

uint8_t count
The transfer data count in a DMA request

uint32_t receivedBytes
total transfer count

uint32_t state
Internal state for PDM eDMA transfer

pdm_edma_callback_t callback
Callback for users while transfer finish or error occurs

bool isLoopTransfer
loop transfer

void *userData
User callback parameter

edma_tcd_t *tcd
TCD pool for eDMA transfer.

uint32_t tcdNum
TCD number

uint32_t tcdUser
Index for user to queue transfer.

uint32_t tcdDriver
Index for driver to get the transfer data and size

volatile uint32_t tcdUsedNum
Index for user to queue transfer.

pdm_edma_multi_channel_interleave_t interleaveType
multi channel transfer interleave type

uint8_t endChannel
The last enabled channel

uint8_t channelNums
total channel numbers

2.109 PMU Driver

void PMU_SetPllLdoControlMode(ANADIG_PMU_Type *base, *pmu_control_mode_t* mode)

brief Selects the control mode of the PLL LDO.

param base PMU peripheral base address. param mode The control mode of the PLL LDO. Please refer to *pmu_control_mode_t*.

void PMU_StaticEnablePllLdo(ANADIG_PMU_Type *base)

Enables PLL LDO via AI interface in Static/Software mode.

Parameters

- base – PMU peripheral base address.

void PMU_StaticDisablePllLdo(void)

Disables PLL LDO via AI interface in Static/Software mode.

void PMU_StaticGetAonAnaLdoDefaultConfig(*pmu_static_aon_ana_ldo_config_t* *config)

Fill the AON ANA LDO configuration structure with default settings.

The default values are:

```
config->mode           = kPMU_HighPowerMode;
config->enable2mALoad   = true;
config->enable20uALoad  = false;
config->enable4mALoad   = true;
config->enableStandbyMode = false;
config->driverStrength  = kPMU_AonAnaLdoDriverStrength0;
config->brownOutDetectorConfig = kPMU_AonAnaLdoBrownOutDetectorDisable;
config->chargePumpCurrent = kPMU_AonAnaChargePump300nA;
config->outputRange     = kPMU_AonAnaLdoOutputFrom1P77To1P83;
```

Parameters

- config – Pointer to the structure *pmu_static_aon_ana_ldo_config_t*.

void PMU_StaticAonAnaLdoInit(ANADIG_LDO_BBSM_Type *base, const *pmu_static_aon_ana_ldo_config_t* *config)

Initialize the AON ANA LDO in Static/Software Mode.

Parameters

- base – ANADIG_LDO_BBSM peripheral base address.
- config – Pointer to the structure *pmu_static_aon_ana_ldo_config_t*.

void PMU_StaticAonAnaLdoDeinit(ANADIG_LDO_BBSM_Type *base)

Disable the output of AON ANA LDO.

Parameters

- base – ANADIG_LDO_BBSM peripheral base address.

void PMU_StaticGetAonDigLdoDefaultConfig(*pmu_static_aon_dig_config_t* *config)

Gets the default configuration of AON DIG LDO.

The default values are:

```
config->enableStableDetect = false;
config->voltageStepTime    = kPMU_AonDigVoltageStepInc50us;
config->brownOutConfig     = kPMU_AonDigBrownOutDisable;
config->targetVoltage      = kPMU_AonDigTargetStableVoltage1P0V;
config->mode               = kPMU_HighPowerMode;
```

Parameters

- config – Pointer to the structure `pmu_static_aon_dig_config_t`.

```
void PMU__StaticAonDigLdoInit(ANADIG_LDO_BBSM_Type *base, const
                             pmu_static_aon_dig_config_t *config)
```

Initialize the AON DIG LDO in static mode.

Parameters

- base – ANADIG_LDO_BBSM peripheral base address.
- config – Pointer to the structure `pmu_static_aon_dig_config_t`.

```
void PMU__StaticAonDigLdoDeinit(ANADIG_LDO_BBSM_Type *base)
```

Disable the AON DIG LDO.

Parameters

- base – ANADIG_LDO_BBSM peripheral base address.

```
void PMU__GetBbsmDigLdoDefaultConfig(pmu_bbsm_dig_config_t *config)
```

Gets the default config of the BBSM DIG LDO.

The default values are:

```
config->mode           = kPMU_LowPowerMode;
config->chargePumpCurrent = kPMU_BbsmDigChargePump12P5nA;
config->dischargeResistorValue = kPMU_BbsmDigDischargeResistor15K;
config->trimValue       = 0U;
config->enablePullDown   = true;
config->enableLdoStable  = false;
```

Parameters

- config – Pointer to `pmu_bbsm_dig_config_t`.

```
void PMU__EnableLdoStandbyMode(pmu_ldo_name_t name, bool enable)
```

brief When STBY assert, enable/disable the selected LDO enter it's Low power mode.

param name The name of the selected ldo. Please see the enumeration `pmu_ldo_name_t` for details. param enable Enable GPC standby mode or not.

```
void PMU__DisableBandgapSelfBiasAfterPowerUp(void)
```

Disables Bandgap self bias for best noise performance.

This function should be invoked after powering up. This function will wait for the bandgap stable and disable the bandgap self bias. After powering up, it need to wait for the bandgap to get stable and then disable Bandgap Self bias for best noise performance.

```
void PMU__EnableBandgapSelfBiasBeforePowerDown(void)
```

Enables Bandgap self bias before power down.

This function will enable Bandgap self bias feature before powering down or there will be risk of Bandgap not starting properly.

```
void PMU__StaticBandgapInit(const pmu_static_bandgap_config_t *config)
```

Initialize Bandgap.

Parameters

- config – Pointer to the structure `pmu_static_bandgap_config_t`.

```
void PMU__WellBiasInit(ANADIG_PMU_Type *base, const pmu_well_bias_config_t *config)
```

Configures Well bias, such as power source, clock source and so on.

Parameters

- base – PMU peripheral base address.
- config – Pointer to the `pmu_well_bias_config_t` structure.

`void PMU__GetWellBiasDefaultConfig(pmu_well_bias_config_t *config)`

Gets the default configuration of well bias.

Parameters

- config – The pointer to the `pmu_well_bias_config_t` structure.

`void PMU__EnableFBB(ANADIG_PMU_Type *base, bool enable)`

brief Enables/disables FBB.

param base PMU peripheral base address. param enable Used to turn on/off FBB.

`void PMU__EnableFBBStandbyMode(ANADIG_PMU_Type *base, bool enable)`

brief Controls the ON/OFF of FBB when GPC send standby request.

param base PMU peripheral base address. param enable Enable GPC standby mode or not.

`FSL_PMU_DRIVER_VERSION`

PMU driver version.

Version 2.1.2.

`enum __pmu_ldo_name`

The name of LDOs.

Values:

enumerator `kPMU_PllLdo`

The PLL LDO in SOC domain.

enumerator `kPMU_AonAnaLdo`

The AON ANA LDO in AON domain.

enumerator `kPMU_AonDigLdo`

The AON DIG LDO in AON domain.

`enum __pmu_control_mode`

The control mode of LDOs/Bandgaps/Body Bias.

Values:

enumerator `kPMU_StaticMode`

Static/Software Control mode.

enumerator `kPMU_GPCMode`

GPC/Hardware Control mode.

`enum __pmu_ldo_operate_mode`

The operation mode for the LDOs.

Values:

enumerator `kPMU_LowPowerMode`

LDOs operate in Low power mode.

enumerator `kPMU_HighPowerMode`

LDOs operate in High power mode.

`enum __pmu_aon_ana_ldo_charge_pump_current`

The enumeration of AON ANA LDO's charge pump current.

Values:

enumerator kPMU__AonAnaChargePump300nA

The current of the charge pump is selected as 300nA.

enumerator kPMU__AonAnaChargePump400nA

The current of the charge pump is selected as 400nA.

enumerator kPMU__AonAnaChargePump500nA

The current of the charge pump is selected as 500nA.

enumerator kPMU__AonAnaChargePump600nA

The current of the charge pump is selected as 600nA.

enum __pmu_aon_ana_ldo_output_range

The enumeration of AON ANA LDO's output range.

Values:

enumerator kPMU__AonAnaLdoOutputFrom1P77To1P83

The output voltage varies from 1.77V to 1.83V.

enumerator kPMU__AonAnaLdoOutputFrom1P72To1P77

The output voltage varies from 1.72V to 1.77V.

enumerator kPMU__AonAnaLdoOutputFrom1P82To1P88

The output voltage varies from 1.82V to 1.88V.

enum __pmu_aon_dig_voltage_step_time

The enumeration of voltage step time for AON DIG LDO.

Values:

enumerator kPMU__AonDigVoltageStepInc15us

AON DIG LDO voltage step time selected as 15us.

enumerator kPMU__AonDigVoltageStepInc25us

AON DIG LDO voltage step time selected as 25us.

enumerator kPMU__AonDigVoltageStepInc50us

AON DIG LDO voltage step time selected as 50us.

enumerator kPMU__AonDigVoltageStepInc100us

AON DIG LDO voltage step time selected as 100us.

enum __pmu_aon_dig_target_output_voltage

The target output voltage of AON DIG LDO.

Values:

enumerator kPMU__AonDigTargetStableVoltage0P631V

The target voltage selected as 0.631V

enumerator kPMU__AonDigTargetStableVoltage0P65V

The target voltage selected as 0.65V

enumerator kPMU__AonDigTargetStableVoltage0P67V

The target voltage selected as 0.67V

enumerator kPMU__AonDigTargetStableVoltage0P689V

The target voltage selected as 0.689V

enumerator kPMU__AonDigTargetStableVoltage0P709V

The target voltage selected as 0.709V

enumerator kPMU__AonDigTargetStableVoltage0P728V

The target voltage selected as 0.728V

enumerator kPMU__AonDigTargetStableVoltage0P748V

The target voltage selected as 0.748V

enumerator kPMU__AonDigTargetStableVoltage0P767V

The target voltage selected as 0.767V

enumerator kPMU__AonDigTargetStableVoltage0P786V

The target voltage selected as 0.786V

enumerator kPMU__AonDigTargetStableVoltage0P806V

The target voltage selected as 0.806V

enumerator kPMU__AonDigTargetStableVoltage0P825V

The target voltage selected as 0.825V

enumerator kPMU__AonDigTargetStableVoltage0P845V

The target voltage selected as 0.845V

enumerator kPMU__AonDigTargetStableVoltage0P864V

The target voltage selected as 0.864V

enumerator kPMU__AonDigTargetStableVoltage0P883V

The target voltage selected as 0.883V

enumerator kPMU__AonDigTargetStableVoltage0P903V

The target voltage selected as 0.903V

enumerator kPMU__AonDigTargetStableVoltage0P922V

The target voltage selected as 0.922V

enumerator kPMU__AonDigTargetStableVoltage0P942V

The target voltage selected as 0.942V

enumerator kPMU__AonDigTargetStableVoltage0P961V

The target voltage selected as 0.961V

enumerator kPMU__AonDigTargetStableVoltage0P981V

The target voltage selected as 0.981V

enumerator kPMU__AonDigTargetStableVoltage1P0V

The target voltage selected as 1.0V

enumerator kPMU__AonDigTargetStableVoltage1P019V

The target voltage selected as 1.019V

enumerator kPMU__AonDigTargetStableVoltage1P039V

The target voltage selected as 1.039V

enumerator kPMU__AonDigTargetStableVoltage1P058V

The target voltage selected as 1.058V

enumerator kPMU__AonDigTargetStableVoltage1P078V

The target voltage selected as 1.078V

enumerator kPMU__AonDigTargetStableVoltage1P097V

The target voltage selected as 1.097V

enumerator kPMU__AonDigTargetStableVoltage1P117V

The target voltage selected as 1.117V

enumerator kPMU__AonDigTargetStableVoltage1P136V

The target voltage selected as 1.136V

enumerator kPMU__AonDigTargetStableVoltage1P155V

The target voltage selected as 1.155V

enumerator kPMU__AonDigTargetStableVoltage1P175V

The target voltage selected as 1.175V

enumerator kPMU__AonDigTargetStableVoltage1P194V

The target voltage selected as 1.194V

enumerator kPMU__AonDigTargetStableVoltage1P214V

The target voltage selected as 1.214V

enumerator kPMU__AonDigTargetStableVoltage1P233V

The target voltage selected as 1.233V

enum __pmu__bbsm__dig__charge__pump__current

The enumeration of the BBSM DIG LDO's charge pump current.

Values:

enumerator kPMU__BbsmDigChargePump12P5nA

The current of BBSM DIG LDO's charge pump is selected as 12.5nA.

enumerator kPMU__BbsmDigChargePump6P25nA

The current of BBSM DIG LDO's charge pump is selected as 6.25nA.

enumerator kPMU__BbsmDigChargePump18P75nA

The current of BBSM DIG LDO's charge pump is selected as 18.75nA.

enum __pmu__bbsm__dig__discharge__resistor__value

The enumeration of the BBSM DIG LDO's discharge resistor.

Values:

enumerator kPMU__BbsmDigDischargeResistor15K

The Discharge Resistor is selected as 15K ohm

enumerator kPMU__BbsmDigDischargeResistor30K

The Discharge Resistor is selected as 30K ohm

enumerator kPMU__BbsmDigDischargeResistor9K

The Discharge Resistor is selected as 9K ohm

enum __pmu__static__bandgap__power__down__option

The enumeration of bandgap power down option.

Values:

enumerator kPMU__PowerDownBandgapFully

Fully power down the bandgap module.

enumerator kPMU__PowerDownVoltageReferenceOutputOnly

Power down only the reference output section of the bandgap

enumerator kPMU__PowerDownBandgapVBGUPDetector

Power down the VBGUP detector of the bandgap without affecting any additional functionality.

enum __pmu__bandgap__output__VBG__voltage__value

The enumeration of output VBG voltage.

Values:

enumerator kPMU__BandgapOutputVBGVoltageNominal
Output nominal voltage.

enumerator kPMU__BandgapOutputVBGVoltagePlus10mV
Output VBG voltage Plus 10mV.

enumerator kPMU__BandgapOutputVBGVoltagePlus20mV
Output VBG voltage Plus 20mV.

enumerator kPMU__BandgapOutputVBGVoltagePlus30mV
Output VBG voltage Plus 30mV.

enumerator kPMU__BandgapOutputVBGVoltageMinus10mV
Output VBG voltage Minus 10mV.

enumerator kPMU__BandgapOutputVBGVoltageMinus20mV
Output VBG voltage Minus 20mV.

enumerator kPMU__BandgapOutputVBGVoltageMinus30mV
Output VBG voltage Minus 30mV.

enumerator kPMU__BandgapOutputVBGVoltageMinus40mV
Output VBG voltage Minus 40mV.

enum __pmu__bandgap_output_current_value
The enumeration of output current.

Values:

enumerator kPMU__OutputCurrent11P5uA
Output 11.5uA current from the bandgap.

enumerator kPMU__OutputCurrent11P8uA
Output 11.8uA current from the bandgap.

enumerator kPMU__OutputCurrent12P1uA
Output 12.1uA current from the bandgap.

enumerator kPMU__OutputCurrent12P4uA
Output 12.4uA current from the bandgap.

enumerator kPMU__OutputCurrent12P7uA
Output 12.7uA current from the bandgap.

enumerator kPMU__OutputCurrent13P0uA
Output 13.0uA current from the bandgap.

enumerator kPMU__OutputCurrent13P3uA
Output 13.3uA current from the bandgap.

enum __pmu__well_bias_power_source
The enumerator of well bias power source.

Values:

enumerator kPMU__WellBiasPowerFromAonDigLdo
AON Dig LDO supplies the power stage and NWELL sampler.

enumerator kPMU__WellBiasPowerFromDCDC
DCDC supplies the power stage and NWELL sampler.

enum __pmu__bias_area_size
The enumerator of bias area size.

Values:

enumerator kPMU_180uA_6mm2At125C

Imax = 180uA; Areamax-RVT = 6.00mm2 at 125C

enumerator kPMU_150uA_5mm2At125C

Imax = 150uA; Areamax-RVT = 5.00mm2 at 125C

enumerator kPMU_120uA_4mm2At125C

Imax = 120uA; Areamax-RVT = 4.00mm2 at 125C

enumerator kPMU_90uA_3mm2At125C

Imax = 90uA; Areamax-RVT = 3.00mm2 at 125C

enumerator kPMU_60uA_2mm2At125C

Imax = 60uA; Areamax-RVT = 2.00mm2 at 125C

enumerator kPMU_45uA_1P5mm2At125C

Imax = 45uA; Areamax-RVT = 1P5mm2 at 125C

enumerator kPMU_30uA_1mm2At125C

Imax = 30uA; Areamax-RVT = 1.00mm2 at 125C

enumerator kPMU_15uA_0P5mm2At125C

Imax = 15uA; Areamax-RVT = 0.50mm2 at 125C

enum __pmu_well_bias_typical_freq

The enumerator of well bias typical frequency.

Values:

enumerator kPMU_OscFreqDiv128

Typical frequency = osc_freq / 128.

enumerator kPMU_OscFreqDiv64

Typical frequency = osc_freq / 64.

enumerator kPMU_OscFreqDiv32

Typical frequency = osc_freq / 32.

enumerator kPMU_OscFreqDiv16

Typical frequency = osc_freq / 16.

enumerator kPMU_OscFreqDiv8

Typical frequency = osc_freq / 8.

enumerator kPMU_OscFreqDiv2

Typical frequency = osc_freq / 2.

enumerator kPMU_OscFreq

Typical frequency = oscillator frequency.

enum __pmu_adaptive_clock_source

The enumerator of well bias adaptive clock source.

Values:

enumerator kPMU_AdaptiveClkSourceOscClk

The adaptive clock source is oscillator clock.

enumerator kPMU_AdaptiveClkSourceChargePumpClk

The adaptive clock source is charge pump clock.

enum __pmu_freq_reduction

The enumerator of frequency reduction due to cap increment.

Values:

enumerator kPMU_FreqReductionNone

No frequency reduction.

enumerator kPMU_FreqReduction30PCT

30% frequency reduction due to cap increment.

enumerator kPMU_FreqReduction40PCT

40% frequency reduction due to cap increment.

enumerator kPMU_FreqReduction50PCT

50% frequency reduction due to cap increment.

enum __pmu_well_bias_1P8_adjustment

The enumerator of well bias 1P8 adjustment.

Values:

enumerator kPMU_Cref0fFCspl0fFDeltaC0fF

Cref = 0fF, Cspl = 0fF, DeltaC = 0fF.

enumerator kPMU_Cref0fFCspl30fFDeltaCN30fF

Cref = 0fF, Cspl = 30fF, DeltaC = -30fF.

enumerator kPMU_Cref0fFCspl43fFDeltaCN43fF

Cref = 0fF, Cspl = 43fF, DeltaC = -43fF.

enumerator kPMU_Cref0fFCspl62fFDeltaCN62fF

Cref = 0fF, Cspl = 62fF, DeltaC = -62fF.

enumerator kPMU_Cref0fFCspl105fFDeltaCN105fF

Cref = 0fF, Cspl = 105fF, DeltaC = -105fF.

enumerator kPMU_Cref30fFCspl0fFDeltaC30fF

Cref = 30fF, Cspl = 0fF, DeltaC = 30fF.

enumerator kPMU_Cref30fFCspl43fFDeltaCN12fF

Cref = 30fF, Cspl = 43fF, DeltaC = -12fF.

enumerator kPMU_Cref30fFCspl105fFDeltaCN75fF

Cref = 30fF, Cspl = 105fF, DeltaC = -75fF.

enumerator kPMU_Cref43fFCspl0fFDeltaC43fF

Cref = 43fF, Cspl = 0fF, DeltaC = 43fF.

enumerator kPMU_Cref43fFCspl30fFDeltaC13fF

Cref = 43fF, Cspl = 30fF, DeltaC = 13fF.

enumerator kPMU_Cref43fFCspl62fFDeltaCN19fF

Cref = 43fF, Cspl = 62fF, DeltaC = -19fF.

enumerator kPMU_Cref62fFCspl0fFDeltaC62fF

Cref = 62fF, Cspl = 0fF, DeltaC = 62fF.

enumerator kPMU_Cref62fFCspl43fFDeltaC19fF

Cref = 62fF, Cspl = 43fF, DeltaC = 19fF.

enumerator kPMU_Cref105fFCspl0fFDeltaC105fF

Cref = 105fF, Cspl = 0fF, DeltaC = 105fF.

enumerator kPMU_Cref105fFCspl30fFDeltaC75fF

Cref = 105fF, Cspl = 30fF, DeltaC = 75fF.

typedef enum *_pmu_ldo_name* pmu_ldo_name_t

The name of LDOs.

typedef enum *_pmu_control_mode* pmu_control_mode_t

The control mode of LDOs/Bandgaps/Body Bias.

typedef enum *_pmu_ldo_operate_mode* pmu_ldo_operate_mode_t

The operation mode for the LDOs.

typedef enum *_pmu_aon_ana_ldo_charge_pump_current*

pmu_aon_ana_ldo_charge_pump_current_t

The enumeration of AON ANA LDO's charge pump current.

typedef enum *_pmu_aon_ana_ldo_output_range* pmu_aon_ana_ldo_output_range_t

The enumeration of AON ANA LDO's output range.

typedef enum *_pmu_aon_dig_voltage_step_time* pmu_aon_dig_voltage_step_time_t

The enumeration of voltage step time for AON DIG LDO.

typedef enum *_pmu_aon_dig_target_output_voltage* pmu_aon_dig_target_output_voltage_t

The target output voltage of AON DIG LDO.

typedef enum *_pmu_bbsm_dig_charge_pump_current* pmu_bbsm_dig_charge_pump_current_t

The enumeration of the BBSM DIG LDO's charge pump current.

typedef enum *_pmu_bbsm_dig_discharge_resistor_value*

pmu_bbsm_dig_discharge_resistor_value_t

The enumeration of the BBSM DIG LDO's discharge resistor.

typedef enum *_pmu_bandgap_output_VBG_voltage_value*

pmu_bandgap_output_VBG_voltage_value_t

The enumeration of output VBG voltage.

typedef enum *_pmu_bandgap_output_current_value* pmu_bandgap_output_current_value_t

The enumeration of output current.

typedef enum *_pmu_well_bias_power_source* pmu_well_bias_power_source_t

The enumerator of well bias power source.

typedef enum *_pmu_bias_area_size* pmu_bias_area_size_t

The enumerator of bias area size.

typedef enum *_pmu_well_bias_typical_freq* pmu_well_bias_typical_freq_t

The enumerator of well bias typical frequency.

typedef enum *_pmu_adaptive_clock_source* pmu_adaptive_clock_source_t

The enumerator of well bias adaptive clock source.

typedef enum *_pmu_freq_reduction* pmu_freq_reduction_t

The enumerator of frequency reduction due to cap increment.

typedef enum *_pmu_well_bias_1P8_adjustment* pmu_well_bias_1P8_adjustment_t

The enumerator of well bias 1P8 adjustment.

typedef struct *_pmu_static_aon_ana_ldo_config* pmu_static_aon_ana_ldo_config_t

AON ANA LDO config.

typedef struct *_pmu_static_aon_dig_config* pmu_static_aon_dig_config_t

AON DIG LDO Config in Static/Software Mode.

typedef struct *_pmu_bbsm_dig_config* pmu_bbsm_dig_config_t

BBSM DIG LDO config.

```
typedef struct _pmu_static_bandgap_config pmu_static_bandgap_config_t
```

Bandgap config in static mode.

```
typedef union _pmu_well_bias_option pmu_well_bias_option_t
```

The union of well bias basic options, such as clock source, power source and so on.

```
typedef struct _pmu_well_bias_config pmu_well_bias_config_t
```

The structure of well bias configuration.

```
struct _pmu_static_aon_ana_ldo_config
```

#include <fsl_pmu.h> AON ANA LDO config.

Public Members

```
pmu_ldo_operate_mode_t mode
```

The operate mode of AON ANA LDO.

```
bool enable2mALoad
```

Enable/Disable 2mA load.

- **true** Enables 2mA loading to prevent overshoot;
- **false** Disables 2mA loading.

```
bool enable4mALoad
```

Enable/Disable 4mA load.

- **true** Enables 4mA loading to prevent dramatic voltage drop;
- **false** Disables 4mA load.

```
bool enable20uALoad
```

Enable/Disable 20uA load.

- **true** Enables 20uA loading to prevent overshoot;
- **false** Disables 20uA load.

```
bool enableStandbyMode
```

Enable/Disable Standby Mode.

- **true** Enables Standby mode, if the STBY assert, the AON ANA LDO enter LP mode
- **false** Disables Standby mode.

```
struct _pmu_static_aon_dig_config
```

#include <fsl_pmu.h> AON DIG LDO Config in Static/Software Mode.

Public Members

```
bool enableStableDetect
```

Enable/Disable Stable Detect.

- **true** Enables Stable Detect.
- **false** Disables Stable Detect.

```
pmu_aon_dig_voltage_step_time_t voltageStepTime
```

Step time.

```
pmu_aon_dig_target_output_voltage_t targetVoltage
```

The target output voltage.

```
struct _pmu_bbsm_dig_config
```

#include <fsl_pmu.h> BBSM DIG LDO config.

Public Members

pmu_ldo_operate_mode_t mode

The operate mode the BBSM DIG LDO.

pmu_bbsm_dig_charge_pump_current_t chargePumpCurrent

The current of BBSM DIG LDO's charge pump current.

pmu_bbsm_dig_discharge_resistor_value_t dischargeResistorValue

The value of BBSM DIG LDO's Discharge Resistor.

uint8_t trimValue

The trim value.

bool enablePullDown

Enable/Disable Pull down.

- **true** Enables the feature of using 1M ohm resistor to discharge the LDO output.
- **false** Disables the feature of using 1M ohm resistor to discharge the LDO output.

bool enableLdoStable

Enable/Disable BBSM DIG LDO Stable.

struct _pmu_static_bandgap_config

#include <fsl_pmu.h> Bandgap config in static mode.

Public Members

uint8_t powerDownOption

The OR'ed value of *_pmu_static_bandgap_power_down_option*. Please refer to *_pmu_static_bandgap_power_down_option*.

bool enableLowPowerMode

Turn on/off the Low power mode.

- **true** Turns on the low power operation of the bandgap.
- **false** Turns off the low power operation of the bandgap.

pmu_bandgap_output_VBG_voltage_value_t outputVoltage

The output VBG voltage of Bandgap.

pmu_bandgap_output_current_value_t outputCurrent

The output current from the bandgap to the temperature sensors.

union _pmu_well_bias_option

#include <fsl_pmu.h> The union of well bias basic options, such as clock source, power source and so on.

Public Members

uint16_t wellBiasData

well bias configuration data.

struct _pmu_well_bias_option wellBiasStruct

struct _pmu_well_bias_config

#include <fsl_pmu.h> The structure of well bias configuration.

Public Members

pmu_well_bias_option_t wellBiasOption

Well bias basic function, please refer to *pmu_well_bias_option_t*.

pmu_well_bias_1P8_adjustment_t adjustment

Well bias adjustment 1P8, please refer to *pmu_well_bias_1P8_adjustment_t*.

struct wellBiasStruct

Public Members

uint16_t enablePWellOnly

Turn on both PWELL and NWELL, or only trun on PWELL.

- **1b0** PWELL and NEWLL are both turned on.
- **1b1** PWELL is turned on only.

uint16_t reserved1

Reserved.

uint16_t biasAreaSize

Select size of bias area, please refer to *pmu_bias_area_size_t*

uint16_t disableAdaptiveFreq

Enable/Disable adaptive frequency.

- **1b0** Frequency change after each half cycle minimum frequency determined by typical frequency.
- **1b1** Adaptive frequency disabled. Frequency determined by typical frequency.

uint16_t wellBiasFreq

Set well bias typical frequency, please refer to *pmu_well_bias_typical_freq_t*.

uint16_t clkSource

Config the adaptive clock source, please *pmu_adaptive_clock_source_t*.

uint16_t freqReduction

Config the percent of frequency reduction due to cap increment, please refer to *pmu_freq_reduction_t*.

uint16_t enablePullDownOption

Enable/Disable pull down option.

- **false** Pull down option is disabled.
- **true** Pull down option is enabled.

uint16_t reserved2

Reserved.

uint16_t powerSource

Set power source, please refer to *pmu_well_bias_power_source_t*.

uint16_t reserved3

Reserved.

2.110 PWM: Pulse Width Modulator

status_t PWM_Init(PWM_Type *base, *pwm_submodule_t* subModule, const *pwm_config_t* *config)

Ungates the PWM submodule clock and configures the peripheral for basic operation.

This API should be called at the beginning of the application using the PWM driver. When user select PWMX, user must choose edge aligned output, because there are some limitation on center aligned PWMX output. When output PWMX in center aligned mode, VAL1 register controls both PWM period and PWMX duty cycle, PWMA and PWMB output will be corrupted. But edge aligned PWMX output do not have such limit. In master reload counter initialization mode, PWM period is depended by period of set LDOK in submodule 0 because this operation will reload register. Submodule 0 counter initialization cannot be master sync or master reload.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- config – Pointer to user's PWM config structure.

Returns

kStatus_Success means success; else failed.

void PWM_Deinit(PWM_Type *base, *pwm_submodule_t* subModule)

Gate the PWM submodule clock.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to deinitialize

void PWM_GetDefaultConfig(*pwm_config_t* *config)

Fill in the PWM config struct with the default settings.

The default values are:

```
config->enableDebugMode = false;
config->enableWait = false;
config->reloadSelect = kPWM_LocalReload;
config->clockSource = kPWM_BusClock;
config->prescale = kPWM_Prescale_Divide_1;
config->initializationControl = kPWM_Initialize_LocalSync;
config->forceTrigger = kPWM_Force_Local;
config->reloadFrequency = kPWM_LoadEveryOpportunity;
config->reloadLogic = kPWM_ReloadImmediate;
config->pairOperation = kPWM_Independent;
```

Parameters

- config – Pointer to user's PWM config structure.

status_t PWM_SetupPwm(PWM_Type *base, *pwm_submodule_t* subModule, const *pwm_signal_param_t* *chnlParams, uint8_t numOfChnls, *pwm_mode_t* mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)

Sets up the PWM signals for a PWM submodule.

The function initializes the submodule according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements. If the dead time insertion logic is enabled, the pulse period is reduced by the dead time period specified by the user. When user select PWMX, user must choose edge aligned

output, because there are some limitations on center aligned PWMX output. Due to edge aligned PWMX is negative true signal, need to configure PWMX active low true level to get correct duty cycle. The half cycle point will not be exactly in the middle of the PWM cycle when PWMX enabled.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `chnlParams` – Array of PWM channel parameters to configure the channel(s).
- `numOfChnls` – Number of channels to configure, this should be the size of the array passed in. Array size should not be more than 3 as each submodule has 3 pins to output PWM.
- `mode` – PWM operation mode, options available in enumeration `pwm_mode_t`
- `pwmFreq_Hz` – PWM signal frequency in Hz
- `srcClock_Hz` – PWM source clock of correspond submodule in Hz. If source clock of submodule1,2,3 is from submodule0 AUX_CLK, its source clock is submodule0 source clock divided with submodule0 prescaler value instead of submodule0 source clock.

Returns

Returns `kStatus_Fail` if there was error setting up the signal; `kStatus_Success` otherwise

`status_t` PWM_SetupPwmPhaseShift(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmChannel, `uint32_t` pwmFreq_Hz, `uint32_t` srcClock_Hz, `uint8_t` shiftvalue, `bool` doSync)

Set PWM phase shift for PWM channel running on channel PWM_A, PWM_B which with 50% duty cycle.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `pwmChannel` – PWM channel to configure
- `pwmFreq_Hz` – PWM signal frequency in Hz
- `srcClock_Hz` – PWM main counter clock in Hz.
- `shiftvalue` – Phase shift value, range in 0 ~ 50
- `doSync` – `true`: Set LDOK bit for the submodule list; `false`: LDOK bit don't set, need to call PWM_SetPwmLdok to sync update.

Returns

Returns `kStatus_Fail` if there was error setting up the signal; `kStatus_Success` otherwise

`void` PWM_UpdatePwmDutycycle(PWM_Type *base, *pwm_submodule_t* subModule, *pwm_channels_t* pwmSignal, *pwm_mode_t* currPwmMode, `uint8_t` dutyCyclePercent)

Updates the PWM signal's dutycycle.

The function updates the PWM dutycycle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A, PWM B, PWM X) to update
- currPwmMode – The current PWM mode set during PWM setup
- dutyCyclePercent – New PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

```
void PWM_UpdatePwmDutycycleHighAccuracy(PWM_Type *base, pwm_submodule_t subModule,  
                                         pwm_channels_t pwmSignal, pwm_mode_t  
                                         currPwmMode, uint16_t dutyCycle)
```

Updates the PWM signal's dutycycle with 16-bit accuracy.

The function updates the PWM dutycycle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A, PWM B, PWM X) to update
- currPwmMode – The current PWM mode set during PWM setup
- dutyCycle – New PWM pulse width, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle)

```
void PWM_UpdatePwmPeriodAndDutycycle(PWM_Type *base, pwm_submodule_t subModule,  
                                      pwm_channels_t pwmSignal, pwm_mode_t  
                                      currPwmMode, uint16_t pulseCnt, uint16_t  
                                      dutyCycle)
```

Update the PWM signal's period and dutycycle for a PWM submodule.

The function updates PWM signal period generated by a specific submodule according to the parameters passed in by the user. This function can also set dutycycle whether you want to keep original dutycycle or update new dutycycle. Call this function in local sync control mode because PWM period is depended by

INIT and VAL1 register of each submodule. In master sync initialization control mode, call this function to update INIT and VAL1 register of all submodule because PWM period is depended by INIT and VAL1 register in submodule0. If the dead time insertion logic is enabled, the pulse period is reduced by the dead time period specified by the user. PWM signal will not be generated if its period is less than dead time duration.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmSignal – Signal (PWM A or PWM B) to update
- currPwmMode – The current PWM mode set during PWM setup, options available in enumeration pwm_mode_t
- pulseCnt – New PWM period, value should be between 0 to 65535 0=minimum PWM period... 65535=maximum PWM period

- `dutyCycle` – New PWM pulse width of channel, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle) You can keep original duty cycle or update new duty cycle

```
static inline void PWM_EnableInterrupts(PWM_Type *base, pwm_submodule_t subModule,  
                                       uint32_t mask)
```

Enables the selected PWM interrupts.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `mask` – The interrupts to enable. This is a logical OR of members of the enumeration `pwm_interrupt_enable_t`

```
static inline void PWM_DisableInterrupts(PWM_Type *base, pwm_submodule_t subModule,  
                                       uint32_t mask)
```

Disables the selected PWM interrupts.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `mask` – The interrupts to enable. This is a logical OR of members of the enumeration `pwm_interrupt_enable_t`

```
static inline uint32_t PWM_GetEnabledInterrupts(PWM_Type *base, pwm_submodule_t  
                                              subModule)
```

Gets the enabled PWM interrupts.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure

Returns

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

```
static inline void PWM_DMAFIFOWatermarkControl(PWM_Type *base, pwm_submodule_t  
                                              subModule, pwm_watermark_control_t  
                                              pwm_watermark_control)
```

Capture DMA Enable Source Select.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `pwm_watermark_control` – PWM FIFO watermark and control

```
static inline void PWM_DMACaptureSourceSelect(PWM_Type *base, pwm_submodule_t  
                                              subModule, pwm_dma_source_select_t  
                                              pwm_dma_source_select)
```

Capture DMA Enable Source Select.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `pwm_dma_source_select` – PWM capture DMA enable source select

```
static inline void PWM_EnableDMACapture(PWM_Type *base, pwm_submodule_t subModule,
                                         uint16_t mask, bool activate)
```

Enables or disables the selected PWM DMA Capture read request.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- mask – The DMA to enable or disable. This is a logical OR of members of the enumeration `pwm_dma_enable_t`
- activate – true: Enable DMA read request; false: Disable DMA read request

```
static inline void PWM_EnableDMAWrite(PWM_Type *base, pwm_submodule_t subModule, bool
                                       activate)
```

Enables or disables the PWM DMA write request.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- activate – true: Enable DMA write request; false: Disable DMA write request

```
static inline uint32_t PWM_GetStatusFlags(PWM_Type *base, pwm_submodule_t subModule)
```

Gets the PWM status flags.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure

Returns

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

```
static inline void PWM_ClearStatusFlags(PWM_Type *base, pwm_submodule_t subModule,
                                         uint32_t mask)
```

Clears the PWM status flags.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- mask – The status flags to clear. This is a logical OR of members of the enumeration `pwm_status_flags_t`

```
static inline void PWM_StartTimer(PWM_Type *base, uint8_t subModulesToStart)
```

Starts the PWM counter for a single or multiple submodules.

Sets the Run bit which enables the clocks to the PWM submodule. This function can start multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToStart – PWM submodules to start. This is a logical OR of members of the enumeration `pwm_module_control_t`

static inline void PWM_StopTimer(PWM_Type *base, uint8_t subModulesToStop)

Stops the PWM counter for a single or multiple submodules.

Clears the Run bit which resets the submodule's counter. This function can stop multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToStop – PWM submodules to stop. This is a logical OR of members of the enumeration pwm_module_control_t

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enum __pwm_submodule

List of PWM submodules.

Values:

enumerator kPWM_Module_0

Submodule 0

enumerator kPWM_Module_1

Submodule 1

enumerator kPWM_Module_2

Submodule 2

enum __pwm_channels

List of PWM channels in each module.

Values:

enumerator kPWM_PwmB

enumerator kPWM_PwmA

enumerator kPWM_PwmX

enum __pwm_value_register

List of PWM value registers.

Values:

enumerator kPWM_ValueRegister_0

PWM Value0 register

enumerator kPWM_ValueRegister_1

PWM Value1 register

enumerator kPWM_ValueRegister_2

PWM Value2 register

enumerator kPWM_ValueRegister_3

PWM Value3 register

enumerator kPWM_ValueRegister_4

PWM Value4 register

enumerator kPWM_ValueRegister_5

PWM Value5 register

enum _pwm_value_register_mask

List of PWM value registers mask.

Values:

enumerator kPWM_ValueRegisterMask_0

PWM Value0 register mask

enumerator kPWM_ValueRegisterMask_1

PWM Value1 register mask

enumerator kPWM_ValueRegisterMask_2

PWM Value2 register mask

enumerator kPWM_ValueRegisterMask_3

PWM Value3 register mask

enumerator kPWM_ValueRegisterMask_4

PWM Value4 register mask

enumerator kPWM_ValueRegisterMask_5

PWM Value5 register mask

enum _pwm_clock_source

PWM clock source selection.

Values:

enumerator kPWM_BusClock

Device specific IPBus clock, refer reference manual for frequency

enumerator kPWM_ExternalClock

EXT_CLK is used as the clock

enumerator kPWM_Submodule0Clock

Clock of the submodule 0 (AUX_CLK) is used as the source clock

enum _pwm_clock_prescale

PWM prescaler factor selection for clock source.

Values:

enumerator kPWM_Prescale_Divide_1

PWM clock frequency = $f_{clk}/1$

enumerator kPWM_Prescale_Divide_2

PWM clock frequency = $f_{clk}/2$

enumerator kPWM_Prescale_Divide_4

PWM clock frequency = $f_{clk}/4$

enumerator kPWM_Prescale_Divide_8

PWM clock frequency = $f_{clk}/8$

enumerator kPWM_Prescale_Divide_16

PWM clock frequency = $f_{clk}/16$

enumerator kPWM_Prescale_Divide_32

PWM clock frequency = $f_{clk}/32$

enumerator kPWM_Prescale_Divide_64

PWM clock frequency = $f_{clk}/64$

enumerator kPWM_Prescale_Divide_128

PWM clock frequency = fclk/128

enum __pwm_force_output_trigger

Options that can trigger a PWM FORCE_OUT.

Values:

enumerator kPWM_Force_Local

The local force signal, CTRL2[FORCE], from the submodule is used to force updates

enumerator kPWM_Force_Master

The master force signal from submodule 0 is used to force updates

enumerator kPWM_Force_LocalReload

The local reload signal from this submodule is used to force updates without regard to the state of LDOK

enumerator kPWM_Force_MasterReload

The master reload signal from submodule 0 is used to force updates if LDOK is set

enumerator kPWM_Force_LocalSync

The local sync signal from this submodule is used to force updates

enumerator kPWM_Force_MasterSync

The master sync signal from submodule0 is used to force updates

enumerator kPWM_Force_External

The external force signal, EXT_FORCE, from outside the PWM module causes updates

enumerator kPWM_Force_ExternalSync

The external sync signal, EXT_SYNC, from outside the PWM module causes updates

enum __pwm_output_state

PWM channel output status.

Values:

enumerator kPWM_HighState

The output state of PWM channel is high

enumerator kPWM_LowState

The output state of PWM channel is low

enumerator kPWM_NormalState

The output state of PWM channel is normal

enumerator kPWM_InvertState

The output state of PWM channel is invert

enumerator kPWM_MaskState

The output state of PWM channel is mask

enum __pwm_init_source

PWM counter initialization options.

Values:

enumerator kPWM_Initialize_LocalSync

Local sync causes initialization

enumerator kPWM_Initialize_MasterReload

Master reload from submodule 0 causes initialization

enumerator kPWM_Initialize_MasterSync

Master sync from submodule 0 causes initialization

enumerator kPWM_Initialize_ExtSync

EXT_SYNC causes initialization

enum __pwm_load_frequency

PWM load frequency selection.

Values:

enumerator kPWM_LoadEveryOpportunity

Every PWM opportunity

enumerator kPWM_LoadEvery2Opportunity

Every 2 PWM opportunities

enumerator kPWM_LoadEvery3Opportunity

Every 3 PWM opportunities

enumerator kPWM_LoadEvery4Opportunity

Every 4 PWM opportunities

enumerator kPWM_LoadEvery5Opportunity

Every 5 PWM opportunities

enumerator kPWM_LoadEvery6Opportunity

Every 6 PWM opportunities

enumerator kPWM_LoadEvery7Opportunity

Every 7 PWM opportunities

enumerator kPWM_LoadEvery8Opportunity

Every 8 PWM opportunities

enumerator kPWM_LoadEvery9Opportunity

Every 9 PWM opportunities

enumerator kPWM_LoadEvery10Opportunity

Every 10 PWM opportunities

enumerator kPWM_LoadEvery11Opportunity

Every 11 PWM opportunities

enumerator kPWM_LoadEvery12Opportunity

Every 12 PWM opportunities

enumerator kPWM_LoadEvery13Opportunity

Every 13 PWM opportunities

enumerator kPWM_LoadEvery14Opportunity

Every 14 PWM opportunities

enumerator kPWM_LoadEvery15Opportunity

Every 15 PWM opportunities

enumerator kPWM_LoadEvery16Opportunity

Every 16 PWM opportunities

enum __pwm_fault_input

List of PWM fault selections.

Values:

enumerator kPWM_Fault_0

Fault 0 input pin

enumerator kPWM_Fault_1

Fault 1 input pin

enumerator kPWM_Fault_2

Fault 2 input pin

enumerator kPWM_Fault_3

Fault 3 input pin

enum _pwm_fault_disable

List of PWM fault disable mapping selections.

Values:

enumerator kPWM_FaultDisable_0

Fault 0 disable mapping

enumerator kPWM_FaultDisable_1

Fault 1 disable mapping

enumerator kPWM_FaultDisable_2

Fault 2 disable mapping

enumerator kPWM_FaultDisable_3

Fault 3 disable mapping

enum _pwm_fault_channels

List of PWM fault channels.

Values:

enumerator kPWM_faultchannel_0

enumerator kPWM_faultchannel_1

enum _pwm_input_capture_edge

PWM capture edge select.

Values:

enumerator kPWM_Disable

Disabled

enumerator kPWM_FallingEdge

Capture on falling edge only

enumerator kPWM_RisingEdge

Capture on rising edge only

enumerator kPWM_RiseAndFallEdge

Capture on rising or falling edge

enum _pwm_force_signal

PWM output options when a FORCE_OUT signal is asserted.

Values:

enumerator kPWM_UsePwm

Generated PWM signal is used by the deadtime logic.

enumerator kPWM_InvertedPwm

Inverted PWM signal is used by the deadtime logic.

enumerator kPWM_SoftwareControl

Software controlled value is used by the deadtime logic.

enumerator kPWM_UseExternal

PWM_EXT_A signal is used by the deadtime logic.

enum __pwm_chnl_pair_operation

Options available for the PWM A & B pair operation.

Values:

enumerator kPWM_Independent

PWM A & PWM B operate as 2 independent channels

enumerator kPWM_ComplementaryPwmA

PWM A & PWM B are complementary channels, PWM A generates the signal

enumerator kPWM_ComplementaryPwmB

PWM A & PWM B are complementary channels, PWM B generates the signal

enum __pwm_register_reload

Options available on how to load the buffered-registers with new values.

Values:

enumerator kPWM_ReloadImmediate

Buffered-registers get loaded with new values as soon as LDOK bit is set

enumerator kPWM_ReloadPwmHalfCycle

Registers loaded on a PWM half cycle

enumerator kPWM_ReloadPwmFullCycle

Registers loaded on a PWM full cycle

enumerator kPWM_ReloadPwmHalfAndFullCycle

Registers loaded on a PWM half & full cycle

enum __pwm_fault_recovery_mode

Options available on how to re-enable the PWM output when recovering from a fault.

Values:

enumerator kPWM_NoRecovery

PWM output will stay inactive

enumerator kPWM_RecoverHalfCycle

PWM output re-enabled at the first half cycle

enumerator kPWM_RecoverFullCycle

PWM output re-enabled at the first full cycle

enumerator kPWM_RecoverHalfAndFullCycle

PWM output re-enabled at the first half or full cycle

enum __pwm_interrupt_enable

List of PWM interrupt options.

Values:

enumerator kPWM_CompareVal0InterruptEnable

PWM VAL0 compare interrupt

enumerator kPWM_CompareVal1InterruptEnable

PWM VAL1 compare interrupt

enumerator kPWM__CompareVal2InterruptEnable
PWM VAL2 compare interrupt

enumerator kPWM__CompareVal3InterruptEnable
PWM VAL3 compare interrupt

enumerator kPWM__CompareVal4InterruptEnable
PWM VAL4 compare interrupt

enumerator kPWM__CompareVal5InterruptEnable
PWM VAL5 compare interrupt

enumerator kPWM__CaptureX0InterruptEnable
PWM capture X0 interrupt

enumerator kPWM__CaptureX1InterruptEnable
PWM capture X1 interrupt

enumerator kPWM__CaptureB0InterruptEnable
PWM capture B0 interrupt

enumerator kPWM__CaptureB1InterruptEnable
PWM capture B1 interrupt

enumerator kPWM__CaptureA0InterruptEnable
PWM capture A0 interrupt

enumerator kPWM__CaptureA1InterruptEnable
PWM capture A1 interrupt

enumerator kPWM__ReloadInterruptEnable
PWM reload interrupt

enumerator kPWM__ReloadErrorInterruptEnable
PWM reload error interrupt

enumerator kPWM__Fault0InterruptEnable
PWM fault 0 interrupt

enumerator kPWM__Fault1InterruptEnable
PWM fault 1 interrupt

enumerator kPWM__Fault2InterruptEnable
PWM fault 2 interrupt

enumerator kPWM__Fault3InterruptEnable
PWM fault 3 interrupt

enum __pwm_status_flags
List of PWM status flags.

Values:

enumerator kPWM__CompareVal0Flag
PWM VAL0 compare flag

enumerator kPWM__CompareVal1Flag
PWM VAL1 compare flag

enumerator kPWM__CompareVal2Flag
PWM VAL2 compare flag

enumerator kPWM__CompareVal3Flag

PWM VAL3 compare flag

enumerator kPWM__CompareVal4Flag

PWM VAL4 compare flag

enumerator kPWM__CompareVal5Flag

PWM VAL5 compare flag

enumerator kPWM__CaptureX0Flag

PWM capture X0 flag

enumerator kPWM__CaptureX1Flag

PWM capture X1 flag

enumerator kPWM__CaptureB0Flag

PWM capture B0 flag

enumerator kPWM__CaptureB1Flag

PWM capture B1 flag

enumerator kPWM__CaptureA0Flag

PWM capture A0 flag

enumerator kPWM__CaptureA1Flag

PWM capture A1 flag

enumerator kPWM__ReloadFlag

PWM reload flag

enumerator kPWM__ReloadErrorFlag

PWM reload error flag

enumerator kPWM__RegUpdatedFlag

PWM registers updated flag

enumerator kPWM__Fault0Flag

PWM fault 0 flag

enumerator kPWM__Fault1Flag

PWM fault 1 flag

enumerator kPWM__Fault2Flag

PWM fault 2 flag

enumerator kPWM__Fault3Flag

PWM fault 3 flag

enum __pwm_dma_enable

List of PWM DMA options.

Values:

enumerator kPWM__CaptureX0DMAEnable

PWM capture X0 DMA

enumerator kPWM__CaptureX1DMAEnable

PWM capture X1 DMA

enumerator kPWM__CaptureB0DMAEnable

PWM capture B0 DMA

enumerator kPWM_CaptureB1DMAEnable

PWM capture B1 DMA

enumerator kPWM_CaptureA0DMAEnable

PWM capture A0 DMA

enumerator kPWM_CaptureA1DMAEnable

PWM capture A1 DMA

enum __pwm_dma_source_select

List of PWM capture DMA enable source select.

Values:

enumerator kPWM_DMAResourceDisable

Read DMA requests disabled

enumerator kPWM_DMAWatermarksEnable

Exceeding a FIFO watermark sets the DMA read request

enumerator kPWM_DMALocalSync

A local sync (VAL1 matches counter) sets the read DMA request

enumerator kPWM_DMALocalReload

A local reload (STS[RF] being set) sets the read DMA request

enum __pwm_watermark_control

PWM FIFO Watermark AND Control.

Values:

enumerator kPWM_FIFOWatermarksOR

Selected FIFO watermarks are OR'ed together

enumerator kPWM_FIFOWatermarksAND

Selected FIFO watermarks are AND'ed together

enum __pwm_mode

PWM operation mode.

Values:

enumerator kPWM_SignedCenterAligned

Signed center-aligned

enumerator kPWM_CenterAligned

Unsigned center-aligned

enumerator kPWM_SignedEdgeAligned

Signed edge-aligned

enumerator kPWM_EdgeAligned

Unsigned edge-aligned

enum __pwm_level_select

PWM output pulse mode, high-true or low-true.

Values:

enumerator kPWM_HighTrue

High level represents “on” or “active” state

enumerator kPWM_LowTrue

Low level represents “on” or “active” state

enum `_pwm_fault_state`

PWM output fault status.

Values:

enumerator `kPWM_PwmFaultState0`

Output is forced to logic 0 state prior to consideration of output polarity control.

enumerator `kPWM_PwmFaultState1`

Output is forced to logic 1 state prior to consideration of output polarity control.

enumerator `kPWM_PwmFaultState2`

Output is tristated.

enumerator `kPWM_PwmFaultState3`

Output is tristated.

enum `_pwm_reload_source_select`

PWM reload source select.

Values:

enumerator `kPWM_LocalReload`

The local reload signal is used to reload registers

enumerator `kPWM_MasterReload`

The master reload signal (from submodule 0) is used to reload

enum `_pwm_fault_clear`

PWM fault clearing options.

Values:

enumerator `kPWM_Automatic`

Automatic fault clearing

enumerator `kPWM_ManualNormal`

Manual fault clearing with no fault safety mode

enumerator `kPWM_ManualSafety`

Manual fault clearing with fault safety mode

enum `_pwm_module_control`

Options for submodule master control operation.

Values:

enumerator `kPWM_Control_Module_0`

Control submodule 0's start/stop,buffer reload operation

enumerator `kPWM_Control_Module_1`

Control submodule 1's start/stop,buffer reload operation

enumerator `kPWM_Control_Module_2`

Control submodule 2's start/stop,buffer reload operation

enumerator `kPWM_Control_Module_3`

Control submodule 3's start/stop,buffer reload operation

typedef enum `_pwm_submodule` `pwm_submodule_t`

List of PWM submodules.

typedef enum `_pwm_channels` `pwm_channels_t`

List of PWM channels in each module.

`typedef enum _pwm_value_register` `pwm_value_register_t`

List of PWM value registers.

`typedef enum _pwm_clock_source` `pwm_clock_source_t`

PWM clock source selection.

`typedef enum _pwm_clock_prescale` `pwm_clock_prescale_t`

PWM prescaler factor selection for clock source.

`typedef enum _pwm_force_output_trigger` `pwm_force_output_trigger_t`

Options that can trigger a PWM FORCE_OUT.

`typedef enum _pwm_output_state` `pwm_output_state_t`

PWM channel output status.

`typedef enum _pwm_init_source` `pwm_init_source_t`

PWM counter initialization options.

`typedef enum _pwm_load_frequency` `pwm_load_frequency_t`

PWM load frequency selection.

`typedef enum _pwm_fault_input` `pwm_fault_input_t`

List of PWM fault selections.

`typedef enum _pwm_fault_disable` `pwm_fault_disable_t`

List of PWM fault disable mapping selections.

`typedef enum _pwm_fault_channels` `pwm_fault_channels_t`

List of PWM fault channels.

`typedef enum _pwm_input_capture_edge` `pwm_input_capture_edge_t`

PWM capture edge select.

`typedef enum _pwm_force_signal` `pwm_force_signal_t`

PWM output options when a FORCE_OUT signal is asserted.

`typedef enum _pwm_chnl_pair_operation` `pwm_chnl_pair_operation_t`

Options available for the PWM A & B pair operation.

`typedef enum _pwm_register_reload` `pwm_register_reload_t`

Options available on how to load the buffered-registers with new values.

`typedef enum _pwm_fault_recovery_mode` `pwm_fault_recovery_mode_t`

Options available on how to re-enable the PWM output when recovering from a fault.

`typedef enum _pwm_interrupt_enable` `pwm_interrupt_enable_t`

List of PWM interrupt options.

`typedef enum _pwm_status_flags` `pwm_status_flags_t`

List of PWM status flags.

`typedef enum _pwm_dma_enable` `pwm_dma_enable_t`

List of PWM DMA options.

`typedef enum _pwm_dma_source_select` `pwm_dma_source_select_t`

List of PWM capture DMA enable source select.

`typedef enum _pwm_watermark_control` `pwm_watermark_control_t`

PWM FIFO Watermark AND Control.

`typedef enum _pwm_mode` `pwm_mode_t`

PWM operation mode.

```
typedef enum _pwm_level_select pwm_level_select_t
```

PWM output pulse mode, high-true or low-true.

```
typedef enum _pwm_fault_state pwm_fault_state_t
```

PWM output fault status.

```
typedef enum _pwm_reload_source_select pwm_reload_source_select_t
```

PWM reload source select.

```
typedef enum _pwm_fault_clear pwm_fault_clear_t
```

PWM fault clearing options.

```
typedef enum _pwm_module_control pwm_module_control_t
```

Options for submodule master control operation.

```
typedef struct _pwm_signal_param pwm_signal_param_t
```

Structure for the user to define the PWM signal characteristics.

```
typedef struct _pwm_config pwm_config_t
```

PWM config structure.

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

The config struct can be made const so it resides in flash

```
typedef struct _pwm_fault_input_filter_param pwm_fault_input_filter_param_t
```

Structure for the user to configure the fault input filter.

```
typedef struct _pwm_fault_param pwm_fault_param_t
```

Structure is used to hold the parameters to configure a PWM fault.

```
typedef struct _pwm_input_capture_param pwm_input_capture_param_t
```

Structure is used to hold parameters to configure the capture capability of a signal pin.

```
void PWM_SetupInputCapture(PWM_Type *base, pwm_submodule_t subModule,  
                           pwm_channels_t pwmChannel, const  
                           pwm_input_capture_param_t *inputCaptureParams)
```

Sets up the PWM input capture.

Each PWM submodule has 3 pins that can be configured for use as input capture pins. This function sets up the capture parameters for each pin and enables the pin for input capture operation.

Parameters

- `base` – PWM peripheral base address
- `subModule` – PWM submodule to configure
- `pwmChannel` – Channel in the submodule to setup
- `inputCaptureParams` – Parameters passed in to set up the input pin

```
void PWM_SetupFaultInputFilter(PWM_Type *base, const pwm_fault_input_filter_param_t  
                              *faultInputFilterParams)
```

Sets up the PWM fault input filter.

Parameters

- `base` – PWM peripheral base address
- `faultInputFilterParams` – Parameters passed in to set up the fault input filter.

```
void PWM_SetupFaults(PWM_Type *base, pwm_fault_input_t faultNum, const  
                    pwm_fault_param_t *faultParams)
```

Sets up the PWM fault protection.

PWM has 4 fault inputs.

Parameters

- base – PWM peripheral base address
- faultNum – PWM fault to configure.
- faultParams – Pointer to the PWM fault config structure

```
void PWM_FaultDefaultConfig(pwm_fault_param_t *config)
```

Fill in the PWM fault config struct with the default settings.

The default values are:

```
config->faultClearingMode = kPWM_Automatic;  
config->faultLevel = false;  
config->enableCombinationalPath = true;  
config->recoverMode = kPWM_NoRecovery;
```

Parameters

- config – Pointer to user's PWM fault config structure.

```
void PWM_SetupForceSignal(PWM_Type *base, pwm_submodule_t subModule, pwm_channels_t  
                          pwmChannel, pwm_force_signal_t mode)
```

Selects the signal to output on a PWM pin when a FORCE_OUT signal is asserted.

The user specifies which channel to configure by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel to configure
- mode – Signal to output when a FORCE_OUT is triggered

```
static inline void PWM_SetVALxValue(PWM_Type *base, pwm_submodule_t subModule,  
                                    pwm_value_register_t valueRegister, uint16_t value)
```

Set the PWM VALx registers.

This function allows the user to write value into VAL registers directly. And it will destroying the PWM clock period set by the PWM_SetupPwm()/PWM_SetupPwmPhaseShift() functions. Due to VALx registers are buffered, the new value will not active unless call PWM_SetPwmLdok() and the reload point is reached.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegister – VALx register that will be written new value
- value – Value that will be written into VALx register

```
static inline uint16_t PWM_GetVALxValue(PWM_Type *base, pwm_submodule_t subModule,  
                                         pwm_value_register_t valueRegister)
```

Get the PWM VALx registers.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegister – VALx register that will be read value

Returns

The VALx register value

```
static inline void PWM__OutputTriggerEnable(PWM_Type *base, pwm_submodule_t subModule,  
                                           pwm_value_register_t valueRegister, bool activate)
```

Enables or disables the PWM output trigger.

This function allows the user to enable or disable the PWM trigger. The PWM has 2 triggers. Trigger 0 is activated when the counter matches VAL 0, VAL 2, or VAL 4 register. Trigger 1 is activated when the counter matches VAL 1, VAL 3, or VAL 5 register.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegister – Value register that will activate the trigger
- activate – true: Enable the trigger; false: Disable the trigger

```
static inline void PWM__ActivateOutputTrigger(PWM_Type *base, pwm_submodule_t subModule,  
                                             uint16_t valueRegisterMask)
```

Enables the PWM output trigger.

This function allows the user to enable one or more (VAL0-5) PWM trigger.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegisterMask – Value register mask that will activate one or more (VAL0-5) trigger enumeration *_pwm_value_register_mask*

```
static inline void PWM__DeactivateOutputTrigger(PWM_Type *base, pwm_submodule_t  
                                              subModule, uint16_t valueRegisterMask)
```

Disables the PWM output trigger.

This function allows the user to disables one or more (VAL0-5) PWM trigger.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- valueRegisterMask – Value register mask that will Deactivate one or more (VAL0-5) trigger enumeration *_pwm_value_register_mask*

```
static inline void PWM__SetupSwCtrlOut(PWM_Type *base, pwm_submodule_t subModule,  
                                       pwm_channels_t pwmChannel, bool value)
```

Sets the software control output for a pin to high or low.

The user specifies which channel to modify by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – Channel to configure

- value – true: Supply a logic 1, false: Supply a logic 0.

```
static inline void PWM_SetPwmLdok(PWM_Type *base, uint8_t subModulesToUpdate, bool value)
```

Sets or clears the PWM LDOK bit on a single or multiple submodules.

Set LDOK bit to load buffered values into CTRL[PRSC] and the INIT, FRACVAL and VAL registers. The values are loaded immediately if kPWM_ReloadImmediate option was chosen during config. Else the values are loaded at the next PWM reload point. This function can issue the load command to multiple submodules at the same time.

Parameters

- base – PWM peripheral base address
- subModulesToUpdate – PWM submodules to update with buffered values. This is a logical OR of members of the enumeration `pwm_module_control_t`
- value – true: Set LDOK bit for the submodule list; false: Clear LDOK bit

```
static inline void PWM_SetPwmFaultState(PWM_Type *base, pwm_submodule_t submodule, pwm_channels_t pwmChannel, pwm_fault_state_t faultState)
```

Set PWM output fault status.

These bits determine the fault state for the PWM_A output in fault conditions and STOP mode. It may also define the output state in WAIT and DEBUG modes depending on the settings of CTRL2[WAITEN] and CTRL2[DBGEN]. This function can update PWM output fault status.

Parameters

- base – PWM peripheral base address
- submodule – PWM submodule to configure
- pwmChannel – Channel to configure
- faultState – PWM output fault status

```
static inline void PWM_SetupFaultDisableMap(PWM_Type *base, pwm_submodule_t submodule, pwm_channels_t pwmChannel, pwm_fault_channels_t pwm_fault_channels, uint16_t value)
```

Set PWM fault disable mapping.

Each of the four bits of this read/write field is one-to-one associated with the four FAULTx inputs of fault channel 0/1. The PWM output will be turned off if there is a logic 1 on an FAULTx input and a 1 in the corresponding bit of this field. A reset sets all bits in this field.

Parameters

- base – PWM peripheral base address
- submodule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- pwm_fault_channels – PWM fault channel to configure
- value – Fault disable mapping mask value enumeration `pwm_fault_disable_t`

```
static inline void PWM_OutputEnable(PWM_Type *base, pwm_channels_t pwmChannel, pwm_submodule_t submodule)
```

Set PWM output enable.

This feature allows the user to enable the PWM Output. Recommend to invoke this API after PWM and fault configuration. But invoke this API before configure MCTRL register is okay, such as set LDOK or start timer.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure

```
static inline void PWM_OutputDisable(PWM_Type *base, pwm_channels_t pwmChannel,  
                                     pwm_submodule_t subModule)
```

Set PWM output disable.

This feature allows the user to disable the PWM output. Recommend to invoke this API after PWM and fault configuration. But invoke this API before configure MCTRL register is okay, such as set LDOK or start timer.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure

```
uint8_t PWM_GetPwmChannelState(PWM_Type *base, pwm_submodule_t subModule,  
                               pwm_channels_t pwmChannel)
```

Get the dutycycle value.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure

Returns

Current channel dutycycle value.

```
status_t PWM_SetOutputToIdle(PWM_Type *base, pwm_channels_t pwmChannel,  
                             pwm_submodule_t subModule, bool idleStatus)
```

Set PWM output in idle status (high or low).

Note: This API should call after PWM_SetupPwm() APIs, and PWMX submodule is not supported.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure
- idleStatus – True: PWM output is high in idle status; false: PWM output is low in idle status.

Returns

kStatus_Fail if there was error setting up the signal; kStatus_Success if set output idle success

```
void PWM_SetClockMode(PWM_Type *base, pwm_submodule_t subModule,  
                     pwm_clock_prescale_t prescaler)
```

Set the pwm submodule prescaler.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- prescaler – Set prescaler value

```
void PWM_SetPwmForceOutputToZero(PWM_Type *base, pwm_submodule_t subModule,  
                                 pwm_channels_t pwmChannel, bool forcetozero)
```

This function enables-disables the forcing of the output of a given eFlexPwm channel to logic 0.

Parameters

- base – PWM peripheral base address
- pwmChannel – PWM channel to configure
- subModule – PWM submodule to configure
- forcetozero – True: Enable the pwm force output to zero; False: Disable the pwm output resumes normal function.

```
void PWM_SetChannelOutput(PWM_Type *base, pwm_submodule_t subModule,  
                          pwm_channels_t pwmChannel, pwm_output_state_t outputstate)
```

This function set the output state of the PWM pin as requested for the current cycle.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- outputstate – Set pwm output state, see *pwm_output_state_t*.

```
status_t PWM_SetPhaseDelay(PWM_Type *base, pwm_channels_t pwmChannel,  
                           pwm_submodule_t subModule, uint16_t delayCycles)
```

This function set the phase delay from the master sync signal of submodule 0.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- delayCycles – Number of cycles delayed from submodule 0.

Returns

kStatus_Fail if the number of delay cycles is set larger than the period defined in submodule 0; kStatus_Success if set phase delay success

```
static inline void PWM_SetFilterSampleCount(PWM_Type *base, pwm_channels_t pwmChannel,  
                                           pwm_submodule_t subModule, uint8_t  
                                           filterSampleCount)
```

This function set the number of consecutive samples that must agree prior to the input filter.

Parameters

- base – PWM peripheral base address

- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- filterSampleCount – Number of consecutive samples.

```
static inline void PWM_SetFilterSamplePeriod(PWM_Type *base, pwm_channels_t pwmChannel,
                                             pwm_submodule_t subModule, uint8_t
                                             filterSamplePeriod)
```

This function set the sampling period of the fault pin input filter.

Parameters

- base – PWM peripheral base address
- subModule – PWM submodule to configure
- pwmChannel – PWM channel to configure
- filterSamplePeriod – Sampling period of input filter.

```
PWM_SUBMODULE_SWCONTROL_WIDTH
```

Number of bits per submodule for software output control

```
PWM_SUBMODULE_CHANNEL
```

Submodule channels include PWMA, PWMB, PWMX.

```
struct __pwm_signal_param
```

#include <fsl_pwm.h> Structure for the user to define the PWM signal characteristics.

Public Members

```
pwm_channels_t pwmChannel
```

PWM channel being configured; PWM A or PWM B

```
uint8_t dutyCyclePercent
```

PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)...
100=always active signal (100% duty cycle)

```
pwm_level_select_t level
```

PWM output active level select

```
uint16_t deadtimeValue
```

The deadtime value; only used if channel pair is operating in complementary mode

```
pwm_fault_state_t faultState
```

PWM output fault status

```
bool pwmchannelenable
```

Enable PWM output

```
struct __pwm_config
```

#include <fsl_pwm.h> PWM config structure.

This structure holds the configuration settings for the PWM peripheral. To initialize this structure to reasonable defaults, call the PWM_GetDefaultConfig() function and pass a pointer to your config structure instance.

The config struct can be made const so it resides in flash

Public Members

`bool enableDebugMode`

true: PWM continues to run in debug mode; false: PWM is paused in debug mode

`pwm_init_source_t` initializationControl

Option to initialize the counter

`pwm_clock_source_t` clockSource

Clock source for the counter

`pwm_clock_prescale_t` prescale

Pre-scaler to divide down the clock

`pwm_chnl_pair_operation_t` pairOperation

Channel pair in independent or complementary mode

`pwm_register_reload_t` reloadLogic

PWM Reload logic setup

`pwm_reload_source_select_t` reloadSelect

Reload source select

`pwm_load_frequency_t` reloadFrequency

Specifies when to reload, used when user's choice is not immediate reload

`pwm_force_output_trigger_t` forceTrigger

Specify which signal will trigger a FORCE_OUT

`struct __pwm_fault_input_filter_param`

`#include <fsl_pwm.h>` Structure for the user to configure the fault input filter.

Public Members

`uint8_t faultFilterCount`

Fault filter count

`uint8_t faultFilterPeriod`

Fault filter period; value of 0 will bypass the filter

`bool faultGlitchStretch`

Fault Glitch Stretch Enable: A logic 1 means that input fault signals will be stretched to at least 2 IPBus clock cycles

`struct __pwm_fault_param`

`#include <fsl_pwm.h>` Structure is used to hold the parameters to configure a PWM fault.

Public Members

`pwm_fault_clear_t` faultClearingMode

Fault clearing mode to use

`bool faultLevel`

true: Logic 1 indicates fault; false: Logic 0 indicates fault

`bool enableCombinationalPath`

true: Combinational Path from fault input is enabled; false: No combination path is available

pwm_fault_recovery_mode_t recoverMode

Specify when to re-enable the PWM output

struct *_pwm_input_capture_param*

#include <fsl_pwm.h> Structure is used to hold parameters to configure the capture capability of a signal pin.

Public Members

bool captureInputSel

true: Use the edge counter signal as source false: Use the raw input signal from the pin as source

uint8_t edgeCompareValue

Compare value, used only if edge counter is used as source

pwm_input_capture_edge_t edge0

Specify which edge causes a capture for input circuitry 0

pwm_input_capture_edge_t edge1

Specify which edge causes a capture for input circuitry 1

bool enableOneShotCapture

true: Use one-shot capture mode; false: Use free-running capture mode

uint8_t fifoWatermark

Watermark level for capture FIFO. The capture flags in the status register will set if the word count in the FIFO is greater than this watermark level

2.111 QTMR: Quad Timer Driver

void QTMR_Init(TMR_Type *base, *qtmr_channel_selection_t* channel, const *qtmr_config_t* *config)

Ungates the Quad Timer clock and configures the peripheral for basic operation.

Note: This API should be called at the beginning of the application using the Quad Timer driver.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- config – Pointer to user's Quad Timer config structure

void QTMR_Deinit(TMR_Type *base, *qtmr_channel_selection_t* channel)

Stops the counter and gates the Quad Timer clock.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

void QTMR_GetDefaultConfig(*qtmr_config_t* *config)

Fill in the Quad Timer config struct with the default settings.

The default values are:

```
config->debugMode = kQTMR_RunNormalInDebug;
config->enableExternalForce = false;
config->enableMasterMode = false;
config->faultFilterCount = 0;
config->faultFilterPeriod = 0;
config->primarySource = kQTMR_ClockDivide_2;
config->secondarySource = kQTMR_Counter0InputPin;
```

Parameters

- config – Pointer to user's Quad Timer config structure.

void QTMR_EnableInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Enables the selected Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration *qtmr_interrupt_enable_t*

void QTMR_DisableInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t mask)

Disables the selected Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration *qtmr_interrupt_enable_t*

uint32_t QTMR_GetEnabledInterrupts(TMR_Type *base, *qtmr_channel_selection_t* channel)

Gets the enabled Quad Timer interrupts.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

The enabled interrupts. This is the logical OR of members of the enumeration *qtmr_interrupt_enable_t*

uint32_t QTMR_GetStatus(TMR_Type *base, *qtmr_channel_selection_t* channel)

Gets the Quad Timer status flags.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

The status flags. This is the logical OR of members of the enumeration *qtmr_status_flags_t*

```
void QTMR_ClearStatusFlags(TMR_Type *base, qtmr_channel_selection_t channel, uint32_t mask)
```

Clears the Quad Timer status flags.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The status flags to clear. This is a logical OR of members of the enumeration `qtmr_status_flags_t`

```
void QTMR_SetTimerPeriod(TMR_Type *base, qtmr_channel_selection_t channel, uint16_t ticks)
```

Sets the timer period in ticks.

Timers counts from initial value till it equals the count value set here. The counter will then reinitialize to the value specified in the Load register.

Note:

- a. This function will write the time period in ticks to COMP1 or COMP2 register depending on the count direction
 - b. User can call the utility macros provided in `fsl_common.h` to convert to ticks
 - c. This function supports cases, providing only primary source clock without secondary source clock.
-

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- ticks – Timer period in units of ticks

```
void QTMR_SetCompareValue(TMR_Type *base, qtmr_channel_selection_t channel, uint16_t ticks)
```

Set compare value.

This function sets the value used for comparison with the counter value.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- ticks – Timer period in units of ticks.

```
static inline void QTMR_SetLoadValue(TMR_Type *base, qtmr_channel_selection_t channel, uint16_t value)
```

Set load value.

This function sets the value used to initialize the counter after a counter comparison.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- value – Load register initialization value.


```
static inline uint16_t QTMR_GetCurrentTimerCount(TMR_Type *base, qtmr_channel_selection_t channel)
```

Reads the current timer counting value.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: User can call the utility macros provided in `fsl_common.h` to convert ticks to usec or msec

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current counter value in ticks

```
static inline void QTMR_StartTimer(TMR_Type *base, qtmr_channel_selection_t channel, qtmr_counting_mode_t clockSource)
```

Starts the Quad Timer counter.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- clockSource – Quad Timer clock source

```
static inline void QTMR_StopTimer(TMR_Type *base, qtmr_channel_selection_t channel)
```

Stops the Quad Timer counter.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

```
void QTMR_EnableDma(TMR_Type *base, qtmr_channel_selection_t channel, uint32_t mask)
```

Enable the Quad Timer DMA.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The DMA to enable. This is a logical OR of members of the enumeration `qtmr_dma_enable_t`

```
void QTMR_DisableDma(TMR_Type *base, qtmr_channel_selection_t channel, uint32_t mask)
```

Disable the Quad Timer DMA.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- mask – The DMA to enable. This is a logical OR of members of the enumeration `qtmr_dma_enable_t`

```
void QTMR_SetPwmOutputToIdle(TMR_Type *base, qtmr_channel_selection_t channel, bool
                             idleStatus)
```

Set PWM output in idle status (high or low).

Note: When the PWM is set again, the counting needs to be restarted.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- idleStatus – True: PWM output is high in idle status; false: PWM output is low in idle status.

```
static inline qtmr_pwm_out_state_t QTMR_GetPwmOutputStatus(TMR_Type *base,
                                                           qtmr_channel_selection_t
                                                           channel)
```

Get the channel output status.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current channel output status.

```
uint8_t QTMR_GetPwmChannelStatus(TMR_Type *base, qtmr_channel_selection_t channel)
```

Get the PWM channel dutycycle value.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number

Returns

Current channel dutycycle value.

```
void QTMR_SetPwmClockMode(TMR_Type *base, qtmr_channel_selection_t channel,
                          qtmr_primary_count_source_t prescaler)
```

This function set the value of the prescaler on QTimer channels.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- prescaler – Set prescaler value

```
FSL_QTMR_DRIVER_VERSION
```

Version

```
enum __qtmr_primary_count_source
```

Quad Timer primary clock source selection.

Values:

```
enumerator kQTMR_ClockCounter0InputPin
```

Use counter 0 input pin

enumerator kQTMR__ClockCounter1InputPin

Use counter 1 input pin

enumerator kQTMR__ClockCounter2InputPin

Use counter 2 input pin

enumerator kQTMR__ClockCounter3InputPin

Use counter 3 input pin

enumerator kQTMR__ClockCounter0Output

Use counter 0 output

enumerator kQTMR__ClockCounter1Output

Use counter 1 output

enumerator kQTMR__ClockCounter2Output

Use counter 2 output

enumerator kQTMR__ClockCounter3Output

Use counter 3 output

enumerator kQTMR__ClockDivide__1

IP bus clock divide by 1 prescaler

enumerator kQTMR__ClockDivide__2

IP bus clock divide by 2 prescaler

enumerator kQTMR__ClockDivide__4

IP bus clock divide by 4 prescaler

enumerator kQTMR__ClockDivide__8

IP bus clock divide by 8 prescaler

enumerator kQTMR__ClockDivide__16

IP bus clock divide by 16 prescaler

enumerator kQTMR__ClockDivide__32

IP bus clock divide by 32 prescaler

enumerator kQTMR__ClockDivide__64

IP bus clock divide by 64 prescaler

enumerator kQTMR__ClockDivide__128

IP bus clock divide by 128 prescaler

enum __qtmr_input_source

Quad Timer input sources selection.

Values:

enumerator kQTMR__Counter0InputPin

Use counter 0 input pin

enumerator kQTMR__Counter1InputPin

Use counter 1 input pin

enumerator kQTMR__Counter2InputPin

Use counter 2 input pin

enumerator kQTMR__Counter3InputPin

Use counter 3 input pin

enum _qtmr_counting_mode

Quad Timer counting mode selection.

Values:

enumerator kQTMR_NoOperation

No operation

enumerator kQTMR_PriSrcRiseEdge

Count rising edges of primary source

enumerator kQTMR_PriSrcRiseAndFallEdge

Count rising and falling edges of primary source

enumerator kQTMR_PriSrcRiseEdgeSecInpHigh

Count rise edges of pri SRC while sec inp high active

enumerator kQTMR_QuadCountMode

Quadrature count mode, uses pri and sec sources

enumerator kQTMR_PriSrcRiseEdgeSecDir

Count rising edges of pri SRC; sec SRC specifies dir

enumerator kQTMR_SecSrcTrigPriCnt

Edge of sec SRC trigger primary count until compare

enumerator kQTMR_CascadeCount

Cascaded count mode (up/down)

enum _qtmr_pwm_out_state

Quad Timer PWM output state.

Values:

enumerator kQTMR_PwmLow

The output state of PWM channel is low

enumerator kQTMR_PwmHigh

The output state of PWM channel is low

enum _qtmr_output_mode

Quad Timer output mode selection.

Values:

enumerator kQTMR_AssertWhenCountActive

Assert OFLAG while counter is active

enumerator kQTMR_ClearOnCompare

Clear OFLAG on successful compare

enumerator kQTMR_SetOnCompare

Set OFLAG on successful compare

enumerator kQTMR_ToggleOnCompare

Toggle OFLAG on successful compare

enumerator kQTMR_ToggleOnAltCompareReg

Toggle OFLAG using alternating compare registers

enumerator kQTMR_SetOnCompareClearOnSecSrcInp

Set OFLAG on compare, clear on sec SRC input edge

enumerator kQTMR_SetOnCompareClearOnCountRoll
Set OFLAG on compare, clear on counter rollover

enumerator kQTMR_EnableGateClock
Enable gated clock output while count is active

enum __qtmr_input_capture_edge
Quad Timer input capture edge mode, rising edge, or falling edge.

Values:

enumerator kQTMR_NoCapture
Capture is disabled

enumerator kQTMR_RisingEdge
Capture on rising edge (IPS=0) or falling edge (IPS=1)

enumerator kQTMR_FallingEdge
Capture on falling edge (IPS=0) or rising edge (IPS=1)

enumerator kQTMR_RisingAndFallingEdge
Capture on both edges

enum __qtmr_preload_control
Quad Timer input capture edge mode, rising edge, or falling edge.

Values:

enumerator kQTMR_NoPreload
Never preload

enumerator kQTMR_LoadOnComp1
Load upon successful compare with value in COMP1

enumerator kQTMR_LoadOnComp2
Load upon successful compare with value in COMP2

enum __qtmr_debug_action
List of Quad Timer run options when in Debug mode.

Values:

enumerator kQTMR_RunNormalInDebug
Continue with normal operation

enumerator kQTMR_HaltCounter
Halt counter

enumerator kQTMR_ForceOutToZero
Force output to logic 0

enumerator kQTMR_HaltCountForceOutZero
Halt counter and force output to logic 0

enum __qtmr_interrupt_enable
List of Quad Timer interrupts.

Values:

enumerator kQTMR_CompareInterruptEnable
Compare interrupt.

enumerator kQTMR_Compare1InterruptEnable
Compare 1 interrupt.

enumerator kQTMR_Compare2InterruptEnable

Compare 2 interrupt.

enumerator kQTMR_OverflowInterruptEnable

Timer overflow interrupt.

enumerator kQTMR_EdgeInterruptEnable

Input edge interrupt.

enum __qtmr_status_flags

List of Quad Timer flags.

Values:

enumerator kQTMR_CompareFlag

Compare flag

enumerator kQTMR_Compare1Flag

Compare 1 flag

enumerator kQTMR_Compare2Flag

Compare 2 flag

enumerator kQTMR_OverflowFlag

Timer overflow flag

enumerator kQTMR_EdgeFlag

Input edge flag

enum __qtmr_channel_selection

List of channel selection.

Values:

enumerator kQTMR_Channel_0

TMR Channel 0

enumerator kQTMR_Channel_1

TMR Channel 1

enumerator kQTMR_Channel_2

TMR Channel 2

enumerator kQTMR_Channel_3

TMR Channel 3

enum __qtmr_dma_enable

List of Quad Timer DMA enable.

Values:

enumerator kQTMR_InputEdgeFlagDmaEnable

Input Edge Flag DMA Enable.

enumerator kQTMR_ComparatorPreload1DmaEnable

Comparator Preload Register 1 DMA Enable.

enumerator kQTMR_ComparatorPreload2DmaEnable

Comparator Preload Register 2 DMA Enable.

typedef enum __qtmr_primary_count_source qtmr_primary_count_source_t

Quad Timer primary clock source selection.

typedef enum *_qtmr_input_source* qtmr_input_source_t

Quad Timer input sources selection.

typedef enum *_qtmr_counting_mode* qtmr_counting_mode_t

Quad Timer counting mode selection.

typedef enum *_qtmr_pwm_out_state* qtmr_pwm_out_state_t

Quad Timer PWM output state.

typedef enum *_qtmr_output_mode* qtmr_output_mode_t

Quad Timer output mode selection.

typedef enum *_qtmr_input_capture_edge* qtmr_input_capture_edge_t

Quad Timer input capture edge mode, rising edge, or falling edge.

typedef enum *_qtmr_preload_control* qtmr_preload_control_t

Quad Timer input capture edge mode, rising edge, or falling edge.

typedef enum *_qtmr_debug_action* qtmr_debug_action_t

List of Quad Timer run options when in Debug mode.

typedef enum *_qtmr_interrupt_enable* qtmr_interrupt_enable_t

List of Quad Timer interrupts.

typedef enum *_qtmr_status_flags* qtmr_status_flags_t

List of Quad Timer flags.

typedef enum *_qtmr_channel_selection* qtmr_channel_selection_t

List of channel selection.

typedef enum *_qtmr_dma_enable* qtmr_dma_enable_t

List of Quad Timer DMA enable.

typedef struct *_qtmr_config* qtmr_config_t

Quad Timer config structure.

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

The config struct can be made const so it resides in flash

status_t QTMR_SetupPwm(TMR_Type *base, *qtmr_channel_selection_t* channel, uint32_t pwmFreqHz, uint8_t dutyCyclePercent, bool outputPolarity, uint32_t srcClock_Hz)

Sets up Quad timer module for PWM signal output.

The function initializes the timer module according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- pwmFreqHz – PWM signal frequency in Hz
- dutyCyclePercent – PWM pulse width, value should be between 0 to 100
0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)
- outputPolarity – true: invert polarity of the output signal, false: no inversion
- srcClock_Hz – Main counter clock in Hz.

Returns

Returns an error if there was error setting up the signal.

```
void QTMR_SetupInputCapture(TMR_Type *base, qtmr_channel_selection_t channel,
                           qtmr_input_source_t capturePin, bool inputPolarity, bool
                           reloadOnCapture, qtmr_input_capture_edge_t captureMode)
```

Allows the user to count the source clock cycles until a capture event arrives.

The count is stored in the capture register.

Parameters

- base – Quad Timer peripheral base address
- channel – Quad Timer channel number
- capturePin – Pin through which we receive the input signal to trigger the capture
- inputPolarity – true: invert polarity of the input signal, false: no inversion
- reloadOnCapture – true: reload the counter when an input capture occurs, false: no reload
- captureMode – Specifies which edge of the input signal triggers a capture

TMR_CSCTRL_OFLAG_MASK

TMR_CSCTRL_OFLAG_SHIFT

```
struct __qtmr_config
```

#include <fsl_qtmr.h> Quad Timer config structure.

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

The config struct can be made const so it resides in flash

Public Members

qtmr_primary_count_source_t primarySource

Specify the primary count source

qtmr_input_source_t secondarySource

Specify the secondary count source

bool enableMasterMode

true: Broadcast compare function output to other counters; false no broadcast

bool enableExternalForce

true: Compare from another counter force state of OFLAG signal false: OFLAG controlled by local counter

uint8_t faultFilterCount

Fault filter count

uint8_t faultFilterPeriod

Fault filter period; value of 0 will bypass the filter

qtmr_debug_action_t debugMode

Operation in Debug mode

2.112 RGPIO: Rapid General-Purpose Input/Output Driver

FSL_RGPIODRIVER_VERSION

RGPIO driver version 2.1.0.

enum _rgpio_pin_direction

RGPIO direction definition.

Values:

enumerator kRGPIO_DigitalInput

Set current pin as digital input

enumerator kRGPIO_DigitalOutput

Set current pin as digital output

enum _rgpio_checker_attribute

RGPIO checker attribute.

Values:

enumerator kRGPIO_UsernonsecureRWUsersecureRWPrivilegedsecureRW

User nonsecure:Read+Write; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureRUsersecureRWPrivilegedsecureRW

User nonsecure:Read; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureNUsersecureRWPrivilegedsecureRW

User nonsecure:None; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureRUsersecureRPrivilegedsecureRW

User nonsecure:Read; User Secure:Read; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureNUsersecureRPrivilegedsecureRW

User nonsecure:None; User Secure:Read; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureNUsersecureNPrivilegedsecureRW

User nonsecure:None; User Secure:None; Privileged Secure:Read+Write

enumerator kRGPIO_UsernonsecureNUsersecureNPrivilegedsecureR

User nonsecure:None; User Secure:None; Privileged Secure:Read

enumerator kRGPIO_UsernonsecureNUsersecureNPrivilegedsecureN

User nonsecure:None; User Secure:None; Privileged Secure:None

enumerator kRGPIO_IgnoreAttributeCheck

Ignores the attribute check

enum _rgpio_interrupt_sel

Configures the interrupt generation condition.

Values:

enumerator kRGPIO_InterruptOutput0

Interrupt/DMA request/trigger output 0.

enumerator kRGPIO_InterruptOutput1

Interrupt/DMA request/trigger output 1.

enumerator kRGPIO_InterruptOutput2

Interrupt/DMA request/trigger output 2.

enumerator kRGPIO_InterruptOutput3
Interrupt/DMA request/trigger output 3.

enum _rgpio_interrupt_config
Configures the interrupt generation condition.

Values:

enumerator kRGPIO_InterruptOrDMADisabled
Interrupt/DMA request is disabled.

enumerator kRGPIO_DMARisingEdge
DMA request on rising edge.

enumerator kRGPIO_DMAFallingEdge
DMA request on falling edge.

enumerator kRGPIO_DMAEitherEdge
DMA request on either edge.

enumerator kRGPIO_FlagRisingEdge
Flag sets on rising edge.

enumerator kRGPIO_FlagFallingEdge
Flag sets on falling edge.

enumerator kRGPIO_FlagEitherEdge
Flag sets on either edge.

enumerator kRGPIO_InterruptLogicZero
Interrupt when logic zero.

enumerator kRGPIO_InterruptRisingEdge
Interrupt on rising edge.

enumerator kRGPIO_InterruptFallingEdge
Interrupt on falling edge.

enumerator kRGPIO_InterruptEitherEdge
Interrupt on either edge.

enumerator kRGPIO_InterruptLogicOne
Interrupt when logic one.

enumerator kRGPIO_ActiveHighTriggerOutputEnable
Enable active high-trigger output.

enumerator kRGPIO_ActiveLowTriggerOutputEnable
Enable active low-trigger output.

typedef enum _rgpio_pin_direction rgpio_pin_direction_t
RGPIO direction definition.

typedef enum _rgpio_checker_attribute rgpio_checker_attribute_t
RGPIO checker attribute.

typedef enum _rgpio_interrupt_sel rgpio_interrupt_sel_t
Configures the interrupt generation condition.

typedef enum _rgpio_interrupt_config rgpio_interrupt_config_t
Configures the interrupt generation condition.

```
typedef struct _rgpio_pin_config rgpio_pin_config_t
```

The RGPIO 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().

```
struct _rgpio_pin_config
```

#include <fsl_rgpio.h> The RGPIO 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

rgpio_pin_direction_t pinDirection

RGPIO direction, input or output

uint8_t outputLogic

Set a default output logic, which has no use in input

2.113 RGPIO Driver

```
void RGPIO_PinInit(RGPIO_Type *base, uint32_t pin, const rgpio_pin_config_t *config)
```

Initializes a RGPIO pin used by the board.

To initialize the RGPIO, define a pin configuration, as either input or output, in the user file. Then, call the RGPIO_PinInit() function.

This is an example to define an input pin or an output pin configuration.

```
Define a digital input pin configuration,
rgpio_pin_config_t config =
{
    kRGPIO_DigitalInput,
    0,
}
Define a digital output pin configuration,
rgpio_pin_config_t config =
{
    kRGPIO_DigitalOutput,
    0,
}
```

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- pin – RGPIO port pin number
- config – RGPIO pin configuration pointer

```
uint32_t RGPIO_GetInstance(RGPIO_Type *base)
```

Gets the RGPIO instance according to the RGPIO base.

Parameters

- base – RGPIO peripheral base pointer(PTA, PTB, PTC, etc.)

Return values

RGPIO – instance

```
static inline void RGPIO_PinWrite(RGPIO_Type *base, uint32_t pin, uint8_t output)
```

Sets the output level of the multiple RGPIO pins to the logic 1 or 0.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- pin – RGPIO pin number
- output – RGPIO pin output logic level.
 - 0: corresponding pin output low-logic level.
 - 1: corresponding pin output high-logic level.

```
static inline void RGPIO_WritePinOutput(RGPIO_Type *base, uint32_t pin, uint8_t output)
```

Sets the output level of the multiple RGPIO pins to the logic 1 or 0.

Deprecated:

Do not use this function. It has been superceded by RGPIO_PinWrite.

```
static inline void RGPIO_PortSet(RGPIO_Type *base, uint32_t mask)
```

Sets the output level of the multiple RGPIO pins to the logic 1.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro

```
static inline void RGPIO_SetPinsOutput(RGPIO_Type *base, uint32_t mask)
```

Sets the output level of the multiple RGPIO pins to the logic 1.

Deprecated:

Do not use this function. It has been superceded by RGPIO_PortSet.

```
static inline void RGPIO_PortClear(RGPIO_Type *base, uint32_t mask)
```

Sets the output level of the multiple RGPIO pins to the logic 0.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro

```
static inline void RGPIO_ClearPinsOutput(RGPIO_Type *base, uint32_t mask)
```

Sets the output level of the multiple RGPIO pins to the logic 0.

Deprecated:

Do not use this function. It has been superceded by RGPIO_PortClear.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro

```
static inline void RGPIO_PortToggle(RGPIO_Type *base, uint32_t mask)
```

Reverses the current output logic of the multiple RGPIO pins.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro

```
static inline void RGPIO_TogglePinsOutput(RGPIO_Type *base, uint32_t mask)
```

Reverses the current output logic of the multiple RGPIO pins.

Deprecated:

Do not use this function. It has been superceded by RGPIO_PortToggle.

```
static inline uint32_t RGPIO_PinRead(RGPIO_Type *base, uint32_t pin)
```

Reads the current input value of the RGPIO port.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- pin – RGPIO pin number

Return values

RGPIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

```
static inline uint32_t RGPIO_ReadPinInput(RGPIO_Type *base, uint32_t pin)
```

Reads the current input value of the RGPIO port.

Deprecated:

Do not use this function. It has been superceded by RGPIO_PinRead.

```
static inline void RGPIO_EnablePortInput(RGPIO_Type *base, uint32_t mask, bool enable)
```

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number mask
- enable – RGPIO digital input enable/disable flag.

```
void RGPIO_CheckAttributeBytes(RGPIO_Type *base, rgpio_checker_attribute_t attribute)
```

The RGPIO module supports a device-specific number of data ports, organized as 32-bit words. Each 32-bit data port includes a GACR register, which defines the byte-level attributes required for a successful access to the RGPIO programming model. The attribute controls for the 4 data bytes in the GACR follow a standard little endian data convention.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro

```
static inline void RGPIO_SetPinInterruptConfig(RGPIO_Type *base, uint32_t pin,  
                                              rgpio_interrupt_sel_t sel,  
                                              rgpio_interrupt_config_t config)
```

Configures the gpio pin interrupt/DMA request.

Parameters

- base – RGPIO peripheral base pointer.
- pin – RGPIO pin number.
- sel – RGPIO pin interrupt selection(0-3).
- config – RGPIO pin interrupt configuration.

```
static inline void __SetMultipleInterruptPinsConfig(RGPIO_Type *base, uint32_t mask,  
                                                  rgpio_interrupt_sel_t sel,  
                                                  rgpio_interrupt_config_t config)
```

Sets the gpio interrupt configuration in ICR register for multiple pins.

Parameters

- base – RGPIO peripheral base pointer (RGPIOA, RGPIOB, RGPIOC, and so on.)
- mask – RGPIO pin number macro.
- sel – RGPIO pin interrupt selection(0-3).
- config – RGPIO pin interrupt configuration.

```
static inline uint32_t RGPIO_GetPinsInterruptFlags(RGPIO_Type *base, rgpio_interrupt_sel_t sel)
```

Reads the whole gpio 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 – RGPIO peripheral base pointer.
- sel – RGPIO pin interrupt selection(0-3).

Returns

Current gpio interrupt status flags, for example, 0x00010001 means the pin 0 and 16 have the interrupt.

```
static inline void RGPIO_ClearPinsInterruptFlags(RGPIO_Type *base, rgpio_interrupt_sel_t sel,  
                                                uint32_t mask)
```

Clears the multiple pin interrupt status flag.

Parameters

- base – RGPIO peripheral base pointer.
- sel – RGPIO pin interrupt selection(0-3).
- mask – RGPIO pin number macro.

2.114 Romapi

Flash Pad Definitions.

Values:

enumerator kSerialFlash_1Pad

1-wire communication

enumerator kSerialFlash_2Pads

2-wire communication

enumerator kSerialFlash_4Pads

4-wire communication

enumerator kSerialFlash_8Pads

8-wire communication

FLEXSPI clock configuration type.

Values:

enumerator kFLEXSPIClk_SDR

Clock configure for SDR mode

enumerator kFLEXSPIClk_DDR

Clock configure for DDR mode

enum _flexspi_read_sample_clk

FLEXSPI Read Sample Clock Source definition.

Values:

enumerator kFLEXSPIReadSampleClk_LoopbackInternally

FLEXSPI Read Sample Clock Source from the Internal loopback

enumerator kFLEXSPIReadSampleClk_LoopbackFromDqsPad

FLEXSPI Read Sample Clock Source from the Dqs Pad loopback

enumerator kFLEXSPIReadSampleClk_LoopbackFromSckPad

FLEXSPI Read Sample Clock Source from the Sck Pad loopback

enumerator kFLEXSPIReadSampleClk_ExternalInputFromDqsPad

FLEXSPI Read Sample Clock Source from the External Input by the Dqs Pad

Flash Type Definition.

Values:

enumerator kFLEXSPIDeviceType_SerialNOR

Flash device is Serial NOR

Flash Configuration Command Type.

Values:

enumerator kDeviceConfigCmdType_Generic

Generic command, for example: configure dummy cycles, drive strength, etc.

enumerator kDeviceConfigCmdType_QuadEnable

Quad Enable command

enumerator kDeviceConfigCmdType_Spi2Xpi

Switch from SPI to DPI/QPI/OPI mode

enumerator kDeviceConfigCmdType_Xpi2Spi

Switch from DPI/QPI/OPI to SPI mode

enumerator kDeviceConfigCmdType_Spi2NoCmd

Switch to 0-4-4/0-8-8 mode

enumerator kDeviceConfigCmdType_Reset

Reset device command

enum _flexspi_serial_clk_freq

Definitions for FLEXSPI Serial Clock Frequency.

Values:

enumerator kFLEXSPISerialClk_NoChange

FlexSPI serial clock no changed

enumerator kFLEXSPISerialClk_30MHz

FlexSPI serial clock 30MHz

enumerator kFLEXSPISerialClk_50MHz

FlexSPI serial clock 50MHz

enumerator kFLEXSPISerialClk_60MHz

FlexSPI serial clock 60MHz

enumerator kFLEXSPISerialClk_75MHz

FlexSPI serial clock 75MHz

enumerator kFLEXSPISerialClk_80MHz

FlexSPI serial clock 80MHz

enumerator kFLEXSPISerialClk_100MHz

FlexSPI serial clock 100MHz

enumerator kFLEXSPISerialClk_133MHz

FlexSPI serial clock 133MHz

enumerator kFLEXSPISerialClk_166MHz

FlexSPI serial clock 166MHz

Misc feature bit definitions.

Values:

enumerator kFLEXSPIMiscOffset_DiffClkEnable

Bit for Differential clock enable

enumerator kFLEXSPIMiscOffset_Ck2Enable

Bit for CK2 enable

enumerator kFLEXSPIMiscOffset_ParallelEnable

Bit for Parallel mode enable

enumerator kFLEXSPIMiscOffset_WordAddressableEnable

Bit for Word Addressable enable

enumerator kFLEXSPIMiscOffset_SafeConfigFreqEnable

Bit for Safe Configuration Frequency enable

enumerator kFLEXSPIMiscOffset_PadSettingOverrideEnable

Bit for Pad setting override enable

enumerator kFLEXSPIMiscOffset_DdrModeEnable

Bit for DDR clock configuration indication.

enumerator kFLEXSPIMiscOffset_UseValidTimeForAllFreq

Bit for DLLCR settings under all modes

Manufacturer ID.

Values:

enumerator kSerialFlash_ISSI_ManufacturerID

Manufacturer ID of the ISSI serial flash

enumerator kSerialFlash_Adesto_ManufacturerID

Manufacturer ID of the Adesto Technologies serial flash

enumerator kSerialFlash_Winbond_ManufacturerID

Manufacturer ID of the Winbond serial flash

enumerator kSerialFlash_Cypress_ManufacturerID

Manufacturer ID for Cypress

enum _flexspi_nor_status

ROM FLEXSPI NOR flash status.

Values:

enumerator kStatus_ROM_FLEXSPI_SequenceExecutionTimeout

Status for Sequence Execution timeout

enumerator kStatus_ROM_FLEXSPI_InvalidSequence

Status for Invalid Sequence

enumerator kStatus_ROM_FLEXSPI_DeviceTimeout

Status for Device timeout

enumerator kStatus_ROM_FLEXSPINOR_SFDP_NotFound

Status for SFDP read failure

enumerator kStatus_ROM_FLEXSPINOR_Flash_NotFound

Status for Flash detection failure

enumerator kStatus_FLEXSPINOR_DTRRead_DummyProbeFailed

Status for DDR Read dummy probe failure

enum _flexspi_operation

FLEXSPI Operation Context.

Values:

enumerator kFLEXSPIOperation_Command

FLEXSPI operation: Only command, both TX and RX buffer are ignored.

enumerator kFLEXSPIOperation_Config

FLEXSPI operation: Configure device mode, the TX FIFO size is fixed in LUT.

enumerator kFLEXSPIOperation_Write

FLEXSPI operation: Write, only TX buffer is effective

enumerator kFLEXSPIOperation_Read

FLEXSPI operation: Read, only Rx Buffer is effective.

typedef struct *_flexspi_lut_seq* flexspi_lut_seq_t

FLEXSPI LUT Sequence structure.

typedef struct *_flexspi_mem_config* flexspi_mem_config_t

FLEXSPI Memory Configuration Block.

typedef struct *_flexspi_nor_config* flexspi_nor_config_t

Serial NOR configuration block.

typedef enum *_flexspi_operation* flexspi_operation_t

FLEXSPI Operation Context.

typedef struct *_flexspi_xfer* flexspi_xfer_t

FLEXSPI Transfer Context.

void ROM_API_Init(void)

ROM API init.

Get the bootloader api entry address.

kFLEXSPIOperation_End

MISRA_CAST(to_type, to_var, from_type, from_var)

convert the type for MISRA

typedef struct *_serial_nor_config_option* serial_nor_config_option_t

Serial NOR Configuration Option.

void ROM_RunBootloader(void *arg)

Enter Bootloader.

Parameters

- arg – A pointer to the storage for the bootloader param. refer to System Boot Chapter in device reference manual for details.

status_t ROM_FLEXSPI_NorFlash_GetConfig(uint32_t instance, *flexspi_nor_config_t* *config, *serial_nor_config_option_t* *option)

Get FLEXSPI NOR Configuration Block based on specified option.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- option – A pointer to the storage Serial NOR Configuration Option Context.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Init(uint32_t instance, *flexspi_nor_config_t* *config)

Initialize Serial NOR devices via FLEXSPI.

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

Parameters

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

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_ProgramPage(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t dst_addr, const uint32_t *src)

Program data to Serial NOR via FLEXSPI.

This function programs the NOR flash memory with the dest address for a given flash area as determined by the dst address and the length.

Note: It is recommended that use page aligned access; If the dst_addr is not aligned to page, the driver automatically aligns address down with the page address.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- dst_addr – A pointer to the desired flash memory to be programmed.
- src – A pointer to the source buffer of data that is to be programmed into the NOR flash.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Read(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t *dst, uint32_t start, uint32_t lengthInBytes)

Read data from Serial NOR via FLEXSPI.

This function read the NOR flash memory with the start address for a given flash area as determined by the dst address and the length.

Note: It is recommended that use page aligned access; If the dstAddr is not aligned to page, the driver automatically aligns address down with the page address.

Parameters

- instance – storage the instance of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- dst – A pointer to the dest buffer of data that is to be read from the NOR flash.
- start – The start address of the desired NOR flash memory to be read.
- lengthInBytes – The length, given in bytes to be read.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

status_t ROM_FLEXSPI_NorFlash_Erase(uint32_t instance, *flexspi_nor_config_t* *config, uint32_t start, uint32_t length)

Erase Flash Region specified by address and length.

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

Note: It is recommended that use sector-aligned access nor device; If dstAddr is not aligned with the sector, the driver automatically aligns address down with the sector address.

Note: It is recommended that use sector-aligned access nor device; If length is not aligned with the sector, the driver automatically aligns up with the sector.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.
- length – The length, given in bytes to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

```
status_t ROM_FLEXSPI_NorFlash_EraseSector(uint32_t instance, flexspi_nor_config_t *config,
                                           uint32_t start)
```

Erase one sector specified by address.

This function erases one of NOR flash sectors based on the desired address.

Note: It is recommended that use sector-aligned access nor device; If dstAddr is not aligned with the sector, the driver automatically aligns address down with the sector address.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

```
status_t ROM_FLEXSPI_NorFlash_EraseBlock(uint32_t instance, flexspi_nor_config_t *config,
                                           uint32_t start)
```

Erase one block specified by address.

This function erases one block of NOR flash based on the desired address.

Note: It is recommended that use block-aligned access nor device; If dstAddr is not aligned with the block, the driver automatically aligns address down with the block address.

Parameters

- instance – storage the index of FLEXSPI.
- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired NOR flash memory to be erased.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_DeviceTimeout – the device timeout

```
status_t ROM_FLEXSPI_NorFlash_EraseAll(uint32_t instance, flexspi_nor_config_t *config)
```

Erase all the Serial NOR devices connected on FLEXSPI.

Parameters

- instance – storage the instance of FLEXSPI.

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

Return values

- `kStatus_Success` – Api was executed successfully.
- `kStatus_InvalidArgument` – A invalid argument is provided.
- `kStatus_ROM_FLEXSPI_InvalidSequence` – A invalid Sequence is provided.
- `kStatus_ROM_FLEXSPI_SequenceExecutionTimeout` – Sequence Execution timeout.
- `kStatus_ROM_FLEXSPI_DeviceTimeout` – the device timeout

status_t ROM_FLEXSPI_NorFlash_CommandXfer(uint32_t instance, flexspi_xfer_t *xfer)
FLEXSPI command.

This function is used to perform the command write sequence to the NOR device.

Parameters

- `instance` – storage the index of FLEXSPI.
- `xfer` – A pointer to the storage FLEXSPI Transfer Context.

Return values

- `kStatus_Success` – Api was executed successfully.
- `kStatus_InvalidArgument` – A invalid argument is provided.
- `kStatus_ROM_FLEXSPI_InvalidSequence` – A invalid Sequence is provided.
- `kStatus_ROM_FLEXSPI_SequenceExecutionTimeout` – Sequence Execution timeout.

status_t ROM_FLEXSPI_NorFlash_UpdateLut(uint32_t instance, uint32_t seqIndex, const
uint32_t *lutBase, uint32_t seqNumber)

Configure FLEXSPI Lookup table.

Parameters

- `instance` – storage the index of FLEXSPI.
- `seqIndex` – storage the sequence Id.
- `lutBase` – A pointer to the look-up-table for command sequences.
- `seqNumber` – storage sequence number.

Return values

- `kStatus_Success` – Api was executed successfully.
- `kStatus_InvalidArgument` – A invalid argument is provided.
- `kStatus_ROM_FLEXSPI_InvalidSequence` – A invalid Sequence is provided.
- `kStatus_ROM_FLEXSPI_SequenceExecutionTimeout` – Sequence Execution timeout.

status_t ROM_FLEXSPI_NorFlash_WaitBusy(uint32_t instance, flexspi_nor_config_t *config,
bool isParallelMode, uint32_t address)

Wait until device is idle.

Parameters

- `instance` – Indicates the index of FLEXSPI.
- `config` – A pointer to the storage for the driver runtime state
- `isParallelMode` – Indicates whether NOR flash is in parallel mode.

- address – Indicates the operation(erase/program/read) address for serial NOR flash.

Return values

- kStatus_Success – Api was executed successfully.
- kStatus_InvalidArgument – A invalid argument is provided.
- kStatus_ROM_FLEXSPI_SequenceExecutionTimeout – Sequence Execution timeout.
- kStatus_ROM_FLEXSPI_InvalidSequence – A invalid Sequence is provided.
- kStatus_ROM_FLEXSPI_DeviceTimeout – Device timeout.

void ROM_FLEXSPI_NorFlash_ClearCache(uint32_t instance)

Software reset for the FLEXSPI logic.

This function sets the software reset flags for both AHB and buffer domain and resets both AHB buffer and also IP FIFOs.

Parameters

- instance – storage the index of FLEXSPI.

FSL_ROM_HAS_FLEXSPINOR_API

ROM has FLEXSPI NOR API.

FSL_ROM_HAS_RUNBOOTLOADER_API

ROM has run bootloader API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_GET_CONFIG

ROM has FLEXSPI NOR get config API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_FLASH_INIT

ROM has flash init API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE

ROM has erase API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_SECTOR

ROM has erase sector API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_BLOCK

ROM has erase block API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_ERASE_ALL

ROM has erase all API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_READ

ROM has read API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_UPDATE_LUT

ROM has update lut API.

FSL_ROM_FLEXSPINOR_API_HAS_FEATURE_CMD_XFER

ROM has FLEXSPI command API.

kROM_StatusGroup_FLEXSPINOR

ROM FLEXSPI NOR status group number.

FSL_ROM_FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)

FSL_ROM_FLEXSPI_BITMASK(bit_offset)

Generate bit mask.

FLEXSPI_CFG_BLK_TAG

FLEXSPI memory config block related definitions.

ascii “FCFB” Big Endian

FLEXSPI_CFG_BLK_VERSION

V1.4.0

CMD_SDR

CMD_DDR

RADDR_SDR

RADDR_DDR

CADDR_SDR

CADDR_DDR

MODE1_SDR

MODE1_DDR

MODE2_SDR

MODE2_DDR

MODE4_SDR

MODE4_DDR

MODE8_SDR

MODE8_DDR

WRITE_SDR

WRITE_DDR

READ_SDR

READ_DDR

LEARN_SDR

LEARN_DDR

DATSZ_SDR

DATSZ_DDR

DUMMY_SDR

DUMMY_DDR

DUMMY_RWDS_SDR

DUMMY_RWDS_DDR

JMP_ON_CS

STOP

FLEXSPI_1PAD

FLEXSPI_2PAD

FLEXSPI_4PAD

FLEXSPI_8PAD

NOR_CMD_LUT_SEQ_IDX_READ

NOR LUT sequence index used for default LUT assignment.

Note: It will take effect if the lut sequences are not customized. READ LUT sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_READSTATUS

Read Status LUT sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_READSTATUS_XPI

Read status DPI/QPI/OPI sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_WRITEENABLE

Write Enable sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_WRITEENABLE_XPI

Write Enable DPI/QPI/OPI sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_ERASESECTOR

Erase Sector sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_READID

NOR_CMD_LUT_SEQ_IDX_ERASEBLOCK

Erase Block sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_PAGEPROGRAM

Program sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_CHIPERASE

Chip Erase sequence in lookupTable id stored in config block

NOR_CMD_LUT_SEQ_IDX_READ_SFDP

Read SFDP sequence in lookupTable id stored in config block

NOR_CMD_LUT_SEQ_IDX_RESTORE_NOCMD

Restore 0-4-4/0-8-8 mode sequence id in lookupTable stored in config block

NOR_CMD_LUT_SEQ_IDX_EXIT_NOCMD

Exit 0-4-4/0-8-8 mode sequence id in lookupTable stored in config block

uint32_t max_freq

Maximum supported Frequency

uint32_t misc_mode

miscellaneous mode

uint32_t quad_mode_setting

Quad mode setting

uint32_t cmd_pads

Command pads

uint32_t query_pads

SFDP read pads

uint32_t device_type
Device type

uint32_t option_size
Option size, in terms of uint32_t, size = (option_size + 1) * 4

uint32_t tag
Tag, must be 0x0E

struct *_serial_nor_config_option* B

uint32_t U

union *_serial_nor_config_option* option0

uint32_t dummy_cycles
Dummy cycles before read

uint32_t status_override
Override status register value during device mode configuration

uint32_t pinmux_group
The pinmux group selection

uint32_t dqs_pinmux_group
The DQS Pinmux Group Selection

uint32_t drive_strength
The Drive Strength of FlexSPI Pads

uint32_t flash_connection
Flash connection option: 0 - Single Flash connected to port A, 1 - Parallel mode, 2 - Single Flash connected to Port B

struct *_serial_nor_config_option* B

uint32_t U

union *_serial_nor_config_option* option1

uint8_t seqNum
Sequence Number, valid number: 1-16

uint8_t seqId
Sequence Index, valid number: 0-15

uint16_t reserved

uint8_t time_100ps
Data valid time, in terms of 100ps

uint8_t delay_cells
Data valid time, in terms of delay cells

uint32_t tag
[0x000-0x003] Tag, fixed value 0x42464346UL

uint32_t version
[0x004-0x007] Version, [31:24] - 'V', [23:16] - Major, [15:8] - Minor, [7:0] - bugfix

uint32_t reserved0
[0x008-0x00b] Reserved for future use

uint8_t readSampleClkSrc

[0x00c-0x00c] Read Sample Clock Source, valid value: 0/1/3

uint8_t csHoldTime

[0x00d-0x00d] Data hold time, default value: 3

uint8_t csSetupTime

[0x00e-0x00e] Data setup time, default value: 3

uint8_t columnAddressWidth

[0x00f-0x00f] Column Address width, for HyperBus protocol, it is fixed to 3, For Serial NAND, need to refer to datasheet

uint8_t deviceModeCfgEnable

[0x010-0x010] Device Mode Configure enable flag, 1 - Enable, 0 - Disable

uint8_t deviceModeType

[0x011-0x011] Specify the configuration command type: Quad Enable, DPI/QPI/OPI switch, Generic configuration, etc.

uint16_t waitTimeCfgCommands

[0x012-0x013] Wait time for all configuration commands, unit: 100us, Used for DPI/QPI/OPI switch or reset command

flexspi_lut_seq_t deviceModeSeq

[0x014-0x017] Device mode sequence info, [7:0] - LUT sequence id, [15:8] - LUT sequence number, [31:16] Reserved

uint32_t deviceModeArg

[0x018-0x01b] Argument/Parameter for device configuration

uint8_t configCmdEnable

[0x01c-0x01c] Configure command Enable Flag, 1 - Enable, 0 - Disable

uint8_t configModeType[3]

[0x01d-0x01f] Configure Mode Type, similar as deviceModeType

flexspi_lut_seq_t configCmdSeqs[3]

[0x020-0x02b] Sequence info for Device Configuration command, similar as deviceModeSeq

uint32_t reserved1

[0x02c-0x02f] Reserved for future use

uint32_t configCmdArgs[3]

[0x030-0x03b] Arguments/Parameters for device Configuration commands

uint32_t reserved2

[0x03c-0x03f] Reserved for future use

uint32_t controllerMiscOption

[0x040-0x043] Controller Misc Options, see Misc feature bit definitions for more details

uint8_t deviceType

[0x044-0x044] Device Type: See Flash Type Definition for more details

uint8_t sflashPadType

[0x045-0x045] Serial Flash Pad Type: 1 - Single, 2 - Dual, 4 - Quad, 8 - Octal

uint8_t serialClkFreq

[0x046-0x046] Serial Flash Frequency, device specific definitions. See System Boot Chapter for more details

uint8_t lutCustomSeqEnable

[0x047-0x047] LUT customization Enable, it is required if the program/erase cannot be done using 1 LUT sequence, currently, only applicable to HyperFLASH

uint32_t reserved3[2]

[0x048-0x04f] Reserved for future use

uint32_t sflashA1Size

[0x050-0x053] Size of Flash connected to A1

uint32_t sflashA2Size

[0x054-0x057] Size of Flash connected to A2

uint32_t sflashB1Size

[0x058-0x05b] Size of Flash connected to B1

uint32_t sflashB2Size

[0x05c-0x05f] Size of Flash connected to B2

uint32_t csPadSettingOverride

[0x060-0x063] CS pad setting override value

uint32_t sclkPadSettingOverride

[0x064-0x067] SCK pad setting override value

uint32_t dataPadSettingOverride

[0x068-0x06b] data pad setting override value

uint32_t dqsPadSettingOverride

[0x06c-0x06f] DQS pad setting override value

uint32_t timeoutInMs

[0x070-0x073] Timeout threshold for read status command

uint32_t commandInterval

[0x074-0x077] CS deselect interval between two commands

flexspi_dll_time_t dataValidTime[2]

[0x078-0x07b] CLK edge to data valid time for PORT A and PORT B

uint16_t busyOffset

[0x07c-0x07d] Busy offset, valid value: 0-31

uint16_t busyBitPolarity

[0x07e-0x07f] Busy flag polarity, 0 - busy flag is 1 when flash device is busy, 1 - busy flag is 0 when flash device is busy

uint32_t lookupTable[64]

[0x080-0x17f] Lookup table holds Flash command sequences

flexspi_lut_seq_t lutCustomSeq[12]

[0x180-0x1af] Customizable LUT Sequences

uint32_t reserved4[4]

[0x1b0-0x1bf] Reserved for future use

flexspi_mem_config_t memConfig

Common memory configuration info via FLEXSPI

uint32_t pageSize

Page size of Serial NOR

uint32_t sectorSize

Sector size of Serial NOR

uint8_t ipcmdSerialClkFreq

Clock frequency for IP command

uint8_t isUniformBlockSize

Sector/Block size is the same

uint8_t isDataOrderSwapped

Data order (D0, D1, D2, D3) is swapped (D1,D0, D3, D2)

uint8_t reserved0[1]

Reserved for future use

uint8_t serialNorType

Serial NOR Flash type: 0/1/2/3

uint8_t needExitNoCmdMode

Need to exit NoCmd mode before other IP command

uint8_t halfClkForNonReadCmd

Half the Serial Clock for non-read command: true/false

uint8_t needRestoreNoCmdMode

Need to Restore NoCmd mode after IP command execution

uint32_t blockSize

Block size

uint32_t reserve2[11]

Reserved for future use

flexspi_operation_t operation

FLEXSPI operation

uint32_t baseAddress

FLEXSPI operation base address

uint32_t seqId

Sequence Id

uint32_t seqNum

Sequence Number

bool isParallelModeEnable

Is a parallel transfer

uint32_t *txBuffer

Tx buffer

uint32_t txSize

Tx size in bytes

uint32_t *rxBuffer

Rx buffer

uint32_t rxSize

Rx size in bytes

FSL_ROM_ROMAPI_VERSION

ROM API version 1.1.2.

FSL_ROM_FLEXSPINOR_DRIVER_VERSION

ROM FLEXSPI NOR driver version 1.7.0.

struct _serial_nor_config_option

#include <fsl_romapi.h> Serial NOR Configuration Option.

struct _flexspi_lut_seq

#include <fsl_romapi.h> FLEXSPI LUT Sequence structure.

struct flexspi_dll_time_t

#include <fsl_romapi.h> FLEXSPI DLL time.

struct _flexspi_mem_config

#include <fsl_romapi.h> FLEXSPI Memory Configuration Block.

struct _flexspi_nor_config

#include <fsl_romapi.h> Serial NOR configuration block.

struct _flexspi_xfer

#include <fsl_romapi.h> FLEXSPI Transfer Context.

union option0

Public Members

struct _serial_nor_config_option B

uint32_t U

struct B

Public Members

uint32_t max_freq

Maximum supported Frequency

uint32_t misc_mode

miscellaneous mode

uint32_t quad_mode_setting

Quad mode setting

uint32_t cmd_pads

Command pads

uint32_t query_pads

SFDP read pads

uint32_t device_type

Device type

uint32_t option_size

Option size, in terms of uint32_t, size = (option_size + 1) * 4

uint32_t tag

Tag, must be 0x0E

union option1

Public Members

struct *_serial_nor_config_option* B

uint32_t U

struct B

Public Members

uint32_t dummy__cycles

Dummy cycles before read

uint32_t status__override

Override status register value during device mode configuration

uint32_t pinmux__group

The pinmux group selection

uint32_t dqs__pinmux__group

The DQS Pinmux Group Selection

uint32_t drive__strength

The Drive Strength of FlexSPI Pads

uint32_t flash__connection

Flash connection option: 0 - Single Flash connected to port A, 1 - Parallel mode, 2 - Single Flash connected to Port B

2.115 RTWDOG: 32-bit Watchdog Timer

void RTWDOG_GetDefaultConfig(*rtwdog_config_t* *config)

Initializes the RTWDOG configuration structure.

This function initializes the RTWDOG configuration structure to default values. The default values are:

```
rtwdogConfig->enableRtwdog = true;
rtwdogConfig->clockSource = kRTWDOG_ClockSource1;
rtwdogConfig->prescaler = kRTWDOG_ClockPrescalerDivide1;
rtwdogConfig->workMode.enableWait = true;
rtwdogConfig->workMode.enableStop = false;
rtwdogConfig->workMode.enableDebug = false;
rtwdogConfig->testMode = kRTWDOG_TestModeDisabled;
rtwdogConfig->enableUpdate = true;
rtwdogConfig->enableInterrupt = false;
rtwdogConfig->enableWindowMode = false;
rtwdogConfig->windowValue = 0U;
rtwdogConfig->timeoutValue = 0xFFFFU;
```

See also:

rtwdog_config_t

Parameters

- config – Pointer to the RTWDOG configuration structure.

AT_QUICKACCESS_SECTION_CODE (void RTWDOG_Init(RTWDOG_Type *base,
const rtwdog_config_t *config))

Initializes the RTWDOG module.

This function initializes the RTWDOG. To reconfigure the RTWDOG without forcing a reset first, enableUpdate must be set to true in the configuration.

Example:

```
rtwdog_config_t config;
RTWDOG_GetDefaultConfig(&config);
config.timeoutValue = 0x7ffU;
config.enableUpdate = true;
RTWDOG_Init(wdog_base,&config);
```

Parameters

- base – RTWDOG peripheral base address.
- config – The configuration of the RTWDOG.

void RTWDOG_Deinit(RTWDOG_Type *base)

De-initializes the RTWDOG module.

This function shuts down the RTWDOG. Ensure that the WDOG_CS.UPDATE is 1, which means that the register update is enabled.

Parameters

- base – RTWDOG peripheral base address.

static inline void RTWDOG_Enable(RTWDOG_Type *base)

Enables the RTWDOG module.

This function writes a value into the WDOG_CS register to enable the RTWDOG. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.

static inline void RTWDOG_Disable(RTWDOG_Type *base)

Disables the RTWDOG module.

This function writes a value into the WDOG_CS register to disable the RTWDOG. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address

static inline void RTWDOG_EnableInterrupts(RTWDOG_Type *base, uint32_t mask)

Enables the RTWDOG interrupt.

This function writes a value into the WDOG_CS register to enable the RTWDOG interrupt. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.
- mask – The interrupts to enable. The parameter can be a combination of the following source if defined:
 - kRTWDOG_InterruptEnable


```
static inline void RTWDOG_DisableInterrupts(RTWDOG_Type *base, uint32_t mask)
```

Disables the RTWDOG interrupt.

This function writes a value into the WDOG_CS register to disable the RTWDOG interrupt. The WDOG_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- base – RTWDOG peripheral base address.
- mask – The interrupts to disabled. The parameter can be a combination of the following source if defined:
 - kRTWDOG_InterruptEnable

```
static inline uint32_t RTWDOG_GetStatusFlags(RTWDOG_Type *base)
```

Gets the RTWDOG all status flags.

This function gets all status flags.

Example to get the running flag:

```
uint32_t status;  
status = RTWDOG_GetStatusFlags(wdog_base) & kRTWDOG_RunningFlag;
```

See also:

`_rtwdog_status_flags_t`

- true: related status flag has been set.
- false: related status flag is not set.

Parameters

- base – RTWDOG peripheral base address

Returns

State of the status flag: asserted (true) or not-asserted (false).

```
static inline void RTWDOG_EnableWindowMode(RTWDOG_Type *base, bool enable)
```

Enables/disables the window mode.

Parameters

- base – RTWDOG peripheral base address.
- enable – Enables(true) or disables(false) the feature.

```
static inline uint32_t RTWDOG_CountToMsec(RTWDOG_Type *base, uint32_t count, uint32_t  
                                         clockFreqInHz)
```

Converts raw count value to millisecond.

Note that if the clock frequency is too high the timeout period can be less than 1 ms. In this case this api will return 0 value.

Parameters

- base – RTWDOG peripheral base address.
- count – Raw count value.
- clockFreqInHz – The frequency of the clock source RTWDOG uses.

Returns

Return converted time. Will return 0 if result is larger than 0xFFFFFFFF.

```
void RTWDOG_ClearStatusFlags(RTWDOG_Type *base, uint32_t mask)
```

Clears the RTWDOG flag.

This function clears the RTWDOG status flag.

Example to clear an interrupt flag:

```
RTWDOG_ClearStatusFlags(wdog_base, kRTWDOG_InterruptFlag);
```

Parameters

- `base` – RTWDOG peripheral base address.
- `mask` – The status flags to clear. The parameter can be any combination of the following values:
 - `kRTWDOG_InterruptFlag`

```
static inline void RTWDOG_SetTimeoutValue(RTWDOG_Type *base, uint16_t timeoutCount)
```

Sets the RTWDOG timeout value.

This function writes a timeout value into the WDOG_TOVAL register. The WDOG_TOVAL register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- `base` – RTWDOG peripheral base address
- `timeoutCount` – RTWDOG timeout value, count of RTWDOG clock ticks.

```
static inline void RTWDOG_SetWindowValue(RTWDOG_Type *base, uint16_t windowValue)
```

Sets the RTWDOG window value.

This function writes a window value into the WDOG_WIN register. The WDOG_WIN register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

- `base` – RTWDOG peripheral base address.
- `windowValue` – RTWDOG window value.

```
__STATIC_FORCEINLINE void RTWDOG_Unlock(RTWDOG_Type *base)
```

Unlocks the RTWDOG register written.

This function unlocks the RTWDOG register written.

Before starting the unlock sequence and following the configuration, disable the global interrupts. Otherwise, an interrupt could effectively invalidate the unlock sequence and the WCT may expire. After the configuration finishes, re-enable the global interrupts.

Parameters

- `base` – RTWDOG peripheral base address

```
static inline void RTWDOG_Refresh(RTWDOG_Type *base)
```

Refreshes the RTWDOG timer.

This function feeds the RTWDOG. This function should be called before the Watchdog timer is in timeout. Otherwise, a reset is asserted.

Parameters

- `base` – RTWDOG peripheral base address

static inline uint32_t RTWDOG_GetCounterValue(RTWDOG_Type *base)

Gets the RTWDOG counter value.

This function gets the RTWDOG counter value.

Parameters

- base – RTWDOG peripheral base address.

Returns

Current RTWDOG counter value.

WDOG_FIRST_WORD_OF_UNLOCK

First word of unlock sequence

WDOG_SECOND_WORD_OF_UNLOCK

Second word of unlock sequence

WDOG_FIRST_WORD_OF_REFRESH

First word of refresh sequence

WDOG_SECOND_WORD_OF_REFRESH

Second word of refresh sequence

FSL_RTWDOG_DRIVER_VERSION

RTWDOG driver version.

enum _rtwdog_clock_source

Describes RTWDOG clock source.

Values:

enumerator kRTWDOG_ClockSource0

Clock source 0

enumerator kRTWDOG_ClockSource1

Clock source 1

enumerator kRTWDOG_ClockSource2

Clock source 2

enumerator kRTWDOG_ClockSource3

Clock source 3

enum _rtwdog_clock_prescaler

Describes the selection of the clock prescaler.

Values:

enumerator kRTWDOG_ClockPrescalerDivide1

Divided by 1

enumerator kRTWDOG_ClockPrescalerDivide256

Divided by 256

enum _rtwdog_test_mode

Describes RTWDOG test mode.

Values:

enumerator kRTWDOG_TestModeDisabled

Test Mode disabled

enumerator kRTWDOG_UserModeEnabled

User Mode enabled

enumerator kRTWDOG_LowByteTest

Test Mode enabled, only low byte is used

enumerator kRTWDOG_HighByteTest

Test Mode enabled, only high byte is used

enum _rtwdog_interrupt_enable_t

RTWDOG interrupt configuration structure.

This structure contains the settings for all of the RTWDOG interrupt configurations.

Values:

enumerator kRTWDOG_InterruptEnable

Interrupt is generated before forcing a reset

enum _rtwdog_status_flags_t

RTWDOG status flags.

This structure contains the RTWDOG status flags for use in the RTWDOG functions.

Values:

enumerator kRTWDOG_RunningFlag

Running flag, set when RTWDOG is enabled

enumerator kRTWDOG_InterruptFlag

Interrupt flag, set when interrupt occurs

typedef enum _rtwdog_clock_source rtwdog_clock_source_t

Describes RTWDOG clock source.

typedef enum _rtwdog_clock_prescaler rtwdog_clock_prescaler_t

Describes the selection of the clock prescaler.

typedef struct _rtwdog_work_mode rtwdog_work_mode_t

Defines RTWDOG work mode.

typedef enum _rtwdog_test_mode rtwdog_test_mode_t

Describes RTWDOG test mode.

typedef struct _rtwdog_config rtwdog_config_t

Describes RTWDOG configuration structure.

struct _rtwdog_work_mode

#include <fsl_rtwdog.h> Defines RTWDOG work mode.

Public Members

bool enableWait

Enables or disables RTWDOG in wait mode

bool enableStop

Enables or disables RTWDOG in stop mode

bool enableDebug

Enables or disables RTWDOG in debug mode

struct _rtwdog_config

#include <fsl_rtwdog.h> Describes RTWDOG configuration structure.

Public Members

`bool enableRtwdog`
Enables or disables RTWDOG

`rtwdog_clock_source_t clockSource`
Clock source select

`rtwdog_clock_prescaler_t prescaler`
Clock prescaler value

`rtwdog_work_mode_t workMode`
Configures RTWDOG work mode in debug stop and wait mode

`rtwdog_test_mode_t testMode`
Configures RTWDOG test mode

`bool enableUpdate`
Update write-once register enable

`bool enableInterrupt`
Enables or disables RTWDOG interrupt

`bool enableWindowMode`
Enables or disables RTWDOG window mode

`uint16_t windowValue`
Window value

`uint16_t timeoutValue`
Timeout value

2.116 S3MU: Sentinel

`FSL_S3MU_DRIVER_VERSION`

Defines S3MU driver version 2.0.2.

Change log:

- Version 2.0.2
 - Fix macro BIT redefined warning when compiling with Zephyr.
- Version 2.0.1
 - Update `kStatusGroup_SNT` to `kStatusGroup_ELEMU`
- Version 2.0.0
 - initial version

Values:

enumerator `kStatus_S3MU_AgumentOutOfRange`
S3MU status for out of range access.

enumerator `kStatus_S3MU_InvalidArgument`
S3MU status for invalid argument check.

enumerator `kStatus_S3MU_RequestTimeout`
S3MU status for timeout.

enumerator `kStatus_S3MU_Busy`

S3MU status for reservation by other core.

status_t `S3MU_SendMessage(S3MU_Type *mu, void *buf, size_t wordCount)`

Send message to MU.

This function writes message into MU registers and send message to EdgeLock Enclave.

Parameters

- `base` – MU peripheral base address
- `buf` – buffer to store read data
- `wordCount` – size of data in words

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

status_t `S3MU_GetResponse(S3MU_Type *mu, void *buf)`

Get response from MU.

This function reads response data from EdgeLock Enclave if available.

Note: number of read response word is obtained by header, so user need to prepare buffer with enough space for expected response

Parameters

- `base` – MU peripheral base address
- `buf` – buffer to store read data

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

status_t `S3MU_WaitForData(S3MU_Type *mu, uint32_t *buf, size_t wordCount, uint32_t wait)`

Wait and Read data from MU.

This function waits limited time (ticks) and tests if data are ready to be read. When data are ready, reads them into buffer, timeout otherwise.

Parameters

- `base` – MU peripheral base address
- `buf` – buffer to store read data
- `wordCount` – size of data in words
- `wait` – number of iterations to wait

Returns

Status `kStatus_Success` if success, `kStatus_S3MU_RequestTimeout` if timeout Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

status_t `S3MU_ReadMessage(S3MU_Type *mu, uint32_t *buf, size_t *size, uint8_t read_header)`

Read message from MU.

This function reads message data from EdgeLock Enclave if available.

Parameters

- `base` – MU peripheral base address
- `buf` – buffer to store read data

- `size` – length of data in words. If `read_header` equal `MU_READ_HEADER`, `size` is read from response header.
- `read_header` – specifies if `size` is obtained by response header or provided in parameter.

Returns

Status `kStatus_Success` if success, `kStatus_Fail` if fail Possible errors: `kStatus_S3MU_InvalidArgument`, `kStatus_S3MU_AgumentOutOfRange`

```
void S3MU__Init(S3MU_Type *mu)
```

Init MU.

This function does nothing. MU is initialized after leaving ROM.

Parameters

- `base` – MU peripheral base address

```
uint32_t S3MU__ComputeMsgCrc(uint32_t *msg, uint32_t msg_len)
```

Computes CRC.

This function computes CRC of input message.

Parameters

- `msg` – pointer to message
- `msg_len` – size of message in words

Returns

CRC32 checksum value

```
MU_MSG_HEADER_SIZE
```

```
MESSAGING_TAG_COMMAND
```

```
MESSAGING_TAG_REPLY
```

```
struct mu_hdr_t
```

```
    #include <fsl_s3mu.h>
```

```
union __unnamed224__
```

Public Members

```
uint32_t value
```

```
struct mu_hdr_t hdr_byte
```

```
struct hdr_byte
```

2.117 SAI: Serial Audio Interface

2.118 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.

```
FSL_SAI_DRIVER_VERSION
```

Version 2.4.8

_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

2.119 SAI EDMA Driver

void SAI_TransferTxCreateHandleEDMA(I2S_Type *base, sai_edma_handle_t *handle,
sai_edma_callback_t callback, void *userData,
edma_handle_t *txDmaHandle)

Initializes the SAI eDMA handle.

This function initializes the SAI master DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- txDmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

```
void SAI_TransferRxCreateHandleEDMA(I2S_Type *base, sai_edma_handle_t *handle,
                                   sai_edma_callback_t callback, void *userData,
                                   edma_handle_t *rxDmaHandle)
```

Initializes the SAI Rx eDMA handle.

This function initializes the SAI slave DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- rxDmaHandle – eDMA handle pointer, this handle shall be static allocated by users.

```
void SAI_TransferSetInterleaveType(sai_edma_handle_t *handle, sai_edma_interleave_t
                                   interleaveType)
```

Initializes the SAI interleave type.

This function initializes the SAI DMA handle member interleaveType, it shall be called only when application would like to use type kSAI_EDMAInterleavePerChannelBlock, since the default interleaveType is kSAI_EDMAInterleavePerChannelSample always

Parameters

- handle – SAI eDMA handle pointer.
- interleaveType – Multi channel interleave type.

```
void SAI_TransferTxSetConfigEDMA(I2S_Type *base, sai_edma_handle_t *handle,
                                 sai_transceiver_t *saiConfig)
```

Configures the SAI Tx.

Note: SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of sai_transceiver_t with the corresponding values of _sai_channel_mask enum, enable the FIFO Combine mode by assigning kSAI_FifoCombineModeEnabledOnWrite to the fifoCombine member of sai_fifo_combine_t which is a member of sai_transceiver_t. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_
↪Channel1Mask);
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnWrite;
SAI_TransferTxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

```
void SAI_TransferRxSetConfigEDMA(I2S_Type *base, sai_edma_handle_t *handle,  
                                sai_transceiver_t *saiConfig)
```

Configures the SAI Rx.

Note: SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of sai_transceiver_t with the corresponding values of _sai_channel_mask enum, enable the FIFO Combine mode by assigning kSAI_FifoCombineModeEnabledOnRead to the fifoCombine member of sai_fifo_combine_t which is a member of sai_transceiver_t. This is an example of multi-channel data transfer configuration step.

```
sai_transceiver_t config;  
SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits, kSAI_Stereo, kSAI_Channel0Mask|kSAI_  
↪Channel1Mask);  
config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnRead;  
SAI_TransferRxSetConfigEDMA(I2S0, &edmaHandle, &config);
```

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- saiConfig – sai configurations.

```
status_t SAI_TransferSendEDMA(I2S_Type *base, sai_edma_handle_t *handle, sai_transfer_t  
                             *xfer)
```

Performs a non-blocking SAI transfer using DMA.

This function support multi channel transfer,

- a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
- b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Note: This interface returns immediately after the transfer initiates. Call SAI_GetTransferStatus to poll the transfer status and check whether the SAI transfer is finished.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- `kStatus_Success` – Start a SAI eDMA send successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.
- `kStatus_TxBusy` – SAI is busy sending data.

`status_t SAI_TransferReceiveEDMA(I2S_Type *base, sai_edma_handle_t *handle, sai_transfer_t *xfer)`

Performs a non-blocking SAI receive using eDMA.

This function support multi channel transfer,

- a. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
- b. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Note: This interface returns immediately after the transfer initiates. Call the `SAI_GetReceiveRemainingBytes` to poll the transfer status and check whether the SAI transfer is finished.

Parameters

- `base` – SAI base pointer
- `handle` – SAI eDMA handle pointer.
- `xfer` – Pointer to DMA transfer structure.

Return values

- `kStatus_Success` – Start a SAI eDMA receive successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.
- `kStatus_RxBusy` – SAI is busy receiving data.

`status_t SAI_TransferSendLoopEDMA(I2S_Type *base, sai_edma_handle_t *handle, sai_transfer_t *xfer, uint32_t loopTransferCount)`

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function `SAI_TransferAbortSendEDMA` to stop the loop transfer.

Note: This function support loop transfer only, such as `A->B->...->A`, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in `sai_edma_handle_t`, so application could redefine the `SAI_XFER_QUEUE_SIZE` to determine the proper TCD pool size. This function support one sai channel only.

Parameters

- `base` – SAI base pointer.
- `handle` – SAI eDMA handle pointer.
- `xfer` – Pointer to the DMA transfer structure, should be a array with elements counts ≥ 1 (`loopTransferCount`).
- `loopTransferCount` – the counts of `xfer` array.

Return values

- `kStatus_Success` – Start a SAI eDMA send successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.

`status_t` SAI_TransferReceiveLoopEDMA(I2S_Type *base, *sai_edma_handle_t* *handle, *sai_transfer_t* *xfer, uint32_t loopTransferCount)

Performs a non-blocking SAI loop transfer using eDMA.

Once the loop transfer start, application can use function SAI_TransferAbortReceiveEDMA to stop the loop transfer.

Note: This function support loop transfer only, such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in *sai_edma_handle_t*, so application could redefine the SAI_XFER_QUEUE_SIZE to determine the proper TCD pool size. This function support one sai channel only.

Parameters

- *base* – SAI base pointer.
- *handle* – SAI eDMA handle pointer.
- *xfer* – Pointer to the DMA transfer structure, should be a array with elements counts >=1(loopTransferCount).
- *loopTransferCount* – the counts of *xfer* array.

Return values

- `kStatus_Success` – Start a SAI eDMA receive successfully.
- `kStatus_InvalidArgument` – The input argument is invalid.

`void` SAI_TransferTerminateSendEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Terminate all SAI send.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortSendEDMA.

Parameters

- *base* – SAI base pointer.
- *handle* – SAI eDMA handle pointer.

`void` SAI_TransferTerminateReceiveEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Terminate all SAI receive.

This function will clear all transfer slots buffered in the sai queue. If users only want to abort the current transfer slot, please call SAI_TransferAbortReceiveEDMA.

Parameters

- *base* – SAI base pointer.
- *handle* – SAI eDMA handle pointer.

`void` SAI_TransferAbortSendEDMA(I2S_Type *base, *sai_edma_handle_t* *handle)

Aborts a SAI transfer using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call SAI_TransferTerminateSendEDMA.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferAbortReceiveEDMA(I2S_Type *base, sai_edma_handle_t *handle)

Aborts a SAI receive using eDMA.

This function only aborts the current transfer slots, the other transfer slots' information still kept in the handler. If users want to terminate all transfer slots, just call SAI_TransferTerminateReceiveEDMA.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.

status_t SAI_TransferGetSendCountEDMA(I2S_Type *base, sai_edma_handle_t *handle, size_t *count)

Gets byte count sent by SAI.

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.
- count – Bytes count sent by SAI.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

status_t SAI_TransferGetReceiveCountEDMA(I2S_Type *base, sai_edma_handle_t *handle, size_t *count)

Gets byte count received by SAI.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.
- count – Bytes count received by SAI.

Return values

- kStatus_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is no non-blocking transaction in progress.

uint32_t SAI_TransferGetValidTransferSlotsEDMA(I2S_Type *base, sai_edma_handle_t *handle)

Gets valid transfer slot.

This function can be used to query the valid transfer request slot that the application can submit. It should be called in the critical section, that means the application could call it in the corresponding callback function or disable IRQ before calling it in the application, otherwise, the returned value may not correct.

Parameters

- base – SAI base pointer
- handle – SAI eDMA handle pointer.

Return values

valid – slot count that application submit.

FSL_SAI_EDMA_DRIVER_VERSION

Version 2.7.3

enum _sai_edma_interleave

sai interleave type

Values:

enumerator kSAI_EDMAInterleavePerChannelSample

enumerator kSAI_EDMAInterleavePerChannelBlock

typedef struct *sai_edma_handle* sai_edma_handle_t

typedef void (*sai_edma_callback_t)(I2S_Type *base, *sai_edma_handle_t* *handle, *status_t* status, void *userData)

SAI eDMA transfer callback function for finish and error.

typedef enum *_sai_edma_interleave* sai_edma_interleave_t

sai interleave type

MCUX_SDK_SAI_EDMA_RX_ENABLE_INTERNAL

the SAI enable position When calling SAI_TransferReceiveEDMA

MCUX_SDK_SAI_EDMA_TX_ENABLE_INTERNAL

the SAI enable position When calling SAI_TransferSendEDMA

struct sai_edma_handle

#include <fsl_sai_edma.h> SAI DMA transfer handle, users should not touch the content of the handle.

Public Members

edma_handle_t *dmaHandle

DMA handler for SAI send

uint8_t nbytes

eDMA minor byte transfer count initially configured.

uint8_t bytesPerFrame

Bytes in a frame

uint8_t channelMask

Enabled channel mask value, reference *_sai_channel_mask*

uint8_t channelNums

total enabled channel nums

uint8_t channel

Which data channel

uint8_t count

The transfer data count in a DMA request

uint32_t state

Internal state for SAI eDMA transfer

sai_edma_callback_t callback

Callback for users while transfer finish or error occurs

`void *userData`
User callback parameter

`uint8_t tcd[((4U) + 1U) * sizeof(edma_tcd_t)]`
TCD pool for eDMA transfer.

`sai_transfer_t saiQueue[(4U)]`
Transfer queue storing queued transfer.

`size_t transferSize[(4U)]`
Data bytes need to transfer

`sai_edma_interleave_t interleaveType`
Transfer interleave type

`volatile uint8_t queueUser`
Index for user to queue transfer.

`volatile uint8_t queueDriver`
Index for driver to get the transfer data and size

2.120 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 reseting 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_t 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_GATE_n(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_GATE_n 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.

2.121 SEMC: Smart External DRAM Controller Driver

void SEMC_GetDefaultConfig(*semc_config_t* *config)

Gets the SEMC default basic configuration structure.

The purpose of this API is to get the default SEMC configure structure for SEMC_Init(). User may use the initialized structure unchanged in SEMC_Init(), or modify some fields of the structure before calling SEMC_Init(). Example:

```
semc_config_t config;  
SEMC_GetDefaultConfig(&config);
```

Parameters

- config – The SEMC configuration structure pointer.

`void SEMC_Init(SEMC_Type *base, semc_config_t *configure)`

Initializes SEMC. This function ungates the SEMC clock and initializes SEMC. This function must be called before calling any other SEMC driver functions.

Parameters

- `base` – SEMC peripheral base address.
- `configure` – The SEMC configuration structure pointer.

`void SEMC_Deinit(SEMC_Type *base)`

Deinitializes the SEMC module and gates the clock.

This function gates the SEMC clock. As a result, the SEMC module doesn't work after calling this function, for some IDE, calling this API may cause the next downloading operation failed. so, please call this API cautiously. Additional, users can using “#define FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL (1)” to disable the clock control operation in drivers.

Parameters

- `base` – SEMC peripheral base address.

`status_t SEMC_ConfigureSDRAM(SEMC_Type *base, semc_sdram_cs_t cs, semc_sdram_config_t *config, uint32_t clkSrc_Hz)`

Configures SDRAM controller in SEMC.

Parameters

- `base` – SEMC peripheral base address.
- `cs` – The chip selection.
- `config` – The sdram configuration.
- `clkSrc_Hz` – The SEMC clock frequency.

`status_t SEMC_ConfigureNAND(SEMC_Type *base, semc_nand_config_t *config, uint32_t clkSrc_Hz)`

Configures NAND controller in SEMC.

Parameters

- `base` – SEMC peripheral base address.
- `config` – The nand configuration.
- `clkSrc_Hz` – The SEMC clock frequency.

`status_t SEMC_ConfigureNOR(SEMC_Type *base, semc_nor_config_t *config, uint32_t clkSrc_Hz)`

Configures NOR controller in SEMC.

Parameters

- `base` – SEMC peripheral base address.
- `config` – The nor configuration.
- `clkSrc_Hz` – The SEMC clock frequency.

`status_t SEMC_ConfigureSRAMWithChipSelection(SEMC_Type *base, semc_sram_cs_t cs, semc_sram_config_t *config, uint32_t clkSrc_Hz)`

Configures SRAM controller in SEMC.

Parameters

- `base` – SEMC peripheral base address.
- `cs` – The chip selection.

- config – The sram configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureSRAM(SEMC_Type *base, *semc_sram_config_t* *config, uint32_t clkSrc_Hz)

Configures SRAM controller in SEMC.

Deprecated:

Do not use this function. It has been superseded by SEMC_ConfigureSRAMWithChipSelection.

Parameters

- base – SEMC peripheral base address.
- config – The sram configuration.
- clkSrc_Hz – The SEMC clock frequency.

status_t SEMC_ConfigureDBI(SEMC_Type *base, *semc_dbi_config_t* *config, uint32_t clkSrc_Hz)

Configures DBI controller in SEMC.

Parameters

- base – SEMC peripheral base address.
- config – The dbi configuration.
- clkSrc_Hz – The SEMC clock frequency.

static inline void SEMC_EnableInterrupts(SEMC_Type *base, uint32_t mask)

Enables the SEMC interrupt.

This function enables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See *semc_interrupt_enable_t*. For example, to enable the IP command done and error interrupt, do the following.

```
SEMC_EnableInterrupts(ENET, kSEMC_IPCmdDoneInterrupt | kSEMC_IPCmdErrInterrupt);
```

Parameters

- base – SEMC peripheral base address.
- mask – SEMC interrupts to enable. This is a logical OR of the enumeration :: *semc_interrupt_enable_t*.

static inline void SEMC_DisableInterrupts(SEMC_Type *base, uint32_t mask)

Disables the SEMC interrupt.

This function disables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See *semc_interrupt_enable_t*. For example, to disable the IP command done and error interrupt, do the following.

```
SEMC_DisableInterrupts(ENET, kSEMC_IPCmdDoneInterrupt | kSEMC_IPCmdErrInterrupt);
```

Parameters

- base – SEMC peripheral base address.
- mask – SEMC interrupts to disable. This is a logical OR of the enumeration :: *semc_interrupt_enable_t*.

static inline bool SEMC_GetStatusFlag(SEMC_Type *base)

Gets the SEMC status.

This function gets the SEMC interrupts event status. User can use the a logical OR of enumeration member as a mask. See `semc_interrupt_enable_t`.

Parameters

- base – SEMC peripheral base address.

Returns

status flag, use status flag in `semc_interrupt_enable_t` to get the related status.

static inline void SEMC_ClearStatusFlags(SEMC_Type *base, uint32_t mask)

Clears the SEMC status flag state.

The following status register flags can be cleared SEMC interrupt status.

Parameters

- base – SEMC base pointer
- mask – The status flag mask, a logical OR of enumeration member `semc_interrupt_enable_t`.

static inline bool SEMC_IsInIdle(SEMC_Type *base)

Check if SEMC is in idle.

Parameters

- base – SEMC peripheral base address.

Returns

True SEMC is in idle, false is not in idle.

status_t SEMC_SendIPCommand(SEMC_Type *base, *semc_mem_type_t* memType, uint32_t address, uint32_t command, uint32_t write, uint32_t *read)

SEMC IP command access.

Parameters

- base – SEMC peripheral base address.
- memType – SEMC memory type. refer to “`semc_mem_type_t`”
- address – SEMC device address.
- command – SEMC IP command. For NAND device, we should use the `SEMC_BuildNandIPCommand` to get the right nand command. For NOR/DBI device, take refer to “`semc_ipcmd_nor_dbi_t`”. For SRAM device, take refer to “`semc_ipcmd_sram_t`”. For SDRAM device, take refer to “`semc_ipcmd_sdram_t`”.
- write – Data for write access.
- read – Data pointer for read data out.

static inline uint16_t SEMC_BuildNandIPCommand(uint8_t userCommand,
 semc_ipcmd_nand_addrmode_t addrMode,
 semc_ipcmd_nand_cmdmode_t cmdMode)

Build SEMC IP command for NAND.

This function build SEMC NAND IP command. The command is build of user command code, SEMC address mode and SEMC command mode.

Parameters

- userCommand – NAND device normal command.

- `addrMode` – NAND address mode. Refer to “`semc_ipcmd_nand_addrmode_t`”.
- `cmdMode` – NAND command mode. Refer to “`semc_ipcmd_nand_cmdmode_t`”.

`static inline bool SEMC_IsNandReady(SEMC_Type *base)`

Check if the NAND device is ready.

Parameters

- `base` – SEMC peripheral base address.

Returns

True NAND is ready, false NAND is not ready.

`status_t SEMC_IPCommandNandWrite(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)`

SEMC NAND device memory write through IP command.

Parameters

- `base` – SEMC peripheral base address.
- `address` – SEMC NAND device address.
- `data` – Data for write access.
- `size_bytes` – Data length.

`status_t SEMC_IPCommandNandRead(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)`

SEMC NAND device memory read through IP command.

Parameters

- `base` – SEMC peripheral base address.
- `address` – SEMC NAND device address.
- `data` – Data pointer for data read out.
- `size_bytes` – Data length.

`status_t SEMC_IPCommandNorWrite(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)`

SEMC NOR device memory write through IP command.

Parameters

- `base` – SEMC peripheral base address.
- `address` – SEMC NOR device address.
- `data` – Data for write access.
- `size_bytes` – Data length.

`status_t SEMC_IPCommandNorRead(SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)`

SEMC NOR device memory read through IP command.

Parameters

- `base` – SEMC peripheral base address.
- `address` – SEMC NOR device address.
- `data` – Data pointer for data read out.
- `size_bytes` – Data length.

FSL_SEMC_DRIVER_VERSION

SEMC driver version.

SEMC status, `_semc_status`.

Values:

enumerator `kStatus_SEMC_InvalidDeviceType`
Invalid device type.

enumerator `kStatus_SEMC_IpCommandExecutionError`
IP command execution error.

enumerator `kStatus_SEMC_AxiCommandExecutionError`
AXI command execution error.

enumerator `kStatus_SEMC_InvalidMemorySize`
Invalid memory size.

enumerator `kStatus_SEMC_InvalidIpcmdDataSize`
Invalid IP command data size.

enumerator `kStatus_SEMC_InvalidAddressPortWidth`
Invalid address port width.

enumerator `kStatus_SEMC_InvalidDataPortWidth`
Invalid data port width.

enumerator `kStatus_SEMC_InvalidSwPinmuxSelection`
Invalid SW pinmux selection.

enumerator `kStatus_SEMC_InvalidBurstLength`
Invalid burst length

enumerator `kStatus_SEMC_InvalidColumnAddressBitWidth`
Invalid column address bit width.

enumerator `kStatus_SEMC_InvalidBaseAddress`
Invalid base address.

enumerator `kStatus_SEMC_InvalidTimerSetting`
Invalid timer setting.

enum `_semc_mem_type`

SEMC memory device type.

Values:

enumerator `kSEMC_MemType_SDRAM`
SDRAM

enumerator `kSEMC_MemType_SRAM`
SRAM

enumerator `kSEMC_MemType_NOR`
NOR

enumerator `kSEMC_MemType_NAND`
NAND

enumerator `kSEMC_MemType_8080`

i.

enum _semc_waitready_polarity

SEMC WAIT/RDY polarity.

Values:

enumerator kSEMC_LowActive

Low active.

enumerator kSEMC_HighActive

High active.

enum _semc_sdram_cs

SEMC SDRAM Chip selection .

Values:

enumerator kSEMC_SDRAM_CS0

SEMC SDRAM CS0.

enumerator kSEMC_SDRAM_CS1

SEMC SDRAM CS1.

enumerator kSEMC_SDRAM_CS2

SEMC SDRAM CS2.

enumerator kSEMC_SDRAM_CS3

SEMC SDRAM CS3.

enum _semc_sram_cs

SEMC SRAM Chip selection .

Values:

enumerator kSEMC_SRAM_CS0

SEMC SRAM CS0.

enum _semc_nand_access_type

SEMC NAND device type.

Values:

enumerator kSEMC_NAND_ACCESS_BY_AXI

Access to NAND flash by AXI bus.

enumerator kSEMC_NAND_ACCESS_BY_IPCMD

Access to NAND flash by IP bus.

enum _semc_interrupt_enable

SEMC interrupts .

Values:

enumerator kSEMC_IPCmdDoneInterrupt

Ip command done interrupt.

enumerator kSEMC_IPCmdErrInterrupt

Ip command error interrupt.

enumerator kSEMC_AXICmdErrInterrupt

AXI command error interrupt.

enumerator kSEMC_AXIBusErrInterrupt

AXI bus error interrupt.

enum _semc_ipcmd_datasize

SEMC IP command data size in bytes.

Values:

enumerator kSEMC_IPcmdDataSize_1bytes

The IP command data size 1 byte.

enumerator kSEMC_IPcmdDataSize_2bytes

The IP command data size 2 byte.

enumerator kSEMC_IPcmdDataSize_3bytes

The IP command data size 3 byte.

enumerator kSEMC_IPcmdDataSize_4bytes

The IP command data size 4 byte.

enum _semc_refresh_time

SEMC auto-refresh timing.

Values:

enumerator kSEMC_RefreshThreeClocks

The refresh timing with three bus clocks.

enumerator kSEMC_RefreshSixClocks

The refresh timing with six bus clocks.

enumerator kSEMC_RefreshNineClocks

The refresh timing with nine bus clocks.

enum _semc_caslatency

CAS latency.

Values:

enumerator kSEMC_LatencyOne

Latency 1.

enumerator kSEMC_LatencyTwo

Latency 2.

enumerator kSEMC_LatencyThree

Latency 3.

enum _semc_sdram_column_bit_num

SEMC sdram column address bit number.

Values:

enumerator kSEMC_SdramColumn_12bit

12 bit.

enumerator kSEMC_SdramColumn_11bit

11 bit.

enumerator kSEMC_SdramColumn_10bit

10 bit.

enumerator kSEMC_SdramColumn_9bit

9 bit.

enumerator kSEMC_SdramColumn_8bit

8 bit.

enum _semc_sdram_burst_len
SEMC sdram burst length.

Values:

enumerator kSEMC_Sdram_BurstLen1

According to ERR050577, Auto-refresh command may possibly fail to be triggered during long time back-to-back write (or read) when SDRAM controller's burst length is greater than 1. Burst length 1

enum _semc_nand_column_bit_num
SEMC nand column address bit number.

Values:

enumerator kSEMC_NandColumn_16bit
16 bit.

enumerator kSEMC_NandColumn_15bit
15 bit.

enumerator kSEMC_NandColumn_14bit
14 bit.

enumerator kSEMC_NandColumn_13bit
13 bit.

enumerator kSEMC_NandColumn_12bit
12 bit.

enumerator kSEMC_NandColumn_11bit
11 bit.

enumerator kSEMC_NandColumn_10bit
10 bit.

enumerator kSEMC_NandColumn_9bit
9 bit.

enum _semc_nand_burst_len
SEMC nand burst length.

Values:

enumerator kSEMC_Nand_BurstLen1
Burst length 1

enumerator kSEMC_Nand_BurstLen2
Burst length 2

enumerator kSEMC_Nand_BurstLen4
Burst length 4

enumerator kSEMC_Nand_BurstLen8
Burst length 8

enumerator kSEMC_Nand_BurstLen16
Burst length 16

enumerator kSEMC_Nand_BurstLen32
Burst length 32

enumerator kSEMC_Nand_BurstLen64
Burst length 64

enum _semc_norsram_column_bit_num

SEMC nor/sram column address bit number.

Values:

enumerator kSEMC_NorColumn_12bit
12 bit.

enumerator kSEMC_NorColumn_11bit
11 bit.

enumerator kSEMC_NorColumn_10bit
10 bit.

enumerator kSEMC_NorColumn_9bit
9 bit.

enumerator kSEMC_NorColumn_8bit
8 bit.

enumerator kSEMC_NorColumn_7bit
7 bit.

enumerator kSEMC_NorColumn_6bit
6 bit.

enumerator kSEMC_NorColumn_5bit
5 bit.

enumerator kSEMC_NorColumn_4bit
4 bit.

enumerator kSEMC_NorColumn_3bit
3 bit.

enumerator kSEMC_NorColumn_2bit
2 bit.

enum _semc_norsram_burst_len

SEMC nor/sram burst length.

Values:

enumerator kSEMC_Nor_BurstLen1
Burst length 1

enumerator kSEMC_Nor_BurstLen2
Burst length 2

enumerator kSEMC_Nor_BurstLen4
Burst length 4

enumerator kSEMC_Nor_BurstLen8
Burst length 8

enumerator kSEMC_Nor_BurstLen16
Burst length 16

enumerator kSEMC_Nor_BurstLen32
Burst length 32

enumerator kSEMC_Nor_BurstLen64
Burst length 64

enum _semc_dbi_column_bit_num

SEMC dbi column address bit number.

Values:

enumerator kSEMC_Dbi_Colum_12bit
12 bit.

enumerator kSEMC_Dbi_Colum_11bit
11 bit.

enumerator kSEMC_Dbi_Colum_10bit
10 bit.

enumerator kSEMC_Dbi_Colum_9bit
9 bit.

enumerator kSEMC_Dbi_Colum_8bit
8 bit.

enumerator kSEMC_Dbi_Colum_7bit
7 bit.

enumerator kSEMC_Dbi_Colum_6bit
6 bit.

enumerator kSEMC_Dbi_Colum_5bit
5 bit.

enumerator kSEMC_Dbi_Colum_4bit
4 bit.

enumerator kSEMC_Dbi_Colum_3bit
3 bit.

enumerator kSEMC_Dbi_Colum_2bit
2 bit.

enum _semc_dbi_burst_len

SEMC dbi burst length.

Values:

enumerator kSEMC_Dbi_BurstLen1
Burst length 1

enumerator kSEMC_Dbi_BurstLen2
Burst length 2

enumerator kSEMC_Dbi_Dbi_BurstLen4
Burst length 4

enumerator kSEMC_Dbi_BurstLen8
Burst length 8

enumerator kSEMC_Dbi_BurstLen16
Burst length 16

enumerator kSEMC_Dbi_BurstLen32
Burst length 32

enumerator kSEMC_Dbi_BurstLen64
Burst length 64

enum _semc_iomux_pin

SEMC IOMUXC.

Values:

enumerator kSEMC_MUXA8

MUX A8 pin.

enumerator kSEMC_MUXCSX0

MUX CSX0 pin

enumerator kSEMC_MUXCSX1

MUX CSX1 Pin.

enumerator kSEMC_MUXCSX2

MUX CSX2 Pin.

enumerator kSEMC_MUXCSX3

MUX CSX3 Pin.

enumerator kSEMC_MUXRDY

MUX RDY pin.

enum _semc_iomux_nora27_pin

SEMC NOR/PSRAM Address bit 27 A27.

Values:

enumerator kSEMC_MORA27_NONE

No NOR/SRAM A27 pin.

enumerator kSEMC_NORA27_MUXCSX3

MUX CSX3 Pin.

enumerator kSEMC_NORA27_MUXRDY

MUX RDY pin.

enum _semc_port_size

SEMC port size.

Values:

enumerator kSEMC_PortSize8Bit

8-Bit port size.

enumerator kSEMC_PortSize16Bit

16-Bit port size.

enum _semc_addr_mode

SEMC address mode.

Values:

enumerator kSEMC_AddrDataMux

SEMC address/data mux mode.

enumerator kSEMC_AdvAddrdataMux

Advanced address/data mux mode.

enumerator kSEMC_AddrDataNonMux

Address/data non-mux mode.

enum _semc_dqs_mode

SEMC DQS read strobe mode.

Values:

enumerator kSEMC_Loopbackinternal

Dummy read strobe loopbacked internally.

enumerator kSEMC_Loopbackdqspad

Dummy read strobe loopbacked from DQS pad.

enum _semc_adv_polarity

SEMC ADV signal active polarity.

Values:

enumerator kSEMC_AdvActiveLow

Adv active low.

enumerator kSEMC_AdvActiveHigh

Adv active high.

enum _semc_sync_mode

SEMC sync mode.

Values:

enumerator kSEMC_AsyncMode

Async mode.

enumerator kSEMC_SyncMode

Sync mode.

enum _semc_adv_level_control

SEMC ADV signal level control.

Values:

enumerator kSEMC_AdvHigh

Adv is high during address hold state.

enumerator kSEMC_AdvLow

Adv is low during address hold state.

enum _semc_rdy_polarity

SEMC RDY signal active polarity.

Values:

enumerator kSEMC_RdyActiveLow

Adv active low.

enumerator kSEMC_RdyActivehigh

Adv active low.

enum _semc_ipcmd_nand_addrmode

SEMC IP command for NAND: address mode.

Values:

enumerator kSEMC_NANDAM_ColumnRow

Address mode: column and row address(5Byte-CA0/CA1/RA0/RA1/RA2).

enumerator kSEMC_NANDAM_ColumnCA0

Address mode: column address only(1 Byte-CA0).

enumerator kSEMC_NANDAM_ColumnCA0CA1

Address mode: column address only(2 Byte-CA0/CA1).

enumerator kSEMC_NANDAM_RawRA0

Address mode: row address only(1 Byte-RA0).

enumerator kSEMC_NANDAM_RawRA0RA1

Address mode: row address only(2 Byte-RA0/RA1).

enumerator kSEMC_NANDAM_RawRA0RA1RA2

Address mode: row address only(3 Byte-RA0).

enum _semc_ipcmd_nand_cmdmode

SEMC IP command for NAND command mode.

Values:

enumerator kSEMC_NANDCM_Command
command.

enumerator kSEMC_NANDCM_CommandHold
Command hold.

enumerator kSEMC_NANDCM_CommandAddress
Command address.

enumerator kSEMC_NANDCM_CommandAddressHold
Command address hold.

enumerator kSEMC_NANDCM_CommandAddressRead
Command address read.

enumerator kSEMC_NANDCM_CommandAddressWrite
Command address write.

enumerator kSEMC_NANDCM_CommandRead
Command read.

enumerator kSEMC_NANDCM_CommandWrite
Command write.

enumerator kSEMC_NANDCM_Read
Read.

enumerator kSEMC_NANDCM_Write
Write.

enum _semc_nand_address_option

SEMC NAND address option.

Values:

enumerator kSEMC_NandAddrOption_5byte_CA2RA3
CA0+CA1+RA0+RA1+RA2

enumerator kSEMC_NandAddrOption_4byte_CA2RA2
CA0+CA1+RA0+RA1

enumerator kSEMC_NandAddrOption_3byte_CA2RA1
CA0+CA1+RA0

enumerator kSEMC_NandAddrOption_4byte_CA1RA3
CA0+RA0+RA1+RA2

enumerator kSEMC_NandAddrOption_3byte_CA1RA2
CA0+RA0+RA1

enumerator kSEMC_NandAddrOption_2byte_CA1RA1
CA0+RA0

enum _semc_ipcmd_nor_dbi
SEMC IP command for NOR.

Values:

enumerator kSEMC_NORDBICM_Read
NOR read.

enumerator kSEMC_NORDBICM_Write
NOR write.

enum _semc_ipcmd_sram
SEMC IP command for SRAM.

Values:

enumerator kSEMC_SRAMCM_ArrayRead
SRAM memory array read.

enumerator kSEMC_SRAMCM_ArrayWrite
SRAM memory array write.

enumerator kSEMC_SRAMCM_RegRead
SRAM memory register read.

enumerator kSEMC_SRAMCM_RegWrite
SRAM memory register write.

enum _semc_ipcmd_sdram
SEMC IP command for SDARM.

Values:

enumerator kSEMC_SDRAMCM_Read
SDRAM memory read.

enumerator kSEMC_SDRAMCM_Write
SDRAM memory write.

enumerator kSEMC_SDRAMCM_Modeset
SDRAM MODE SET.

enumerator kSEMC_SDRAMCM_Active
SDRAM active.

enumerator kSEMC_SDRAMCM_AutoRefresh
SDRAM auto-refresh.

enumerator kSEMC_SDRAMCM_SelfRefresh
SDRAM self-refresh.

enumerator kSEMC_SDRAMCM_Precharge
SDRAM precharge.

enumerator kSEMC_SDRAMCM_Prechargeall
SDRAM precharge all.

```
typedef enum _semc_mem_type semc_mem_type_t
    SEMC memory device type.

typedef enum _semc_waitready_polarity semc_waitready_polarity_t
    SEMC WAIT/RDY polarity.

typedef enum _semc_sdram_cs semc_sdram_cs_t
    SEMC SDRAM Chip selection .

typedef enum _semc_sram_cs semc_sram_cs_t
    SEMC SRAM Chip selection .

typedef enum _semc_nand_access_type semc_nand_access_type_t
    SEMC NAND device type.

typedef enum _semc_interrupt_enable semc_interrupt_enable_t
    SEMC interrupts .

typedef enum _semc_ipcmd_datasize semc_ipcmd_datasize_t
    SEMC IP command data size in bytes.

typedef enum _semc_refresh_time semc_refresh_time_t
    SEMC auto-refresh timing.

typedef enum _semc_caslatency semc_caslatency_t
    CAS latency.

typedef enum _semc_sdram_column_bit_num semc_sdram_column_bit_num_t
    SEMC sdram column address bit number.

typedef enum _semc_sdram_burst_len sem_sdram_burst_len_t
    SEMC sdram burst length.

typedef enum _semc_nand_column_bit_num semc_nand_column_bit_num_t
    SEMC nand column address bit number.

typedef enum _semc_nand_burst_len sem_nand_burst_len_t
    SEMC nand burst length.

typedef enum _semc_norsram_column_bit_num semc_norsram_column_bit_num_t
    SEMC nor/sram column address bit number.

typedef enum _semc_norsram_burst_len sem_norsram_burst_len_t
    SEMC nor/sram burst length.

typedef enum _semc_dbi_column_bit_num semc_dbi_column_bit_num_t
    SEMC dbi column address bit number.

typedef enum _semc_dbi_burst_len sem_dbi_burst_len_t
    SEMC dbi burst length.

typedef enum _semc_iomux_pin semc_iomux_pin
    SEMC IOMUXC.

typedef enum _semc_iomux_nora27_pin semc_iomux_nora27_pin
    SEMC NOR/PSRAM Address bit 27 A27.

typedef enum _semc_port_size smec_port_size_t
    SEMC port size.

typedef enum _semc_addr_mode semc_addr_mode_t
    SEMC address mode.
```

typedef enum *_semc_dqs_mode* semc_dqs_mode_t

SEMC DQS read strobe mode.

typedef enum *_semc_adv_polarity* semc_adv_polarity_t

SEMC ADV signal active polarity.

typedef enum *_semc_sync_mode* semc_sync_mode_t

SEMC sync mode.

typedef enum *_semc_adv_level_control* semc_adv_level_control_t

SEMC ADV signal level control.

typedef enum *_semc_rdy_polarity* semc_rdy_polarity_t

SEMC RDY signal active polarity.

typedef enum *_semc_ipcmd_nand_addrmode* semc_ipcmd_nand_addrmode_t

SEMC IP command for NAND: address mode.

typedef enum *_semc_ipcmd_nand_cmdmode* semc_ipcmd_nand_cmdmode_t

SEMC IP command for NAND command mode.

typedef enum *_semc_nand_address_option* semc_nand_address_option_t

SEMC NAND address option.

typedef enum *_semc_ipcmd_nor_dbi* semc_ipcmd_nor_dbi_t

SEMC IP command for NOR.

typedef enum *_semc_ipcmd_sram* semc_ipcmd_sram_t

SEMC IP command for SRAM.

typedef enum *_semc_ipcmd_sdram* semc_ipcmd_sdram_t

SEMC IP command for SDARM.

typedef struct *_semc_sdram_config* semc_sdram_config_t

SEMC SDRAM configuration structure.

a. The memory size in the configuration is in the unit of KB. So memsize_kbytes should be set as 2^2 , 2^3 , 2^4 .etc which is base 2KB exponential function. Take refer to BR0~BR3 register in RM for details.

b. The prescalePeriod_N16Cycle is in unit of 16 clock cycle. It is a exception for prescaleTimer_n16cycle = 0, it means the prescaler timer period is $256 * 16$ clock cycles. For precalerIf precalerTimer_n16cycle not equal to 0, The prescaler timer period is prescalePeriod_N16Cycle * 16 clock cycles. idleTimeout_NprescalePeriod, refreshUrgThreshold_NprescalePeriod, refreshPeriod_NprescalePeriod are similar to prescalePeriod_N16Cycle.

typedef struct *_semc_nand_timing_config* semc_nand_timing_config_t

SEMC NAND device timing configuration structure.

typedef struct *_semc_nand_config* semc_nand_config_t

SEMC NAND configuration structure.

typedef struct *_semc_nor_config* semc_nor_config_t

SEMC NOR configuration structure.

typedef struct *_semc_sram_config* semc_sram_config_t

SEMC SRAM configuration structure.

typedef struct *_semc_dbi_config* semc_dbi_config_t

SEMC DBI configuration structure.

```
typedef struct _semc_queuea_weight_struct semc_queuea_weight_struct_t
```

SEMC AXI queue a weight setting structure.

```
typedef union _semc_queuea_weight semc_queuea_weight_t
```

SEMC AXI queue a weight setting union.

```
typedef struct _semc_queueb_weight_struct semc_queueb_weight_struct_t
```

SEMC AXI queue b weight setting structure.

```
typedef union _semc_queueb_weight semc_queueb_weight_t
```

SEMC AXI queue b weight setting union.

```
typedef struct _semc_axi_queueweight semc_axi_queueweight_t
```

SEMC AXI queue weight setting.

```
typedef struct _semc_config_t semc_config_t
```

SEMC configuration structure.

busTimeoutCycles: when busTimeoutCycles is zero, the bus timeout cycle is 255*1024. otherwise the bus timeout cycles is busTimeoutCycles*1024. cmdTimeoutCycles: is used for command execution timeout cycles. it's similar to the busTimeoutCycles.

```
struct _semc_sdram_config
```

#include <fsl_semc.h> SEMC SDRAM configuration structure.

- a. The memory size in the configuration is in the unit of KB. So memsize_kbytes should be set as 2^2 , 2^3 , 2^4 .etc which is base 2KB exponential function. Take refer to BR0~BR3 register in RM for details.
- b. The prescalePeriod_N16Cycle is in unit of 16 clock cycle. It is a exception for prescaleTimer_n16cycle = 0, it means the prescaler timer period is $256 * 16$ clock cycles. For precalerIf precalerTimer_n16cycle not equal to 0, The prescaler timer period is prescalePeriod_N16Cycle * 16 clock cycles. idleTimeout_NprescalePeriod, refreshUrgThreshold_NprescalePeriod, refreshPeriod_NprescalePeriod are similar to prescalePeriod_N16Cycle.

Public Members

semc_iomux_pin csxPinMux

CS pin mux. The kSEMC_MUXA8 is not valid in sdram pin mux setting.

uint32_t address

The base address.

uint32_t memsize_kbytes

The memory size in unit of kbytes.

smec_port_size_t portSize

Port size.

sem_sdram_burst_len_t burstLen

Burst length.

semc_sdram_column_bit_num_t columnAddrBitNum

Column address bit number.

semc_caslatency_t casLatency

CAS latency.

uint8_t tPrecharge2Act_Ns

Precharge to active wait time in unit of nanosecond.

uint8_t tAct2ReadWrite_Ns

Act to read/write wait time in unit of nanosecond.

uint8_t tRefreshRecovery_Ns

Refresh recovery time in unit of nanosecond.

uint8_t tWriteRecovery_Ns

write recovery time in unit of nanosecond.

uint8_t tCkeOff_Ns

CKE off minimum time in unit of nanosecond.

uint8_t tAct2Prechage_Ns

Active to precharge in unit of nanosecond.

uint8_t tSelfRefRecovery_Ns

Self refresh recovery time in unit of nanosecond.

uint8_t tRefresh2Refresh_Ns

Refresh to refresh wait time in unit of nanosecond.

uint8_t tAct2Act_Ns

Active to active wait time in unit of nanosecond.

uint32_t tPrescalePeriod_Ns

Prescaler timer period should not be larger than $256 * 16 * \text{clock cycle}$.

uint32_t tIdleTimeout_Ns

Idle timeout in unit of prescale time period.

uint32_t refreshPeriod_nsPerRow

Refresh timer period like $64\text{ms} * 1000000/8192$.

uint32_t refreshUrgThreshold

Refresh urgent threshold.

uint8_t refreshBurstLen

Refresh burst length.

uint8_t delayChain

Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

uint8_t autofreshTimes

Auto Refresh cycles times.

struct _semc_nand_timing_config

#include <fsl_semc.h> SEMC NAND device timing configuration structure.

Public Members

uint8_t tCeSetup_Ns

CE setup time: tCS.

uint8_t tCeHold_Ns

CE hold time: tCH.

uint8_t tCeInterval_Ns

CE interval time:tCEITV.

```

uint8_t tWeLow_Ns
    WE low time: tWP.
uint8_t tWeHigh_Ns
    WE high time: tWH.
uint8_t tReLow_Ns
    RE low time: tRP.
uint8_t tReHigh_Ns
    RE high time: tREH.
uint8_t tTurnAround_Ns
    Turnaround time for async mode: tTA.
uint8_t tWehigh2Relow_Ns
    WE# high to RE# wait time: tWHR.
uint8_t tRehigh2Welow_Ns
    RE# high to WE# low wait time: tRHW.
uint8_t tAle2WriteStart_Ns
    ALE to write start wait time: tADL.
uint8_t tReady2Relow_Ns
    Ready to RE# low min wait time: tRR.
uint8_t tWehigh2Busy_Ns
    WE# high to busy wait time: tWB.
struct _semc_nand_config
    #include <fsl_semc.h> SEMC NAND configuration structure.

```

Public Members

```

semc_iomux_pin cePinMux
    The CE pin mux setting. The kSEMC_MUXRDY is not valid for CE pin setting.
uint32_t axiAddress
    The base address for AXI nand.
uint32_t axiMemsizes_kbytes
    The memory size in unit of kbytes for AXI nand.
uint32_t ipgAddress
    The base address for IPG nand .
uint32_t ipgMemsizes_kbytes
    The memory size in unit of kbytes for IPG nand.
semc_rdy_polarity_t rdyactivePolarity
    Wait ready polarity.
bool edoModeEnabled
    EDO mode enabled.
semc_nand_column_bit_num_t columnAddrBitNum
    Column address bit number.
semc_nand_address_option_t arrayAddrOption
    Address option.

```

sem_nand_burst_len_t burstLen

Burst length.

smec_port_size_t portSize

Port size.

semc_nand_timing_config_t *timingConfig

SEMC nand timing configuration.

struct __semc_nor_config

#include <fsl_semc.h> SEMC NOR configuration structure.

Public Members

semc_iomux_pin cePinMux

The CE# pin mux setting.

semc_iomux_nora27_pin addr27

The Addr bit 27 pin mux setting.

uint32_t address

The base address.

uint32_t memsize_kbytes

The memory size in unit of kbytes.

uint8_t addrPortWidth

The address port width.

semc_rdy_polarity_t rdyactivePolarity

Wait ready polarity.

semc_adv_polarity_t advActivePolarity

ADV# polarity.

semc_norsram_column_bit_num_t columnAddrBitNum

Column address bit number.

semc_addr_mode_t addrMode

Address mode.

sem_norsram_burst_len_t burstLen

Burst length.

smec_port_size_t portSize

Port size.

uint8_t tCeSetup_Ns

The CE setup time.

uint8_t tCeHold_Ns

The CE hold time.

uint8_t tCeInterval_Ns

CE interval minimum time.

uint8_t tAddrSetup_Ns

The address setup time.

uint8_t tAddrHold_Ns

The address hold time.

uint8_t tWeLow_Ns

WE low time for async mode.

uint8_t tWeHigh_Ns

WE high time for async mode.

uint8_t tReLow_Ns

RE low time for async mode.

uint8_t tReHigh_Ns

RE high time for async mode.

uint8_t tTurnAround_Ns

Turnaround time for async mode.

uint8_t tAddr2WriteHold_Ns

Address to write data hold time for async mode.

uint8_t tWriteSetup_Ns

Write data setup time for sync mode.

uint8_t tWriteHold_Ns

Write hold time for sync mode.

uint8_t latencyCount

Latency count for sync mode.

uint8_t readCycle

Read cycle time for sync mode.

uint8_t delayChain

Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

struct _semc_sram_config

#include <fsl_semc.h> SEMC SRAM configuration structure.

Public Members

semc_iomux_pin cePinMux

The CE# pin mux setting.

semc_iomux_nora27_pin addr27

The Addr bit 27 pin mux setting.

uint32_t address

The base address.

uint32_t memsize_kbytes

The memory size in unit of kbytes.

uint8_t addrPortWidth

The address port width.

semc_adv_polarity_t advActivePolarity

ADV# polarity 1: active high, 0: active low.

semc_addr_mode_t addrMode

Address mode.

sem_norsram_burst_len_t burstLen
Burst length.

smec_port_size_t portSize
Port size.

semc_sync_mode_t syncMode
Sync mode.

bool waitEnable
Wait enable.

uint8_t waitSample
Wait sample.

semc_adv_level_control_t advLevelCtrl
ADV# level control during address hold state, 1: low, 0: high.

uint8_t tCeSetup_Ns
The CE setup time.

uint8_t tCeHold_Ns
The CE hold time.

uint8_t tCeInterval_Ns
CE interval minimum time.

uint8_t readHoldTime_Ns
read hold time.

uint8_t tAddrSetup_Ns
The address setup time.

uint8_t tAddrHold_Ns
The address hold time.

uint8_t tWeLow_Ns
WE low time for async mode.

uint8_t tWeHigh_Ns
WE high time for async mode.

uint8_t tReLow_Ns
RE low time for async mode.

uint8_t tReHigh_Ns
RE high time for async mode.

uint8_t tTurnAround_Ns
Turnaround time for async mode.

uint8_t tAddr2WriteHold_Ns
Address to write data hold time for async mode.

uint8_t tWriteSetup_Ns
Write data setup time for sync mode.

uint8_t tWriteHold_Ns
Write hold time for sync mode.

uint8_t latencyCount
Latency count for sync mode.

uint8_t readCycle

Read cycle time for sync mode.

uint8_t delayChain

Delay chain, which adds delays on DQS clock to compensate timings while DQS is faster than read data.

struct __semc_dbi_config

#include <fsl_semc.h> SEMC DBI configuration structure.

Public Members

semc_iomux_pin csxPinMux

The CE# pin mux.

uint32_t address

The base address.

uint32_t memsize_kbytes

The memory size in unit of 4kbytes.

semc_dbi_column_bit_num_t columnAddrBitNum

Column address bit number.

sem_dbi_burst_len_t burstLen

Burst length.

smec_port_size_t portSize

Port size.

uint8_t tCsxSetup_Ns

The CSX setup time.

uint8_t tCsxHold_Ns

The CSX hold time.

uint8_t tWexLow_Ns

WEX low time.

uint8_t tWexHigh_Ns

WEX high time.

uint8_t tRdxLow_Ns

RDX low time.

uint8_t tRdxHigh_Ns

RDX high time.

uint8_t tCsxInterval_Ns

Write data setup time.

struct __semc_queuea_weight_struct

#include <fsl_semc.h> SEMC AXI queue a weight setting structure.

Public Members

uint32_t qos

weight of qos for queue 0 .

uint32_t aging
weight of aging for queue 0.

uint32_t slaveHitNoswitch
weight of read/write no switch for queue 0 .

uint32_t slaveHitSwitch
weight of read/write switch for queue 0.

union __semc_queuea_weight
#include <fsl_semc.h> SEMC AXI queue a weight setting union.

Public Members

semc_queuea_weight_struct_t queueaConfig
Structure configuration for queueA.

uint32_t queueaValue
Configuration value for queueA which could directly write to the reg.

struct __semc_queueb_weight_struct
#include <fsl_semc.h> SEMC AXI queue b weight setting structure.

Public Members

uint32_t qos
weight of qos for queue 1.

uint32_t aging
weight of aging for queue 1.

uint32_t weightPagehit
weight of page hit for queue 1 only .

uint32_t slaveHitNoswitch
weight of read/write no switch for queue 1.

uint32_t bankRotation
weight of bank rotation for queue 1 only .

union __semc_queueb_weight
#include <fsl_semc.h> SEMC AXI queue b weight setting union.

Public Members

semc_queueb_weight_struct_t queuebConfig
Structure configuration for queueB.

uint32_t queuebValue
Configuration value for queueB which could directly write to the reg.

struct __semc_axi_queueweight
#include <fsl_semc.h> SEMC AXI queue weight setting.

Public Members

`bool queueaEnable`
Enable queue a.

`semc_queuea_weight_t queueaWeight`
Weight settings for queue a.

`bool queuebEnable`
Enable queue b.

`semc_queueb_weight_t queuebWeight`
Weight settings for queue b.

`struct _semc_config_t`
`#include <fsl_semc.h>` SEMC configuration structure.

`busTimeoutCycles`: when `busTimeoutCycles` is zero, the bus timeout cycle is 255×1024 . otherwise the bus timeout cycles is `busTimeoutCycles` $\times 1024$. `cmdTimeoutCycles`: is used for command execution timeout cycles. it's similar to the `busTimeoutCycles`.

Public Members

`semc_dqs_mode_t dqsMode`
Dummy read strobe mode: use enum in “`semc_dqs_mode_t`”.

`uint8_t cmdTimeoutCycles`
Command execution timeout cycles.

`uint8_t busTimeoutCycles`
Bus timeout cycles.

`semc_axi_queueweight_t queueWeight`
AXI queue weight.

2.122 SINC: SINC Filter

`void SINC_Init(SINC_Type *base, const sinc_config_t *config)`
Initialize selected SINC instance, including clock options and channel options.

Parameters

- `base` – SINC peripheral base address.
- `config` – The pointer to `sinc_config_t` structure.

`void SINC_Deinit(SINC_Type *base)`
De-initialize selected SINC instance.

Parameters

- `base` – SINC peripheral base address.

`void SINC_GetDefaultConfig(sinc_config_t *config)`
Get default configuration.

```
config->clockPreDivider = kSINC_ClkPrescale1;
config->modClkDivider   = 2UL;
config->disableModClk0Output = false;
config->disableModClk1Output = false;
```

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```
config->disableModClk2Output = false;

config->channelsConfigArray[4] = {NULL, NULL, NULL, NULL};

config->disableDozeMode      = false;
config->enableMaster         = false;
```

Parameters

- config – The pointer to sinc_config_t structure, must not be NULL.

static inline void SINC_EnableMaster(SINC_Type *base, bool enable)

Enable/disable all function blocks enabled in their respective registers.

Parameters

- base – SINC peripheral base address.
- enable – Used to enable/disable all function blocks:
 - **true** Enable all function blocks, please note that clock must be configured previously;
 - **false** Disable all function blocks.

static inline void SINC_DoSoftwareReset(SINC_Type *base)

Reset all function blocks(except for the clock blocks), interrupt statuses.

Parameters

- base – SINC peripheral base address.

static inline void SINC_DisableDozeMode(SINC_Type *base, bool disable)

Disable/enable SINC module when the chip enters Doze or Stop mode.

Parameters

- base – SINC peripheral base address.
- disable – Used to control if module functional when the chip enters Doze and Stop mode:
 - **true** Disable SINC when the chip enters Doze or Stop mode;
 - **false** Enable SINC when the chip enters Doze or stop mode.

static inline bool SINC_CheckModulatorClockReady(SINC_Type *base, uint32_t modClkMasks)

Check whether selected modulator clocks are ready.

Note: The result of this APIs means all selected modulator clocks are (not) ready.

Parameters

- base – SINC peripheral base address.
- modClkMasks – The mask of modulator clocks, please refer to _sinc_modulator_clock.

Return values

- true – The input mask of modulator clocks are ready.
- false – The input mask of modulator clocks are not ready.

```
static inline void SINC_DisableModulatorClockOutput(SINC_Type *base, uint32_t modClkMasks,  
                                                    bool disable)
```

Disable/enable modulator clocks' output.

Note: By default, modulator clock's output is enabled.

Parameters

- *base* – SINC peripheral base address.
- *modClkMasks* – The mask of modulator clocks, please refer to *_sinc_modulator_clock*.
- *disable* – Used to enable/disable clock output:
 - **true** Disable modulator clocks' output;
 - **false** Enable modulator clocks' output.

```
static inline void SINC_SetClkPrescale(SINC_Type *base, sinc_clock_prescale_t clkPrescale)
```

Set the clock divider ratio for the modulator clock.

Parameters

- *base* – SINC peripheral base address.
- *clkPrescale* – Clock prescale value, please refer to *sinc_clock_prescale_t*.

```
static inline void SINC_SetModulatorClockDivider(SINC_Type *base, uint32_t modClkDivider)
```

Set modulator clock divider value.

Note: $IMCLK0 = PRE\_CLK / modClkDivider$, the minimum clock divider ration is 2.

Parameters

- *base* – SINC peripheral base address.
- *modClkDivider* – Range from 2 to 256, 0 and 1 are prohibited, to obtain a 50% duty cycle in the MCLK output, write an even value to **modClkDivider**.

```
void SINC_SetChannelConfig(SINC_Type *base, sinc_channel_id_t chId, sinc_channel_config_t  
                          *chConfig)
```

Set channel configurations, including input options, conversion options and protection options.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.
- *chConfig* – Pointer to *sinc_channel_config_t* structure, must not be NULL.

```
void SINC_SetChannelInputOption(SINC_Type *base, sinc_channel_id_t chId,  
                               sinc_channel_input_option_t *chInputOption)
```

Set channel input options, including input bit format, input bit source, input bit delay, input clock source, input clock edge.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.

- `chInputOption` – Pointer to `sinc_channel_input_option_t` structure, must not be NULL.

```
void SINC_SetChannelConversionOption(SINC_Type *base, sinc_channel_id_t chId,  
                                     sinc_channel_conv_option_t *chConvOption)
```

Set channel conversion options, including conversion mode, trigger source, and primary filter settings.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `chConvOption` – Pointer to `sinc_channel_conv_option_t` structure, must not be NULL.

```
void SINC_SetChannelProtectionOption(SINC_Type *base, sinc_channel_id_t chId,  
                                     sinc_channel_protection_option_t *chProtection)
```

Set channel protection options, including limit check, short-circuit detector, clock-absence detector, and zero-crossing detector.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `chProtection` – Pointer to `sinc_channel_protection_option_t`, must not be NULL.

```
static inline uint32_t SINC_ReadChannelResultData(SINC_Type *base, sinc_channel_id_t chId)
```

Read selected channel's result data.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.

Returns

Result data of the selected channel, 24 bits width.

```
static inline void SINC_EnableChannelFIFO(SINC_Type *base, sinc_channel_id_t chId, bool  
                                         enable)
```

Enable/disable FIFO transfers for the primary filter.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `enable` – Used to enable/disable channel FIFO:
 - **true** Enable channel FIFO.
 - **false** Disable channel FIFO.

```
static inline void SINC_SetChannelFifoWatermark(SINC_Type *base, sinc_channel_id_t chId,  
                                                uint8_t fifoWaterMark)
```

Set the FIFO watermark.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `fifoWaterMark` – Specify the fifo watermark, range from 0 to 15.

static inline void SINC_EnableChannel(SINC_Type *base, *sinc_channel_id_t* chId, bool enable)
Enable/disable selected channel.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- enable – Used to enable/disable selected channel:
 - **true** Enable selected channel;
 - **false** Disable selected channel.

static inline void SINC_EnableChannelPrimaryDma(SINC_Type *base, *sinc_channel_id_t* chId, bool enable)

Enable/disable selected channel's primary DMA transfers when the channel's FIFO exceeds its watermark.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- enable – Used to enable/disable primary DMA :
 - **true** Enable primary DMA;
 - **false** Disable primary DMA.

static inline void SINC_SetChannelAltDmaSource(SINC_Type *base, *sinc_channel_id_t* chId, *sinc_alternate_dma_source_t* altDmaSource)

Set selected channel's alternate DMA source selection.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- altDmaSource – Specify the trigger source for alternate DMA, please refer to *sinc_alternate_dma_source_t*.

static inline void SINC_SetChannelResultDataFormat(SINC_Type *base, *sinc_channel_id_t* chId, *sinc_result_data_format_t* dataFormat)

Set selected channel's result data format.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- dataFormat – Specify the result data format, please refer to *sinc_result_data_format_t*.

static inline uint8_t SINC_GetChannelFifoCount(SINC_Type *base, *sinc_channel_id_t* chId)

Get the number of remaining data entries in the FIFO.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.

Returns

The number of remaining data entries in the FIFO.

static inline bool SINC_CheckChannelResultDataReady(SINC_Type *base, *sinc_channel_id_t* chId)
Check whether the data in selected channel's result data register is stable when FIFO is disabled.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to *sinc_channel_id_t* for details.

Return values

- true – Data in selected channel's result data register is stable.
- false – Data in selected channel's result data register is not stable.

static inline bool SINC_CheckChannelFifoEmpty(SINC_Type *base, *sinc_channel_id_t* chId)
Check whether selected channel's FIFO is empty.

Parameters

- base – SINC peripheral base address.
- chId – The id of sinc channel to check.

Return values

- true – Selected channel's FIFO is empty.
- false – Selected channel's FIFO is not empty.

static inline void SINC_AffirmChannelSoftwareTrigger(SINC_Type *base, uint32_t chMask)
Trigger selected channel's conversion.

Parameters

- base – SINC peripheral base address.
- chMask – The mask of channels to trigger.

static inline void SINC_NegateChannelSoftwareTrigger(SINC_Type *base, uint32_t chMask)
Negate the trigger of selected channel.

Parameters

- base – SINC peripheral base address.
- chMask – The mask of channels.

static inline void SINC_SetChannelConversionMode(SINC_Type *base, *sinc_channel_id_t* chId,
sinc_conv_mode_t mode)

Set selected channel's conversion mode.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- mode – The conversion mode to set, please refer to *sinc_conv_mode_t*.

static inline void SINC_SetChannelTriggerSource(SINC_Type *base, *sinc_channel_id_t* chId,
sinc_conv_trigger_source_t triggerSource)

Set selected channel's trigger source.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.

- `triggerSource` – Trigger source to set, please refer to `sinc_conv_trigger_source_t`.

```
static inline void SINC_SetChannelMultipurposeData(SINC_Type *base, sinc_channel_id_t chId,  
                                                uint32_t data)
```

Set multipurpose data to selected channel.

Note: If input bit format is set as ManchesterCode, multipurpose data indicates the Manchester decoder threshold value and is 11 bits width; if input bit format is set as parallel, multipurpose data indicates the parallel 16-bit data and is 16 bits width; if input bit format is set as serial, multipurpose data indicates the serial data and is 32 bits width.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `data` – Multipurpose data to set.

```
static inline void SINC_SetChannelPfOrder(SINC_Type *base, sinc_channel_id_t chId,  
                                         sinc_primary_filter_order_t pfOrder)
```

Set selected channel's PF order.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `pfOrder` – Primary filter order to set, please refer to `sinc_primary_filter_order_t`

```
static inline void SINC_SetChannelPfOsr(SINC_Type *base, sinc_channel_id_t chId, uint16_t  
                                       pfOsr)
```

Set selected channel's PF over sample rate.

Note: If PF order is third order and data format is signed, the maximum OSR value is 1289, if PF order is third order and data format is unsigned, the maximum OSR value is 1624, otherwise the maximum OSR value is 2047.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `pfOsr` – Control the channel's PF OSR, the minimum permissible value is 3, low value produce unpredictable result, the maximum permissible value depend on PF order and the desired data format.

```
static inline void SINC_SetChannelPfHpfAlphaCoeff(SINC_Type *base, sinc_channel_id_t chId,  
                                                  sin_primary_filter_hpf_alpha_coeff_t  
                                                  pfHpfAlphaCoeff)
```

set selected channel's HPF DC remover Alpha coefficient.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.

- `pfHpfAlphaCoeff` – Specify the HPF alpha coefficient or disable HPF as described in `sin_primary_filter_hpf_alpha_coeff_t`.

```
static inline void SINC_SetChannelPfShiftConfig(SINC_Type *base, sinc_channel_id_t chId,  
                                              sinc_primary_filter_shift_direction_t  
                                              pfShiftDirection, uint8_t pfShiftBitsNum)
```

Set the value that shifts the PF data for the correct 24-bit precision.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `pfShiftDirection` – Specify the PF shift direction, including right and left.
- `pfShiftBitsNum` – Specify the PF shift value, range from 0 to 15.

```
static inline void SINC_SetChannelPfBiasConfig(SINC_Type *base, sinc_channel_id_t chId,  
                                              sinc_primary_filter_bias_sign_t pfBiasSign,  
                                              uint32_t pfBiasValue)
```

Set the bias offset for the selected channel's PF.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `pfBiasSign` – Specify the bias sign, please refer to `sinc_primary_filter_bias_sign_t` for details.
- `pfBiasValue` – The bias value to subtracted from the output of PF shift block, range from 0 to `0x7FFFFFFUL`.

```
static inline void SINC_EnableChannelPrimaryFilter(SINC_Type *base, sinc_channel_id_t chId,  
                                                  bool enable)
```

Enable/disable selected channel's primary filter.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `enable` – Used to enable primary filter:
 - **true** Enable channel's PF;
 - **false** Disable channel's PF.

```
static inline bool SINC_CheckChannelParallelSerialDataReady(SINC_Type *base, sinc_channel_id_t  
                                                           chId)
```

Check whether selected channel's multipurpose data is ready to write parallel or serial data.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, refer to `sinc_channel_id_t` for details.

Return values

- **true** – Selected channel's multipurpose data is ready to write parallel or serial data.
- **false** – Selected channel's multipurpose data is not ready to write parallel or serial data.

```
static inline bool SINC_CheckChannelPrimaryCICSaturation(SINC_Type *base, sinc_channel_id_t chId)
```

Check whether primary CIC filter saturation occurred.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to sinc_channel_id_t for details.

Return values

- true – Selected channel's primary CIC filter saturation occurred.
- false – Selected channel's primary CIC filter saturation did not occurred.

```
static inline bool SINC_CheckChannelHPFSaturation(SINC_Type *base, sinc_channel_id_t chId)
```

Check whether HPF saturation occurred.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to sinc_channel_id_t for details.

Return values

- true – Selected channel's HPF saturation occurred.
- false – Selected channel's HPF saturation did not occurred.

```
static inline bool SINC_CheckChannelShiftSaturation(SINC_Type *base, sinc_channel_id_t chId)
```

Check whether Shift saturation occurred.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to sinc_channel_id_t for details.

Return values

- true – Selected channel's shift saturation occurred.
- false – Selected channel's shift saturation did not occurred.

```
static inline bool SINC_CheckChannelBiasSaturation(SINC_Type *base, sinc_channel_id_t chId)
```

Check whether bias saturation occurred.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to sinc_channel_id_t for details.

Return values

- true – Selected channel's bias saturation occurred.
- false – Selected channel's bias saturation did not occurred.

```
uint8_t SINC_GetChannelConversionCount(SINC_Type *base, sinc_channel_id_t chId)
```

Get selected channel's number of conversions.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, refer to sinc_channel_id_t for details.

Returns

uint8_t Selected channel's number of conversions.

static inline bool SINC_CheckChannelConvProgress(SINC_Type *base, *sinc_channel_id_t* chId)
Check whether the selected channel is in conversion.

Parameters

- base – SINC peripheral base address.
- chId – The id of sinc channel to check.

Return values

- false – Selected channel conversion not in progress.
- true – Selected channel conversion in progress.

static inline bool SINC_CheckChannelReadyForConv(SINC_Type *base, *sinc_channel_id_t* chId)
Check whether the selected channel is ready for conversion.

Parameters

- base – SINC peripheral base address.
- chId – The id of sinc channel to check.

Return values

- true – Selected channel is ready for conversion.
- false – Selected channel is not ready for conversion.

static inline void SINC_SetChannelLowLimitThreshold(SINC_Type *base, *sinc_channel_id_t* chId,
uint32_t lowLimitThreshold)

Set selected channel's low-limit threshold value.

Note: When the data exceeds the low-limit threshold value, a low-limit event occurs, and the limit threshold format is determined by channel's result data format *sinc_result_data_format_t*.

Note: Low limit value must be lower than high limit value, otherwise the low-limit threshold does not work.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- lowLimitThreshold – Specify the low-limit threshold value, range from 0 to 0xFFFFFFFFUL.

static inline void SINC_SetChannelHighLimitThreshold(SINC_Type *base, *sinc_channel_id_t* chId,
uint32_t highLimitThreshold)

Set selected channel's high-limit threshold value.

Note: When the data exceeds the high-limit threshold value, a high-limit event occurs, and the limit threshold format is determined by channel's result data format *sinc_result_data_format_t*.

Parameters

- base – SINC peripheral base address.

- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `highLimitThreshold` – Specify the high-limit threshold value, range from 0 to 0xFFFFFFFFUL.

```
static inline void SINC_SetChannelLimitDetectorMode(SINC_Type *base, sinc_channel_id_t chId,  
                                                    sinc_limit_detector_mode_t mode)
```

Set selected channel's limit detector mode.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `mode` – Specify the mode of limit detector, please refer to `sinc_limit_detector_mode_t`.

```
static inline void SINC_EnableChannelHighLimitBreakSignal(SINC_Type *base, sinc_channel_id_t  
                                                         chId, bool enable)
```

Enable/disable selected channel's high limit break signal.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `enable` – Used to enable/disable high limit break signal:
 - **true** Enable the automatic assertion of the `BREAK_HIGH` signal when SINC detects a high-limit event on the selected channel.
 - **false** Disable high limit break signal.

```
static inline void SINC_EnableChannelWindowLimitBreakSignal(SINC_Type *base,  
                                                           sinc_channel_id_t chId, bool  
                                                           enable)
```

Enable/disable selected channel's window limit break signal.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `enable` – Used to enable/disable window limit break signal:
 - **true** Enable the automatic assertion of the `BREAK_WIN` signal when SINC detects a window-limit event on the selected channel.
 - **false** Disable window limit break signal.

```
static inline void SINC_EnableChannelLowLimitBreakSignal(SINC_Type *base, sinc_channel_id_t  
                                                         chId, bool enable)
```

Enable/disable selected channel's low limit break signal.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `enable` – Used to enable/disable low limit break signal:
 - **true** Enable the automatic assertion of the `BREAK_LOW` signal when SINC detects a low-limit event on the selected channel.
 - **false** Disable low limit break signal.

```
static inline void SINC_SetChannelScdOperateMode(SINC_Type *base, sinc_channel_id_t chId,  
                                                sinc_scd_operate_mode_t opMode)
```

Set selected channel's short-circuit detector operate mode.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- opMode – Specify the operate mode to set, please refer to *sinc_scd_operate_mode_t*.

```
static inline void SINC_SetChannelScdLimitThreshold(SINC_Type *base, sinc_channel_id_t chId,  
                                                  uint8_t u8ScdLimitThreshold)
```

Set selected channel's Scd limit threshold.

Note:

The SCD counter tracks the number of received bits with the same repeating value(always 0 or always 1, set by

`SINC_SetChannelScdOption()`), if that number exceeds the `scdLimitThreshold`, an SCD event occurs on the associated channel.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- u8ScdLimitThreshold – Specify the threshold value for the SCD counter, range from 2 to 255.

```
static inline void SINC_SetChannelScdOption(SINC_Type *base, sinc_channel_id_t chId,  
                                           sinc_scd_option_t option)
```

Set selected channel's SDC option.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- option – Specify which repeating bit value increments the SCD counter.

```
static inline void SINC_EnableChannelScdBreakSignal(SINC_Type *base, sinc_channel_id_t chId,  
                                                  bool enable)
```

Enable/disable the automatic assertion of the `BREAK_SCD` signal when SINC detects an SCD event on the selected channel.

Parameters

- base – SINC peripheral base address.
- chId – Selected channel id, please refer to *sinc_channel_id_t*.
- enable – Used to enable/disable SCD break signal:
 - **true** Enable SCD break signal.
 - **false** Disable SCD break signal.

```
static inline void SINC_SetChannelCadLimitThreshold(SINC_Type *base, sinc_channel_id_t chId,  
                                                    sinc_cad_threshold_t cadLimitThreshold)
```

Set the threshold value for the CAD counter.

Note: The CAD counter tracks the number of clock cycles during which SINC does not detect a clock, if that number exceeds the threshold value, a CAD event occurs on the selected channel.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.
- *cadLimitThreshold* – Specify the threshold value for the CAD counter, please refer to *sinc_cad_threshold_t*.

```
static inline void SINC_EnableChannelCadBreakSignal(SINC_Type *base, sinc_channel_id_t chId,  
                                                    bool enable)
```

Enable/disable the automatic assertion of the BREAK_CAD signal when SINC detects a CAD event on the associated channel.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.
- *enable* – Used to enable/disable CAD break signal:
 - **true** Enable selected channel's CAD break signal;
 - **false** Disable selected channel's CAD break signal.

```
static inline void SINC_SetChannelZcdOperateMode(SINC_Type *base, sinc_channel_id_t chId,  
                                                  sinc_zero_cross_operate_mode_t opMode)
```

Set selected channel's zero-crossing detector operate mode.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.
- *opMode* – Specify the operate mode, please refer to *sinc_zero_cross_operate_mode_t*.

```
static inline void SINC_SetChannelPulseTriggerMux(SINC_Type *base, sinc_channel_id_t chId,  
                                                  sinc_pulse_trigger_mux_t pulseTrigMux)
```

Set selected channel's pulse trigger mux.

Parameters

- *base* – SINC peripheral base address.
- *chId* – Selected channel id, please refer to *sinc_channel_id_t*.
- *pulseTrigMux* – Used to selected the signal for pulse-trigger output.

```
static inline void SINC_SetChannelDebugOutput(SINC_Type *base, sinc_channel_id_t chId,  
                                              sinc_debug_output_t debugOutput)
```

Set selected channel's debug output.

Parameters

- *base* – SINC peripheral base address.

- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.
- `debugOutput` – Used to select debug output, please refer to `sinc_debug_output_t`.

`static inline void SINC_LatchChannelDebugProceduce(SINC_Type *base, sinc_channel_id_t chId)`
Start selected channel's debug data latch proceduce.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.

`static inline bool SINC_CheckChannelDebugDataValid(SINC_Type *base, sinc_channel_id_t chId)`
Check if the selected channel's debug data is valid.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.

Return values

- `true` – Data is valid.
- `false` – Data is invalid.

`static inline uint32_t SINC_GetChannelDebugData(SINC_Type *base, sinc_channel_id_t chId)`
Return selected channel's the debug data that requested by `SINC_SetChannelDebugOutput()`.

Parameters

- `base` – SINC peripheral base address.
- `chId` – Selected channel id, please refer to `sinc_channel_id_t`.

Returns

Selected channel's debug data.

`static inline void SINC_EnableInterrupts(SINC_Type *base, uint64_t interruptMasks)`
Enable the mask of interrupts, such as channel data ready interrupt, channel limit detect interrupt and so on.

Parameters

- `base` – SINC peripheral base address.
- `interruptMasks` – Mask of interrupts to enable, should be the OR'ed value of `sinc_interrupt_enable_t`.

`static inline void SINC_DisableInterrupts(SINC_Type *base, uint64_t interruptMasks)`
Enable the mask of interrupts, such as channel data ready interrupt, channel limit detect interrupt and so on.

Parameters

- `base` – SINC peripheral base address.
- `interruptMasks` – Mask of interrupts to disable, should be the OR'ed value of `sinc_interrupt_enable_t`.

`static inline uint64_t SINC_GetInterruptStatus(SINC_Type *base)`
Get interrupt status flags.

Parameters

- `base` – SINC peripheral base address.

Returns

SINC module's interrupt status flags, the OR'ed value of `sinc_interrupt_status_t`.

```
static inline void SINC_ClearInterruptStatus(SINC_Type *base, uint64_t statusMasks)
```

Clear selected mask of interrupt status flags.

Parameters

- `base` – SINC peripheral base address.
- `statusMasks` – The mask of interrupt status flags to clear, should be the OR'ed value of `sinc_interrupt_status_t`.

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```
enum _sinc_interrupt_enable
```

The enumeration of SINC module's interrupts. .

Values:

enumerator `kSINC_CH0ConvCompleteIntEnable`

enumerator `kSINC_CH1ConvCompleteIntEnable`

enumerator `kSINC_CH2ConvCompleteIntEnable`

enumerator `kSINC_CH3ConvCompleteIntEnable`

enumerator `kSINC_CH0DataReadyIntEnable`

enumerator `kSINC_CH1DataReadyIntEnable`

enumerator `kSINC_CH2DataReadyIntEnable`

enumerator `kSINC_CH3DataReadyIntEnable`

enumerator `kSINC_CH0ZeroCrossDetectedIntEnable`

enumerator `kSINC_CH1ZeroCrossDetectedIntEnable`

enumerator `kSINC_CH2ZeroCrossDetectedIntEnable`

enumerator `kSINC_CH3ZeroCrossDetectedIntEnable`

enumerator `kSINC_CH0SCDIntEnable`

enumerator `kSINC_CH1SCDIntEnable`

enumerator `kSINC_CH2SCDIntEnable`

enumerator `kSINC_CH3SCDIntEnable`

enumerator `kSINC_CH0WindowLimitIntEnable`

enumerator `kSINC_CH1WindowLimitIntEnable`

enumerator `kSINC_CH2WindowLimitIntEnable`

enumerator `kSINC_CH3WindowLimitIntEnable`

enumerator `kSINC_CH0LowLimitIntEnable`

enumerator `kSINC_CH1LowLimitIntEnable`

enumerator kSINC_CH2LowLimitIntEnable
enumerator kSINC_CH3LowLimitIntEnable
enumerator kSINC_CH0HighLimitIntEnable
enumerator kSINC_CH1HighLimitIntEnable
enumerator kSINC_CH2HighLimitIntEnable
enumerator kSINC_CH3HighLimitIntEnable
enumerator kSINC_CH0FifoUnderflowIntEnable
enumerator kSINC_CH1FifoUnderflowIntEnable
enumerator kSINC_CH2FifoUnderflowIntEnable
enumerator kSINC_CH3FifoUnderflowIntEnable
enumerator kSINC_CH0FifoOverflowIntEnable
enumerator kSINC_CH1FifoOverflowIntEnable
enumerator kSINC_CH2FifoOverflowIntEnable
enumerator kSINC_CH3FifoOverflowIntEnable
enumerator kSINC_CH0CADIntEnable
enumerator kSINC_CH1CADIntEnable
enumerator kSINC_CH2CADIntEnable
enumerator kSINC_CH3CADIntEnable
enumerator kSINC_CH0SaturationIntEnable
enumerator kSINC_CH1SaturationIntEnable
enumerator kSINC_CH2SaturationIntEnable
enumerator kSINC_CH3SaturationIntEnable

enum _sinc_interrupt_status

The enumeration of SINC interrupt status flags. .

Values:

enumerator kSINC_CH0ConvCompleteIntStatus
enumerator kSINC_CH1ConvCompleteIntStatus
enumerator kSINC_CH2ConvCompleteIntStatus
enumerator kSINC_CH3ConvCompleteIntStatus
enumerator kSINC_CH0DataReadyIntStatus
enumerator kSINC_CH1DataReadyIntStatus
enumerator kSINC_CH2DataReadyIntStatus
enumerator kSINC_CH3DataReadyIntStatus
enumerator kSINC_CH0ZeroCrossDetectedIntStatus

enumerator kSINC_CH1ZeroCrossDetectedIntStatus
enumerator kSINC_CH2ZeroCrossDetectedIntStatus
enumerator kSINC_CH3ZeroCrossDetectedIntStatus
enumerator kSINC_CH0SCDIntStatus
enumerator kSINC_CH1SCDIntStatus
enumerator kSINC_CH2SCDIntStatus
enumerator kSINC_CH3SCDIntStatus
enumerator kSINC_CH0WindowLimitIntStatus
enumerator kSINC_CH1WindowLimitIntStatus
enumerator kSINC_CH2WindowLimitIntStatus
enumerator kSINC_CH3WindowLimitIntStatus
enumerator kSINC_CH0LowLimitIntStatus
enumerator kSINC_CH1LowLimitIntStatus
enumerator kSINC_CH2LowLimitIntStatus
enumerator kSINC_CH3LowLimitIntStatus
enumerator kSINC_CH0HighLimitIntStatus
enumerator kSINC_CH1HighLimitIntStatus
enumerator kSINC_CH2HighLimitIntStatus
enumerator kSINC_CH3HighLimitIntStatus
enumerator kSINC_CH0FifoUnderflowIntStatus
enumerator kSINC_CH1FifoUnderflowIntStatus
enumerator kSINC_CH2FifoUnderflowIntStatus
enumerator kSINC_CH3FifoUnderflowIntStatus
enumerator kSINC_CH0FifoOverflowIntStatus
enumerator kSINC_CH1FifoOverflowIntStatus
enumerator kSINC_CH2FifoOverflowIntStatus
enumerator kSINC_CH3FifoOverflowIntStatus
enumerator kSINC_CH0CADIntStatus
enumerator kSINC_CH1CADIntStatus
enumerator kSINC_CH2CADIntStatus
enumerator kSINC_CH3CADIntStatus
enumerator kSINC_CH0SaturationIntStatus
enumerator kSINC_CH1SaturationIntStatus

enumerator kSINC_CH2SaturationIntStatus

enumerator kSINC_CH3SaturationIntStatus

enum _sinc_channel_id

The enumeration of channel id, the sinc module contains 4 channels.

Values:

enumerator kSINC_Channel0

Channel 0.

enumerator kSINC_Channel1

Channel 1.

enumerator kSINC_Channel2

Channel 2.

enumerator kSINC_Channel3

Channel 3.

enum _sinc_modulator_clock

The enumeration of modulator clock name. .

Values:

enumerator kSINC_ModClk0

Modulator Clock 0 output.

enumerator kSINC_ModClk1

Modulator Clock 1 output.

enumerator kSINC_ModClk2

Modulator Clock 2 output.

enum _sinc_inputClk_source

The enumeration of input clock.

Values:

enumerator kSINC_InputClk_SourceMclkOut0

MCLK_OUT0 with internal routeback.

enumerator kSINC_InputClk_SourceMclkOut1

MCLK_OUT1 with internal routeback.

enumerator kSINC_InputClk_SourceMclkOut2

MCLK_OUT2 with internal routeback.

enumerator kSINC_InputClk_SourceExternalModulatorClk

External modulator clock dedicated to the selected channel.

enumerator kSINC_InputClk_SourceAdjacentChannelClk

Grouped clock shared with an adjacent channel.

enum _sinc_inputClk_edge

The enumeration of clock edge.

Values:

enumerator kSINC_InputClk_EdgePositive

Positive edge.

enumerator kSINC_InputClk_EdgeNegative

Negative edge.

enumerator kSINC_InputClk_EdgeBoth

Both edges.

enumerator kSINC_InputClk_EdgeOddPositive

Every other odd positive edge.

enumerator kSINC_InputClk_EdgeEvenPositive

Every other even positive edge.

enumerator kSINC_InputClk_EdgeOddNegative

Every other odd negative edge.

enumerator kSINC_InputClk_EdgeEvenNegative

Every other even negative edge.

enum _sinc_inputBit_format

The enumeration of input bit format.

Values:

enumerator kSINC_InputBit_FormatExternalBitstream

External bitstream from the MBIT[n] signal.

enumerator kSINC_InputBit_FormatExternalManchesterCode

External Manchester code.

enumerator kSINC_InputBit_FormatInternal16bitParallelData

Internal 16-bit parallel data from MPDATA register.

enumerator kSINC_InputBit_FormatInternal32bitSerialData

Internal 32-bit serial data from MPDATA.

enum _sinc_inputBit_source

The enumeration of input bit source.

Values:

enumerator kSINC_InputBit_SourceExternalBitstream

External bitstream from the MBIT[n] signal.

enumerator kSINC_InputBit_SourceInternalBitstream

Alternate internal bitstream from the INP[n] signal.

enumerator kSINC_InputBit_SourceAdjacentChannel

Grouped bitstream shared with an adjacent channel.

enum _sinc_conv_trigger_source

The enumeration of trigger source.

Values:

enumerator kSINC_ConvTrig_SoftPosEdge

Positive edge software trigger.

enumerator kSINC_ConvTrig_SoftHighLevel

High level software trigger.

enumerator kSINC_ConvTrig_HardPosEdge

Positive edge hardware trigger.

enumerator kSINC_ConvTrig_HardHighLevel

High level hardware trigger.

enumerator kSINC_ConvTrig_AdjacentChannel

Grouped hardware trigger shared with an adjacent channel.

enum _sinc_conv_mode

The enumeration of conversion mode.

Values:

enumerator kSINC_ConvMode_Single

One conversion that follows an edge or level trigger event.

enumerator kSINC_ConvMode_Continuous

Multiple conversions that follow a triggering event, a new triggering event cancels and restarts conversion.

enumerator kSINC_ConvMode_Always

Multiple conversions that follow the first triggering event, SINC ignores the next triggering event.

enumerator kSINC_ConvMode_FixedNumber

Fixed number conversions that follow the first triggering event, a new triggering event cancels and restarts conversion.

enum _sinc_pulse_trigger_mux

The enumeration of pulse trigger mux.

Values:

enumerator kSINC_PulseTrigger_Disabled

Disable pulse trigger output.

enumerator kSINC_PulseTrigger_MuxHighLimitLevelSignal

Select high limit level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxLowLimitLevelSignal

Select low limit level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxHighLowLimitLevelSignal

Select low or high limit level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxWindowLimitLevelSignal

Select window limit level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxZeroCrossRisingLevelSignal

Select zero cross rising level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxZeroCrossFallingLevelSignal

Select zero cross falling level signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxRsLimHighLevelSignal

Select level signal that indicates a high level from an RS flip-flop or a schmitt trigger for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxRsLimLowLevelSignal

Select level signal that indicates a low level from an RS flip-flop or a schmitt trigger for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxChannelRawInputModBitStream

Select channel raw input modulator bitstream for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxChannelRawInputModClock

Select channel raw input modulator clock for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxChannelRecoveredModBitStream
Select channel output recovered modulator bitstream for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxChannelRecoveredModClock
Select channel output recovered modulator clock for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxHighLimitPulseSignal
Select high limit pulse signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxLowLimitPulseSignal
Select low limit pulse signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxLimitPulseSignal
Select the pulse signal that indicates a high/low/window limit for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxWindowLimitPulseSignal
Select window limit pulse signal for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxHighLowLimitPulseSignal
Select the pulse signal that indicates a high or low limit for pulse trigger output.

enumerator kSINC_PulseTrigger_MuxZeroCrossRisePulseSignal
Select zero cross rise pulse signal for trigger output.

enumerator kSINC_PulseTrigger_MuxZeroCrossFallPulseSignal
Select zero cross fall pulse signal for trigger output.

enumerator kSINC_PulseTrigger_MuxZeroCrossRiseFallPulseSignal
Select zero cross rise/fall pulse signal for trigger output.

enumerator kSINC_PulseTrigger_MuxFifoWatermarkOkPulseSignal
Select FIFO watermark OK pulse signal for trigger output.

enumerator kSINC_PulseTrigger_MuxFifoOverflowPulseSignal
Select FIFO overflow pulse signal.

enumerator kSINC_PulseTrigger_MuxFifoUnderflowPulseSignal
Select FIFO underflow pulse signal.

enumerator kSINC_PulseTrigger_MuxFifoEmptyPulseSignal
Select FIFO empty pulse signal.

enumerator kSINC_PulseTrigger_MuxClockMonitorAssertPulseSignal
Select clock monitor assert pulse signal.

enumerator kSINC_PulseTrigger_MuxShortCircuitAssertPulseSignal
Select short circuit assert pulse signal.

enumerator kSINC_PulseTrigger_MuxSaturationPulseSignal
Select saturation pulse signal.

enumerator kSINC_PulseTrigger_MuxConversionCompletePulseSignal
Select conversion complete pulse signal.

enum _sinc_zero_cross_operate_mode
The enumeration of zero cross detector operate mode.
Values:

enumerator kSINC_ZCD_BothRiseAndFall
Zero cross detector operate on both rise and fall.

enumerator kSINC_ZCD_OnlyFall

Zero cross detector operate on fall edge.

enumerator kSINC_ZCD_OnlyRise

Zero cross detector operate on rise edge.

enumerator kSINC_ZCD_Disabled

Zero cross detector disabled.

enum _sinc_primary_filter_order

The enumeration of primary filter order.

Values:

enumerator kSINC_PF_FastSinc

Fast sinc filter, ORD is 4.

enumerator kSINC_PF_FirstOrder

First order filter, ORD is 1.

enumerator kSINC_PF_SecondOrder

Second order filter, ORD is 2.

enumerator kSINC_PF_ThirdOrder

Third order filter, ORD is 3.

enum _sinc_clock_prescale

The enumeration of clock prescale that specify the clock divider ratio for the modulator clock.

Values:

enumerator kSINC_ClkPrescale1

No prescale.

enumerator kSINC_ClkPrescale2

Modulator clock divider ratio is 2.

enumerator kSINC_ClkPrescale4

Modulator clock divider ratio is 4.

enumerator kSINC_ClkPrescale8

Modulator clock divider ratio is 8.

enum _sinc_primary_filter_shift_direction

The enumeration of primary filter shift direction.

Values:

enumerator kSINC_PF_ShiftRight

Right shift the raw data.

enumerator kSINC_PF_ShiftLeft

Left shift the raw data.

enum _sinc_primary_filter_bias_sign

The enumeration of primary filter bias sign.

Values:

enumerator kSINC_PF_BiasPositive

The bias sign is positive.

enumerator kSINC_PF_BiasNegative

The bias sign is negative.

enum _sinc_primary_filter_hpf_alpha_coeff

The enumeration of HPF DC remover Alpha coefficient.

Values:

enumerator kSINC_PF_HPFAAlphaCoeff0

Disabled HPF.

enumerator kSINC_PF_HPFAAlphaCoeff1

Alpha coefficient = $1 - (2^{-5})$

enumerator kSINC_PF_HPFAAlphaCoeff2

Alpha coefficient = $1 - (2^{-6})$

enumerator kSINC_PF_HPFAAlphaCoeff3

Alpha coefficient = $1 - (2^{-7})$

enumerator kSINC_PF_HPFAAlphaCoeff4

Alpha coefficient = $1 - (2^{-8})$

enumerator kSINC_PF_HPFAAlphaCoeff5

Alpha coefficient = $1 - (2^{-9})$

enumerator kSINC_PF_HPFAAlphaCoeff6

Alpha coefficient = $1 - (2^{-10})$

enumerator kSINC_PF_HPFAAlphaCoeff7

Alpha coefficient = $1 - (2^{-11})$

enumerator kSINC_PF_HPFAAlphaCoeff8

Alpha coefficient = $1 - (2^{-12})$

enumerator kSINC_PF_HPFAAlphaCoeff9

Alpha coefficient = $1 - (2^{-13})$

enumerator kSINC_PF_HPFAAlphaCoeff10

Alpha coefficient = $1 - (2^{-14})$

enumerator kSINC_PF_HPFAAlphaCoeff11

Alpha coefficient = $1 - (2^{-15})$

enumerator kSINC_PF_HPFAAlphaCoeff12

Alpha coefficient = $1 - (2^{-16})$

enumerator kSINC_PF_HPFAAlphaCoeff13

Alpha coefficient = $1 - (2^{-17})$

enumerator kSINC_PF_HPFAAlphaCoeff14

Alpha coefficient = $1 - (2^{-18})$

enumerator kSINC_PF_HPFAAlphaCoeff15

Alpha coefficient = $1 - (2^{-19})$

enum _sinc_inputBit_delay

The enumeration of input bit delay.

Values:

enumerator kSINC_InputBit_DelayDisabled

Input modulator bitstream delay disabled.

enumerator kSINC_InputBit_Delay1ClkCycle
Input modulator bitstream delay 1 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay2ClkCycle
Input modulator bitstream delay 2 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay3ClkCycle
Input modulator bitstream delay 3 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay4ClkCycle
Input modulator bitstream delay 4 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay5ClkCycle
Input modulator bitstream delay 5 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay6ClkCycle
Input modulator bitstream delay 6 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay7ClkCycle
Input modulator bitstream delay 7 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay8ClkCycle
Input modulator bitstream delay 8 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay9ClkCycle
Input modulator bitstream delay 9 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay10ClkCycle
Input modulator bitstream delay 10 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay11ClkCycle
Input modulator bitstream delay 11 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay12ClkCycle
Input modulator bitstream delay 12 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay13ClkCycle
Input modulator bitstream delay 13 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay14ClkCycle
Input modulator bitstream delay 14 PRE_CLK cycle.

enumerator kSINC_InputBit_Delay15ClkCycle
Input modulator bitstream delay 15 PRE_CLK cycle.

enum _sinc_scd_operate_mode
The enumeration of short-circuit detector operate mode.
Values:

enumerator kSINC_Scd_OperateAtChannelEnabled
SCD operates when the channel is enabled.

enumerator kSINC_Scd_OperateAtConversion
SCD operates when the PF is performing a conversion.

enumerator kSINC_Scd_OperateDisabled
Short circuit detect is disabled.

enum _sinc_scd_option
The enumeration of short-circuit detector option.
Values:

enumerator kSINC_Scd_DetectRepeating0And1

Both repeating 0 and 1 increment the SCD counter.

enumerator kSINC_Scd_DetectRepeatingOnly1

Only repeating 1 increment the SCD counter.

enumerator kSINC_Scd_DetectRepeatingOnly0

Only repeating 1 increment the SCD counter.

enum _sinc_limit_detector_mode

The mode of limit detector.

Note: The value of each limit detector contains lot of information: bit[1:0]: limit detection options, bit[2]: low limit break signal. bit[3]: window limit break signal. bit[4]: High limit break signal. bit[7]: Enable/disable limit detector.

Values:

enumerator kSINC_Lmt_BothHighAndLowLimit

Limit detector is enabled, and compare the filter sample value to high and low limit, if the value larger than high limit will trigger interrupt or break, and if the value lower than low limit will trigger interrupt or break.

enumerator kSINC_Lmt_OnlyHighLimit

Limit detector is enabled, and compare the filter sample value to high limit, if the value larger than high limit will trigger interrupt or break.

enumerator kSINC_Lmt_OnlyLowLimit

Limit detector is enabled, and compare the filter sample value to low limit, if the value lower than low limit will trigger interrupt or break.

enumerator kSINC_Lmt_WindowedValue

Limit detector is enabled, and compare the filter sample value to high and low limit, if the value higher than low limit and lower than high limit will trigger interrupt or break.

enumerator kSINC_Lmt_Disabled

Limit detector is disabled.

enum _sinc_cad_threshold

The enumeration of clock-absence threshold.

Values:

enumerator kSINC_Cad_Disabled

Clock absence detector is disabled.

enumerator kSINC_Cad_Count1ClkCycle

Clock absence detector threshold is 1 clock cycle.

enumerator kSINC_Cad_Count2ClkCycle

Clock absence detector threshold is 2 clock cycle.

enumerator kSINC_Cad_Count3ClkCycle

Clock absence detector threshold is 3 clock cycle.

enumerator kSINC_Cad_Count4ClkCycle

Clock absence detector threshold is 4 clock cycle.

enumerator kSINC_Cad_Count5ClkCycle

Clock absence detector threshold is 5 clock cycle.

enumerator kSINC_Cad_Count6ClkCycle

Clock absence detector threshold is 6 clock cycle.

enumerator kSINC_Cad_Count7ClkCycle

Clock absence detector threshold is 7 clock cycle.

enumerator kSINC_Cad_Count8ClkCycle

Clock absence detector threshold is 8 clock cycle.

enumerator kSINC_Cad_Count9ClkCycle

Clock absence detector threshold is 9 clock cycle.

enumerator kSINC_Cad_Count10ClkCycle

Clock absence detector threshold is 10 clock cycle.

enumerator kSINC_Cad_Count11ClkCycle

Clock absence detector threshold is 11 clock cycle.

enumerator kSINC_Cad_Count12ClkCycle

Clock absence detector threshold is 12 clock cycle.

enumerator kSINC_Cad_Count13ClkCycle

Clock absence detector threshold is 13 clock cycle.

enumerator kSINC_Cad_Count14ClkCycle

Clock absence detector threshold is 14 clock cycle.

enumerator kSINC_Cad_Count15ClkCycle

Clock absence detector threshold is 15 clock cycle.

enum _sinc_alternate_dma_source

The enumeration of alternate DMA source.

Values:

enumerator kSINC_AltDma_Disabled

Alternate DMA disabled.

enumerator kSINC_AltDma_PfConvComplete

Select PF conversion complete for alternate DMA.

enumerator kSINC_AltDma_PfDataOutputReady

Select PF data output ready for alternate DMA.

enumerator kSINC_AltDma_ZeroCrossDetected

Select zero crossing detected for alternate DMA.

enumerator kSINC_AltDma_ShortCircuitDetected

Select short circuit detected for alternate DMA.

enumerator kSINC_AltDma_WindowLimitDetected

Select window limit detected for alternate DMA.

enumerator kSINC_AltDma_LowLimitDetected

Select low limit detected for alternate DMA.

enumerator kSINC_AltDma_HighLimitDetected

Select high limit detected for alternate DMA.

enumerator kSINC_AltDma_FifoUnderflow

Select FIFO underflow detected for alternate DMA.

enumerator kSINC_AltDma_FifoOverflow
Select FIFO overflow detected for alternate DMA.

enumerator kSINC_AltDma_ClockAbsence
Select clock absence detected for alternate DMA.

enumerator kSINC_AltDma_Saturation
Select channel saturation for alternate DMA.

enum _sinc_result_data_format
The enumeration of result data format.
Values:

enumerator kSINC_LeftJustifiedSigned
Left justified, signed.

enumerator kSINC_LeftJustifiedUnsigned
Left justified, unsigned.

enum _sinc_debug_output
The enumeration of debug output.
Values:

enumerator kSINC_Debug_PfFinalData
Final data from PF(24 bits).

enumerator kSINC_Debug_OffsetData
Offset data(24 bits).

enumerator kSINC_Debug_PfShiftedData
Shifted data from the PF(24 bits).

enumerator kSINC_Debug_HpfData
DC remover(HPF) data(32 bits).

enumerator kSINC_Debug_CicRawData
Raw data from the PF's CIC filter.

enumerator kSINC_Debug_ScdHistoricalData
Historical data from SCD.

enumerator kSINC_Debug_ManchesterDecoderData
Data from the Manchester decoder.

enumerator kSINC_Debug_CadData
Data from CAD.

enumerator kSINC_Debug_FifoEntriesNum
Number of available entries in the FIFO.

enumerator kSINC_Debug_ParallelSerialConverterStatus
Status of the parallel or serial data converter.

typedef enum _sinc_channel_id sinc_channel_id_t
The enumeration of channel id, the sinc module contains 4 channels.

typedef enum _sinc_inputClk_source sinc_inputClk_source_t
The enumeration of input clock.

typedef enum _sinc_inputClk_edge sinc_inputClk_edge_t
The enumeration of clock edge.

`typedef enum _sinc_inputBit_format sinc_inputBit_format_t`

The enumeration of input bit format.

`typedef enum _sinc_inputBit_source sinc_inputBit_source_t`

The enumeration of input bit source.

`typedef enum _sinc_conv_trigger_source sinc_conv_trigger_source_t`

The enumeration of trigger source.

`typedef enum _sinc_conv_mode sinc_conv_mode_t`

The enumeration of conversion mode.

`typedef enum _sinc_pulse_trigger_mux sinc_pulse_trigger_mux_t`

The enumeration of pulse trigger mux.

`typedef enum _sinc_zero_cross_operate_mode sinc_zero_cross_operate_mode_t`

The enumeration of zero cross detector operate mode.

`typedef enum _sinc_primary_filter_order sinc_primary_filter_order_t`

The enumeration of primary filter order.

`typedef enum _sinc_clock_prescale sinc_clock_prescale_t`

The enumeration of clock prescale that specify the clock divider ratio for the modulator clock.

`typedef enum _sinc_primary_filter_shift_direction sinc_primary_filter_shift_direction_t`

The enumeration of primary filter shift direction.

`typedef enum _sinc_primary_filter_bias_sign sinc_primary_filter_bias_sign_t`

The enumeration of primary filter bias sign.

`typedef enum _sinc_primary_filter_hpf_alpha_coeff sinc_primary_filter_hpf_alpha_coeff_t`

The enumeration of HPF DC remover Alpha coefficient.

`typedef enum _sinc_inputBit_delay sinc_inputBit_delay_t`

The enumeration of input bit delay.

`typedef enum _sinc_scd_operate_mode sinc_scd_operate_mode_t`

The enumeration of short-circuit detector operate mode.

`typedef enum _sinc_scd_option sinc_scd_option_t`

The enumeration of short-circuit detector option.

`typedef enum _sinc_limit_detector_mode sinc_limit_detector_mode_t`

The mode of limit detector.

Note: The value of each limit detector contains lot of information: bit[1:0]: limit detection options, bit[2]: low limit break signal. bit[3]: window limit break signal. bit[4]: High limit break signal. bit[7]: Enable/disable limit detector.

`typedef enum _sinc_cad_threshold sinc_cad_threshold_t`

The enumeration of clock-absence threshold.

`typedef enum _sinc_alternate_dma_source sinc_alternate_dma_source_t`

The enumeration of alternate DMA source.

`typedef enum _sinc_result_data_format sinc_result_data_format_t`

The enumeration of result data format.

`typedef enum _sinc_debug_output sinc_debug_output_t`

The enumeration of debug output.

```
typedef struct _sinc_channel_input_option sinc_channel_input_option_t
```

The structure of channel input options, including input bit settings and input clock settings.

```
typedef struct _sinc_channel_conv_option sinc_channel_conv_option_t
```

The structure of channel conversion options, including CIC filter settings, HPF settings, shift settings, bias settings and so on.

```
typedef struct _sinc_channel_protection_option sinc_channel_protection_option_t
```

The structure of channel protection options, including limit check settings, short-circuit settings, clock-absence settings, and zero-crossing settings.

```
typedef struct _sinc_channel_config sinc_channel_config_t
```

The structure of channel configurations, including channel input option, channel conversion options, channel protection options, and so on.

```
typedef struct _sinc_config sinc_config_t
```

The structure of sinc configurations, including clock settings and channels' settings.

```
SINC_CHANNEL_COUNT
```

```
SINC_NORMAL_INT_REG_ID
```

```
SINC_NORMAL_INT_NAME_COCIE
```

```
SINC_NORMAL_INT_NAME_CHFIE
```

```
SINC_NORMAL_INT_NAME_ZCDIE
```

```
SINC_ERROR_INT_REG_ID
```

```
SINC_ERROR_INT_NAME_SCDIE
```

```
SINC_ERROR_INT_NAME_WLMTIE
```

```
SINC_ERROR_INT_NAME_LLMTIE
```

```
SINC_ERROR_INT_NAME_HLMTIE
```

```
SINC_FIFO_CAD_INT_REG_ID
```

```
SINC_FIFO_CAD_INT_FUNFIE
```

```
SINC_FIFO_CAD_INT_FOVFIE
```

```
SINC_FIFO_CAD_INT_CADIE
```

```
SINC_FIFO_CAD_INT_SATIE
```

```
SINC_ENCODE_INTERRUPT(regId, name, channelId)
```

```
SINC_DECODE_INTERRUPT(interruptMask)
```

```
SINC_FIND_INT_FIELD_VALUE(mask, name)
```

```
SINC_FIND_STATUS_FIELD_VALUE(statusValue, name)
```

```
struct _sinc_channel_input_option
```

#include <fsl_sinc.h> The structure of channel input options, including input bit settings and input clock settings.

Public Members

sinc_inputBit_format_t inputBitFormat

Specify input bit format, please refer to *sinc_inputBit_format_t*.

sinc_inputBit_source_t inputBitSource

Specify input bit source, please refer to *sinc_inputBit_source_t*.

sinc_inputBit_delay_t inputBitDelay

Specify input bit delay, please refer to *sinc_inputBit_delay_t*.

sinc_inputClk_source_t inputClkSource

Specify input clock source, please refer to *sinc_inputClk_source_t*.

sinc_inputClk_edge_t inputClkEdge

Specify input clock edge, please refer to *sinc_inputClk_edge_t*.

struct *_sinc_channel_conv_option*

#include <fsl_sinc.h> The structure of channel conversion options, including CIC filter settings, HPF settings, shift settings, bias settings and so on.

Public Members

sinc_conv_mode_t convMode

Specify conversion mode, please refer to *sinc_conv_mode_t*.

sinc_conv_trigger_source_t convTriggerSource

Specify conversion trigger source, please refer to *sinc_conv_trigger_source_t*.

bool enableChPrimaryFilter

Enable/disable channel's primary filter.

sinc_primary_filter_order_t pfOrder

Specify the order of primary filter, please refer to *sinc_primary_filter_order_t*.

uint16_t u16pfOverSampleRatio

Control primary filter's OSR, the minimum permissible value is 3, low value produce unpredictable result, the maximum permissible value depend on PF order and the desired data format, if PF order is third order and data format is signed, the maximum OSR value is 1289, if PF order is third order and data format is unsigned, the maximum OSR value is 1624, otherwise the maximum OSR value is 2047. Please note that the OSR for equation is $u16pfOverSampleRatio + 1$

sinc_primary_filter_hpf_alpha_coeff_t pfHpfAlphaCoeff

Specify HPF's alpha coeff, please refer to *sinc_primary_filter_hpf_alpha_coeff_t*.

sinc_primary_filter_shift_direction_t pfShiftDirection

Select shift direction, right or left.

uint8_t u8pfShiftBitsNum

Specify the number of bits to shift the data, ranges from 0 to 15.

sinc_primary_filter_bias_sign_t pfBiasSign

Select bias sign, please refer to *sinc_primary_filter_bias_sign_t*.

uint32_t u32pfBiasValue

Range from 0 to 0x7FFFFFFUL.

struct *_sinc_channel_protection_option*

#include <fsl_sinc.h> The structure of channel protection options, including limit check settings, short-circuit settings, clock-absence settings, and zero-crossing settings.

Public Members

sinc_limit_detector_mode_t limitDetectorMode

Specify limit detector mode, please refer to *sinc_limit_detector_mode_t*.

bool bEnableLmtBreakSignal

Enable/disable limit break signal, the details of break signal is depended on detector mode.

uint32_t u32LowLimitThreshold

Specify the low-limit threshold value, range from 0 to 0xFFFFFFFFUL.

uint32_t u32HighLimitThreshold

Specify the high-limit threshold value, range from 0 to 0xFFFFFFFFUL.

sinc_scd_operate_mode_t scdOperateMode

Enable/disable scd, and set SCD operate timing.

uint8_t u8ScdLimitThreshold

Range from 2 to 255, 0 and 1 are prohibited.

sinc_scd_option_t scdOption

Specify SCD options, please refer to *sinc_scd_option_t*.

bool bEnableScdBreakSignal

Enable/disable SCD break signal.

sinc_cad_threshold_t cadLimitThreshold

Specify the threshold value for the CAD counter.

bool bEnableCadBreakSignal

Enable/disable CAD break signal.

sinc_zero_cross_operate_mode_t zcdOperateMode

Specify zero cross detector operate mode.

struct *_sinc_channel_config*

#include <fsl_sinc.h> The structure of channel configurations, including channel input option, channel conversion options, channel protection options, and so on.

Public Members

bool bEnableChannel

Enable/disable channel.

bool bEnableFifo

Enable/disable channel's FIFO.

uint8_t u8FifoWaterMark

Specify the fifo watermark, range from 0 to 15.

bool bEnablePrimaryDma

Used to enable/disable primary DMA.

sinc_alternate_dma_source_t altDmaSource

Set channel's alternate DMA source, please refer to *sinc_alternate_dma_source_t*.

sinc_result_data_format_t dataFormat

Set channel's result data format, please refer to *sinc_result_data_format_t*.

sinc_channel_input_option_t *chInputOption

The pointer to *sinc_channel_input_option_t* that contains channel input options.

sinc_channel_conv_option_t *chConvOption

The pointer to *sinc_channel_conv_option_t* that contains channel conversion options.

sinc_channel_protection_option_t *chProtectionOption

The pointer to *sinc_channel_protection_option_t* that contains channel protection options.

struct __sinc_config

#include <fsl_sinc.h> The structure of sinc configurations, including clock settings and channels' settings.

Public Members

sinc_clock_prescale_t clockPreDivider

Specify modulator clock pre divider, please refer to *sinc_clock_prescale_t*.

uint32_t modClkDivider

Range from 2 to 256, 0 and 1 are prohibited, to obtain a 50% duty cycle in the MCLK output, write an even value to

bool disableModClk0Output

Disable/enable modulator clock0 output.

bool disableModClk1Output

Disable/enable modulator clock1 output.

bool disableModClk2Output

Disable/enable modulator clock2 output.

sinc_channel_config_t *channelsConfigArray[(1)]

The array that contains 4 elements, and the type of each element is ***sinc_channel_config_t*** *, *channelsConfigArray*[0] corresponding to channel0, *channelsConfigArray*[1] corresponding to channel1, *channelsConfigArray*[2] corresponding to channel2, *channelsConfigArray*[3] corresponding to channel3, if some channels are not used, the corresponding elements should be set as NULL.

bool disableDozeMode

Disable/enable SINC module when the chip enters Doze or stop mode.

bool enableMaster

Enable/disable all function blocks of SINC module.

2.123 SOC_SRC Driver

enum __src_core_name

System core.

Values:

enumerator kSRC_CM33Core

System Core CM33.

enumerator kSRC_CM7Core

System Core CM7.

enum _src_boot_fuse_selection

The enumeration of the boot fuse selection.

Values:

enumerator kSRC_SerialDownloaderBootFlow

The Boot flow jumps directly to the serial downloader.

enumerator kSRC_NormalBootFlow

The Boot flow follows the Normal Boot flow.

enum _src_reset_source

The enumeration of global system reset sources.

Values:

enumerator kSRC_Wdog1Reset

WDOG1 triggers the global system reset.

enumerator kSRC_Wdog2Reset

WDOG2 triggers the global system reset.

enumerator kSRC_Wdog3Reset

WDOG3 triggers the global system reset.

enumerator kSRC_Wdog4Reset

WDOG4 triggers the global system reset.

enumerator kSRC_Wdog5Reset

WDOG5 triggers the global system reset.

enumerator kSRC_TempsenseReset

Tempsense triggers the global system reset.

enumerator kSRC_SentinelReset

Sentinel triggers the global system reset.

enumerator kSRC_JtagSoftwareReset

JTAG software triggers the global system reset.

enumerator kSRC_CM33LockUpReset

CM33 lockup triggers the global system reset.

enumerator kSRC_CM33RequestReset

CM33 request triggers the global system reset.

enumerator kSRC_CM7LockUpReset

CM7 lockup triggers the global system reset.

enumerator kSRC_CM7RequestReset

CM7 request triggers the global system reset.

enumerator kSRC_DcdcOverVoltageReset

DCDC over voltage triggers the global system reset.

enumerator kSRC_EcatResetOutputReset

EtherCAT reset output triggers the global system reset.

enum _src_reset_status_flags

The enumeration of reset status flags.

Values:

enumerator kSRC_PORResetFlag

Reset is the result of POR.

enumerator kSRC_Wdog1ResetFlag

Reset is the result of watchdog1 time-out event.

enumerator kSRC_Wdog2ResetFlag

Reset is the result of watchdog2 time-out event.

enumerator kSRC_Wdog3ResetFlag

Reset is the result of watchdog3 time-out event.

enumerator kSRC_Wdog4ResetFlag

Reset is the result of watchdog4 time-out event.

enumerator kSRC_Wdog5ResetFlag

Reset is the result of watchdog5 time-out event.

enumerator kSRC_TempsenseResetFlag

Reset is the result of software reset from temperature sensor.

enumerator kSRC_SentinelResetFlag

Reset is the result of the Sentinel's reset event.

enumerator kSRC_JtagSoftwareResetFlag

Reset is the result of software reset from JTAG.

enumerator kSRC_CM33RequestResetFlag

Reset is the result of CM33 reset request.

enumerator kSRC_CM33LockUpResetFlag

Reset is the result of CM33 CPU lockup.

enumerator kSRC_CM7RequestResetFlag

Reset is the result of CM7 reset request.

enumerator kSRC_CM7LockUpResetFlag

Reset is the result of CM7 CPU lockup.

enumerator kSRC_DcdcOverVoltageResetFlag

Reset is the result of DCDC over voltage.

enumerator kSRC_EcatResetOutputResetFlag

Reset is the result of ECAT reset output.

enumerator kSRC_IppResetFlag

Reset is the result of chip PAD POR_B.

enum _src_reset_mode

The enumeration of global system reset mode.

Values:

enumerator kSRC_ResetSystem

Generate the global system reset.

enumerator kSRC_DoNotResetSystem

Do not generate the global system reset.

enum _src_general_purpose_register_index

The index of each general purpose register.

Values:

enumerator kSRC_GeneralPurposeRegister0
The index of General Purpose Register0.

enumerator kSRC_GeneralPurposeRegister1
The index of General Purpose Register1.

enumerator kSRC_GeneralPurposeRegister2
The index of General Purpose Register2.

enumerator kSRC_GeneralPurposeRegister3
The index of General Purpose Register3.

enumerator kSRC_GeneralPurposeRegister4
The index of General Purpose Register4.

enumerator kSRC_GeneralPurposeRegister5
The index of General Purpose Register5.

enumerator kSRC_GeneralPurposeRegister6
The index of General Purpose Register6.

enumerator kSRC_GeneralPurposeRegister7
The index of General Purpose Register7.

enumerator kSRC_GeneralPurposeRegister8
The index of General Purpose Register8.

enumerator kSRC_GeneralPurposeRegister9
The index of General Purpose Register9.

enumerator kSRC_GeneralPurposeRegister10
The index of General Purpose Register10.

enumerator kSRC_GeneralPurposeRegister11
The index of General Purpose Register11.

enumerator kSRC_GeneralPurposeRegister12
The index of General Purpose Register12.

enumerator kSRC_GeneralPurposeRegister13
The index of General Purpose Register13.

enumerator kSRC_GeneralPurposeRegister14
The index of General Purpose Register14.

enumerator kSRC_GeneralPurposeRegister15
The index of General Purpose Register15.

enumerator kSRC_GeneralPurposeRegister16
The index of General Purpose Register16.

enumerator kSRC_GeneralPurposeRegister17
The index of General Purpose Register17.

enumerator kSRC_GeneralPurposeRegister18
The index of General Purpose Register18.

enumerator kSRC_GeneralPurposeRegister19
The index of General Purpose Register19.

enum _src_power_ctrl_step
software power control step in power on/off sequence.

Values:

enumerator kSRC_PDN_EdgelockHandshake

Power down Edgelock handshake step.

enumerator kSRC_PDN_IsolationOn

Power down isolation on step.

enumerator kSRC_PDN_ResetAssert

Power down reset assert step.

enumerator kSRC_PDN_PowerSwitchOff

Power down power switch off step.

enumerator kSRC_PUP_PowerSwitchOn

Power up power switch on step.

enumerator kSRC_PUP_ResetRelease

Power up reset release step.

enumerator kSRC_PUP_IsolationOff

Power up isolation off step.

enumerator kSRC_PUP_EdgeLockHandshake

Power up Edgelock handshake step.

enum _src_power_level

The power level of low power mode setting.

Values:

enumerator kSRC_PowerLevel1

enumerator kSRC_PowerLevel2

power on when domain n is in RUN, off in WAIT/STOP/SUSPEND

enumerator kSRC_PowerLevel3

power on when domain n is in RUN/WAIT, off in STOP/SUSPEND

enumerator kSRC_PowerLevel4

power on when domain n is in RUN/WAIT/STOP, off in SUSPEND

typedef enum _src_core_name src_core_name_t

System core.

typedef enum _src_boot_fuse_selection src_boot_fuse_selection_t

The enumeration of the boot fuse selection.

typedef enum _src_reset_source src_reset_source_t

The enumeration of global system reset sources.

typedef enum _src_reset_mode src_reset_mode_t

The enumeration of global system reset mode.

typedef enum _src_general_purpose_register_index src_general_purpose_register_index_t

The index of each general purpose register.

typedef enum _src_power_ctrl_step src_power_ctrl_step_t

software power control step in power on/off sequence.

typedef enum _src_power_level src_power_level_t

The power level of low power mode setting.

FSL_SRC_DRIVER_VERSION

SRC driver version 2.0.1.

`void SRC_ReleaseCM7(SRC_GENERAL_Type *base)`

Releases related core reset operation.

The core reset will be held until the boot core to release it.

Parameters

- `base` – SRC peripheral base address.

`static inline uint32_t SRC_GetBootConfig(SRC_GENERAL_Type *base)`

Gets Boot configuration.

Parameters

- `base` – SRC peripheral base address.

Returns

Boot configuration. Please refer to fusemap.

`static inline uint8_t SRC_GetBootMode(SRC_GENERAL_Type *base)`

Gets the latched state of the BOOT_MODE1 and BOOT_MODE0 signals.

Parameters

- `base` – SRC peripheral base address.

Returns

Boot mode. Please refer to the Boot mode pin setting section of System Boot.

`void SRC_SetGlobalSystemResetMode(SRC_GENERAL_Type *base, src_reset_source_t resetSource, src_reset_mode_t resetMode)`

Sets the reset mode of global system reset source.

This function sets the selected mode of the input global system reset sources.

Parameters

- `base` – SRC peripheral base address.
- `resetSource` – The global system reset source. See `src_reset_source_t` for more details.
- `resetMode` – The reset mode of each reset source. See `src_reset_mode_t` for more details.

`static inline uint32_t SRC_GetResetStatusFlags(SRC_GENERAL_Type *base)`

Gets global system reset status flags.

Parameters

- `base` – SRC peripheral base address.

Returns

The status of global system reset status. See `_src_reset_status_flags` for more details.

`static inline void SRC_ClearGlobalSystemResetStatus(SRC_GENERAL_Type *base, uint32_t mask)`

Clears the status of global reset.

Parameters

- `base` – SRC peripheral base address.
- `mask` – The reset status flag to be cleared. See `_src_reset_status_flags` for more details.

`static inline void SRC_SetGeneralPurposeRegister(SRC_GENERAL_Type *base, src_general_purpose_register_index_t index, uint32_t value)`

Sets value to general purpose registers.

Parameters

- base – SRC peripheral base address.
- index – The index of GPRx register array. Please refer to `src_general_purpose_register_index_t`.
- value – Setting value for GPRx register.

```
static inline uint32_t SRC_GetGeneralPurposeRegister(SRC_GENERAL_Type *base,  
                                                    src_general_purpose_register_index_t  
                                                    index)
```

Gets the value from general purpose registers.

Parameters

- base – SRC peripheral base address.
- index – The index of GPRx register array. Please refer to `src_general_purpose_register_index_t`.

Returns

The setting value for GPRx register.

```
static inline void SRC_SLICE__AllowUserModeAccess(SRC_MIX_SLICE_Type *base, bool enable)
```

Allows/disallows user mode access.

Parameters

- base – SRC peripheral base address.
- enable – Used to control user mode access.
 - **true** Allow user mode access.
 - **false** Disallow user mode access.

```
static inline void SRC_SLICE__AllowNonSecureModeAccess(SRC_MIX_SLICE_Type *base, bool  
                                                         enable)
```

Allows/disallows non secure mode access.

Parameters

- base – SRC peripheral base address.
- enable – Used to control non secure mode access.
 - **true** Allow non secure mode access.
 - **false** Disallow non secure mode access.

```
static inline void SRC_SLICE__LockAccessSetting(SRC_MIX_SLICE_Type *base)
```

Locks the setting of user mode access and non secure mode access.

Note: Once locked only reset can unlock related settings.

Parameters

- base – SRC peripheral base address.

```
static inline void SRC_SLICE__SetWhiteList(SRC_MIX_SLICE_Type *base, uint8_t domainId)
```

Sets the domain ID white list for the selected slice.

Parameters

- base – SRC peripheral base address.
- domainId – The core to access registers, should be the OR'ed value of `src_core_name_t`.

static inline void SRC_SLICE_LockWhiteList(SRC_MIX_SLICE_Type *base)
Locks the value of white list.

Note: Once locked only reset can unlock related settings.

Parameters

- base – SRC peripheral base address.

void SRC_SLICE_SoftwareControl(SRC_MIX_SLICE_Type *base, *src_power_ctrl_step_t* step)
brief Set software control step for slice power on/off sequence.

param base SRC peripheral base address. param step Slice power on/off sequence step. See *src_power_ctrl_step_t* for more details.

void SRC_SLICE_PowerDown(SRC_MIX_SLICE_Type *base, bool powerOff)
brief Power on/off slice.

param base SRC peripheral base address. param powerOff Used to trigger slice power on/off sequence.

- **true** Trigger a power off sequence.
- **false** Trigger a power on sequence.

void SRC_SLICE_ControlByCpuLowPowerMode(SRC_MIX_SLICE_Type *base, uint32_t domainMap, *src_power_level_t* level)

2.124 SPDIF: Sony/Philips Digital Interface

void SPDIF_Init(SPDIF_Type *base, const *spdif_config_t* *config)
Initializes the SPDIF peripheral.

Ungates the SPDIF clock, resets the module, and configures SPDIF with a configuration structure. The configuration structure can be custom filled or set with default values by `SPDIF_GetDefaultConfig()`.

Note: This API should be called at the beginning of the application to use the SPDIF driver. Otherwise, accessing the SPDIF module can cause a hard fault because the clock is not enabled.

Parameters

- base – SPDIF base pointer
- config – SPDIF configuration structure.

void SPDIF_GetDefaultConfig(*spdif_config_t* *config)
Sets the SPDIF configuration structure to default values.

This API initializes the configuration structure for use in `SPDIF_Init`. The initialized structure can remain unchanged in `SPDIF_Init`, or it can be modified before calling `SPDIF_Init`. This is an example.

```
spdif_config_t config;  
SPDIF_GetDefaultConfig(&config);
```

Parameters

- config – pointer to master configuration structure

void SPDIF_Deinit(SPDIF_Type *base)

De-initializes the SPDIF peripheral.

This API gates the SPDIF clock. The SPDIF module can't operate unless SPDIF_Init is called to enable the clock.

Parameters

- base – SPDIF base pointer

uint32_t SPDIF_GetInstance(SPDIF_Type *base)

Get the instance number for SPDIF.

Parameters

- base – SPDIF base pointer.

static inline void SPDIF_TxFIFOReset(SPDIF_Type *base)

Resets the SPDIF Tx.

This function makes Tx FIFO in reset mode.

Parameters

- base – SPDIF base pointer

static inline void SPDIF_RxFIFOReset(SPDIF_Type *base)

Resets the SPDIF Rx.

This function enables the software reset and FIFO reset of SPDIF Rx. After reset, clear the reset bit.

Parameters

- base – SPDIF base pointer

void SPDIF_TxEnable(SPDIF_Type *base, bool enable)

Enables/disables the SPDIF Tx.

Parameters

- base – SPDIF base pointer
- enable – True means enable SPDIF Tx, false means disable.

static inline void SPDIF_RxEnable(SPDIF_Type *base, bool enable)

Enables/disables the SPDIF Rx.

Parameters

- base – SPDIF base pointer
- enable – True means enable SPDIF Rx, false means disable.

static inline uint32_t SPDIF_GetStatusFlag(SPDIF_Type *base)

Gets the SPDIF status flag state.

Parameters

- base – SPDIF base pointer

Returns

SPDIF status flag value. Use the `_spdif_interrupt_enable_t` to get the status value needed.

```
static inline void SPDIF__ClearStatusFlags(SPDIF_Type *base, uint32_t mask)
```

Clears the SPDIF status flag state.

Parameters

- `base` – SPDIF base pointer
- `mask` – State mask. It can be a combination of the `_spdif_interrupt_enable_t` member. Notice these members cannot be included, as these flags cannot be cleared by writing 1 to these bits:
 - `kSPDIF_UChannelReceiveRegisterFull`
 - `kSPDIF_QChannelReceiveRegisterFull`
 - `kSPDIF_TxFIFOEmpty`
 - `kSPDIF_RxFIFOFull`

```
static inline void SPDIF__EnableInterrupts(SPDIF_Type *base, uint32_t mask)
```

Enables the SPDIF Tx interrupt requests.

Parameters

- `base` – SPDIF base pointer
- `mask` – interrupt source The parameter can be a combination of the following sources if defined.
 - `kSPDIF_WordStartInterruptEnable`
 - `kSPDIF_SyncErrorInterruptEnable`
 - `kSPDIF_FIFOWarningInterruptEnable`
 - `kSPDIF_FIFORequestInterruptEnable`
 - `kSPDIF_FIFOErrorInterruptEnable`

```
static inline void SPDIF__DisableInterrupts(SPDIF_Type *base, uint32_t mask)
```

Disables the SPDIF Tx interrupt requests.

Parameters

- `base` – SPDIF base pointer
- `mask` – interrupt source The parameter can be a combination of the following sources if defined.
 - `kSPDIF_WordStartInterruptEnable`
 - `kSPDIF_SyncErrorInterruptEnable`
 - `kSPDIF_FIFOWarningInterruptEnable`
 - `kSPDIF_FIFORequestInterruptEnable`
 - `kSPDIF_FIFOErrorInterruptEnable`

```
static inline void SPDIF__EnableDMA(SPDIF_Type *base, uint32_t mask, bool enable)
```

Enables/disables the SPDIF DMA requests.

Parameters

- `base` – SPDIF base pointer
- `mask` – SPDIF DMA enable mask, The parameter can be a combination of the following sources if defined

- kSPDIF_RxDMAEnable
- kSPDIF_TxDMAEnable
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t SPDIF__TxGetLeftDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Tx left data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

static inline uint32_t SPDIF__TxGetRightDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Tx right data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

static inline uint32_t SPDIF__RxGetLeftDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Rx left data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

static inline uint32_t SPDIF__RxGetRightDataRegisterAddress(SPDIF_Type *base)

Gets the SPDIF Rx right data register address.

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

- base – SPDIF base pointer.

Returns

data register address.

void SPDIF__TxSetSampleRate(SPDIF_Type *base, uint32_t sampleRate_Hz, uint32_t sourceClockFreq_Hz)

Configures the SPDIF Tx sample rate.

The audio format can be changed at run-time. This function configures the sample rate.

Parameters

- base – SPDIF base pointer.
- sampleRate_Hz – SPDIF sample rate frequency in Hz.
- sourceClockFreq_Hz – SPDIF tx clock source frequency in Hz.

uint32_t SPDIF_GetRxSampleRate(SPDIF_Type *base, uint32_t clockSourceFreq_Hz)

Configures the SPDIF Rx audio format.

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – SPDIF base pointer.
- clockSourceFreq_Hz – SPDIF system clock frequency in hz.

void SPDIF_WriteBlocking(SPDIF_Type *base, uint8_t *buffer, uint32_t size)

Sends data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SPDIF base pointer.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

static inline void SPDIF_WriteLeftData(SPDIF_Type *base, uint32_t data)

Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteRightData(SPDIF_Type *base, uint32_t data)

Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteChannelStatusHigh(SPDIF_Type *base, uint32_t data)

Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

static inline void SPDIF_WriteChannelStatusLow(SPDIF_Type *base, uint32_t data)

Writes data into SPDIF FIFO.

Parameters

- base – SPDIF base pointer.
- data – Data needs to be written.

void SPDIF_ReadBlocking(SPDIF_Type *base, uint8_t *buffer, uint32_t size)

Receives data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SPDIF base pointer.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

```
static inline uint32_t SPDIF_ReadLeftData(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
static inline uint32_t SPDIF_ReadRightData(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
static inline uint32_t SPDIF_ReadChannelStatusHigh(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
static inline uint32_t SPDIF_ReadChannelStatusLow(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
static inline uint32_t SPDIF_ReadQChannel(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
static inline uint32_t SPDIF_ReadUChannel(SPDIF_Type *base)
```

Reads data from the SPDIF FIFO.

Parameters

- base – SPDIF base pointer.

Returns

Data in SPDIF FIFO.

```
void SPDIF__TransferTxCreateHandle(SPDIF_Type *base, spdif_handle_t *handle,  
                                  spdif_transfer_callback_t callback, void *userData)
```

Initializes the SPDIF Tx handle.

This function initializes the Tx handle for the SPDIF Tx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SPDIF base pointer
- handle – SPDIF handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function

```
void SPDIF__TransferRxCreateHandle(SPDIF_Type *base, spdif_handle_t *handle,  
                                  spdif_transfer_callback_t callback, void *userData)
```

Initializes the SPDIF Rx handle.

This function initializes the Rx handle for the SPDIF Rx transactional APIs. Call this function once to get the handle initialized.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

```
status_t SPDIF__TransferSendNonBlocking(SPDIF_Type *base, spdif_handle_t *handle,  
                                         spdif_transfer_t *xfer)
```

Performs an interrupt non-blocking send transfer on SPDIF.

Note: This API returns immediately after the transfer initiates. Call the `SPDIF_TxGetTransferStatusIRQ` to poll the transfer status and check whether the transfer is finished. If the return status is not `kStatus_SPDIF_Busy`, the transfer is finished.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the `spdif_handle_t` structure which stores the transfer state.
- xfer – Pointer to the `spdif_transfer_t` structure.

Return values

- `kStatus_Success` – Successfully started the data receive.
- `kStatus_SPDIF_TxBusy` – Previous receive still not finished.
- `kStatus_InvalidArgument` – The input parameter is invalid.

```
status_t SPDIF__TransferReceiveNonBlocking(SPDIF_Type *base, spdif_handle_t *handle,  
                                           spdif_transfer_t *xfer)
```

Performs an interrupt non-blocking receive transfer on SPDIF.

Note: This API returns immediately after the transfer initiates. Call the SPDIF_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SPDIF_Busy, the transfer is finished.

Parameters

- base – SPDIF base pointer
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- xfer – Pointer to the spdif_transfer_t structure.

Return values

- kStatus__Success – Successfully started the data receive.
- kStatus_SPDIF_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SPDIF_TransferGetSendCount(SPDIF_Type *base, *spdif_handle_t* *handle, *size_t* *count)

Gets a set byte count.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- count – Bytes count sent.

Return values

- kStatus__Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

status_t SPDIF_TransferGetReceiveCount(SPDIF_Type *base, *spdif_handle_t* *handle, *size_t* *count)

Gets a received byte count.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the spdif_handle_t structure which stores the transfer state.
- count – Bytes count received.

Return values

- kStatus__Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void SPDIF_TransferAbortSend(SPDIF_Type *base, *spdif_handle_t* *handle)

Aborts the current send.

Note: This API can be called any time when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the `spdif_handle_t` structure which stores the transfer state.

`void SPDIF__TransferAbortReceive(SPDIF_Type *base, spdif_handle_t *handle)`

Aborts the current IRQ receive.

Note: This API can be called when an interrupt non-blocking transfer initiates to abort the transfer early.

Parameters

- base – SPDIF base pointer
- handle – Pointer to the `spdif_handle_t` structure which stores the transfer state.

`void SPDIF__TransferTxHandleIRQ(SPDIF_Type *base, spdif_handle_t *handle)`

Tx interrupt handler.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the `spdif_handle_t` structure.

`void SPDIF__TransferRxHandleIRQ(SPDIF_Type *base, spdif_handle_t *handle)`

Tx interrupt handler.

Parameters

- base – SPDIF base pointer.
- handle – Pointer to the `spdif_handle_t` structure.

`FSL_SPDIF_DRIVER_VERSION`

Version 2.0.7

SPDIF return status.

Values:

enumerator `kStatus_SPDIF_RxDPLLLocked`

SPDIF Rx PLL locked.

enumerator `kStatus_SPDIF_TxFIFOError`

SPDIF Tx FIFO error.

enumerator `kStatus_SPDIF_TxFIFOResync`

SPDIF Tx left and right FIFO resync.

enumerator `kStatus_SPDIF_RxCnew`

SPDIF Rx status channel value updated.

enumerator `kStatus_SPDIF_ValidatyNoGood`

SPDIF validaty flag not good.

enumerator `kStatus_SPDIF_RxIllegalSymbol`

SPDIF Rx receive illegal symbol.

enumerator kStatus_SPDIF_RxParityBitError
SPDIF Rx parity bit error.

enumerator kStatus_SPDIF_UChannelOverrun
SPDIF receive U channel overrun.

enumerator kStatus_SPDIF_QChannelOverrun
SPDIF receive Q channel overrun.

enumerator kStatus_SPDIF_UQChannelSync
SPDIF U/Q channel sync found.

enumerator kStatus_SPDIF_UQChannelFrameError
SPDIF U/Q channel frame error.

enumerator kStatus_SPDIF_RxFIFOError
SPDIF Rx FIFO error.

enumerator kStatus_SPDIF_RxFIFOResync
SPDIF Rx left and right FIFO resync.

enumerator kStatus_SPDIF_LockLoss
SPDIF Rx PLL clock lock loss.

enumerator kStatus_SPDIF_TxIdle
SPDIF Tx is idle

enumerator kStatus_SPDIF_RxIdle
SPDIF Rx is idle

enumerator kStatus_SPDIF_QueueFull
SPDIF queue full

enum _spdif_rxfull_select
SPDIF Rx FIFO full falg select, it decides when assert the rx full flag.

Values:

enumerator kSPDIF_RxFull1Sample
Rx full at least 1 sample in left and right FIFO

enumerator kSPDIF_RxFull4Samples
Rx full at least 4 sample in left and right FIFO

enumerator kSPDIF_RxFull8Samples
Rx full at least 8 sample in left and right FIFO

enumerator kSPDIF_RxFull16Samples
Rx full at least 16 sample in left and right FIFO

enum _spdif_txempty_select
SPDIF tx FIFO EMPTY falg select, it decides when assert the tx empty flag.

Values:

enumerator kSPDIF_TxEmpty0Sample
Tx empty at most 0 sample in left and right FIFO

enumerator kSPDIF_TxEmpty4Samples
Tx empty at most 4 sample in left and right FIFO

enumerator kSPDIF_TxEmpty8Samples
Tx empty at most 8 sample in left and right FIFO

enumerator kSPDIF_TxEmpty12Samples

Tx empty at most 12 sample in left and right FIFO

enum __spdif_uchannel_source

SPDIF U channel source.

Values:

enumerator kSPDIF_NoUChannel

No embedded U channel

enumerator kSPDIF_UChannelFromRx

U channel from receiver, it is CD mode

enumerator kSPDIF_UChannelFromTx

U channel from on chip tx

enum __spdif_gain_select

SPDIF clock gain.

Values:

enumerator kSPDIF_GAIN_24

Gain select is 24

enumerator kSPDIF_GAIN_16

Gain select is 16

enumerator kSPDIF_GAIN_12

Gain select is 12

enumerator kSPDIF_GAIN_8

Gain select is 8

enumerator kSPDIF_GAIN_6

Gain select is 6

enumerator kSPDIF_GAIN_4

Gain select is 4

enumerator kSPDIF_GAIN_3

Gain select is 3

enum __spdif_tx_source

SPDIF tx data source.

Values:

enumerator kSPDIF_txFromReceiver

Tx data directly through SPDIF receiver

enumerator kSPDIF_txNormal

Normal operation, data from processor

enum __spdif_validity_config

SPDIF tx data source.

Values:

enumerator kSPDIF_validityFlagAlwaysSet

Outgoing validity flags always set

enumerator kSPDIF_validityFlagAlwaysClear

Outgoing validity flags always clear

The SPDIF interrupt enable flag.

Values:

enumerator kSPDIF_RxDPLLLocked
SPDIF DPLL locked

enumerator kSPDIF_TxFIFOError
Tx FIFO underrun or overrun

enumerator kSPDIF_TxFIFOResync
Tx FIFO left and right channel resync

enumerator kSPDIF_RxControlChannelChange
SPDIF Rx control channel value changed

enumerator kSPDIF_VValidityFlagNoGood
SPDIF validity flag no good

enumerator kSPDIF_RxIllegalSymbol
SPDIF receiver found illegal symbol

enumerator kSPDIF_RxParityBitError
SPDIF receiver found parity bit error

enumerator kSPDIF_UChannelReceiveRegisterFull
SPDIF U channel receive register full

enumerator kSPDIF_UChannelReceiveRegisterOverrun
SPDIF U channel receive register overrun

enumerator kSPDIF_QChannelReceiveRegisterFull
SPDIF Q channel receive register full

enumerator kSPDIF_QChannelReceiveRegisterOverrun
SPDIF Q channel receive register overrun

enumerator kSPDIF_UQChannelSync
SPDIF U/Q channel sync found

enumerator kSPDIF_UQChannelFrameError
SPDIF U/Q channel frame error

enumerator kSPDIF_RxFIFOError
SPDIF Rx FIFO underrun/overrun

enumerator kSPDIF_RxFIFOResync
SPDIF Rx left and right FIFO resync

enumerator kSPDIF_LockLoss
SPDIF receiver loss of lock

enumerator kSPDIF_TxFIFOEmpty
SPDIF Tx FIFO empty

enumerator kSPDIF_RxFIFOFull
SPDIF Rx FIFO full

enumerator kSPDIF_AllInterrupt
all interrupt

The DMA request sources.

Values:

enumerator kSPDIF_RxDMAEnable

Rx FIFO full

enumerator kSPDIF_TxDMAEnable

Tx FIFO empty

typedef enum *_spdif_rxfull_select* spdif_rxfull_select_t

SPDIF Rx FIFO full falg select, it decides when assert the rx full flag.

typedef enum *_spdif_txempty_select* spdif_txempty_select_t

SPDIF tx FIFO EMPTY falg select, it decides when assert the tx empty flag.

typedef enum *_spdif_uchannel_source* spdif_uchannel_source_t

SPDIF U channel source.

typedef enum *_spdif_gain_select* spdif_gain_select_t

SPDIF clock gain.

typedef enum *_spdif_tx_source* spdif_tx_source_t

SPDIF tx data source.

typedef enum *_spdif_validity_config* spdif_validity_config_t

SPDIF tx data source.

typedef struct *_spdif_config* spdif_config_t

SPDIF user configuration structure.

typedef struct *_spdif_transfer* spdif_transfer_t

SPDIF transfer structure.

typedef struct *_spdif_handle* spdif_handle_t

typedef void (*spdif_transfer_callback_t)(SPDIF_Type *base, *spdif_handle_t* *handle, *status_t* status, void *userData)

SPDIF transfer callback prototype.

SPDIF_XFER_QUEUE_SIZE

SPDIF transfer queue size, user can refine it according to use case.

struct *_spdif_config*

#include <fsl_spdif.h> SPDIF user configuration structure.

Public Members

bool isTxAutoSync

If auto sync mechanism open

bool isRxAutoSync

If auto sync mechanism open

uint8_t DPLLClkSource

SPDIF DPLL clock source, range from 0~15, meaning is chip-specific

uint8_t txClkSource

SPDIF tx clock source, range from 0~7, meaning is chip-specific

spdif_rxfull_select_t rxFullSelect
SPDIF rx buffer full select

spdif_txempty_select_t txFullSelect
SPDIF tx buffer empty select

spdif_uchannel_source_t uChannelSrc
U channel source

spdif_tx_source_t txSource
SPDIF tx data source

spdif_validity_config_t validityConfig
Validity flag config

spdif_gain_select_t gain
Rx receive clock measure gain parameter.

struct *_spdif_transfer*
#include <fsl_spdif.h> SPDIF transfer structure.

Public Members

uint8_t *data
Data start address to transfer.

uint8_t *qdata
Data buffer for Q channel

uint8_t *udata
Data buffer for C channel

size_t dataSize
Transfer size.

struct *_spdif_handle*
#include <fsl_spdif.h> SPDIF handle structure.

Public Members

uint32_t state
Transfer status

spdif_transfer_callback_t callback
Callback function called at transfer event

void *userData
Callback parameter passed to callback function

spdif_transfer_t spdifQueue[(4U)]
Transfer queue storing queued transfer

size_t transferSize[(4U)]
Data bytes need to transfer

volatile uint8_t queueUser
Index for user to queue transfer

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

uint8_t watermark
Watermark value

2.125 SPDIF eDMA Driver

```
void SPDIF__TransferTxCreateHandleEDMA(SPDIF_Type *base, spdif_edma_handle_t *handle,  
                                       spdif_edma_callback_t callback, void *userData,  
                                       edma_handle_t *dmaLeftHandle, edma_handle_t  
                                       *dmaRightHandle)
```

Initializes the SPDIF eDMA handle.

This function initializes the SPDIF master DMA handle, which can be used for other SPDIF master transactional APIs. Usually, for a specified SPDIF instance, call this API once to get the initialized handle.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaLeftHandle – eDMA handle pointer for left channel, this handle shall be static allocated by users.
- dmaRightHandle – eDMA handle pointer for right channel, this handle shall be static allocated by users.

```
void SPDIF__TransferRxCreateHandleEDMA(SPDIF_Type *base, spdif_edma_handle_t *handle,  
                                       spdif_edma_callback_t callback, void *userData,  
                                       edma_handle_t *dmaLeftHandle, edma_handle_t  
                                       *dmaRightHandle)
```

Initializes the SPDIF Rx eDMA handle.

This function initializes the SPDIF slave DMA handle, which can be used for other SPDIF master transactional APIs. Usually, for a specified SPDIF instance, call this API once to get the initialized handle.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- callback – Pointer to user callback function.
- userData – User parameter passed to the callback function.
- dmaLeftHandle – eDMA handle pointer for left channel, this handle shall be static allocated by users.
- dmaRightHandle – eDMA handle pointer for right channel, this handle shall be static allocated by users.

```
status_t SPDIF__TransferSendEDMA(SPDIF_Type *base, spdif_edma_handle_t *handle,  
                                 spdif_edma_transfer_t *xfer)
```

Performs a non-blocking SPDIF transfer using DMA.

Note: This interface returns immediately after the transfer initiates. Call SPDIF_GetTransferStatus to poll the transfer status and check whether the SPDIF transfer is finished.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.
- xfer – Pointer to the DMA transfer structure.

Return values

- kStatus_Success – Start a SPDIF eDMA send successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_TxBusy – SPDIF is busy sending data.

status_t SPDIF_TransferReceiveEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *spdif_edma_transfer_t* *xfer)

Performs a non-blocking SPDIF receive using eDMA.

Note: This interface returns immediately after the transfer initiates. Call the SPDIF_GetReceiveRemainingBytes to poll the transfer status and check whether the SPDIF transfer is finished.

Parameters

- base – SPDIF base pointer
- handle – SPDIF eDMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a SPDIF eDMA receive successfully.
- kStatus_InvalidArgument – The input argument is invalid.
- kStatus_RxBusy – SPDIF is busy receiving data.

void SPDIF_TransferAbortSendEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle)

Aborts a SPDIF transfer using eDMA.

Parameters

- base – SPDIF base pointer.
- handle – SPDIF eDMA handle pointer.

void SPDIF_TransferAbortReceiveEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle)

Aborts a SPDIF receive using eDMA.

Parameters

- base – SPDIF base pointer
- handle – SPDIF eDMA handle pointer.

status_t SPDIF_TransferGetSendCountEDMA(SPDIF_Type *base, *spdif_edma_handle_t* *handle, *size_t* *count)

Gets byte count sent by SPDIF.

Parameters

- `base` – SPDIF base pointer.
- `handle` – SPDIF eDMA handle pointer.
- `count` – Bytes count sent by SPDIF.

Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is no non-blocking transaction in progress.

```
status_t SPDIF_TransferGetReceiveCountEDMA(SPDIF_Type *base, spdif_edma_handle_t
                                           *handle, size_t *count)
```

Gets byte count received by SPDIF.

Parameters

- `base` – SPDIF base pointer
- `handle` – SPDIF eDMA handle pointer.
- `count` – Bytes count received by SPDIF.

Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is no non-blocking transaction in progress.

```
FSL_SPDIF_EDMA_DRIVER_VERSION
```

Version 2.0.8

```
typedef struct _spdif_edma_handle spdif_edma_handle_t
```

```
typedef void (*spdif_edma_callback_t)(SPDIF_Type *base, spdif_edma_handle_t *handle, status_t
status, void *userData)
```

SPDIF eDMA transfer callback function for finish and error.

```
typedef struct _spdif_edma_transfer spdif_edma_transfer_t
```

SPDIF transfer structure.

```
struct _spdif_edma_transfer
```

```
#include <fsl_spdif_edma.h> SPDIF transfer structure.
```

Public Members

```
uint8_t *leftData
```

Data start address to transfer.

```
uint8_t *rightData
```

Data start address to transfer.

```
size_t dataSize
```

Transfer size.

```
struct _spdif_edma_handle
```

```
#include <fsl_spdif_edma.h> SPDIF DMA transfer handle, users should not touch the content
of the handle.
```

Public Members

edma_handle_t *dmaLeftHandle
DMA handler for SPDIF left channel

edma_handle_t *dmaRightHandle
DMA handler for SPDIF right channel

uint8_t nbytes
eDMA minor byte transfer count initially configured.

uint8_t count
The transfer data count in a DMA request

uint32_t state
Internal state for SPDIF eDMA transfer

spdif_edma_callback_t callback
Callback for users while transfer finish or error occurs

void *userData
User callback parameter

edma_tcd_t leftTcd[(4U) + 1U]
TCD pool for eDMA transfer.

edma_tcd_t rightTcd[(4U) + 1U]
TCD pool for eDMA transfer.

spdif_edma_transfer_t spdifQueue[(4U)]
Transfer queue storing queued transfer.

size_t transferSize[(4U)]
Data bytes need to transfer, left and right are the same, so use one

volatile uint8_t queueUser
Index for user to queue transfer.

volatile uint8_t queueDriver
Index for driver to get the transfer data and size

2.126 Sysctr

enum __sysctr_clock_source
System Counter clock source selection.
Values:

enumerator kSYSCTR_BaseFrequency
24MHz base clock from crystal oscillator is used as the clock.

enumerator kSYSCTR_AlternateFrequency
32kHz alternate slow clock from crystal oscillator is used as the clock.

enum __sysctr_compare_frame
System Counter compare frame selection.
Values:

enumerator kSYSCTR_CompareFrame_0
Select compare frame 0.

enumerator kSYSCTR_CompareFrame_1

Select compare frame 1.

enum __sysctr_frequency_modes_table

System Counter frequency modes table selection.

Values:

enumerator kSYSCTR_FrequencyModesTable_0

Select frequency modes table 0.

enumerator kSYSCTR_FrequencyModesTable_1

Select frequency modes table 1.

enumerator kSYSCTR_FrequencyModesTable_2

Select frequency modes table 2.

enum __sysctr_interrupt_enable

List of System Counter interrupt options.

Values:

enumerator kSYSCTR_Compare0InterruptEnable

Compare frame 0 interrupt.

enumerator kSYSCTR_Compare1InterruptEnable

Compare frame 1 interrupt.

enum __sysctr_status_flags

List of System Counter status flags.

Values:

enumerator kSYSCTR_Compare0Flag

Compare frame 0 compare flag.

enumerator kSYSCTR_Compare1Flag

Compare frame 1 compare flag.

enum __sysctr_flags

System Counter status flags.

This provides constants for the System Counter status flags for use in the System Counter functions. The system counter status flags provide information concerning the clock frequency and debug state.

Values:

enumerator kSYSCTR_DebugHalt

enumerator kSYSCTR_FrequencyChangeAck_0

enumerator kSYSCTR_FrequencyChangeAck_1

typedef enum __sysctr_clock_source sysctr_clock_source_t

System Counter clock source selection.

typedef enum __sysctr_compare_frame sysctr_compare_frame_t

System Counter compare frame selection.

typedef enum __sysctr_frequency_modes_table sysctr_frequency_modes_table_t

System Counter frequency modes table selection.

typedef enum __sysctr_interrupt_enable sysctr_interrupt_enable_t

List of System Counter interrupt options.

```
typedef enum _sysctr_status_flags sysctr_status_flags_t
```

List of System Counter status flags.

```
typedef struct _sysctr_config sysctr_config_t
```

System Counter config structure.

This structure holds the configuration settings for the System Counter peripheral. To initialize this structure to reasonable defaults, call the `PWM_GetDefaultConfig()` function and pass a pointer to your config structure instance.

```
FSL_SYSCTR_DRIVER_VERSION
```

System Counter driver version.

```
void SYSCTR_Init(SYS_CTR_CONTROL_Type *ctrlBase, SYS_CTR_COMPARE_Type *cmpBase,  
                const sysctr_config_t *pConfig)
```

Initializes a System Counter instance.

This function initializes the System Counter module with user-defined settings. This example shows how to set up the `sysctr_config_t` parameters and how to call the `SYSCTR_Init` function by passing in these parameters. Default clock source is 24MHz base clock from crystal oscillator.

```
sysctr_config_t sysctrConfig;  
sysctrConfig.enableDebugHalt = false;  
sysctrConfig.enableHardwareFrequencyChange = false;  
SYSCTR_Init(SYS_CTR_CONTROL, SYS_CTR_COMPARE, &sysctr_config_t);
```

Parameters

- `ctrlBase` – System Counter peripheral control model base address.
- `cmpBase` – System Counter peripheral compare model base address.
- `pConfig` – Configuration pointer to user's System Counter config structure.

```
void SYSCTR_Deinit(SYS_CTR_CONTROL_Type *ctrlBase, SYS_CTR_COMPARE_Type *cmpBase)
```

De-initializes a System Counter instance.

This function disables the System Counter module clock and sets all register values to the reset value.

Parameters

- `ctrlBase` – System Counter peripheral control model base address.
- `cmpBase` – System Counter peripheral compare model base address.

```
void SYSCTR_GetDefaultConfig(sysctr_config_t *pConfig)
```

Fill in the System Counter config struct with the default settings.

The default values are:

```
config->enableDebugHalt = false;  
config->enableHardwareFrequencyChange = false;
```

Parameters

- `pConfig` – Configuration pointer to user's System Counter config structure.

```
static inline void SYSCTR_EnableInterrupts(SYS_CTR_COMPARE_Type *base, uint32_t mask)
```

Enables the selected System Counter interrupts.

Parameters

- `base` – System Counter peripheral compare model base address.

- mask – The interrupts to enable. This is a logical OR of members of the enumeration `sysctr_interrupt_enable_t`.

static inline void SYSCTR_DisableInterrupts(SYS_CTR_COMPARE_Type *base, uint32_t mask)

Disable the selected System Counter interrupts.

Parameters

- base – System Counter peripheral compare model base address.
- mask – The interrupts to disable. This is a logical OR of members of the enumeration `sysctr_interrupt_enable_t`.

static inline uint32_t SYSCTR_GetStatusFlags(SYS_CTR_COMPARE_Type *base)

Get System Counter status flags.

Parameters

- base – System Counter peripheral compare model base address.

Returns

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

static inline void SYSCTR_StartCounter(SYS_CTR_CONTROL_Type *base)

Enables the System Counter counting.

Parameters

- base – System Counter peripheral control model base address.

static inline void SYSCTR_StopCounter(SYS_CTR_CONTROL_Type *base)

Disables the System Counter counting.

Parameters

- base – System Counter peripheral control model base address.

bool enableDebugHalt

true: Debug input causes the System Counter to halt; false: Debug input is ignored

bool enableHardwareFrequencyChange

true: Hardware changes frequency automatically when entering or exiting low power mode; false: Frequency changes are fully under software control

static inline void SYSCTR_SetCounterValue(SYS_CTR_CONTROL_Type *base, uint64_t value)

Set System Counter count value.

User can set System Counter initial count value before starting counter. Be cautious that user must set count value while operating on the base frequency only. Set count value while running on the alternate frequency may have unpredictable results.

Parameters

- base – System Counter peripheral control model base address.
- value – System Counter count value.

static inline uint64_t SYSCTR_GetCounterValue(SYS_CTR_READ_Type *base)

Get System Counter current count value.

Parameters

- base – System Counter peripheral read model base address.

Returns

System Counter current count value.

```
void SYSCTR_SetCounterClockSource(SYS_CTR_CONTROL_Type *base, sysctr_clock_source_t  
                                clockSource)
```

Set System Counter clock source.

Parameters

- base – System Counter peripheral control model base address.
- sysctr_clock_source_t – System Counter clock source.

```
void SYSCTR_EnableCompare(SYS_CTR_COMPARE_Type *base, sysctr_compare_frame_t  
                          cmpFrame, bool enable)
```

Enable or disable compare function of specific compare frame.

Parameters

- base – System Counter peripheral control model base address.
- cmpFrame – System Counter compare frame selection.
- enable – true: Enable compare function; false: Disable compare function

```
void SYSCTR_SetCompareValue(SYS_CTR_CONTROL_Type *ctrlBase, SYS_CTR_COMPARE_Type  
                            *cmpBase, sysctr_compare_frame_t cmpFrame, uint64_t value)
```

Set System Counter compare value of specific compare frame.

Be cautious that user must set compare value while operating on the base frequency only. Set compare value while running on the alternate frequency may have unpredictable results.

Parameters

- ctrlBase – System Counter peripheral control model base address.
- cmpBase – System Counter peripheral compare model base address.
- cmpFrame – System Counter compare frame selection.
- value – System Counter compare value.

```
uint32_t SYSCTR_GetFrequencyModesTableValue(SYS_CTR_CONTROL_Type *base,  
                                             sysctr_frequency_modes_table_t index)
```

Get specific Frequency Modes Table value.

Parameters

- base – System Counter peripheral control model base address.
- index – Frequency Modes Table index.

Returns

Frequency modes table value.

```
struct _sysctr_config
```

#include <fsl_sysctr.h> System Counter config structure.

This structure holds the configuration settings for the System Counter peripheral. To initialize this structure to reasonable defaults, call the `PWM_GetDefaultConfig()` function and pass a pointer to your config structure instance.

2.127 SYSCTR: System Counter Driver

2.128 SYSPM: System Performance Monitor

```
enum __syspm_monitor
    syspm select control monitor
    Values:
    enumerator kSYSPM_Monitor0
        Monitor 0
enum __syspm_event
    syspm select event
    Values:
    enumerator kSYSPM_Event1
        Event 1
    enumerator kSYSPM_Event2
        Event 2
    enumerator kSYSPM_Event3
        Event 3
enum __syspm_mode
    syspm set count mode
    Values:
    enumerator kSYSPM_BothMode
        count in both modes
    enumerator kSYSPM_UserMode
        count only in user mode
    enumerator kSYSPM_PrivilegedMode
        count only in privileged mode
enum __syspm_startstop_control
    syspm start/stop control
    Values:
    enumerator kSYSPM_Idle
        idle >
    enumerator kSYSPM_LocalStop
        local stop
    enumerator kSYSPM_LocalStart
        local start
    enumerator kSYSPM_EnableTraceControl
        enable global TSTART/TSTOP
    enumerator kSYSPM_GlobalStart
        global stop
    enumerator kSYSPM_GlobalStop
        global start
typedef enum __syspm_monitor syspm_monitor_t
    syspm select control monitor
typedef enum __syspm_event syspm_event_t
    syspm select event
```



```
typedef enum _syspm_mode syspm_mode_t  
    syspm_set_count_mode
```

```
typedef enum _syspm_startstop_control syspm_startstop_control_t  
    syspm_startstop_control
```

`void SYSPM_Init(SYSPM_Type *base)`
Initializes the SYSPM.
This function enables the SYSPM clock.

Parameters

- `base` – SYSPM peripheral base address.

`void SYSPM_Deinit(SYSPM_Type *base)`
Deinitializes the SYSPM.
This function disables the SYSPM clock.

Parameters

- `base` – SYSPM peripheral base address.

`void SYSPM_SelectEvent(SYSPM_Type *base, syspm_monitor_t monitor, syspm_event_t event, uint8_t eventCode)`
Select event counters.

Parameters

- `base` – SYSPM peripheral base address.
- `event` – syspm select event, see to `syspm_event_t`.
- `eventCode` – select which event to be counted in PMECTR_x, see to table Events.

`void SYSPM_ResetEvent(SYSPM_Type *base, syspm_monitor_t monitor, syspm_event_t event)`
Reset event counters.

Parameters

- `base` – SYSPM peripheral base address.
- `monitor` – syspm control monitor, see to `syspm_monitor_t`.

`void SYSPM_ResetInstructionEvent(SYSPM_Type *base, syspm_monitor_t monitor)`
Reset Instruction Counter.

Parameters

- `base` – SYSPM peripheral base address.
- `monitor` – syspm control monitor, see to `syspm_monitor_t`.

`void SYSPM_SetCountMode(SYSPM_Type *base, syspm_monitor_t monitor, syspm_mode_t mode)`
Set count mode.

Parameters

- `base` – SYSPM peripheral base address.
- `monitor` – syspm control monitor, see to `syspm_monitor_t`.
- `mode` – syspm select counter mode, see to `syspm_mode_t`.

```
void SYSPM_SetStartStopControl(SYSPM_Type *base, syspm_monitor_t monitor,
                              syspm_startstop_control_t ssc)
```

Set Start/Stop Control.

Parameters

- base – SYSPM peripheral base address.
- monitor – syspm control monitor, see to syspm_monitor_t.
- ssc – This 3-bit field provides a three-phase mechanism to start/stop the counters. It includes a prioritized scheme with local start > local stop > global start > global stop > conditional TSTART > TSTOP. The global and conditional start/stop affect all configured PM/PSAM module concurrently so counters are “coherent”. see to syspm_startstop_control_t

```
void SYSPM_DisableCounter(SYSPM_Type *base, syspm_monitor_t monitor)
```

Disable Counters if Stopped or Halted.

Parameters

- base – SYSPM peripheral base address.
- monitor – syspm control monitor, see to syspm_monitor_t.

```
uint64_t SYSPM_GetEventCounter(SYSPM_Type *base, syspm_monitor_t monitor, syspm_event_t
                               event)
```

This is the the 40-bits of eventx counter. The value in this register increments each time the event selected in PMCRx[SELEVTx] occurs.

Parameters

- base – SYSPM peripheral base address.
- monitor – syspm control monitor, see to syspm_monitor_t.
- event – syspm select event, see to syspm_event_t.

Returns

- When the return value is not equal to SYSPM_COUNT_STABLE_TIMEOUT_RETURN_VALUE, the return value represents a 40 bits eventx counter.
- When the return value is equal to SYSPM_COUNT_STABLE_TIMEOUT_RETURN_VALUE, the return value represents timeout occurred.

```
uint64_t SYSPM_GetInstructionCounter(SYSPM_Type *base, syspm_monitor_t monitor)
```

This is the the 40-bits of instructionx counter. The value in this register increments each time the CPU count signals occurs.

Parameters

- base – SYSPM peripheral base address.
- monitor – syspm control monitor, see to syspm_monitor_t.

Returns

- When the return value is not equal to SYSPM_COUNT_STABLE_TIMEOUT_RETURN_VALUE, the return value represents a 40 bits instruction counter.
- When the return value is equal to SYSPM_COUNT_STABLE_TIMEOUT_RETURN_VALUE, the return value represents timeout occurred.

```
EVENT_COUNT_STABLE_TIMEOUT
```

Max loops to wait for SYSPM event count stable (0 means wait forever)

INSTRUCTION_COUNT_STABLE_TIMEOUT

Max loops to wait for SYSPM instruction count stable (0 means wait forever)

FSL_SYSPM_DRIVER_VERSION

SYSPM driver version.

SYSPM_COUNT_STABLE_TIMEOUT_RETURN_VALUE

2.129 TEMPSNS: Temperature Sensor Module

FSL_TMPSNS_DRIVER_VERSION

TMPSNS interrupt status enable type, `tmplsns_interrupt_status_enable_t`.

Values:

enumerator `kTEMPSENSOR_HighTempInterruptStatusEnable`

High temperature interrupt status enable.

enumerator `kTEMPSENSOR_LowTempInterruptStatusEnable`

Low temperature interrupt status enable.

enumerator `kTEMPSENSOR_PanicTempInterruptStatusEnable`

Panic temperature interrupt status enable.

enumerator `kTEMPSENSOR_FinishInterruptStatusEnable`

Finish interrupt enable.

TMPSNS interrupt status type, `tmplsns_interrupt_status_t`.

Values:

enumerator `kTEMPSENSOR_HighTempInterruptStatus`

High temperature interrupt status.

enumerator `kTEMPSENSOR_LowTempInterruptStatus`

Low temperature interrupt status.

enumerator `kTEMPSENSOR_PanicTempInterruptStatus`

Panic temperature interrupt status.

enum `tmplsns_measure_mode_t`

TMPSNS measure mode, `tempsensor_measure_mode`.

Values:

enumerator `kTEMPSENSOR_SingleMode`

Single measurement mode.

enumerator `kTEMPSENSOR_ContinuousMode`

Continuous measurement mode.

enum `_tmplsns_alarm_mode`

TMPSNS alarm mode.

Values:

enumerator `kTEMPMON_HighAlarmMode`

The high alarm temperature interrupt mode.

enumerator kTEMPMON_PanicAlarmMode

The panic alarm temperature interrupt mode.

enumerator kTEMPMON_LowAlarmMode

The low alarm temperature interrupt mode.

typedef struct *tmplsns_config* tmplsns_config_t

TMPSNS temperature structure.

typedef enum *tmplsns_alarm_mode* tmplsns_alarm_mode_t

TMPSNS alarm mode.

void TMPSNS_Init(TMPSNS_Type *base, const *tmplsns_config_t* *config)

Initializes the TMPSNS module.

Parameters

- base – TMPSNS base pointer
- config – Pointer to configuration structure.

void TMPSNS_Deinit(TMPSNS_Type *base)

Deinitializes the TMPSNS module.

Parameters

- base – TMPSNS base pointer

void TMPSNS_GetDefaultConfig(*tmplsns_config_t* *config)

Gets the default configuration structure.

This function initializes the TMPSNS configuration structure to a default value. The default values are: tempmonConfig->frequency = 0x02U; tempmonConfig->highAlarmTemp = 44U; tempmonConfig->panicAlarmTemp = 90U; tempmonConfig->lowAlarmTemp = 39U;

Parameters

- config – Pointer to a configuration structure.

void TMPSNS_StartMeasure(TMPSNS_Type *base)

start the temperature measurement process.

Parameters

- base – TMPSNS base pointer.

void TMPSNS_StopMeasure(TMPSNS_Type *base)

stop the measurement process.

Parameters

- base – TMPSNS base pointer

float TMPSNS_GetCurrentTemperature(TMPSNS_Type *base)

Get current temperature with the fused temperature calibration data.

Parameters

- base – TMPSNS base pointer

Returns

current temperature with degrees Celsius.

void TMPSNS_SetTempAlarm(TMPSNS_Type *base, int32_t tempVal, *tmplsns_alarm_mode_t* alarmMode)

Set the temperature count (raw sensor output) that will generate an alarm interrupt.

Parameters

- base – TMPSNS base pointer
- tempVal – The alarm temperature with degrees Celsius
- alarmMode – The alarm mode.

void TMPSNS_EnableInterrupt(TMPSNS_Type *base, uint32_t mask)

Enable interrupt status.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to enable from `tmplsns_interrupt_status_enable_t`.

void TMPSNS_DisableInterrupt(TMPSNS_Type *base, uint32_t mask)

Disable interrupt status.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to disable from `tmplsns_interrupt_status_enable_t`.

static inline uint32_t TMPSNS_GetInterruptFlags(TMPSNS_Type *base)

Get interrupt status flag.

Parameters

- base – TMPSNS base pointer

static inline void TMPSNS_ClearInterruptFlags(TMPSNS_Type *base, uint32_t mask)

Clear interrupt status flag.

Parameters

- base – TMPSNS base pointer
- mask – The interrupts to disable from `tmplsns_interrupt_status_t`.

struct __tmplsns_config

#include <fsl_tmplsns.h> TMPSNS temperature structure.

Public Members

tmplsns_measure_mode_t measureMode

The temperature measure mode.

uint16_t frequency

The temperature measure frequency.

int32_t highAlarmTemp

The high alarm temperature.

int32_t panicAlarmTemp

The panic alarm temperature.

int32_t lowAlarmTemp

The low alarm temperature.

2.130 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

2.131 TRDC: Trusted Resource Domain Controller

`void TRDC_Init(TRDC_Type *base)`

Initializes the TRDC module.

This function enables the TRDC clock.

Parameters

- `base` – TRDC peripheral base address.

`void TRDC_Deinit(TRDC_Type *base)`

De-initializes the TRDC module.

This function disables the TRDC clock.

Parameters

- `base` – TRDC peripheral base address.

`static inline uint8_t TRDC_GetCurrentMasterDomainId(TRDC_Type *base)`

Gets the domain ID of the current bus master.

Parameters

- `base` – TRDC peripheral base address.

Returns

Domain ID of current bus master.

`void TRDC_GetHardwareConfig(TRDC_Type *base, trdc_hardware_config_t *config)`

Gets the TRDC hardware configuration.

This function gets the TRDC hardware configurations, including number of bus masters, number of domains, number of MRCs and number of PACs.

Parameters

- `base` – TRDC peripheral base address.
- `config` – Pointer to the structure to get the configuration.

`static inline void TRDC_SetDacGlobalValid(TRDC_Type *base)`

Sets the TRDC DAC(Domain Assignment Controllers) global valid.

Once enabled, it will remain enabled until next reset.

Parameters

- `base` – TRDC peripheral base address.

`static inline void TRDC_LockMasterDomainAssignment(TRDC_Type *base, uint8_t master)`

Locks the bus master domain assignment register.

This function locks the master domain assignment. After it is locked, the register can't be changed until next reset.

Parameters

- `base` – TRDC peripheral base address.
- `master` – Which master to configure.

`static inline void TRDC_SetMasterDomainAssignmentValid(TRDC_Type *base, uint8_t master, bool valid)`

Sets the master domain assignment as valid or invalid.

This function sets the master domain assignment as valid or invalid.

Parameters

- base – TRDC peripheral base address.
- master – Which master to configure.
- valid – True to set valid, false to set invalid.

```
void TRDC_GetDefaultProcessorDomainAssignment(trdc_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 = kTRDC_DidMda;  
assignment->lock          = 0U;
```

Parameters

- domainAssignment – Pointer to the assignment structure.

```
void TRDC_GetDefaultNonProcessorDomainAssignment(trdc_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  = kTRDC_ForceUser;  
assignment->secureAttr    = kTRDC_ForceSecure;  
assignment->bypassDomainId = 0U;  
assignment->lock          = 0U;
```

Parameters

- domainAssignment – Pointer to the assignment structure.

```
void TRDC_SetProcessorDomainAssignment(TRDC_Type *base, const  
                                       trdc_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.

```
trdc_processor_domain_assignment_t processorAssignment;  
  
TRDC_GetDefaultProcessorDomainAssignment(&processorAssignment);  
  
processorAssignment.domainId = 0;  
processorAssignment.xxx     = xxx;  
TRDC_SetMasterDomainAssignment(TRDC, &processorAssignment);
```

Parameters

- base – TRDC peripheral base address.
- domainAssignment – Pointer to the assignment structure.

static inline void TRDC_EnableProcessorDomainAssignment(TRDC_Type *base, bool enable)
 Enables the processor bus master domain assignment.

Parameters

- base – TRDC peripheral base address.
- enable – True to enable, false to disable.

void TRDC_SetNonProcessorDomainAssignment(TRDC_Type *base, uint8_t master, const

 *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.

```
trdc_non_processor_domain_assignment_t nonProcessorAssignment;

TRDC_GetDefaultNonProcessorDomainAssignment(&nonProcessorAssignment);
nonProcessorAssignment.domainId = 1;
nonProcessorAssignment.xxx      = xxx;

TRDC_SetMasterDomainAssignment(TRDC, kTrdcMasterDma0, 0U, &nonProcessorAssignment);
```

Parameters

- base – TRDC peripheral base address.
- master – Which master to configure, refer to `trdc_master_t` in processor header file.
- domainAssignment – Pointer to the assignment structure.

void TRDC_GetDefaultIDAUConfig(*trdc_idau_config_t* *idauConfiguration)
 Gets the default IDAU(Implementation-Defined Attribution Unit) configuration.

```
config->lockSecureVTOR   = false;
config->lockNonsecureVTOR = false;
config->lockSecureMPU     = false;
config->lockNonsecureMPU  = false;
config->lockSAU           = false;
```

Parameters

- idauConfiguration – Pointer to the configuration structure.

void TRDC_SetIDAU(TRDC_Type *base, const *trdc_idau_config_t* *idauConfiguration)
 Sets the IDAU(Implementation-Defined Attribution Unit) control configuration.

Example: Lock the secure and non-secure MPU registers.

```
trdc_idau_config_t idauConfiguration;

TRDC_GetDefaultIDAUConfig(&idauConfiguration);

idauConfiguration.lockSecureMPU = true;
idauConfiguration.lockNonsecureMPU = true;
TRDC_SetIDAU(TRDC, &idauConfiguration);
```

Parameters

- base – TRDC peripheral base address.
- idauConfiguration – Pointer to the configuration structure.

static inline void TRDC_EnableFlashLogicalWindow(TRDC_Type *base, bool enable)

Enables/disables the FLW(flash logical window) function.

Parameters

- base – TRDC peripheral base address.
- enable – True to enable, false to disable.

static inline void TRDC_LockFlashLogicalWindow(TRDC_Type *base)

Locks FLW registers. Once locked the registers can not be updated until next reset.

Parameters

- base – TRDC peripheral base address.

static inline uint32_t TRDC_GetFlashLogicalWindowPbase(TRDC_Type *base)

Gets the FLW physical base address.

Parameters

- base – TRDC peripheral base address.

Returns

Physical address of the FLW function.

static inline void TRDC_GetSetFlashLogicalWindowSize(TRDC_Type *base, uint16_t size)

Sets the FLW size.

Parameters

- base – TRDC peripheral base address.
- size – Size of the FLW in unit of 32k bytes.

void TRDC_GetDefaultFlashLogicalWindowConfig(*trdc_flw_config_t* *flwConfiguration)

Gets the default FLW(Flash Logical Window) configuration.

```
config->blockCount    = false;
config->arrayBaseAddr = false;
config->lock           = false;
config->enable         = false;
```

Parameters

- flwConfiguration – Pointer to the configuration structure.

void TRDC_SetFlashLogicalWindow(TRDC_Type *base, const *trdc_flw_config_t* *flwConfiguration)

Sets the FLW function's configuration.

```
trdc_flw_config_t flwConfiguration;

TRDC_GetDefaultIDAUConfig(&flwConfiguration);

flwConfiguration.blockCount = 32U;
flwConfiguration.arrayBaseAddr = 0xFFFFFFFF;
TRDC_SetIDAU(TRDC, &flwConfiguration);
```

Parameters

- base – TRDC peripheral base address.
- flwConfiguration – Pointer to the configuration structure.

status_t TRDC_GetAndClearFirstDomainError(TRDC_Type *base, *trdc_domain_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 – TRDC 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_NoData*.

status_t TRDC_GetAndClearFirstSpecificDomainError(TRDC_Type *base, *trdc_domain_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 – TRDC 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_NoData*.

static inline void TRDC_SetMrcGlobalValid(TRDC_Type *base)

Sets the TRDC MRC(Memory Region Checkers) global valid.

Once enabled, it will remain enabled until next reset.

Parameters

- base – TRDC peripheral base address.

static inline *uint8_t* TRDC_GetMrcRegionNumber(TRDC_Type *base, *uint8_t* mrcIdx)

Gets the TRDC MRC(Memory Region Checkers) region number valid.

Parameters

- base – TRDC peripheral base address.
- mrcIdx – MRC index.

Returns

the region number of the given MRC instance

void TRDC_MrcSetMemoryAccessConfig(TRDC_Type *base, const *trdc_memory_access_control_config_t* *config, *uint8_t* mrcIdx, *uint8_t* regIdx)

Sets the memory access configuration for one of the access control register of one MRC.

Example: Enable the secure operations and lock the configuration for MRC0 region 1.

```
trdc_memory_access_control_config_t config;

config.securePrivX = true;
config.securePrivW = true;
config.securePrivR = true;
config.lock = true;
TRDC_SetMrcMemoryAccess(TRDC, &config, 0, 1);
```

Parameters

- base – TRDC peripheral base address.
- config – Pointer to the configuration structure.
- mrcIdx – MRC index.
- regIdx – Register number.

```
void TRDC_MrcEnableDomainNseUpdate(TRDC_Type *base, uint8_t mrcIdx, uint16_t
                                   domainMask, bool enable)
```

Enables the update of the selected domains.

After the domains' update are enabled, their regions' NSE bits can be set or clear.

Parameters

- base – TRDC peripheral base address.
- mrcIdx – MRC index.
- domainMask – Bit mask of the domains to be enabled.
- enable – True to enable, false to disable.

```
void TRDC_MrcRegionNseSet(TRDC_Type *base, uint8_t mrcIdx, uint16_t regionMask)
```

Sets the NSE bits of the selected regions for domains.

This function sets the NSE bits for the selected regions for the domains whose update are enabled.

Parameters

- base – TRDC peripheral base address.
- mrcIdx – MRC index.
- regionMask – Bit mask of the regions whose NSE bits to set.

```
void TRDC_MrcRegionNseClear(TRDC_Type *base, uint8_t mrcIdx, uint16_t regionMask)
```

Clears the NSE bits of the selected regions for domains.

This function clears the NSE bits for the selected regions for the domains whose update are enabled.

Parameters

- base – TRDC peripheral base address.
- mrcIdx – MRC index.
- regionMask – Bit mask of the regions whose NSE bits to clear.

```
void TRDC_MrcDomainNseClear(TRDC_Type *base, uint8_t mrcIdx, uint16_t domainMask)
```

Clears the NSE bits for all the regions of the selected domains.

This function clears the NSE bits for all regions of selected domains whose update are enabled.

Parameters

- base – TRDC peripheral base address.
- mrcIdx – MRC index.
- domainMask – Bit mask of the domains whose NSE bits to clear.

```
void TRDC__MrcSetRegionDescriptorConfig(TRDC_Type *base, const
                                         trdc_mrc_region_descriptor_config_t *config)
```

Sets the configuration for one of the region descriptor per domain per MRC instance.

This function sets the configuration for one of the region descriptor, including the start and end address of the region, memory access control policy and valid.

Parameters

- base – TRDC peripheral base address.
- config – Pointer to region descriptor configuration structure.

```
static inline void TRDC__SetMbcGlobalValid(TRDC_Type *base)
```

Sets the TRDC MBC(Memory Block Checkers) global valid.

Once enabled, it will remain enabled until next reset.

Parameters

- base – TRDC peripheral base address.

```
void TRDC__GetMbcHardwareConfig(TRDC_Type *base, trdc_slave_memory_hardware_config_t
                                *config, uint8_t mbcIdx, uint8_t slvIdx)
```

Gets the hardware configuration of the one of two slave memories within each MBC(memory block checker).

Parameters

- base – TRDC peripheral base address.
- config – Pointer to the structure to get the configuration.
- mbcIdx – MBC number.
- slvIdx – Slave number.

```
void TRDC__MbcSetNseUpdateConfig(TRDC_Type *base, const trdc_mbc_nse_update_config_t
                                  *config, uint8_t mbcIdx)
```

Sets the NSR update configuration for one of the MBC instance.

After set the NSE configuration, the configured memory area can be update by NSE set/clear.

Parameters

- base – TRDC peripheral base address.
- config – Pointer to NSE update configuration structure.
- mbcIdx – MBC index.

```
void TRDC__MbcWordNseSet(TRDC_Type *base, uint8_t mbcIdx, uint32_t bitMask)
```

Sets the NSE bits of the selected configuration words according to NSE update configuration.

This function sets the NSE bits of the word for the configured region, memory.

Parameters

- base – TRDC peripheral base address.
- mbcIdx – MBC index.
- bitMask – Mask of the bits whose NSE bits to set.

```
void TRDC_MbcWordNseClear(TRDC_Type *base, uint8_t mbcIdx, uint32_t bitMask)
```

Clears the NSE bits of the selected configuration words according to NSE update configuration.

This function sets the NSE bits of the word for the configured regio, memory.

Parameters

- base – TRDC peripheral base address.
- mbcIdx – MBC index.
- bitMask – Mask of the bits whose NSE bits to clear.

```
void TRDC_MbcNseClearAll(TRDC_Type *base, uint8_t mbcIdx, uint16_t domainMask, uint8_t slaveMask)
```

Clears all configuration words' NSE bits of the selected domain and memory.

Parameters

- base – TRDC peripheral base address.
- mbcIdx – MBC index.
- domainMask – Mask of the domains whose NSE bits to clear, 0b110 means clear domain 1&2.
- slaveMask – Mask of the slaves whose NSE bits to clear, 0x11 means clear all slave 0&1's NSE bits.

```
void TRDC_MbcSetMemoryAccessConfig(TRDC_Type *base, const  
trdc_memory_access_control_config_t *config, uint8_t  
mbcIdx, uint8_t rgdIdx)
```

Sets the memory access configuration for one of the region descriptor of one MBC.

Example: Enable the secure operations and lock the configuration for MRC0 region 1.

```
trdc_memory_access_control_config_t config;  
  
config.securePrivX = true;  
config.securePrivW = true;  
config.securePrivR = true;  
config.lock = true;  
TRDC_SetMbcMemoryAccess(TRDC, &config, 0, 1);
```

Parameters

- base – TRDC peripheral base address.
- config – Pointer to the configuration structure.
- mbcIdx – MBC index.
- rgdIdx – Region descriptor number.

```
void TRDC_MbcSetMemoryBlockConfig(TRDC_Type *base, const  
trdc_mbc_memory_block_config_t *config)
```

Sets the configuration for one of the memory block per domain per MBC instance.

This function sets the configuration for one of the memory block, including the memory access control policy and nse enable.

Parameters

- base – TRDC peripheral base address.
- config – Pointer to memory block configuration structure.

enum _trdc_did_sel

TRDC domain ID select method, the register bit TRDC_MDA_W0_0_DFMT0[DIDS], used for domain hit evaluation.

Values:

enumerator kTRDC_DidMda

Use MDAn[2:0] as DID.

enumerator kTRDC_DidInput

Use the input DID (DID_in) as DID.

enumerator kTRDC_DidMdaAndInput

Use MDAn[2] concatenated with DID_in[1:0] as DID.

enumerator kTRDC_DidReserved

Reserved.

enum _trdc_secure_attr

TRDC secure attribute, the register bit TRDC_MDA_W0_0_DFMT0[SA], used for bus master domain assignment.

Values:

enumerator kTRDC_ForceSecure

Force the bus attribute for this master to secure.

enumerator kTRDC_ForceNonSecure

Force the bus attribute for this master to non-secure.

enumerator kTRDC_MasterSecure

Use the bus master's secure/nonsecure attribute directly.

enumerator kTRDC_MasterSecure1

Use the bus master's secure/nonsecure attribute directly.

enum _trdc_privilege_attr

TRDC privileged attribute, the register bit TRDC_MDA_W0_x_DFMT1[PA], used for non-processor bus master domain assignment.

Values:

enumerator kTRDC_ForceUser

Force the bus attribute for this master to user.

enumerator kTRDC_ForcePrivilege

Force the bus attribute for this master to privileged.

enumerator kTRDC_MasterPrivilege

Use the bus master's attribute directly.

enumerator kTRDC_MasterPrivilege1

Use the bus master's attribute directly.

enum _trdc_controller

TRDC controller definition for domain error check. Each TRDC instance may have different MRC or MBC count, call TRDC_GetHardwareConfig to get the actual count.

Values:

enumerator kTRDC_MemBlockController0

Memory block checker 0.

enumerator kTRDC_MemBlockController1

Memory block checker 1.

enumerator kTRDC_MemBlockController2

Memory block checker 2.

enumerator kTRDC_MemBlockController3

Memory block checker 3.

enumerator kTRDC_MemRegionChecker0

Memory region checker 0.

enumerator kTRDC_MemRegionChecker1

Memory region checker 1.

enumerator kTRDC_MemRegionChecker2

Memory region checker 2.

enumerator kTRDC_MemRegionChecker3

Memory region checker 3.

enumerator kTRDC_MemRegionChecker4

Memory region checker 4.

enumerator kTRDC_MemRegionChecker5

Memory region checker 5.

enumerator kTRDC_MemRegionChecker6

Memory region checker 6.

enum _trdc_error_state

TRDC domain error state	definition	TRDC_MBCn_DERR_W1[EST]	or
TRDC_MRCn_DERR_W1[EST].			

Values:

enumerator kTRDC_ErrorStateNone

No access violation detected.

enumerator kTRDC_ErrorStateNone1

No access violation detected.

enumerator kTRDC_ErrorStateSingle

Single access violation detected.

enumerator kTRDC_ErrorStateMulti

Multiple access violation detected.

enum _trdc_error_attr

TRDC domain error attribute	definition	TRDC_MBCn_DERR_W1[EATR]	or
TRDC_MRCn_DERR_W1[EATR].			

Values:

enumerator kTRDC_ErrorSecureUserInst

Secure user mode, instruction fetch access.

enumerator kTRDC_ErrorSecureUserData

Secure user mode, data access.

enumerator kTRDC_ErrorSecurePrivilegeInst

Secure privileged mode, instruction fetch access.

enumerator kTRDC_ErrorSecurePrivilegeData
Secure privileged mode, data access.

enumerator kTRDC_ErrorNonSecureUserInst
NonSecure user mode, instruction fetch access.

enumerator kTRDC_ErrorNonSecureUserData
NonSecure user mode, data access.

enumerator kTRDC_ErrorNonSecurePrivilegeInst
NonSecure privileged mode, instruction fetch access.

enumerator kTRDC_ErrorNonSecurePrivilegeData
NonSecure privileged mode, data access.

enum _trdc_error_type
TRDC domain error access type definition TRDC_DERR_W1_n[ERW].

Values:

enumerator kTRDC_ErrorTypeRead
Error occurs on read reference.

enumerator kTRDC_ErrorTypeWrite
Error occurs on write reference.

enum _trdc_region_descriptor
The region descriptor enumeration, used to form a mask to set/clear the NSE bits for one or several regions.

Values:

enumerator kTRDC_RegionDescriptor0
Region descriptor 0.

enumerator kTRDC_RegionDescriptor1
Region descriptor 1.

enumerator kTRDC_RegionDescriptor2
Region descriptor 2.

enumerator kTRDC_RegionDescriptor3
Region descriptor 3.

enumerator kTRDC_RegionDescriptor4
Region descriptor 4.

enumerator kTRDC_RegionDescriptor5
Region descriptor 5.

enumerator kTRDC_RegionDescriptor6
Region descriptor 6.

enumerator kTRDC_RegionDescriptor7
Region descriptor 7.

enumerator kTRDC_RegionDescriptor8
Region descriptor 8.

enumerator kTRDC_RegionDescriptor9
Region descriptor 9.

enumerator kTRDC_RegionDescriptor10
Region descriptor 10.

enumerator kTRDC_RegionDescriptor11

Region descriptor 11.

enumerator kTRDC_RegionDescriptor12

Region descriptor 12.

enumerator kTRDC_RegionDescriptor13

Region descriptor 13.

enumerator kTRDC_RegionDescriptor14

Region descriptor 14.

enumerator kTRDC_RegionDescriptor15

Region descriptor 15.

enum _trdc_MRC_domain

The MRC domain enumeration, used to form a mask to enable/disable the update or clear all NSE bits of one or several domains.

Values:

enumerator kTRDC_MrcDomain0

Domain 0.

enumerator kTRDC_MrcDomain1

Domain 1.

enumerator kTRDC_MrcDomain2

Domain 2.

enumerator kTRDC_MrcDomain3

Domain 3.

enumerator kTRDC_MrcDomain4

Domain 4.

enumerator kTRDC_MrcDomain5

Domain 5.

enumerator kTRDC_MrcDomain6

Domain 6.

enumerator kTRDC_MrcDomain7

Domain 7.

enumerator kTRDC_MrcDomain8

Domain 8.

enumerator kTRDC_MrcDomain9

Domain 9.

enumerator kTRDC_MrcDomain10

Domain 10.

enumerator kTRDC_MrcDomain11

Domain 11.

enumerator kTRDC_MrcDomain12

Domain 12.

enumerator kTRDC_MrcDomain13

Domain 13.

enumerator kTRDC_MrcDomain14

Domain 14.

enumerator kTRDC_MrcDomain15

Domain 15.

enum _trdc_MBC_domain

The MBC domain enumeration, used to form a mask to enable/disable the update or clear NSE bits of one or several domains.

Values:

enumerator kTRDC_MbcDomain0

Domain 0.

enumerator kTRDC_MbcDomain1

Domain 1.

enumerator kTRDC_MbcDomain2

Domain 2.

enumerator kTRDC_MbcDomain3

Domain 3.

enumerator kTRDC_MbcDomain4

Domain 4.

enumerator kTRDC_MbcDomain5

Domain 5.

enumerator kTRDC_MbcDomain6

Domain 6.

enumerator kTRDC_MbcDomain7

Domain 7.

enum _trdc_MBC_memory

The MBC slave memory enumeration, used to form a mask to enable/disable the update or clear NSE bits of one or several memory block.

Values:

enumerator kTRDC_MbcSlaveMemory0

Memory 0.

enumerator kTRDC_MbcSlaveMemory1

Memory 1.

enumerator kTRDC_MbcSlaveMemory2

Memory 2.

enumerator kTRDC_MbcSlaveMemory3

Memory 3.

enum _trdc_MBC_bit

The MBC bit enumeration, used to form a mask to set/clear configured words' NSE.

Values:

enumerator kTRDC_MbcBit0

Bit 0.

enumerator kTRDC_MbcBit1

Bit 1.

enumerator kTRDC_MbcBit2
Bit 2.

enumerator kTRDC_MbcBit3
Bit 3.

enumerator kTRDC_MbcBit4
Bit 4.

enumerator kTRDC_MbcBit5
Bit 5.

enumerator kTRDC_MbcBit6
Bit 6.

enumerator kTRDC_MbcBit7
Bit 7.

enumerator kTRDC_MbcBit8
Bit 8.

enumerator kTRDC_MbcBit9
Bit 9.

enumerator kTRDC_MbcBit10
Bit 10.

enumerator kTRDC_MbcBit11
Bit 11.

enumerator kTRDC_MbcBit12
Bit 12.

enumerator kTRDC_MbcBit13
Bit 13.

enumerator kTRDC_MbcBit14
Bit 14.

enumerator kTRDC_MbcBit15
Bit 15.

enumerator kTRDC_MbcBit16
Bit 16.

enumerator kTRDC_MbcBit17
Bit 17.

enumerator kTRDC_MbcBit18
Bit 18.

enumerator kTRDC_MbcBit19
Bit 19.

enumerator kTRDC_MbcBit20
Bit 20.

enumerator kTRDC_MbcBit21
Bit 21.

enumerator kTRDC_MbcBit22
Bit 22.

enumerator `kTRDC_MbcBit23`

Bit 23.

enumerator `kTRDC_MbcBit24`

Bit 24.

enumerator `kTRDC_MbcBit25`

Bit 25.

enumerator `kTRDC_MbcBit26`

Bit 26.

enumerator `kTRDC_MbcBit27`

Bit 27.

enumerator `kTRDC_MbcBit28`

Bit 28.

enumerator `kTRDC_MbcBit29`

Bit 29.

enumerator `kTRDC_MbcBit30`

Bit 30.

enumerator `kTRDC_MbcBit31`

Bit 31.

typedef struct *_trdc_hardware_config* trdc_hardware_config_t

TRDC hardware configuration.

typedef struct *_trdc_slave_memory_hardware_config* trdc_slave_memory_hardware_config_t

Hardware configuration of the two slave memories within each MBC(memory block checker).

typedef enum *_trdc_did_sel* trdc_did_sel_t

TRDC domain ID select method, the register bit `TRDC_MDA_W0_0_DFMT0[DIDS]`, used for domain hit evaluation.

typedef enum *_trdc_secure_attr* trdc_secure_attr_t

TRDC secure attribute, the register bit `TRDC_MDA_W0_0_DFMT0[SA]`, used for bus master domain assignment.

typedef struct *_trdc_processor_domain_assignment* trdc_processor_domain_assignment_t

Domain assignment for the processor bus master.

typedef enum *_trdc_privilege_attr* trdc_privilege_attr_t

TRDC privileged attribute, the register bit `TRDC_MDA_W0_x_DFMT1[PA]`, used for non-processor bus master domain assignment.

typedef struct *_trdc_non_processor_domain_assignment*

trdc_non_processor_domain_assignment_t

Domain assignment for the non-processor bus master.

typedef struct *_trdc_idau_config* trdc_idau_config_t

IDAU(Implementation-Defined Attribution Unit) configuration for TZ-M function control.

typedef struct *_trdc_flw_config* trdc_flw_config_t

FLW(Flash Logical Window) configuration.

typedef enum *_trdc_controller* trdc_controller_t

TRDC controller definition for domain error check. Each TRDC instance may have different MRC or MBC count, call `TRDC_GetHardwareConfig` to get the actual count.

```
typedef enum _trdc_error_state trdc_error_state_t
    TRDC domain error state definition TRDC_MBCn_DERR_W1[EST] or
    TRDC_MRCn_DERR_W1[EST].
```

```
typedef enum _trdc_error_attr trdc_error_attr_t
    TRDC domain error attribute definition TRDC_MBCn_DERR_W1[EATR] or
    TRDC_MRCn_DERR_W1[EATR].
```

```
typedef enum _trdc_error_type trdc_error_type_t
    TRDC domain error access type definition TRDC_DERR_W1_n[ERW].
```

```
typedef struct _trdc_domain_error trdc_domain_error_t
    TRDC domain error definition.
```

```
typedef struct _trdc_memory_access_control_config trdc_memory_access_control_config_t
    Memory access control configuration for MBC/MRC.
```

```
typedef struct _trdc_mrc_region_descriptor_config trdc_mrc_region_descriptor_config_t
    The configuration of each region descriptor per domain per MRC instance.
```

```
typedef struct _trdc_mbc_nse_update_config trdc_mbc_nse_update_config_t
    The configuration of MBC NSE update.
```

```
typedef struct _trdc_mbc_memory_block_config trdc_mbc_memory_block_config_t
    The configuration of each memory block per domain per MBC instance.
```

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```
struct _trdc_hardware_config
    #include <fsl_trdc.h> TRDC hardware configuration.
```

Public Members

uint8_t masterNumber
Number of bus masters.

uint8_t domainNumber
Number of domains.

uint8_t mbcNumber
Number of MBCs.

uint8_t mrcNumber
Number of MRCs.

```
struct _trdc_slave_memory_hardware_config
    #include <fsl_trdc.h> Hardware configuration of the two slave memories within each
    MBC(memory block checker).
```

Public Members

uint32_t blockNum
Number of blocks.

uint32_t blockSize
Block size.

```
struct _trdc_processor_domain_assignment
    #include <fsl_trdc.h> Domain assignment for the processor bus master.
```

Public Members

uint32_t domainId

Domain ID.

uint32_t domainIdSelect

Domain ID select method, see trdc_did_sel_t.

uint32_t __pad0__

Reserved.

uint32_t secureAttr

Secure attribute, see trdc_secure_attr_t.

uint32_t __pad1__

Reserved.

uint32_t lock

Lock the register.

uint32_t __pad2__

Reserved.

struct __trdc_non_processor_domain_assignment

#include <fsl_trdc.h> Domain assignment for the non-processor bus master.

Public Members

uint32_t domainId

Domain ID.

uint32_t privilegeAttr

Privileged attribute, see trdc_privilege_attr_t.

uint32_t secureAttr

Secure attribute, see trdc_secure_attr_t.

uint32_t bypassDomainId

Bypass domain ID.

uint32_t __pad0__

Reserved.

uint32_t lock

Lock the register.

uint32_t __pad1__

Reserved.

struct __trdc_idau_config

#include <fsl_trdc.h> IDAU(Implementation-Defined Attribution Unit) configuration for TZ-M function control.

Public Members

uint32_t __pad0__

Reserved.

uint32_t lockSecureVTOR

Disable writes to secure VTOR(Vector Table Offset Register).

uint32_t lockNonsecureVTOR

Disable writes to non-secure VTOR, Application interrupt and Reset Control Registers.

uint32_t lockSecureMPU

Disable writes to secure MPU(Memory Protection Unit) from software or from a debug agent connected to the processor in Secure state.

uint32_t lockNonsecureMPU

Disable writes to non-secure MPU(Memory Protection Unit) from software or from a debug agent connected to the processor.

uint32_t lockSAU

Disable writes to SAU(Security Attribution Unit) registers.

uint32_t __pad1__

Reserved.

struct __trdc_flw_config

#include <fsl_trdc.h> FLW(Flash Logical Window) configuration.

Public Members

uint16_t blockCount

Block count of the Flash Logic Window in 32KByte blocks.

uint32_t arrayBaseAddr

Flash array base address of the Flash Logical Window.

bool lock

Disable writes to FLW registers.

bool enable

Enable FLW function.

struct __trdc_domain_error

#include <fsl_trdc.h> TRDC domain error definition.

Public Members

trdc_controller_t controller

Which controller captured access violation.

uint32_t address

Access address that generated access violation.

trdc_error_state_t errorState

Error state.

trdc_error_attr_t errorAttr

Error attribute.

trdc_error_type_t errorType

Error type.

uint8_t errorPort

Error port.

uint8_t domainId

Domain ID.

uint8_t slaveMemoryIdx

The slave memory index. Only apply when violation in MBC.

struct __trdc_memory_access_control_config

#include <fsl_trdc.h> Memory access control configuration for MBC/MRC.

Public Members

uint32_t nonsecureUsrX

Allow nonsecure user execute access.

uint32_t nonsecureUsrW

Allow nonsecure user write access.

uint32_t nonsecureUsrR

Allow nonsecure user read access.

uint32_t __pad0__

Reserved.

uint32_t nonsecurePrivX

Allow nonsecure privilege execute access.

uint32_t nonsecurePrivW

Allow nonsecure privilege write access.

uint32_t nonsecurePrivR

Allow nonsecure privilege read access.

uint32_t __pad1__

Reserved.

uint32_t secureUsrX

Allow secure user execute access.

uint32_t secureUsrW

Allow secure user write access.

uint32_t secureUsrR

Allow secure user read access.

uint32_t __pad2__

Reserved.

uint32_t securePrivX

Allownonsecure privilege execute access.

uint32_t securePrivW

Allownonsecure privilege write access.

uint32_t securePrivR

Allownonsecure privilege read access.

uint32_t __pad3__

Reserved.

uint32_t lock

Lock the configuration until next reset, only apply to access control register 0.

struct __trdc_mrc_region_descriptor_config

#include <fsl_trdc.h> The configuration of each region descriptor per domain per MRC instance.

Public Members

uint8_t memoryAccessControlSelect

Select one of the 8 access control policies for this region, for access control policies see `trdc_memory_access_control_config_t`.

uint32_t startAddr

Physical start address.

bool valid

Lock the register.

bool nseEnable

Enable non-secure accesses and disable secure accesses.

uint32_t endAddr

Physical start address.

uint8_t mrcIdx

The index of the MRC for this configuration to take effect.

uint8_t domainIdx

The index of the domain for this configuration to take effect.

uint8_t regionIdx

The index of the region for this configuration to take effect.

struct `_trdc_mbc_nse_update_config`

#include <fsl_trdc.h> The configuration of MBC NSE update.

Public Members

uint32_t __pad0__

Reserved.

uint32_t wordIdx

MBC configuration word index to be updated.

uint32_t __pad1__

Reserved.

uint32_t memorySelect

Bit mask of the selected memory to be updated. `_trdc_MBC_memory`.

uint32_t __pad2__

Reserved.

uint32_t domainSelect

Bit mask of the selected domain to be updated. `_trdc_MBC_domain`.

uint32_t __pad3__

Reserved.

uint32_t autoIncrement

Whether to increment the word index after current word is updated using this configuration.

struct `_trdc_mbc_memory_block_config`

#include <fsl_trdc.h> The configuration of each memory block per domain per MBC instance.

Public Members

uint32_t memoryAccessControlSelect

Select one of the 8 access control policies for this memory block, for access control policies see `trdc_memory_access_control_config_t`.

uint32_t nseEnable

Enable non-secure accesses and disable secure accesses.

uint32_t mbcIdx

The index of the MBC for this configuration to take effect.

uint32_t domainIdx

The index of the domain for this configuration to take effect.

uint32_t slaveMemoryIdx

The index of the slave memory for this configuration to take effect.

uint32_t memoryBlockIdx

The index of the memory block for this configuration to take effect.

2.132 TSTMR: Timestamp Timer Driver

FSL_TSTMR_DRIVER_VERSION

Version 2.0.3

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.

static inline 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.

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2.133 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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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. Transfer 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_TransferDataBootcontinuous`

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 field 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 field 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.

2.134 Xbar

void XBAR_Init(xbar_instance_t xbarInstance)

Initializes the XBAR modules.

This function un-gates the XBAR clock.

Parameters

- xbarInstance – XBAR peripheral address.

void XBAR_Deinit(xbar_instance_t xbarInstance)

Shutdown the XBAR modules.

This function disables XBAR clock.

Parameters

- xbarInstance – XBAR peripheral address.

status_t XBAR_SetSignalsConnection(xbar_input_signal_t input, xbar_output_signal_t output)

Set connection between the selected XBAR_IN[*] input and the XBAR_OUT[*] output signal.

This function connects the XBAR input to the selected XBAR output. If more than one XBAR module is available, only the inputs and outputs from the same module can be connected.

Example:

```
XBAR_SetSignalsConnection(kXBAR_DSC1_InputLogicLow, kXBAR_DSC1_OutputTriggerSyncIn0);
```

Parameters

- input – XBAR input signal.
- output – XBAR output signal.

Return values

- kStatus_Success – Signal connection set successfully.
- kStatus_InvalidArgument – Failed because of invalid argument.

status_t XBAR_ClearOutputStatusFlag(xbar_output_signal_t output)

Clears the edge detection status flags.

Parameters

- output – XBAR output signal.

Return values

- kStatus_Success – Signal connection set successfully.
- kStatus_InvalidArgument – Failed because of invalid argument.

status_t XBAR_GetOutputStatusFlag(xbar_output_signal_t output, bool *flag)

Gets the active edge detection status.

This function gets the active edge detect status of all XBAR_OUTs. If the active edge occurs, the return value is asserted. When the interrupt or the DMA functionality is enabled for the XBAR_OUTx, this field is 1 when the interrupt or DMA request is asserted and 0 when the interrupt or DMA request has been cleared.

Parameters

- output – XBAR output signal.
- flag – get XBAR output status flag.

Return values

- kStatus_Success – Signal connection set successfully.
- kStatus_InvalidArgument – Failed because of invalid argument.

status_t XBAR_SetOutputSignalConfig(xbar_output_signal_t output, const xbar_control_config_t *controlConfig)

Configures the XBAR control register.

This function configures an XBAR control register. The active edge detection and the DMA/IRQ function on the corresponding XBAR output can be set.

Example:

```
xbar_control_config_t userConfig;  
userConfig.activeEdge = kXBAR_EdgeRising;  
userConfig.requestType = kXBAR_RequestInterruptEnable;  
XBAR_SetOutputSignalConfig(kXBARA_OutputDMAMUX18, &userConfig);
```

Parameters

- output – XBAR output signal.
- controlConfig – Pointer to structure that keeps configuration of control register.

Return values

- kStatus_Success – Signal connection set successfully.
- kStatus_InvalidArgument – Failed because of invalid argument.

enum `_xbar_active_edge`

XBAR active edge for detection.

Values:

enumerator `kXBAR_EdgeNone`

Edge detection status bit never asserts.

enumerator `kXBAR_EdgeRising`

Edge detection status bit asserts on rising edges.

enumerator `kXBAR_EdgeFalling`

Edge detection status bit asserts on falling edges.

enumerator `kXBAR_EdgeRisingAndFalling`

Edge detection status bit asserts on rising and falling edges.

enum `_xbar_request`

Defines the XBAR DMA and interrupt configurations.

Values:

enumerator `kXBAR_RequestDisable`

Interrupt and DMA are disabled.

enumerator `kXBAR_RequestDMAEnable`

DMA enabled, interrupt disabled.

enumerator `kXBAR_RequestInterruptEnable`

Interrupt enabled, DMA disabled.

typedef `uint16_t xbar_reg_t`

typedef `enum _xbar_active_edge xbar_active_edge_t`

XBAR active edge for detection.

typedef `enum _xbar_request xbar_request_t`

Defines the XBAR DMA and interrupt configurations.

typedef `struct _xbar_control_config xbar_control_config_t`

Defines the configuration structure of the XBAR control register.

This structure keeps the configuration of XBAR control register for one output. Control registers are available only for a few outputs. Not every XBAR module has control registers.

`FSL_XBAR_DRIVER_VERSION`

struct `xbar_info_t`

`#include <fsl_xbar.h>` Find the instance index from base address and register offset mappings.

struct `_xbar_control_config`

#include <fsl_xbar.h> Defines the configuration structure of the XBAR control register.

This structure keeps the configuration of XBAR control register for one output. Control registers are available only for a few outputs. Not every XBAR module has control registers.

Public Members

xbar_active_edge_t activeEdge

Active edge to be detected.

xbar_request_t requestType

Selects DMA/Interrupt request.

2.135 CACHE: CACHE Memory Controller

uint32_t XCACHE_GetInstanceByAddr(uint32_t address)

brief Returns an instance number given physical memory address.

param address The physical memory address.

Returns

XCACHE instance number starting from 0.

void XCACHE_EnableCache(XCACHE_Type *base)

Enables the cache.

Parameters

- base – XCACHE peripheral base address.

void XCACHE_DisableCache(XCACHE_Type *base)

Disables the cache.

Parameters

- base – XCACHE peripheral base address.

void XCACHE_InvalidateCache(XCACHE_Type *base)

Invalidates the cache.

Parameters

- base – XCACHE peripheral base address.

void XCACHE_InvalidateCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates cache by range.

Note: Address and size should be aligned to “XCACHE_LINESIZE_BYTE”. The startAddr here will be forced to align to XCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be invalidated, should be larger than 0, better to align with cache line size.

```
void XCACHE_CleanCache(XCACHE_Type *base)
```

Cleans the cache.

Parameters

- base – XCACHE peripheral base address.

```
void XCACHE_CleanCacheByRange(uint32_t address, uint32_t size_byte)
```

Cleans cache by range.

Note: Address and size should be aligned to “XCACHE_LINESIZE_BYTE”. The startAddr here will be forced to align to XCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be cleaned, should be larger than 0, better to align with cache line size.

```
void XCACHE_CleanInvalidateCache(XCACHE_Type *base)
```

Cleans and invalidates the cache.

Parameters

- base – XCACHE peripheral base address.

```
void XCACHE_CleanInvalidateCacheByRange(uint32_t address, uint32_t size_byte)
```

Cleans and invalidate cache by range.

Note: Address and size should be aligned to “XCACHE_LINESIZE_BYTE”. The startAddr here will be forced to align to XCACHE_LINESIZE_BYTE if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address of cache.
- size_byte – size of the memory to be Cleaned and Invalidated, should be larger than 0, better to align with cache line size.

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

Invalidates instruction cache by range.

Note: Address and size should be aligned to XCACHE_LINESIZE_BYTE due to the cache operation unit FSL_FEATURE_XCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated, should be larger than 0, better to align with cache line size.

static inline void DCACHE_InvalidateByRange(uint32_t address, uint32_t size_byte)

Invalidates data cache by range.

Note: Address and size should be aligned to XCACHE_LINESIZE_BYTE due to the cache operation unit FSL_FEATURE_XCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be invalidated, should be larger than 0, better to align with cache line size.

static inline void DCACHE_CleanByRange(uint32_t address, uint32_t size_byte)

Clean data cache by range.

Note: Address and size should be aligned to XCACHE_LINESIZE_BYTE due to the cache operation unit FSL_FEATURE_XCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be cleaned, should be larger than 0, better to align with cache line size.

static inline void DCACHE_CleanInvalidateByRange(uint32_t address, uint32_t size_byte)

Cleans and Invalidates data cache by range.

Note: Address and size should be aligned to XCACHE_LINESIZE_BYTE due to the cache operation unit FSL_FEATURE_XCACHE_LINESIZE_BYTE. The startAddr here will be forced to align to the cache line size if startAddr is not aligned. For the size_byte, application should make sure the alignment or make sure the right operation order if the size_byte is not aligned.

Parameters

- address – The physical address.
- size_byte – size of the memory to be Cleaned and Invalidated, should be larger than 0, better to align with cache line size.

FSL_CACHE_DRIVER_VERSION

cache driver version.

XCACHE_LINESIZE_BYTE

cache line size.

Chapter 3

Middleware

3.1 Boot

3.1.1 MCUXpresso SDK : mcuxsdk-middleware-mcuboot_opensource

Overview

This repository is a fork of MCUboot (<https://github.com/mcu-tools/mcuboot>) for MCUXpresso SDK delivery and it contains the components officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository (mcuxsdk-manifests) for the complete delivery of MCUXpresso SDK.

Documentation

Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

Visit [MCUboot - Documentation](#) to review details on the contents in this sub-repo.

Setup

Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution

Contributions are not currently accepted. If the intended contribution is not related to NXP specific code, consider contributing directly to the upstream MCUboot project. Once this MCUboot fork is synchronized with the upstream project, such contributions will end up here as well. If the intended contribution is a bugfix or improvement for NXP porting layer or for code added or modified by NXP, please open an issue or contact NXP support.

NXP Fork

This fork of MCUboot contains specific modifications and enhancements for NXP MCUXpresso SDK integration.

See *changelog* for details.

3.1.2 MCUboot



This is MCUboot version 2.2.0

MCUboot is a secure bootloader for 32-bits microcontrollers. It defines a common infrastructure for the bootloader and the system flash layout on microcontroller systems, and provides a secure bootloader that enables easy software upgrade.

MCUboot is not dependent on any specific operating system and hardware and relies on hardware porting layers from the operating system it works with. Currently, MCUboot works with the following operating systems and SoCs:

- [Zephyr](#)
- [Apache Mynewt](#)
- [Apache NuttX](#)
- [RIOT](#)
- [Mbed OS](#)
- [Espressif](#)
- [Cypress/Infineon](#)

RIOT is supported only as a boot target. We will accept any new port contributed by the community once it is good enough.

MCUboot How-tos

See the following pages for instructions on using MCUboot with different operating systems and SoCs:

- [Zephyr](#)
- [Apache Mynewt](#)
- [Apache NuttX](#)
- [RIOT](#)
- [Mbed OS](#)
- [Espressif](#)
- [Cypress/Infineon](#)

There are also instructions for the *Simulator*.

Roadmap

The issues being planned and worked on are tracked using GitHub issues. To give your input, visit [MCUboot GitHub Issues](#).

Source files

You can find additional documentation on the bootloader in the source files. For more information, use the following links:

- [boot/bootutil](#) - The core of the bootloader itself.
- [boot/boot_serial](#) - Support for serial upgrade within the bootloader itself.
- [boot/zephyr](#) - Port of the bootloader to Zephyr.
- [boot/mynewt](#) - Bootloader application for Apache Mynewt.
- [boot/nuttX](#) - Bootloader application and port of MCUboot interfaces for Apache NuttX.
- [boot/mbed](#) - Port of the bootloader to Mbed OS.
- [boot/espressif](#) - Bootloader application and MCUboot port for Espressif SoCs.
- [boot/cypress](#) - Bootloader application and MCUboot port for Cypress/Infineon SoCs.
- [imgtool](#) - A tool to securely sign firmware images for booting by MCUboot.
- [sim](#) - A bootloader simulator for testing and regression.

Joining the project

Developers are welcome!

Use the following links to join or see more about the project:

- [Our developer mailing list](#)
- [Our Discord channel](#) [Get your invite](#)

3.2 Cloud

3.2.1 AWS IoT

Device Shadow Library

AWS IoT Device Shadow library The AWS IoT Device Shadow library enables you to store and retrieve the current state (the “shadow”) of every registered device. The device’s shadow is a persistent, virtual representation of your device that you can interact with from AWS IoT Core even if the device is offline. The device state is captured as its “shadow” within a [JSON](#) document. The device can send commands over MQTT to get, update and delete its latest state as well as receive notifications over MQTT about changes in its state. Each device’s shadow is uniquely identified by the name of the corresponding “thing”, a representation of a specific device or logical entity on the AWS Cloud. See [Managing Devices with AWS IoT](#) for more information on IoT “thing”. More details about AWS IoT Device Shadow can be found in [AWS IoT documentation](#). This library is distributed under the *MIT Open Source License*.

Note: From [v1.1.0](#) release onwards, you can use named shadow, a feature of the AWS IoT Device Shadow service that allows you to create multiple shadows for a single IoT device.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

AWS IoT Device Shadow v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Device Shadow v1.0.2 source code is part of the FreeRTOS 202012.00 LTS release.

AWS IoT Device Shadow Config File The AWS IoT Device Shadow library exposes configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *shadow_config_defaults.h*. To provide custom values for the configuration macros, a custom config file named *shadow_config.h* can be provided by the user application to the library.

By default, a *shadow_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `SHADOW_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

Building the Library The *shadowFilePaths.cmake* file contains the information of all source files and the header include path required to build the AWS IoT Device Shadow library.

As mentioned in the [previous section](#), either a custom config file (i.e. *shadow_config.h*) OR the `SHADOW_DO_NOT_USE_CUSTOM_CONFIG` macro needs to be provided to build the AWS IoT Device Shadow library.

For a CMake example of building the AWS IoT Device Shadow library with the *shadowFilePaths.cmake* file, refer to the *coverity_analysis* library target in *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule By default, the submodules in this repository are configured with `update=none` in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive --test/unit-test/CMock
```

Platform Prerequisites

- For building the library, **CMake 3.13.0** or later and a **C90 compiler**.
- For running unit tests, **Ruby 2.0.0** or later is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build unit tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#).)
2. Run the *cmake* command: `cmake -S test -B build`

3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples Please refer to the demos of the AWS IoT Device Shadow library in the following locations for reference examples on POSIX and FreeRTOS platforms:

Platform	Location	Transport Interface Implementation (for coreMQTT stack)
POSIX	AWS IoT Device SDK for Embedded C	POSIX sockets for TCP/IP and OpenSSL for TLS stack
FreeRTOS	FreeRTOS/FreeRTOS	FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack
FreeRTOS	FreeRTOS AWS Reference Integrations	Based on Secure Sockets Abstraction

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of IoT Device Shadow library may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

Device Defender Library

AWS IoT Device Defender Library The Device Defender library enables you to send device metrics to the [AWS IoT Device Defender Service](#). This library also supports custom metrics, a feature that helps you monitor operational health metrics that are unique to your fleet or use case. For example, you can define a new metric to monitor the memory usage or CPU usage

on your devices. This library has no dependencies on any additional libraries other than the standard C library, and therefore, can be used with any MQTT client library. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone static code analysis using [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

AWS IoT Device Defender v1.3.0 source code is part of the [FreeRTOS 202210.00 LTS](#) release.

AWS IoT Device Defender v1.1.0 source code is part of the [FreeRTOS 202012.01 LTS](#) release.

AWS IoT Device Defender Client Config File The AWS IoT Device Defender Client Library exposes build configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *defender_config_defaults.h*. To provide custom values for the configuration macros, a config file named *defender_config.h* can be provided by the application to the library.

By default, a *defender_config.h* config file is required to build the library. To disable this requirement and build the library with default configuration values, provide `DEFENDER_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

Thus, the Device Defender client library can be built by either:

- Defining a *defender_config.h* file in the application, and adding it to the include directories list of the library.

OR

- Defining the `DEFENDER_DO_NOT_USE_CUSTOM_CONFIG` preprocessor macro for the library build.

Building the Library The *defenderFilePaths.cmake* file contains the information of all source files and the header include paths required to build the Device Defender client library.

As mentioned in the previous section, either a custom config file (i.e. *defender_config.h*) or `DEFENDER_DO_NOT_USE_CUSTOM_CONFIG` macro needs to be provided to build the Device Defender client library.

For a CMake example of building the Device Defender client library with the *defenderFilePaths.cmake* file, refer to the *coverity_analysis* library target in *test/CMakeLists.txt* file.

Building Unit Tests

Platform Prerequisites

- For running unit tests:
 - **C90 compiler** like gcc.
 - **CMake 3.13.0 or later**.
 - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository.
2. Run the `cmake` command: `cmake -S test -B build -DBUILD_CLONE_SUBMODULES=ON`.
3. Run this command to build the library and unit tests: `make -C build all`.
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples The AWS IoT Embedded C-SDK repository contains a demo showing the use of AWS IoT Device Defender Client Library [here](#) on a POSIX platform.

Documentation

Existing documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of the AWS IoT Device Defender library may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

Jobs Library

README

AWS IoT Jobs library The AWS IoT Jobs library helps you notify connected IoT devices of a pending **Job**. A Job can be used to manage your fleet of devices, update firmware and security certificates on your devices, or perform administrative tasks such as restarting devices and performing diagnostics. It interacts with the [AWS IoT Jobs service](#) using MQTT, a lightweight publish-subscribe protocol. This library provides a convenience API to compose and recognize the MQTT topic strings used by the Jobs service. The library is written in C compliant with ISO C90 and MISRA C:2012, and is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity](#), and validation of memory safety with the [CBMC bounded model checker](#).

See memory requirements for this library [here](#).

AWS IoT Jobs v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

AWS IoT Jobs v1.1.0 source code is part of the FreeRTOS 202012.01 LTS release.

Building the Jobs library A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Given an application in a file named `example.c`, *gcc* can be used like so:

```
gcc -I source/include example.c source/jobs.c -o example
```

gcc can also produce an object file to be linked later:

```
gcc -I source/include -c source/jobs.c
```

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference example The AWS IoT Device SDK for Embedded C repository contains a demo using the jobs library on a POSIX platform. https://github.com/aws/aws-iot-device-sdk-embedded-C/tree/main/demos/jobs/jobs_demo_mosquitto

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of the AWS IoT Jobs library may differ across repositories.

Generating Documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Building unit tests

Checkout Unity Submodule By default, the submodules in this repository are configured with `update=none` in `.gitmodules` to avoid increasing clone time and disk space usage of other repositories that submodule this repository.

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive --test/unit-test/Unity
```

Platform Prerequisites

- For running unit tests
 - C90 compiler like gcc
 - CMake 3.13.0 or later
 - Ruby 2.0.0 or later is additionally required for the Unity test framework (that we use).
- For running the coverage target, lcov is additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described [above](#).)
2. Create build directory: `mkdir build && cd build`
3. Run `cmake` while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

Contributing See *CONTRIBUTING.md* for information on contributing.

Over-the-air Update Library

AWS IoT Over-the-air Update Library The OTA library enables you to manage the notification of a newly available update, download the update, and perform cryptographic verification of the firmware update. Using the library, you can logically separate firmware updates from the application running on your devices. The OTA library can share a network connection with the application, saving memory in resource-constrained devices. In addition, the OTA library lets you define application-specific logic for testing, committing, or rolling back a firmware update. The library supports different application protocols like Message Queuing Telemetry Transport (MQTT) and Hypertext Transfer Protocol (HTTP), and provides various configuration options you can fine tune depending on network type and conditions. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8. This library has also undergone static code analysis from [Coverity static analysis](#).

See memory requirements for this library [here](#).

AWS IoT Over-the-air Update Library v3.4.0 source code is part of the [FreeRTOS 202210.00 LTS](#) release.

AWS IoT Over-the-air Update Library v3.3.0 source code is part of the [FreeRTOS 202012.01 LTS](#) release.

AWS IoT Over-the-air Updates Config File The AWS IoT Over-the-air Updates library exposes configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *ota_config_defaults.h*. To provide custom values for the configuration macros, a custom config file named *ota_config.h* can be provided by the user application to the library.

By default, a *ota_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `OTA_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

Building the Library The *otaFilePaths.cmake* file contains the information of all source files and the header include paths required to build the AWS IoT Over-the-air Updates library.

As mentioned in the previous section, either a custom config file (i.e. *ota_config.h*) OR the `OTA_DO_NOT_USE_CUSTOM_CONFIG` macro needs to be provided to build the AWS IoT Over-the-air Updates library.

For a CMake example of building the AWS IoT Over-the-air Updates library with the *otaFilePaths.cmake* file, refer to the *coverity_analysis* library target in the *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule By default, the submodules in this repository are configured with `update=none` in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like [AWS IoT Device SDK for Embedded C](#) that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

Platform Prerequisites

- For building the library, **CMake 3.13.0** or later and a **C90 compiler**.
- For running unit tests, **Ruby 2.0.0** or later is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build unit tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#).)
2. Run the *cmake* command: `cmake -S test -B build`

3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

Migration Guide

How to migrate from v2.0.0 (Release Candidate) to v3.4.0 The following table lists equivalent API function signatures in v2.0.0 (Release Candidate) and v3.4.0 declared in *ota.h*

v2.0.0 (Release Candidate)	v3.4.0	Notes
OtaState_t OTA_Shutdown(uint32_t tick- sToWait);	OtaState_t OTA_Shutdown(uint32_t ticksToWait, uint8_t unsubscribeFlag);	unsubscribeFlag indicates if unsubscribe operations should be performed from the job topics when shutdown is called. Set this as 1 to unsubscribe, 0 otherwise.

How to migrate from version 1.0.0 to version 3.4.0 for OTA applications Refer to [OTA Migration document](#) for the summary of updates to the API. [Migration document for OTA PAL](#) also provides a summary of updates required for upgrading the OTA-PAL to work with v3.4.0 of the library.

Porting In order to support AWS IoT Over-the-air Updates on your device, it is necessary to provide the following components:

1. [Port for the OTA Portable Abstraction Layer \(PAL\)](#).
2. [OS Interface](#)
3. [MQTT Interface](#)

For enabling data transfer over HTTP dataplane the following component should also be provided:

1. [HTTP Interface](#)

NOTE When using OTA over HTTP dataplane, MQTT is required for control plane operations and should also be provided.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples Please refer to the demos of the AWS IoT Over-the-air Updates library in the following location for reference examples on POSIX and FreeRTOS:

Platform	Location
POSIX	AWS IoT Device SDK for Embedded C
FreeRTOS	FreeRTOS/FreeRTOS
FreeRTOS	FreeRTOS AWS Reference Integrations

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of coreMQTT may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

3.3 Connectivity

3.3.1 lwIP

This is the NXP fork of the [lwIP networking stack](#).

- For details about changes and additions made by NXP, see CHANGELOG.
- For details about the NXP porting layer, see [The NXP lwIP Port](#).
- For usage and API of lwIP, use official documentation at <http://www.nongnu.org/lwip/>.

The NXP lwIP Port

Below is description of possible settings of the port layer and an overview of a few helper functions.

The best place for redefinition of any mentioned macro is `lwipopts.h`.

The declaration of every mentioned function is in `ethernetif.h`. Please check the doxygen comments of those functions before.

Link state Physical link state (up/down) and its speed and duplex must be read out from PHY over MDIO bus. Especially link information is useful for lwIP stack so it can for example send DHCP discovery immediately when a link becomes up.

To simplify this port layer offers a function `ethernetif_probe_link()` which reads those data from PHY and forwards them into lwIP stack.

In almost all examples this function is called every `ETH_LINK_POLLING_INTERVAL_MS` (1500ms) by a function `probe_link_cyclic()`.

By setting `ETH_LINK_POLLING_INTERVAL_MS` to 0 polling will be disabled. On FreeRTOS, `probe_link_cyclic()` will be then called on an interrupt generated by PHY. GPIO port and pin for

the interrupt line must be set in the `ethernetifConfig` struct passed to `ethernetif_init()`. On bare metal interrupts are not supported right now.

Rx task To improve the reaction time of the app, reception of packets is done in a dedicated task. The rx task stack size can be set by `ETH_RX_TASK_STACK_SIZE` macro, its priority by `ETH_RX_TASK_PRIO`.

If you want to save memory you can set reception to be done in an interrupt by setting `ETH_DO_RX_IN_SEPARATE_TASK` macro to 0.

Disabling Rx interrupt when out of buffers If `ETH_DISABLE_RX_INT_WHEN_OUT_OF_BUFFERS` is set to 1, then when the port gets out of Rx buffers, Rx enet interrupt will be disabled for a particular controller. Everytime Rx buffer is freed, Rx interrupt will be enabled.

This prevents your app from never getting out of Rx interrupt when the network is flooded with traffic.

`ETH_DISABLE_RX_INT_WHEN_OUT_OF_BUFFERS` is by default turned on, on FreeRTOS and off on bare metal.

Limit the number of packets read out from the driver at once on bare metal. You may define macro `ETH_MAX_RX_PKTS_AT_ONCE` to limit the number of received packets read out from the driver at once.

In case of heavy Rx traffic, lowering this number improves the realtime behaviour of an app. Increasing improves Rx throughput.

Setting it to value < 1 or not defining means “no limit”.

Helper functions If your application needs to wait for the link to become up you can use one of the following functions:

- `ethernetif_wait_linkup()` - Blocks until the link on the passed netif is not up.
- `ethernetif_wait_linkup_array()` - Blocks until the link on at least one netif from the passed list of netifs becomes up.

If your app needs to wait for the IPv4 address on a particular netif to become different than “ANY” address (255.255.255.255) function `ethernetif_wait_ipv4_valid()` does this.

3.4 File System

3.4.1 FatFs

MCUXpresso SDK : mcuxsdk-middleware-fatfs

Overview This repository is for FatFs middleware delivery and it contains the components officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository (`mcuxsdk-manifests`) for the complete delivery of MCUXpresso SDK.

Documentation Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

Visit [FatFs - Documentation](#) to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution Contributions are not currently accepted. Guidelines to contribute will be posted in the future.

Repo Specific Content This is MCUXpresso SDK fork of FatFs (FAT file system created by ChaN). Official documentation is available at <http://elm-chan.org/fsw/ff/>

MCUXpresso version is extending original content by following hardware specific porting layers:

- mmc_disk
- nand_disk
- ram_disk
- sd_disk
- sdspi_disk
- usb_disk

Changelog FatFs

All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#)

[R0.15_rev0]

- Upgraded to version 0.15
- Applied patches from <http://elm-chan.org/fsw/ff/patches.html>

[R0.14b_rev1]

- Applied patches from <http://elm-chan.org/fsw/ff/patches.html>

[R0.14b_rev0]

- Upgraded to version 0.14b

[R0.14a_rev0]

- Upgraded to version 0.14a
- Applied patch ff14a_p1.diff and ff14a_p2.diff

[R0.14_rev0]

- Upgraded to version 0.14
- Applied patch ff14_p1.diff and ff14_p2.diff

[R0.13c_rev0]

- Upgraded to version 0.13c
- Applied patches ff_13c_p1.diff,ff_13c_p2.diff, ff_13c_p3.diff and ff_13c_p4.diff.

[R0.13b_rev0]

- Upgraded to version 0.13b

[R0.13a_rev0]

- Upgraded to version 0.13a. Added patch ff_13a_p1.diff.

[R0.12c_rev1]

- Add NAND disk support.

[R0.12c_rev0]

- Upgraded to version 0.12c and applied patches ff_12c_p1.diff and ff_12c_p2.diff.

[R0.12b_rev0]

- Upgraded to version 0.12b.

[R0.11a]

- Added glue functions for low-level drivers (SDHC, SDSPI, RAM, MMC). Modified diskio.c.
- Added RTOS wrappers to make FatFs thread safe. Modified syscall.c.
- Renamed ffconf.h to ffconf_template.h. Each application should contain its own ffconf.h.
- Included ffconf.h into diskio.c to enable the selection of physical disk from ffconf.h by macro definition.
- Conditional compilation of physical disk interfaces in diskio.c.

3.5 Motor Control

3.5.1 FreeMASTER

Communication Driver User Guide

Introduction

What is FreeMASTER? **FreeMASTER** is a PC-based application developed by NXP for NXP customers. It is a versatile tool usable as a real-time monitor, visualization tool, and a graphical control panel of embedded applications based on the NXP processing units.

This document describes the embedded-side software driver which implements an interface between the application and the host PC. The interface covers the following communication:

- **Serial** UART communication either over plain RS232 interface or more typically over a USB-to-Serial either external or built in a debugger probe.

- **USB** direct connection to target microcontroller
- **CAN bus**
- **TCP/IP network** wired or WiFi
- **Segger J-Link RTT**
- **JTAG** debug port communication
- ...and all of the above also using a **Zephyr** generic drivers.

The driver also supports so-called “packet-driven BDM” interface which enables a protocol-based communication over a debugging port. The BDM stands for Background Debugging Module and its physical implementation is different on each platform. Some platforms leverage a semi-standard JTAG interface, other platforms provide a custom implementation called BDM. Regardless of the name, this debugging interface enables non-intrusive access to the memory space while the target CPU is running. For basic memory read and write operations, there is no communication driver required on the target when communicating with the host PC. Use this driver to get more advanced FreeMASTER protocol features over the BDM interface. The driver must be configured for the packet-driven BDM mode, in which the host PC uses the debugging interface to write serial command frames directly to the target memory buffer. The same method is then used to read response frames from that memory buffer.

Similar to “packet-driven BDM”, the FreeMASTER also supports a communication over [J-Link RTT](<https://www.segger.com/products/debug-probes/j-link/technology/about-real-time-transfer/>) interface defined by SEGGER Microcontroller GmbH for ARM CortexM-based microcontrollers. This method also uses JTAG physical interface and enables high-speed real time communication to run over the same channel as used for application debugging.

Driver version 3 This document describes version 3 of the FreeMASTER Communication Driver. This version features the implementation of the new Serial Protocol, which significantly extends the features and security of its predecessor. The new protocol internal number is v4 and its specification is available in the documentation accompanying the driver code.

Driver V3 is deployed to modern 32-bit MCU platforms first, so the portfolio of supported platforms is smaller than for the previous V2 versions. It is recommended to keep using the V2 driver for legacy platforms, such as S08, S12, ColdFire, or Power Architecture. Reach out to [FreeMASTER community](#) or to the local NXP representative with requests for more information or to port the V3 driver to legacy MCU devices.

Thanks to a layered approach, the new driver simplifies the porting of the driver to new UART, CAN or networking communication interfaces significantly. Users are encouraged to port the driver to more NXP MCU platforms and contribute the code back to NXP for integration into future releases. Existing code and low-level driver layers may be used as an example when porting to new targets.

Note: Using the FreeMASTER tool and FreeMASTER Communication Driver is only allowed in systems based on NXP microcontroller or microprocessor unit. Use with non-NXP MCU platforms is **not permitted** by the license terms.

Target platforms The driver implementation uses the following abstraction mechanisms which simplify driver porting and supporting new communication modules:

- **General CPU Platform** (see source code in the `src/platforms` directory). The code in this layer is only specific to native data type sizes and CPU architectures (for example; alignment-aware memory copy routines). This driver version brings two generic implementations of 32-bit platforms supporting both little-endian and big-endian architectures. There are also implementations customized for the 56F800E family of digital signal controllers and S12Z MCUs. **Zephyr** is treated as a specific CPU platform as it brings unified

user configuration (Kconfig) and generic hardware device drivers. With Zephyr, the transport layer and low-level communication layers described below are configured automatically using Kconfig and Device Tree technologies.

- **Transport Communication Layer** - The Serial, CAN, Networking, PD-BDM, and other methods of transport logic are implemented as a driver layer called FMSTR_TRANSPORT with a uniform API. A support of the Network transport also extends single-client modes of operation which are native for Serial, USB and CAN by a concept of multiple client sessions.
- **Low-level Communication Driver** - Each type of transport further defines a low-level API used to access the physical communication module. For example, the Serial transport defines a character-oriented API implemented by different serial communication modules like UART, LPUART, USART, and also USB-CDC. Similarly, the CAN transport defines a message-oriented API implemented by the FlexCAN or MCAN modules. Moreover, there are multiple different implementations for the same kind of communication peripherals. The difference between the implementation is in the way the low-level hardware registers are accessed. The *mcuxsdk* folder contains implementations which use MCUXpresso SDK drivers. These drivers should be used in applications based on the NXP MCUXpresso SDK. The “ampsdk” drivers target automotive-specific MCUs and their respective SDKs. The “dreg” implementations use a plain C-language access to hardware register addresses which makes it a universal and the most portable solution. In this case, users are encouraged to add more drivers for other communication modules or other respective SDKs and contribute the code back to NXP for integration.

The low-level drivers defined for the Networking transport enable datagram-oriented UDP and stream TCP communication. This implementation is demonstrated using the lwIP software stack but shall be portable to other TCP/IP stacks. It may sound surprisingly, but also the Segger J-Link RTT communication driver is linked to the Networking transport (RTT is stream oriented communication handled similarly to TCP).

Replacing existing drivers For all supported platforms, the driver described in this document replaces the V2 implementation and also older driver implementations that were available separately for individual platforms (PC Master SCI drivers).

Clocks, pins, and peripheral initialization The FreeMASTER communication driver is only responsible for runtime processing of the communication and must be integrated with an user application code to function properly. The user application code is responsible for general initialization of clock sources, pin multiplexers, and peripheral registers related to the communication speed. Such initialization should be done before calling the FMSTR_Init function.

It is recommended to develop the user application using one of the Software Development Kits (SDKs) available from third parties or directly from NXP, such as MCUXpresso SDK, MCUXpresso IDE, and related tools. This approach simplifies the general configuration process significantly.

MCUXpresso SDK The MCUXpresso SDK is a software package provided by NXP which contains the device initialization code, linker files, and software drivers with example applications for the NXP family of MCUs. The MCUXpresso Config Tools may be used to generate the clock-setup and pin-multiplexer setup code suitable for the selected processor.

The MCUXpresso SDK also contains this FreeMASTER communication driver as a “middleware” component which may be downloaded along with the example applications from <https://mcuxpresso.nxp.com/en/welcome>.

MCUXpresso SDK on GitHub The FreeMASTER communication driver is also released as one of the middleware components of the MCUXpresso SDK on the GitHub. This release enables direct integration of the FreeMASTER source code Git repository into a target applications including Zephyr applications.

Related links:

- [The official FreeMASTER middleware repository.](#)
- [Online version of this document](#)

FreeMASTER in Zephyr The FreeMASTER middleware repository can be used with MCUXpresso SDK as well as a Zephyr module. Zephyr-specific samples which include examples of Kconfig and Device Tree configurations for Serial, USB and Network communications are available in separate repository. West manifest in this sample repository fetches the full Zephyr package including the FreeMASTER middleware repository used as a Zephyr module.

Example applications

MCUX SDK Example applications There are several example applications available for each supported MCU platform.

- **fmstr_uart** demonstrates a plain serial transmission, typically connecting to a computer's physical or virtual COM port. The typical transmission speed is 115200 bps.
- **fmstr_can** demonstrates CAN bus communication. This requires a suitable CAN interface connected to the computer and interconnected with the target MCU using a properly terminated CAN bus. The typical transmission speed is 500 kbps. A FreeMASTER-over-CAN communication plug-in must be used.
- **fmstr_usb_cdc** uses an on-chip USB controller to implement a CDC communication class. It is connected directly to a computer's USB port and creates a virtual COM port device. The typical transmission speed is above 1 Mbps.
- **fmstr_net** demonstrates the Network communication over UDP or TCP protocol. Existing examples use lwIP stack to implement the communication, but in general, it shall be possible to use any other TCP/IP stack to achieve the same functionality.
- **fmstr_wifi** is the fmstr_net application modified to use a WiFi network interface instead of a wired Ethernet connection.
- **fmstr_rtt** demonstrates the communication over SEGGER J-Link RTT interface. Both fmstr_net and fmstr_rtt examples require the FreeMASTER TCP/UDP communication plug-in to be used on the PC host side.
- **fmstr_eonce** uses the real-time data unit on the JTAG EOnCE module of the 56F800E family to implement pseudo-serial communication over the JTAG port. The typical transmission speed is around 10 kbps. This communication requires FreeMASTER JTAG/EOnCE communication plug-in.
- **fmstr_pdbdm** uses JTAG or BDM debugging interface to access the target RAM directly while the CPU is running. Note that such approach can be used with any MCU application, even without any special driver code. The computer reads from and writes into the RAM directly without CPU intervention. The Packet-Driven BDM (PD-BDM) communication uses the same memory access to exchange command and response frames. With PD-BDM, the FreeMASTER tool is able to go beyond basic memory read/write operations and accesses also advanced features like Recorder, TSA, or Pipes. The typical transmission speed is around 10 kbps. A PD-BDM communication plug-in must be used in FreeMASTER and configured properly for the selected debugging interface. Note that this communication cannot be used while a debugging interface is used by a debugger session.
- **fmstr_any** is a special example application which demonstrates how the NXP MCUXpresso Config Tools can be used to configure pins, clocks, peripherals, interrupts, and even the FreeMASTER "middleware" driver features in a graphical and user friendly way. The user can switch between the Serial, CAN, and other ways of communication and generate the required initialization code automatically.

Zephyr sample 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_QUEUE_SIZE

```
#define FMSTR_COMM_QUEUE_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_QUEUE_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 */
```

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```

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 *fmstr:* protocol.

This example provides an overview of the supported TSA Active Content entries:

```
FMSTR_TSA_TABLE_BEGIN(files_and_links)

/* Directory entry applies to all subsequent MEMFILE entries */
FMSTR_TSA_DIRECTORY("/text_files") /* entering a new virtual directory */

/* The readme.txt file will be accessible at the fmstr://text_files/readme.txt URL */
FMSTR_TSA_MEMFILE("readme.txt", readme_txt, sizeof(readme_txt)) /* memory-mapped file */

/* Files can also be specified with a full path so the DIRECTORY entry does not apply */
FMSTR_TSA_MEMFILE("/index.htm", index, sizeof(index)) /* memory-mapped file */
FMSTR_TSA_MEMFILE("/prj/demo.pmp", demo_pmp, sizeof(demo_pmp)) /* memory-mapped file */

/* Hyperlinks can point to a local MEMFILE object or to the Internet */
FMSTR_TSA_HREF("Board's Built-in Welcome Page", "/index.htm")
FMSTR_TSA_HREF("FreeMASTER Home Page", "http://www.nxp.com/freemaster")

/* Project file links simplify opening the projects from any URLs */
FMSTR_TSA_PROJECT("Demonstration Project (embedded)", "/prj/demo.pmp")
FMSTR_TSA_PROJECT("Full Project (online)", "http://mycompany.com/prj/demo.pmp")

FMSTR_TSA_TABLE_END()
```

TSA API

FMSTR_SetUpTsaBuff

Prototype

```
FMSTR_BOOL FMSTR_SetUpTsaBuff(FMSTR_ADDR buffAddr, FMSTR_SIZE buffSize);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_tsa.c*

Arguments

- *buffAddr* [in] - address of the memory buffer for the dynamic TSA table
- *buffSize* [in] - size of the memory buffer which determines the maximum number of TSA entries to be added in the runtime

Description This function must be used to assign the RAM memory buffer to the TSA subsystem when FMSTR_USE_TSA_DYNAMIC is enabled. The memory buffer is then used to store the TSA entries added dynamically to the runtime TSA table using the FMSTR_TsaAddVar function call. The runtime TSA table is processed by the FreeMASTER PC Host tool along with all static tables as soon as the communication port is open.

The size of the memory buffer determines the number of TSA entries that can be added dynamically. Depending on the MCU platform, one TSA entry takes either 8 or 16 bytes.

FMSTR_TsaAddVar

Prototype

```
FMSTR_BOOL FMSTR_TsaAddVar(FMSTR_TSATBL_STRPTR tsaName, FMSTR_TSATBL_STRPTR ↵
↵ tsaType,
    FMSTR_TSATBL_VOIDPTR varAddr, FMSTR_SIZE32 varSize,
    FMSTR_SIZE flags);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_tsa.c*

Arguments

- *tsaName* [in] - name of the object
- *tsaType* [in] - name of the object type
- *varAddr* [in] - address of the object
- *varSize* [in] - size of the object
- *flags* [in] - access flags; a combination of these values:
 - FMSTR_TSA_INFO_RO_VAR — read-only memory-mapped object (typically a variable)
 - FMSTR_TSA_INFO_RW_VAR — read/write memory-mapped object
 - FMSTR_TSA_INFO_NON_VAR — other entry, describing structure types, structure members, enumerations, and other types

Description This function can be called only when the dynamic TSA table is enabled by the FMSTR_USE_TSA_DYNAMIC configuration option and when the FMSTR_SetUpTsaBuff function call is made to assign the dynamic TSA table memory. This function adds an entry into the dynamic TSA table. It can be used to register a read-only or read/write memory object or describe an item of the user-defined type.

See [TSA table definition](#) for more details about the TSA table entries.

Application Commands API

FMSTR_GetAppCmd

Prototype

```
FMSTR_APPCMD_CODE FMSTR_GetAppCmd(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Description This function can be used to detect if there is an Application Command waiting to be processed by the application. If no command is pending, this function returns the FMSTR_APPCMDRESULT_NOCMD constant. Otherwise, this function returns the code of the Application Command that must be processed. Use the FMSTR_AppCmdAck call to acknowledge the Application Command after it is processed and to return the appropriate result code to the host.

The FMSTR_GetAppCmd function does not report the commands for which a callback handler function exists. If the FMSTR_GetAppCmd function is called when a callback-registered command is pending (and before it is actually processed by the callback function), this function returns FMSTR_APPCMDRESULT_NOCMD.

FMSTR_GetAppCmdData

Prototype

```
FMSTR_APPCMD_PDATA FMSTR_GetAppCmdData(FMSTR_SIZE* dataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *dataLen* [out] - pointer to the variable that receives the length of the data available in the buffer. It can be NULL when this information is not needed.

Description This function can be used to retrieve the Application Command data when the application determines that an Application Command is pending (see [FMSTR_GetAppCmd](#)).

There is just a single buffer to hold the Application Command data (the buffer length is FMSTR_APPCMD_BUFF_SIZE bytes). If the data are to be used in the application after the command is processed by the FMSTR_AppCmdAck call, copy the data out to a private buffer.

FMSTR_AppCmdAck

Prototype

```
void FMSTR_AppCmdAck(FMSTR_APPCMD_RESULT resultCode);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultCode* [in] - the result code which is to be returned to FreeMASTER

Description This function is used when the Application Command processing finishes in the application. The resultCode passed to this function is returned back to the host and the driver is re-initialized to expect the next Application Command.

After this function is called and before the next Application Command arrives, the return value of the FMSTR_GetAppCmd function is FMSTR_APPCMDRESULT_NOCMD.

FMSTR_AppCmdSetResponseData

Prototype

```
void FMSTR_AppCmdSetResponseData(FMSTR_ADDR resultDataAddr, FMSTR_SIZE resultDataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultDataAddr* [in] - pointer to the data buffer that is to be copied to the Application Command data buffer
- *resultDataLen* [in] - length of the data to be copied. It must not exceed the FMSTR_APPCMD_BUFF_SIZE value.

Description This function can be used before the Application Command processing finishes, when there are data to be returned back to the PC.

The response data buffer is copied into the Application Command data buffer, from where it is accessed when the host requires it. Do not use FMSTR_GetAppCmdData and the data buffer after FMSTR_AppCmdSetResponseData is called.

Note: The current version of FreeMASTER does not support the Application Command response data.

FMSTR_RegisterAppCmdCall

Prototype

```
FMSTR_BOOL FMSTR_RegisterAppCmdCall(FMSTR_APPCMD_CODE appCmdCode, FMSTR_
↳PAPPCMDFUNC callbackFunc);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *appCmdCode* [in] - the Application Command code for which the callback is to be registered
- *callbackFunc* [in] - pointer to the callback function that is to be registered. Use NULL to unregister a callback registered previously with this Application Command.

Return value This function returns a non-zero value when the callback function was successfully registered or unregistered. It can return zero when trying to register a callback function for more than FMSTR_MAX_APPCMD_CALLS different Application Commands.

Description This function can be used to register the given function as a callback handler for the Application Command. The Application Command is identified using single-byte code. The callback function is invoked automatically by the FreeMASTER driver when the protocol decoder obtains a request to get the application command result code.

The prototype of the callback function is

```
FMSTR_APPCMD_RESULT HandlerFunction(FMSTR_APPCMD_CODE nAppcmd,
FMSTR_APPCMD_PDATA pData, FMSTR_SIZE nDataLen);
```

Where:

- *nAppcmd* -Application Command code
- *pData* —points to the Application Command data received (if any)
- *nDataLen* —information about the Application Command data length

The return value of the callback function is used as the Application Command Result Code and returned to FreeMASTER.

Note: The FMSTR_MAX_APPCMD_CALLS configuration macro defines how many different Application Commands may be handled by a callback function. When FMSTR_MAX_APPCMD_CALLS is undefined or defined as zero, the FMSTR_RegisterAppCmdCall function always fails.

Pipes API

FMSTR_PipeOpen

Prototype

```
FMSTR_HPIPE FMSTR_PipeOpen(FMSTR_PIPE_PORT pipePort, FMSTR_PPIPEFUNC pipeCallback,
    FMSTR_ADDR pipeRxBuff, FMSTR_PIPE_SIZE pipeRxSize,
    FMSTR_ADDR pipeTxBuff, FMSTR_PIPE_SIZE pipeTxSize,
    FMSTR_U8 type, const FMSTR_CHAR *name);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipePort* [in] - port number that identifies the pipe for the client
- *pipeCallback* [in] - pointer to the callback function that is called whenever a pipe data status changes
- *pipeRxBuff* [in] - address of the receive memory buffer
- *pipeRxSize* [in] - size of the receive memory buffer
- *pipeTxBuff* [in] - address of the transmit memory buffer
- *pipeTxSize* [in] - size of the transmit memory buffer
- *type* [in] - a combination of FMSTR_PIPE_MODE_XXX and FMSTR_PIPE_SIZE_XXX constants describing primary pipe data format and usage. This type helps FreeMASTER decide how to access the pipe by default. Optional, use 0 when undetermined.
- *name* [in] - user name of the pipe port. This name is visible to the FreeMASTER user when creating the graphical pipe interface.

Description This function initializes a new pipe and makes it ready to accept or send the data to the PC Host client. The receive memory buffer is used to store the received data before they are read out by the FMSTR_PipeRead call. When this buffer gets full, the PC Host client denies the data transmission into this pipe until there is enough free space again. The transmit memory buffer is used to store the data transmitted by the application to the PC Host client using the FMSTR_PipeWrite call. The transmit buffer can get full when the PC Host is disconnected or when it is slow in receiving and reading out the pipe data.

The function returns the pipe handle which must be stored and used in the subsequent calls to manage the pipe object.

The callback function (if specified) is called whenever new data are received through the pipe and available for reading. This callback is also called when the data waiting in the transmit buffer are successfully pushed to the PC Host and the transmit buffer free space increases. The prototype of the callback function provided by the user application must be as follows. The *PipeHandler* name is only a placeholder and must be defined by the application.

```
void PipeHandler(FMSTR_HPIPE pipeHandle);
```

FMSTR_PipeClose

Prototype

```
void FMSTR_PipeClose(FMSTR_HPIPE pipeHandle);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call

Description This function de-initializes the pipe object. No data can be received or sent on the pipe after this call.

FMSTR_PipeWrite

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeWrite(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,  
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE writeGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data to be written
- *pipeDataLen* [in] - length of the data to be written
- *writeGranularity* [in] - size of the minimum unit of data which is to be written

Description This function puts the user-specified data into the pipe's transmit memory buffer and schedules it for transmission. This function returns the number of bytes that were successfully written into the buffer. This number may be smaller than the number of the requested bytes if there is not enough free space in the transmit buffer.

The *writeGranularity* argument can be used to split the data into smaller chunks, each of the size given by the *writeGranularity* value. The FMSTR_PipeWrite function writes as many data chunks as possible into the transmit buffer and does not attempt to write an incomplete chunk.

This feature can prove to be useful to avoid the intermediate caching when writing an array of integer values or other multi-byte data items. When making the `nGranularity` value equal to the `nLength` value, all data are considered as one chunk which is either written successfully as a whole or not at all. The `nGranularity` value of 0 or 1 disables the data-chunk approach.

FMSTR_PipeRead

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeRead(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE readGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data buffer to be filled with the received data
- *pipeDataLen* [in] - length of the data to be read
- *readGranularity* [in] - size of the minimum unit of data which is to be read

Description This function copies the data received from the pipe from its receive buffer to the user buffer for further processing. The function returns the number of bytes that were successfully copied to the buffer. This number may be smaller than the number of the requested bytes if there is not enough data bytes available in the receive buffer.

The `readGranularity` argument can be used to copy the data in larger chunks in the same way as described in the FMSTR_PipeWrite function.

API data types This section describes the data types used in the FreeMASTER driver. The information provided here can be useful when modifying or porting the FreeMASTER Communication Driver to new NXP platforms.

Note: The licensing conditions prohibit use of FreeMASTER and the FreeMASTER Communication Driver with non-NXP MPU or MCU products.

Public common types The table below describes the public data types used in the FreeMASTER driver API calls. The data types are declared in the *freemaster.h* header file.

Type name	Description
<i>FM-STR_ADDR</i> For example, this type is defined as long integer on the 56F8xxx platform where the 24-bit addresses must be supported, but the C-pointer may be only 16 bits wide in some compiler configurations.	Data type used to hold the memory address. On most platforms, this is normally a C-pointer, but it may also be a pure integer type.
<i>FM-STR_SIZE</i> It is required that this type is unsigned and at least 16 bits wide integer.	Data type used to hold the memory block size.
<i>FM-STR_BOOL</i> This type is used only in zero/non-zero conditions in the driver code.	Data type used as a general boolean type.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to hold the Application Command code.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to create the Application Command data buffer.
<i>FM-STR_APPCM</i> Generally, this is an unsigned 8-bit value.	Data type used to hold the Application Command result code.

Public TSA types The table describes the TSA-specific public data types. These types are declared in the *freemaster_tsa.h* header file, which is included in the user application indirectly by the *freemaster.h* file.

<i>FM-STR_TSA_TII</i>	Data type used to hold a descriptor index in the TSA table or a table index in the list of TSA tables. By default, this is defined as <i>FM-STR_SIZE</i> .
<i>FM-STR_TSA_TS</i>	Data type used to hold a memory block size, as used in the TSA descriptors. By default, this is defined as <i>FM-STR_SIZE</i> .

Public Pipes types The table describes the data types used by the FreeMASTER Pipes API:

<i>FM-STR_HPIPE</i>	Pipe handle that identifies the open-pipe object. Generally, this is a pointer to a void type.
<i>FM-STR_PIPE_PC</i>	Integer type required to hold at least 7 bits of data. Generally, this is an unsigned 8-bit or 16-bit type.
<i>FM-STR_PIPE_SI</i>	Integer type required to hold at least 16 bits of data. This is used to store the data buffer sizes.
<i>FM-STR_PPIPEF</i>	Pointer to the pipe handler function. See FM-STR_PipeOpen for more details.

Internal types The table describes the data types used internally by the FreeMASTER driver. The data types are declared in the platform-specific header file and they are not available in the application code.

<i>FMSTR_U8</i>	The smallest memory entity.
On the vast majority of platforms, this is an unsigned 8-bit integer.	
On the 56F8xx DSP platform, this is defined as an unsigned 16-bit integer.	
<i>FMSTR_U16</i>	Unsigned 16-bit integer.
<i>FMSTR_U32</i>	Unsigned 32-bit integer.
<i>FMSTR_S8</i>	Signed 8-bit integer.
<i>FMSTR_S16</i>	Signed 16-bit integer.
<i>FMSTR_S32</i>	Signed 32-bit integer.
<i>FMSTR_FLOAT</i>	4-byte standard IEEE floating-point type.
<i>FMSTR_FLAGS</i>	Data type forming a union with a structure of flag bit-fields.
<i>FMSTR_SIZE8</i>	Data type holding a general size value, at least 8 bits wide.
<i>FMSTR_INDEX</i>	General for-loop index. Must be signed, at least 16 bits wide.
<i>FMSTR_BCHR</i>	A single character in the communication buffer.
Typically, this is an 8-bit unsigned integer, except for the DSP platforms where it is a 16-bit integer.	
<i>FMSTR_BPTR</i>	A pointer to the communication buffer (an array of <i>FMSTR_BCHR</i>).

Document references

Links

- This document online: <https://mcuxpresso.nxp.com/mcuxsdk/latest/html/middleware/freemaster/doc/index.html>

- FreeMASTER tool home: www.nxp.com/freemaster
- FreeMASTER community area: community.nxp.com/community/freemaster
- FreeMASTER GitHub code repo: <https://github.com/nxp-mcuxpresso/mcux-freemaster>
- MCUXpresso SDK home: www.nxp.com/mcuxpresso
- MCUXpresso SDK builder: mcuxpresso.nxp.com/en

Documents

- *FreeMASTER Usage Serial Driver Implementation* (document [AN4752](#))
- *Integrating FreeMASTER Time Debugging Tool With CodeWarrior For Microcontrollers v10.X Project* (document [AN4771](#))
- *Flash Driver Library For MC56F847xx And MC56F827xx DSC Family* (document [AN4860](#))

Revision history This Table summarizes the changes done to this document since the initial release.

Revision	Date	Description
1.0	03/2006	Limited initial release
2.0	09/2007	Updated for FreeMASTER version. New Freescale document template used.
2.1	12/2007	Added description of the new Fast Recorder feature and its API.
2.2	04/2010	Added support for MPC56xx platform, Added new API for use CAN interface.
2.3	04/2011	Added support for Kxx Kinetis platform and MQX operating system.
2.4	06/2011	Serial driver update, adds support for USB CDC interface.
2.5	08/2011	Added Packet Driven BDM interface.
2.7	12/2013	Added FLEXCAN32 interface, byte access and isr callback configuration option.
2.8	06/2014	Removed obsolete license text, see the software package content for up-to-date license.
2.9	03/2015	Update for driver version 1.8.2 and 1.9: FreeMASTER Pipes, TSA Active Content, LIN Transport Layer support, DEBUG-TX communication troubleshooting, Kinetis SDK support.
3.0	08/2016	Update for driver version 2.0: Added support for MPC56xx, MPC57xx, KEAxx and S32Kxx platforms. New NXP document template as well as new license agreement used. added MCAN interface. Folders structure at the installation destination was rearranged.
4.0	04/2019	Update for driver released as part of FreeMASTER v3.0 and MCUXpresso SDK 2.6. Updated to match new V4 serial communication protocol and new configuration options. This version of the document removes substantial portion of outdated information related to S08, S12, ColdFire, Power and other legacy platforms.
4.1	04/2020	Minor update for FreeMASTER driver included in MCUXpresso SDK 2.8.
4.2	09/2020	Added example applications description and information about the MCUXpresso Config Tools. Fixed the pipe-related API description.
4.3	10/2024	Added description of Network and Segger J-Link RTT interface configuration. Accompanying the MCUXpresso SDK version 24.12.00.
4.4	04/2025	Added Zephyr-specific information. Accompanying the MCUXpresso SDK version 25.06.00.

3.6 MultiCore

3.6.1 Multicore SDK

Multicore Software Development Kit (MCSDK) is a Software Development Kit that provides comprehensive software support for NXP dual/multicore devices. The MCSDK is combined with the MCUXpresso SDK to make the software framework for easy development of multicore applications.

Multicore SDK (MCSDK) Release Notes

Overview These are the release notes for the NXP Multicore Software Development Kit (MCSDK) version 25.06.00.

This software package contains components for efficient work with multicore devices as well as for the multiprocessor communication.

What is new

- eRPC [CHANGELOG](#)
- RPPMsg-Lite [CHANGELOG](#)
- MCMgr [CHANGELOG](#)
- Supported evaluation boards (multicore examples):
 - LPCXpresso55S69
 - FRDM-K32L3A6
 - MIMXRT1170-EVKB
 - MIMXRT1160-EVK
 - MIMXRT1180-EVK
 - MCX-N5XX-EVK
 - MCX-N9XX-EVK
 - FRDM-MCXN947
 - MIMXRT700-EVK
 - KW47-EVK
 - KW47-LOC
 - FRDM-MCXW72
 - MCX-W72-EVK
- Supported evaluation boards (multiprocessor examples):
 - LPCXpresso55S36
 - FRDM-K22F
 - FRDM-K32L2B
 - MIMXRT685-EVK
 - MIMXRT1170-EVKB
 - MIMXRT1180
 - FRDM-MCXN236
 - FRDM-MCXC242
 - FRDM-MCXC444
 - MCX-N9XX-EVK
 - FRDM-MCXN947
 - MIMXRT700-EVK

Development tools The Multicore SDK (MCSDK) was compiled and tested with development tools referred in: [Development tools](#)

Release contents This table describes the release contents. Not all MCUXpresso SDK packages contain the whole set of these components.

Deliverable	Location
Multicore SDK location	<MCUXpressoSDK_install_dir>/middleware/multicore/
Documentation	<MCSDK_dir>/mcuxsdk-doc/
Embedded Remote Procedure Call component	<MCSDK_dir>/erpc/
Multicore Manager component	<MCSDK_dir>/mcmgr/
RPMMsg-Lite	<MCSDK_dir>/rpmsg_lite/
Multicore demo applications	<MCUXpressoSDK_install_dir>/examples/multicore_examples/
Multiprocessor demo applications	<MCUXpressoSDK_install_dir>/examples/multiprocessor_examples/

Multicore SDK release overview Together, the Multicore SDK (MCSDK) and the MCUXpresso SDK (SDK) form a framework for the development of software for NXP multicore devices. The MCSDK release consists of the following elementary software components for multicore:

- Embedded Remote Procedure Call (eRPC)
- Multicore Manager (MCMGR) - included just in SDK for multicore devices
- Remote Processor Messaging - Lite (RPMMsg-Lite) - included just in SDK for multicore devices

The MCSDK is also accompanied with documentation and several multicore and multiprocessor demo applications.

Demo applications The multicore demo applications demonstrate the usage of the MCSDK software components on supported multicore development boards.

The following multicore demo applications are located together with other MCUXpresso SDK examples in the <MCUXpressoSDK_install_dir>/examples/multicore_examples subdirectories.

- erpc_matrix_multiply_mu
- erpc_matrix_multiply_mu_rtos
- erpc_matrix_multiply_rpmsg
- erpc_matrix_multiply_rpmsg_rtos
- erpc_two_way_rpc_rpmsg_rtos
- freertos_message_buffers
- hello_world
- multicore_manager
- rpmsg_lite_pingpong
- rpmsg_lite_pingpong_rtos
- rpmsg_lite_pingpong_tzm

The eRPC multicore component can be leveraged for inter-processor communication and remote procedure calls between SoCs / development boards.

The following multiprocessor demo applications are located together with other MCUXpresso SDK examples in

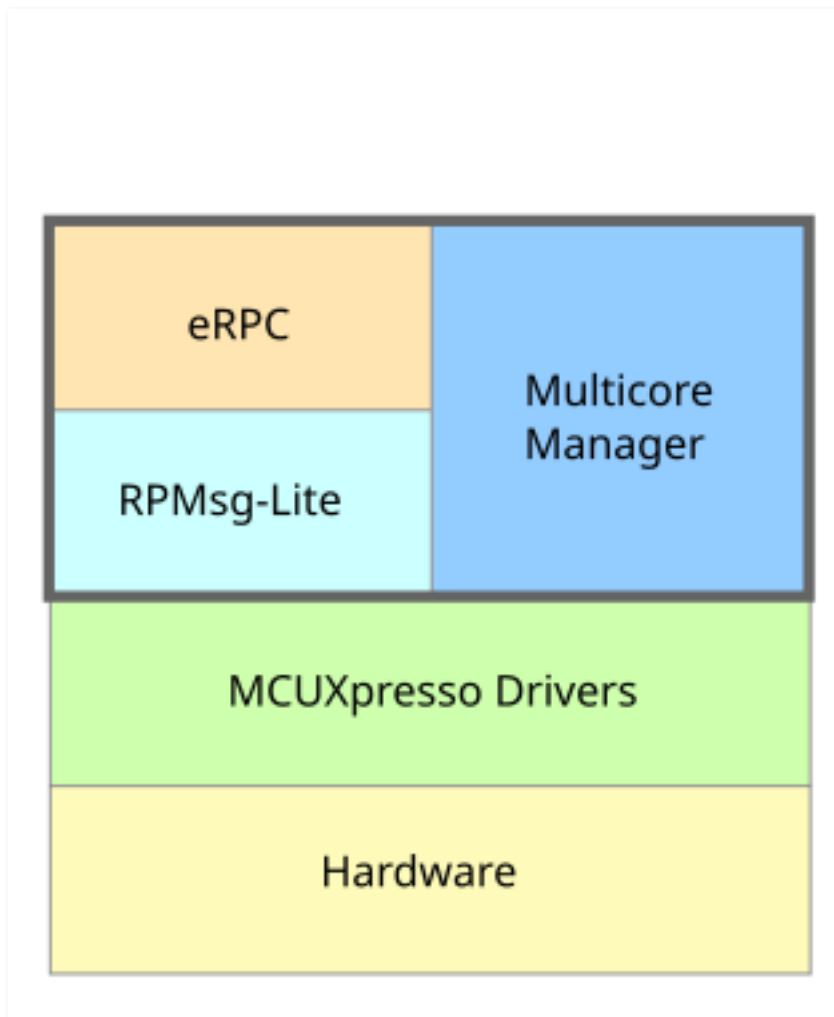
the <MCUXpressoSDK_install_dir>/examples/multiprocessor_examples subdirectories.

- erpc_client_matrix_multiply_spi
- erpc_server_matrix_multiply_spi
- erpc_client_matrix_multiply_uart
- erpc_server_matrix_multiply_uart
- erpc_server_dac_adc
- erpc_remote_control

Getting Started with Multicore SDK (MCSDK)

Overview Multicore Software Development Kit (MCSDK) is a Software Development Kit that provides comprehensive software support for NXP dual/multicore devices. The MCSDK is combined with the MCUXpresso SDK to make the software framework for easy development of multicore applications.

The following figure highlights the layers and main software components of the MCSDK.

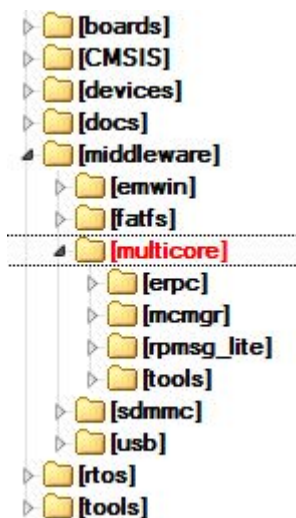


All the MCSDK-related files are located in `<MCUXpressoSDK_install_dir>/middleware/multicore` folder.

For supported toolchain versions, see the *Multicore SDK v25.06.00 Release Notes* (document MCS-DKRN). For the latest version of this and other MCSDK documents, visit www.nxp.com.

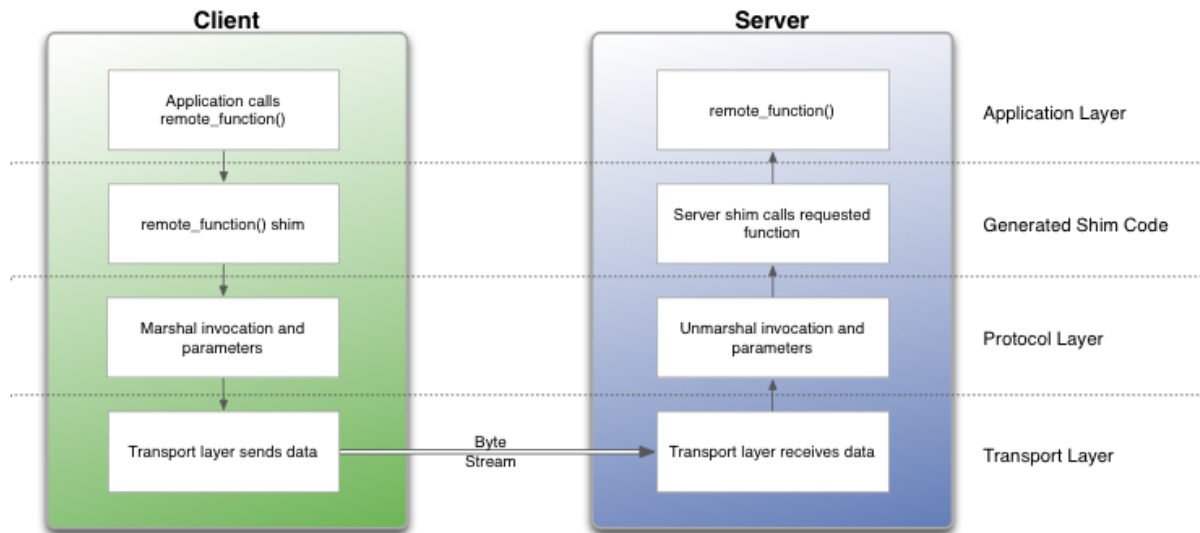
Multicore SDK (MCSDK) components The MCSDK consists of the following software components:

- **Embedded Remote Procedure Call (eRPC):** This component is a combination of a library and code generator tool that implements a transparent function call interface to remote services (running on a different core).
- **Multicore Manager (MCMGR):** This library maintains information about all cores and starts up secondary/auxiliary cores.
- **Remote Processor Messaging - Lite (RPMsg-Lite):** Inter-Processor Communication library.



Embedded Remote Procedure Call (eRPC) The Embedded Remote Procedure Call (eRPC) is the RPC system created by NXP. The RPC is a mechanism used to invoke a software routine on a remote system via a simple local function call.

When a remote function is called by the client, the function's parameters and an identifier for the called routine are marshaled (or serialized) into a stream of bytes. This byte stream is transported to the server through a communications channel (IPC, TPC/IP, UART, and so on). The server unmarshals the parameters, determines which function was invoked, and calls it. If the function returns a value, it is marshaled and sent back to the client.



RPC implementations typically use a combination of a tool (erpcgen) and IDL (interface definition language) file to generate source code to handle the details of marshaling a function's parameters and building the data stream.

Main eRPC features:

- Scalable from BareMetal to Linux OS - configurable memory and threading policies.
- Focus on embedded systems - intrinsic support for C, modular, and lightweight implementation.
- Abstracted transport interface - RPMsg is the primary transport for multicore, UART, or SPI-based solutions can be used for multichip.

The eRPC library is located in the `<MCUXpressoSDK_install_dir>/middleware/multicore/erpc` folder. For detailed information about the eRPC, see the documentation available in the `<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/doc` folder.

Multicore Manager (MCMGR) The Multicore Manager (MCMGR) software library provides a number of services for multicore systems.

The main MCMGR features:

- Maintains information about all cores in system.
- Secondary/auxiliary cores startup and shutdown.
- Remote core monitoring and event handling.

The MCMGR library is located in the `<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr` folder. For detailed information about the MCMGR library, see the documentation available in the `<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/doc` folder.

Remote Processor Messaging Lite (RPMsg-Lite) RPMsg-Lite is a lightweight implementation of the RPMsg protocol. The RPMsg protocol defines a standardized binary interface used to communicate between multiple cores in a heterogeneous multicore system. Compared to the legacy OpenAMP implementation, RPMsg-Lite offers a code size reduction, API simplification, and improved modularity.

The main RPMsg protocol features:

- Shared memory interprocessor communication.
- Virtio-based messaging bus.
- Application-defined messages sent between endpoints.

- Portable to different environments/platforms.
- Available in upstream Linux OS.

The RPMsg-Lite library is located in the `<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg-lite` folder. For detailed information about the RPMsg-Lite, see the RPMsg-Lite User's Guide located in the `<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/doc` folder.

MCSDK demo applications Multicore and multiprocessor example applications are stored together with other MCUXpresso SDK examples, in the dedicated multicore subfolder.

Location		Folder
Multicore projects	example	<code><MCUXpressoSDK_install_dir>/examples/multicore_examples/<application_name>/</code>
Multiprocessor projects	example	<code><MCUXpressoSDK_install_dir>/examples/multiprocessor_examples/<application_name>/</code>

See the *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) and *Getting Started with MCUXpresso SDK for XXX Derivatives* documents for more information about the MCUXpresso SDK example folder structure and the location of individual files that form the example application projects. These documents also contain information about building, running, and debugging multicore demo applications in individual supported IDEs. Each example application also contains a readme file that describes the operation of the example and required setup steps.

Inter-Processor Communication (IPC) levels The MCSDK provides several mechanisms for Inter-Processor Communication (IPC). Particular ways and levels of IPC are described in this chapter.

IPC using low-level drivers

The NXP multicore SoCs are equipped with peripheral modules dedicated for data exchange between individual cores. They deal with the Mailbox peripheral for LPC parts and the Messaging Unit (MU) peripheral for Kinetis and i.MX parts. The common attribute of both modules is the ability to provide a means of IPC, allowing multiple CPUs to share resources and communicate with each other in a simple manner.

The most lightweight method of IPC uses the MCUXpresso SDK low-level drivers for these peripherals. Using the Mailbox/MU driver API functions, it is possible to pass a value from core to core via the dedicated registers (could be a scalar or a pointer to shared memory) and also to trigger inter-core interrupts for notifications.

For details about individual driver API functions, see the MCUXpresso SDK API Reference Manual of the specific multicore device. The MCUXpresso SDK is accompanied with the RPMsg-Lite documentation that shows how to use this API in multicore applications.

Messaging mechanism

On top of Mailbox/MU drivers, a messaging system can be implemented, allowing messages to send between multiple endpoints created on each of the CPUs. The RPMsg-Lite library of the MCSDK provides this ability and serves as the preferred MCUXpresso SDK messaging library. It implements ring buffers in shared memory for messages exchange without the need of a locking mechanism.

The RPMsg-Lite provides the abstraction layer and can be easily ported to different multicore platforms and environments (Operating Systems). The advantages of such a messaging system are ease of use (there is no need to study behavior of the used underlying hardware) and smooth application code portability between platforms due to unified messaging API.

However, this costs several kB of code and data memory. The MCUXpresso SDK is accompanied by the RPMsg-Lite documentation and several multicore examples. You can also obtain the latest RPMsg-Lite code from the GitHub account github.com/nxp-mcuxpresso/rpmsg-lite.

Remote procedure calls

To facilitate the IPC even more and to allow the remote functions invocation, the remote procedure call mechanism can be implemented. The eRPC of the MCSDK serves for these purposes and allows the ability to invoke a software routine on a remote system via a simple local function call. Utilizing different transport layers, it is possible to communicate between individual cores of multicore SoCs (via RPMsg-Lite) or between separate processors (via SPI, UART, or TCP/IP). The eRPC is mostly applicable to the MPU parts with enough of memory resources like i.MX parts.

The eRPC library allows you to export existing C functions without having to change their prototypes (in most cases). It is accompanied by the code generator tool that generates the shim code for serialization and invocation based on the IDL file with definitions of data types and remote interfaces (API).

If the communicating peer is running as a Linux OS user-space application, the generated code can be either in C/C++ or Python.

Using the eRPC simplifies the access to services implemented on individual cores. This way, the following types of applications running on dedicated cores can be easily interfaced:

- Communication stacks (USB, Thread, Bluetooth Low Energy, Zigbee)
- Sensor aggregation/fusion applications
- Encryption algorithms
- Virtual peripherals

The eRPC is publicly available from the following GitHub account: github.com/EmbeddedRPC/erpc. Also, the MCUXpresso SDK is accompanied by the eRPC code and several multicore and multiprocessor eRPC examples.

The mentioned IPC levels demonstrate the scalability of the Multicore SDK library. Based on application needs, different IPC techniques can be used. It depends on the complexity, required speed, memory resources, system design, and so on. The MCSDK brings users the possibility for quick and easy development of multicore and multiprocessor applications.

Changelog Multicore SDK

All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

[25.06.00]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.14.0
 - eRPC generator (erpcgen) v1.14.0
 - Multicore Manager (MCMgr) v5.0.0
 - RPMsg-Lite v5.2.0

[25.03.00]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.13.0

- eRPC generator (erpcgen) v1.13.0
- Multicore Manager (MCMgr) v4.1.7
- RPPMsg-Lite v5.1.4

[24.12.00]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.13.0
 - eRPC generator (erpcgen) v1.13.0
 - Multicore Manager (MCMgr) v4.1.6
 - RPPMsg-Lite v5.1.3

[2.16.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.13.0
 - eRPC generator (erpcgen) v1.13.0
 - Multicore Manager (MCMgr) v4.1.5
 - RPPMsg-Lite v5.1.2

[2.15.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.12.0
 - eRPC generator (erpcgen) v1.12.0
 - Multicore Manager (MCMgr) v4.1.5
 - RPPMsg-Lite v5.1.1

[2.14.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.11.0
 - eRPC generator (erpcgen) v1.11.0
 - Multicore Manager (MCMgr) v4.1.4
 - RPPMsg-Lite v5.1.0

[2.13.0_imxrt1180a0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.10.0
 - eRPC generator (erpcgen) v1.10.0
 - Multicore Manager (MCMgr) v4.1.3
 - RPPMsg-Lite v5.0.0

[2.13.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.10.0
 - eRPC generator (erpcgen) v1.10.0
 - Multicore Manager (MCMgr) v4.1.3
 - RPSMsg-Lite v5.0.0

[2.12.0_imx93]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.9.1
 - eRPC generator (erpcgen) v1.9.1
 - Multicore Manager (MCMgr) v4.1.2
 - RPSMsg-Lite v4.0.1

[2.12.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.9.1
 - eRPC generator (erpcgen) v1.9.1
 - Multicore Manager (MCMgr) v4.1.2
 - RPSMsg-Lite v4.0.0

[2.11.1]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.9.0
 - eRPC generator (erpcgen) v1.9.0
 - Multicore Manager (MCMgr) v4.1.1
 - RPSMsg-Lite v3.2.1

[2.11.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.9.0
 - eRPC generator (erpcgen) v1.9.0
 - Multicore Manager (MCMgr) v4.1.1
 - RPSMsg-Lite v3.2.0

[2.10.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.8.1
 - eRPC generator (erpcgen) v1.8.1
 - Multicore Manager (MCMgr) v4.1.1
 - RPSMsg-Lite v3.1.2

[2.9.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.8.0
 - eRPC generator (erpcgen) v1.8.0
 - Multicore Manager (MCMgr) v4.1.1
 - RPSMsg-Lite v3.1.1

[2.8.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.7.4
 - eRPC generator (erpcgen) v1.7.4
 - Multicore Manager (MCMgr) v4.1.0
 - RPSMsg-Lite v3.1.0

[2.7.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.7.3
 - eRPC generator (erpcgen) v1.7.3
 - Multicore Manager (MCMgr) v4.1.0
 - RPSMsg-Lite v3.0.0

[2.6.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.7.2
 - eRPC generator (erpcgen) v1.7.2
 - Multicore Manager (MCMgr) v4.0.3
 - RPSMsg-Lite v2.2.0

[2.5.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.7.1
 - eRPC generator (erpcgen) v1.7.1
 - Multicore Manager (MCMgr) v4.0.2
 - RPSMsg-Lite v2.0.2

[2.4.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.7.0
 - eRPC generator (erpcgen) v1.7.0
 - Multicore Manager (MCMgr) v4.0.1
 - RPSMsg-Lite v2.0.1

[2.3.1]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.6.0
 - eRPC generator (erpcgen) v1.6.0
 - Multicore Manager (MCMgr) v4.0.0
 - RPSMsg-Lite v1.2.0

[2.3.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.5.0
 - eRPC generator (erpcgen) v1.5.0
 - Multicore Manager (MCMgr) v3.0.0
 - RPSMsg-Lite v1.2.0

[2.2.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.4.0
 - eRPC generator (erpcgen) v1.4.0
 - Multicore Manager (MCMgr) v2.0.1
 - RPSMsg-Lite v1.1.0

[2.1.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.3.0
 - eRPC generator (erpcgen) v1.3.0

[2.0.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.2.0
 - eRPC generator (erpcgen) v1.2.0
 - Multicore Manager (MCMgr) v2.0.0
 - RPMMsg-Lite v1.0.0

[1.1.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.1.0
 - Multicore Manager (MCMgr) v1.1.0
 - Open-AMP / RPMMsg based on SHA1 ID 44b5f3c0a6458f3cf80 rev01

[1.0.0]

- Multicore SDK component versions:
 - embedded Remote Procedure Call (eRPC) v1.0.0
 - Multicore Manager (MCMgr) v1.0.0
 - Open-AMP / RPMMsg based on SHA1 ID 44b5f3c0a6458f3cf80 rev00

Multicore SDK Components

RPMSG-Lite

MCUXpresso SDK : mcuxsdk-middleware-rpmsg-lite

Overview This repository is for MCUXpresso SDK RPMSG-Lite middleware delivery and it contains RPMSG-Lite component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk](#) for the complete delivery of MCUXpresso SDK to be able to build and run RPMSG-Lite examples that are based on mcux-sdk-middleware-rpmsg-lite component.

Documentation Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

Visit [RPMSG-Lite - Documentation](#) to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution We welcome and encourage the community to submit patches directly to the rpmsg-lite project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

RPMSG-Lite This documentation describes the RPMsg-Lite component, which is a lightweight implementation of the Remote Processor Messaging (RPMsg) protocol. The RPMsg protocol defines a standardized binary interface used to communicate between multiple cores in a heterogeneous multicore system.

Compared to the RPMsg implementation of the Open Asymmetric Multi Processing (OpenAMP) framework (<https://github.com/OpenAMP/open-amp>), the RPMsg-Lite offers a code size reduction, API simplification, and improved modularity. On smaller Cortex-M0+ based systems, it is recommended to use RPMsg-Lite.

The RPMsg-Lite is an open-source component developed by NXP Semiconductors and released under the BSD-compatible license.

For Further documentation, please look at doxygen documentation at: <https://nxp-mcuxpresso.github.io/rpmsg-lite/>

For overview please read RPMSG-Lite VirtIO Overview.

For RPMSG-Lite Design Considerations please read RPMSG-Lite Design Considerations.

Motivation to create RPMsg-Lite There are multiple reasons why RPMsg-Lite was developed. One reason is the need for the small footprint of the RPMsg protocol-compatible communication component, another reason is the simplification of extensive API of OpenAMP RPMsg implementation.

RPMsg protocol was not documented, and its only definition was given by the Linux Kernel and legacy OpenAMP implementations. This has changed with [1] which is a standardization protocol allowing multiple different implementations to coexist and still be mutually compatible.

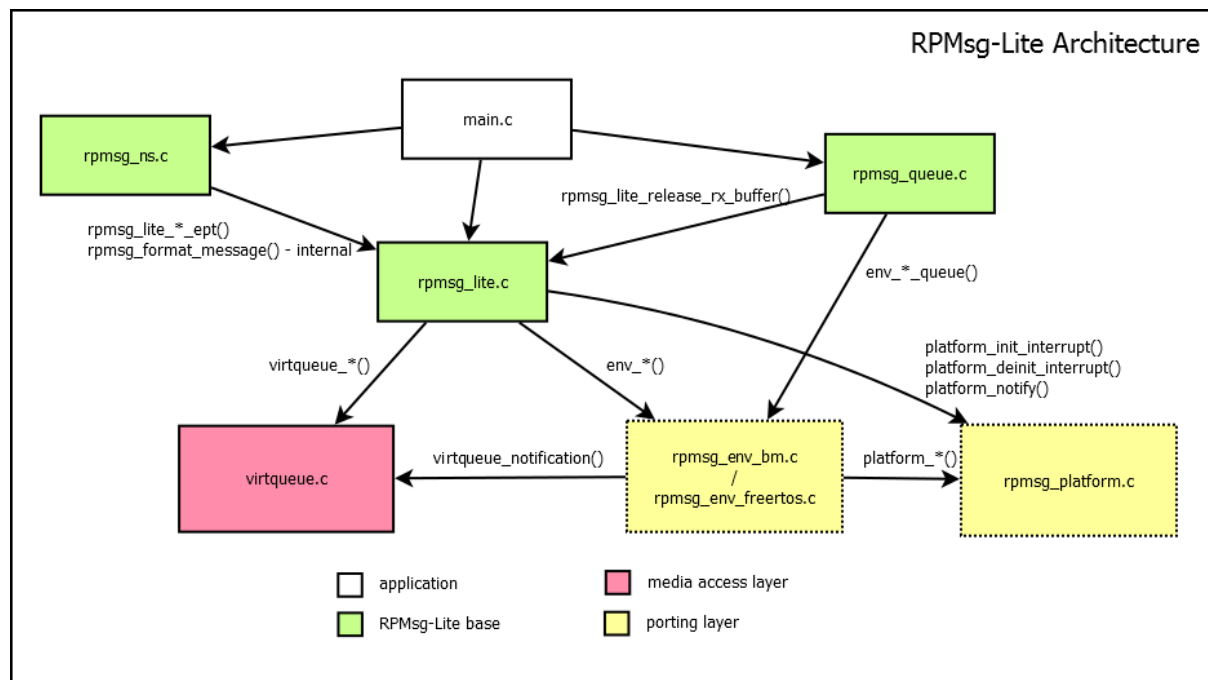
Small MCU-based systems often do not implement dynamic memory allocation. The creation of static API in RPMsg-Lite enables another reduction of resource usage. Not only does the dynamic allocation adds another 5 KB of code size, but also communication is slower and less deterministic, which is a property introduced by dynamic memory. The following table shows some rough comparison data between the OpenAMP RPMsg implementation and new RPMsg-Lite implementation:

Component / Configuration	Flash [B]	RAM [B]
OpenAMP RPMsg / Release (reference)	5547	456 + dynamic
RPMsg-Lite / Dynamic API, Release	3462	56 + dynamic
Relative Difference [%]	~62.4%	~12.3%
RPMsg-Lite / Static API (no malloc), Release	2926	352
Relative Difference [%]	~52.7%	~77.2%

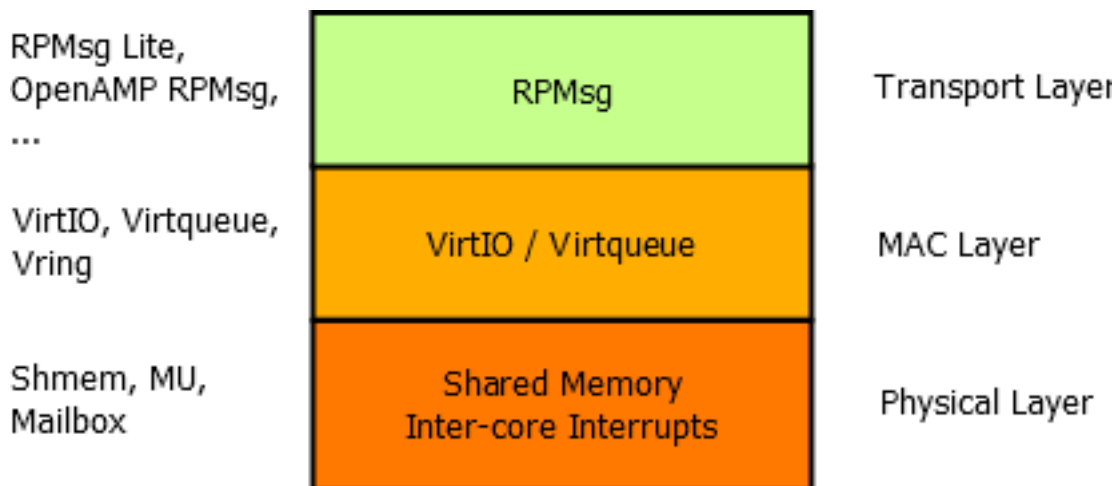
Implementation The implementation of RPMsg-Lite can be divided into three sub-components, from which two are optional. The core component is situated in `rpmsg_lite.c`. Two optional components are used to implement a blocking receive API (in `rpmsg_queue.c`) and dynamic “named” endpoint creation and deletion announcement service (in `rpmsg_ns.c`).

The actual “media access” layer is implemented in `virtqueue.c`, which is one of the few files shared with the OpenAMP implementation. This layer mainly defines the shared memory model, and internally defines used components such as `vring` or `virtqueue`.

The porting layer is split into two sub-layers: the environment layer and the platform layer. The first sublayer is to be implemented separately for each environment. (The bare metal environment already exists and is implemented in `rpmsg_env_bm.c`, and the FreeRTOS environment is implemented in `rpmsg_env_freertos.c` etc.) Only the source file, which matches the used environment, is included in the target application project. The second sublayer is implemented in `rpmsg_platform.c` and defines low-level functions for interrupt enabling, disabling, and triggering mainly. The situation is described in the following figure:



RPMsg-Lite core sub-component This subcomponent implements a blocking send API and callback-based receive API. The RPMsg protocol is part of the transport layer. This is realized by using so-called endpoints. Each endpoint can be assigned a different receive callback function. However, it is important to notice that the callback is executed in an interrupt environment in current design. Therefore, certain actions like memory allocation are discouraged to execute in the callback. The following figure shows the role of RPMsg in an ISO/OSI-like layered model:



Queue sub-component (optional) This subcomponent is optional and requires implementation of the `env_*_queue()` functions in the environment porting layer. It uses a blocking receive API, which is common in RTOS-environments. It supports both copy and nocopy blocking receive functions.

Name Service sub-component (optional) This subcomponent is a minimum implementation of the name service which is present in the Linux Kernel implementation of RPMsg. It allows the communicating node both to send announcements about “named” endpoint (in other words, channel) creation or deletion and to receive these announcement taking any user-defined action

in an application callback. The endpoint address used to receive name service announcements is arbitrarily fixed to be 53 (0x35).

Usage The application should put the `/rpmmsg_lite/lib/include` directory to the include path and in the application, include either the `rpmmsg_lite.h` header file, or optionally also include the `rpmmsg_queue.h` and/or `rpmmsg_ns.h` files. Both porting sublayers should be provided for you by NXP, but if you plan to use your own RTOS, all you need to do is to implement your own environment layer (in other words, `rpmmsg_env_myrtos.c`) and to include it in the project build.

The initialization of the stack is done by calling the `rpmmsg_lite_master_init()` on the master side and the `rpmmsg_lite_remote_init()` on the remote side. This initialization function must be called prior to any RPMMsg-Lite API call. After the init, it is wise to create a communication endpoint, otherwise communication is not possible. This can be done by calling the `rpmmsg_lite_create_ept()` function. It optionally accepts a last argument, where an internal context of the endpoint is created, just in case the `RL_USE_STATIC_API` option is set to 1. If not, the stack internally calls `env_alloc()` to allocate dynamic memory for it. In case a callback-based receiving is to be used, an ISR-callback is registered to each new endpoint with user-defined callback data pointer. If a blocking receive is desired (in case of RTOS environment), the `rpmmsg_queue_create()` function must be called before calling `rpmmsg_lite_create_ept()`. The queue handle is passed to the endpoint creation function as a callback data argument and the callback function is set to `rpmmsg_queue_rx_cb()`. Then, it is possible to use `rpmmsg_queue_receive()` function to listen on a queue object for incoming messages. The `rpmmsg_lite_send()` function is used to send messages to the other side.

The RPMMsg-Lite also implements no-copy mechanisms for both sending and receiving operations. These methods require specifics that have to be considered when used in an application.

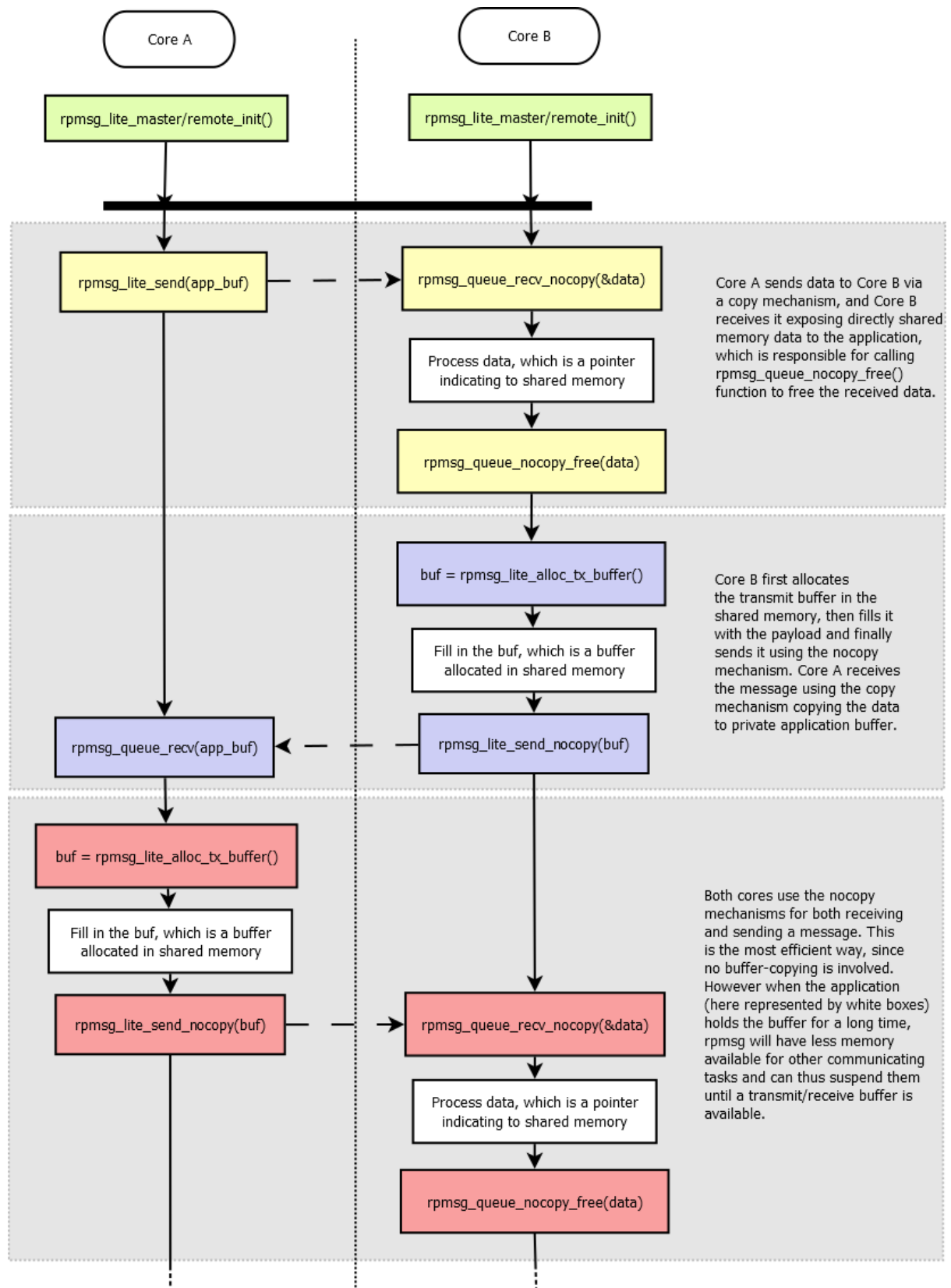
no-copy-send mechanism: This mechanism allows sending messages without the cost for copying data from the application buffer to the RPMMsg/virtio buffer in the shared memory. The sequence of no-copy sending steps to be performed is as follows:

- Call the `rpmmsg_lite_alloc_tx_buffer()` function to get the virtio buffer and provide the buffer pointer to the application.
- Fill the data to be sent into the pre-allocated virtio buffer. Ensure that the filled data does not exceed the buffer size (provided as the `rpmmsg_lite_alloc_tx_buffer()` size output parameter).
- Call the `rpmmsg_lite_send_nocopy()` function to send the message to the destination endpoint. Consider the cache functionality and the virtio buffer alignment. See the `rpmmsg_lite_send_nocopy()` function description below.

no-copy-receive mechanism: This mechanism allows reading messages without the cost for copying data from the virtio buffer in the shared memory to the application buffer. The sequence of no-copy receiving steps to be performed is as follows:

- Call the `rpmmsg_queue_rcv_nocopy()` function to get the virtio buffer pointer to the received data.
- Read received data directly from the shared memory.
- Call the `rpmmsg_queue_nocopy_free()` function to release the virtio buffer and to make it available for the next data transfer.

The user is responsible for destroying any RPMMsg-Lite objects he has created in case of deinitialization. In order to do this, the function `rpmmsg_queue_destroy()` is used to destroy a queue, `rpmmsg_lite_destroy_ept()` is used to destroy an endpoint and finally, `rpmmsg_lite_deinit()` is used to deinitialize the RPMMsg-Lite intercore communication stack. Deinitialize all endpoints using a queue before deinitializing the queue. Otherwise, you are actively invalidating the used queue handle, which is not allowed. RPMMsg-Lite does not check this internally, since its main aim is to be lightweight.



Examples RPSMsg Lite multicore examples are part of NXP MCUXpressoSDK packages. Visit <https://mcuxpresso.nxp.com> to configure, build and download these packages. To get the board list with multicore support (RPSMsg Lite included) use filtering based on Middleware and search for 'multicore' string. Once the selected package with the multicore middleware is downloaded,

see

<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples for RPSMsg_Lite multicore examples with 'rpsmsg_lite_' name prefix.

Another way of getting NXP MCUXpressoSDK RPSMsg_Lite multicore examples is using the [mcuxsdk-manifests](#) Github repo. Follow the description how to use the West tool to clone and update the mcuxsdk-manifests repo in [readme section](#). Once done the armgcc rpsmsg_lite examples can be found in

mcuxsdk/examples/_<board_name>/multicore_examples

You can use the evkmimxrt1170 as the board_name for instance. Similar to MCUXpressoSDK packages the RPSMsg_Lite examples use the 'rpsmsg_lite_' name prefix.

Notes

Environment layers implementation Several environment layers are provided in lib/rpsmsg_lite/porting/environment folder. Not all of them are fully tested however. Here is the list of environment layers that passed testing:

- rpsmsg_env_bm.c
- rpsmsg_env_freertos.c
- rpsmsg_env_xos.c
- rpsmsg_env_threadx.c

The rest of environment layers has been created and used in some experimental projects, it has been running well at the time of creation but due to the lack of unit testing there is no guarantee it is still fully functional.

Shared memory configuration It is important to correctly initialize/configure the shared memory for data exchange in the application. The shared memory must be accessible from both the master and the remote core and it needs to be configured as Non-Cacheable memory. Dedicated shared memory section in linker file is also a good practise, it is recommended to use linker files from MCUXpressoSDK packages for NXP devices based applications. It needs to be ensured no other application part/component is unintentionally accessing this part of memory.

Configuration options The RPSMsg-Lite can be configured at the compile time. The default configuration is defined in the rpsmsg_default_config.h header file. This configuration can be customized by the user by including rpsmsg_config.h file with custom settings. The following table summarizes all possible RPSMsg-Lite configuration options.

Config- uration option	De- fault value	Usage
RL_MS_PE (1)		Delay in milliseconds used in non-blocking API functions for polling.
RL_BUFEE (496)		Size of the buffer payload, it must be equal to (240, 496, 1008, ...) [$2^n - 16$]
RL_BUFEE (2)		Number of the buffers, it must be power of two (2, 4, ...)
RL_API_H (1)		Zero-copy API functions enabled/disabled.
RL_USE_S' (0)		Static API functions (no dynamic allocation) enabled/disabled.
RL_USE_D (0)		Memory cache management of shared memory. Use in case of data cache is enabled for shared memory.
RL_CLEAF (0)		Clearing used buffers before returning back to the pool of free buffers enabled/disabled.
RL_USE_M (0)		When enabled IPC interrupts are managed by the Multicore Manager (IPC interrupts router), when disabled RPMsg-Lite manages IPC interrupts by itself.
RL_USE_E (0)		When enabled the environment layer uses its own context. Required for some environments (QNX). The default value is 0 (no context, saves some RAM).
RL_DEBU (0)		When enabled buffer pointers passed to <code>rpmsg_lite_send_nocopy()</code> and <code>rpmsg_lite_release_rx_buffer()</code> functions (enabled by <code>RL_API_HAS_ZEROCOPY</code> config) are checked to avoid passing invalid buffer pointer. The default value is 0 (disabled). Do not use in RPMsg-Lite to Linux configuration.
RL_ALLO (0)		When enabled the opposite side is notified each time received buffers are consumed and put into the queue of available buffers. Enable this option in RPMsg-Lite to Linux configuration to allow unblocking of the Linux blocking send. The default value is 0 (RPMsg-Lite to RPMsg-Lite communication).
RL_ALLO (0)		It allows to define custom shared memory configuration and replacing the shared memory related global settings from <code>rpmsg_config.h</code> . This is useful when multiple instances are running in parallel but different shared memory arrangement (vring size & alignment, buffers size & count) is required. The default value is 0 (all RPMsg-Lite instances use the same shared memory arrangement as defined by common config macros).
RL_ASSERT	see <code>rpmsg</code>	Assert implementation.

How to format rpmsg-lite code To format code, use the application developed by Google, named *clang-format*. This tool is part of the [llvm](#) project. Currently, the clang-format 10.0.0 version is used for rpmsg-lite. The set of style settings used for clang-format is defined in the `.clang-format` file, placed in a root of the rpmsg-lite directory where Python script `run_clang_format.py` can be executed. This script executes the application named *clang-format.exe*. You need to have the path of this application in the OS's environment path, or you need to change the script.

References

[1] M. Novak, M. Cingel, **Lockless Shared Memory Based Multicore Communication Protocol**
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Changelog RPMSG-Lite All notable changes to this project will be documented in this file. The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

Unreleased

Fixed

- Fixed CERT-C INT31-C violation in platform_notify function in rpmsg_platform.c for imxrt700_m33, imxrt700_hifi4, imxrt700_hifi1 platforms

v5.2.0

Added

- Add MCXL20 porting layer and unit testing
- New utility macro RL_CALCULATE_BUFFER_COUNT_DOWN_SAFE to safely determine maximum buffer count within shared memory while preventing integer underflow.
- RT700 platform add support for MCMGR in DSPs

Changed

- Change rpmsg_platform.c to support new MCMGR API
- Improved input validation in initialization functions to properly handle insufficient memory size conditions.
- Refactored repeated buffer count calculation pattern for better code maintainability.
- To make sure that remote has already registered IRQ there is required App level IPC mechanism to notify master about it

Fixed

- Fixed env_wait_for_link_up function to handle timeout in link state checks for baremetal and qnx environment, RL_BLOCK mode can be used to wait indefinitely.
- Fixed CERT-C INT31-C violation by adding compile-time check to ensure RL_PLATFORM_HIGHEST_LINK_ID remains within safe range for 16-bit casting in virtqueue ID creation.
- Fixed CERT-C INT30-C violations by adding protection against unsigned integer underflow in shared memory calculations, specifically in shmem_length - (uint32_t)RL_VRING_OVERHEAD and shmem_length - 2U * shmem_config.vring_size expressions.
- Fixed CERT INT31-C violation in platform_interrupt_disable() and similar functions by replacing unsafe cast from uint32_t to int32_t with a return of 0 constant.
- Fixed unsigned integer underflow in rpmsg_lite_alloc_tx_buffer() where subtracting header size from buffer size could wrap around if buffer was too small, potentially leading to incorrect buffer sizing.
- Fixed CERT-C INT31-C violation in rpmsg_lite.c where size parameter was cast from uint32_t to uint16_t without proper validation.
 - Applied consistent masking approach to both size and flags parameters: (uint16_t)(value & 0xFFFFU).
 - This fix prevents potential data loss when size values exceed 65535.

- Fixed CERT INT31-C violation in `env_memset` functions by explicitly converting `int32_t` values to unsigned char using bit masking. This prevents potential data loss or misinterpretation when passing values outside the unsigned char range (0-255) to the standard `memset()` function.
- Fixed CERT-C INT31-C violations in RPMsg-Lite environment porting: Added validation checks for signed-to-unsigned integer conversions to prevent data loss and misinterpretation.
 - `rpmsg_env_freertos.c`: Added validation before converting `int32_t` to `UBaseType_t`.
 - `rpmsg_env_qnx.c`: Fixed format string and added validation before assigning to `mqstat` fields.
 - `rpmsg_env_threadx.c`: Added validation to prevent integer overflow and negative values.
 - `rpmsg_env_xos.c`: Added range checking before casting to `uint16_t`.
 - `rpmsg_env_zephyr.c`: Added validation before passing values to `k_msgq_init`.
- Fixed a CERT INT31-C compliance issue in `env_get_current_queue_size()` function where an unsigned queue count was cast to a signed `int32_t` without proper validation, which could lead to lost or misinterpreted data if queue size exceeded `INT32_MAX`.
- Fixed CERT INT31-C violation in `rpmsg_platform.c` where `memcmp()` return value (signed int) was compared with unsigned constant without proper type handling.
- Fixed CERT INT31-C violation in `rpmsg_platform.c` where casting from `uint32_t` to `uint16_t` could potentially result in data loss. Changed length variable type from `uint16_t` to `uint32_t` to properly handle memory address differences without truncation.
- Fixed potential integer overflow in `env_sleep_msec()` function in ThreadX environment implementation by rearranging calculation order in the sleep duration formula.
- Fixed CERT-C INT31-C violation in RPMsg-Lite where bitwise NOT operations on integer constants were performed in signed integer context before being cast to unsigned. This could potentially lead to misinterpreted data on `imx943` platform.
- Added `RL_MAX_BUFFER_COUNT` (32768U) and `RL_MAX_VRING_ALIGN` (65536U) limit to ensure alignment values cannot contribute to integer overflow
- Fixed CERT INT31-C violation in `vring_need_event()`, added cast to `uint16_t` for each operand.

v5.1.4 - 27-Mar-2025

Added

- Add KW43B43 porting layer

Changed

- Doxygen bump to version 1.9.6

v5.1.3 - 13-Jan-2025

Added

- Memory cache management of shared memory. Enable with `#define RL_USE_DCACHE (1)` in `rpmsg_config.h` in case of data cache is used.
- Cmake/Kconfig support added.
- Porting layers for imx95, imxrt700, mcmxw71x, mcmxw72x, kw47b42 added.

v5.1.2 - 08-Jul-2024**Changed**

- Zephyr-related changes.
- Minor Misra corrections.

v5.1.1 - 19-Jan-2024**Added**

- Test suite provided.
- Zephyr support added.

Changed

- Minor changes in platform and env. layers, minor test code updates.

v5.1.0 - 02-Aug-2023**Added**

- RPMsg-Lite: Added aarch64 support.

Changed

- RPMsg-Lite: Increased the queue size to $(2 * RL\_BUFFER\_COUNT)$ to cover zero copy cases.
- Code formatting using LLVM16.

Fixed

- Resolved issues in ThreadX env. layer implementation.

v5.0.0 - 19-Jan-2023**Added**

- Timeout parameter added to `rpmsg_lite_wait_for_link_up` API function.

Changed

- Improved debug check buffers implementation - instead of checking the pointer fits into shared memory check the presence in the VirtIO ring descriptors list.
- VRING_SIZE is set based on number of used buffers now (as calculated in vring_init) - updated for all platforms that are not communicating to Linux rpmsg counterpart.

Fixed

- Fixed wrong RL_VRING_OVERHEAD macro comment in platform.h files
- Misra corrections.

v4.0.0 - 20-Jun-2022

Added

- Added support for custom shared memory arrangement per the RPMsg_Lite instance.
- Introduced new rpmsg_lite_wait_for_link_up() API function - this allows to avoid using busy loops in rtos environments, GitHub PR [#21](#).

Changed

- Adjusted rpmsg_lite_is_link_up() to return RL_TRUE/RL_FALSE.

v3.2.0 - 17-Jan-2022

Added

- Added support for i.MX8 MP multicore platform.

Changed

- Improved static allocations - allow OS-specific objects being allocated statically, GitHub PR [#14](#).
- Aligned rpmsg_env_xos.c and some platform layers to latest static allocation support.

Fixed

- Minor Misra and typo corrections, GitHub PR [#19](#), [#20](#).

v3.1.2 - 16-Jul-2021

Added

- Addressed MISRA 21.6 rule violation in rpmsg_env.h (use SDK's PRINTF in MCUXpressoSDK examples, otherwise stdio printf is used).
- Added environment layers for XOS.
- Added support for i.MX RT500, i.MX RT1160 and i.MX RT1170 multicore platforms.

Fixed

- Fixed incorrect description of the `rpmsg_lite_get_endpoint_from_addr` function.

Changed

- Updated `RL_BUFFER_COUNT` documentation (issue [#10](#)).
- Updated `imxrt600_hifi4` platform layer.

v3.1.1 - 15-Jan-2021**Added**

- Introduced `RL_ALLOW_CONSUMED_BUFFERS_NOTIFICATION` config option to allow opposite side notification sending each time received buffers are consumed and put into the queue of available buffers.
- Added environment layers for Threadx.
- Added support for i.MX8QM multicore platform.

Changed

- Several MISRA C-2012 violations addressed.

v3.1.0 - 22-Jul-2020**Added**

- Added support for several new multicore platforms.

Fixed

- MISRA C-2012 violations fixed (7.4).
- Fixed missing lock in `rpmsg_lite_rx_callback()` for QNX env.
- Correction of `rpmsg_lite_instance` structure members description.
- Address -Waddress-of-packed-member warnings in GCC9.

Changed

- Clang update to v10.0.0, code re-formatted.

v3.0.0 - 20-Dec-2019**Added**

- Added support for several new multicore platforms.

Fixed

- MISRA C-2012 violations fixed, incl. data types consolidation.
- Code formatted.

v2.2.0 - 20-Mar-2019

Added

- Added configuration macro `RL_DEBUG_CHECK_BUFFERS`.
- Several MISRA violations fixed.
- Added environment layers for QNX and Zephyr.
- Allow environment context required for some environment (controlled by the `RL_USE_ENVIRONMENT_CONTEXT` configuration macro).
- Data types consolidation.

v1.1.0 - 28-Apr-2017

Added

- Supporting i.MX6SX and i.MX7D MPU platforms.
- Supporting LPC5411x MCU platform.
- Baremetal and FreeRTOS support.
- Support of copy and zero-copy transfer.
- Support of static API (without dynamic allocations).

Multicore Manager

MCUXpresso SDK : `mcuxsdk-middleware-mcmgr` (Multicore Manager)

Overview This repository is for MCUXpresso SDK Multicore Manager middleware delivery and it contains Multicore Manager component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk](#) for the complete delivery of MCUXpresso SDK to be able to build and run Multicore Manager examples that are based on `mcux-sdk-middleware-mcmgr` component.

Documentation Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

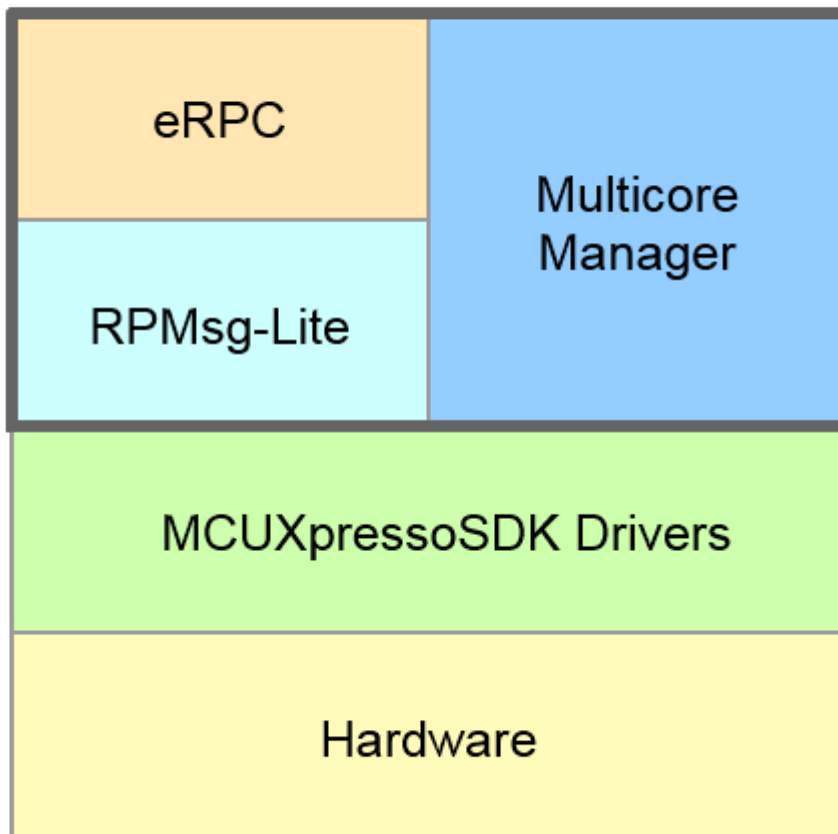
Visit [Multicore Manager - Documentation](#) to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution We welcome and encourage the community to submit patches directly to the mcmgr project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

Multicore Manager (MCMGR) The Multicore Manager (MCMGR) software library provides a number of services for multicore systems. This library is distributed as a part of the Multicore SDK (MCSDK). Together, the MCSDK and the MCUXpresso SDK (SDK) form a framework for development of software for NXP multicore devices.

The MCMGR component is located in the <MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr directory.



The Multicore Manager provides the following major functions:

- Maintains information about all cores in system.
- Secondary/auxiliary core(s) startup and shutdown.
- Remote core monitoring and event handling.

For Further API documentation, please look at doxygen documentation at: <https://nxp-mcuxpresso.github.io/mcux-mcmgr/>

Usage of the MCMGR software component The main use case of MCMGR is the secondary/auxiliary core start. This functionality is performed by the public API function.

Example of MCMGR usage to start secondary core:

```
#include "mcmgr.h"

void main()
{
    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* Initialize MCMGR, install generic event handlers */
    MCMGR_Init();

    /* Boot secondary core application from the CORE1_BOOT_ADDRESS, pass "1" as startup data,
    ↪starting synchronously. */
    MCMGR_StartCore(kMCMGR_Core1, CORE1_BOOT_ADDRESS, 1, kMCMGR_Start_Synchronous);
    .
    .
    .
    /* Stop secondary core execution. */
    MCMGR_StopCore(kMCMGR_Core1);
}
```

Some platforms allow stopping and re-starting the secondary core application again, using the MCMGR_StopCore / MCMGR_StartCore API calls. It is necessary to ensure the initially loaded image is not corrupted before re-starting, especially if it deals with the RAM target. Cache coherence has to be considered/ensured as well.

Another important MCMGR feature is the ability for remote core monitoring and handling of events such as reset, exception, and application events. Application-specific callback functions for events are registered by the MCMGR_RegisterEvent() API. Triggering these events is done using the MCMGR_TriggerEvent() API. mcmgr_event_type_t enums all possible event types.

An example of MCMGR usage for remote core monitoring and event handling. Code for the primary side:

```
#include "mcmgr.h"

#define APP_RPMSG_READY_EVENT_DATA (1)
#define APP_NUMBER_OF_CORES (2)
#define APP_SECONDARY_CORE kMCMGR_Core1

/* Callback function registered via the MCMGR_RegisterEvent() and triggered by MCMGR_TriggerEvent()
↪called on the secondary core side */
void RPSGRemoteReadyEventHandler(mcmgr_core_t coreNum, uint16_t eventData, void *context)
{
    uint16_t *data = &((uint16_t *)context)[coreNum];

    *data = eventData;
}

void main()
{
    uint16_t RPSGRemoteReadyEventData[NUMBER_OF_CORES] = {0};

    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();
```

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```

/* Initialize MCMGR, install generic event handlers */
MCMGR_Init();

/* Register the application event before starting the secondary core */
MCMGR_RegisterEvent(kMCMGR_RemoteApplicationEvent, RPSMsgRemoteReadyEventHandler, (void*)
↳RPSMsgRemoteReadyEventData);

/* Boot secondary core application from the CORE1_BOOT_ADDRESS, pass rpsmsg_lite_base address
↳as startup data, starting synchronously. */
MCMGR_StartCore(APP_SECONDARY_CORE, CORE1_BOOT_ADDRESS, (uint32_t)rpsmsg_lite_
↳base, kMCMGR_Start_Synchronous);

/* Wait until the secondary core application signals the rpsmsg remote has been initialized and is ready to
↳communicate. */
while(APP_RPSMSG_READY_EVENT_DATA != RPSMsgRemoteReadyEventData[APP_SECONDARY_
↳CORE]) {};
.
.
.
}

```

Code for the secondary side:

```

#include "mcmgr.h"

#define APP_RPSMSG_READY_EVENT_DATA (1)

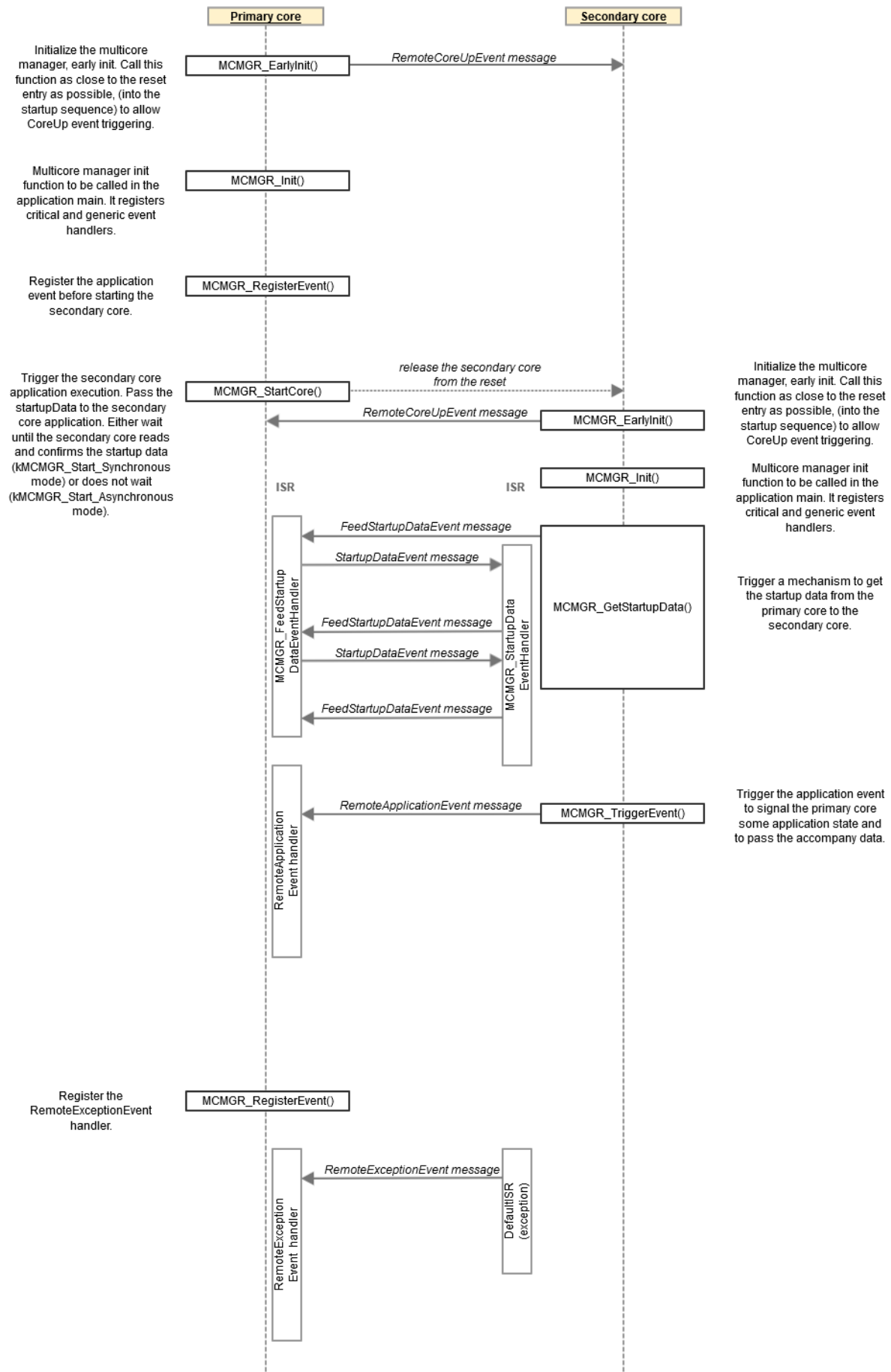
void main()
{
    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* Initialize MCMGR, install generic event handlers */
    MCMGR_Init();
    .
    .
    .

    /* Signal the to other core that we are ready by triggering the event and passing the APP_RPSMSG_
    ↳READY_EVENT_DATA */
    MCMGR_TriggerEvent(kMCMGR_Core0, kMCMGR_RemoteApplicationEvent, APP_RPSMSG_
    ↳READY_EVENT_DATA);
    .
    .
    .
}

```

MCMGR Data Exchange Diagram The following picture shows how the handshakes are supposed to work between the two cores in the MCMGR software.



Changelog Multicore Manager All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

Unreleased

Added

Fixed

- Added CX flag into CMakeLists.txt to allow c++ build compatibility.

v5.0.0

Added

- Added MCMGR_BUSY_POLL_COUNT macro to prevent infinite polling loops in MCMGR operations.
- Implemented timeout mechanism for all polling loops in MCMGR code.
- Added support to handle more than two cores. Breaking API change by adding parameter `coreNum` specifying core number in functions bellow.
 - MCMGR_GetStartupData(uint32_t *startupData, mcmgr_core_t coreNum)
 - MCMGR_TriggerEvent(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
 - MCMGR_TriggerEventForce(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
 - typedef void (*mcmgr_event_callback_t)(uint16_t data, void *context, mcmgr_core_t coreNum);

When registering the event with function `MCMGR_RegisterEvent()` user now needs to provide `callbackData` pointer to array of elements per every core in system (see README.md for example). In case of systems with only two cores the `coreNum` in callback can be ignored as events can arrive only from one core. Please see Porting guide for more details: [Porting-GuideTo_v5.md](#)

- Updated all porting files to support new MCMGR API.
- Added new platform specific include file `mcmgr_platform.h`. It will contain common platform specific macros that can be then used in `mcmgr` and application. e.g. platform core count `MCMGR_CORECOUNT` 4.
- Move all header files to new `inc` directory.
- Added new platform-specific include files `inc/platform/<platform_name>/mcmgr_platform.h`.

Added

- Add MCXL20 porting layer and unit testing

v4.1.7

Fixed

- `mcmgr_stop_core_internal()` function now returns `kStatus_MCMGR_NotImplemented` status code instead of `kStatus_MCMGR_Success` when device does not support stop of secondary core. Ports affected: kw32w1, kw45b41, kw45b42, mcxw716, mcxw727.

[v4.1.6]

Added

- Multicore Manager moved to standalone repository.
- Add porting layers for imxrt700, mcmxw727, kw47b42.
- New `MCMGR_ProcessDeferredRxIsr()` API added.

[v4.1.5]

Added

- Add notification into `MCMGR_EarlyInit` and `mcmgr_early_init_internal` functions to avoid using uninitialized data in their implementations.

[v4.1.4]

Fixed

- Avoid calling tx isr callbacks when respective Messaging Unit Transmit Interrupt Enable flag is not set in the CR/TCR register.
- Messaging Unit RX and status registers are cleared after the initialization.

[v4.1.3]

Added

- Add porting layers for imxrt1180.

Fixed

- `mu_isr()` updated to avoid calling tx isr callbacks when respective Transmit Interrupt Enable flag is not set in the CR/TCR register.
- `mcmgr_mu_internal.c` code adaptation to new supported SoCs.

[v4.1.2]

Fixed

- Update `mcmgr_stop_core_internal()` implementations to set core state to `kMCMGR_ResetCoreState`.

[v4.1.0]

Fixed

- Code adjustments to address MISRA C-2012 Rules

[v4.0.3]

Fixed

- Documentation updated to describe handshaking in a graphic form.
- Minor code adjustments based on static analysis tool findings

[v4.0.2]

Fixed

- Align porting layers to the updated MCUXpressoSDK feature files.

[v4.0.1]

Fixed

- Code formatting, removed unused code

[v4.0.0]

Added

- Add new MCMGR_TriggerEventForce() API.

[v3.0.0]

Removed

- Removed MCMGR_LoadApp(), MCMGR_MapAddress() and MCMGR_SignalReady()

Modified

- Modified MCMGR_GetStartupData()

Added

- Added MCMGR_EarlyInit(), MCMGR_RegisterEvent() and MCMGR_TriggerEvent()
- Added the ability for remote core monitoring and event handling

[v2.0.1]

Fixed

- Updated to be Misra compliant.

[v2.0.0]

Added

- Support for lpcxpresso54114 board.

[v1.1.0]

Fixed

- Ported to KSDK 2.0.0.

[v1.0.0]

Added

- Initial release.

eRPC

MCUXpresso SDK : mcuxsdk-middleware-erpc

Overview This repository is for MCUXpresso SDK eRPC middleware delivery and it contains eRPC component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk](#) for the complete delivery of MCUXpresso SDK to be able to build and run eRPC examples that are based on mcux-sdk-middleware-erpc component.

Documentation Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

Visit [eRPC - Documentation](#) to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution We welcome and encourage the community to submit patches directly to the eRPC project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

eRPC

- [MCUXpresso SDK : mcuxsdk-middleware-erpc](#)

- [Overview](#)
- [Documentation](#)
- [Setup](#)
- [Contribution](#)

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 - * [Building](#)
 - [CMake and KConfig](#)
 - [Make](#)
 - * [Installing for Python](#)
- [Known issues and limitations](#)
- [Code providing](#)

About

eRPC (Embedded RPC) is an open source Remote Procedure Call (RPC) system for multichip embedded systems and heterogeneous multicore SoCs.

Unlike other modern RPC systems, such as the excellent [Apache Thrift](#), eRPC distinguishes itself by being designed for tightly coupled systems, using plain C for remote functions, and having a small code size (<5kB). It is not intended for high performance distributed systems over a network.

eRPC does not force upon you any particular API style. It allows you to export existing C functions, without having to change their prototypes. (There are limits, of course.) And although the

internal infrastructure is written in C++, most users will be able to use only the simple C setup APIs shown in the examples below.

A code generator tool called `erpcgen` is included. It accepts input IDL files, having an `.erpc` extension, that have definitions of your data types and remote interfaces, and generates the shim code that handles serialization and invocation. `erpcgen` can generate either C/C++ or Python code.

Example `.erpc` file:

```
// Define a data type.
enum LEDName { kRed, kGreen, kBlue }

// An interface is a logical grouping of functions.
interface IO {
    // Simple function declaration with an empty reply.
    set_led(LEDName whichLed, bool onOrOff) -> void
}
```

Client side usage:

```
void example_client(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_client_t client_manager;

    /* Init eRPC client infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    client_manager = erpc_client_init(transport, message_buffer_factory);

    /* init eRPC client IO service */
    initIO_client(client_manager);

    // Now we can call the remote function to turn on the green LED.
    set_led(kGreen, true);

    /* deinit objects */
    deinitIO_client();
    erpc_client_deinit(client_manager);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}
```

```
void example_client(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_client_t client_manager;

    /* Init eRPC client infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    client_manager = erpc_client_init(transport, message_buffer_factory);

    /* scope for client service */
    {
        /* init eRPC client IO service */
        IO_client client(client_manager);

        // Now we can call the remote function to turn on the green LED.
        client.set_led(kGreen, true);
    }

    /* deinit objects */
}
```

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```

    erpc_client_deinit(client_manager);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}

```

Server side usage:

```

// Implement the remote function.
void set_led(LEDName whichLed, bool onOrOff) {
    // implementation goes here
}

void example_server(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_server_t server;
    erpc_service_t service = create_IO_service();

    /* Init eRPC server infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    server = erpc_server_init(transport, message_buffer_factory);

    /* add custom service implementation to the server */
    erpc_add_service_to_server(server, service);

    // Run the server.
    erpc_server_run();

    /* deinit objects */
    destroy_IO_service(service);
    erpc_server_deinit(server);
    erpc_mbf_dynamic_deinit(message_buffer_factory);
    erpc_transport_tcp_deinit(transport);
}

```

```

// Implement the remote function.
class IO : public IO_interface
{
    /* eRPC call definition */
    void set_led(LEDName whichLed, bool onOrOff) override {
        // implementation goes here
    }
}

void example_server(void) {
    erpc_transport_t transport;
    erpc_mbf_t message_buffer_factory;
    erpc_server_t server;
    IO IOImpl;
    IO_service io(&IOImpl);

    /* Init eRPC server infrastructure */
    transport = erpc_transport_cmsis_uart_init(Driver_USART0);
    message_buffer_factory = erpc_mbf_dynamic_init();
    server = erpc_server_init(transport, message_buffer_factory);

    /* add custom service implementation to the server */
    erpc_add_service_to_server(server, &io);

    /* poll for requests */
}

```

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```
erpc_status_t err = server.run();

/* deinit objects */
erpc_server_deinit(server);
erpc_mbf_dynamic_deinit(message_buffer_factory);
erpc_transport_tcp_deinit(transport);
}
```

A number of transports are supported, and new transport classes are easy to write.

Supported transports can be found in *erpc/erpc_c/transport* folder. E.g:

- CMSIS UART
- NXP Kinetis SPI and DSPI
- POSIX and Windows serial port
- TCP/IP (mostly for testing)
- [NXP RPMsg-Lite / RPMsg TTY](#)
- SPIdev Linux
- USB CDC
- NXP Messaging Unit

eRPC is available with an unrestrictive BSD 3-clause license. See the [LICENSE file](#) for the full license text.

Releases [eRPC releases](#)

Edge releases Edge releases can be found on [eRPC CircleCI](#) webpage. Choose build of interest, then platform target and choose ARTIFACTS tab. Here you can find binary application from chosen build.

Documentation [Documentation](#) is in the wiki section.

[eRPC Infrastructure documentation](#)

Examples *Example IDL* is available in the *examples/* folder.

Plenty of eRPC multicore and multiprocessor examples can be also found in NXP MCUXpressoSDK packages. Visit <https://mcuxpresso.nxp.com> to configure, build and download these packages.

To get the board list with multicore support (eRPC included) use filtering based on Middleware and search for ‘multicore’ string. Once the selected package with the multicore middleware is downloaded, see

<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples for eRPC multicore examples (RPMsg_Lite or Messaging Unit transports used) or

<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples for eRPC multiprocessor examples (UART or SPI transports used).

eRPC examples use the ‘erpc_’ name prefix.

Another way of getting NXP MCUXpressoSDK eRPC multicore and multiprocessor examples is using the [mcux-sdk](#) Github repo. Follow the description how to use the West tool to clone and

update the mcuxsdk repo in [readme Overview section](#). Once done the armgcc eRPC examples can be found in

mcuxsdk/examples/<board_name>/multicore_examples or in

mcuxsdk/examples/<board_name>/multiprocessor_examples folders.

You can use the evkmimxrt1170 as the board_name for instance. Similar to MCUXpressoSDK packages the eRPC examples use the 'erpc_' name prefix.

References This section provides links to interesting erpc-based projects, articles, blogs or guides:

- [erpc \(EmbeddedRPC\) getting started notes](#)
- [ERPC Linux Local Environment Construction and Use](#)
- [The New Wio Terminal eRPC Firmware](#)

Directories *doc* - Documentation.

doxygen - Configuration and support files for running Doxygen over the eRPC C++ infrastructure and erpcgen code.

erpc_c - Holds C/C++ infrastructure for eRPC. This is the code you will include in your application.

erpc_python - Holds Python version of the eRPC infrastructure.

erpcgen - Holds source code for erpcgen and makefiles or project files to build erpcgen on Windows, Linux, and OS X.

erpcsniffer - Holds source code for erpcsniffer application.

examples - Several example IDL files.

mk - Contains common makefiles for building eRPC components.

test - Client/server tests. These tests verify the entire communications path from client to server and back.

utilities - Holds utilities which bring additional benefit to eRPC apps developers.

Building and installing These build instructions apply to host PCs and embedded Linux. For bare metal or RTOS embedded environments, you should copy the *erpc_c* directory into your application sources.

CMake and KConfig build:

It builds a static library of the eRPC C/C++ infrastructure, the *erpcgen* executable, and optionally the unit tests and examples.

CMake is compatible with gcc and clang. On Windows local MingGW downloaded by *script* can be used.

Make build:

It builds a static library of the eRPC C/C++ infrastructure, the *erpcgen* executable, and optionally the unit tests.

The makefiles are compatible with gcc or clang on Linux, OS X, and Cygwin. A Windows build of *erpcgen* using Visual Studio is also available in the *erpcgen/VisualStudio_v14* directory. There is also an Xcode project file in the *erpcgen* directory, which can be used to build *erpcgen* for OS X.

Requirements erPC now support building **erpcgen**, **erpc_lib**, **tests** and **C examples** using CMake.

Requirements when using CMake:

- **CMake** (minimal version 3.20.0)
- Generator - **Make, Ninja, ...**
- **C/C++ compiler** - **GCC, CLANG, ...**
- **Bison** - <https://www.gnu.org/software/bison/>
- **Flex** - <https://github.com/westes/flex/>

Requirements when using Make:

- **Make**
- **C/C++ compiler - GCC, CLANG, ...**
- **Binson** - <https://www.gnu.org/software/bison/>
- **Flex** - <https://github.com/westes/flex/>

Windows Related steps to build **erpcgen** using **Visual Studio** are described in `erpcgen/VisualStudio_v14/readme_erpcgen.txt`.

To install MinGW, Bison, Flex locally on Windows:

```
./install_dependencies.ps1
* * *
### Linux
```bash
./install_dependencies.sh
```

Mandatory for case, when build for different architecture is needed

- gcc-multilib, g++-multilib

## Mac OS X

```
./install_dependencies.sh
```

## Building

**CMake and KConfig** eRPC use CMake and KConfig to configurate and build eRPC related targets. KConfig can be edited by *prj.conf* or *menuconfig* when building.

Generate project, config and build. In *erpc/* execute:

```
cmake -B ./build # in erpc/build generate cmake project
cmake --build ./build --target menuconfig # Build menuconfig and configure erpcgen, erpc_lib, tests and
→ examples
cmake --build ./build # Build all selected target from prj.conf/menuconfig
```

**\*\*CMake will use the system's default compilers and generator**

If you want to use Windows and locally installed MinGW, use *CMake preset* :

```
cmake --preset mingw64 # Generate project in ./build using mingw64's make and compilers
cmake --build ./build --target menuconfig # Build menuconfig and configure erpcgen, erpc_lib, tests and ↵
↵examples
cmake --build ./build # Build all selected target from prj.conf/menuconfig
```

**Make** To build the library and erpcgen, run from the repo root directory:

```
make
```

To install the library, erpcgen, and include files, run:

```
make install
```

You may need to sudo the make install.

By default this will install into /usr/local. If you want to install elsewhere, set the PREFIX environment variable. Example for installing into /opt:

```
make install PREFIX=/opt
```

List of top level Makefile targets:

- erpc: build the liberpc.a static library
- erpcgen: build the erpcgen tool
- erpcsniffer: build the sniffer tool
- test: build the unit tests under the *test* directory
- all: build all of the above
- install: install liberpc.a, erpcgen, and include files

eRPC code is validated with respect to the C++ 11 standard.

**Installing for Python** To install the Python infrastructure for eRPC see instructions in the *erpc python readme*.

### Known issues and limitations

- Static allocations controlled by the ERPC\_ALLOCATION\_POLICY config macro are not fully supported yet, i.e. not all erpc objects can be allocated statically now. It deals with the ongoing process and the full static allocations support will be added in the future.

**Code providing** Repository on Github contains two main branches: **main** and **develop**. Code is developed on **develop** branch. Release version is created via merging **develop** branch into **main** branch.

---

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### eRPC Getting Started



**Overview** This *Getting Started User Guide* shows software developers how to use Remote Procedure Calls (RPC) in embedded multicore microcontrollers (eRPC).

The eRPC documentation is located in the `<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/doc` folder.

**Create an eRPC application** This section describes a generic way to create a client/server eRPC application:

1. **Design the eRPC application:** Decide which data types are sent between applications, and define functions that send/receive this data.
2. **Create the IDL file:** The IDL file contains information about data types and functions used in an eRPC application, and is written in the IDL language.
3. **Use the eRPC generator tool:** This tool takes an IDL file and generates the shim code for the client and the server-side applications.
4. **Create an eRPC application:**
  1. Create two projects, where one project is for the client side (primary core) and the other project is for the server side (secondary core).
  2. Add generated files for the client application to the client project, and add generated files for the server application to the server project.
  3. Add infrastructure files.
  4. Add user code for client and server applications.
  5. Set the client and server project options.
5. **Run the eRPC application:** Run both the server and the client applications. Make sure that the server has been run before the client request was sent.

A specific example follows in the next section.

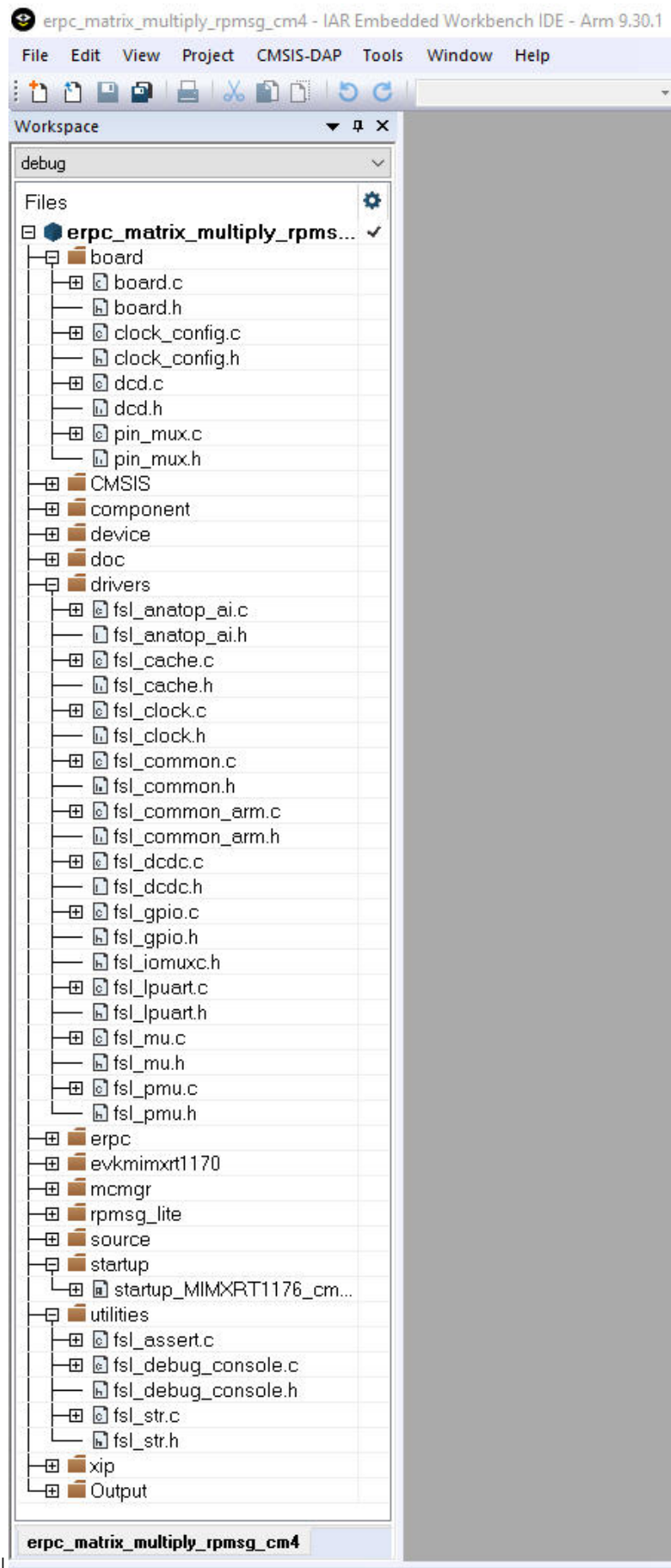
**Multicore server application** The “Matrix multiply” eRPC server project is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmmsg/cm4/iar`

The project files for the eRPC server have the `_cm4` suffix.

**Server project basic source files** The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in:

- `<MCUXpressoSDK_install_dir>/devices/<device>`
- `<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/`



|

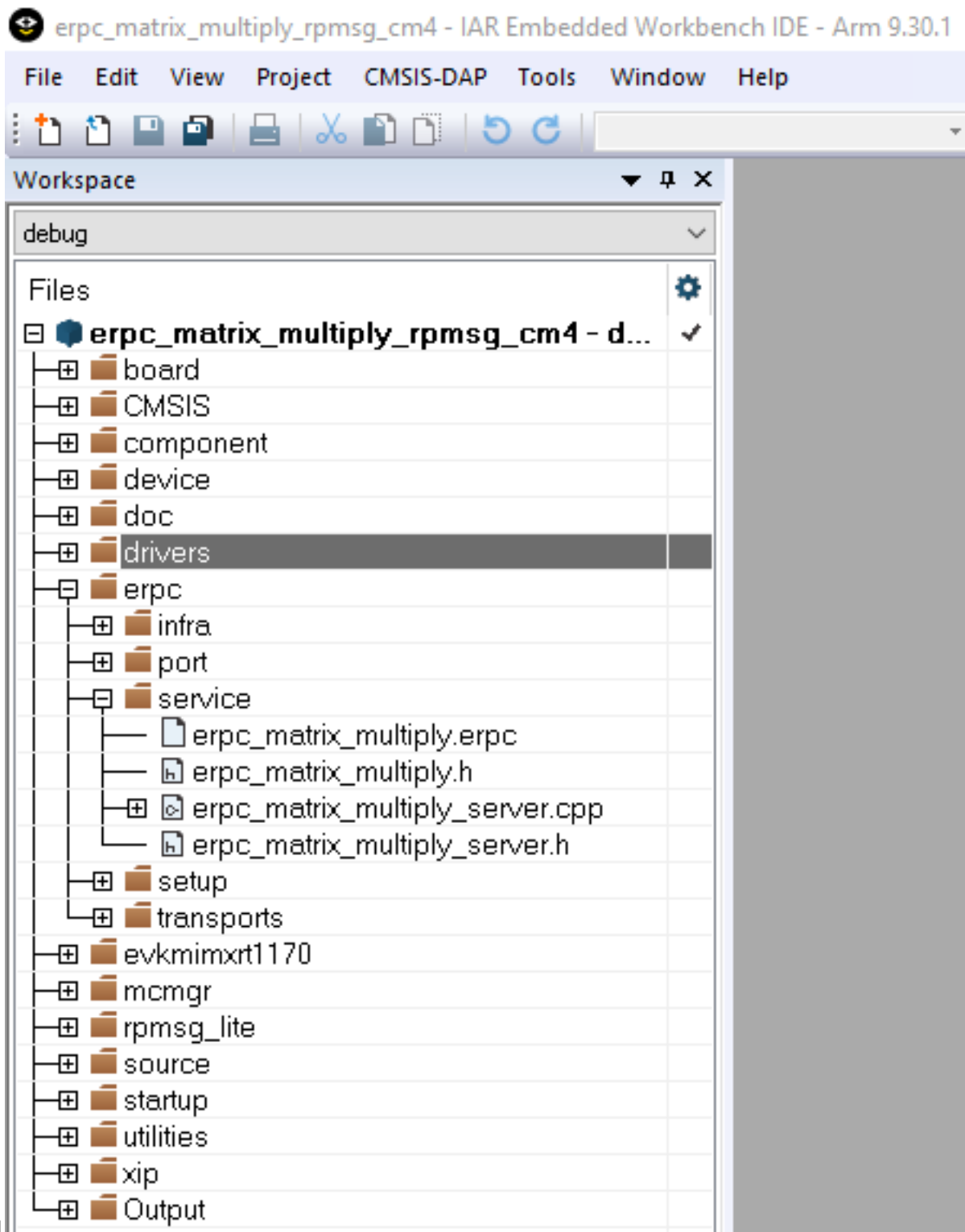
**Parent topic:**Multicore server application

**Server related generated files** The server-related generated files are:

- erpc\_\_matric\_\_multiply.h
- erpc\_\_matrix\_\_multiply\_\_server.h
- erpc\_\_matrix\_\_multiply\_\_server.cpp

The server-related generated files contain the shim code for functions and data types declared in the IDL file. These files also contain functions for the identification of client requested functions, data deserialization, calling requested function's implementations, and data serialization and return, if requested by the client. These shim code files can be found in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_examples/erpc\_common/erpc\_matrix\_multiply/



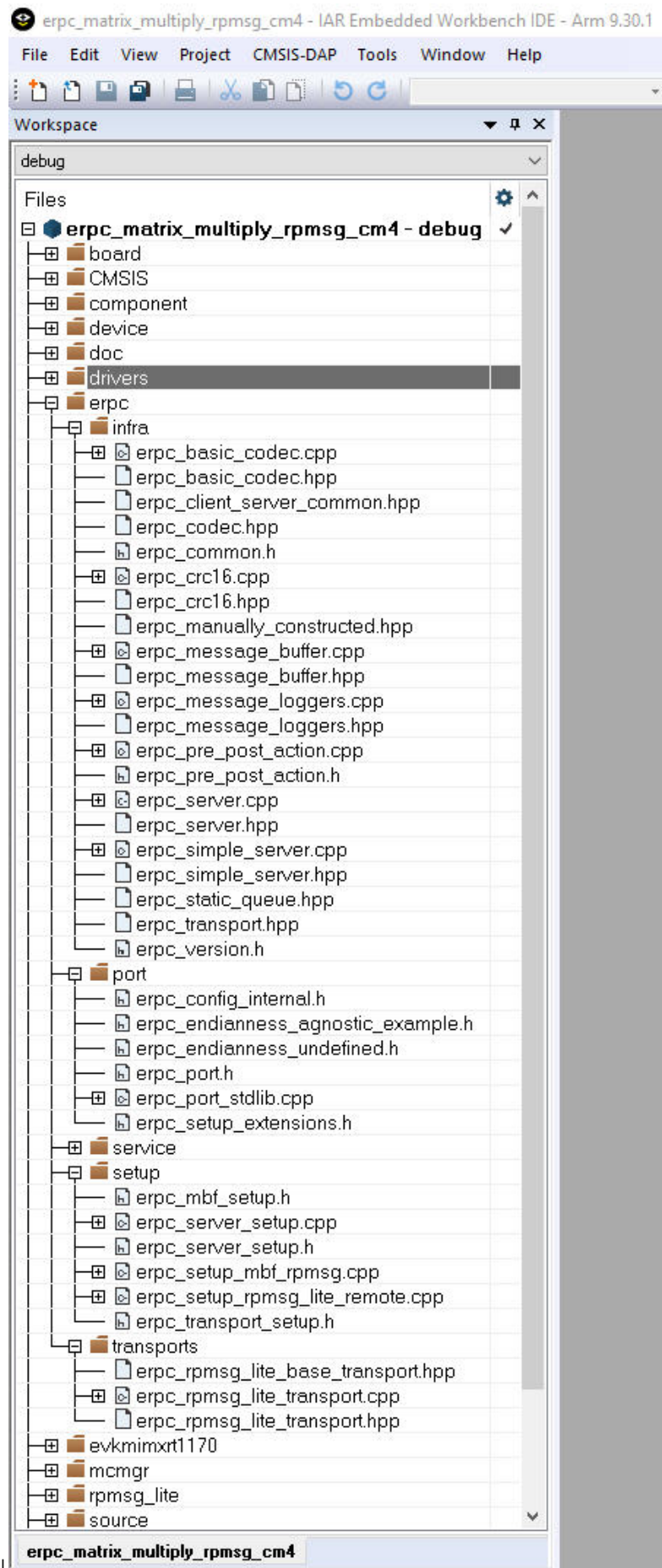
**Parent topic:** Multicore server application

**Server infrastructure files** The eRPC infrastructure files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c`

The **erpc\_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.
  - Four files, `erpc_server.hpp`, `erpc_server.cpp`, `erpc_simple_server.hpp`, and `erpc_simple_server.cpp`, are used for running the eRPC server on the server-side applications. The simple server is currently the only implementation of the server, and its role is to catch client requests, identify and call requested functions, and send data back when requested.
  - Three files (`erpc_codec.hpp`, `erpc_basic_codec.hpp`, and `erpc_basic_codec.cpp`) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
  - The `erpc_common.hpp` file is used for common eRPC definitions, typedefs, and enums.
  - The `erpc_manually_constructed.hpp` file is used for allocating static storage for the used objects.
  - Message buffer files are used for storing serialized data: `erpc_message_buffer.h` and `erpc_message_buffer.cpp`.
  - The `erpc_transport.h` file defines the abstract interface for transport layer.
- The **port** subfolder contains the eRPC porting layer to adapt to different environments.
  - `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
  - `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
  - `erpc_config_internal.h` internal erpc configuration file.
- The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.
  - The `erpc_server_setup.h` and `erpc_server_setup.cpp` files need to be added into the “Matrix multiply” example project to demonstrate the use of C-wrapped functions in this example.
  - The `erpc_transport_setup.h` and `erpc_setup_rpmsg_lite_remote.cpp` files need to be added into the project in order to allow the C-wrapped function for transport layer setup.
  - The `erpc_mbf_setup.h` and `erpc_setup_mbf_rpmsg.cpp` files need to be added into the project in order to allow message buffer factory usage.
- The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions in the setup folder.
  - RPMsg-Lite is used as the transport layer for the communication between cores, `erpc_rpmsg_lite_base_transport.hpp`, `erpc_rpmsg_lite_transport.hpp`, and `erpc_rpmsg_lite_transport.cpp` files need to be added into the server project.



|

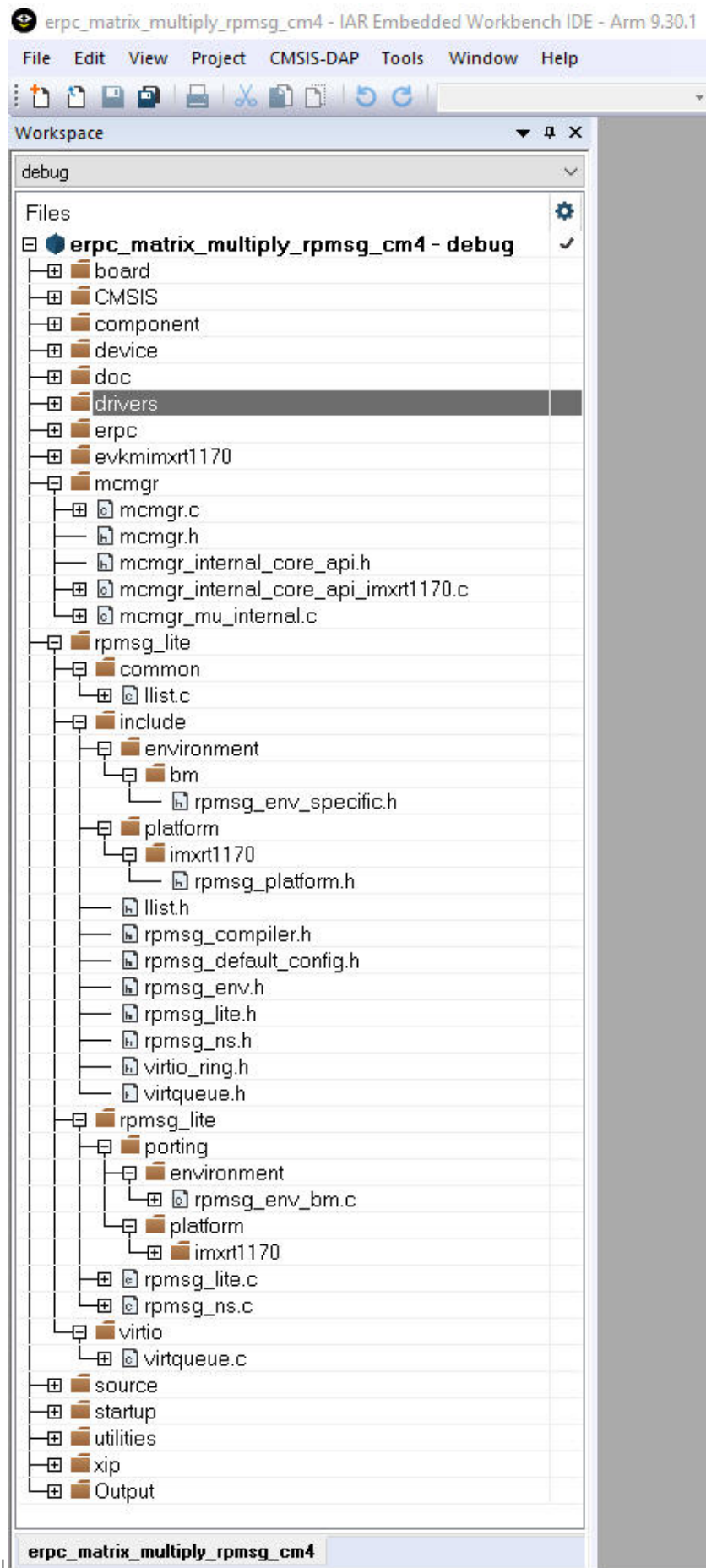
**Parent topic:**Multicore server application

**Server multicore infrastructure files** Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/rpmsg_lite/`

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/`





|

**Parent topic:** Multicore server application

**Server user code** The server's user code is stored in the `main_core1.c` file, located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4`

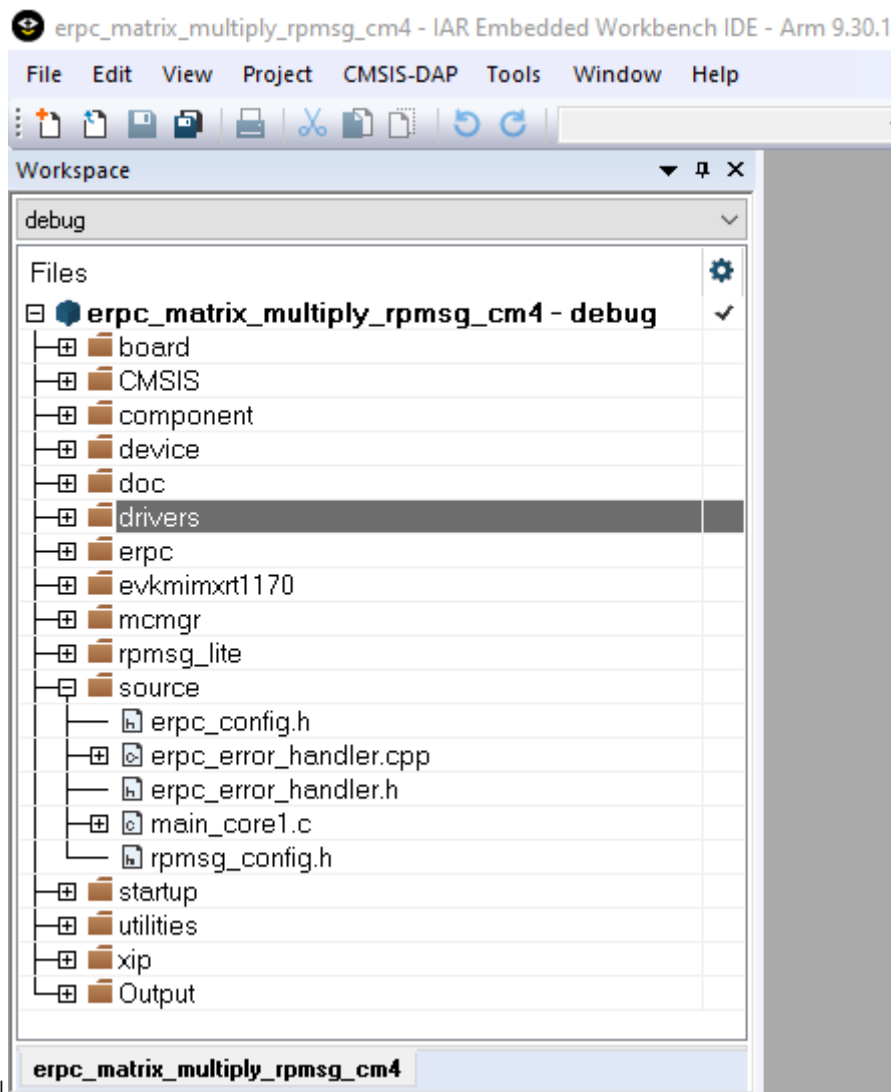
The `main_core1.c` file contains two functions:

- The **main()** function contains the code for the target board and eRPC server initialization. After the initialization, the matrix multiply service is added and the eRPC server waits for client's requests in the while loop.
- The **erpcMatrixMultiply()** function is the user implementation of the eRPC function defined in the IDL file.
- There is the possibility to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in the `erpc_error_handler.h` and `erpc_error_handler.cpp` files.

The eRPC-relevant code is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(const Matrix *matrix1, const Matrix *matrix2, Matrix *result_matrix)
{
 ...
}
int main()
{
 ...
 /* RPSMsg-Lite transport layer initialization */
 erpc_transport_t transport;
 transport = erpc_transport_rpmsg_lite_remote_init(src, dst, (void*)startupData,
 ERPC_TRANSPORT_RPMSG_LITE_LINK_ID, SignalReady, NULL);
 ...
 /* MessageBufferFactory initialization */
 erpc_mbf_t message_buffer_factory;
 message_buffer_factory = erpc_mbf_rpmsg_init(transport);
 ...
 /* eRPC server side initialization */
 erpc_server_t server;
 server = erpc_server_init(transport, message_buffer_factory);
 ...
 /* Adding the service to the server */
 erpc_service_t service = create_MatrixMultiplyService_service();
 erpc_add_service_to_server(server, service);
 ...
 while (1)
 {
 /* Process eRPC requests */
 erpc_status_t status = erpc_server_poll(server);
 /* handle error status */
 if (status != kErpcStatus_Success)
 {
 /* print error description */
 erpc_error_handler(status, 0);
 ...
 }
 ...
 }
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg\_config.h) and eRPC (erpc\_config.h), located in the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg` folder.



**Parent topic:**Multicore server application

**Parent topic:**[Create an eRPC application](#)

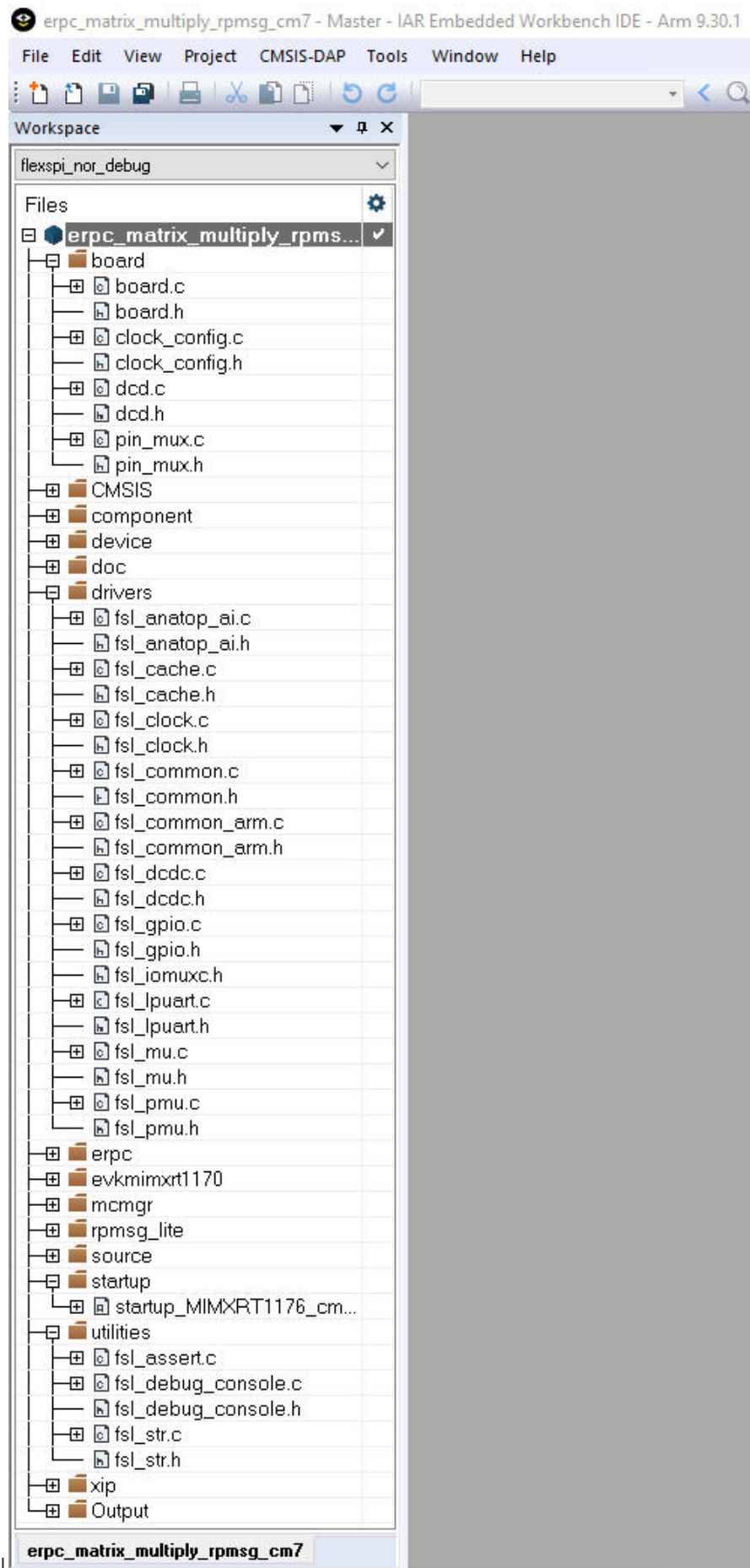
**Multicore client application** The “Matrix multiply” eRPC client project is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm7/iar`

Project files for the eRPC client have the `_cm7` suffix.

**Client project basic source files** The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in the following folders:

- `<MCUXpressoSDK_install_dir>/devices/<device>`
- `<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/`



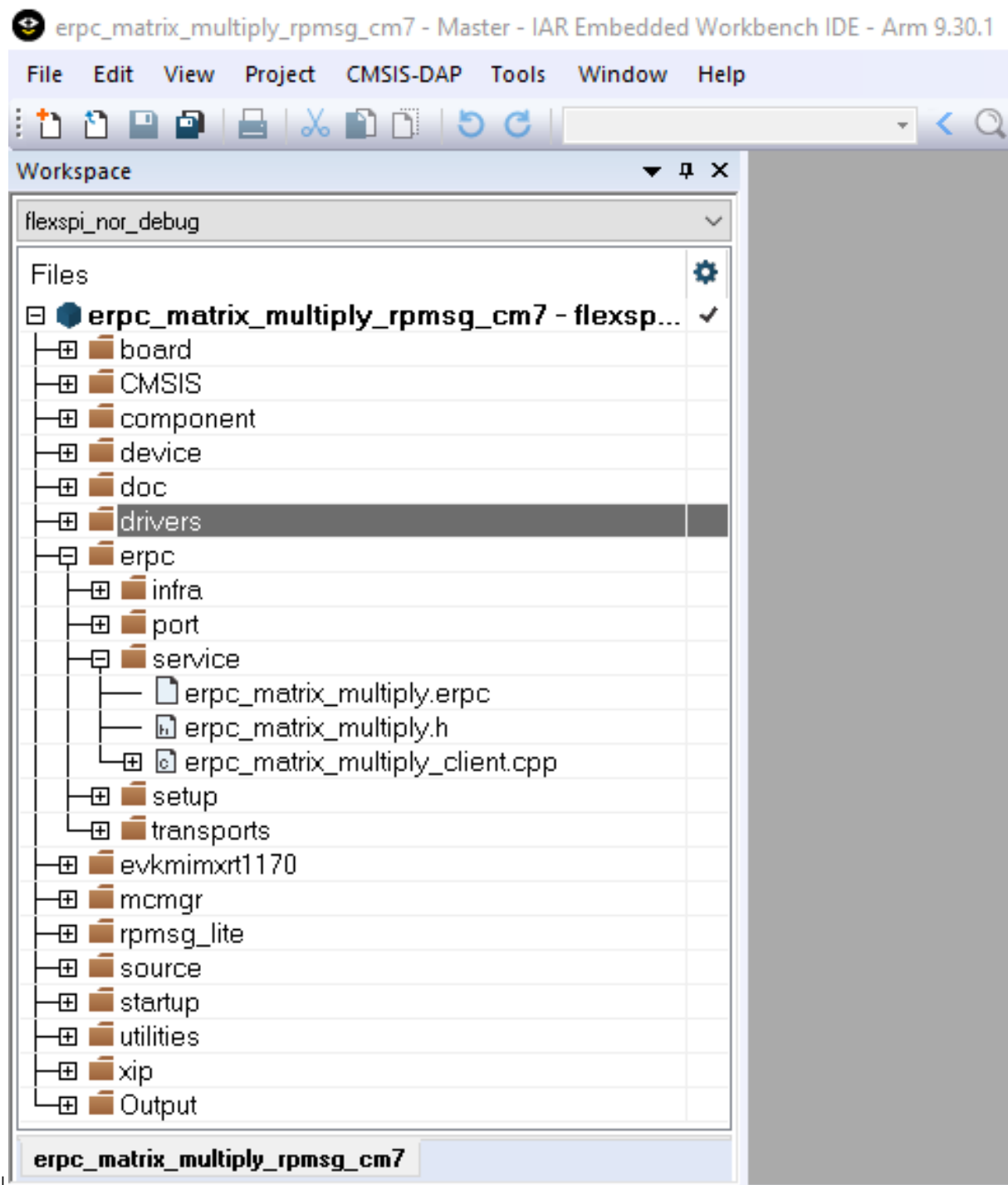
|

**Parent topic:**Multicore client application

**Client-related generated files** The client-related generated files are:

- erpc\_\_matric\_\_multiply.h
- erpc\_\_matrix\_\_multiply\_\_client.cpp

These files contain the shim code for the functions and data types declared in the IDL file. These functions also call methods for codec initialization, data serialization, performing eRPC requests, and de-serializing outputs into expected data structures (if return values are expected). These shim code files can be found in the <MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_examples/erpc\_common/erpc\_matrix\_multiply/service/ folder.



**Parent topic:**Multicore client application

**Client infrastructure files** The eRPC infrastructure files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c`

The **erpc\_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.

- Two files, `erpc_client_manager.h` and `erpc_client_manager.cpp`, are used for managing the client-side application. The main purpose of the client files is to create, perform, and release eRPC requests.
- Three files (`erpc_codec.hpp`, `erpc_basic_codec.hpp`, and `erpc_basic_codec.cpp`) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
- `erpc_common.h` file is used for common eRPC definitions, typedefs, and enums.
- `erpc_manually_constructed.hpp` file is used for allocating static storage for the used objects.
- Message buffer files are used for storing serialized data: `erpc_message_buffer.hpp` and `erpc_message_buffer.cpp`.
- `erpc_transport.hpp` file defines the abstract interface for transport layer.

The **port** subfolder contains the eRPC porting layer to adapt to different environments.

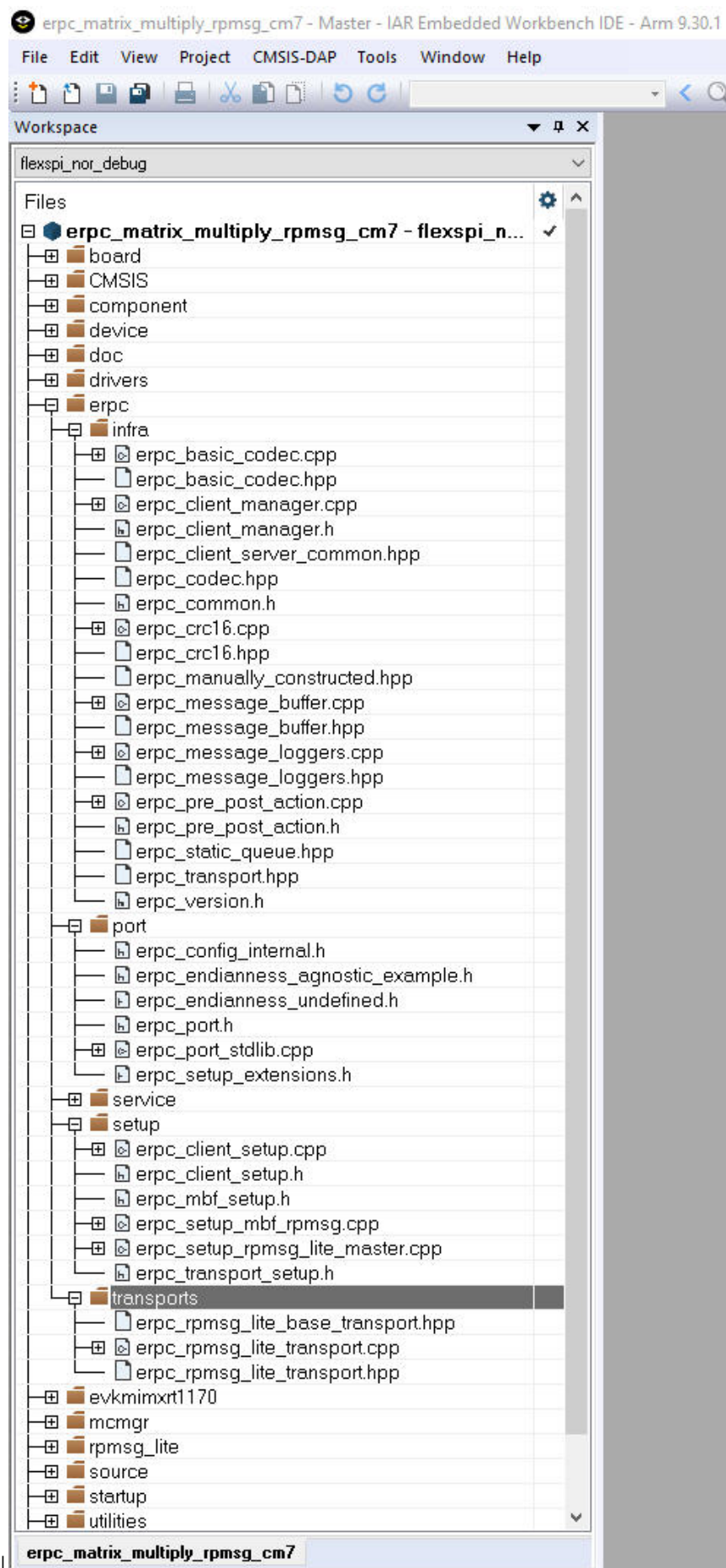
- `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
- `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
- `erpc_config_internal.h` internal eRPC configuration file.

The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.

- `erpc_client_setup.h` and `erpc_client_setup.cpp` files needs to be added into the “Matrix multiply” example project to demonstrate the use of C-wrapped functions in this example.
- `erpc_transport_setup.h` and `erpc_setup_rpmsg_lite_master.cpp` files needs to be added into the project in order to allow C-wrapped function for transport layer setup.
- `erpc_mbf_setup.h` and `erpc_setup_mbf_rpmsg.cpp` files needs to be added into the project in order to allow message buffer factory usage.

The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions, in the setup folder.

- RPMsg-Lite is used as the transport layer for the communication between cores, `erpc_rpmsg_lite_base_transport.hpp`, `erpc_rpmsg_lite_transport.hpp`, and `erpc_rpmsg_lite_transport.cpp` files needs to be added into the client project.



|

**Parent topic:** Multicore client application

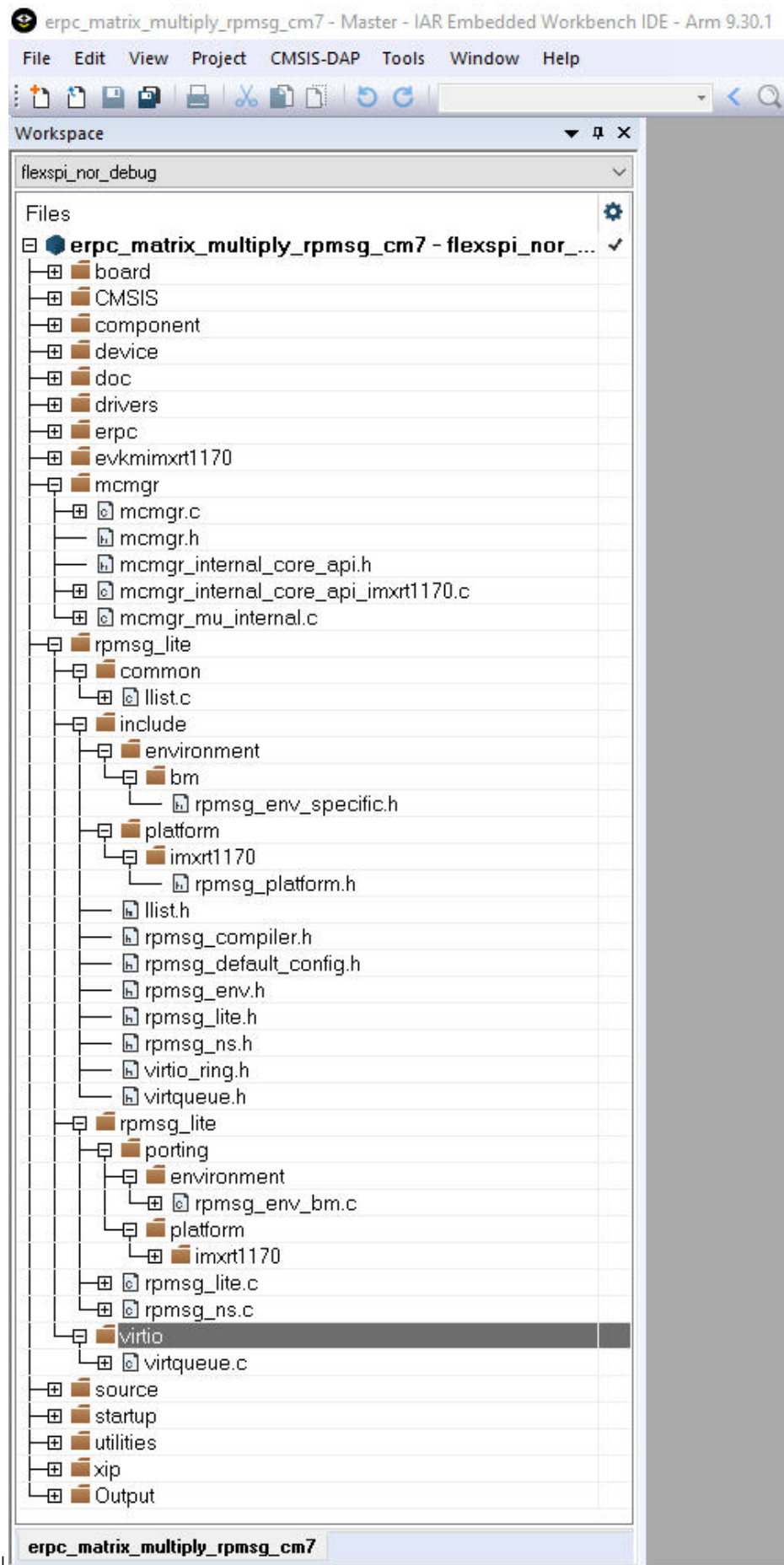
**Client multicore infrastructure files** Because of the RPMsg-Lite (transport layer), it is also necessary to include RPMsg-Lite related files, which are in the following folder:

*<MCUXpressoSDK\_install\_dir>/middleware/multicore/rpmsg\_lite/*

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

*<MCUXpressoSDK\_install\_dir>/middleware/multicore/mcmgr/*





**Parent topic:**Multicore client application

**Client user code** The client's user code is stored in the main\_core0.c file, located in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_example/erpc\_matrix\_multiply\_rpmsg/cm7

The main\_core0.c file contains the code for target board and eRPC initialization.

- After initialization, the secondary core is released from reset.
- When the secondary core is ready, the primary core initializes two matrix variables.
- The erpcMatrixMultiply eRPC function is called to issue the eRPC request and get the result.

It is possible to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in erpc\_error\_handler.h and erpc\_error\_handler.cpp files.

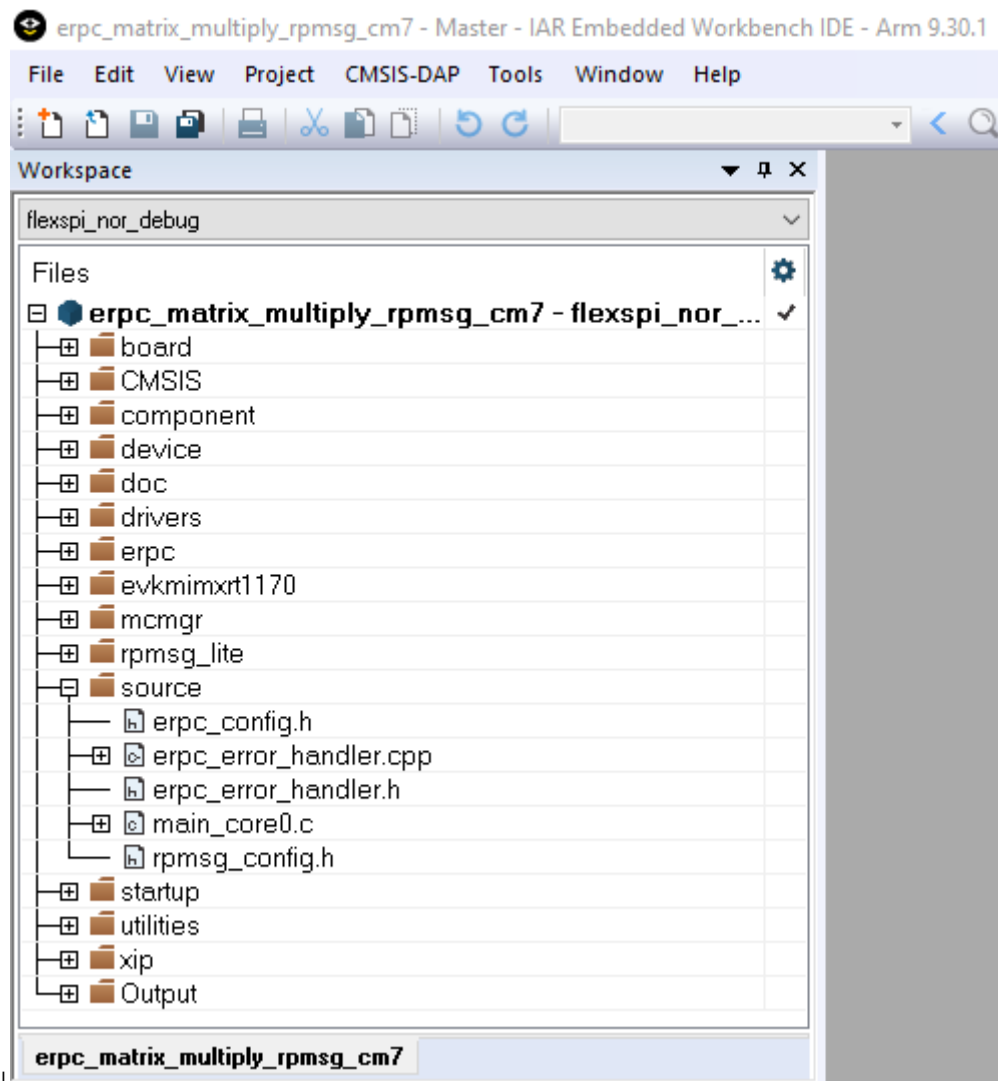
The matrix multiplication can be issued repeatedly, when pressing a software board button.

The eRPC-relevant code is captured in the following code snippet:

```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* RPMsg-Lite transport layer initialization */
erpc_transport_t transport;
transport = erpc_transport_rpmsg_lite_master_init(src, dst,
ERPC_TRANSPORT_RPMSG_LITE_LINK_ID);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_rpmsg_init(transport);
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport, message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
 /* Invoke the erpcMatrixMultiply function */
 erpcMatrixMultiply(matrix1, matrix2, result_matrix);
 ...
 /* Check if some error occurred in eRPC */
 if (g_erpc_error_occurred)
 {
 /* Exit program loop */
 break;
 }
 ...
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg\_config.h) and eRPC (erpc\_config.h), located in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_examples/erpc\_matrix\_multiply\_rpmsg



Parent topic: Multicore client application

Parent topic: [Create an eRPC application](#)

**Multiprocessor server application** The “Matrix multiply” eRPC server project for multiprocessor applications is located in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>` folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires server-related generated files (server shim code), server infrastructure files, and the server user code. There is no need for server multicore infrastructure files (MCMGR and RPMs-Lite). The RPMs-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|      |                                                                         |
|------|-------------------------------------------------------------------------|
| SPI  | <eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_slave.cpp          |
|      | <eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.hpp |
|      | <eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.cpp |
| UART | <eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp            |

<eRPC base directory>/erpc\_c/transport/erpc\_uart\_cmsis\_transport.hpp

<eRPC base directory>/erpc\_c/transport/erpc\_uart\_cmsis\_transport.cpp

|

**Server user code** The server's user code is stored in the main\_server.c file, located in the <MCUXpressoSDK\_install\_dir>/boards/<board\_name>/multiprocessor\_examples/erpc\_server\_matrix\_multiply\_<transport\_layer>/ folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(Matrix matrix1, Matrix matrix2, Matrix result_matrix)
{
 ...
}
int main()
{
 ...
 /* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
 ↪operations */
 erpc_transport_t transport;
 transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
 ...
 /* MessageBufferFactory initialization */
 erpc_mbf_t message_buffer_factory;
 message_buffer_factory = erpc_mbf_dynamic_init();
 ...
 /* eRPC server side initialization */
 erpc_server_t server;
 server = erpc_server_init(transport, message_buffer_factory);
 ...
 /* Adding the service to the server */
 erpc_service_t service = create_MatrixMultiplyService_service();
 erpc_add_service_to_server(server, service);
 ...
 while (1)
 {
 /* Process eRPC requests */
 erpc_status_t status = erpc_server_poll(server)
 /* handle error status */
 if (status != kErpcStatus_Success)
 {
 /* print error description */
 erpc_error_handler(status, 0);
 ...
 }
 ...
 }
}
```

**Parent topic:**Multiprocessor server application

**Multiprocessor client application** The “Matrix multiply” eRPC client project for multiprocessor applications is located in the <MCUXpressoSDK\_install\_dir>/boards/<board\_name>/multiprocessor\_examples/erpc\_client\_matrix\_multiply\_<transport\_layer>/iar/ folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires client-related generated files (server shim code),

client infrastructure files, and the client user code. There is no need for client multicore infrastructure files (MCMGR and RPSMsg-Lite). The RPSMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|                               |                                                                 |
|-------------------------------|-----------------------------------------------------------------|
| SPI                           | <eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_master.cpp |
| <eRPC base directory>/erpc_c/ | transports/ erpc_(d)spi_master_transport.hpp                    |
| <eRPC base directory>/erpc_c/ | transports/ erpc_(d)spi_master_transport.cpp                    |
| UART                          | <eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp    |
| <eRPC base directory>/erpc_c/ | transports/erpc_uart_cmsis_transport.hpp                        |
| <eRPC base directory>/erpc_c/ | transports/erpc_uart_cmsis_transport.cpp                        |
|                               |                                                                 |

**Client user code** The client's user code is stored in the `main_client.c` file, located in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/` folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

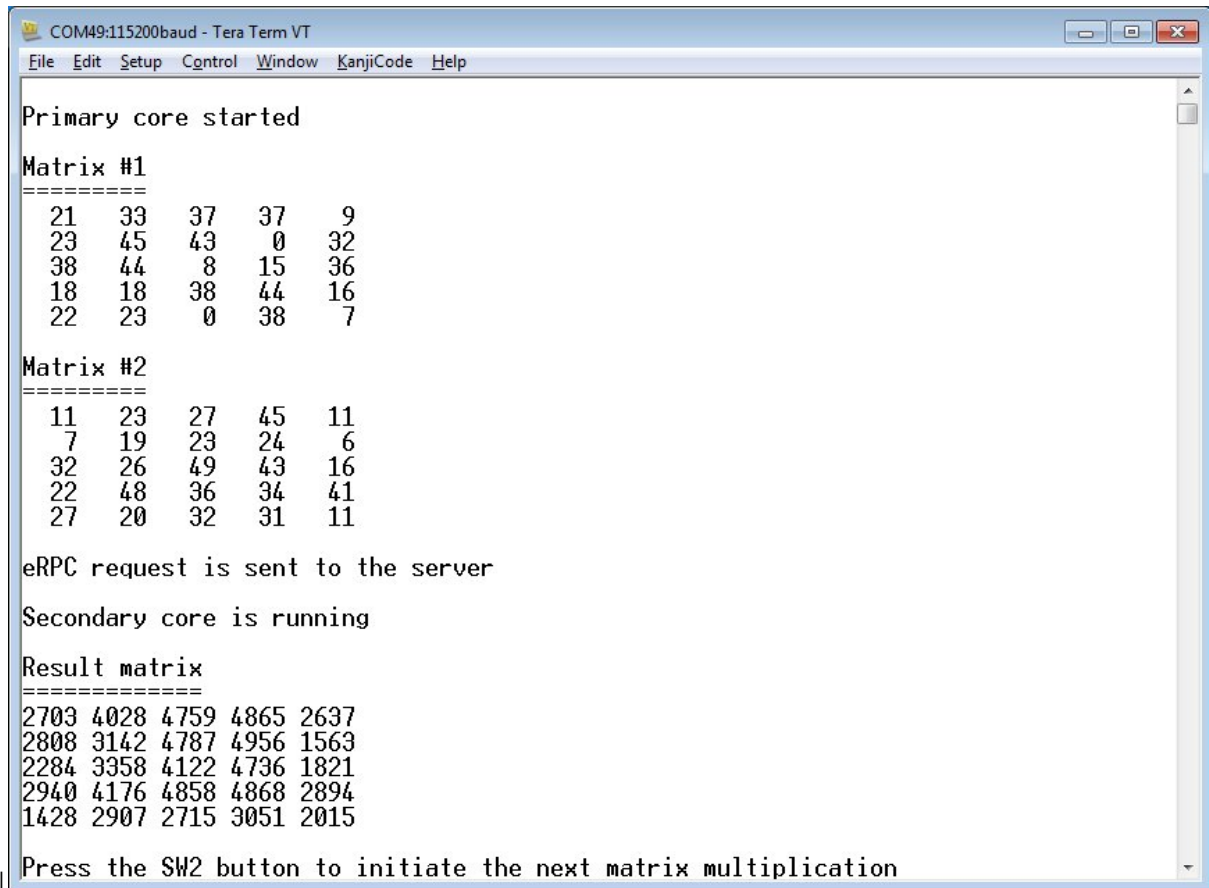
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
↳operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_dynamic_init();
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport,message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
 /* Invoke the erpcMatrixMultiply function */
 erpcMatrixMultiply(matrix1, matrix2, result_matrix);
 ...
 /* Check if some error occurred in eRPC */
 if (g_erpc_error_occurred)
 {
 /* Exit program loop */
 break;
 }
 ...
}
```

**Parent topic:**Multiprocessor client application

**Parent topic:**Multiprocessor server application

Parent topic:[Create an eRPC application](#)

**Running the eRPC application** Follow the instructions in *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) (located in the <MCUXpressoSDK\_install\_dir>/docs folder), to load both the primary and the secondary core images into the on-chip memory, and then effectively debug the dual-core application. After the application is running, the serial console should look like:



```

COM49:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

Primary core started

Matrix #1
=====
 21 33 37 37 9
 23 45 43 0 32
 38 44 8 15 36
 18 18 38 44 16
 22 23 0 38 7

Matrix #2
=====
 11 23 27 45 11
 7 19 23 24 6
 32 26 49 43 16
 22 48 36 34 41
 27 20 32 31 11

eRPC request is sent to the server

Secondary core is running

Result matrix
=====
2703 4028 4759 4865 2637
2808 3142 4787 4956 1563
2284 3358 4122 4736 1821
2940 4176 4858 4868 2894
1428 2907 2715 3051 2015

Press the SW2 button to initiate the next matrix multiplication

```

For multiprocessor applications that are running between PC and the target evaluation board or between two boards, follow the instructions in the accompanied example readme files that provide details about the proper board setup and the PC side setup (Python).

Parent topic:[Create an eRPC application](#)

Parent topic:[eRPC example](#)

**eRPC example** This section shows how to create an example eRPC application called “Matrix multiply”, which implements one eRPC function (matrix multiply) with two function parameters (two matrices). The client-side application calls this eRPC function, and the server side performs the multiplication of received matrices. The server side then returns the result.

For example, use the NXP MIMXRT1170-EVK board as the target dual-core platform, and the IAR Embedded Workbench for ARM (EWARM) as the target IDE for developing the eRPC example.

- The primary core (CM7) runs the eRPC client.
- The secondary core (CM4) runs the eRPC server.
- RPMsg-Lite (Remote Processor Messaging Lite) is used as the eRPC transport layer.

The “Matrix multiply” application can be also run in the multi-processor setup. In other words, the eRPC client running on one SoC communicates with the eRPC server that runs on another SoC, utilizing different transport channels. It is possible to run the board-to-PC example (PC as the eRPC server and a board as the eRPC client, and vice versa) and also the board-to-board example. These multiprocessor examples are prepared for selected boards only.

| Multicore application source and project files | `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore/`  
| Multiprocessor application source and project files | `<MCUXpressoSDK_install_dir>/boards/<board_name>/multi`  
`<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<tr`  
| | eRPC source files | `<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/` | | RPLite  
source files | `<MCUXpressoSDK_install_dir>/middleware/multicore/rplite/`

**Designing the eRPC application** The matrix multiply application is based on calling single eRPC function that takes 2 two-dimensional arrays as input and returns matrix multiplication results as another 2 two-dimensional array. The IDL file syntax supports arrays with the dimension length set by the number only (in the current eRPC implementation). Because of this, a variable is declared in the IDL dedicated to store information about matrix dimension length, and to allow easy maintenance of the user and server code.

For a simple use of the two-dimensional array, the alias name (new type definition) for this data type has been declared in the IDL. Declaring this alias name ensures that the same data type can be used across the client and server applications.

**Parent topic:** [eRPC example](#)

**Creating the IDL file** The created IDL file is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/`

The created IDL file contains the following code:

```
program erpc_matrix_multiply
/*! This const defines the matrix size. The value has to be the same as the
Matrix array dimension. Do not forget to re-generate the erpc code once the
matrix size is changed in the erpc file */
const int32 matrix_size = 5;
/*! This is the matrix array type. The dimension has to be the same as the
matrix size const. Do not forget to re-generate the erpc code once the
matrix size is changed in the erpc file */
type Matrix = int32[matrix_size][matrix_size];
interface MatrixMultiplyService {
erpcMatrixMultiply(in Matrix matrix1, in Matrix matrix2, out Matrix result_matrix) ->
void
}
```

Details:

- The IDL file starts with the program name (*erpc\_matrix\_multiply*), and this program name is used in the naming of all generated outputs.
- The declaration and definition of the constant variable named *matrix\_size* follows next. The *matrix\_size* variable is used for passing information about the length of matrix dimensions to the client/server user code.
- The alias name for the two-dimensional array type (*Matrix*) is declared.
- The interface group *MatrixMultiplyService* is located at the end of the IDL file. This interface group contains only one function declaration *erpcMatrixMultiply*.
- As shown above, the function’s declaration contains three parameters of *Matrix* type: *matrix1* and *matrix2* are input parameters, while *result\_matrix* is the output parameter. Additionally, the returned data type is declared as *void*.



When writing the IDL file, the following order of items is recommended:

1. Program name at the top of the IDL file.
2. New data types and constants declarations.
3. Declarations of interfaces and functions at the end of the IDL file.

**Parent topic:** [eRPC example](#)

**Using the eRPC generator tool** | Windows OS | `<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x64`  
 | Linux OS | `<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x86`  
 | Mac OS | `<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Mac`

The files for the “Matrix multiply” example are pre-generated and already a part of the application projects. The following section describes how they have been created.

- The easiest way to create the shim code is to copy the erpcgen application to the same folder where the IDL file (\*.erpc) is located; then run the following command:

```
erpcgen <IDL_file>.erpc
```

- In the “Matrix multiply” example, the command should look like:

```
erpcgen erpc_matrix_multiply.erpc
```

Additionally, another method to create the shim code is to execute the eRPC application using input commands:

- “-?”/”—help” – Shows supported commands.
- “-o <filePath>”/”—output<filePath>” – Sets the output directory.

For example,

```
<path_to_erpcgen>/erpcgen -o <path_to_output>
<path_to_IDL>/<IDL_file_name>.erpc
```

For the “Matrix multiply” example, when the command is executed from the default erpcgen location, it looks like:

```
erpcgen -o
../../../../../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service
../../../../../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/erpc_matrix_mu
```

In both cases, the following four files are generated into the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service` folder:

- erpc\_matrix\_multiply.h
- erpc\_matrix\_multiply\_client.cpp
- erpc\_matrix\_multiply\_server.h
- erpc\_matrix\_multiply\_server.cpp

For multiprocessor examples, the eRPC file and pre-generated files can be found in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_common/erpc_matrix_multiply/service` folder.

**For Linux OS users:**

- Do not forget to set the permissions for the eRPC generator application.
- Run the application as `./erpcgen...` instead of as `erpcgen ....`



Parent topic: [eRPC example](#)

**Create an eRPC application** This section describes a generic way to create a client/server eRPC application:

1. **Design the eRPC application:** Decide which data types are sent between applications, and define functions that send/receive this data.
2. **Create the IDL file:** The IDL file contains information about data types and functions used in an eRPC application, and is written in the IDL language.
3. **Use the eRPC generator tool:** This tool takes an IDL file and generates the shim code for the client and the server-side applications.
4. **Create an eRPC application:**
  1. Create two projects, where one project is for the client side (primary core) and the other project is for the server side (secondary core).
  2. Add generated files for the client application to the client project, and add generated files for the server application to the server project.
  3. Add infrastructure files.
  4. Add user code for client and server applications.
  5. Set the client and server project options.
5. **Run the eRPC application:** Run both the server and the client applications. Make sure that the server has been run before the client request was sent.

A specific example follows in the next section.

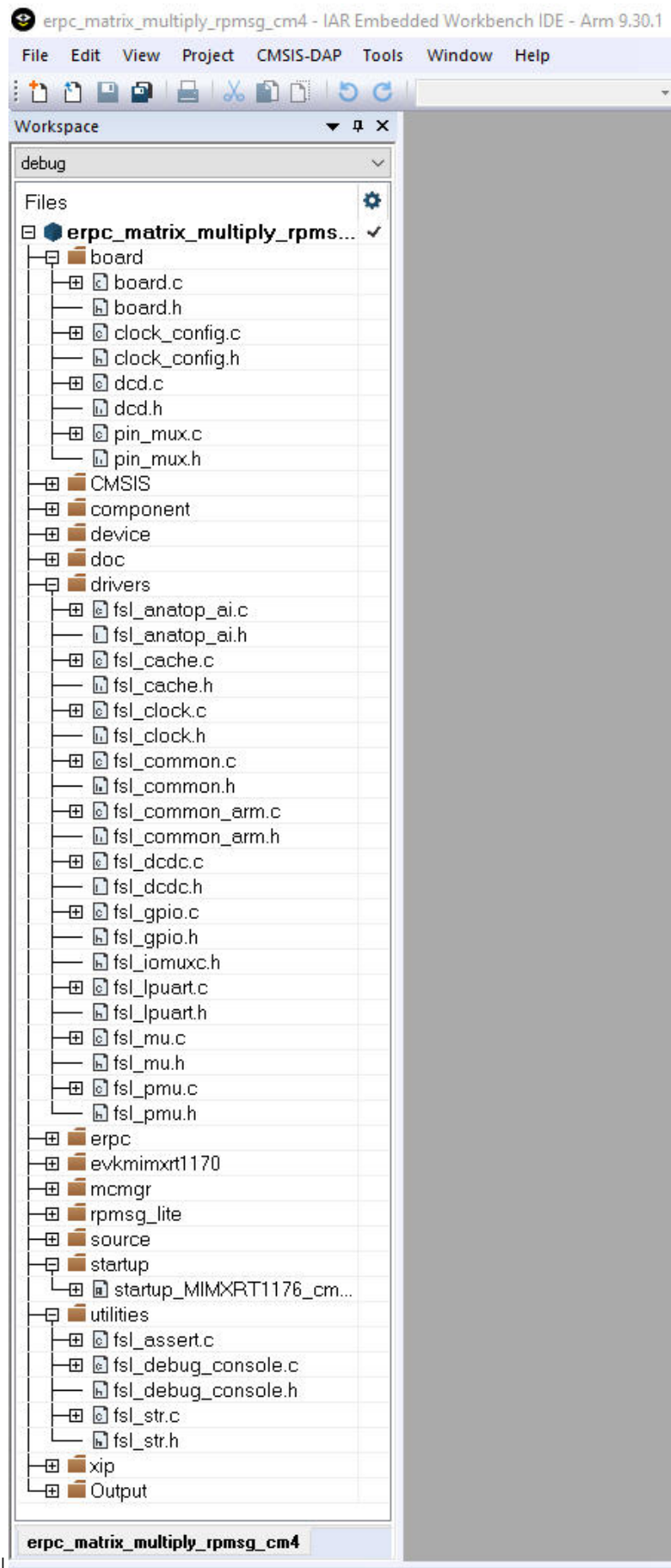
**Multicore server application** The “Matrix multiply” eRPC server project is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmmsg/cm4/iar/`

The project files for the eRPC server have the `_cm4` suffix.

**Server project basic source files** The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in:

- `<MCUXpressoSDK_install_dir>/devices/<device>`
- `<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/`



|

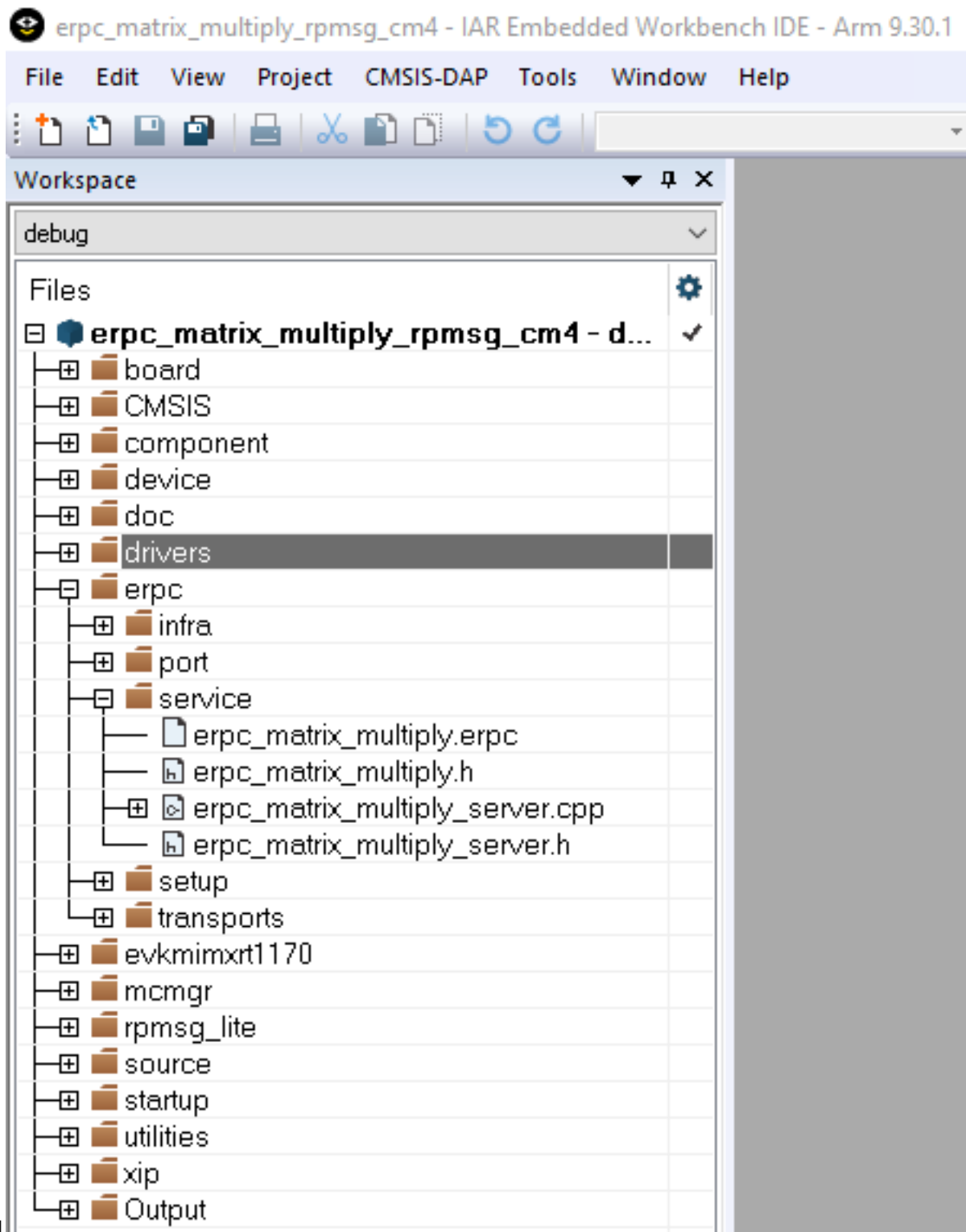
**Parent topic:**Multicore server application

**Server related generated files** The server-related generated files are:

- erpc\_\_matric\_\_multiply.h
- erpc\_\_matrix\_\_multiply\_\_server.h
- erpc\_\_matrix\_\_multiply\_\_server.cpp

The server-related generated files contain the shim code for functions and data types declared in the IDL file. These files also contain functions for the identification of client requested functions, data deserialization, calling requested function's implementations, and data serialization and return, if requested by the client. These shim code files can be found in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_examples/erpc\_common/erpc\_matrix\_multiply/



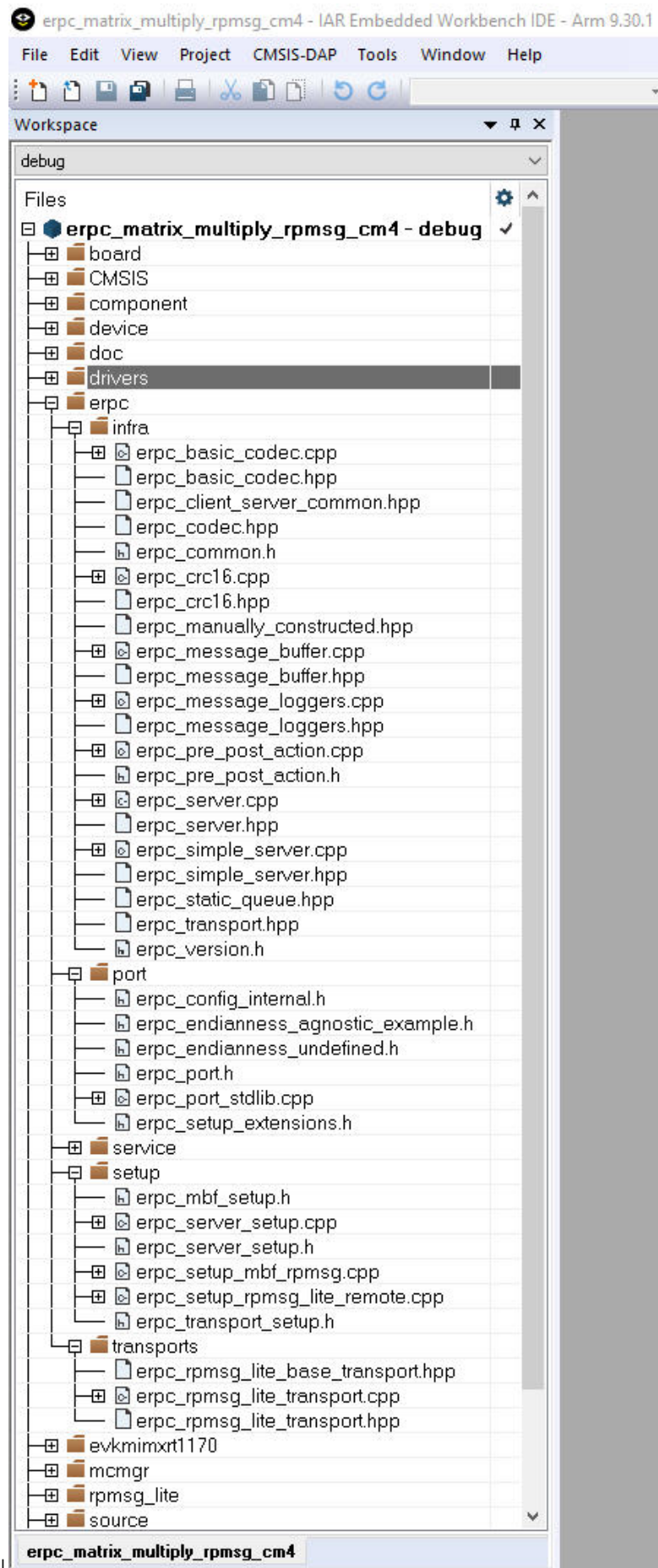
**Parent topic:** Multicore server application

**Server infrastructure files** The eRPC infrastructure files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c`

The **erpc\_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.
  - Four files, `erpc_server.hpp`, `erpc_server.cpp`, `erpc_simple_server.hpp`, and `erpc_simple_server.cpp`, are used for running the eRPC server on the server-side applications. The simple server is currently the only implementation of the server, and its role is to catch client requests, identify and call requested functions, and send data back when requested.
  - Three files (`erpc_codec.hpp`, `erpc_basic_codec.hpp`, and `erpc_basic_codec.cpp`) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
  - The `erpc_common.hpp` file is used for common eRPC definitions, typedefs, and enums.
  - The `erpc_manually_constructed.hpp` file is used for allocating static storage for the used objects.
  - Message buffer files are used for storing serialized data: `erpc_message_buffer.h` and `erpc_message_buffer.cpp`.
  - The `erpc_transport.h` file defines the abstract interface for transport layer.
- The **port** subfolder contains the eRPC porting layer to adapt to different environments.
  - `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
  - `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
  - `erpc_config_internal.h` internal erpc configuration file.
- The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.
  - The `erpc_server_setup.h` and `erpc_server_setup.cpp` files need to be added into the “Matrix multiply” example project to demonstrate the use of C-wrapped functions in this example.
  - The `erpc_transport_setup.h` and `erpc_setup_rpmsg_lite_remote.cpp` files need to be added into the project in order to allow the C-wrapped function for transport layer setup.
  - The `erpc_mbf_setup.h` and `erpc_setup_mbf_rpmsg.cpp` files need to be added into the project in order to allow message buffer factory usage.
- The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions in the setup folder.
  - RPMsg-Lite is used as the transport layer for the communication between cores, `erpc_rpmsg_lite_base_transport.hpp`, `erpc_rpmsg_lite_transport.hpp`, and `erpc_rpmsg_lite_transport.cpp` files need to be added into the server project.



|

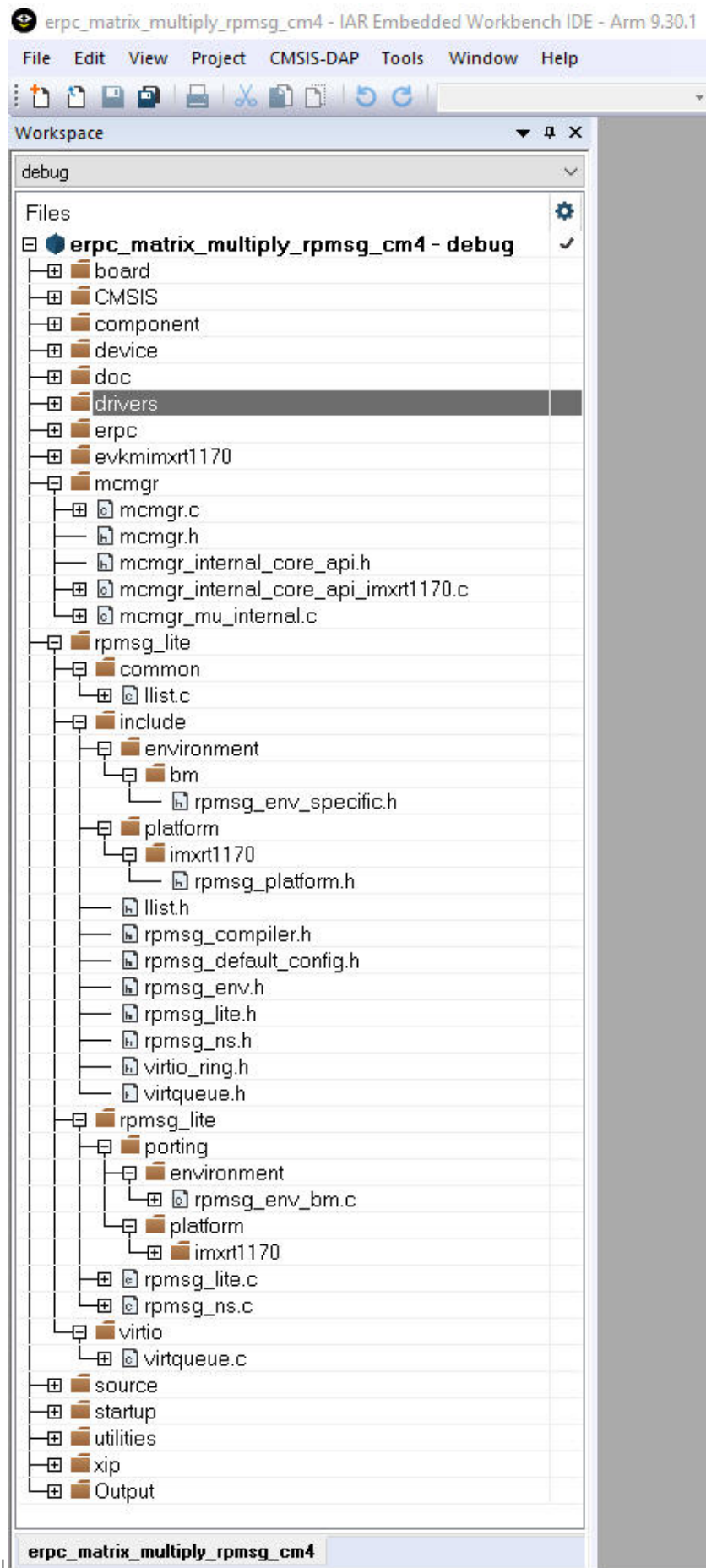
**Parent topic:** Multicore server application

**Server multicore infrastructure files** Because of the RPSMsg-Lite (transport layer), it is also necessary to include RPSMsg-Lite related files, which are in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/rpsmsg_lite/`

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/mcmgr/`





|

**Parent topic:**Multicore server application

**Server user code** The server's user code is stored in the `main_core1.c` file, located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4`

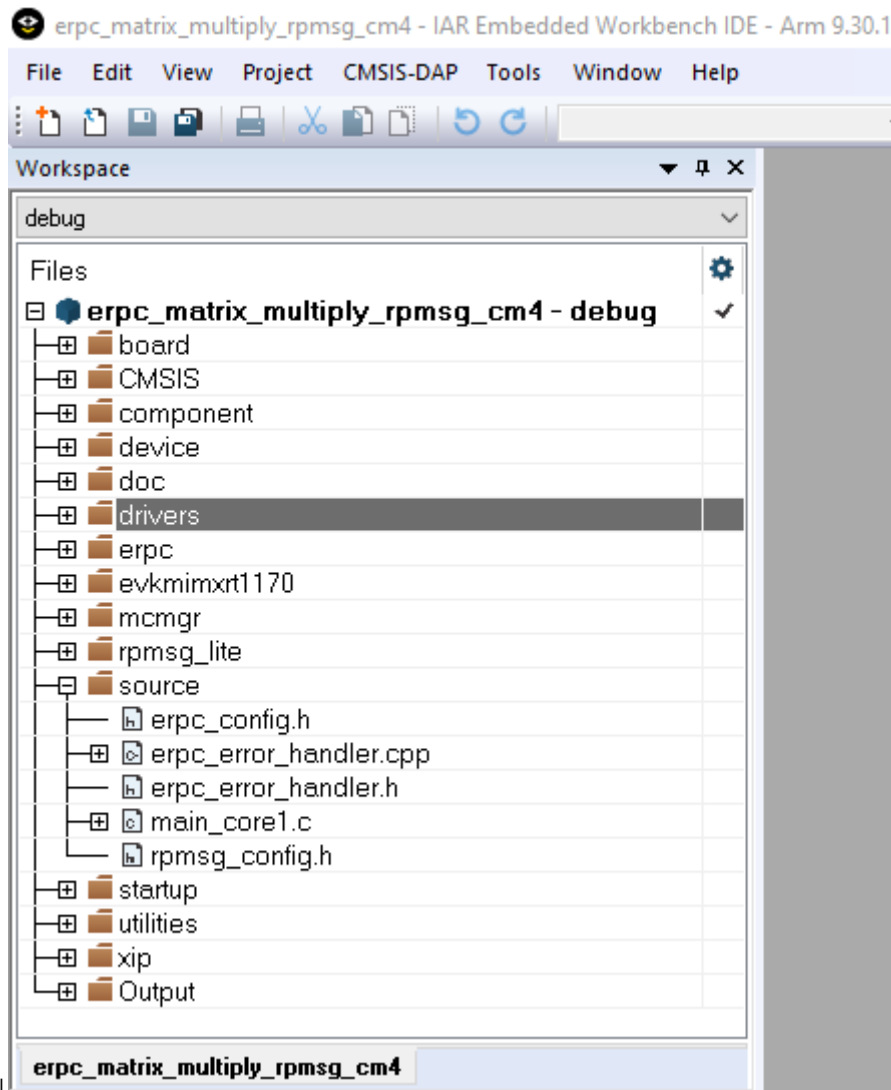
The `main_core1.c` file contains two functions:

- The **main()** function contains the code for the target board and eRPC server initialization. After the initialization, the matrix multiply service is added and the eRPC server waits for client's requests in the while loop.
- The **erpcMatrixMultiply()** function is the user implementation of the eRPC function defined in the IDL file.
- There is the possibility to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in the `erpc_error_handler.h` and `erpc_error_handler.cpp` files.

The eRPC-relevant code is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(const Matrix *matrix1, const Matrix *matrix2, Matrix *result_matrix)
{
 ...
}
int main()
{
 ...
 /* RPSMsg-Lite transport layer initialization */
 erpc_transport_t transport;
 transport = erpc_transport_rpmsg_lite_remote_init(src, dst, (void*)startupData,
 ERPC_TRANSPORT_RPMSG_LITE_LINK_ID, SignalReady, NULL);
 ...
 /* MessageBufferFactory initialization */
 erpc_mbf_t message_buffer_factory;
 message_buffer_factory = erpc_mbf_rpmsg_init(transport);
 ...
 /* eRPC server side initialization */
 erpc_server_t server;
 server = erpc_server_init(transport, message_buffer_factory);
 ...
 /* Adding the service to the server */
 erpc_service_t service = create_MatrixMultiplyService_service();
 erpc_add_service_to_server(server, service);
 ...
 while (1)
 {
 /* Process eRPC requests */
 erpc_status_t status = erpc_server_poll(server);
 /* handle error status */
 if (status != kErpcStatus_Success)
 {
 /* print error description */
 erpc_error_handler(status, 0);
 ...
 }
 ...
 }
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg\_config.h) and eRPC (erpc\_config.h), located in the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg` folder.



**Parent topic:**Multicore server application

**Parent topic:**[Create an eRPC application](#)

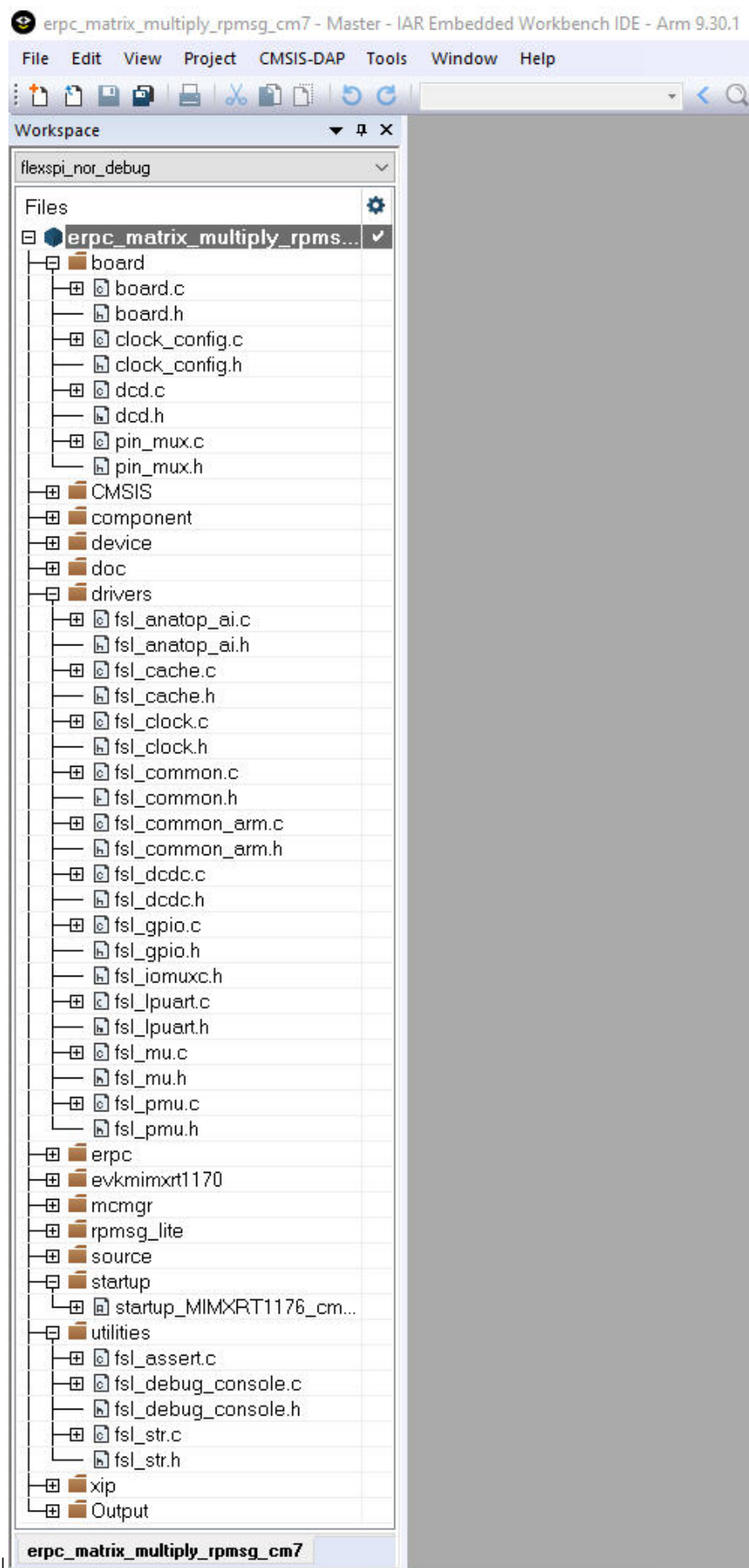
**Multicore client application** The “Matrix multiply” eRPC client project is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm7/iar`

Project files for the eRPC client have the `_cm7` suffix.

**Client project basic source files** The startup files, board-related settings, peripheral drivers, and utilities belong to the basic project source files and form the skeleton of all MCUXpresso SDK applications. These source files are located in the following folders:

- `<MCUXpressoSDK_install_dir>/devices/<device>`
- `<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples/<example_name>/`



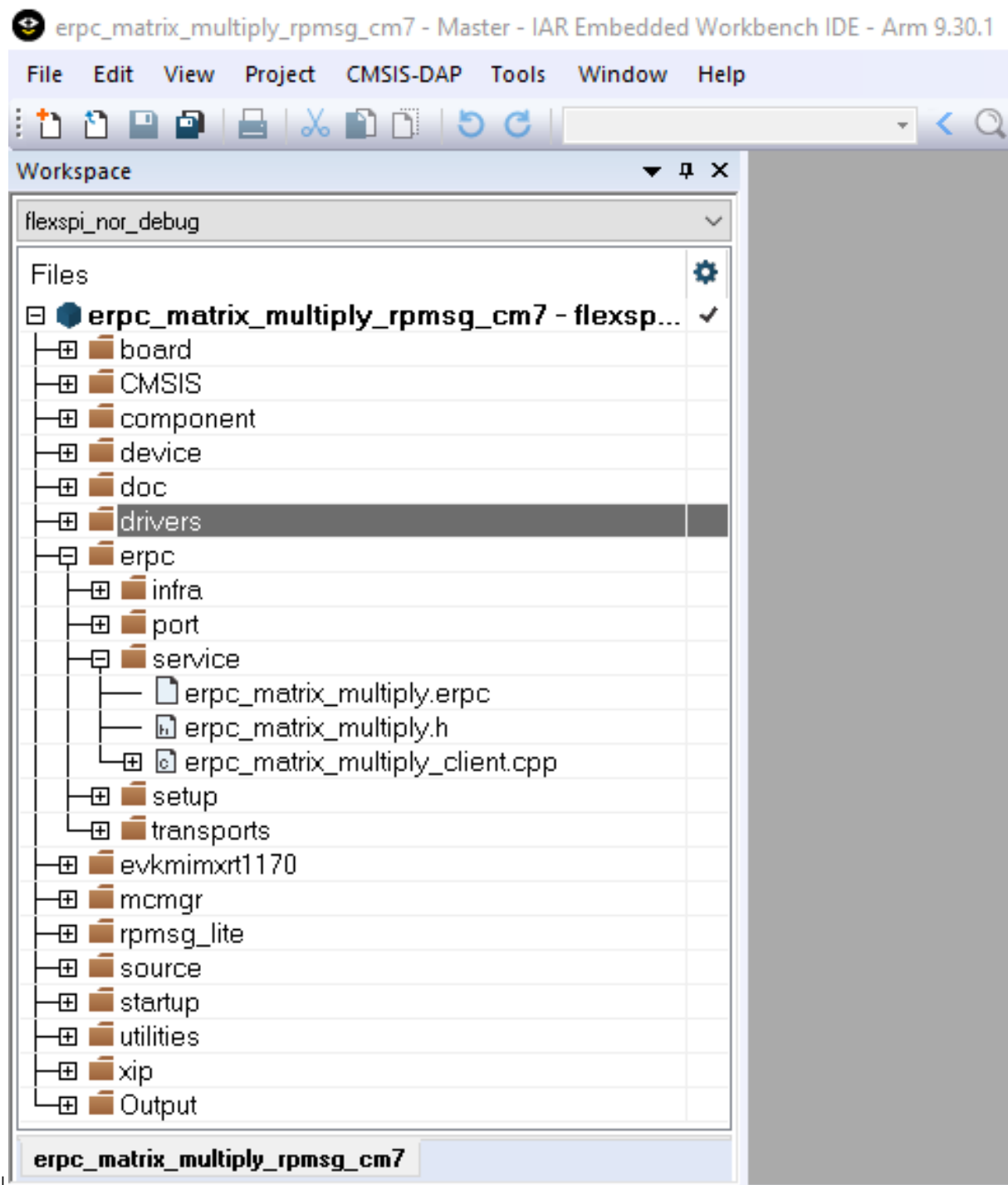
|

**Parent topic:**Multicore client application

**Client-related generated files** The client-related generated files are:

- erpc\_\_matric\_\_multiply.h
- erpc\_\_matrix\_\_multiply\_\_client.cpp

These files contain the shim code for the functions and data types declared in the IDL file. These functions also call methods for codec initialization, data serialization, performing eRPC requests, and de-serializing outputs into expected data structures (if return values are expected). These shim code files can be found in the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/` folder.



**Parent topic:**Multicore client application

**Client infrastructure files** The eRPC infrastructure files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c`

The **erpc\_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.

- Two files, `erpc_client_manager.h` and `erpc_client_manager.cpp`, are used for managing the client-side application. The main purpose of the client files is to create, perform, and release eRPC requests.
- Three files (`erpc_codec.hpp`, `erpc_basic_codec.hpp`, and `erpc_basic_codec.cpp`) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
- `erpc_common.h` file is used for common eRPC definitions, typedefs, and enums.
- `erpc_manually_constructed.hpp` file is used for allocating static storage for the used objects.
- Message buffer files are used for storing serialized data: `erpc_message_buffer.hpp` and `erpc_message_buffer.cpp`.
- `erpc_transport.hpp` file defines the abstract interface for transport layer.

The **port** subfolder contains the eRPC porting layer to adapt to different environments.

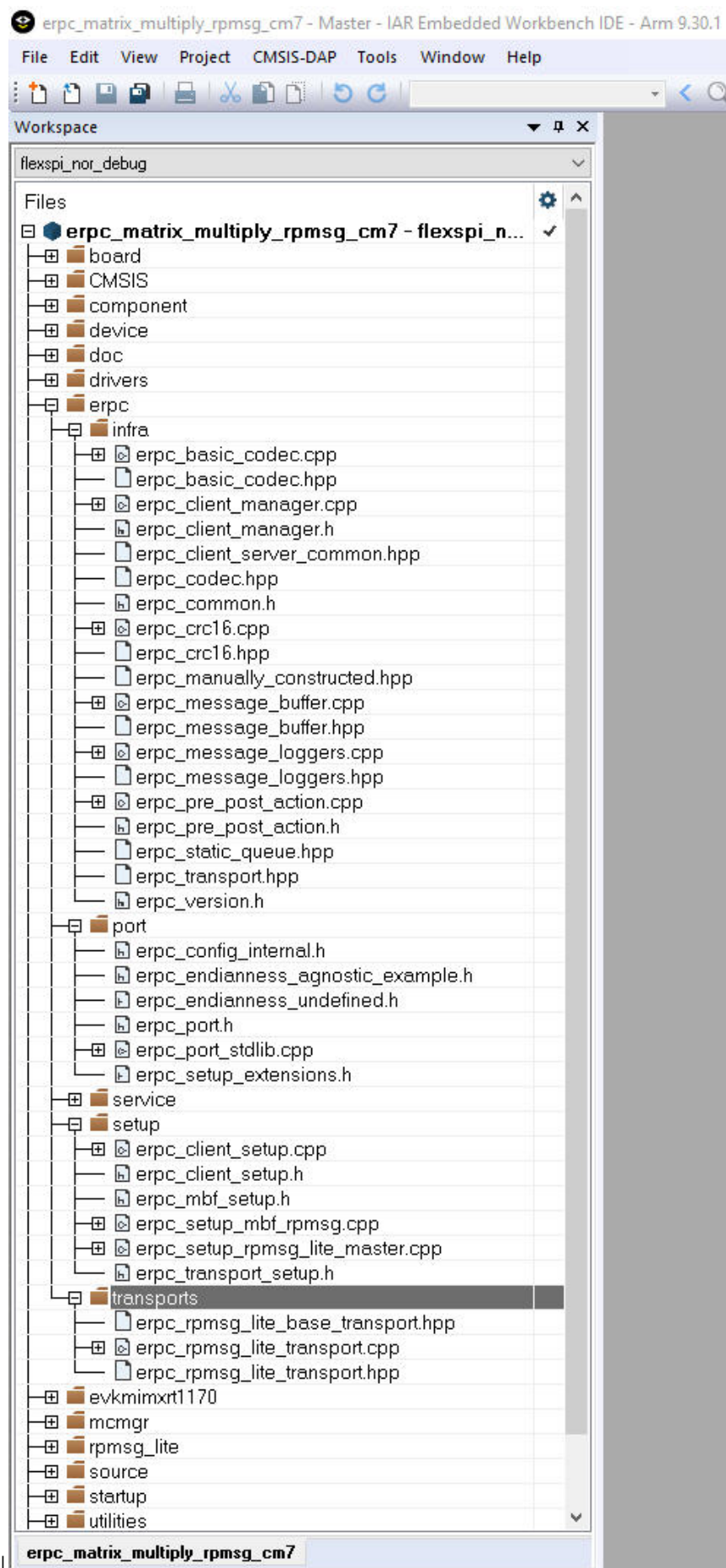
- `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
- `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
- `erpc_config_internal.h` internal eRPC configuration file.

The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.

- `erpc_client_setup.h` and `erpc_client_setup.cpp` files needs to be added into the “Matrix multiply” example project to demonstrate the use of C-wrapped functions in this example.
- `erpc_transport_setup.h` and `erpc_setup_rpmsg_lite_master.cpp` files needs to be added into the project in order to allow C-wrapped function for transport layer setup.
- `erpc_mbf_setup.h` and `erpc_setup_mbf_rpmsg.cpp` files needs to be added into the project in order to allow message buffer factory usage.

The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions, in the setup folder.

- RPMsg-Lite is used as the transport layer for the communication between cores, `erpc_rpmsg_lite_base_transport.hpp`, `erpc_rpmsg_lite_transport.hpp`, and `erpc_rpmsg_lite_transport.cpp` files needs to be added into the client project.



|

**Parent topic:** Multicore client application

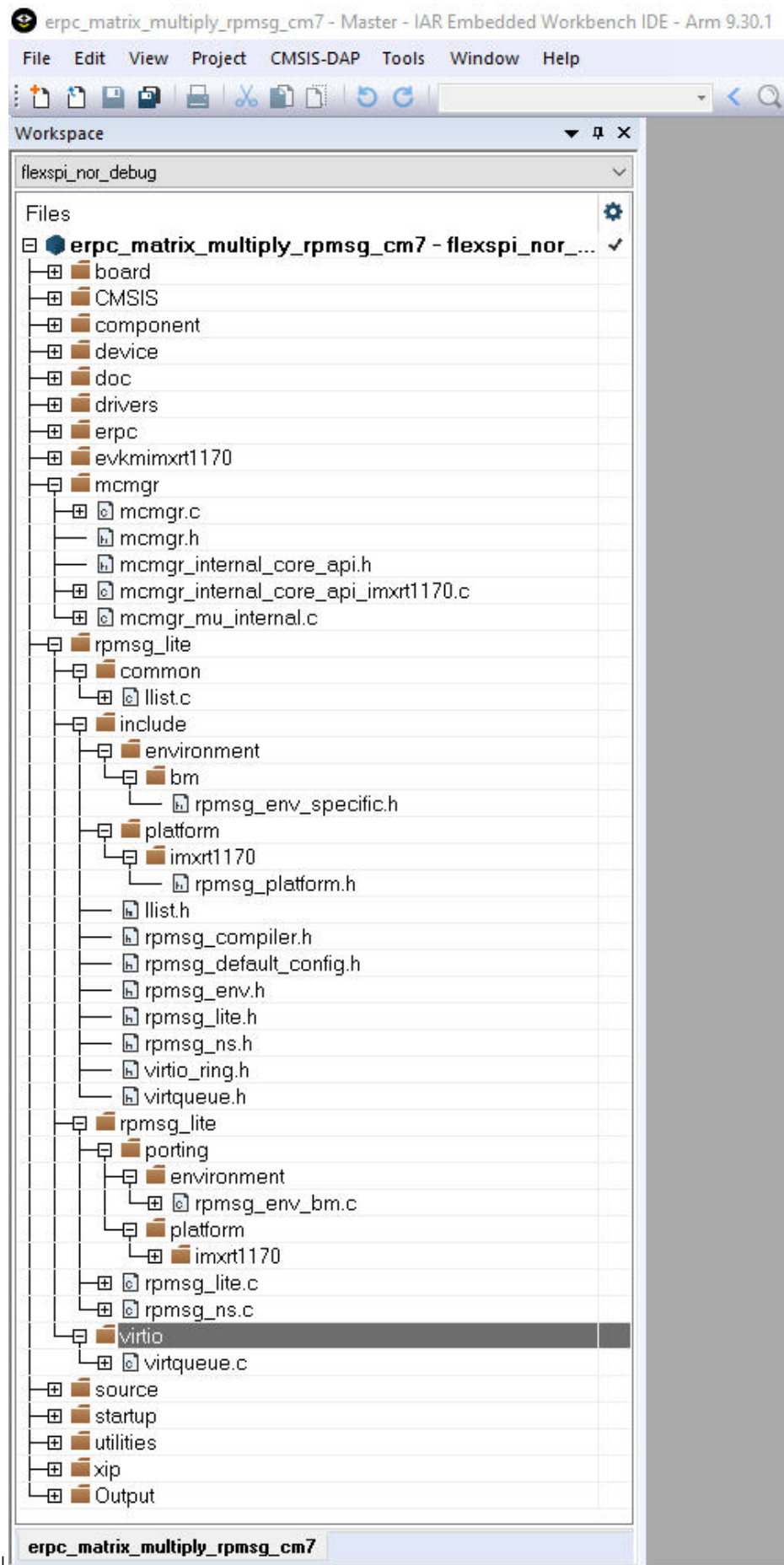
**Client multicore infrastructure files** Because of the RPMMsg-Lite (transport layer), it is also necessary to include RPMMsg-Lite related files, which are in the following folder:

*<MCUXpressoSDK\_install\_dir>/middleware/multicore/rpmsg\_lite/*

The multicore example applications also use the Multicore Manager software library to control the secondary core startup and shutdown. These source files are located in the following folder:

*<MCUXpressoSDK\_install\_dir>/middleware/multicore/mcmgr/*





**Parent topic:**Multicore client application

**Client user code** The client's user code is stored in the main\_core0.c file, located in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_example/erpc\_matrix\_multiply\_rpmsg/cm7

The main\_core0.c file contains the code for target board and eRPC initialization.

- After initialization, the secondary core is released from reset.
- When the secondary core is ready, the primary core initializes two matrix variables.
- The erpcMatrixMultiply eRPC function is called to issue the eRPC request and get the result.

It is possible to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in erpc\_error\_handler.h and erpc\_error\_handler.cpp files.

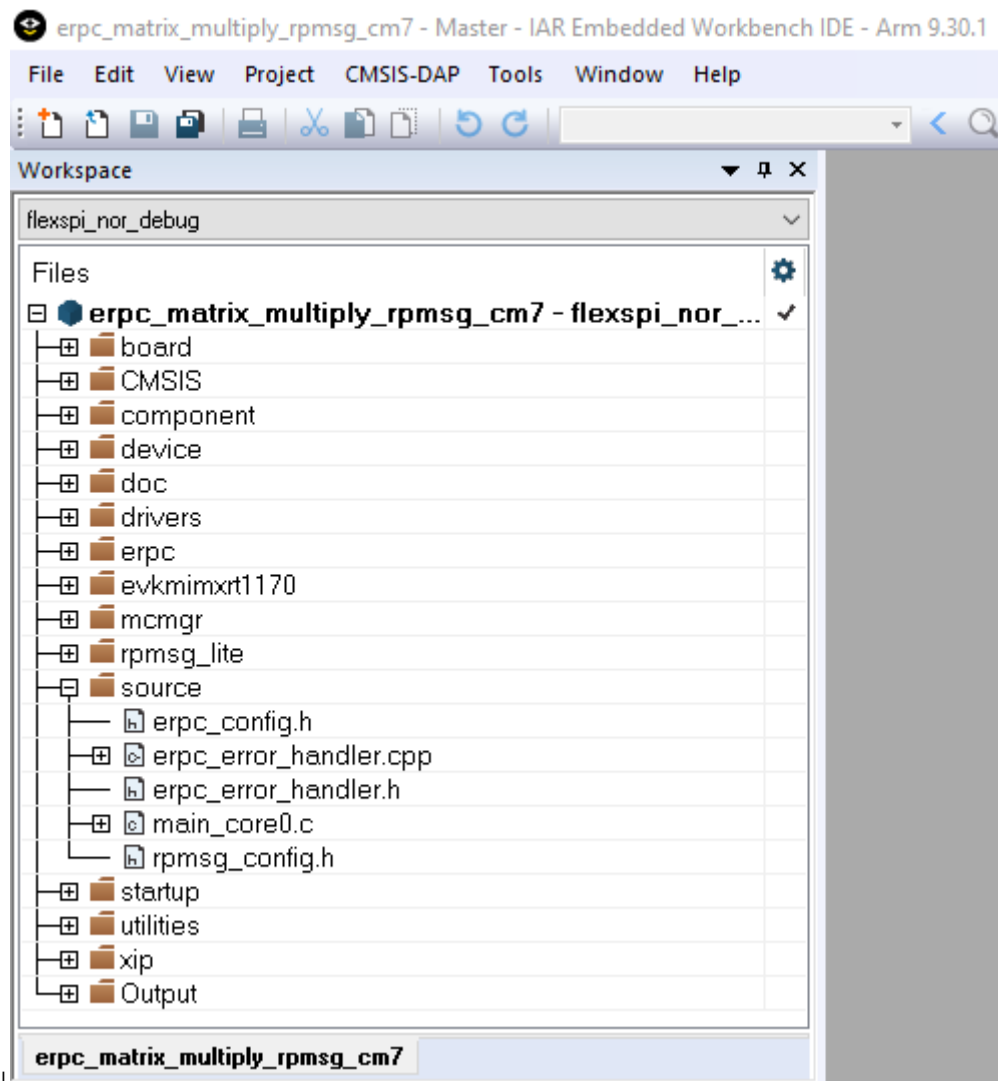
The matrix multiplication can be issued repeatedly, when pressing a software board button.

The eRPC-relevant code is captured in the following code snippet:

```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* RPMsg-Lite transport layer initialization */
erpc_transport_t transport;
transport = erpc_transport_rpmsg_lite_master_init(src, dst,
ERPC_TRANSPORT_RPMSG_LITE_LINK_ID);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_rpmsg_init(transport);
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport, message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
 /* Invoke the erpcMatrixMultiply function */
 erpcMatrixMultiply(matrix1, matrix2, result_matrix);
 ...
 /* Check if some error occurred in eRPC */
 if (g_erpc_error_occurred)
 {
 /* Exit program loop */
 break;
 }
 ...
}
```

Except for the application main file, there are configuration files for the RPMsg-Lite (rpmsg\_config.h) and eRPC (erpc\_config.h), located in the following folder:

<MCUXpressoSDK\_install\_dir>/boards/evkmimxrt1170/multicore\_examples/erpc\_matrix\_multiply\_rpmsg



Parent topic:Multicore client application

Parent topic:[Create an eRPC application](#)

**Multiprocessor server application** The “Matrix multiply” eRPC server project for multiprocessor applications is located in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_server_matrix_multiply_<transport_layer>` folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires server-related generated files (server shim code), server infrastructure files, and the server user code. There is no need for server multicore infrastructure files (MCMGR and RPMsg-Lite). The RPMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|      |                                                                         |
|------|-------------------------------------------------------------------------|
| SPI  | <eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_slave.cpp          |
|      | <eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.hpp |
|      | <eRPC base directory>/erpc_c/transports/erpc_(d)spi_slave_transport.cpp |
| UART | <eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp            |

<eRPC base directory>/erpc\_c/transport/erpc\_uart\_cmsis\_transport.hpp

<eRPC base directory>/erpc\_c/transport/erpc\_uart\_cmsis\_transport.cpp

|

**Server user code** The server's user code is stored in the main\_server.c file, located in the <MCUXpressoSDK\_install\_dir>/boards/<board\_name>/multiprocessor\_examples/erpc\_server\_matrix\_multiply\_<transport\_layer>/ folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(Matrix matrix1, Matrix matrix2, Matrix result_matrix)
{
 ...
}
int main()
{
 ...
 /* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
 ↪operations */
 erpc_transport_t transport;
 transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
 ...
 /* MessageBufferFactory initialization */
 erpc_mbf_t message_buffer_factory;
 message_buffer_factory = erpc_mbf_dynamic_init();
 ...
 /* eRPC server side initialization */
 erpc_server_t server;
 server = erpc_server_init(transport, message_buffer_factory);
 ...
 /* Adding the service to the server */
 erpc_service_t service = create_MatrixMultiplyService_service();
 erpc_add_service_to_server(server, service);
 ...
 while (1)
 {
 /* Process eRPC requests */
 erpc_status_t status = erpc_server_poll(server)
 /* handle error status */
 if (status != kErpcStatus_Success)
 {
 /* print error description */
 erpc_error_handler(status, 0);
 ...
 }
 ...
 }
}
```

**Parent topic:**Multiprocessor server application

**Multiprocessor client application** The “Matrix multiply” eRPC client project for multiprocessor applications is located in the <MCUXpressoSDK\_install\_dir>/boards/<board\_name>/multiprocessor\_examples/erpc\_client\_matrix\_multiply\_<transport\_layer>/iar/ folder.

Most of the multiprocessor application setup is the same as for the multicore application. The multiprocessor server application requires client-related generated files (server shim code),

client infrastructure files, and the client user code. There is no need for client multicore infrastructure files (MCMGR and RPSMsg-Lite). The RPSMsg-Lite transport layer is replaced either by SPI or UART transports. The following table shows the required transport-related files per each transport type.

|                               |                                                                 |
|-------------------------------|-----------------------------------------------------------------|
| SPI                           | <eRPC base directory>/erpc_c/setup/erpc_setup_(d)spi_master.cpp |
| <eRPC base directory>/erpc_c/ | transports/ erpc_(d)spi_master_transport.hpp                    |
| <eRPC base directory>/erpc_c/ | transports/ erpc_(d)spi_master_transport.cpp                    |
| UART                          | <eRPC base directory>/erpc_c/setup/erpc_setup_uart_cmsis.cpp    |
| <eRPC base directory>/erpc_c/ | transports/erpc_uart_cmsis_transport.hpp                        |
| <eRPC base directory>/erpc_c/ | transports/erpc_uart_cmsis_transport.cpp                        |
|                               |                                                                 |

**Client user code** The client's user code is stored in the `main_client.c` file, located in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_client_matrix_multiply_<transport_layer>/` folder.

The eRPC-relevant code with UART as a transport is captured in the following code snippet:

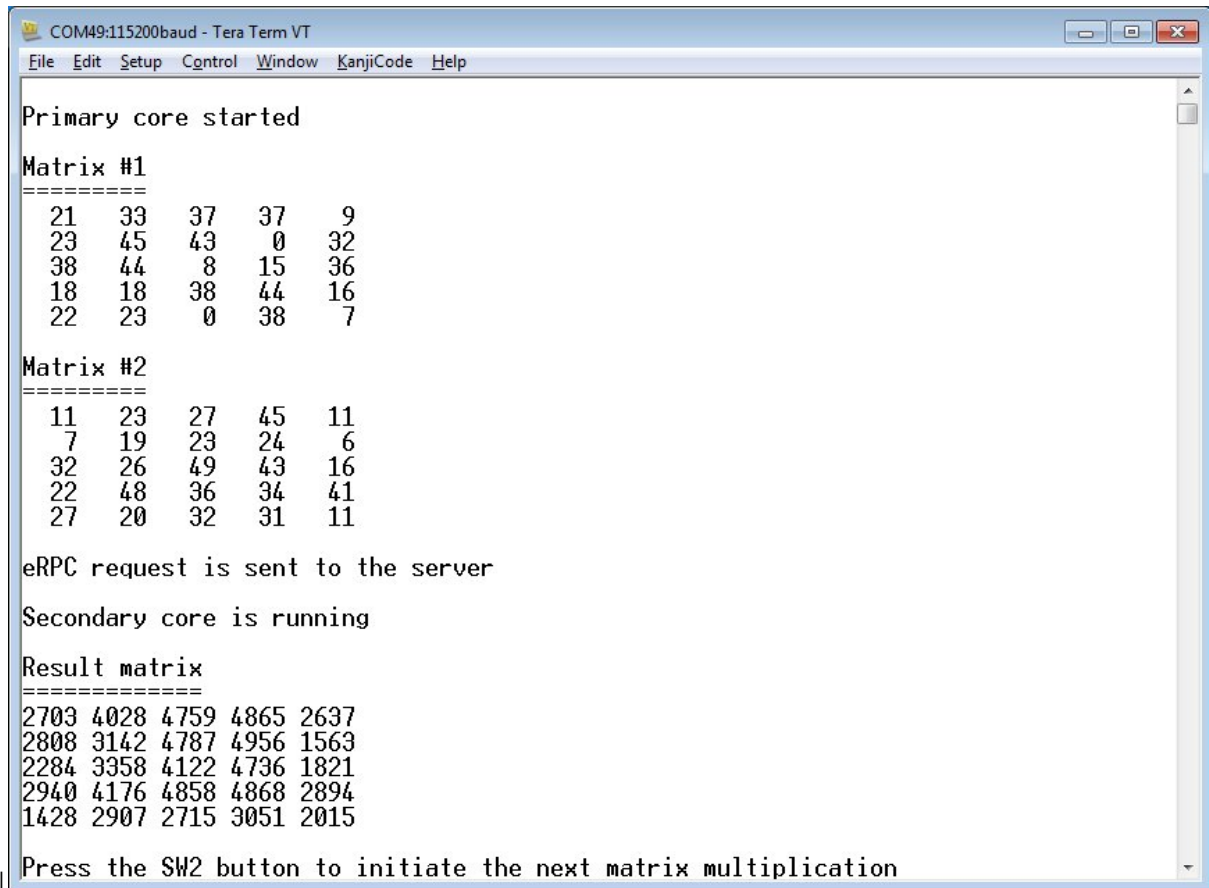
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
↳operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&ERPC_DEMO_UART);
...
/* MessageBufferFactory initialization */
erpc_mbf_t message_buffer_factory;
message_buffer_factory = erpc_mbf_dynamic_init();
...
/* eRPC client side initialization */
erpc_client_t client;
client = erpc_client_init(transport,message_buffer_factory);
...
/* Set default error handler */
erpc_client_set_error_handler(client, erpc_error_handler);
...
while (1)
{
 /* Invoke the erpcMatrixMultiply function */
 erpcMatrixMultiply(matrix1, matrix2, result_matrix);
 ...
 /* Check if some error occurred in eRPC */
 if (g_erpc_error_occurred)
 {
 /* Exit program loop */
 break;
 }
 ...
}
```

**Parent topic:**Multiprocessor client application

**Parent topic:**Multiprocessor server application

Parent topic:[Create an eRPC application](#)

**Running the eRPC application** Follow the instructions in *Getting Started with MCUXpresso SDK* (document MCUXSDKGSUG) (located in the <MCUXpressoSDK\_install\_dir>/docs folder), to load both the primary and the secondary core images into the on-chip memory, and then effectively debug the dual-core application. After the application is running, the serial console should look like:



```

COM49:115200baud - Tera Term VT
File Edit Setup Control Window KanjiCode Help

Primary core started

Matrix #1
=====
 21 33 37 37 9
 23 45 43 0 32
 38 44 8 15 36
 18 18 38 44 16
 22 23 0 38 7

Matrix #2
=====
 11 23 27 45 11
 7 19 23 24 6
 32 26 49 43 16
 22 48 36 34 41
 27 20 32 31 11

eRPC request is sent to the server

Secondary core is running

Result matrix
=====
2703 4028 4759 4865 2637
2808 3142 4787 4956 1563
2284 3358 4122 4736 1821
2940 4176 4858 4868 2894
1428 2907 2715 3051 2015

Press the SW2 button to initiate the next matrix multiplication

```

For multiprocessor applications that are running between PC and the target evaluation board or between two boards, follow the instructions in the accompanied example readme files that provide details about the proper board setup and the PC side setup (Python).

Parent topic:[Create an eRPC application](#)

Parent topic:[eRPC example](#)

**Other uses for an eRPC implementation** The eRPC implementation is generic, and its use is not limited to just embedded applications. When creating an eRPC application outside the embedded world, the same principles apply. For example, this manual can be used to create an eRPC application for a PC running the Linux operating system. Based on the used type of transport medium, existing transport layers can be used, or new transport layers can be implemented.

For more information and erpc updates see the [github.com/EmbeddedRPC](https://github.com/EmbeddedRPC).

**Note about the source code in the document** Example code shown in this document has the following copyright and BSD-3-Clause license:

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1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

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**Changelog eRPC** All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

## Unreleased

### Added

### Fixed

- Python code of the eRPC infrastructure was updated to match the proper python code style, add type annotations and improve readability.

## 1.14.0

### Added

- Added Cmake/Kconfig support.
- Made java code jdk11 compliant, GitHub PR #432.
- Added imxrt1186 support into mu transport layer.
- erpcgen: Added assert for listType before usage, GitHub PR #406.

### Fixed

- eRPC: Sources reformatted.
- erpc: Fixed typo in semaphore get (mutex -> semaphore), and write it can fail in case of timeout, GitHub PR #446.
- erpc: Free the arbitrated client token from client manager, GitHub PR #444.

- erpc: Fixed Makefile, install the erpc\_simple\_server header, GitHub PR #447.
- erpc\_python: Fixed possible AttributeError and OSError on calling TCPTransport.close(), GitHub PR #438.
- Examples and tests consolidated.

### 1.13.0

#### Added

- erpc: Add BSD-3 license to endianness agnostic files, GitHub PR #417.
- eRPC: Add new Zephyr-related transports (zephyr\_uart, zephyr\_mbox).
- eRPC: Add new Zephyr-related examples.

#### Fixed

- eRPC,erpcgen: Fixing/improving markdown files, GitHub PR #395.
- eRPC: Fix Python client TCPTransports not being able to close, GitHub PR #390.
- eRPC,erpcgen: Align switch brackets, GitHub PR #396.
- erpc: Fix zephyr uart transport, GitHub PR #410.
- erpc: UART ZEPHYR Transport stop to work after a few transactions when using USB-CDC resolved, GitHub PR #420.

#### Removed

- eRPC,erpcgen: Remove cstbool library, GitHub PR #403.

### 1.12.0

#### Added

- eRPC: Add dynamic/static option for transport init, GitHub PR #361.
- eRPC,erpcgen: Winsock2 support, GitHub PR #365.
- eRPC,erpcgen: Feature/support multiple clients, GitHub PR #271.
- eRPC,erpcgen: Feature/buffer head - Framed transport header data stored in Message-Buffer, GitHub PR #378.
- eRPC,erpcgen: Add experimental Java support.

#### Fixed

- eRPC: Fix receive error value for spidev, GitHub PR #363.
- eRPC: UartTransport::init adaptation to changed driver.
- eRPC: Fix typo in assert, GitHub PR #371.
- eRPC,erpcgen: Move enums to enum classes, GitHub PR #379.
- eRPC: Fixed rpmsg tty transport to work with serial transport, GitHub PR #373.



### 1.11.0

#### Fixed

- eRPC: Makefiles update, GitHub PR #301.
- eRPC: Resolving warnings in Python, GitHub PR #325.
- eRPC: Python3.8 is not ready for usage of typing.Any type, GitHub PR #325.
- eRPC: Improved codec function to use reference instead of address, GitHub PR #324.
- eRPC: Fix NULL check for pending client creation, GitHub PR #341.
- eRPC: Replace sprintf with snprintf, GitHub PR #343.
- eRPC: Use MU\_SendMsg blocking call in MU transport.
- eRPC: New LPSPI and LPI2C transport layers.
- eRPC: Freeing static objects, GitHub PR #353.
- eRPC: Fixed casting in deinit functions, GitHub PR #354.
- eRPC: Align LIBUSB\_SIO.GetNumPorts API use with libusb\_sio python module v. 2.1.11.
- erpcgen: Renamed temp variable to more generic one, GitHub PR #321.
- erpcgen: Add check that string read is not more than max length, GitHub PR #328.
- erpcgen: Move to g++ in pytest, GitHub PR #335.
- erpcgen: Use build=release for make, GitHub PR #334.
- erpcgen: Removed boost dependency, GitHub PR #346.
- erpcgen: Mingw support, GitHub PR #344.
- erpcgen: VS build update, GitHub PR #347.
- erpcgen: Modified name for common types macro scope, GitHub PR #337.
- erpcgen: Fixed memcpy for template, GitHub PR #352.
- eRPC,erpcgen: Change default build target to release + adding artefacts, GitHub PR #334.
- eRPC,erpcgen: Remove redundant includes, GitHub PR #338.
- eRPC,erpcgen: Many minor code improvements, GitHub PR #323.

### 1.10.0

#### Fixed

- eRPC: MU transport layer switched to blocking MU\_SendMsg() API use.

### 1.10.0

#### Added

- eRPC: Add TCP\_NODELAY option to python, GitHub PR #298.

## Fixed

- eRPC: MUPTransport adaptation to new supported SoCs.
- eRPC: Simplifying CI with installing dependencies using shell script, GitHub PR #267.
- eRPC: Using event for waiting for sock connection in TCP python server, formatting python code, C specific includes, GitHub PR #269.
- eRPC: Endianness agnostic update, GitHub PR #276.
- eRPC: Assertion added for functions which are returning status on freeing memory, GitHub PR #277.
- eRPC: Fixed closing arbitrator server in unit tests, GitHub PR #293.
- eRPC: Makefile updated to reflect the correct header names, GitHub PR #295.
- eRPC: Compare value length to used length() in reading data from message buffer, GitHub PR #297.
- eRPC: Replace EXPECT\_TRUE with EXPECT\_EQ in unit tests, GitHub PR #318.
- eRPC: Adapt rpmsg\_lite based transports to changed rpmsg\_lite\_wait\_for\_link\_up() API parameters.
- eRPC, erpcgen: Better distinguish which file can and cannot be linked by C linker, GitHub PR #266.
- eRPC, erpcgen: Stop checking if pointer is NULL before sending it to the erpc\_free function, GitHub PR #275.
- eRPC, erpcgen: Changed api to count with more interfaces, GitHub PR #304.
- erpcgen: Check before reading from heap the buffer boundaries, GitHub PR #287.
- erpcgen: Several fixes for tests and CI, GitHub PR #289.
- erpcgen: Refactoring erpcgen code, GitHub PR #302.
- erpcgen: Fixed assigning const value to enum, GitHub PR #309.
- erpcgen: Enable runTesttest\_enumErrorCode\_allDirection, serialize enums as int32 instead of uint32.

### 1.9.1

## Fixed

- eRPC: Construct the USB CDC transport, rather than a client, GitHub PR #220.
- eRPC: Fix premature import of package, causing failure when attempting installation of Python library in a clean environment, GitHub PR #38, #226.
- eRPC: Improve python detection in make, GitHub PR #225.
- eRPC: Fix several warnings with deprecated call in pytest, GitHub PR #227.
- eRPC: Fix freeing union members when only default need be freed, GitHub PR #228.
- eRPC: Fix making test under Linux, GitHub PR #229.
- eRPC: Assert costumizing, GitHub PR #148.
- eRPC: Fix corrupt clientList bug in TransportArbitrator, GitHub PR #199.
- eRPC: Fix build issue when invoking g++ with -Wno-error=free-nonheap-object, GitHub PR #233.
- eRPC: Fix inout cases, GitHub PR #237.

- eRPC: Remove ERPC\_PRE\_POST\_ACTION dependency on return type, GitHub PR #238.
- eRPC: Adding NULL to ptr when codec function failed, fixing memcpy when fail is present during deserialization, GitHub PR #253.
- eRPC: MessageBuffer usage improvement, GitHub PR #258.
- eRPC: Get rid of serial and enum34 dependency (enum34 is in python3 since 3.4 (from 2014)), GitHub PR #247.
- eRPC: Several MISRA violations addressed.
- eRPC: Fix timeout for Freertos semaphore, GitHub PR #251.
- eRPC: Use of rpmsg\_lite\_wait\_for\_link\_up() in rpmsg\_lite based transports, GitHub PR #223.
- eRPC: Fix codec nullptr dereferencing, GitHub PR #264.
- erpcgen: Fix two syntax errors in erpcgen Python output related to non-encapsulated unions, improved test for union, GitHub PR #206, #224.
- erpcgen: Fix serialization of list/binary types, GitHub PR #240.
- erpcgen: Fix empty list parsing, GitHub PR #72.
- erpcgen: Fix templates for malloc errors, GitHub PR #110.
- erpcgen: Get rid of encapsulated union declarations in global scale, improve enum usage in unions, GitHub PR #249, #250.
- erpcgen: Fix compile error:UniqueIdChecker.cpp:156:104:'sort' was not declared, GitHub PR #265.

## 1.9.0

### Added

- eRPC: Allow used LIBUSB\_SIO device index being specified from the Python command line argument.

### Fixed

- eRPC: Improving template usage, GitHub PR #153.
- eRPC: run\_clang\_format.py cleanup, GitHub PR #177.
- eRPC: Build TCP transport setup code into liberpc, GitHub PR #179.
- eRPC: Fix multiple definitions of g\_client error, GitHub PR #180.
- eRPC: Fix memset past end of buffer in erpc\_setup\_mbf\_static.cpp, GitHub PR #184.
- eRPC: Fix deprecated error with newer pytest version, GitHub PR #203.
- eRPC, erpcgen: Static allocation support and usage of rpmsg static FreeRTOSs related API, GitHub PR #168, #169.
- erpcgen: Remove redundant module imports in erpcgen, GitHub PR #196.

## 1.8.1

### Added

- eRPC: New i2c\_slave\_transport transport introduced.

### Fixed

- eRPC: Fix misra erpc c, GitHub PR #158.
- eRPC: Allow conditional compilation of message\_loggers and pre\_post\_action.
- eRPC: (D)SPI slave transports updated to avoid busy loops in rtos environments.
- erpcgen: Re-implement EnumMember::hasValue(), GitHub PR #159.
- erpcgen: Fixing several misra issues in shim code, erpcgen and unit tests updated, GitHub PR #156.
- erpcgen: Fix bison file, GitHub PR #156.

### 1.8.0

### Added

- eRPC: Support win32 thread, GitHub PR #108.
- eRPC: Add mbed support for malloc() and free(), GitHub PR #92.
- eRPC: Introduced pre and post callbacks for eRPC call, GitHub PR #131.
- eRPC: Introduced new USB CDC transport.
- eRPC: Introduced new Linux spidev-based transport.
- eRPC: Added formatting extension for VSC, GitHub PR #134.
- erpcgen: Introduce ustring type for unsigned char and force cast to char\*, GitHub PR #125.

### Fixed

- eRPC: Update makefile.
- eRPC: Fixed warnings and error with using MessageLoggers, GitHub PR #127.
- eRPC: Extend error msg for python server service handle function, GitHub PR #132.
- eRPC: Update CMSIS UART transport layer to avoid busy loops in rtos environments, introduce semaphores.
- eRPC: SPI transport update to allow usage without handshaking GPIO.
- eRPC: Native \_WIN32 erpc serial transport and threading.
- eRPC: Arbitrator deadlock fix, TCP transport updated, TCP setup functions introduced, GitHub PR #121.
- eRPC: Update of matrix\_multiply.py example: Add -serial and -baud argument, GitHub PR #137.
- eRPC: Update of .clang-format, GitHub PR #140.
- eRPC: Update of erpc\_framed\_transport.cpp: return error if received message has zero length, GitHub PR #141.
- eRPC, erpcgen: Fixed error messages produced by -Wall -Wextra -Wshadow -pedantic-errors compiler flags, GitHub PR #136, #139.
- eRPC, erpcgen: Core re-formatted using Clang version 10.
- erpcgen: Enable deallocation in server shim code when callback/function pointer used as out parameter in IDL.
- erpcgen: Removed '\$' character from generated symbol name in '\_\$union' suffix, GitHub PR #103.

- erpcgen: Resolved mismatch between C++ and Python for callback index type, GitHub PR #111.
- erpcgen: Python generator improvements, GitHub PR #100, #118.
- erpcgen: Fixed error messages produced by -Wall -Wextra -Wshadow -pedantic-errors compiler flags, GitHub PR #136.

#### 1.7.4

##### Added

- eRPC: Support MU transport unit testing.
- eRPC: Adding mbed os support.

##### Fixed

- eRPC: Unit test code updated to handle service add and remove operations.
- eRPC: Several MISRA issues in rpmsg-based transports addressed.
- eRPC: Fixed Linux/TCP acceptance tests in release target.
- eRPC: Minor documentation updates, code formatting.
- erpcgen: Whitespace removed from C common header template.

#### 1.7.3

##### Fixed

- eRPC: Improved the test\_callbacks logic to be more understandable and to allow requested callback execution on the server side.
- eRPC: TransportArbitrator::prepareClientReceive modified to avoid incorrect return value type.
- eRPC: The ClientManager and the ArbitratedClientManager updated to avoid performing client requests when the previous serialization phase fails.
- erpcgen: Generate the shim code for destroy of statically allocated services.

#### 1.7.2

##### Added

- eRPC: Add missing doxygen comments for transports.

##### Fixed

- eRPC: Improved support of const types.
- eRPC: Fixed Mac build.
- eRPC: Fixed serializing python list.
- eRPC: Documentation update.

### 1.7.1

#### Fixed

- eRPC: Fixed semaphore in static message buffer factory.
- erpcgen: Fixed MU received error flag.
- erpcgen: Fixed tcp transport.

### 1.7.0

#### Added

- eRPC: List names are based on their types. Names are more deterministic.
- eRPC: Service objects are as a default created as global static objects.
- eRPC: Added missing doxygen comments.
- eRPC: Added support for 64bit numbers.
- eRPC: Added support of program language specific annotations.

#### Fixed

- eRPC: Improved code size of generated code.
- eRPC: Generating crc value is optional.
- eRPC: Fixed CMSIS Uart driver. Removed dependency on KSDK.
- eRPC: Forbid users use reserved words.
- eRPC: Removed outByref for function parameters.
- eRPC: Optimized code style of callback functions.

### 1.6.0

#### Added

- eRPC: Added @nullable support for scalar types.

#### Fixed

- eRPC: Improved code size of generated code.
- eRPC: Improved eRPC nested calls.
- eRPC: Improved eRPC list length variable serialization.

### 1.5.0

### Added

- eRPC: Added support for unions type non-wrapped by structure.
- eRPC: Added callbacks support.
- eRPC: Added support @external annotation for functions.
- eRPC: Added support @name annotation.
- eRPC: Added Messaging Unit transport layer.
- eRPC: Added RPMSG Lite RTOS TTY transport layer.
- eRPC: Added version verification and IDL version verification between eRPC code and eRPC generated shim code.
- eRPC: Added support of shared memory pointer.
- eRPC: Added annotation to forbid generating const keyword for function parameters.
- eRPC: Added python matrix multiply example.
- eRPC: Added nested call support.
- eRPC: Added struct member “byref” option support.
- eRPC: Added support of forward declarations of structures
- eRPC: Added Python RPMsg Multiendpoint kernel module support
- eRPC: Added eRPC sniffer tool

### 1.4.0

### Added

- eRPC: New RPMsg-Lite Zero Copy (RPMsgZC) transport layer.

### Fixed

- eRPC: win\_flex\_bison.zip for windows updated.
- eRPC: Use one codec (instead of inCodec outCodec).

### [1.3.0]

### Added

- eRPC: New annotation types introduced (@length, @max\_length, ...).
- eRPC: Support for running both erpc client and erpc server on one side.
- eRPC: New transport layers for (LP)UART, (D)SPI.
- eRPC: Error handling support.

### [1.2.0]

### Added

- eRPC source directory organization changed.
- Many eRPC improvements.

### [1.1.0]

#### Added

- Multicore SDK 1.1.0 ported to KSDK 2.0.0.

### [1.0.0]

#### Added

- Initial Release

## 3.7 Wireless

### 3.7.1 NXP Wireless Framework and Stacks

#### Wi-Fi, Bluetooth, 802.15.4

##### Application notes

- [Link AN12918-Wi-Fi-Tx-Power-Table-and-Channel-Scan-Management-for-i.MX-RT-SDK.pdf](#)
- [Link TN00066-WFA-Derivative-Certification-Process.pdf](#)

##### User manuals

- [Link UM11441-Getting-Started-with-NXP-based-Wireless-Modules-and-i.MX-RT-Platforms.pdf](#)
- [UM11442-NXP-Wi-Fi-and-Bluetooth-Demo-Applications-for-i.MX-RT-Platforms.pdf](#)
- [Link UM11443-NXP-Wi-Fi-and-Bluetooth-Debug-Feature-Configuration-Guide-for-i.MX-RT-Platforms.pdf](#)
- [Link UM11567-WFA-Certification-Guide-for-NXP-based-Wireless-Modules-on-i.MX-RT-Platform-Running-RTOS.pdf](#)

##### Release notes

#### Wireless SoC features and release notes for FreeRTOS

**About this document** This document provides information about the supported features, release versions, fixed and/or known issues, performance of the Wi-Fi, Bluetooth/802.15.4 radios, including the coexistence.

The SDK release version 25.06.00 has been tested for the wireless SoCs listed in Supported products.



## Supported products

- 88W8987
- IW416
- IW611<sup>1</sup>
- IW612<sup>2</sup>
- AW611<sup>3</sup>
- RW610
- RW612

**Parent topic:**[About this document](#)

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## Features

### Wi-Fi radio

#### Client mode

| Features                        | Sub features                                                  |
|---------------------------------|---------------------------------------------------------------|
| 802.11n - High throughput       | 2.4 GHz band operation supported channel bandwidth: 20 MHz    |
| 802.11n - High throughput       | 2.4 GHz band supported channel bandwidth: 40 MHz              |
| 802.11n - High throughput       | 5 GHz band supported channel bandwidth: 20 MHz                |
| 802.11n - High throughput       | 5 GHz band supported channel bandwidth: 40 MHz                |
| 802.11n - High throughput       | Short/long guard interval (400 ns/800 ns)                     |
| 802.11n - High throughput       | Data rates up to 72 Mbit/s (MCS 0 to MCS 7)                   |
| 802.11n - High throughput       | Data rates up to 150 Mbit/s (MCS 0 to MCS 7)                  |
| 802.11n - High throughput       | 1 spatial stream (1x1)                                        |
| 802.11n - High throughput       | HT protection mechanisms                                      |
| 802.11n - High throughput       | Aggregated MAC protocol data unit (AMPDU) TX and RX support   |
| 802.11n - High throughput       | Aggregated MAC service data unit (AMSDU) 4k TX and RX support |
| 802.11n - High throughput       | TX MCS rate adaptation (BGN)                                  |
| 802.11n - High throughput       | RX low density parity check (LDPC) 1x1 20 MHz and 40 MHz      |
| 802.11n - High throughput       | HT Beamformee (explicit)                                      |
| 802.11ac - Very high throughput | 2.4 GHz band supported channel bandwidth: 20MHz               |
| 802.11ac - Very high throughput | 5 GHz band supported channel bandwidth: 20 MHz                |
| 802.11ac - Very high throughput | 5 GHz band supported channel bandwidth: 40 MHz                |
| 802.11ac - Very high throughput | 5 GHz band supported channel bandwidth: 80 MHz                |
| 802.11ac - Very high throughput | Data rates up to 86.7 Mbps (MCS0 to MCS 8)                    |
| 802.11ac - Very high throughput | Data rates up to 433.3 Mbps (MCS 0 to MCS 9) - 1x1            |
| 802.11ac - Very high throughput | MU-MIMO Beamformee (Explicit and Implicit)                    |
| 802.11ac - Very high throughput | RTS/CTS with BW signaling                                     |
| 802.11ac - Very high throughput | Operation mode notification                                   |
| 802.11ac - Very high throughput | Backward compatibility with non-VHT devices                   |
| 802.11ac - Very high throughput | TX VHT MCS rate adaptation                                    |
| 802.11ac - Very high throughput | Low density parity check (LDPC)                               |
| 802.11ax - High efficiency      | 2.4 GHz band supported channel bandwidth: 20MHz               |

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<sup>1</sup> The support of IW611 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

<sup>2</sup> The support of IW612 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

<sup>3</sup> AW611 module support is available only in i.MX RT1180 EVKA

Table 1 – continued from p

| Features                                    | Sub features                                                |
|---------------------------------------------|-------------------------------------------------------------|
| 802.11ax - High efficiency                  | 5 GHz band supported channel bandwidth: 20 MHz              |
| 802.11ax - High efficiency                  | 5 GHz band supported channel bandwidth: 40 MHz              |
| 802.11ax - High efficiency                  | 5 GHz band supported channel bandwidths: 80 MHz             |
| 802.11ax - High efficiency                  | OFDMA (UL/DL, 106 RU)                                       |
| 802.11ax - High efficiency                  | OFDMA (UL/DL, 484 RU)                                       |
| 802.11ax - High efficiency                  | 1024 QAM                                                    |
| 802.11ax - High efficiency                  | Target wake time (TWT)                                      |
| 802.11ax - High efficiency                  | 256 QAM modulation – MCS8 and MCS9                          |
| 802.11ax - High efficiency                  | 1024 QAM modulation – MCS10 and MCS11, 2.4 GHz              |
| 802.11ax - High efficiency                  | 1024 QAM modulation – MCS10 and MCS11, 5 GHz                |
| 802.11ax - High efficiency                  | DCM                                                         |
| 802.11ax - High efficiency                  | DCM                                                         |
| 802.11ax - High efficiency                  | ER (extended range)                                         |
| 802.11ax - High efficiency                  | SU Beamforming                                              |
| 802.11ax - High efficiency                  | OMI (operating mode indication)                             |
| 802.11a/b/g features                        | 802.11b/g data rates up to 54 Mbit/s                        |
| 802.11a/b/g features                        | 802.11a data rates up to 54 Mbit/s                          |
| 802.11a/b/g features                        | TX rate adaptation (BG)                                     |
| 802.11a/b/g features                        | Fragmentation/defragmentation                               |
| 802.11a/b/g features                        | ERP protection, slot time, preamble                         |
| 802.11d                                     | 802.11d - Regulatory domain/operating class/country info    |
| 802.11e QoS                                 | EDCA [enhanced distributed channel access] / WMM (wireless  |
| 802.11i security                            | Opensource WPA Supplicant Support                           |
| 802.11i security                            | WPA2-PSK AES   WPA Supplicant                               |
| 802.11i security                            | WPA3-SAE (Simultaneous Authentication of Equals)   WPA      |
| 802.11i security                            | WPA2+WPA3 PSK Mixed Mode (WPA3 Transition Mode)   W         |
| 802.11i security                            | Wi-Fi Enhanced Open - OWE (Opportunistic Wireless Encry     |
| 802.11i security                            | 802.1x EAP Authentication Methods   WPA Supplicant          |
| 802.11i security                            | WPA2-Enterprise Mixed Mode   WPA Supplicant                 |
| 802.11i security                            | WPA3-Enterprise (Suite-B)   National Security Algorithm (CS |
| 802.11i security                            | 802.11w - PMF (Protected Management Frames)   WPA Supp      |
| 802.11i security                            | Embedded Supplicant Support                                 |
| 802.11i security                            | WPA2-PSK AES   Embedded Supplicant                          |
| 802.11i security                            | WPA+WPA2 PSK Mixed Mode   Embedded Supplicant               |
| 802.11i security                            | WPA3-SAE (Simultaneous Authentication of Equals)   Embe     |
| 802.11i security                            | 802.11w - PMF (Protected Management Frames)   Embedde       |
| 802.11i security                            | Wi-Fi Roaming                                               |
| 802.11i security                            | WPA3 Enterprise                                             |
| Power save mode                             | Deep sleep                                                  |
| Power save mode                             | IEEE power save                                             |
| Power save mode                             | Host sleep/WoWLAN (inband)                                  |
| Power save mode                             | Host sleep/WoWLAN (outband)                                 |
| Power save mode                             | U-APSD                                                      |
| 802.11w - PMF (protected management frames) | PMF require and capable                                     |
| 802.11w - PMF (protected management frames) | Unicast management frames - Encryption/decryption - using   |
| 802.11w - PMF (protected management frames) | Broadcast management frames - Encryption/decryption - us    |
| 802.11w - PMF (protected management frames) | SA query request/response                                   |
| 802.11w - PMF (protected management frames) | PMF support using embedded supplicant                       |
| DPP functionality                           | Wi-Fi easy connect <sup>[^3]</sup>                          |
| General features                            | Embedded supplicant                                         |
| General features                            | Host sleep packet filtering                                 |
| General features                            | Host-based supplicant                                       |
| General features                            | Embedded MLME                                               |
| General features                            | EDMAC - EU adaptivity support (ETSI certification)          |
| General features                            | External coexistence                                        |

Table 1 – continued from p

| Features         | Sub features                                                       |
|------------------|--------------------------------------------------------------------|
| General features | IPv6 NS offload                                                    |
| General features | FIPS                                                               |
| General features | TKIP <sup>[^1]</sup>                                               |
| General features | RF test mode                                                       |
| General features | 802.11k                                                            |
| General features | 802.11v                                                            |
| General features | DFS radar detection in peripheral mode (follow AP) <sup>[^5]</sup> |
| General features | Embedded roaming based on RSSI threshold beacon loss               |
| General features | ARP offload                                                        |
| General features | Cloud keep alive                                                   |
| General features | UNII-4 channel support                                             |
| General features | ClockSync using TSF                                                |
| General features | Auto reconnect                                                     |
| General features | CSI (channel state information)                                    |
| General features | Independent reset (in-band) <sup>[^3]</sup>                        |
| General features | Independent reset (out-band) <sup>[^3]</sup>                       |
| General features | Wi-Fi agile multiband                                              |
| General features | Network co-processor (NCP) mode                                    |
| General features | 802.11mc - WLS (Wi-Fi location service)                            |
| General features | 802.11az                                                           |

**Parent topic:**Wi-Fi radio

<sup>[^1]</sup> As per Wi-Fi specification, connecting in TKIP security in non 802.11n mode is allowed.

<sup>[^2]</sup> Support available in host-base supplicant.

<sup>[^3]</sup> Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature.

<sup>[^4]</sup> Read more about NCP feature in [References](#). <sup>[^5]</sup> To enable the feature, CONFIG\_ECSA = 1 must be defined in wifi\_config.h (does not apply to RW610 and RW612).

**AP mode**

| Features                        | Sub features                                               |
|---------------------------------|------------------------------------------------------------|
| 802.11n - High throughput       | 2.4 GHz band operation supported channel bandwidth: 20 MHz |
| 802.11n - High throughput       | 2.4 GHz band supported channel bandwidth: 40 MHz           |
| 802.11n - High throughput       | 5 GHz band supported channel bandwidth: 20 MHz             |
| 802.11n - High throughput       | 5 GHz band supported channel bandwidth: 40 MHz             |
| 802.11n - High throughput       | Short/long guard interval (400 ns/800 ns)                  |
| 802.11n - High throughput       | Data rates up to 72 Mbit/s (MCS 0 to MCS 7)                |
| 802.11n - High throughput       | Data rates up to 150 Mbit/s (MCS 0 to MCS 7)               |
| 802.11n - High throughput       | 1 spatial stream (1x1)                                     |
| 802.11n - High throughput       | HT protection mechanisms                                   |
| 802.11n - High throughput       | Aggregated MAC protocol data unit (AMPDU) Rx support       |
| 802.11n - High throughput       | Aggregated MAC service data unit (AMSDU) -4k RX support    |
| 802.11n - High throughput       | Max client support (up to 8 devices)                       |
| 802.11n - High throughput       | TX MCS rate adaptation (BGN)                               |
| 802.11n - High throughput       | RX low density parity check (LDPC)                         |
| 802.11ac – Very high throughput | 5 GHz band supported channel bandwidth: 20 MHz             |
| 802.11ac – Very high throughput | 5 GHz band supported channel bandwidth: 40 MHz             |
| 802.11ac – Very high throughput | 5 GHz band supported channel bandwidth: 80MHz              |
| 802.11ac – Very high throughput | Short/long guard interval (400ns/800ns)                    |

Table 2 – continued from previ

| Features                                    | Sub features                                                |
|---------------------------------------------|-------------------------------------------------------------|
| 802.11ac – Very high throughput             | Data rates up to 86.7 Mbps (MCS0 to MCS 8)                  |
| 802.11ac – Very high throughput             | Data rates up to 433.3 Mbps (MCS 0 to MCS 9)                |
| 802.11ac – Very high throughput             | Single user- Aggregated MAC protocol data unit (SU-AMPDU)   |
| 802.11ac – Very high throughput             | RTS/CTS with BW signaling                                   |
| 802.11ac – Very high throughput             | Backward compatibility with non-VHT devices                 |
| 802.11ac – Very high throughput             | TX VHT MCS rate adaptation                                  |
| 802.11ac – Very high throughput             | MU-MIMO Beamformee (explicit and implicit)                  |
| 802.11ac – Very high throughput             | Operation mode notification                                 |
| 802.11ax – High efficiency                  | 2.4 GHz band operation (20 MHz channel bandwidth)           |
| 802.11ax – High efficiency                  | 2.4 GHz band operation (40 MHz channel bandwidth)           |
| 802.11ax – High efficiency                  | 5 GHz band operation (20MHz channel bandwidth)              |
| 802.11ax – High efficiency                  | 5 GHz band operation (40MHz channel bandwidth)              |
| 802.11ax – High efficiency                  | 5 GHz band operation (80 MHz channel bandwidth)             |
| 802.11d                                     | 802.11d - Regulatory domain/operating class/country info    |
| 802.11e -QoS                                | EDCA [enhanced distributed channel access] / WMM (wireless  |
| 802.11i security                            | Hostapd Support                                             |
| 802.11i security                            | WPA2-PSK AES   hostapd                                      |
| 802.11i security                            | WPA3-SAE (Simultaneous Authentication of Equals)   Hosta    |
| 802.11i security                            | WPA2+WPA3 PSK Mixed Mode (WPA3 Transition Mode)   H         |
| 802.11i security                            | Wi-Fi Enhanced Open - OWE (Opportunistic Wireless Encry     |
| 802.11i security                            | 802.1x EAP Authentication Methods   Hostapd                 |
| 802.11i security                            | WPA2-Enterprise Mixed Mode   Hostapd                        |
| 802.11i security                            | WPA3-Enterprise (Suite-B)   National Security Algorithm (CS |
| 802.11i security                            | 802.11w - PMF (Protected Management Frames)   Hostapd       |
| 802.11i security                            | Embedded Authenticator                                      |
| 802.11i security                            | WPA2-PSK AES   Embedded Supplicant                          |
| 802.11i security                            | WPA+WPA2 PSK Mixed Mode   Embedded Supplicant               |
| 802.11i security                            | WPA3-SAE (Simultaneous Authentication of Equals)   Embe     |
| 802.11i security                            | 802.11w - PMF (Protected Management Frames)   Embedde       |
| 802.11y                                     | Extended channel switch announcement (ECSA)                 |
| 802.11w - protected management frames (PMF) | PMF require and capable                                     |
| 802.11w - protected management frames (PMF) | Unicast management frames -Encryption/decryption - using    |
| 802.11w - protected management frames (PMF) | Broadcast management frames -encryption/decryption - usi    |
| 802.11w - protected management frames (PMF) | SA query request/response                                   |
| General features                            | Embedded authenticator                                      |
| General features                            | Embedded MLME                                               |
| General features                            | EU adaptivity support                                       |
| General features                            | Automatic channel selection (ACS)                           |
| General features                            | External coexistence (software interface)                   |
| General features                            | Independent reset (in-band) <sup>[^1]</sup>                 |
| General features                            | Network co-processor (NCP) mode <sup>[^2]</sup>             |
| General features                            | Vendor specific IE (custom IE)                              |
| General features                            | Hidden SSID (broadcast SSID disabled)                       |
| General features                            | MAC address filter                                          |
| General features                            | Multiple external STA support                               |

**Parent topic:**Wi-Fi radio

<sup>[^1]</sup> Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory. <sup>[^2]</sup> Read more about NCP feature in [References](#).

**AP-STA mode**

| Features                                     | Sub features                               | 88W8987 | IW416 | IW611/IW612 | RW610/RW611 | IW612 | AW611 |
|----------------------------------------------|--------------------------------------------|---------|-------|-------------|-------------|-------|-------|
| Simultaneous AP-STA operation (same channel) | AP-STA functionality                       | Y       | Y     | Y           | Y           | Y     | Y     |
| SAD                                          | Software antenna diversity <sup>[^1]</sup> | Y       | Y     | Y           | Y           | Y     | Y     |

**Parent topic:**Wi-Fi radio

<sup>[^1]</sup> Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature.

**Parent topic:**[Features](#)

### Wi-Fi Generic features

| Features | Sub features                                 | 88W8987 | IW416 | IW611/IW612 | RW610/RW611 | IW612 | AW611 |
|----------|----------------------------------------------|---------|-------|-------------|-------------|-------|-------|
| Generic  | Firmware download (parallel) <sup>[^1]</sup> | Y       | Y     | Y           | N           | N     | Y     |
| Generic  | Secure boot                                  | N       | N     | Y           | Y           | Y     | Y     |
| Generic  | Kconfig memory optimizer                     | Y       | Y     | Y           | Y           | Y     | Y     |
| Generic  | Firmware Compression <sup>[^2]</sup>         | N       | Y     | N           | N           | N     | N     |
| Generic  | u-AP intra-BSS                               | Y       | N     | Y           | Y           | Y     | Y     |
| Generic  | Net Monitor Mode                             | N       | N     | N           | Y           | Y     | N     |
| Generic  | Net Monitor Mode with packet transmission    | N       | N     | N           | Y           | Y     | N     |
| Generic  | In-Channel Net Monitor mode                  | N       | N     | N           | N           | N     | N     |

**Parent topic:**Wi-Fi radio

<sup>[^1]</sup> Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature. <sup>[^2]</sup> The feature is used to compress the Wi-Fi Bluetooth firmware and optimize the flashing of the host

### Wi-Fi direct/P2P

| Features                                | Sub features | 88W8987 | IW416 <sup>[^1]</sup> | IW611/IW612 | RW610/RW611 | IW612 <sup>[^1]</sup> | AW611 <sup>[^3]</sup> |
|-----------------------------------------|--------------|---------|-----------------------|-------------|-------------|-----------------------|-----------------------|
| P2P basic functionality <sup>[^1]</sup> | P2P Auto GO  | Y       | Y                     | Y           | Y           | Y                     | Y                     |
| P2P basic functionality <sup>[^1]</sup> | P2P GO       | Y       | Y                     | Y           | Y           | Y                     | Y                     |
| P2P basic functionality <sup>[^1]</sup> | P2P GC       | Y       | Y                     | Y           | Y           | Y                     | Y                     |

**Parent topic:**Wi-Fi radio

<sup>[^1]</sup> Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature. <sup>[^2]</sup> This is an experimental software release for this feature for IW416. <sup>[^3]</sup> Contact your support representative to use this feature for.

## Bluetooth radio

## Bluetooth classic

| Feature                         |          |       | Sub feature                                                                  | 88W8 | IW4' | IW611/ | RW610/ | IW6' | AW611 |
|---------------------------------|----------|-------|------------------------------------------------------------------------------|------|------|--------|--------|------|-------|
| General features                | fea-     | tures | Bluetooth Class 1.5 and Class 2 support                                      | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Scatternet support                                                           | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Maximum of seven simultaneous ACL connections – Central links                | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Automatic packet type selection                                              | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Bluetooth - 2.1 to 5.0 specification support                                 | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Low power sniff                                                              | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Deep sleep using out-of-band                                                 | Y    | Y    | N      | N      | N    | N     |
| General features                | fea-     | tures | Wake on Bluetooth (SoC to host)                                              | Y    | Y    | Y      | N      | N    | Y     |
| General features                | fea-     | tures | Independent reset (in-band) <sup>[^1]</sup>                                  | Y    | Y    | Y      | Y      | N    | Y     |
| General features                | fea-     | tures | Independent reset (out-band) <sup>[^1]</sup>                                 | Y    | Y    | N      | N      | N    | N     |
| General features                | fea-     | tures | Firmware download (parallel) <sup>[^1]</sup>                                 | Y    | Y    | N      | N      | N    | N     |
| General features                | fea-     | tures | RF test mode                                                                 | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth packet type supported | type     |       | ACL (DM1, DH1, DM3, DH3, DM5, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5) | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth packet type supported | type     |       | SCO (HV1, HV3)                                                               | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth packet type supported | type     |       | eSCO (EV3, EV4, EV5, 2EV3, 3EV3, 2EV5, 3EV5)                                 | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | A2DP source/sink                                                             | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | AVRCP target/controller                                                      | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | HFP Dev/AG                                                                   | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | OPP server/client                                                            | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | SPP server/client                                                            | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth profiles supported    | profiles | sup-  | HID target/device                                                            | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth audio features        | audio    |       | PCM NBS central/peripheral                                                   | Y    | Y    | Y      | N      | N    | Y     |
| Bluetooth audio features        | audio    |       | PCM WBS central/peripheral                                                   | Y    | Y    | Y      | N      | N    | Y     |



**Parent topic:**Bluetooth radio

**[^1]** Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

### Bluetooth LE

| Features                            | Sub features                                       |
|-------------------------------------|----------------------------------------------------|
| Generic features                    | Maximum 16 Bluetooth LE connections (central role) |
| Generic features                    | Deep sleep using out-of-band                       |
| Generic features                    | Wake on Bluetooth LE (SoC to Host)                 |
| Generic features                    | RF Test mode                                       |
| Bluetooth profile support           | Bluetooth LE GATT                                  |
| Bluetooth profile support           | Bluetooth LE HID over GATT                         |
| Bluetooth profile support           | Bluetooth LE GAP                                   |
| Bluetooth LE 4.0 support            | Low Energy physical layer                          |
| Bluetooth LE 4.0 support            | Low Energy link layer                              |
| Bluetooth LE 4.0 support            | Enhancements to HCI for Low Energy                 |
| Bluetooth LE 4.0 support            | Low energy direct test mode                        |
| Bluetooth 4.1 support               | Low duty cycle directed advertising                |
| Bluetooth 4.1 support               | Bluetooth LE dual mode topology                    |
| Bluetooth 4.1 support               | Bluetooth LE privacy v1.1                          |
| Bluetooth 4.1 support               | Bluetooth LE link layer topology                   |
| Bluetooth 4.2 support               | Bluetooth LE secure connection                     |
| Bluetooth 4.2 support               | Bluetooth LE link layer privacy v1.2               |
| Bluetooth 4.2 support               | Bluetooth LE data length extension                 |
| Bluetooth 4.2 support               | Link layer extended scanner filter policies        |
| Bluetooth 5.0 support               | Bluetooth LE 2 Mbps support                        |
| Bluetooth 5.0 support               | High duty cycle directed advertising               |
| Bluetooth 5.0 support               | Low Energy advertising extension                   |
| Bluetooth 5.0 support               | Low Energy long range                              |
| Bluetooth 5.0 support               | Low Energy periodic advertisement                  |
| Bluetooth 5.2 support               | Low Energy power control                           |
| Bluetooth LE audio support[^1] [^2] | Isochronous channel                                |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio BIS source                      |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio BIS sink                        |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio BIG Validation                  |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio Phy: 1M/2M/ coded               |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio framed mode                     |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio unframed mode                   |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio sequential packing              |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio: Mono and Stereo                |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio BIS encrypted audio             |
| Bluetooth LE audio support[^1] [^2] | Broadcast LE Audio BIS unencrypted audio           |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIS source                        |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIS sink                          |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIG validation                    |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIS synchronization               |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio Phy: 1M/2M/ coded                 |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio framed mode                       |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio unframed mode                     |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio sequential packing                |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio: mono and stereo                  |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIS encrypted audio               |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio CIS unencrypted audio             |
| Bluetooth LE audio support[^1] [^2] | Unicast LE Audio TX/RX and bidirectional traffic   |



Table 3 – continued from prev

| Features                                                   | Sub features                                             |
|------------------------------------------------------------|----------------------------------------------------------|
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | ISO interval for LE Audio: 7.5ms 10ms 20ms 30ms          |
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | Sampling frequency for LE Audio: 8kHz 16kHz 24kHz, 32kHz |
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | LE Audio Auracast use cases: Auracast streaming 2 BISes  |
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | LE Audio Unicast use cases: Unicast streaming 2 CISes    |
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | LE Audio Unicast Use cases: Unicast streaming 4 CISes    |
| Bluetooth LE audio support <sup>[^1]</sup> <sup>[^2]</sup> | A2DP + Auracast/Unicast Bridge use cases – CIS/BIS       |
| BCA TDM Coexistence mode (shared antenna)                  | STA + Bluetooth coexistence                              |
| BCA TDM Coexistence mode (shared antenna)                  | STA + Bluetooth LE coexistence                           |
| BCA TDM Coexistence mode (shared antenna)                  | STA + Bluetooth + Bluetooth LE coexistence               |
| BCA TDM Coexistence mode (shared antenna)                  | AP + Bluetooth coexistence                               |
| BCA TDM Coexistence mode (shared antenna)                  | AP + Bluetooth LE coexistence                            |
| BCA TDM Coexistence mode (shared antenna)                  | AP + Bluetooth + Bluetooth LE coexistence                |
| BCA TDM coexistence mode (separate antenna)                | STA + Bluetooth coexistence                              |
| BCA TDM coexistence mode (separate antenna)                | STA + Bluetooth LE coexistence                           |
| BCA TDM coexistence mode (separate antenna)                | STA + Bluetooth + Bluetooth LE coexistence               |
| BCA TDM coexistence mode (separate antenna)                | AP + Bluetooth coexistence                               |
| BCA TDM coexistence mode (separate antenna)                | AP + Bluetooth LE coexistence                            |
| BCA TDM coexistence mode (separate antenna)                | AP + Bluetooth + Bluetooth LE coexistence                |

**Note:** Details of the tested Bluetooth LE Audio use cases:

- Number of streams:
  - 1-CIG | upto 4-CIS with 1 LE ACL (for 4-CIS: execute only mono UCs, SDU Int: 10ms)
  - 1-CIG | upto 4-CIS with 4 separate LE ACL (for 4-CIS: SDU Size= Max 100 Oct, PHY=2M, RTN=1, SDU Int: 10ms only) (execute only mono UCs for 4-CIS)
  - 1-BIG | upto 4-BIS (for 4-BIS: execute only mono UCs, SDU Int: 10ms only)
- PHY: 2M and 1M
- Audio mode: mono (for 1 to 4 streams) and stereo (for 1 stream)
- Packing: sequential and interleaved
- Bit rate: maximum 96kbps
  - For 1-CIG with upto 3-CIS: maximum bit rate 96kbps
  - For 1-CIG with 4-CIS: maximum bit rate 80kbps
  - For 1-BIG with 4-BIS: maximum bit rate 80kbps
  - For 2-CIG cases: maximum bit rate 80kbps
- Mode: unframed mode
- 48\_5 and 48\_6 mono and stereo configurations are not supported.

Details of the tested Bluetooth coexistence (Bluetooth + Bluetooth LE Audio) use cases:

- Bluetooth + Bluetooth LE Audio
- A2DP + Bluetooth LE Audio bridging support
- A2DP sink link (central) -> LEA 2-CIS (SDU Int: 10ms only | A2DP only with SBC Codec | PHY: 2M)

**Parent topic:**Bluetooth radio

<sup>[^1]</sup> Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

<sup>[^2]</sup> LE audio feature is supported for standalone scenarios only and not for BR/EDR and Wi-Fi coexistence scenarios such as LE audio + BR/EDR link or LE audio + Wi-Fi link. From the

perspective of NXP Edgefast Bluetooth host stack, LE audio feature can be disabled by the CONFIG\_BT\_AUDIO macro without impact on any other features. LE audio feature can be tested by the user, using their own supported host stack.

**Parent topic:** [Features](#)

#### 802.15.4 radio

| Features        | Sub features                                         | IW612 | IW610 | RW612 |
|-----------------|------------------------------------------------------|-------|-------|-------|
| General tures   | fea- Spinel over SPI                                 | Y     | N     | N     |
| General tures   | fea- OpenThread RCP Mode implementing Thread1.3      | Y     | N     | N     |
| General tures   | fea- 802.15.4-2015 MAC/PHY as required by Thread 1.3 | Y     | Y     | Y     |
| General tures   | fea- OpenThread Border Router (OTBR) v1.1            | Y     | Y     | Y     |
| General tures   | fea- Direct/indirect transmission with/without ACK   | Y     | Y     | Y     |
| General tures   | fea- 802.15.4 CSL parent feature implementation      | Y     | Y     | Y     |
| General tures   | fea- Enhanced Frame Pending                          | Y     | Y     | Y     |
| General tures   | fea- Enhanced keep alive                             | Y     | Y     | Y     |
| General tures   | fea- Router                                          | Y     | Y     | Y     |
| General tures   | fea- Leader                                          | Y     | Y     | Y     |
| General tures   | fea- Router Eligible End Device (REED)               | Y     | Y     | Y     |
| General tures   | fea- End Device (FED, MED)                           | Y     | Y     | Y     |
| Zigbee features | Coordinator                                          | N     | N     | Y     |
| Zigbee features | Router                                               | N     | N     | Y     |
| Zigbee features | End Device (RX ON)                                   | N     | N     | Y     |
| Zigbee features | R23                                                  | N     | N     | Y     |
| Zigbee features | OTA Client                                           | N     | N     | Y     |
| Zigbee features | OTA server                                           | N     | N     | Y     |
| Matter features | Matter over Wi-Fi                                    | Y     | N     | N     |
| Matter features | Matter over Thread                                   | Y     | N     | Y     |

**Parent topic:** [Features](#)

#### Coexistence

## Wi-Fi and Bluetooth/802.15.4 coexistence

| Features                                                                                                         | Sub features                                  | IW6' | IW6' | RW612 |
|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|------|------|-------|
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | STA + Bluetooth                               | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Mobile AP + Bluetooth                         | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Bluetooth LE + Wi-Fi                          | Y    | Y    | Y     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Bluetooth + Bluetooth LE + Wi-Fi              | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | OpenThread + Bluetooth                        | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | OpenThread + Bluetooth LE <sup>[^2]</sup>     | Y    | Y    | Y     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | OpenThread + Bluetooth LE                     | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | OpenThread + Wi-Fi                            | Y    | Y    | Y     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Bluetooth + OpenThread + Wi-Fi                | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Bluetooth LE + OpenThread + Wi-Fi             | Y    | Y    | Y     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Bluetooth + Bluetooth LE + OpenThread + Wi-Fi | Y    | N    | N     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | Single antenna configuration                  | Y    | Y    | Y     |
| BCA_TDM separate antenna <sup>[^1]</sup> (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared) | External Coexistence PTA                      | N    | Y    | Y     |

**Parent topic:**Coexistence

<sup>[^1]</sup> Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

<sup>[^2]</sup> The narrow-band radio can be configured to support Bluetooth LE, 802.15.4, and to time-slice between Bluetooth LE and 802.15.4.

**Parent topic:**[Features](#)

## Feature enable and memory impact

| Features                                 | Macros to enable the feature                                                                                                                                                                  | Memory impact                          |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| CSI                                      | CONFIG_CSI                                                                                                                                                                                    | Flash<br>- 60K,<br>RAM -<br>4K         |
| DPP                                      | CONFIG_WPA_SUPP_DPP                                                                                                                                                                           | Flash -<br>240K,<br>RAM -<br>12K       |
| Independent reset                        | CONFIG_WIFI_IND_DNLDCONFIG_WIFI_IND_RESET                                                                                                                                                     | Minimal                                |
| Parallel firmware download Wi-Fi         | CONFIG_WIFI_IND_DNLD                                                                                                                                                                          | Minimal                                |
| Parallel firmware download Bluetooth     | CONFIG_BT_IND_DNLD                                                                                                                                                                            | Minimal                                |
| WPA3 enterprise                          | CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME | Flash -<br>165K,<br>RAM -<br>18K       |
| WPA2 enterprise                          | CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME | Flash -<br>165K,<br>RAM -<br>18K       |
| Host sleep                               | CONFIG_HOST_SLEEP                                                                                                                                                                             | Minimal                                |
| WMM                                      | CONFIG_WMM <sup>[^1]</sup>                                                                                                                                                                    | Flash<br>- 10K,<br>RAM -<br>57K        |
| 802.11mc                                 | CONFIG_11MC CONFIG_CSI CONFIG_WLS_CSI_PROC <sup>[^2]</sup> CONFIG_11AZ                                                                                                                        | Flash:<br>52.78KB,<br>RAM :<br>121.1KB |
| 802.11az                                 | CONFIG_11MC CONFIG_CSI <sup>[2]</sup> CONFIG_WLS_CSI_PROC <sup>[^2]</sup> CONFIG_11AZ                                                                                                         | Flash:<br>52.78KB,<br>RAM :<br>121.1KB |
| Non-blocking firmware download mechanism | CONFIG_FW_DNLD_ASYNC                                                                                                                                                                          | —                                      |
| Antenna diversity                        | CONFIG_WLAN_CALDATA_2ANT_DIVERSITY                                                                                                                                                            | -                                      |
| P2P                                      | CONFIG_WPA_SUPP_P2P                                                                                                                                                                           | -                                      |

**Note:**

- For Wi-Fi, the macros are set with the value “0” by default in the file wifi\_config\_default.h located in <SDK\_PATH>/middleware/wifi\_nxp/incl/ directory.

To enable the features, set the value of the macros to “1\*” in the file wifi\_config.h located in \*<SDK\_Wi-Fi\_Example\_PATH>/ directory\*\*\*.\*\*\*

- Bluetooth

To enable the features, set the value of the macros to “1” in the file `app_bluetooth_config.h` located in `<SDK_Bluetooth_Example_PATH>/` directory.

**Kconfig memory optimizer** The MCUXpresso SDK provides options to reduce the host memory usage with build-time configuration parameters referred to as Kconfig memory optimizer. The configuration parameters are used to reduce the use of the flash memory and SRAM.

This section explains how to enable the host memory saving configurations within the Wi-Fi drivers of NXP wireless devices.

Memory impact of i.MX RT1060 EVKC + IW416 module (Murata 1XK):

- Maximum Flash usage: 889 KB
- Maximum SRAM usage: 418.77 KB

To reduce the use of the flash and SRAM, change the settings of the Kconfig macros listed in table in the file `wifi_config.h` located in `<path-to-SDK_Wi-Fi_Example>` directory.

| Kconfig macros                                        | Feature disabled                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CON-<br>FIG_WIFI_SL]                                  | CONFIG_ROAMING CONFIG_11R                                                                                                                                                                                                                                             |
| CON-<br>FIG_WIFI_SL]                                  | CONFIG_CLOUD_KEEP_ALIVE CONFIG_WIFI_EU_CRYPTO CON-<br>FIG_TX_AMPDU_PROT_MODE CONFIG_WNM_PS CONFIG_TURBO_MODE<br>CONFIG_AUTO_RECONNECT CONFIG_DRIVER_OWE CONFIG_OWE<br>CONFIG_WIFI_FORCE_RTS CONFIG_WIFI_FRAG_THRESHOLD CON-<br>FIG_COMBO_SCAN CONFIG_SCAN_CHANNEL_GAP |
| CON-<br>FIG_WIFI_SL]                                  | CONFIG_UAP_STA_MAC_ADDR_FILTER CONFIG_WIFI_MAX_CLIENTS_CNT                                                                                                                                                                                                            |
| CON-<br>FIG_FREERTC                                   | If the macro is enabled, the heap memory usage is reduced by 10 KB (from 70 KB to 60 KB).                                                                                                                                                                             |
| CON-<br>FIG_LWIP_LC                                   | Curtails LWIP stack parameters, reduces data throughput, disables data net-<br>stats                                                                                                                                                                                  |
| Non-<br>blocking<br>firmware<br>download<br>mechanism | CONFIG_FW_DNLD_ASYNC                                                                                                                                                                                                                                                  |

**Parent topic:** [Feature enable and memory impact](#)

[^1] The macro is not used for IW416.

[^2] Prerequisite macros for 802.11mc and 802.11az features

## 88W8987 release notes

### Package information

- SDK version: 25.06.00

**Parent topic:** [88W8987 release notes](#)

### Version information

- Wireless SoC: 88W8987
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 16.92.21.p151.7
  - 16 - Major revision
  - 91 - Feature pack
  - 21 - Release version
  - p151.7 - Patch number

**Parent topic:**[88W8987 release notes](#)

### Host platform

- All i.MX RT platforms running FreeRTOS.
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:**[88W8987 release notes](#)

**Wi-Fi and Bluetooth certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | 802.11ac
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | QTT

Refer to 6.

**Note:** This release supports STAUT only certifications.

**Parent topic:**Wi-Fi and Bluetooth certification

**Bluetooth controller certification** QDID: refer to 4.

**Parent topic:**Wi-Fi and Bluetooth certification

**Parent topic:**[88W8987 release notes](#)

### Wi-Fi throughput

### Throughput test setup

- Environment: Shield Room - Over the Air
- External Access Point: ASUS AX88U
- DUT: W8987 Murata (Module: **1ZM M.2**) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- External Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi\_wpa\_supPLICant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

#### TCP TX

```
iperf -c <remote_ip> -t 60
```

#### TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 2.

**Parent topic:**Wi-Fi throughput

### STA throughput External APs: ASUS AX88U

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 46           | 51 | 60           | 60 |
| WPA2-AES     | 45           | 42 | 60           | 54 |
| WPA3-SAE     | 46           | 41 | 60           | 54 |

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |     |
|--------------|--------------|----|--------------|-----|
| Direction    | TX           | RX | TX           | RX  |
| OpenSecurity | 62           | 83 | 121          | 124 |
| WPA2-AES     | 61           | 82 | 120          | 126 |
| WPA3-SAE     | 60           | 82 | 120          | 126 |

#### STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 52           | 60           | 64           |
| WPA2-AES     | 43           | 52           | 61           | 64           |
| WPA3-SAE     | 43           | 52           | 60           | 65           |

#### STA mode throughput - AN Mode | 5 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 64           | 87           | 126          | 125          |
| WPA2-AES     | 63           | 85           | 125          | 120          |
| WPA3-SAE     | 63           | 80           | 125          | 123          |

#### STA mode throughput - AC Mode | 5 GHz Band | 20 MHz (VHT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 48           | 60           | 73           | 78           |
| WPA2-AES     | 47           | 60           | 73           | 77           |
| WPA3-SAE     | 47           | 60           | 73           | 77           |

#### STA mode throughput - AC Mode | 5 GHz Band | 40 MHz (VHT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 68           | 96           | 161          | 157          |
| WPA2-AES     | 69           | 92           | 160          | 155          |
| WPA3-SAE     | 70           | 94           | 160          | 155          |

#### STA mode throughput - AC Mode | 5 GHz Band | 80 MHz (VHT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 78           | 99           | 125          | 203          |
| WPA2-AES     | 78           | 98           | 126          | 197          |
| WPA3-SAE     | 82           | 98           | 125          | 197          |

**Parent topic:**Wi-Fi throughput

**Mobile AP throughput** External client: Apple Macbook Air

#### Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 51           | 56           | 62           |
| WPA2-AES     | 42           | 50           | 54           | 61           |
| WPA3-SAE     | 40           | 50           | 65           | 62           |



**Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 66           | 81           | 107          | 121          |
| WPA2-AES     | 65           | 80           | 107          | 120          |
| WPA3-SAE     | 65           | 80           | 108          | 120          |

**Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 44           | 52           | 60           | 61           |
| WPA2-AES     | 44           | 51           | 60           | 61           |
| WPA3-SAE     | 44           | 51           | 60           | 61           |

**Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 70           | 89           | 126          | 103          |
| WPA2-AES     | 70           | 87           | 124          | 102          |
| WPA3-SAE     | 70           | 88           | 125          | 103          |

**Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 49           | 60           | 73           | 76           |
| WPA2-AES     | 48           | 59           | 73           | 76           |
| WPA3-SAE     | 48           | 60           | 73           | 76           |

**Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 77           | 106          | 161          | 102          |
| WPA2-AES     | 77           | 104          | 160          | 102          |
| WPA3-SAE     | 77           | 104          | 160          | 111          |

**Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 80 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 93           | 114          | 125          | 206          |
| WPA2-AES     | 92           | 111          | 125          | 191          |
| WPA3-SAE     | 92           | 111          | 125          | 173          |

Parent topic:Wi-Fi throughput

Parent topic:[88W8987 release notes](#)

**EU conformance tests**

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

**Parent topic:**[88W8987 release notes](#)

**Bug fixes and/or feature enhancements****Firmware version: From 16.91.21.p64.1 to 16.91.21.p82**

| Com-<br>po-<br>nent | Description                                                                                                                                                                                                       |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi               | WPA3-R3 enabled APUT beacons does not have RSNXE when configured in H2E mode-Associated event is received even when connecting using wrong password WFA APUT Low iperf TCP/UDP Tx throughput with Realtek station |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p82 to 16.91.21.p91.6**

| Compo-<br>nent | Description                                                                                         |
|----------------|-----------------------------------------------------------------------------------------------------|
| Wi-Fi          | In wrong password scenario, After updating new password the phone is not able to connect with DUTAP |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p91.6 to 16.91.21.p124**

| Compo-<br>nent | Description                                                                                                       |
|----------------|-------------------------------------------------------------------------------------------------------------------|
| Wi-Fi          | Cloud keep alive packets not seen after DUT enters host sleep. DUT is sending QOS null packets even in host sleep |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p124 to 16.91.21.p133**

| Com-<br>ponent | Description                                                                                                              |
|----------------|--------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi          | Samsung S24 Ultra and Google Pixel 7 mobiles having Android 14 are not able connect to the DUTAP with WPA3 SAE security. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p133 to 16.91.21.p142.5**  
**{#firmware\_version\_from\_16\_91\_21\_p133\_to\_16\_91\_21\_p142\_5}**

| Component | Description                                                                        |
|-----------|------------------------------------------------------------------------------------|
| Wi-Fi     | Fails to encrypt and decrypt data with ccmp 128 and 256 using CLI crypto commands. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p142.5 to 16.91.21.p149.2**  
**{#firmware\_version\_from\_16\_91\_21\_p142\_5\_to\_16\_91\_21\_p149\_2}**

| Component | Description                                                        |
|-----------|--------------------------------------------------------------------|
| Wi-Fi     | DUTSTA does not associate to hidden SSID beaconing in DFS channel. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p149.2 to 16.92.21.p151.7**  
**{#firmware\_version\_from\_16\_91\_21\_p149\_2\_to\_16\_92\_21\_p151\_7}**

| Component | Description                                                                      |
|-----------|----------------------------------------------------------------------------------|
| Wi-Fi     | Getting low TCP/UDP TP in DUT-AP 11ac-vht80 mode after hard-reset or wlan-reset. |

**Parent topic:**Bug fixes and/or feature enhancements

**Parent topic:**[88W8987 release notes](#)

#### Known issues

| Component | Description |
|-----------|-------------|
| -         | NA          |

**Parent topic:**[88W8987 release notes](#)

## IW416 release notes

### Package information

- SDK version: 25.06.00

**Parent topic:**[IW416 release notes](#)

### Version information

- Wireless SoC: IW416
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 16.92.21.p151.7
  - 16 - Major revision

- 92 - Feature pack
- 21 - Release version
- p151.7 - Patch number

**Parent topic:**[IW416 release notes](#)

### Host platform

- All i.MX RT platforms running FreeRTOS.
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 Support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:**[IW416 release notes](#)

**Wi-Fi and Bluetooth certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | QTT

Refer to 6.

**Note:** This release supports STAUT only certifications.

**Parent topic:**Wi-Fi and Bluetooth certification

**Bluetooth controller certification** QDID: refer to 4.

**Note:** QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

**Parent topic:**Wi-Fi and Bluetooth certification

**Parent topic:**[IW416 release notes](#)

### Wi-Fi throughput

### Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW416 Murata (Module: 1XK M.2) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi\_wpa\_supPLICant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

#### TCP TX

```
iperf -c <remote_ip> -t 60
```

#### TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 2.

**Parent topic:** Wi-Fi throughput

### STA throughput External AP: Asus AX88u

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 39           | 38           | 59           | 58           |
| WPA2-AES     | 38           | 36           | 57           | 58           |
| WPA3-SAE     | 41           | 35           | 57           | 57           |

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 58           | 58           | 93           | 91           |
| WPA2-AES     | 56           | 49           | 94           | 74           |
| WPA3-SAE     | 54           | 57           | 94           | 73           |

#### STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 45           | 61           | 58           |
| WPA2-AES     | 40           | 43           | 61           | 57           |
| WPA3-SAE     | 40           | 44           | 61           | 57           |

#### STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 60           | 66           | 94           | 100          |
| WPA2-AES     | 58           | 61           | 94           | 98           |
| WPA3-SAE     | 59           | 61           | 94           | 98           |

Parent topic: Wi-Fi throughput

#### Mobile AP throughput External client: Apple MacBook Air

##### Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 43           | 59           | 57           |
| WPA2-AES     | 40           | 42           | 59           | 57           |
| WPA3-SAE     | 39           | 42           | 59           | 57           |

##### Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 62           | 74           | 121          | 118          |
| WPA2-AES     | 60           | 64           | 116          | 91           |
| WPA3-SAE     | 60           | 65           | 116          | 91           |

##### Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 50           | 42           | 45           | 62           |
| WPA2-AES     | 42           | 45           | 53           | 62           |
| WPA3-SAE     | 42           | 62           | 53           | 45           |

##### Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 66           | 76           | 126          | 96           |
| WPA2-AES     | 63           | 68           | 121          | 95           |
| WPA3-SAE     | 63           | 67           | 121          | 95           |

**Parent topic:**Wi-Fi throughput

**Parent topic:**[IW416 release notes](#)

#### EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

**Parent topic:**[IW416 release notes](#)

#### Bug fixes and/or feature enhancements

##### Firmware version: From 16.91.21.p64.1 to 16.91.21.p82

| Component | Description                                                                  |
|-----------|------------------------------------------------------------------------------|
| Wi-Fi     | WPA3-R3 enabled APUT beacons does not have RSNXE when configured in H2E mode |

**Parent topic:**Bug fixes and/or feature enhancements

##### Firmware version: From 16.91.21.p82 to 16.91.21.p91.6

| Component | Description |
|-----------|-------------|
| Wi-Fi     | NA          |

**Parent topic:**Bug fixes and/or feature enhancements

##### Firmware version: From 16.91.21.p91.6 to 16.91.21.p124

| Component | Description                                                                                                       |
|-----------|-------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | Cloud keep alive packets not seen after DUT enters host sleep. DUT is sending QOS null packets even in host sleep |

**Parent topic:**Bug fixes and/or feature enhancements

##### Firmware version: From 16.91.21.p124 to 16.91.21.p133

| Component | Description |
|-----------|-------------|
| Wi-Fi     | NA          |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p133 to 16.91.21.p133.2**  
**{#firmware\_version\_from\_16\_91\_21\_p133\_to\_16\_91\_21\_p133\_2}**

| Component | Description                                                                                                                         |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | DUT STA getting rebooted after 15~20 iterations of 11R-Command based roaming0xa4 command timeout after several hours of stress test |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p133.2 to 16.91.21.p142.5**  
**{#firmware\_version\_from\_16\_91\_21\_p133\_2\_to\_16\_91\_21\_p142\_5}**

| Component | Description                                                               |
|-----------|---------------------------------------------------------------------------|
| Wi-Fi     | DUT fails to reconnect after the configured auto-reconnect time interval. |
| Coex      | During HFP call, TX side noise is observed with coex CLI                  |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p142.5 to 16.91.21.p149.4**  
**{#firmware\_version\_from\_16\_91\_21\_p142\_5\_to\_16\_91\_21\_p149\_4}**

| Component | Description |
|-----------|-------------|
| -         | NA          |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: From 16.91.21.p149.4 to 16.92.21.p151.7**  
**{#firmware\_version\_from\_16\_91\_21\_p149\_4\_to\_16\_92\_21\_p151\_7}**

| Component | Description                                                                                                              |
|-----------|--------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | Samsung S24 Ultra and Google Pixel 7 mobiles having Android 14 are not able connect to the DUTAP with WPA3 SAE security. |

**Parent topic:**Bug fixes and/or feature enhancements

**Parent topic:**[IW416 release notes](#)

### Known issues

| Component | Description                                                                       |
|-----------|-----------------------------------------------------------------------------------|
| Coex      | Wi-Fi connection in 2.4GHz is not stable, observed deauthentication within 10sec. |

**Parent topic:**[IW416 release notes](#)

**IW611/IW612 release notes** **Note:** The IW611/IW612 support is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.



### Package information

- SDK version: 25.06.00

**Parent topic:** [IW611/IW612 release notes](#)

### Version information

- Wireless SoC: IW611/IW612
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.3.p25.11
  - 18 - Major revision
  - 99 - Feature pack
  - 3 - Release version
  - p25.11 - Patch number

**Parent topic:** [IW611/IW612 release notes](#)

### Host platform

- i.MX RT1170 EVKB and i.MX RT1060 EVKC Platforms running FreeRTOS
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
  - 802.15.4 over SPI (IW612 only)
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:** [IW611/IW612 release notes](#)

**Wi-Fi and Bluetooth certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to 6.

**Note:** This release supports STAUT only certifications.

**Parent topic:** Wi-Fi and Bluetooth certification

**Bluetooth controller certification** QDID: refer to 4.

**Note:** QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

**Parent topic:** Wi-Fi and Bluetooth certification

**Parent topic:** [IW611/IW612 release notes](#)

## Wi-Fi throughput

### Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW612 Murata (Module: 2EL M.2) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi\_wpa\_supplicant
- Compiler used to build application: armgcc
- Compiler Version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

#### TCP TX

```
iperf -c <remote_ip> -t 60
```

#### TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 2

The throughput numbers are captured with default configurations using *wifi\_wpa\_supplicant* sample application.

**Parent topic:** Wi-Fi throughput

### iPerf host configuration and impact on throughput [{#iperf\\_host\\_configuration\\_and\\_impact\\_on\\_throughput}](#)

To get the highest throughput, the throughput values shown in STA throughput and Mobile AP throughput are measured with the maximum values of the default host configuration macros. STA and AP throughput captured with the minimum values of the host configuration macros shows the throughput numbers obtained when using the minimum values of the host configuration macros. The macro values are defined in *lwipopts.h* file.

The table below lists the minimum and maximum values of the host configuration macros.

**Values of the host configuration macros**

| Parameter                 | Maximum value | Minimum value |
|---------------------------|---------------|---------------|
| TCPIP_MBOX_SIZE           | 96            | 32            |
| DEFAULT_RAW_RECVMBOX_SIZE | 32            | 12            |
| DEFAULT_UDP_RECVMBOX_SIZE | 64            | 12            |
| DEFAULT_TCP_RECVMBOX_SIZE | 64            | 12            |
| TCP_MSS                   | 1460          | 536           |
| TCP_SND_BUF               | 24 * TCP_MSS  | 2 * TCP_MSS   |
| MEM_SIZE                  | 319160        | 41,080        |
| TCP_WND                   | 15 * TCP_MSS  | 10 * TCP_MSS  |
| MEMP_NUM_PBUF             | 20            | 10            |
| MEMP_NUM_TCP_SEG          | 96            | 12            |
| MEMP_NUM_TCPIP_MSG_INPKT  | 80            | 16            |
| MEMP_NUM_TCPIP_MSG_API    | 80            | 8             |
| MEMP_NUM_NETBUF           | 32            | 16            |

**STA and AP throughput captured with the minimum values of the host configuration macros**  
**STA mode throughput - HE Mode | 5 GHz Band | 80 MHz**

| Protocol      | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|---------------|--------------|--------------|--------------|--------------|
| Direction     | TX           | RX           | TX           | RX           |
| Open Security | 7            | 18           | 111          | 124          |
| WPA2-AES      | 7            | 18           | 110          | 124          |
| WPA3-SAE      | 6            | 18           | 110          | 124          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz**

| Protocol      | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|---------------|--------------|--------------|--------------|--------------|
| Direction     | TX           | RX           | TX           | RX           |
| Open Security | 2            | 19           | 93           | 127          |
| WPA2-AES      | 2            | 19           | 105          | 126          |
| WPA3-SAE      | 2            | 19           | 104          | 132          |

**Parent topic:**iPerf host configuration and impact on throughput

**Parent topic:**Wi-Fi throughput

**STA throughput** External AP: Asus AX88u

**STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 47           | 45           | 60           |
| WPA2-AES     | 43           | 46           | 48           | 59           |
| WPA3-SAE     | 47           | 49           | 63           | 63           |

**STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 68           | 82           | 131          | 131          |
| WPA2-AES     | 72           | 82           | 130          | 129          |
| WPA3-SAE     | 68           | 81           | 129          | 130          |

**STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 45           | 51           | 63           | 65           |
| WPA2-AES     | 45           | 51           | 63           | 65           |
| WPA3-SAE     | 45           | 51           | 63           | 65           |

**STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 67           | 83           | 129          | 134          |
| WPA2-AES     | 66           | 83           | 129          | 133          |
| WPA3-SAE     | 65           | 83           | 129          | 133          |

**STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 49           | 53           | 72           | 71           |
| WPA2-AES     | 48           | 52           | 73           | 70           |
| WPA3-SAE     | 52           | 56           | 75           | 75           |

**STA mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 74           | 88           | 172          | 172          |
| WPA2-AES     | 75           | 92           | 171          | 169          |
| WPA3-SAE     | 77           | 92           | 172          | 171          |

**STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 50           | 58           | 76           | 78           |
| WPA2-AES     | 49           | 57           | 76           | 77           |
| WPA3-SAE     | 49           | 57           | 76           | 77           |

**STA mode throughput - VHT Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 74           | 93           | 175          | 177          |
| WPA2-AES     | 74           | 93           | 174          | 174          |
| WPA3-SAE     | 73           | 93           | 173          | 175          |

**STA mode throughput - VHT Mode | 5 GHz Band | 80 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 88           | 94           | 221          | 196          |
| WPA2-AES     | 87           | 95           | 219          | 194          |
| WPA3-SAE     | 89           | 95           | 219          | 195          |

**STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 60           | 60           | 98           | 115          |
| WPA2-AES     | 62           | 61           | 94           | 113          |
| WPA3-SAE     | 61           | 59           | 97           | 108          |

**STA mode throughput - HE Mode | 2.4 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 77           | 71           | 215          | 190          |
| WPA2-AES     | 77           | 72           | 212          | 187          |
| WPA3-SAE     | 76           | 72           | 152          | 189          |

**STA mode throughput - HE Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 63           | 65           | 127          | 128          |
| WPA2-AES     | 63           | 67           | 125          | 128          |
| WPA3-SAE     | 63           | 67           | 125          | 126          |

**STA mode throughput - HE Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 79           | 64           | 212          | 199          |
| WPA2-AES     | 78           | 68           | 218          | 199          |
| WPA3-SAE     | 79           | 68           | 217          | 198          |

**STA mode throughput - HE Mode | 5 GHz Band | 80 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 88           | 70           | 219          | 192          |
| WPA2-AES     | 87           | 72           | 219          | 193          |
| WPA3-SAE     | 91           | 72           | 220          | 194          |

**Parent topic:**Wi-Fi throughput

**Mobile AP throughput** External client: Apple MacBook Air

**Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 52           | 61           | 62           |
| WPA2-AES     | 40           | 51           | 61           | 62           |
| WPA3-SAE     | 40           | 51           | 61           | 62           |

**Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 63           | 83           | 116          | 130          |
| WPA2-AES     | 67           | 82           | 115          | 131          |
| WPA3-SAE     | 60           | 81           | 115          | 132          |

**Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 39           | 49           | 60           | 62           |
| WPA2-AES     | 39           | 49           | 60           | 62           |
| WPA3-SAE     | 41           | 51           | 63           | 62           |

**Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 66           | 89           | 128          | 133          |
| WPA2-AES     | 64           | 87           | 128          | 133          |
| WPA3-SAE     | 62           | 86           | 128          | 133          |

**Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 44           | 60           | 74           | 75           |
| WPA2-AES     | 43           | 59           | 74           | 75           |
| WPA3-SAE     | 43           | 59           | 74           | 75           |

**Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 64           | 53           | 112          | 75           |
| WPA2-AES     | 65           | 51           | 111          | 75           |
| WPA3-SAE     | 62           | 51           | 112          | 75           |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 45           | 60           | 76           | 76           |
| WPA2-AES     | 44           | 59           | 76           | 76           |
| WPA3-SAE     | 44           | 59           | 76           | 76           |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 73           | 100          | 155          | 178          |
| WPA2-AES     | 72           | 99           | 152          | 176          |
| WPA3-SAE     | 72           | 99           | 152          | 176          |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 80 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 80           | 86           | 211          | 189          |
| WPA2-AES     | 84           | 87           | 223          | 188          |
| WPA3-SAE     | 83           | 94           | 224          | 192          |

**Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 53           | 66           | 85           | 123          |
| WPA2-AES     | 52           | 65           | 83           | 122          |
| WPA3-SAE     | 52           | 65           | 83           | 120          |

**Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 75           | 102          | 124          | 166          |
| WPA2-AES     | 74           | 100          | 121          | 148          |
| WPA3-SAE     | 73           | 101          | 121          | 154          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 54           | 68           | 84           | 124          |
| WPA2-AES     | 53           | 66           | 83           | 122          |
| WPA3-SAE     | 54           | 66           | 83           | 123          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 76           | 107          | 155          | 193          |
| WPA2-AES     | 75           | 105          | 152          | 192          |
| WPA3-SAE     | 76           | 106          | 151          | 191          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 86           | 118          | 220          | 187          |
| WPA2-AES     | 86           | 119          | 221          | 185          |
| WPA3-SAE     | 86           | 116          | 220          | 188          |

**Parent topic:**Wi-Fi throughput**Parent topic:**[IW611/IW612 release notes](#)**EU conformance tests**

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

**Parent topic:**[IW611/IW612 release notes](#)**Bug fixes and/or feature enhancements****Firmware version: 18.99.2.p7.19**

| Component | Description |
|-----------|-------------|
| -         | NA          |

**Parent topic:**Bug fixes and/or feature enhancements**Firmware version: 18.99.2.p7.19 to 18.99.2.p49.9**

| Component | Description |
|-----------|-------------|
| -         | NA          |

**Parent topic:**Bug fixes and/or feature enhancements



**Firmware version: 18.99.2.p49.9 to 18.99.2.p155**

| Component | Description                                                                                                                                                                   |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bluetooth | Audio lost occurs due to periodic adv sync lost, during 2 BIS 44.1kHz unencrypted streams with 1M PHY configuration.BIS sync loss may occur in long audio streaming sessions. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.2.p155 to 18.99.2.p66.30**

| Component | Description                                                                                                                                                                                                                                                                                                                 |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | 802.11R Fast BSS roaming works only with hostapd and does not work with standard APs (supporting 11R)                                                                                                                                                                                                                       |
| Bluetooth | DUT is not able to sustain a connection with the remote device that does extended advertisement with coded PHY configuration. When 2 CIS streams are active, after the first device disconnects followed by the second device disconnecting, the second peripheral device hangs.Audio Play/Pause does not work in BIS case. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.2.p66.30 to 18.99.3.p10.5**

| Component | Description                                                                                                                                                                                                                                                                                              |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | STAUT not sending Neighbor Advertisement packet after receiving Neighbor Solicitation packet from Ex-AP.Antenna selection time exceeds configured evaluation time                                                                                                                                        |
| Bluetooth | When DUT works as CIS source and CIS Offset is 612us, high packet drops observed which affects the audio streaming.For BIS Source Use Cases, Periodic Interval and ISO Interval should be multiple of each other value.In 1-CIS and 2-CIS, Continuous Audio Glitches are observed with 96 kbps bit rate. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.3.p10.5 to 18.99.3.p17.9**  
**{#firmware\_version\_18\_99\_3\_p10\_5\_to\_18\_99\_3\_p17\_9}**

| Component | Description                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi     | After performing independent reset (out-of-band mode), the STAUT fails to connect to the external AP via wlan-connect command, observed command timeout 0x107 error.                                                                                                                                                                                                                                            |
| Bluetooth | Audio glitches observed with Google Pixel 7 Pro streaming audio after CIS is established with DUT.During Call Gateway (CG) / Call Terminal (CT) Use Case, the firmware periodically sends NULL PDU, which results in frequent Audio Glitch on both CG and CT sides.Heavy audio glitches observed with CIS SRC Google Pixel 7 ProContinuous audio glitches observed in 1 CIS and 2 CIS for 48_3 and 48_4 config. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.3.p17.9 to 18.99.3.p21.154**  
**{#firmware\_version\_18\_99\_3\_p17\_9\_to\_18\_99\_3\_p21\_154}**

| Component | Description                                                                                         |
|-----------|-----------------------------------------------------------------------------------------------------|
| Wi-Fi     | STAUT fail to ping AP backend machine when connected with DFS channel and DUTSTA went in bad state. |
| Bluetooth | CIS Sink frequently fails to acknowledge CIS Source TX PDU.                                         |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.3.p21.154 to 18.99.3.p23.16**  
**{#firmware\_version\_18\_99\_3\_p21\_154\_to\_18\_99\_3\_p23\_16}**

| Component | Description |
|-----------|-------------|
| -         | NA          |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.3.p23.16 to 18.99.3.p25.11**  
**{#firmware\_version\_18\_99\_3\_p23\_16\_to\_18\_99\_3\_p25\_11}**

| Component | Description                                                 |
|-----------|-------------------------------------------------------------|
| Bluetooth | Packet lost observed in CIS case, which causes audio noise. |

**Parent topic:**Bug fixes and/or feature enhancements

**Parent topic:**[IW611/IW612 release notes](#)

### Known issues

| Component | Description                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bluetooth | Sequential Removal of CIS Handles as per current Controller implementation i.e CIS Disconnection sequence should be in sequence => CIS - 4,3,2,1While 4-CIS streaming, audio glitches observed on all CIS SINK with Samsung Galaxy budsWhile 4-CIS streaming, disconnection with connection timeout observed on first CIS SINK with Samsung Galaxy budsOnly two streams (CIS/BIS) with one channel is supported. |

**Parent topic:**[IW611/IW612 release notes](#)

**RW610/RW612 release notes**

### Package information

- SDK version: 25.06.00

**Parent topic:**[RW610/RW612 release notes](#)

### Version information

- Wi-Fi firmware version: 18.99.6.p40
  - rw61x\_sb\_wifi\_a2.bin for A2
  - 18 - Major revision
  - 99 - Feature pack
  - 6 - Release version
  - p40 - Patch number
- Bluetooth LE firmware version: 18.25.6.p40
  - rw61x\_sb\_ble\_a2.bin for A2
  - 18 - Major revision
  - 25 - Feature pack
  - 6 - Release version
  - p40 - Patch number
- 802.15.4 and Bluetooth LE (up to core 4.1) firmware version: 18.34.6.p40
  - rw61x\_sb\_ble\_15d4\_combo\_a2.bin for A2
  - 18 - Major revision
  - 34 - Feature pack
  - 6 - Release version
  - p40 - Patch number

**Parent topic:**[RW610/RW612 release notes](#)

### Host platform

- RW610/RW612 platform running FreeRTOS
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:**[RW610/RW612 release notes](#)

**Wireless certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to 1.

**Note:** This release supports STAUT only certifications.

**Parent topic:** Wireless certification

**Bluetooth LE controller certification** QDID: Refer to 4.

**Parent topic:** Wireless certification

**Thread** Thread group: refer to 7.

Product Name: NXP RW612 Wireless MCU with Integrated Tri-Radio

Thread version: V1.3.0

CID #: 13A109

**Parent topic:** Wireless certification

**Matter** RW612 certification: refer to 8.

Certificate ID: CSA23C36MAT41746-24

Device type: Root Node, Thermostat

Transport: Matter over Wi-Fi

RW610 certification: refer to 9.

Certificate ID: CSA23C43MAT41753-50

Device type: Root Node, Thermostat

Transport: Matter over Wi-Fi and Matter over Thread

**Parent topic:** Wireless certification

**Parent topic:** [RW610/RW612 release notes](#)

## Wi-Fi throughput

### Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: RW610/RW612
- External Client: Intel AX210
- Channel: 6 | 36
- Wi-Fi application: wifi\_cli
- Compiler used to build application: armgcc
- Compiler version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 3.

**Parent topic:**Wi-Fi throughput

### STA throughput External AP: Asus AX88u

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 38           | 38 | 62           | 62 |
| WPA2-AES     | 37           | 37 | 61           | 63 |
| WPA3-SAE     | 37           | 37 | 60           | 61 |

#### STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 39           | 39 | 64           | 64 |
| WPA2-AES     | 37           | 38 | 62           | 64 |
| WPA3-SAE     | 39           | 38 | 62           | 64 |

#### STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 41           | 41 | 75           | 74 |
| WPA2-AES     | 41           | 41 | 73           | 74 |
| WPA3-SAE     | 40           | 41 | 72           | 73 |

#### STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 42           | 42 | 76           | 76 |
| WPA2-AES     | 42           | 41 | 75           | 75 |
| WPA3-SAE     | 42           | 41 | 75           | 74 |

#### STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 44           | 45           | 97           | 99           |
| WPA2-AES     | 43           | 44           | 96           | 98           |
| WPA3-SAE     | 42           | 44           | 97           | 98           |

#### STA mode throughput - HE Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 47           | 47           | 100          | 103          |
| WPA2-AES     | 45           | 46           | 100          | 101          |
| WPA3-SAE     | 47           | 46           | 100          | 101          |

Parent topic: Wi-Fi throughput

#### Mobile AP throughput External client: Apple MacBook Air

##### Mobile AP throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 39           | 39           | 62           | 62           |
| WPA2-AES     | 39           | 39           | 61           | 61           |
| WPA3-SAE     | 38           | 39           | 61           | 61           |

##### Mobile AP throughput - AN Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 40           | 63           | 63           |
| WPA2-AES     | 39           | 39           | 62           | 61           |
| WPA3-SAE     | 39           | 39           | 62           | 61           |

##### Mobile AP throughput - VHT Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 43           | 73           | 73           |
| WPA2-AES     | 43           | 42           | 72           | 72           |
| WPA3-SAE     | 43           | 42           | 73           | 72           |

##### Mobile AP throughput - VHT Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 44           | 44           | 74           | 74           |
| WPA2-AES     | 43           | 43           | 74           | 74           |
| WPA3-SAE     | 43           | 43           | 74           | 74           |

**Mobile AP throughput - HE Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 48           | 48           | 95           | 96           |
| WPA2-AES     | 47           | 47           | 98           | 95           |
| WPA3-SAE     | 47           | 47           | 97           | 95           |

**Mobile AP throughput - HE Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 49           | 49           | 96           | 97           |
| WPA2-AES     | 48           | 48           | 101          | 97           |
| WPA3-SAE     | 48           | 48           | 101          | 97           |

**Parent topic:**Wi-Fi throughput

**Parent topic:**[RW610/RW612 release notes](#)

**Bug fixes and/or feature enhancements**

**Firmware version: 18.99.6.p34 to 18.99.6.p40**  
**{#firmware\_version\_18\_99\_6\_p34\_to\_18\_99\_6\_p40}**

| Com-<br>ponent | Description                                                                                                                    |
|----------------|--------------------------------------------------------------------------------------------------------------------------------|
| Zigbee         | Zigbee Coordinator and Router are disconnected during BLE connection pairing and bonding with a mobile app for the first time. |

**Parent topic:**Bug fixes and/or feature enhancements

**Parent topic:**[RW610/RW612 release notes](#)

**Known issues**

| Component    | Description |
|--------------|-------------|
| Wi-Fi        | —           |
| Bluetooth LE | —           |
| Zigbee       | -           |

**Parent topic:**[RW610/RW612 release notes](#)

**IW610 release notes****Package information**

- SDK version: 25.06.00

**Parent topic:**[IW610 release notes](#)

### Version information

- Wireless SoC: IW610
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.5.p66
  - 18 - Major revision
  - 99 - Feature pack
  - 5 - Release version
  - p66 - Patch number

**Parent topic:**[IW610 release notes](#)

### Host platform

- IW610 platform running FreeRTOS
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:**[IW610 release notes](#)

**Wi-Fi and Bluetooth certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to 6.

**Note:** This release supports STAUT only certifications.

**Parent topic:**Wi-Fi and Bluetooth certification

**Bluetooth controller certification** QDID: Refer to 4.

**Note:** QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

**Parent topic:**Wi-Fi and Bluetooth certification

**Parent topic:**[IW610 release notes](#)

### Wi-Fi throughput



### Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: IW610
- External Client: Intel AX210
- Channel: 6 | 36
- Wi-Fi application: wifi\_cli
- Compiler used to build application: armgcc
- Compiler version gcc-arm-none-eabi-13.2
- iPerf commands used in test:

#### TCP TX

```
iperf -c <remote_ip> -t 60
```

#### TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 3.

**Parent topic:**Wi-Fi throughput

### STA throughput External AP: Asus AX88u

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 42           | 63           | 61           |
| WPA2-AES     | 40           | 47           | 60           | 62           |
| WPA3-SAE     | 40           | 39           | 60           | 62           |

#### STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 42           | 49           | 64           | 64           |
| WPA2-AES     | 41           | 48           | 62           | 63           |
| WPA3-SAE     | 41           | 48           | 62           | 63           |

#### STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 45           | 54           | 75           | 74           |
| WPA2-AES     | 45           | 53           | 73           | 73           |
| WPA3-SAE     | 44           | 53           | 73           | 72           |

**STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 46           | 48           | 77           | 70           |
| WPA2-AES     | 45           | 47           | 74           | 68           |
| WPA3-SAE     | 46           | 47           | 74           | 68           |

**STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 51           | 62           | 98           | 98           |
| WPA2-AES     | 50           | 60           | 96           | 91           |
| WPA3-SAE     | 51           | 60           | 96           | 91           |

**STA mode throughput - HE Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 53           | 60           | 101          | 94           |
| WPA2-AES     | 53           | 58           | 99           | 93           |
| WPA3-SAE     | 52           | 58           | 99           | 93           |

**Parent topic:**Wi-Fi throughput**Mobile AP throughput** External client: Apple MacBook Air**Mobile AP throughput - BGN Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 39           | 39           | 63           | 62           |
| WPA2-AES     | 39           | 38           | 60           | 60           |
| WPA3-SAE     | 39           | 38           | 60           | 60           |

**Mobile AP throughput - AN Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 39           | 64           | 62           |
| WPA2-AES     | 39           | 39           | 61           | 61           |
| WPA3-SAE     | 39           | 38           | 61           | 61           |

**Mobile AP throughput - VHT Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 43           | 74           | 73           |
| WPA2-AES     | 42           | 42           | 73           | 71           |
| WPA3-SAE     | 42           | 42           | 74           | 72           |

**Mobile AP throughput - VHT Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 43           | 43           | 75           | 73           |
| WPA2-AES     | 43           | 42           | 74           | 72           |
| WPA3-SAE     | 43           | 43           | 74           | 72           |

**Mobile AP throughput - HE Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 46           | 46           | 95           | 94           |
| WPA2-AES     | 45           | 45           | 96           | 91           |
| WPA3-SAE     | 45           | 45           | 96           | 91           |

**Mobile AP throughput - HE Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 47           | 47           | 96           | 94           |
| WPA2-AES     | 46           | 46           | 98           | 91           |
| WPA3-SAE     | 46           | 46           | 99           | 91           |

**Parent topic:**Wi-Fi throughput

**Parent topic:**[IW610 release notes](#)

**Known issues**

| Component    | Description |
|--------------|-------------|
| Wi-Fi        | —           |
| Bluetooth LE | —           |

**Parent topic:**[IW610 release notes](#)

**AW611 release notes** **Note:** The AW611 support is enabled in i.MX RT1180 EVKA.

**Package information**

- SDK version: 25.06.00

**Parent topic:**[AW611 release notes](#)

### Version information

- Wireless SoC: AW611
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 18.99.3.p25.11
  - 18 - Major revision
  - 99 - Feature pack
  - 3 - Release version
  - p25.11 - Patch number

**Parent topic:**[AW611 release notes](#)

### Host platform

- i.MX RT1180 EVKA Platform running FreeRTOS
- Host interfaces
  - Wi-Fi over SDIO (SDIO 2.0 Support, SDIO clock frequency: 50 MHz)
  - Bluetooth/Bluetooth LE over UART
- Test tools
  - iPerf (version 2.1.9)

**Parent topic:**[AW611 release notes](#)

**Wi-Fi and Bluetooth certification** The Wi-Fi and Bluetooth certification is obtained with the following combinations.

### WFA certifications

- STA | 802.11n
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | 802.11ac
- STA | 802.11ax
- STA | QTT

Refer to 6.

**Note:** This release supports STAUT only certifications.

**Parent topic:**Wi-Fi and Bluetooth certification

**Bluetooth controller certification** QDID: Refer to 4.

**Note:** QDID upgrade to Bluetooth Core Specification Version 5.4 is in progress.

**Parent topic:**Wi-Fi and Bluetooth certification

**Parent topic:**[AW611 release notes](#)

## Wi-Fi throughput

### Throughput test setup

- Environment: Shield Room - Over the Air
- Access Point: Asus AX88u
- DUT: AW611 uBlox (Module: U-BLOX\_Jody\_W5 M.2) with EVK-MIMXRT1180 EVKA platform
- DUT Power Source: External power supply
- Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi\_wpa\_supplicant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

#### TCP TX

```
iperf -c <remote_ip> -t 60
```

#### TCP RX

```
iperf -s
```

#### UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

**Note:** The default rate is 100 Mbps.

#### UDP RX

```
iperf -s -u -B <local_ip>
```

**Note:** Read more about the throughput test setup and topology in 2.

The throughput numbers are captured with default configurations using *wifi\_wpa\_supplicant* sample application.

**Parent topic:**Wi-Fi throughput

### STA throughput External AP: Asus AX88u

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

| Protocol     | TCP (Mbit/s) |    | UDP (Mbit/s) |    |
|--------------|--------------|----|--------------|----|
| Direction    | TX           | RX | TX           | RX |
| OpenSecurity | 43           | 47 | 45           | 60 |
| WPA2-AES     | 43           | 46 | 48           | 59 |
| WPA3-SAE     | 47           | 49 | 63           | 63 |

#### STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 68           | 82           | 131          | 131          |
| WPA2-AES     | 72           | 82           | 130          | 129          |
| WPA3-SAE     | 68           | 81           | 129          | 130          |

**STA mode throughput - AN Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 45           | 51           | 63           | 65           |
| WPA2-AES     | 45           | 51           | 63           | 65           |
| WPA3-SAE     | 45           | 51           | 63           | 65           |

**STA mode throughput - AN Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 67           | 83           | 129          | 134          |
| WPA2-AES     | 66           | 83           | 129          | 133          |
| WPA3-SAE     | 65           | 83           | 129          | 133          |

**STA mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 49           | 53           | 72           | 71           |
| WPA2-AES     | 48           | 52           | 73           | 70           |
| WPA3-SAE     | 52           | 56           | 75           | 75           |

**STA mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 74           | 88           | 172          | 172          |
| WPA2-AES     | 75           | 92           | 171          | 169          |
| WPA3-SAE     | 77           | 92           | 172          | 171          |

**STA mode throughput - VHT Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 50           | 58           | 76           | 78           |
| WPA2-AES     | 49           | 57           | 76           | 77           |
| WPA3-SAE     | 49           | 57           | 76           | 77           |

**STA mode throughput - VHT Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 74           | 93           | 175          | 177          |
| WPA2-AES     | 74           | 93           | 174          | 174          |
| WPA3-SAE     | 73           | 93           | 173          | 175          |

**STA mode throughput - VHT Mode | 5 GHz Band | 80 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 88           | 94           | 221          | 196          |
| WPA2-AES     | 87           | 95           | 219          | 194          |
| WPA3-SAE     | 89           | 95           | 219          | 195          |

**STA mode throughput - HE Mode | 2.4 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 60           | 60           | 98           | 115          |
| WPA2-AES     | 62           | 61           | 94           | 113          |
| WPA3-SAE     | 61           | 59           | 97           | 108          |

**STA mode throughput - HE Mode | 2.4 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 77           | 71           | 215          | 190          |
| WPA2-AES     | 77           | 72           | 212          | 187          |
| WPA3-SAE     | 76           | 72           | 152          | 189          |

**STA mode throughput - HE Mode | 5 GHz Band | 20 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 63           | 65           | 127          | 128          |
| WPA2-AES     | 63           | 67           | 125          | 128          |
| WPA3-SAE     | 63           | 67           | 125          | 126          |

**STA mode throughput - HE Mode | 5 GHz Band | 40 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 79           | 64           | 212          | 199          |
| WPA2-AES     | 78           | 68           | 218          | 199          |
| WPA3-SAE     | 79           | 68           | 217          | 198          |

**STA mode throughput - HE Mode | 5 GHz Band | 80 MHz (HT)**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 88           | 70           | 219          | 192          |
| WPA2-AES     | 87           | 72           | 219          | 193          |
| WPA3-SAE     | 91           | 72           | 220          | 194          |

**Parent topic:**Wi-Fi throughput

**Mobile AP throughput** External client: Apple MacBook Air

**Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 40           | 52           | 61           | 62           |
| WPA2-AES     | 40           | 51           | 61           | 62           |
| WPA3-SAE     | 40           | 51           | 61           | 62           |

**Mobile AP mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 63           | 83           | 116          | 130          |
| WPA2-AES     | 67           | 82           | 115          | 131          |
| WPA3-SAE     | 60           | 81           | 115          | 132          |

**Mobile AP mode throughput - AN Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 39           | 49           | 60           | 62           |
| WPA2-AES     | 39           | 49           | 60           | 62           |
| WPA3-SAE     | 41           | 51           | 63           | 62           |

**Mobile AP mode throughput - AN Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 66           | 89           | 128          | 133          |
| WPA2-AES     | 64           | 87           | 128          | 133          |
| WPA3-SAE     | 62           | 86           | 128          | 133          |

**Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 44           | 60           | 74           | 75           |
| WPA2-AES     | 43           | 59           | 74           | 75           |
| WPA3-SAE     | 43           | 59           | 74           | 75           |



**Mobile AP mode throughput - VHT Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 64           | 53           | 112          | 75           |
| WPA2-AES     | 65           | 51           | 111          | 75           |
| WPA3-SAE     | 62           | 51           | 112          | 75           |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 45           | 60           | 76           | 76           |
| WPA2-AES     | 44           | 59           | 76           | 76           |
| WPA3-SAE     | 44           | 59           | 76           | 76           |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 73           | 100          | 155          | 178          |
| WPA2-AES     | 72           | 99           | 152          | 176          |
| WPA3-SAE     | 72           | 99           | 152          | 176          |

**Mobile AP mode throughput - VHT Mode | 5 GHz Band | 80 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 80           | 86           | 211          | 189          |
| WPA2-AES     | 84           | 87           | 223          | 188          |
| WPA3-SAE     | 83           | 94           | 224          | 192          |

**Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 53           | 66           | 85           | 123          |
| WPA2-AES     | 52           | 65           | 83           | 122          |
| WPA3-SAE     | 52           | 65           | 83           | 120          |

**Mobile AP mode throughput - HE Mode | 2.4 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 75           | 102          | 124          | 166          |
| WPA2-AES     | 74           | 100          | 121          | 148          |
| WPA3-SAE     | 73           | 101          | 121          | 154          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 20 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 54           | 68           | 84           | 124          |
| WPA2-AES     | 53           | 66           | 83           | 122          |
| WPA3-SAE     | 54           | 66           | 83           | 123          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 40 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 76           | 107          | 155          | 193          |
| WPA2-AES     | 75           | 105          | 152          | 192          |
| WPA3-SAE     | 76           | 106          | 151          | 191          |

**Mobile AP mode throughput - HE Mode | 5 GHz Band | 80 MHz**

| Protocol     | TCP (Mbit/s) | TCP (Mbit/s) | UDP (Mbit/s) | UDP (Mbit/s) |
|--------------|--------------|--------------|--------------|--------------|
| Direction    | TX           | RX           | TX           | RX           |
| OpenSecurity | 86           | 118          | 220          | 187          |
| WPA2-AES     | 86           | 119          | 221          | 185          |
| WPA3-SAE     | 86           | 116          | 220          | 188          |

**Parent topic:**Wi-Fi throughput**Parent topic:**[AW611 release notes](#)**EU conformance tests**

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

**Parent topic:**[AW611 release notes](#)**Bug fixes and/or feature enhancements {#bug\_fixes\_and\_or\_feature\_enhancements\_04}**

**Firmware version: 18.99.3.p10.5 to 18.99.3.p17.9**  
**{#firmware\_version\_18\_99\_3\_p10\_5\_to\_18\_99\_3\_p17\_9\_0}**

| Com po-<br>nent | Description                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wi-Fi           | After performing independent reset (out-of-band mode), the STAUT fails to connect to the external AP via wlan-connect command, observed command timeout 0x107 error.                                                                                                                                                                                                                                            |
| Blue tooth      | Audio glitches observed with Google Pixel 7 Pro streaming audio after CIS is established with DUT.During Call Gateway (CG) / Call Terminal (CT) Use Case, the firmware periodically sends NULL PDU, which results in frequent Audio Glitch on both CG and CT sides.Heavy audio glitches observed with CIS SRC Google Pixel 7 ProContinuous audio glitches observed in 1 CIS and 2 CIS for 48_3 and 48_4 config. |

**Parent topic:**Bug fixes and/or feature enhancements

**Firmware version: 18.99.3.p17.9 to 18.99.3.p21.154**  
**{#firmware\_version\_18\_99\_3\_p17\_9\_to\_18\_99\_3\_p21\_154\_0}**

| Component  | Description                                                                                         |
|------------|-----------------------------------------------------------------------------------------------------|
| Wi-Fi      | STAUT fail to ping AP backend machine when connected with DFS channel and DUTSTA went in bad state. |
| Blue-tooth | CIS Sink frequently fails to acknowledge CIS Source TX PDU.                                         |

**Parent topic:**Bug fixes and/or feature enhancements

**Parent topic:**[AW611 release notes](#)

### Known issues

| Component  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Blue tooth | Packet lost would be observed in CIS case which causes audio noise. Sequential Removal of CIS Handles as per current Controller implementation i.e CIS Disconnection sequence should be in sequence => CIS - 4,3,2,1 While 4-CIS streaming, audio glitches observed on all CIS SINK with Samsung Galaxy buds While 4-CIS streaming, disconnection with connection timeout observed on first CIS SINK with Samsung Galaxy buds Only two streams (CIS/BIS) with one channel is supported. |

**Parent topic:**[AW611 release notes](#)

### Abbreviations

| Abbreviation | Definition                          |
|--------------|-------------------------------------|
| A2DP         | Advanced audio distribution profile |
| AMPDU        | Aggregated MAC protocol data unit   |
| AMSDU        | Aggregated MAC service data unit    |
| AP           | Access point                        |
| BW           | Bandwidth                           |
| CCMP         | Counter mode CBC-MAC protocol       |
| CSI          | Channel state information           |
| CTS          | Clear To Send                       |
| DL           | Down link                           |
| EDCA         | Enhanced distributed channel access |
| ER           | Extended range                      |
| ERP          | Extended rate physical              |
| GATT         | Generic attribute profile           |
| HFP          | Hands free profile                  |
| HID          | Human interface device              |
| HT           | High throughput                     |
| LDPC         | Low density parity check            |
| MCS          | Modulation and coding scheme        |
| MLME         | Mac layer management entity         |
| OMI          | Operating mode indication           |
| PMF          | Protected management frames         |
| RTS          | Request to send                     |

continues on next page

Table 4 – continued from previous page

| Abbreviation | Definition                            |
|--------------|---------------------------------------|
| SAE          | Simultaneous authentication of equals |
| STA          | Station                               |
| TWT          | Target wake time                      |
| UL           | Up link                               |
| VHT          | Very high throughput                  |
| WEP          | Wired equivalent private              |
| WFD          | Wi-Fi direct                          |
| WMM          | Wireless multi-media                  |
| WPA          | Wi-Fi protected access                |
| WPS          | Wi-Fi protected setup                 |
| WSC          | Wi-Fi Simple Configuration            |

## References

1. Application note - AN13681 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
2. User manual – UM11442 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for i.MX RT Platforms (available in the SDK package)
3. User manual – UM11799 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for RW61x (available in the SDK package)
4. Certification – Bluetooth controller - QDID ([link](#))
5. User manual - UM12133 - NXP NCP Application Guide for RW612 with MCU Host
6. Technical note - TN00066 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
7. Web page – Thread certified products ([link](#))
8. Web page – Connectivity standard alliance (csa) – NXP RW612 Tri-Radio Wireless MCU Development Platform ([link](#))
9. Web page – Connectivity standard alliance (csa) – NXP RW610 Wireless MCU Development Platform ([link](#))



# 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.

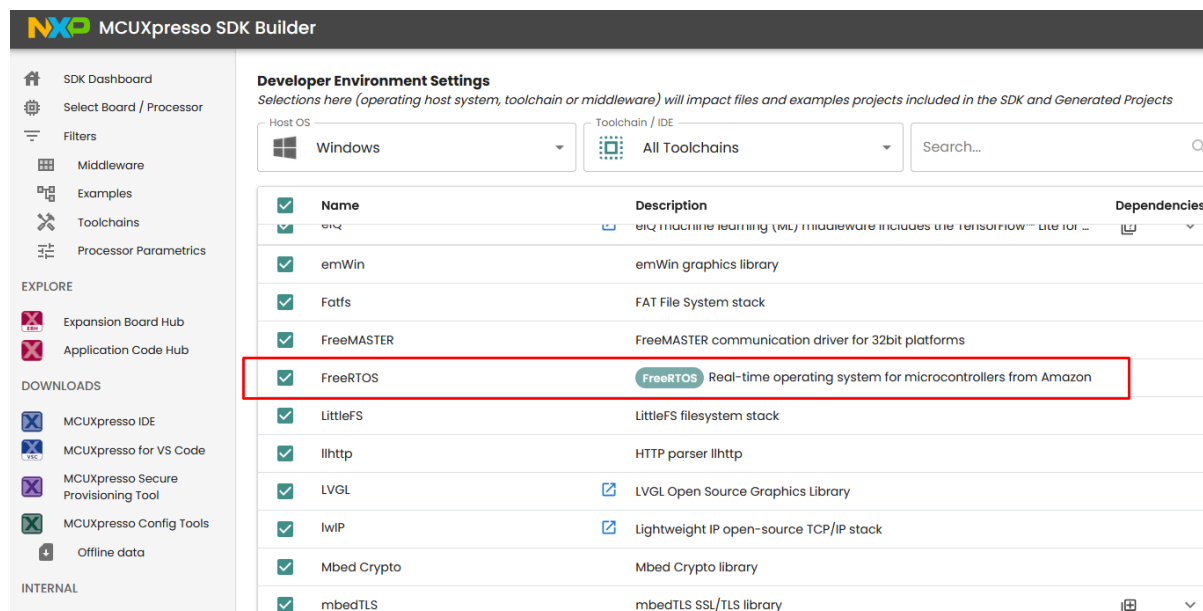
The MCUXpresso SDK framework also contains a set of FreeRTOS examples which show basic FreeRTOS OS features. This makes it easy to start a new FreeRTOS project or begin experimenting with FreeRTOS OS. Selected drivers and middleware are RTOS ready with related FreeRTOS adaptation layer.

**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>) for the complete delivery of MCUXpresso SDK.

**backoffAlgorithm Library** This repository contains the backoffAlgorithm library, a utility library to calculate backoff period using an exponential backoff with jitter algorithm for retrying network operations (like failed network connection with server). This library uses the “Full Jitter” strategy for the exponential backoff with jitter algorithm. More information about the algorithm can be seen in the [Exponential Backoff and Jitter](#) AWS blog.

The backoffAlgorithm library is distributed under the *MIT Open Source License*.

Exponential backoff with jitter is typically used when retrying a failed network connection or operation request with the server. An exponential backoff with jitter helps to mitigate failed network operations with servers, that are caused due to network congestion or high request load on the server, by spreading out retry requests across multiple devices attempting network operations. Besides, in an environment with poor connectivity, a client can get disconnected at any time. A backoff strategy helps the client to conserve battery by not repeatedly attempting reconnections when they are unlikely to succeed.

See memory requirements for this library [here](#).

**backoffAlgorithm v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.**

**backoffAlgorithm v1.0.0 source code is part of the FreeRTOS 202012.00 LTS release.**

**Reference example** The example below shows how to use the backoffAlgorithm library on a POSIX platform to retry a DNS resolution query for amazon.com.

```
#include "backoff_algorithm.h"
#include <stdlib.h>
#include <string.h>
#include <netdb.h>
#include <unistd.h>
#include <time.h>

/* The maximum number of retries for the example code. */
#define RETRY_MAX_ATTEMPTS (5U)

/* The maximum back-off delay (in milliseconds) for between retries in the example. */
#define RETRY_MAX_BACKOFF_DELAY_MS (5000U)

/* The base back-off delay (in milliseconds) for retry configuration in the example. */
#define RETRY_BACKOFF_BASE_MS (500U)

int main()
{
 /* Variables used in this example. */
 BackoffAlgorithmStatus_t retryStatus = BackoffAlgorithmSuccess;
 BackoffAlgorithmContext_t retryParams;
 char serverAddress[] = "amazon.com";
 uint16_t nextRetryBackoff = 0;

 int32_t dnsStatus = -1;
 struct addrinfo hints;
 struct addrinfo ** pListHead = NULL;
 struct timespec tp;

 /* Add hints to retrieve only TCP sockets in getaddrinfo. */
 (void) memset(&hints, 0, sizeof(hints));

 /* Address family of either IPv4 or IPv6. */
 hints.ai_family = AF_UNSPEC;
 /* TCP Socket. */
 hints.ai_socktype = (int32_t) SOCK_STREAM;
 hints.ai_protocol = IPPROTO_TCP;

 /* Initialize reconnect attempts and interval. */
 BackoffAlgorithm_InitializeParams(&retryParams,
 RETRY_BACKOFF_BASE_MS,
 RETRY_MAX_BACKOFF_DELAY_MS,
 RETRY_MAX_ATTEMPTS);

 /* Seed the pseudo random number generator used in this example (with call to
 * rand() function provided by ISO C standard library) for use in backoff period
 * calculation when retrying failed DNS resolution. */

 /* Get current time to seed pseudo random number generator. */
 (void) clock_gettime(CLOCK_REALTIME, &tp);
 /* Seed pseudo random number generator with seconds. */
 srand(tp.tv_sec);

 do
 {
 /* Perform a DNS lookup on the given host name. */
 dnsStatus = getaddrinfo(serverAddress, NULL, &hints, pListHead);
 }
```

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```

/* Retry if DNS resolution query failed. */
if(dnsStatus != 0)
{
 /* Generate a random number and get back-off value (in milliseconds) for the next retry.
 * Note: It is recommended to use a random number generator that is seeded with
 * device-specific entropy source so that backoff calculation across devices is different
 * and possibility of network collision between devices attempting retries can be avoided.
 *
 * For the simplicity of this code example, the pseudo random number generator, rand()
 * function is used. */
 retryStatus = BackoffAlgorithm_GetNextBackoff(&retryParams, rand(), &nextRetryBackoff);

 /* Wait for the calculated backoff period before the next retry attempt of querying DNS.
 * As usleep() takes nanoseconds as the parameter, we multiply the backoff period by 1000. */
 (void) usleep(nextRetryBackoff * 1000U);
}
} while((dnsStatus != 0) && (retryStatus != BackoffAlgorithmRetriesExhausted));

return dnsStatus;
}

```

**Building the library** A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses a header file introduced in ISO C99, *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdint.readme*, which can be renamed to *stdint.h* to build the backoffAlgorithm library.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/backoff_algorithm.c -o example
./example
```

*gcc* can also produce an output file to be linked:

```
gcc -I source/include -c source/backoff_algorithm.c
```

## Building unit tests

**Checkout Unity Submodule** By default, the submodules in this repository are configured with `update=none` in *.gitmodules*, to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/Unity
```

## Platform Prerequisites

- For running unit tests
  - C89 or later compiler like *gcc*
  - CMake 3.13.0 or later
- For running the coverage target, *gcov* is additionally required.

### Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described [above](#).)
2. Create build directory: `mkdir build && cd build`
3. Run `cmake` while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

**Contributing** See *CONTRIBUTING.md* for information on contributing.

### 4.1.4 corehttp

C language HTTP client library designed for embedded platforms.

#### MCUXpresso SDK: coreHTTP Client Library

This repository is a fork of coreHTTP Client library (<https://github.com/FreeRTOS/corehttp>)(3.0.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreHTTP Client repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

#### coreHTTP Client Library

This repository contains a C language HTTP client library designed for embedded platforms. It has no dependencies on any additional libraries other than the standard C library, [lhttp](#), 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 202210.01 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>)(4.0.0). 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.

**Introduction** This branch contains unified IPv4 and IPv6 functionalities. Refer to the Getting started Guide (found [here](#)) for more details.

**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.

**Getting started** The easiest way to use the 4.0.0 version of FreeRTOS-Plus-TCP is to refer the Getting started Guide (found [here](#)) Another way is to start with the pre-configured demo application project (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 bugs/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 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. There are examples on how to use the new files and directory structure. For an example based on the Xilinx Zynq-7000, use the code in this [branch](#) and follow these [instructions](#) to build and run the demo.

**FreeRTOS-Plus-TCP V3.1.0 source code(.c .h) is part of the FreeRTOS 202210.00 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 that was created using the *Cloning this repository* step above. And 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 master #Note: Best practice to use specific git-hash or tagged version
 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.

```

set(FREERTOS_PLUS_FAT_DEV_SUPPORT OFF CACHE BOOL "" FORCE)
Select the native compile PORT
set(FREERTOS_PLUS_FAT_PORT "POSIX" CACHE STRING "" FORCE)
Select the cross-compile PORT
if (CMAKE_CROSSCOMPILING)
 # Eg. Zynq 2019_3 version of port
 set(FREERTOS_PLUS_FAT_PORT "ZYNQ_2019_3" 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](#).