



MCUXpresso SDK Documentation

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This documentation contains information specific to the mimxrt700evk board.

Chapter 1

MIMXRT700-EVK

1.1 Overview

The i.MX RT700 EVK (MIMXRT700-EVK) features NXP's advanced implementation of the Arm Cortex-M33 core, combined with the highly optimized Cadence Tensilica HiFi4 and HiFi1 DSP processor cores. MIMXRT700-EVK supports development for the MIMXRT798, MIMXRT758 and MIMXRT735 products and its features make it ideal for portable HMI applications. The i.MX RT700 EVK can help jump start your next design with the included schematics and layout files.



MCU device and part on board is shown below:

- Device: MIMXRT798S
- PartNumber: MIMXRT798SGFOB

1.2 Getting Started with MCUXpresso SDK Package

1.2.1 Getting Started with Package

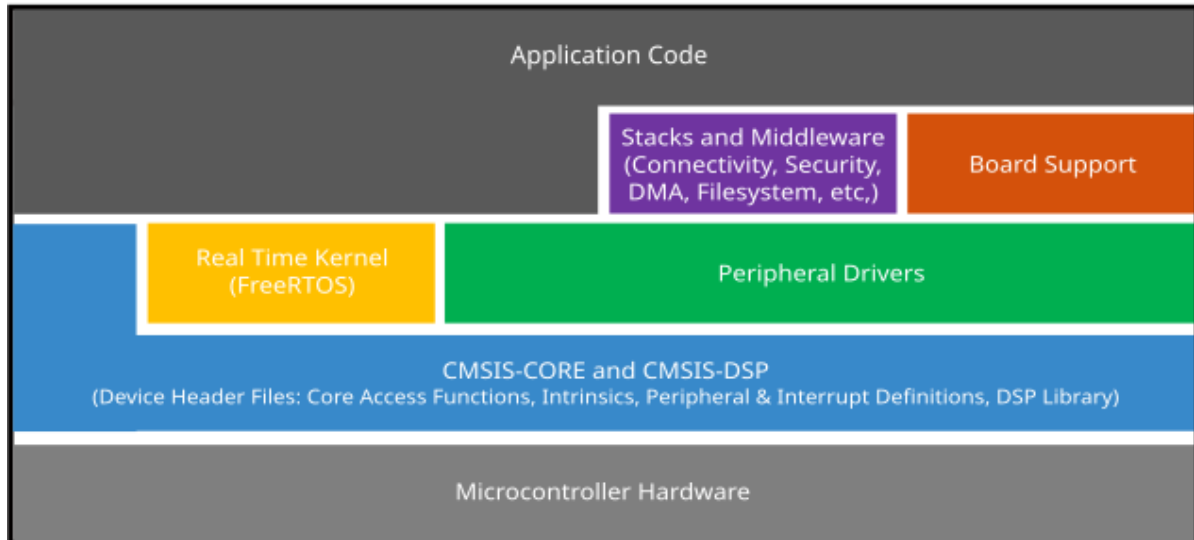
Overview

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

such as FreeRTOS and Azure RTOS, a USB host and device stack, and various other middleware to support rapid development.

For supported toolchain versions, see *MCUXpresso SDK Release Notes for MIMXRT700-EVK* (document MCUXSDKRT798RN).

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



MCUXpresso SDK board support package folders

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

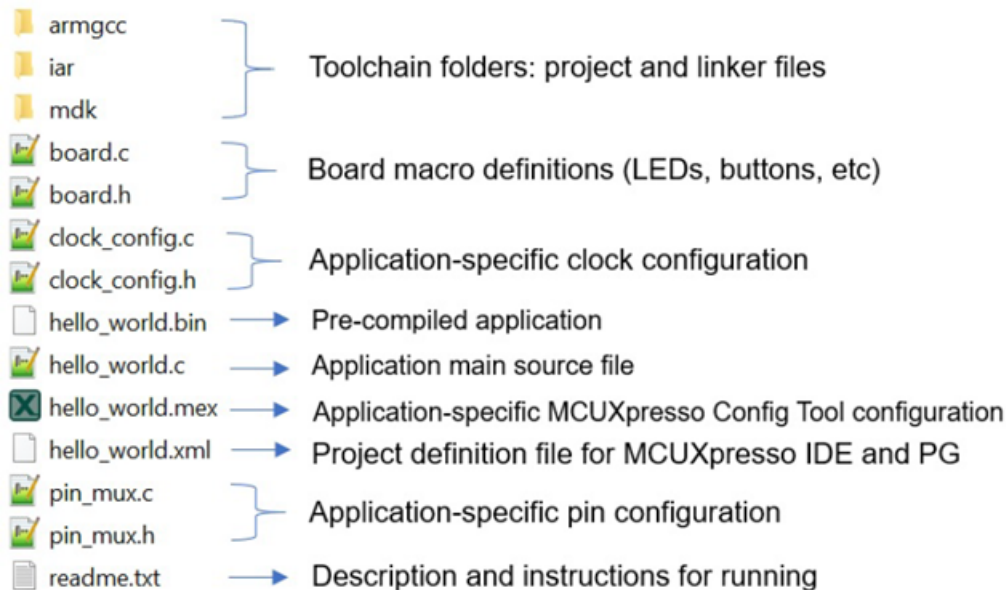
- `cmsis_driver_examples`: Simple applications intended to show how to use CMSIS drivers.
- `demo_apps`: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- `driver_examples`: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

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

Each *<board_name>* folder in the boards directory contains a comprehensive set of examples that are relevant to that specific piece of hardware. Although we use the `hello_world` example (part of

the *demo_apps* folder), the same general rules apply to any type of example in the *<board_name>* folder.

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



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

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 that the examples reference the same source files and, if one of these files is modified, it could potentially impact the behavior of other examples.

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

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

For examples containing 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

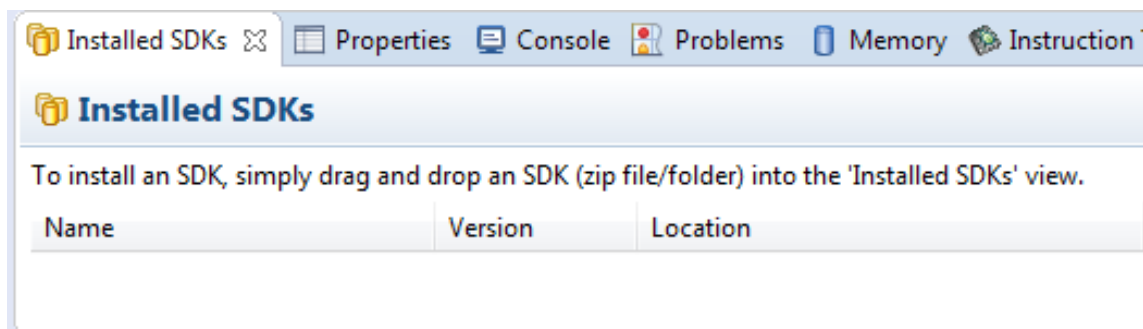
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The `hello_world` demo application targeted for the target hardware platform is used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

Select the workspace location Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse, which uses 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, perform the following steps.

1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK.

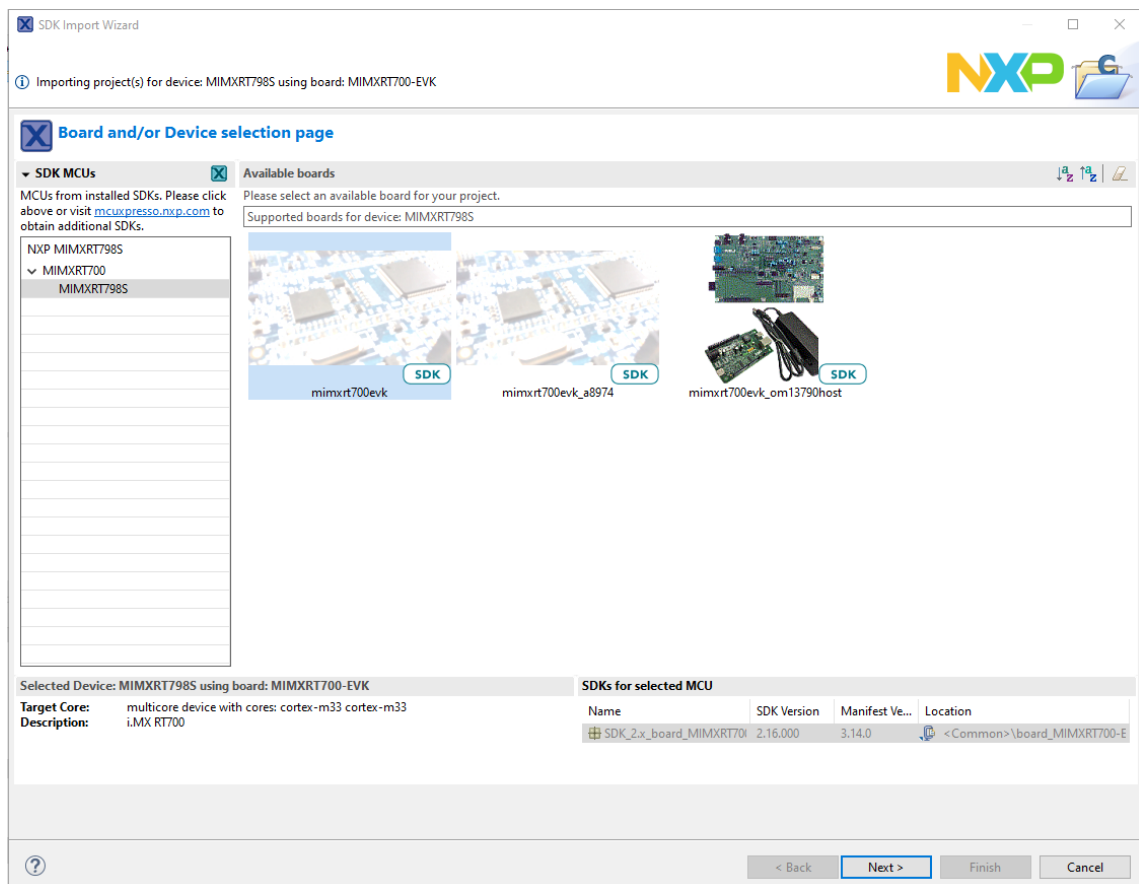


In the window that appears, click **OK** and wait until the import has finished.

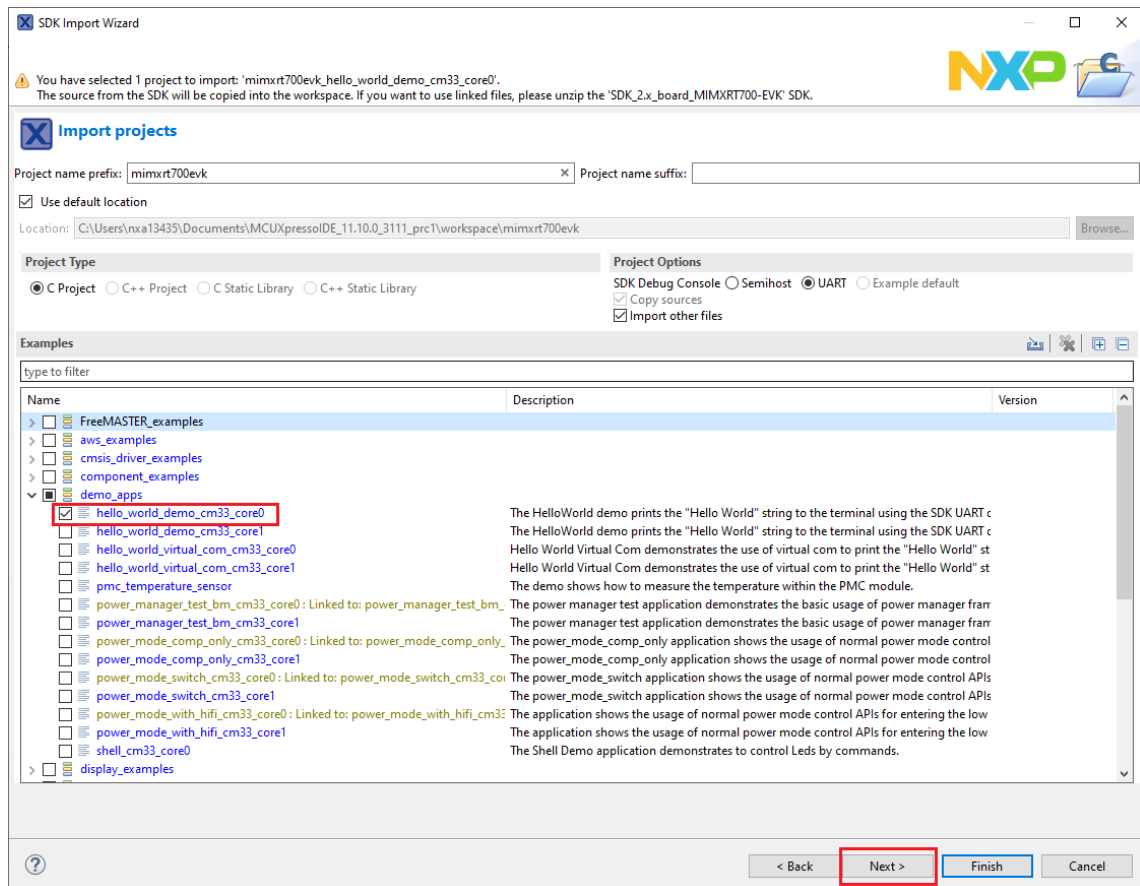
2. On the **Quickstart Panel**, click **Import SDK example(s)**.



3. In the window that appears, select **mimxrt700evk** or **kits** and click **Next**.



4. Expand the *demo_apps* folder and select **hello_world_demo_cm33_core0**. Then, click **Next**.

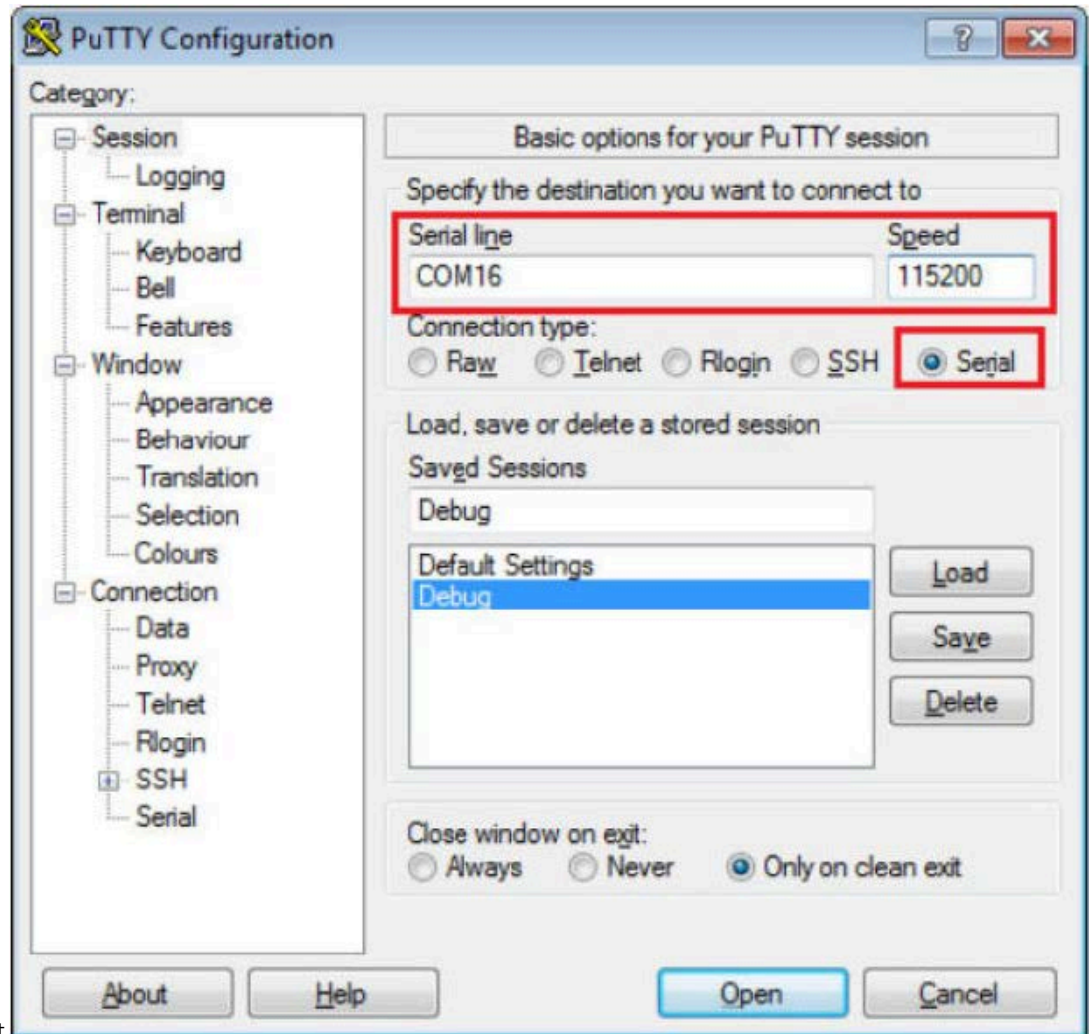


5. Click **Finish**.

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

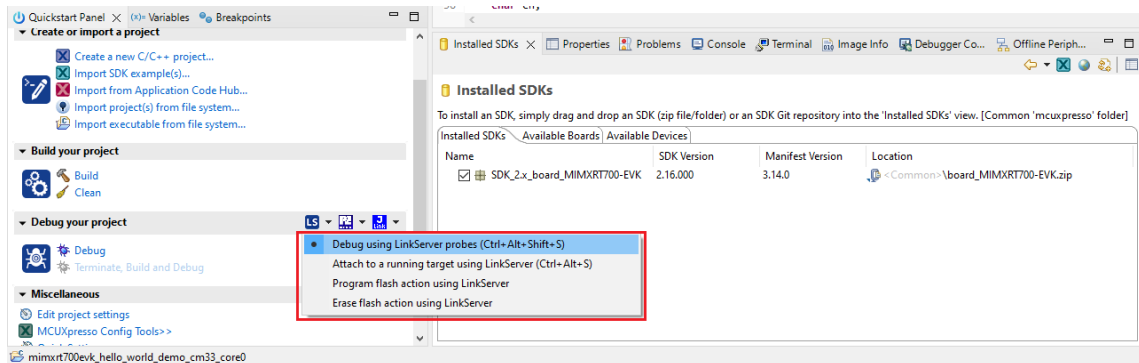
Run an example application To download and run the application, perform the following steps:

1. Determine the debug interface that comes loaded on your specific hardware platform.
 - For MIMXRT700-EVK, MCU-LINK is used.
 - J54 is used as the debugging port which provides both debugging functionality and console out.
2. Connect USB cable between J54 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:
 - 115200 baud rate or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the *board.h* file)
 - No parity
 - 8 data bits

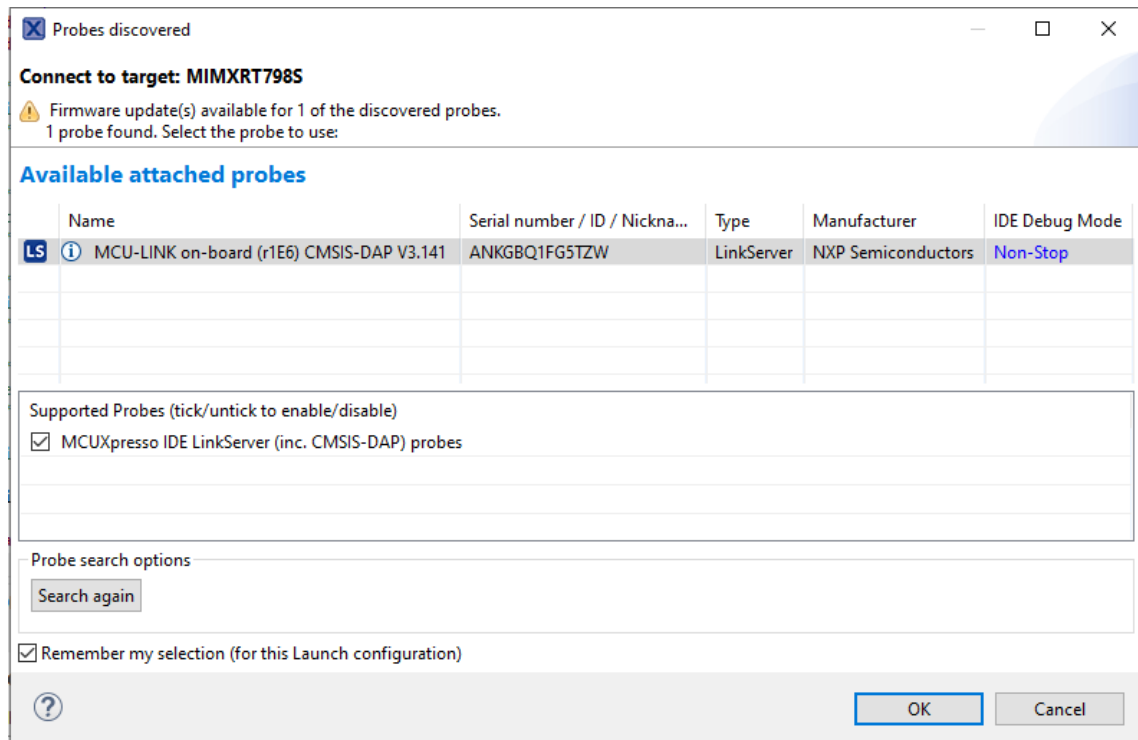


- 1 stop bit

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

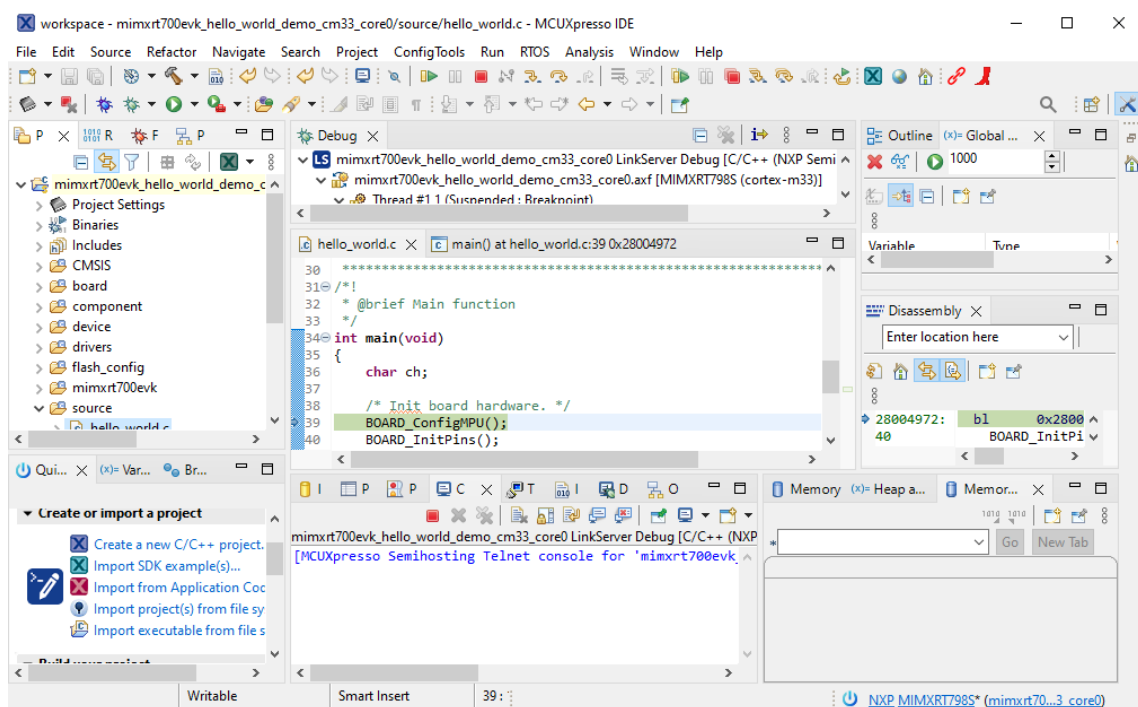


5. The first time you debug a project, the **Debug Emulator Selection** dialog is displayed, showing all supported probes that are attached to your computer. Select the probe through which you want to debug and click **OK**. (For any future debug sessions, the stored probe selection is automatically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



Note: Make sure that the board is set to XSPI0 flash boot mode.

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



- To start the application, click the **Resume**.



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

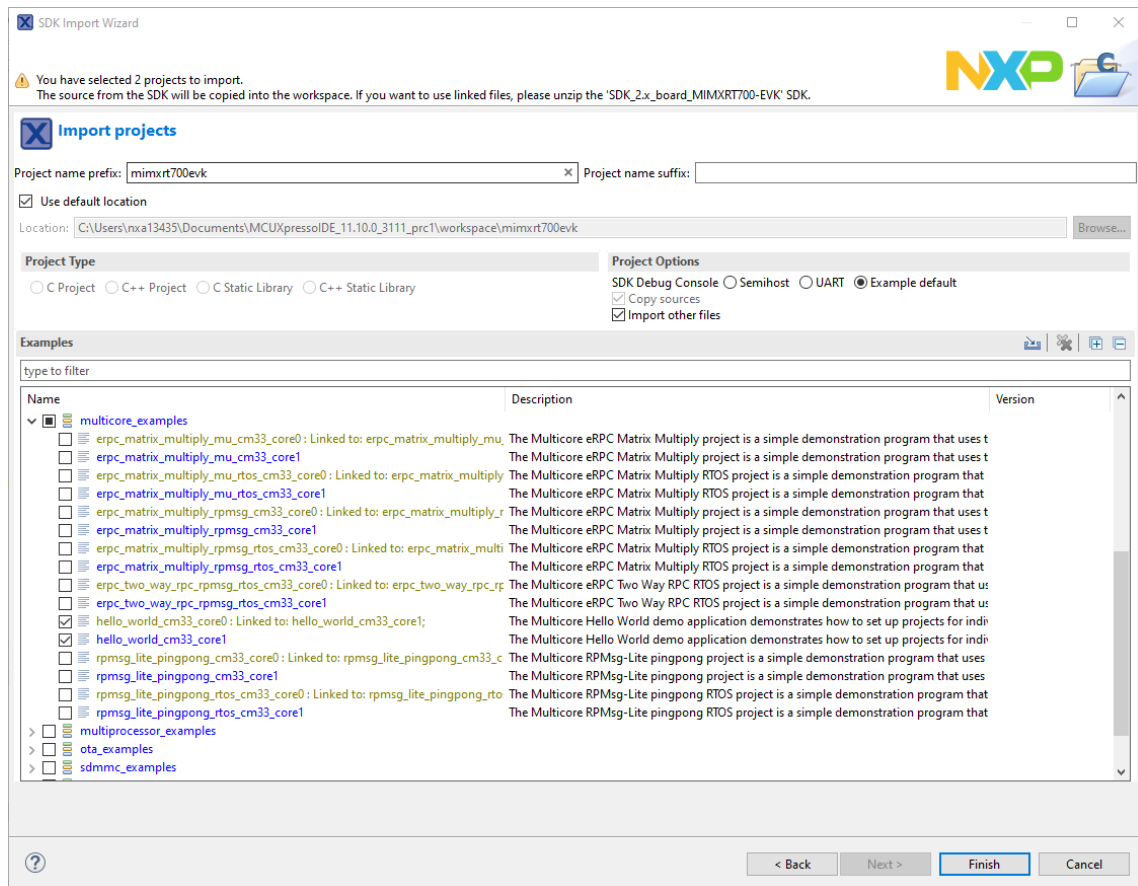
check your terminal settings and connections.



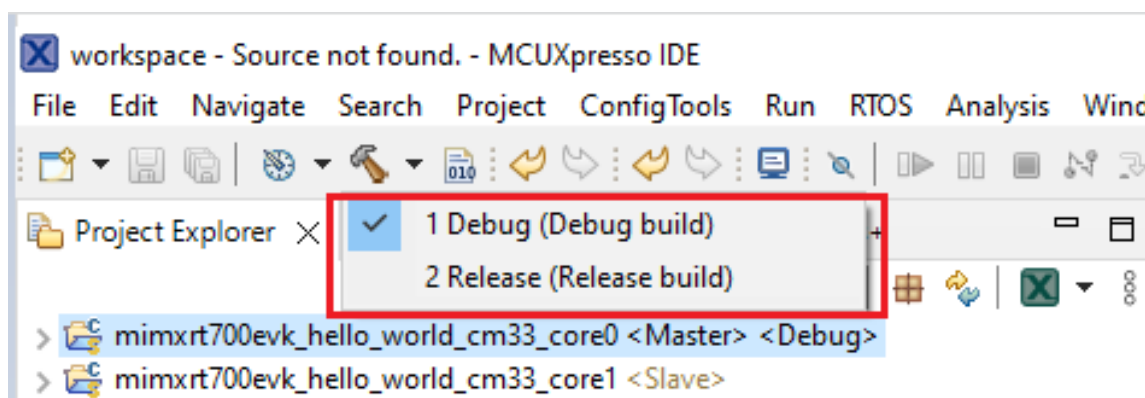
Parent topic: [Run a demo using MCUXpresso IDE](#)

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 **mimxrt700evk** 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 is installed and available in the **Installed SDKs** view, click **Import SDK example(s)...** on the Quickstart Panel. In the window that appears, select **mimxrt700evk** and click **Next**.
2. Expand the *multicore_examples* folder and select **hello_world_cm33_core0**. The `hello_world_cm33_core1` counterpart project is automatically imported with the `cm33_core0` 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 multicore application, highlight the `hello_world_cm33_core0` 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 2*. For this example, select **Debug**.

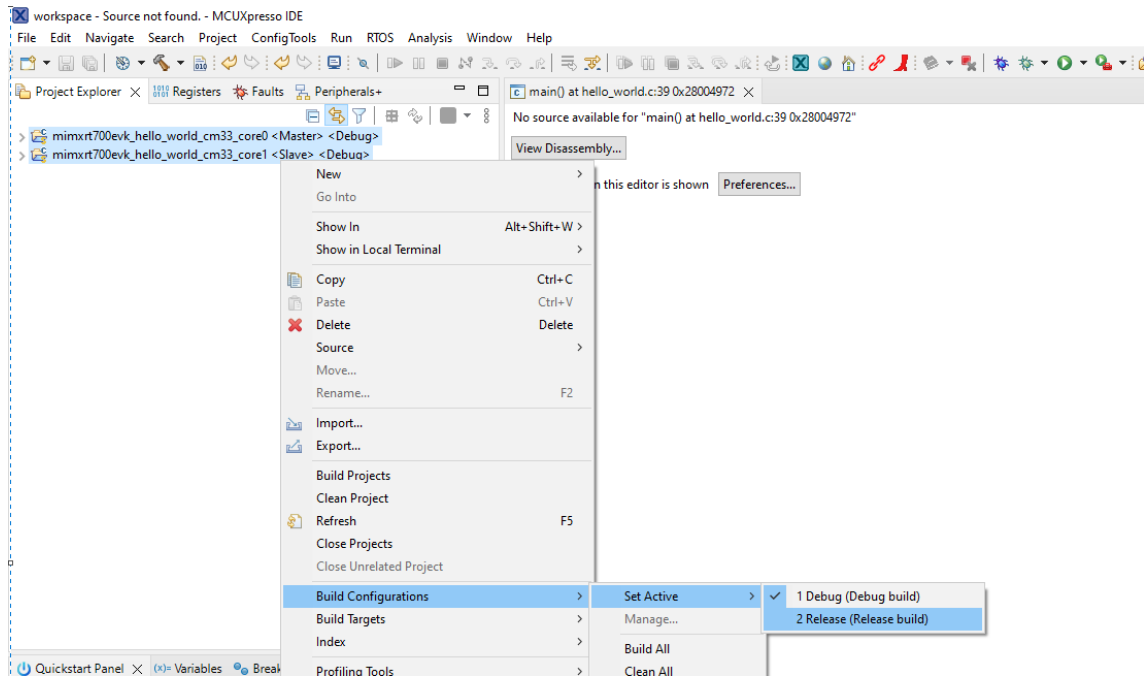


Press the **Build** button to start the multi-core project build.. Because of the project reference settings in multicore projects, triggering the build of the primary core application (`cm33_core0`) also makes the referenced auxiliary core application (`cm33_core1`) to build.

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

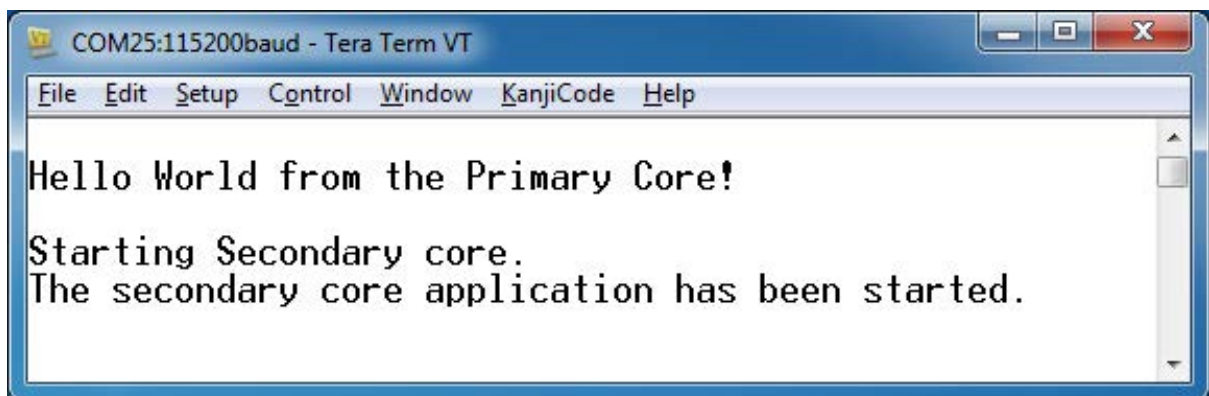
triggering the primary core application (cm33_core0) build.



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 `cm33_core1` project and start debugging the `cm33_core1` project. Then, select the `cm33_core0` project and start debugging the `cm33_core0` project.

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 a demo application using IAR

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

Note:

IAR Embedded Workbench for Arm version 9.50.1 is used in the following example, and the IAR toolchain should correspond to the latest supported version, as described in the *MCUXpresso SDK Release Notes for MIMXRT700-EVK* (document MCUXSDKRT798RN).

When debug or run the flash_debug or flash_release targets, make sure that the board is configured as XSPI0 boot mode (SW10 1 - OFF, 2 - ON).

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

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

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

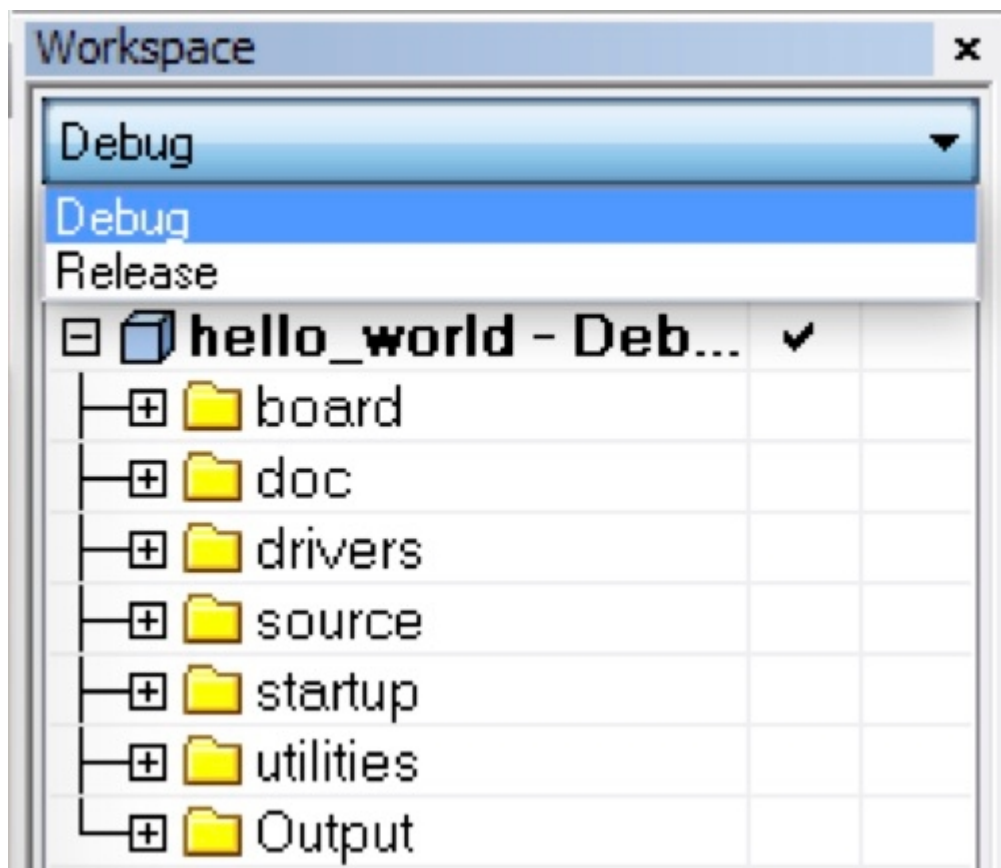
Using the MIMXRT700-EVK hardware platform as an example, the hello_world workspace is located in:

```
<install_dir>/boards/mimxrt700evk/demo_apps/hello_world/cm33_core0/iar/hello_world_cm33_
→core0.eww
```

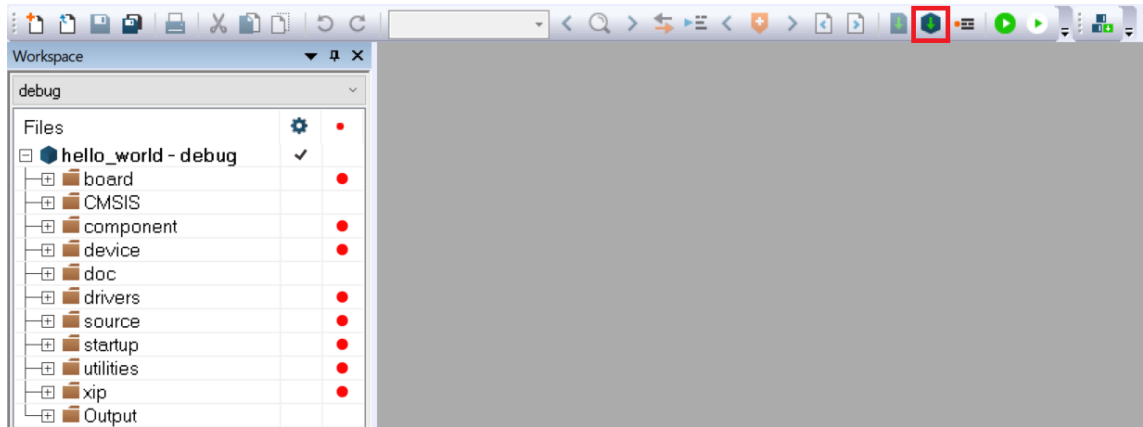
Other example applications may have additional folders in their path.

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

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



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

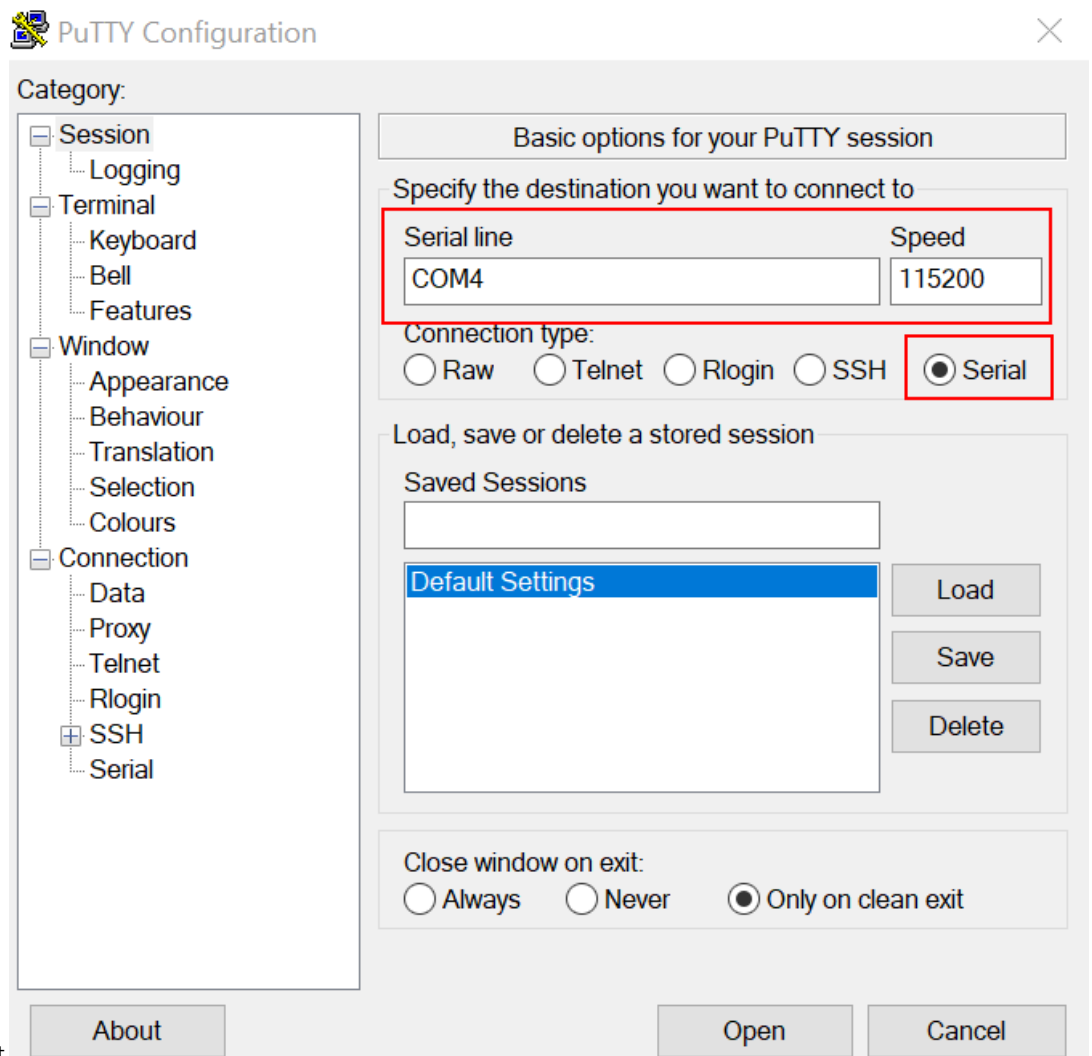


4. The build completes without errors.

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

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

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

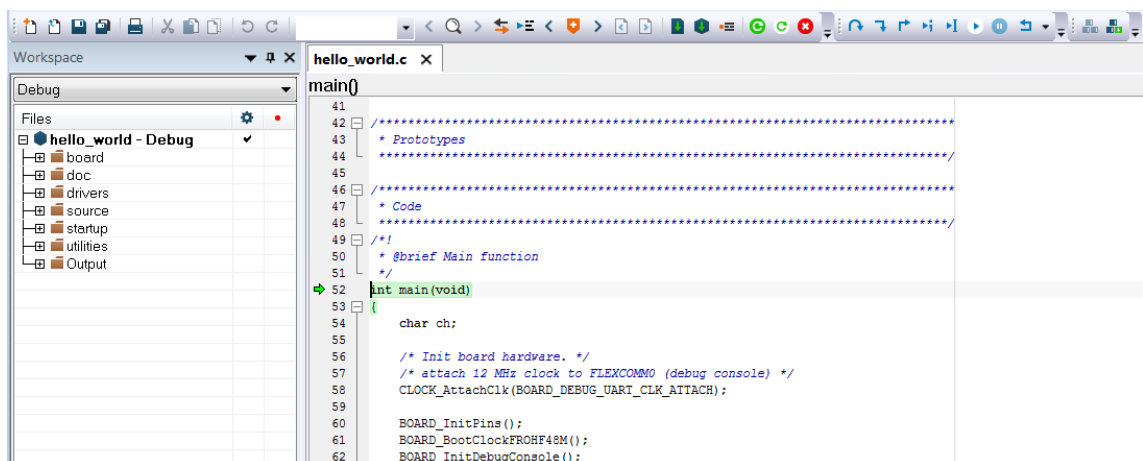


4. 1 stop bit

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



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



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



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



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

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

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

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

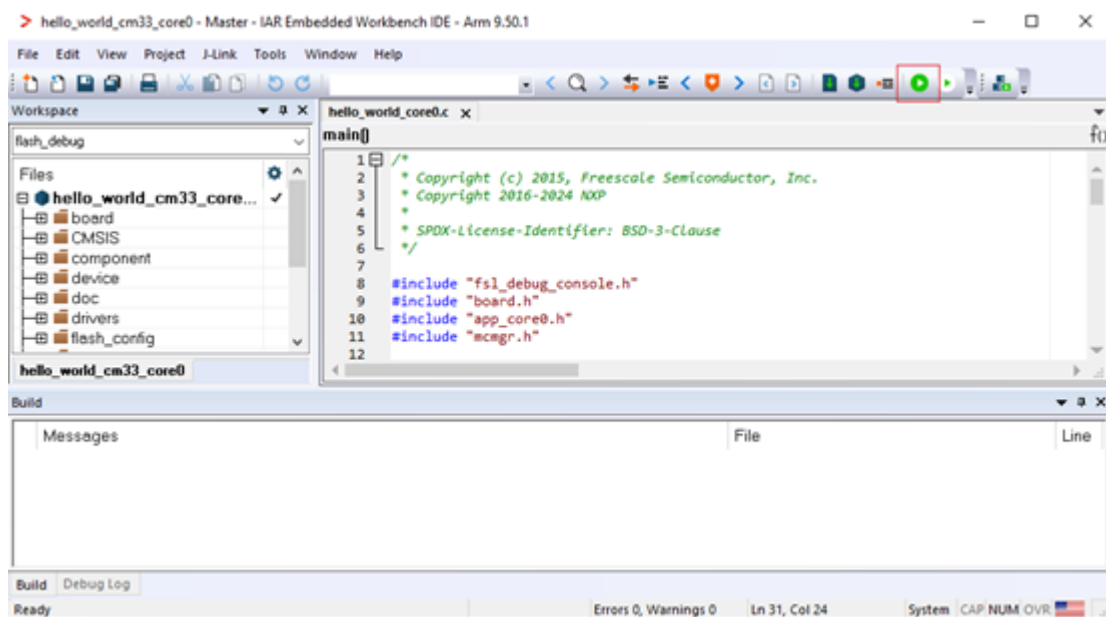
`<install_dir>/boards/mimxrt700evk/multicore_examples/hello_world/cm33_core0/iar/hello_world_cm33_core0.ew`

`<install_dir>/boards/mimxrt700evk/multicore_examples/hello_world/cm33_core1/iar/hello_world_cm33_core1.ew`

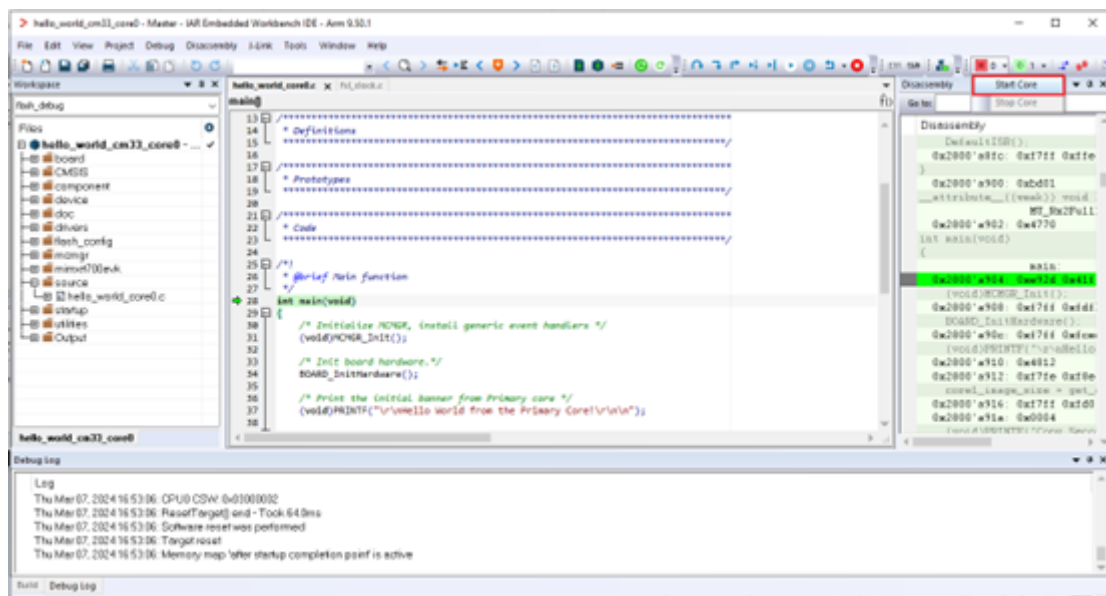
Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (`cm33_core1`) first, because the primary core application project (`cm33_core0`) must know the auxiliary core application binary when running the linker. When the auxiliary core application binary is not ready, it is impossible to finish the primary core linker.

By default, the primary core `flash_debug` target links the auxiliary core debug target, and the primary core `flash_release` target links the auxiliary core release target. During the primary core execution, the auxiliary core image is copied from flash into the SRAM and executed.

1. Build the `CM33_core1` and `CM33_core0` projects respectively.
2. Only click the **Download** and **Debug** button on the `CM33_core0` 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_core0** project.



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

```
Hello World from the Primary Core!

Copy Secondary core image to address: 0x20600000, size: 12272
Starting Secondary core.
The secondary core application has been started.
```

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

Run a demo using Keil MDK/μVision

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

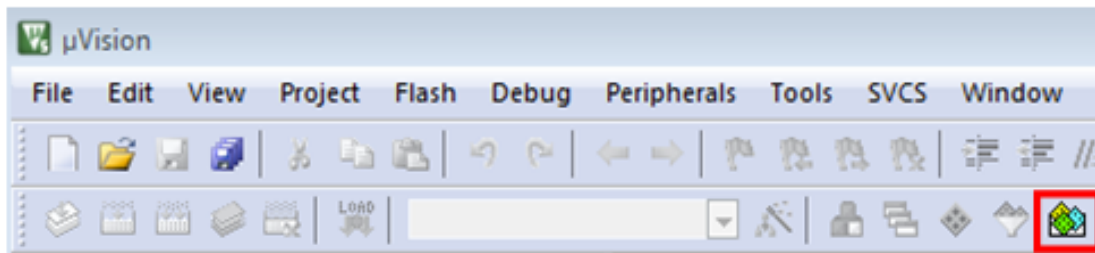
The hello_world demo application is used as an example, although these steps can be applied to any demo or example application in the MCUXpresso SDK.

Note:

Make sure that the board is configured as XSPI0 boot mode when debugging or running the examples.

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

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



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

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

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

1. Open the desired example application workspace in:

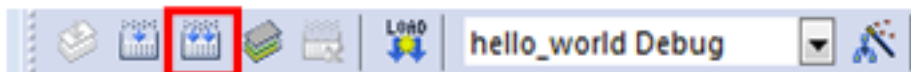
```
<install_dir>/boards/<board_name>/<example_type>/<application_name>/<core_id>/mdk
```

The workspace file is named as <demo_name>.uvmpw.

For this specific example, the actual path is:

```
<install_dir>/boards/mimxrt700evk/demo_apps/hello_world/cm33_core0/mdk/hello_world_demo_cm33_core0
```

2. To build the demo project, select **Rebuild**, as shown in *Figure 1*, highlighted in red.



3. The build completes without errors.

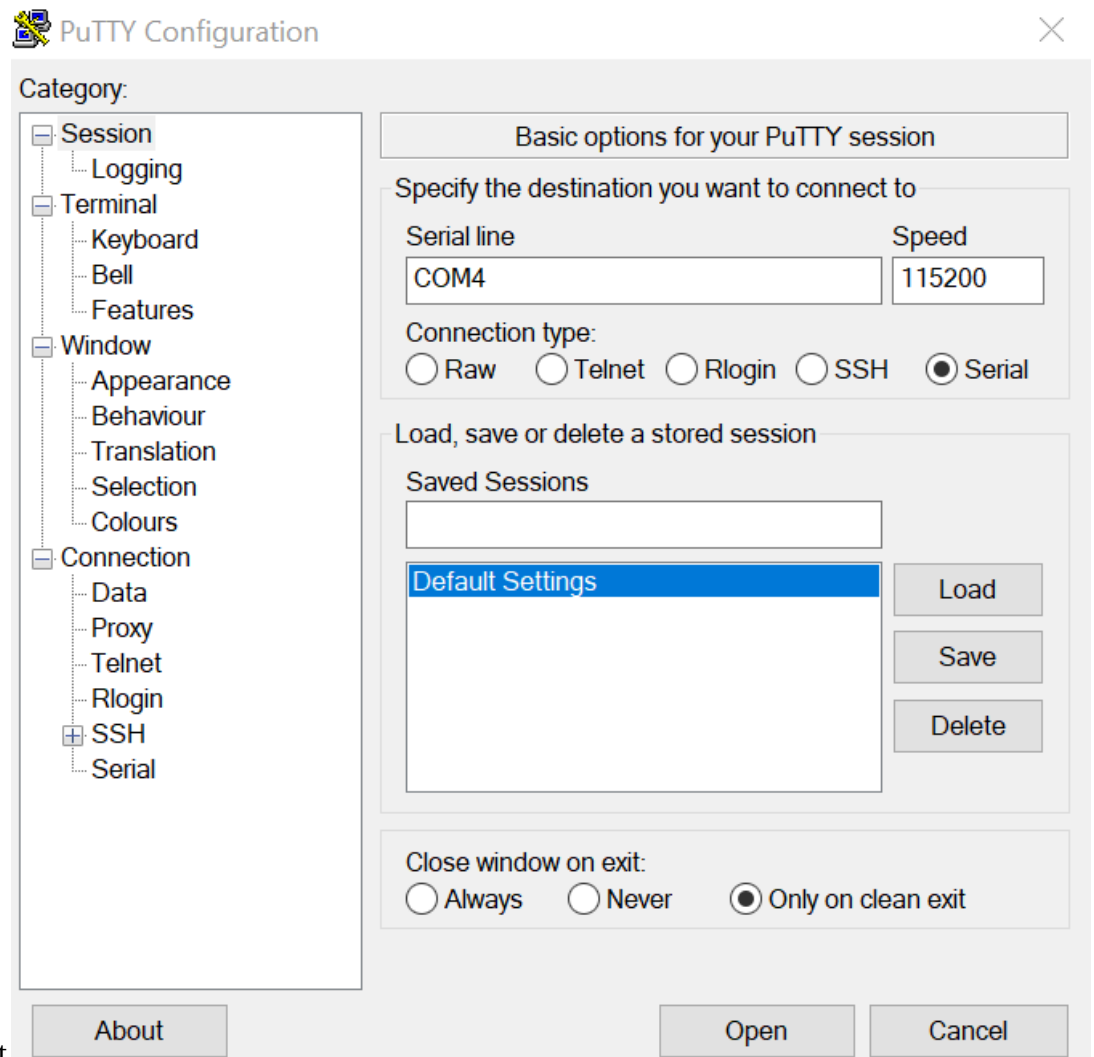
Parent topic: [Run a demo using Keil MDK/μVision](#)

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

1. Determine the debug interface that comes loaded on your specific hardware platform.
 - For boards with the CMSIS-DAP/mbed/DAPLink interface, visit Windows serial configuration and follow the instructions to install the Windows operating system serial driver. If running on Linux operating system, this step is not required.
 - If using J-Link either a standalone debug pod or MCU-LINK, install the J-Link software (drivers and utilities) from Segger.
2. Connect the development platform to your PC via USB cable using MCU-LINK USB connector.

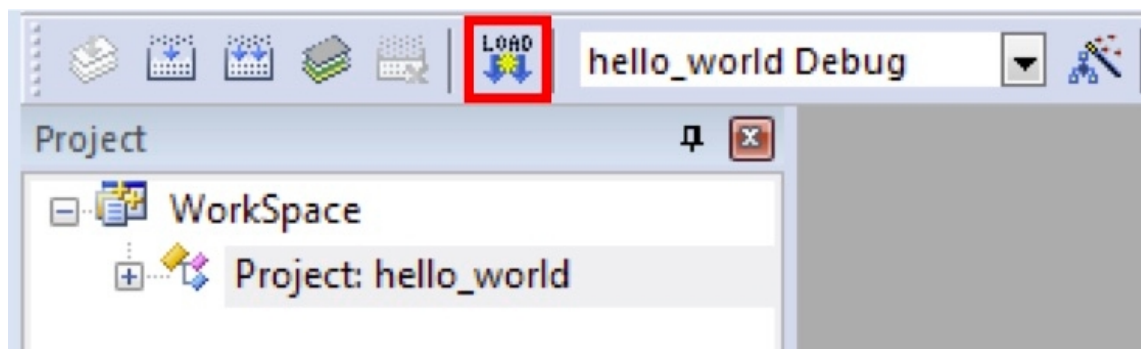
- Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:

- 115200 or 9600 baud rate, depending on your board (reference the BOARD_DEBUG_UART_BAUDRATE variable in the *board.h* file)
- No parity
- 8 data bits



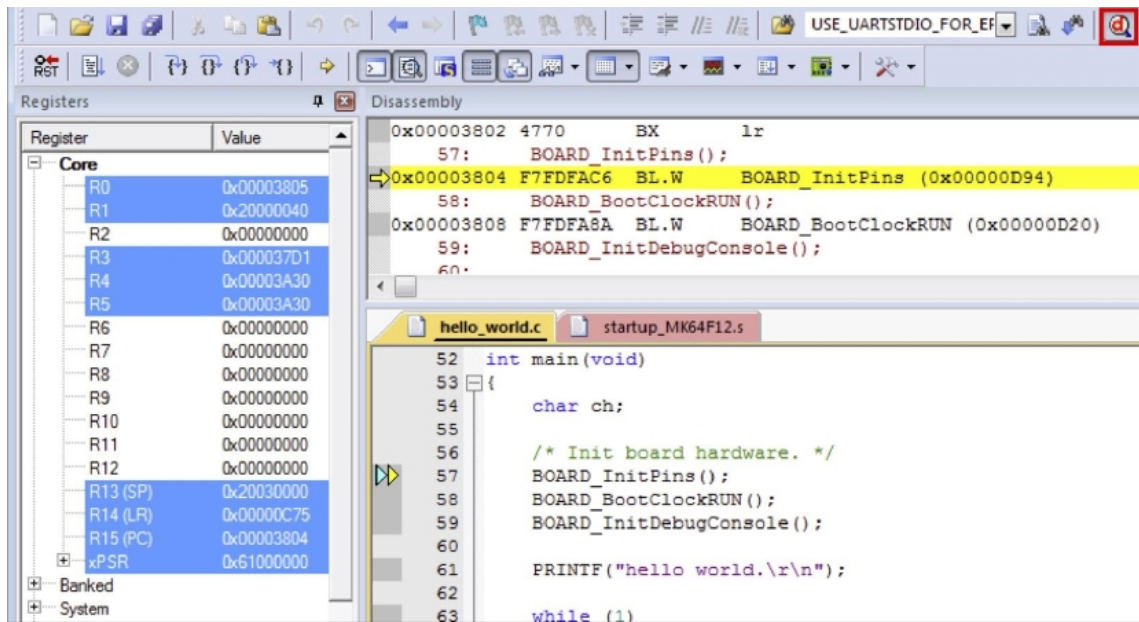
- 1 stop bit

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

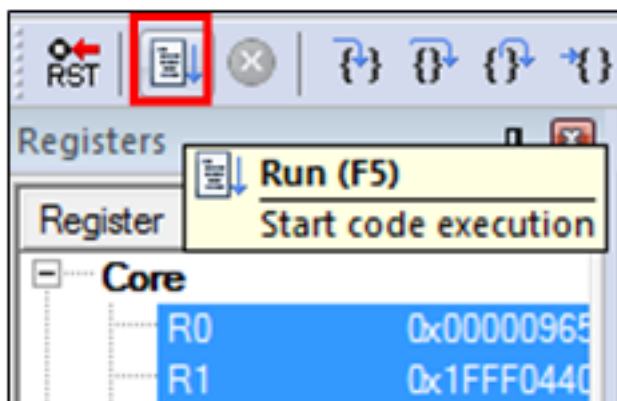


- After clicking the **Download** button, the application downloads to the target and is running.

To debug the application, click the **Start/Stop Debug Session** button, highlighted in red in Figure 3.



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



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



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 multicore application.

The multicore Hello World MDK workspaces are located in this folder:

`<install_dir>/boards/mimxrt700evk/multicore_examples/hello_world/cm33_core0/mdk/hello_world_cm33_core0.u`

`<install_dir>/boards/mimxrt700evk/multicore_examples/hello_world/cm33_core1/mdk/hello_world_cm33_core1.u`

To build both applications separately, click the **Rebuild** button. Build the application for the auxiliary core (cm33_core1) first, because the primary core application project (cm33_core0) 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.

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 Run an example application.
2. Run the primary core project and then run the secondary core project.
3. Hello_World multicore demos are now running. A banner appears on the terminal and the LED blinks. If this is not true, check your terminal settings and connections.

```
Hello World from the Primary Core!

Copy Secondary core image to address: 0x20600000, size: 12844
Starting Secondary core.
The secondary core application has been started.
```

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_world demo application is targeted for the MIMXRT700-EVK hardware platform which is used as an example.

Note:

ARMGCC version 12.3.Rel1 is used as an example in this document. The latest GCC version for this package is as described in the *MCUXpresso SDK Release Notes for MIMXRT700-EVK* (document MCUXSDKRT798RN).

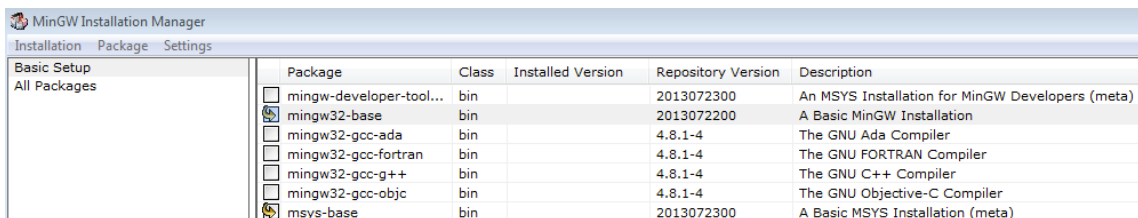
Set up toolchain This section contains the steps to install the necessary components required to build and run an MCUXpresso SDK demo application with the Arm GCC toolchain, as supported by the MCUXpresso SDK. There are many ways to use Arm GCC tools, but this example focuses on a Windows operating system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

Install GCC Arm Embedded tool chain Download and run the installer from GNU Arm Embedded Toolchain. This is the actual toolset (in other words, compiler, linker, and so on). The GCC toolchain should correspond to the latest supported version, as described in the *MCUXpresso SDK Release Notes for MIMXRT700-EVK* (document MCUXSDKRT798RN).

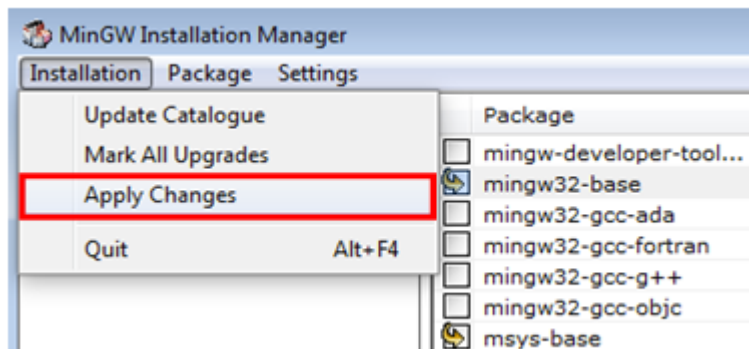
Parent topic:Set up toolchain

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

1. Download the latest MinGW mingw-get-setup installer from [MinGW](#).
 2. Run the installer. The recommended installation path is C:\MinGW, however, you may install to any location.
- Note:** The installation path cannot contain any spaces.
3. Ensure that the **mingw32-base** and **msys-base** are selected under **Basic Setup**.



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

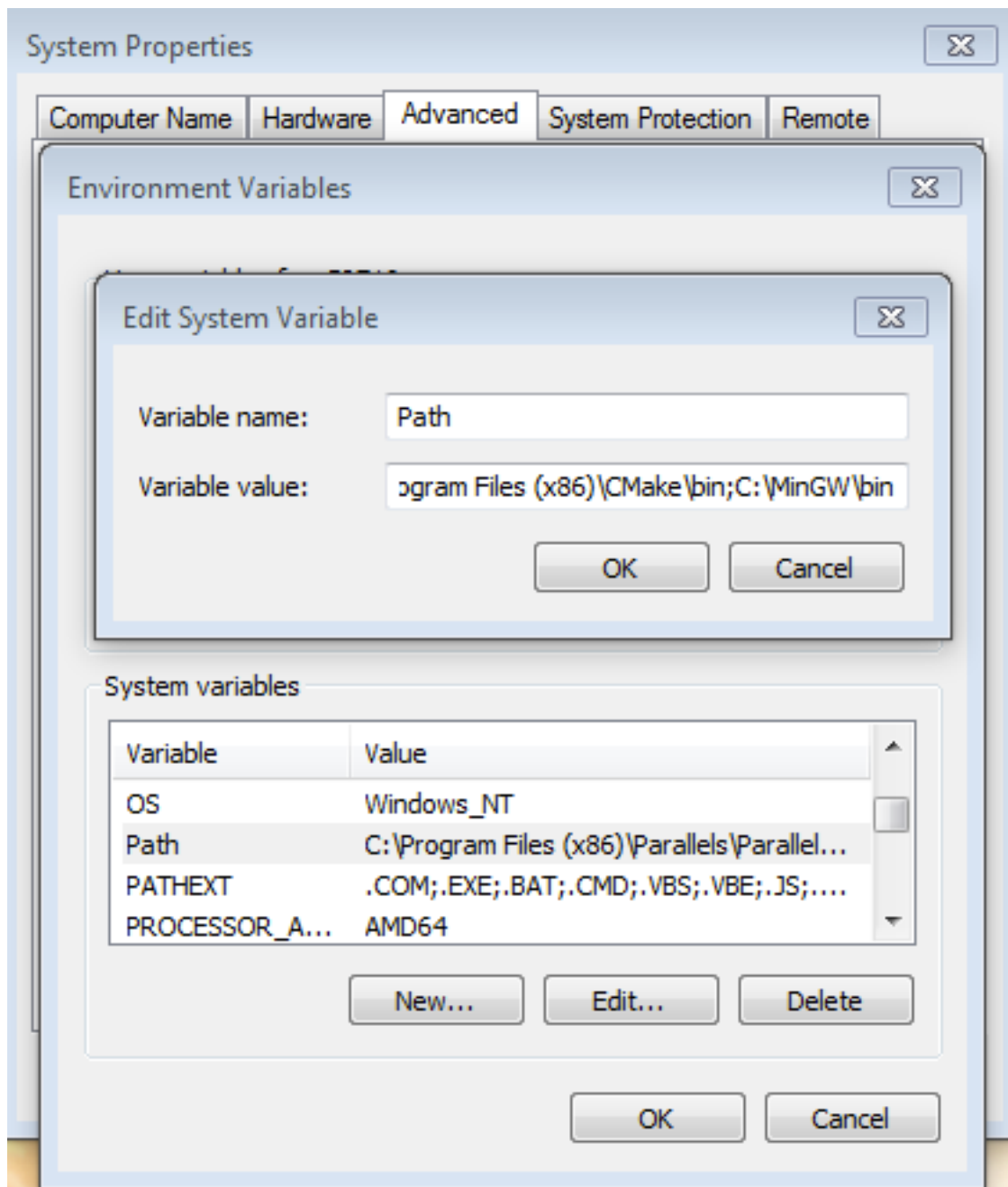


5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel > System and Security System > Advanced System Settings** in the **Environment Variables...** section. The path is:

```
<mingw_install_dir>\bin
```

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

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



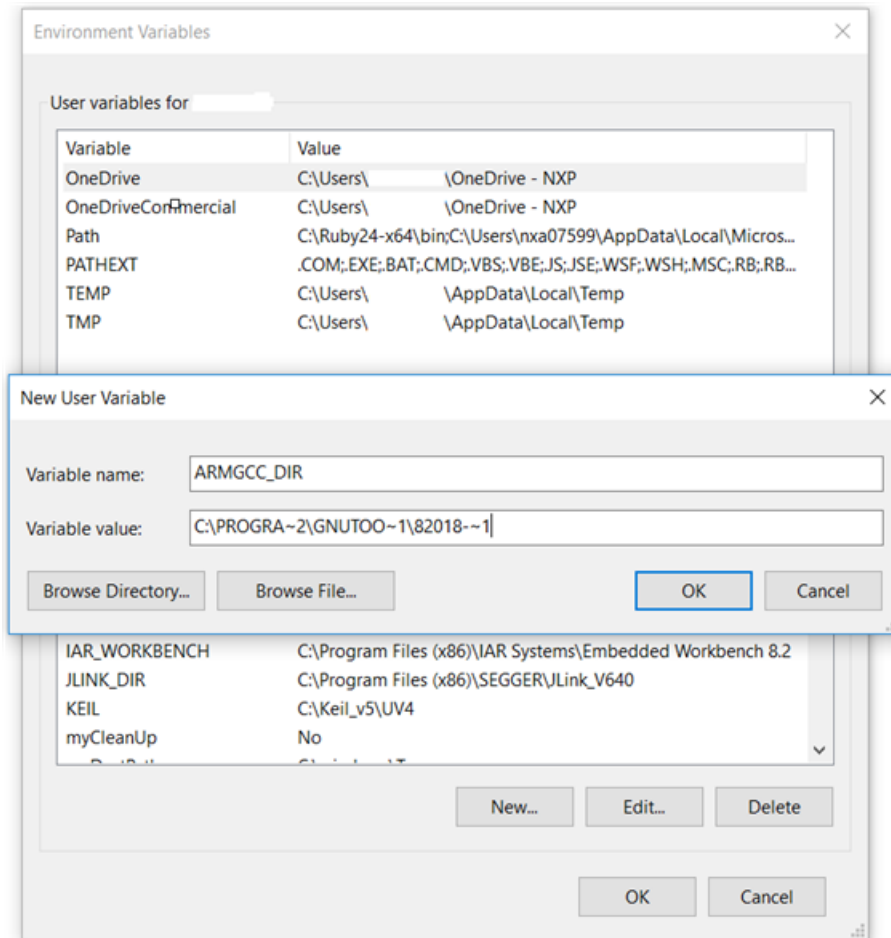
Parent topic:Set up toolchain

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

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

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

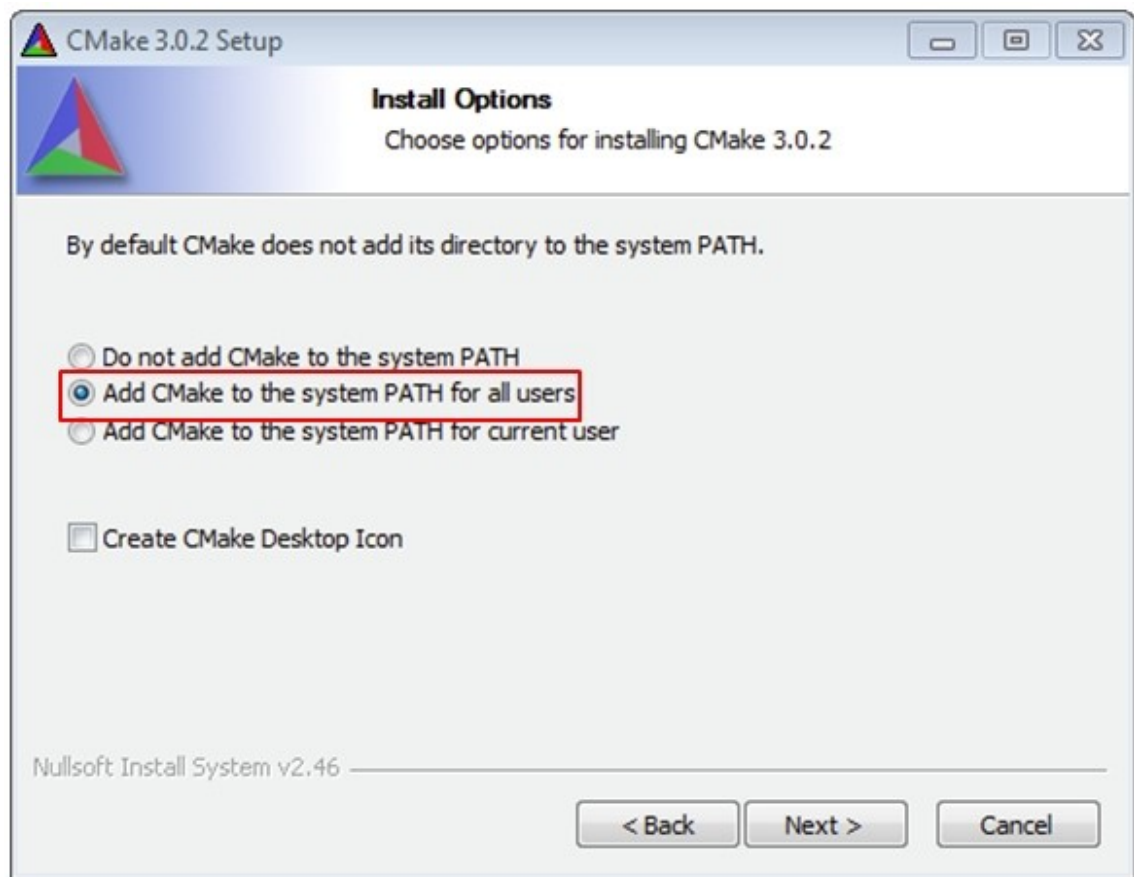
```
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>for %I in (.) do echo %~sI
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>echo C:\PROGRA~2\GNUTOO~1\82018~1
C:\PROGRA~2\GNUTOO~1\82018~1
```



Parent topic:Set up toolchain

Install CMake

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



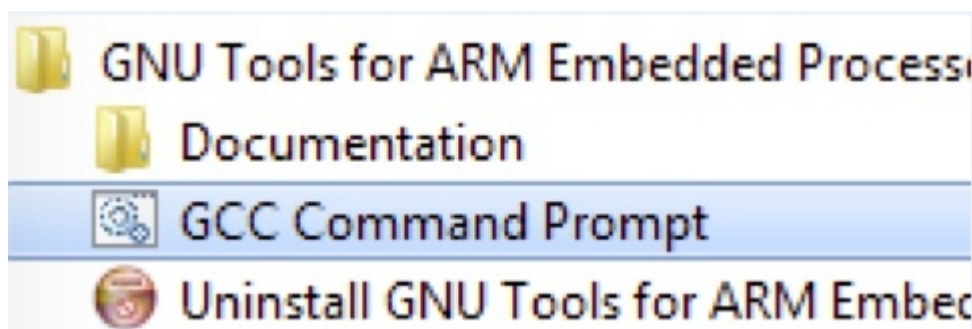
3. Follow the remaining instructions of the installer.
4. You may need to reboot your system for the PATH changes to take effect.
5. Make sure `sh.exe` is not in the Environment Variable PATH. This is a limitation of mingw32-make.

Parent topic:Set up toolchain

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

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

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



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

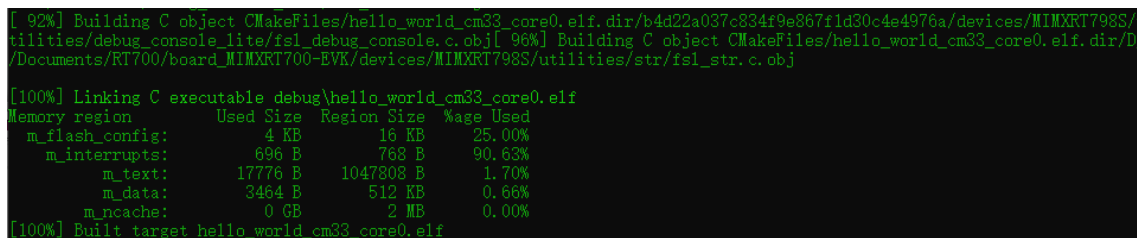
```
<install_dir>/boards/<board_name>/<example_type>/<application_name>/armgcc
```

For this example, the exact path is:

```
<install_dir>/boards/mimxrt700evk/demo_apps/hello_world/cm33_core0/armgcc
```

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

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



```
[ 92%] Building C object CMakeFiles/hello_world_cm33_core0.elf.dir/b4d22a037c834f9e8671d30c4e4976a/devices/MIMXRT798S/ut
ilities/debug_console_lite/fsl_debug_console.c.obj[ 96%] Building C object CMakeFiles/hello_world_cm33_core0.elf.dir/D
/Documents/RT700/board_MIMXRT700-EVK/devices/MIMXRT798S/utilities/str/fsl_str.c.obj

[100%] Linking C executable debug\hello_world_cm33_core0.elf
Memory region      Used Size  Region Size  %age Used
m_flash_config:      4 KB      16 KB      25.00%
m_interrupts:        696 B      768 B      90.63%
m_text:             17776 B    1047808 B     1.70%
m_data:             3464 B      512 KB      0.66%
m_ncache:            0 GB      2 MB         0.00%
[100%] Built target hello_world_cm33_core0.elf
```

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 multicore application. The demo application build scripts locate in this folder:

```
<install_dir>/boards/mimxrt700evk/multicore_examples/<application_name>/<core_id>/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/mimxrt700evk/multicore_examples/hello_world/cm33_core0/armgcc/build_debug.bat
<install_dir>/boards/mimxrt700evk/multicore_examples/hello_world/cm33/armgcc_core1/build_flash_debug.bat
```

Build the application for the auxiliary core (cm33_core1) first, because the primary core application project (cm33_core0) 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 `flash_debug` target links the auxiliary core **debug** target, and the primary core `flash_release` target links the auxiliary core **release** target. During the primary core execution, the auxiliary core image is copied from flash into SRAM and executed.

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

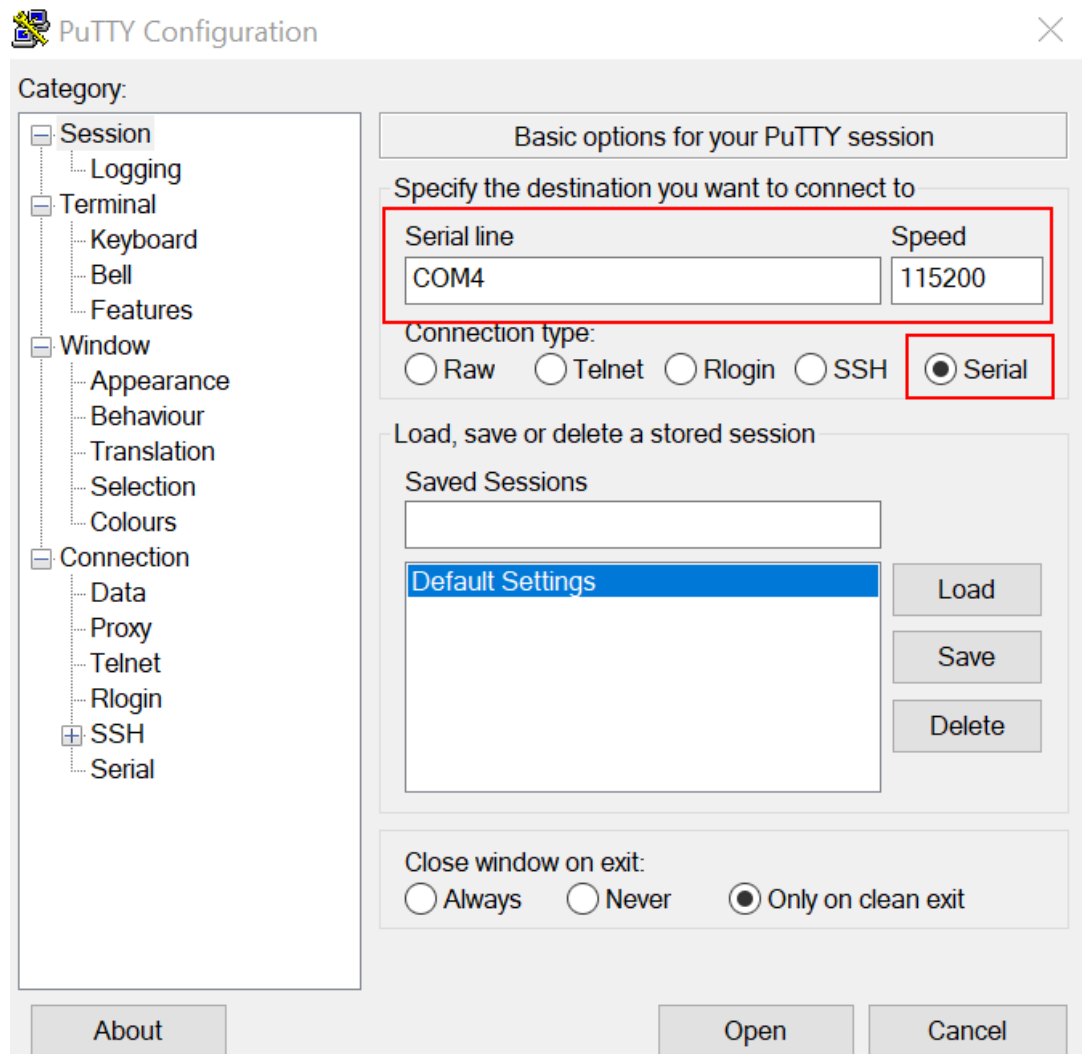
Run an example application This section describes steps to run a demo application using J-Link GDB Server application. To perform this exercise, make sure that either:

- The MCU-Link firmware on your board is programmed with the J-Link MCU-Link firmware. For instructions on reprogramming the MCU-Link firmware, see [Updating debugger firmware](#). If your board does not support MCU-Link, a standalone J-Link pod is required.
- You have a standalone J-Link pod that is connected to the debug interface of your board. Note that some hardware platforms require hardware modification in order to function correctly with an external debug interface.

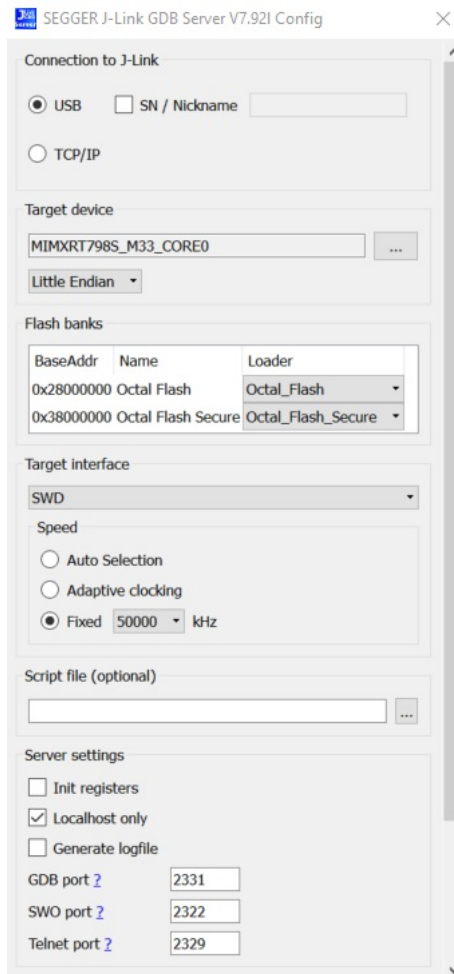
After the J-Link interface is configured and connected, follow these steps to download and run the demo applications:

1. Connect the development platform to your computer via USB cable between the MCU-Link USB connector and the PC USB connector. If using a standalone J-Link debug pod, also connect it to the SWD/JTAG connector of the board.

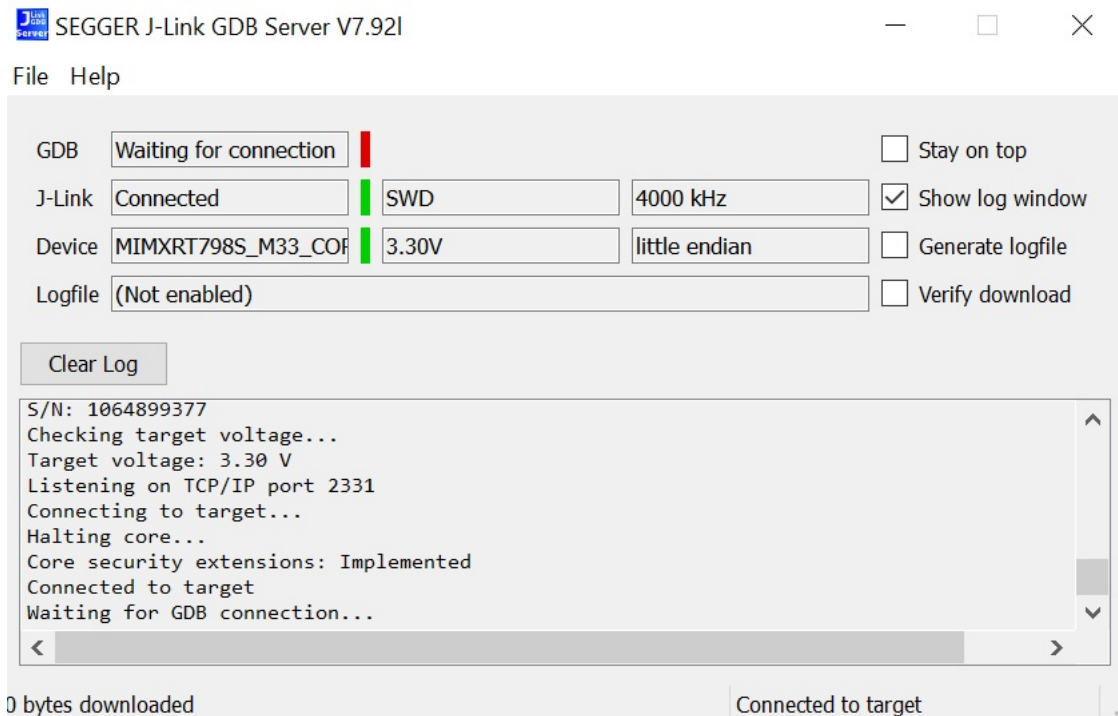
2. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see [How to determine COM port](#)). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the *board.h* file)
 2. No parity
 3. 8 data bits
 4. 1 stop bit



3. Open the J-Link GDB Server application. Assuming the J-Link software is installed, the application can be launched by going to the Windows operating system **Start** menu and selecting **Programs->SEGGER->J-Link <version> J-Link GDB Server**.
4. Modify the settings as shown in *Figure 1*. The target device selection chosen for this example is **MIMXRT798S_M33_CORE0**.

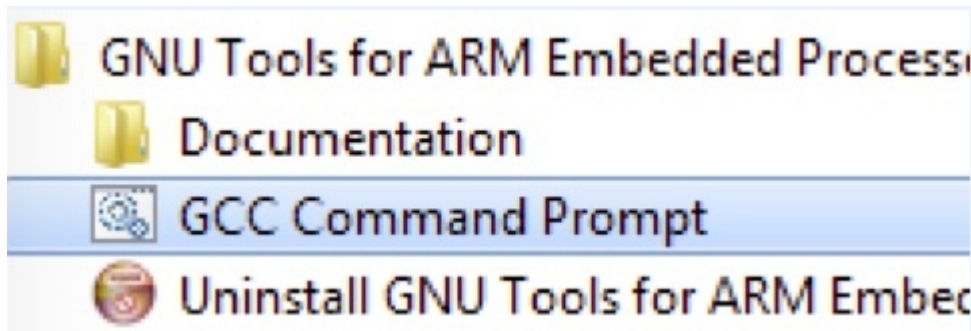


5. After it is connected, the screen should be as shown in *Figure 3*.



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

Tools Arm Embedded <version> and select **GCC Command Prompt**.



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

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

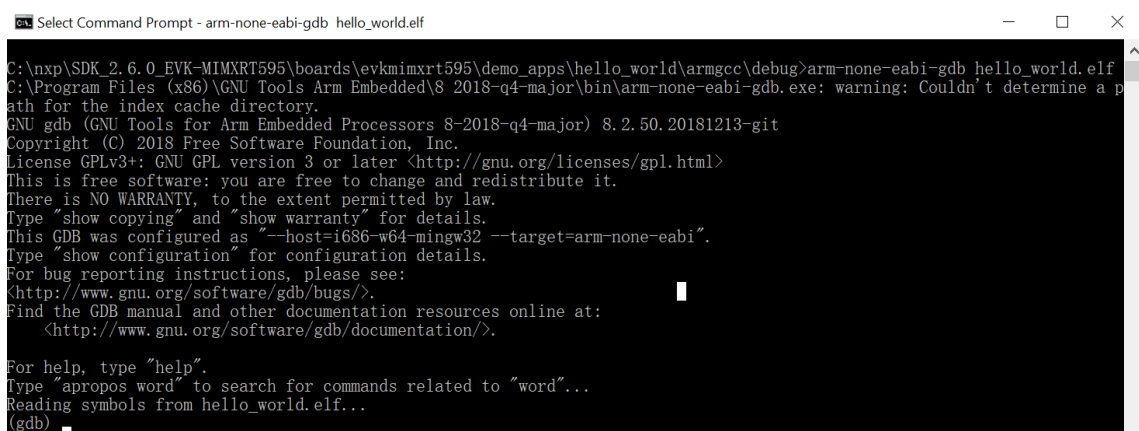
```
<install_dir>/boards/<board_name>/<example_type>/<application_name>/armgcc/release
```

For this example, the path is:

```
<install_dir>/boards/mimxrt700evk/demo_apps/hello_world/cm33_core0/armgcc/debug
```

```
<install_dir>/boards/mimxrt700evk/demo_apps/hello_world/cm33_core0/armgcc/release
```

- Run the `arm-none-eabi-gdb.exe <application_name>.elf` command. For this example, it is `arm-none-eabi-gdb.exe hello_world_cm33_core0`.



Note: Make sure that the board is set to XSPI flash boot mode before debugging.

- Run these commands:

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

- The application is now downloaded and halted. Execute the `c` 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.



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

Build and run the ezhv_examples

This section describes the steps required to configure the environment to build, run, and debug ezhv example applications. The `<install_dir>/boards/<board_name>/ezhv_examples/led_blinky` is used as an example.

For each example, generally there are two folders, one for the cm33_core0 core and the other for the EZHV core. For the led_blinky example, they are:

`<install_dir>/boards/<board_name>/ezhv_examples/led_blinky/cm33_core0`

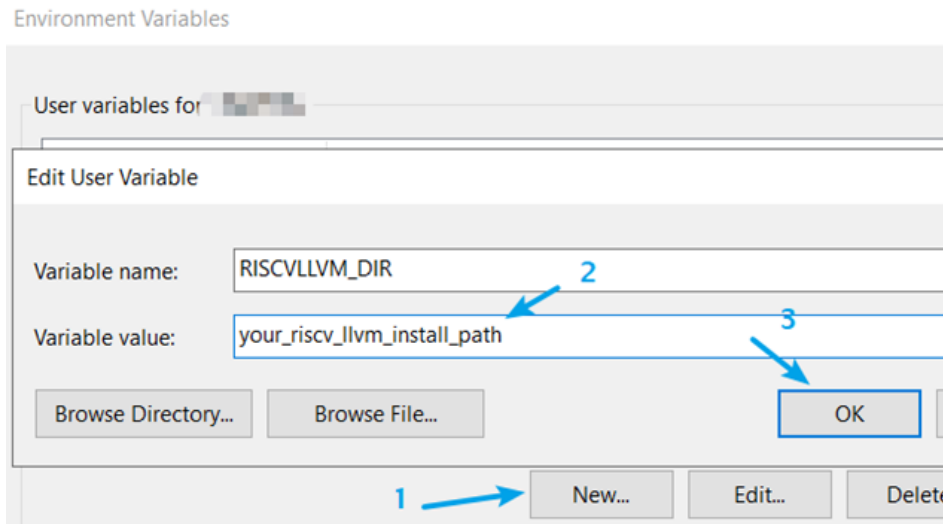
`<install_dir>/boards/<board_name>/ezhv_examples/led_blinky/ezhv`

Build the application for the auxiliary core (ezhv) first, because the primary core application project (cm33_core0) 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. This section focuses on the auxiliary core (ezhv). For details about building the primary core for different toolchain, see the corresponding chapter.

Set the toolchain for EZHV To set the toolchain for EZHV, perform the following steps:

1. Download and install the RISC-V LLVM toolchain.
2. Add a system environment variable RISCVLLVM_DIR, and set the value to the RISC-V LLVM install path.
 - For Linux or Mac, run the command:

```
export RISCVLLVM_DIR=<your_risc_llvm_install_path>
```
 - For Windows, as shown in Set the toolchain for EZHV, perform the following steps:
 1. Click **Windows Start** -> **Settings**.
 2. Search and open **Edit environment variable for your account**



3. Create a new variable.

- Download Ninja from [this link](#). Add the path ninja executable to system environmental variable **PATH**. When it finishes, run the `ninja --version` in command line to verify the installation. The result looks like:

```
$ ninja --version
1.10.1
```

- Download and install CMake.

Parent topic: [Build and run the ezhv_examples](#)

Build the EZHV project To build the EZHV project, go to the project folder `<install_dir>/boards/<board_name>/ezhv_examples/<example>/ezhv/riscvllvm`.

- For Windows, click the **build_debug.bat**.
- For Linux or Mac, run the `build_debug.sh` in the command line.

When the build finishes, a binary `ezhv_image.bin` is generated in the folder `<install_dir>/boards/<board_name>/ezhv_examples/<example>/ezhv/binary`.

Parent topic: [Build and run the ezhv_examples](#)

Run the project There are two ways to run the project: Run with primary core, or run independently.

- Run with primary core.

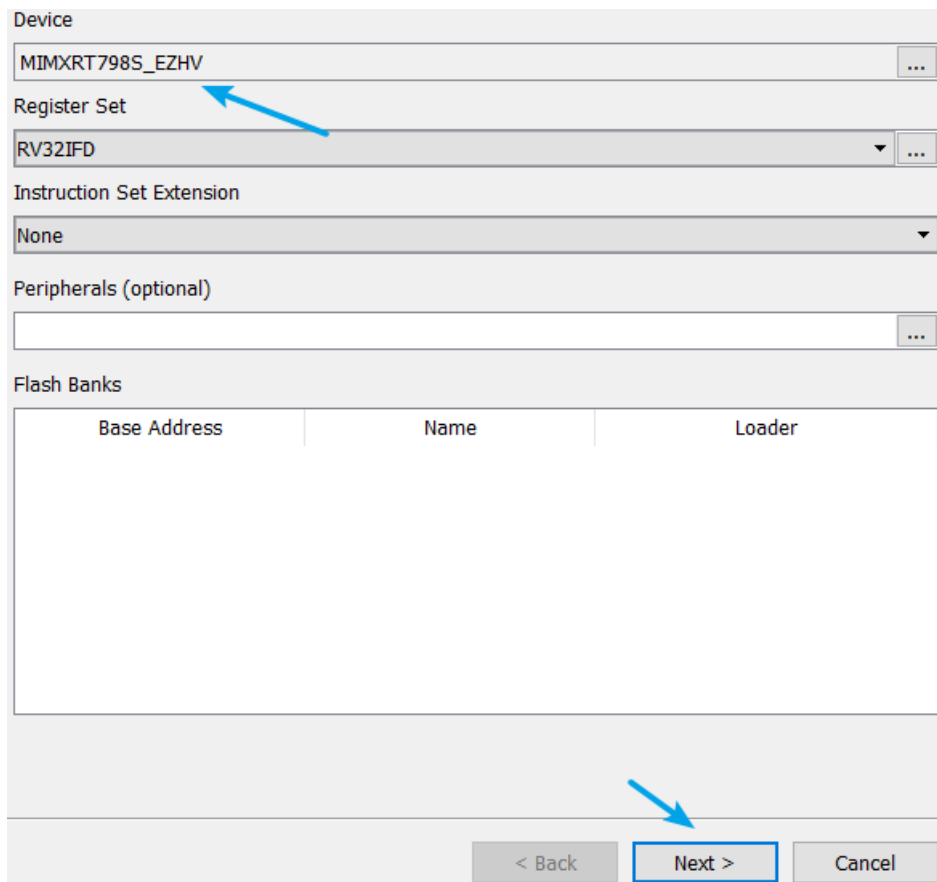
After EZHV binary `ezhv_image.bin` is created, follow the primary core project guide to build the primary core project and run.

- Debug the EZHV independently.

Currently **SEGGER Ozone** can be used to run and debug the EZHV executable.

- An external J-Link plus is needed, connect JP18 1-2 on the mimxrt700evk board to use external debugger and connect external J-Link to J18.
- Download and install the J-Link.
- Download and install the **SEGGER Ozone**.
- Open Ozone and create project, click **File -> New -> New Project Wizard**.

5. Select the device **MIMXRT798S_EZHV**.



Device

MIMXRT798S_EZHV

Register Set

RV32IFD

Instruction Set Extension

None

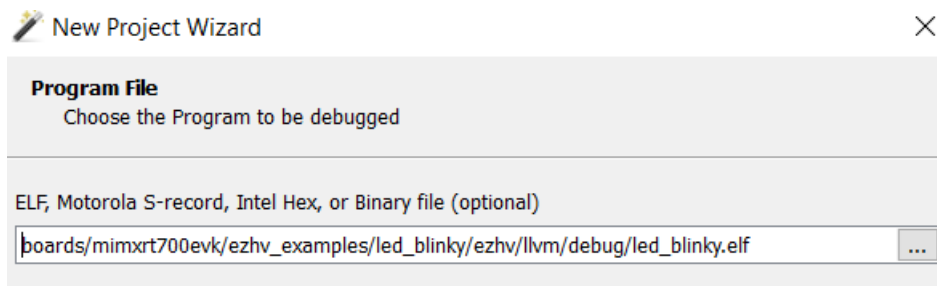
Peripherals (optional)

Flash Banks

Base Address	Name	Loader

< Back Next > Cancel

6. Select the built EZHV executable.



New Project Wizard

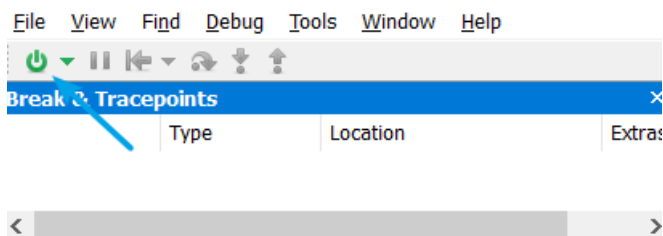
Program File

Choose the Program to be debugged

ELF, Motorola S-record, Intel Hex, or Binary file (optional)

boards/mimxrt700evk/ezhv_examples/led_blinky/ezhv/llvm/debug/led_blinky.elf

7. On the Ozone window, click the button to run.



File View Find Debug Tools Window Help

Run Break Tracepoints

Type	Location	Extras

Parent topic: [Build and run the ezhv_examples](#)

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

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

There are two ports: one is for Compute Domain and the other is for Sense Domain.

2. **Windows:** To determine the COM port open Device Manager in the Windows operating system. Click the **Start** menu and type **Device Manager** in the search bar.
3. In the Device Manager, expand the **Ports (COM & LPT)** section to view the available ports. The COM port names are different for all the NXP boards.

How to define IRQ handler in CPP files

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

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

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

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

Updating debugger firmware

Updating MCU-Link board firmware MCU-Link is the NXP single, unified debug probe architecture for all NXP general-purpose Arm Cortex-M based MCUs. MCU-Link is implemented on the latest evaluation boards (known as MCU-Link OB) of NXP. This firmware in this debug interface may be updated using the host computer utility called MCU-Link firmware. This typically used when switching between the default debugger protocol (CMSIS-DAP) to SEGGER J-Link, or for updating this firmware with new releases of these. This section contains the steps to re-program the debug probe firmware.

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

These steps show how to update the debugger firmware on your board for Windows operating system. For Linux operating system, follow the similar steps.

1. Install the MCU-Link firmware.
2. Unplug the USB cable of the board.
3. Enable ISP mode on MCU-Link Core - LPC55xxx (install the jumper labeled ISP Enable).

4. Connect the probe to the host via USB (use Link USB connector).
5. Open a command shell and call the appropriate script located in the MCU-Link firmware installation directory (*<firmware install dir>*).
 1. To program CMSIS-DAP debug firmware: *<firmware install dir>/scripts/program_CMSIS*
 2. To program J-Link debug firmware: *<LPCScrypt install dir>/scripts/program_JLINK*
6. Disable ISP mode on MCU-Link Core - LPC55xxx (remove the jumper installed in *Step 3*).
7. Repower the board by removing the USB cable and plugging it in again.

Parent topic: [Updating debugger firmware](#)

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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1.3 Getting Started with MCUXpresso SDK GitHub

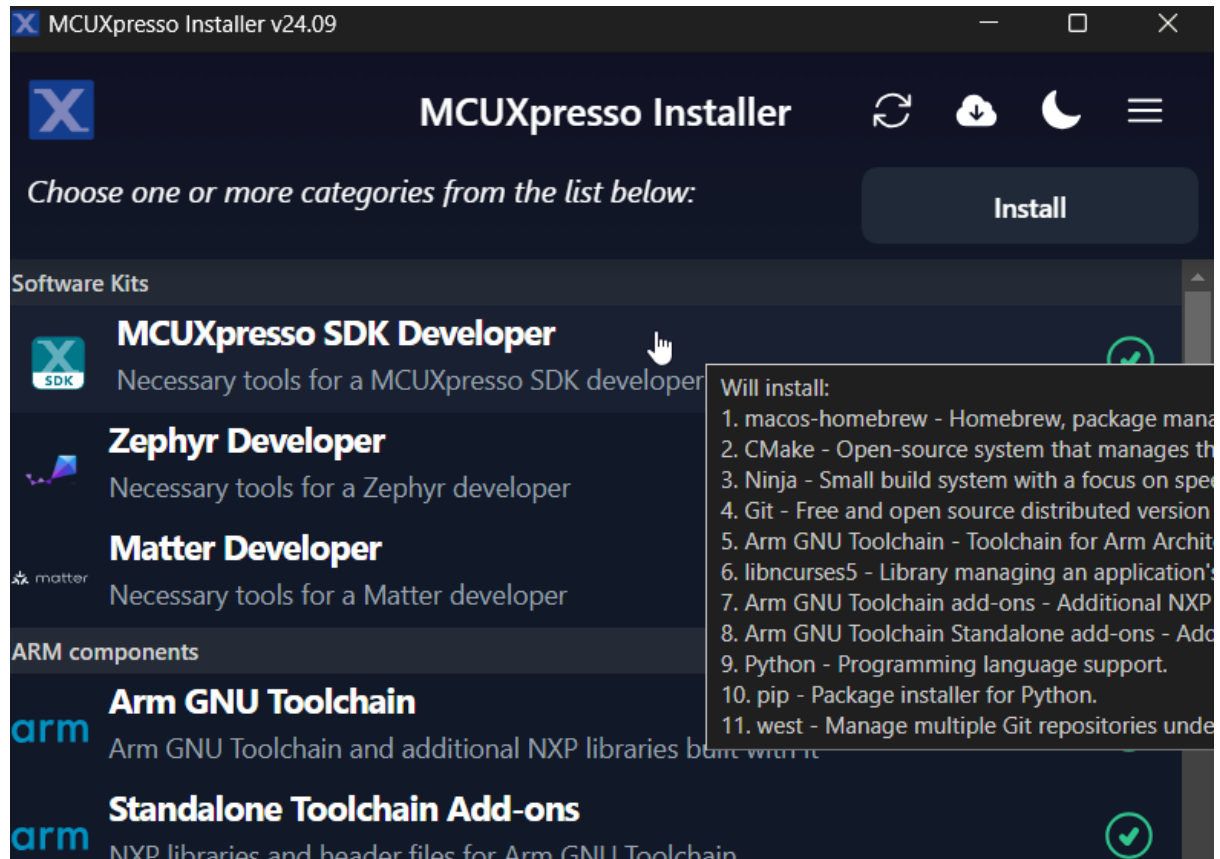
1.3.1 Getting Started with MCUXpresso SDK Repository

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_SE	c:\NXP\zephyr-sdk-<version> for windows/opt/zephyr-sdk-<version> for Linux	– toolchain zephyr
CodeWarrior	CW_DIR	C:\Freescale\CW MCU v11.2 for windowsCodeWarrior is not supported with Linux	– toolchain 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	RISCVL-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:

- arm
- common
- install-info

- 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
mani-fests	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.
com- po- nents	Software components.
de- vices	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.
ex- am- ples	Various demos and examples, support files on different supported boards. For each board support, there are board configuration files.
mid- dle- ware	Middleware components integrated into SDK.
rtos	Rtos components integrated into SDK.
scripts	Script files for the west extension command and build system support.
svd	Svd files for devices, this is optional because of large size. Customers run west manifest config group.filter +optional and west update mcux-soc-svd to get this folder.

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

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

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

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

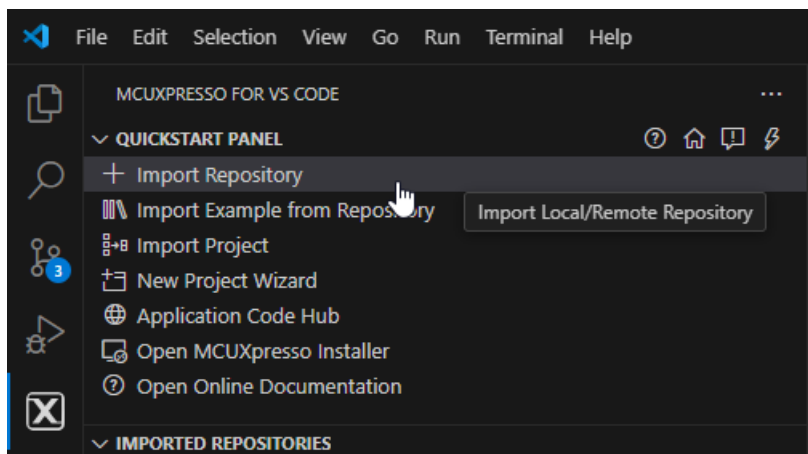
Run a demo using MCUXpresso for VS Code

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

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

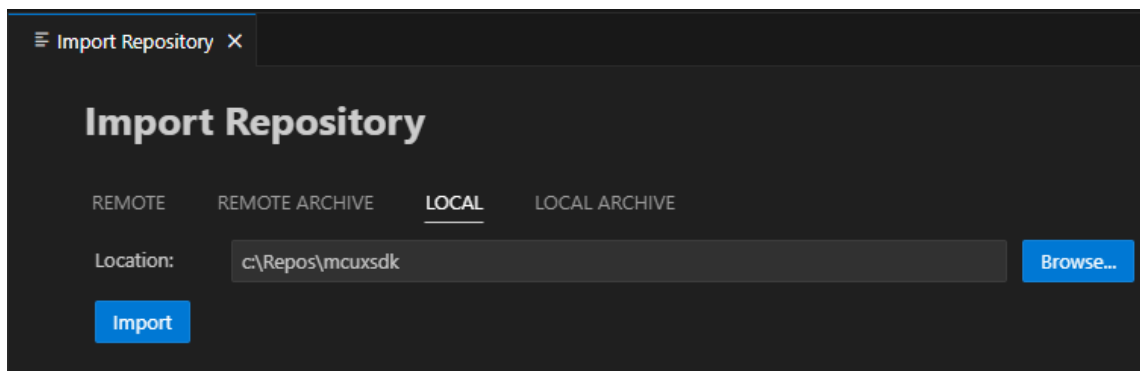
To build an example application:

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

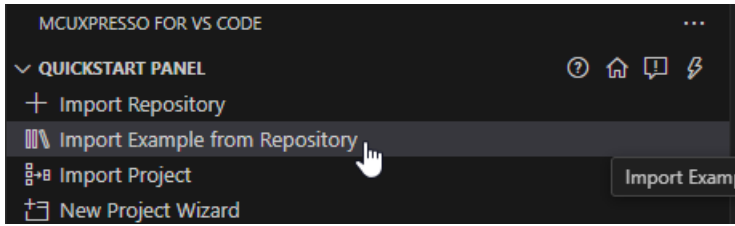


Note: You can import the SDK in several ways. Refer to [MCUXpresso for VS Code Wiki](#) for details.

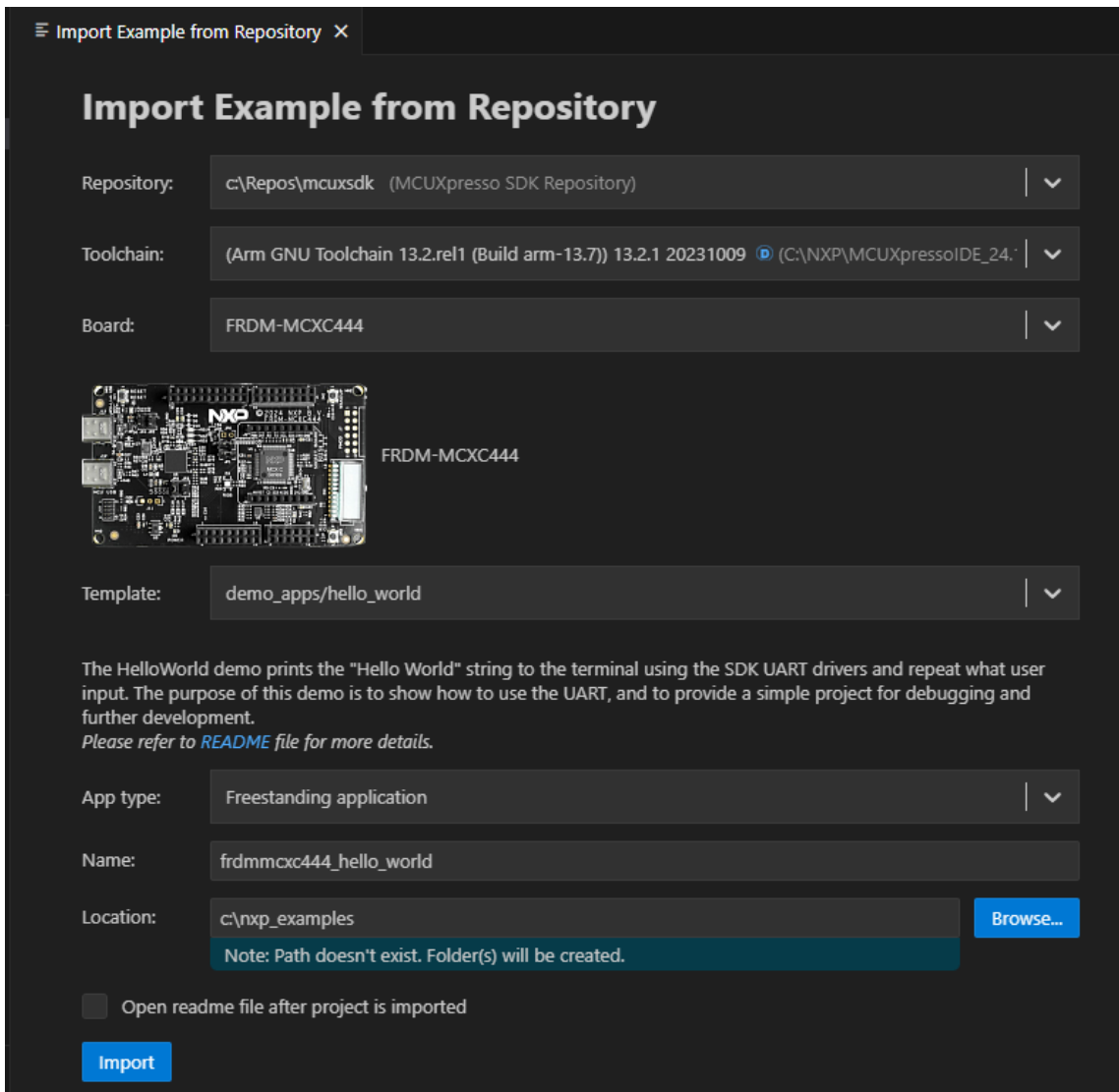
Select **Local** if you've already obtained the SDK as seen in [Get MCUXpresso SDK Repo](#). Select your location and click **Import**.



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

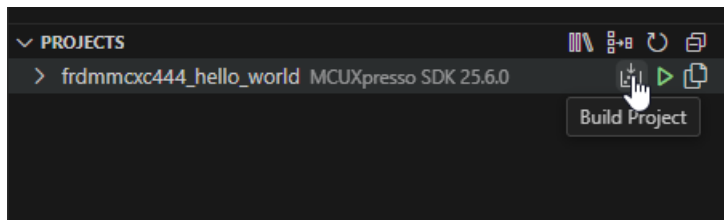


In the dropdown menu, select the MCUXpresso SDK, the Arm GNU Toolchain, your board, template, and application type. Click **Import**.

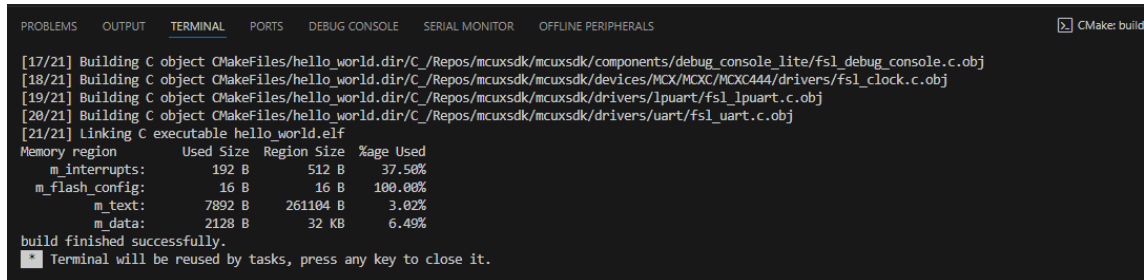


Note: The MCUXpresso SDK projects can be imported as **Repository applications** or **Free-standing applications**. The difference between the two is the import location. Projects imported as Repository examples will be located inside the MCUXpresso SDK, whereas Free-standing examples can be imported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

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

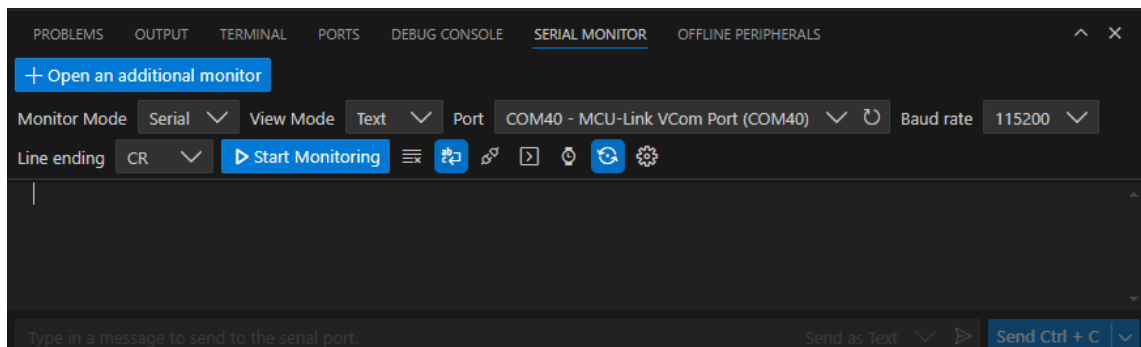


The integrated terminal will open at the bottom and will display the build output.

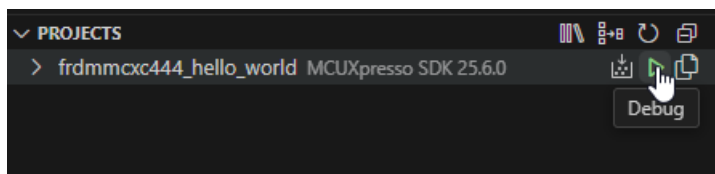


Run an example application **Note:** for full details on MCUXpresso for VS Code debug probe support, see [MCUXpresso for VS Code Wiki](#).

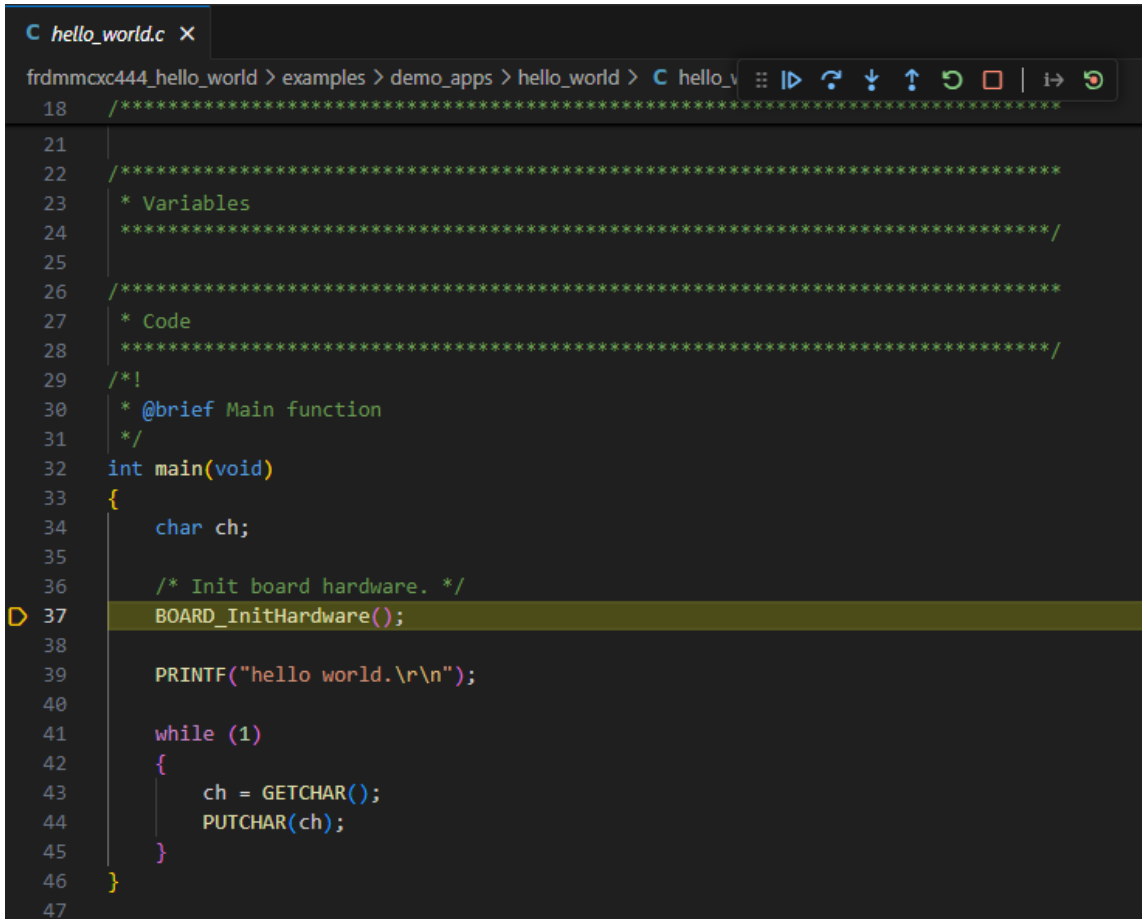
1. Open the **Serial Monitor** from the VS Code's integrated terminal. Select the VCom Port for your device and set the baud rate to 115200.



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



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

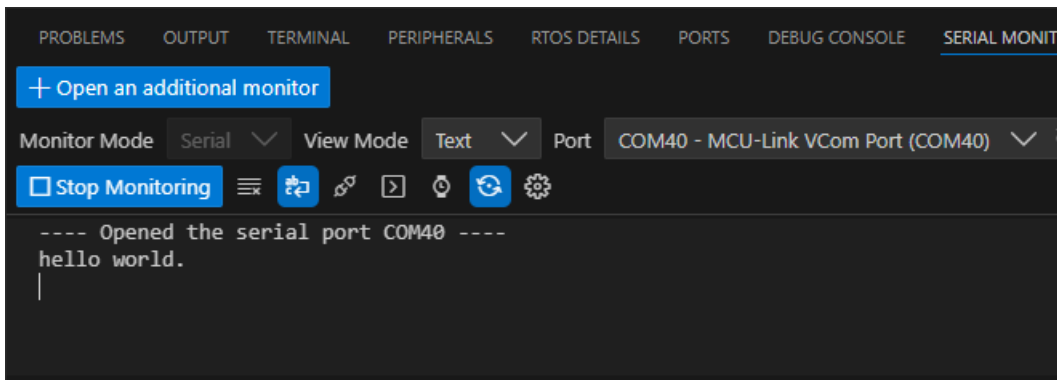


```

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

```

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



```

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

```

Running a demo using ARMGCC CLI/IAR/MDK

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

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

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

```
INFO: [ 2][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
↪evkbimxrt1050]
```

```
INFO: [ 3][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b_
```

(continues on next page)

(continued from previous page)

```

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

```

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

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

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

Here are some typical usages for generating a SDK example:

```

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

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

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

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

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

```

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

```

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

```

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

```

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

```

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

```

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

```

For more details, please refer to System build.

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

1. Run cmake configuration

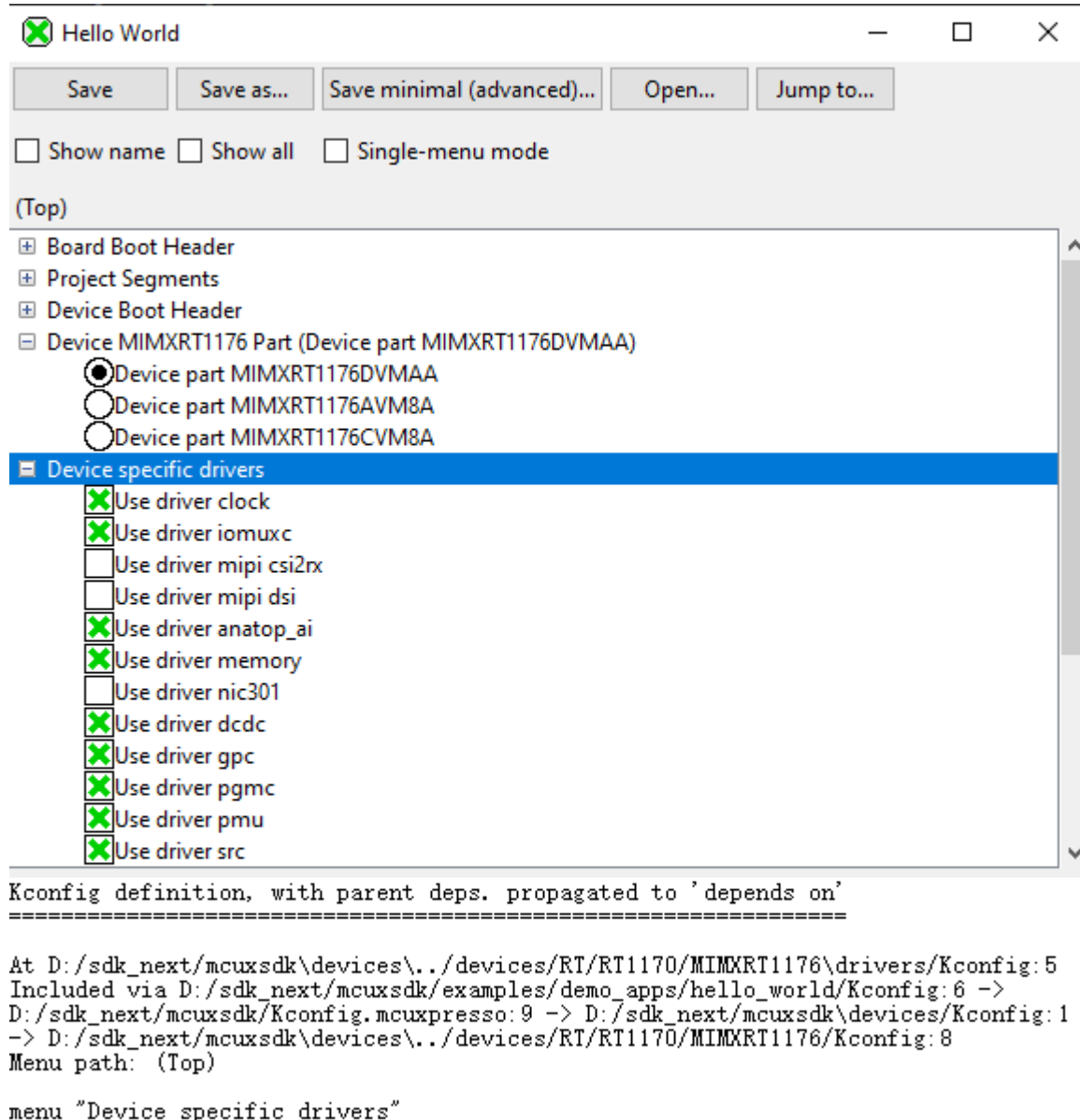
```
west build -b evkbnimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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:

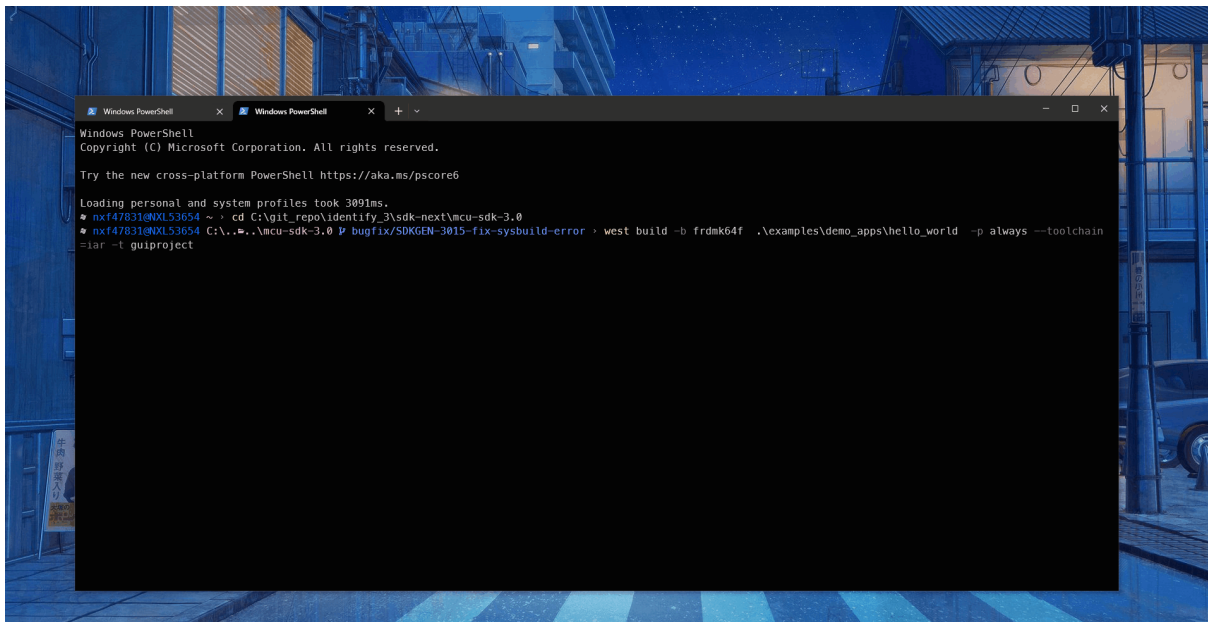
```
west debug -r linkserver
```

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 Getting Started with MCUXpresso SDK Xplorer

1.4.1 Getting Started with MCUXpresso SDK Xplorer

Overview

Cadence Tensilica Xplorer is a complete development environment that helps users create application code for high-performance Tensilica processors. Xplorer is the interface to powerful

software development tools such as the XCC compiler, assembler, linker, debugger, code profiler, and full set of GUI tools.

Xplorer, including both GUI and command-line environment, is the only available development IDE for the DSP core of MIMXRT700.

Install Xplorer Toolchains

This section provides information on Xtensa Software Tools Platform Support and steps to:

- Install the Xtensa Xplorer IDE and Tools
- Install License Key
- Install RT700 DSP Build Configuration
- Install Xtensa On Chip Debugger Daemon
- Program MCU-Link Debug Probe with SEGGER J-Link (Optional)
- Install Xtensa Software Tools without IDE

Xtensa Software Tools Platform Support The Xtensa Software Tools are officially supported on the following platforms:

Windows: Win 10 64-bit, Win 8 64-bit, Win 7 64-bit.

Linux: RHEL 6 64-bit (with 'Desktop' package installed).

There may be compatibility issues with other versions of Linux or Windows, especially when using the IDE.

Note: The security-enhanced Linux (SELinux) is not a supported platform because the OS can prevent different shared libraries (including Xtensa Tools) from loading.

For more information on platform support and installation guidelines, see the Xtensa Development Tools Installation Guide.

Parent topic: [Install Xplorer Toolchains](#)

Install the Xtensa Xplorer IDE and Tools To install the Xtends Xplorer IDE and tools, perform the following steps:

1. Go to the URL <https://tensilicatools.com/download/hifi-dsp-development-tools-for-rt700/> and log in. If you are accessing the site for the first time, make sure to register.
2. Make sure to use your corporate email address to register.



3. Once registered you should receive an email confirmation with an activation link from 'Tensilica Tools' no-reply@tensilicatools.com. Make sure to check the spam folder if this email does not show up in the inbox.
4. To complete the registration, click the activation link.
5. Once registered, log in to see the material available for download:



1. Download and install the **Xplorer IDE V10.1.11** for your operating system (Windows or Linux).
2. Download the **DSP Configuration** for your operating system – installed later through the IDE, see Install RT700 DSP Build Configuration. **Note:** NXP recommends version **10.1.11** of the Xtensa Xplorer IDE and tools for use with the RT700 DSP.

Parent topic:[Install Xplorer Toolchains](#)

Install License Key Xtensa development tools use FLEXlm for license management. FLEXlm licensing is required for tools such as the Xtensa Xplorer IDE, Xtensa C and C++ compiler.

Currently RT700 supports node-locked license for Xtensa tools. A node-locked license permits tools to run on a specific computer, tied to the MAC address of the primary network interface permanently attached to the machine.

Identify PC MAC Address To generate the correct license file, you should first identify the appropriate MAC for the computer you plan to run Xtensa tools on. Remove ‘-’ or ‘:’ symbols in the MAC address.

Windows:

```
C:\Users>ipconfig /all

Wireless LAN adapter Wireless Network Connection:

    Connection-specific DNS Suffix  . : us-sjo01.nxp.com
    Description . . . . . : Intel(R) Dual Band Wireless-AC 8265
    Physical Address. . . . . : 14-4F-8A-63-8C-33
    DHCP Enabled. . . . . : Yes
```

Linux:

```
[user@rhel ~]$ ifconfig
eth0      Link encap:Ethernet  HWaddr 12:34:56:78:90:AB
```

Note: For Linux: MAC address must be associated with eth0 interface. If not, FLEXlm cannot perform the license checkout, compilation, or simulation of code is not possible. If the host has the MAC address associated with another interface, for example em1, the following approach may be used.

```
# Add udev rule for naming interface
$ sudo vim /etc/udev/rules.d/70-persistent-net.rules
# udev rule (replace 'XX' with the MAC address of your PC):
SUBSYSTEM=="net", ACTION=="add", ATTR{address}=="XX:XX:XX:XX:XX:XX", NAME="eth0"
# Change "em1" to "eth0" in your interfaces file.
$ sudo vim /etc/network/interfaces
# Restart udev or reboot machine
$ sudo reboot
```

Alternatively, you can use the approach recommended by your IT team to rename the interface to eth0.

Parent topic:Install License Key**Download License Key** To download the license key:

1. Reload or return to the Tensilica URL: <https://tensilicatools.com/download/hifi-dsp-development-tools-for-rt700/>.
2. Click the button and get the license key for RT700 SDK.

For license keys, please follow the links below:

[Click here for license key for HiFi 1](#)

[Click here for license key for HiFi 4](#)

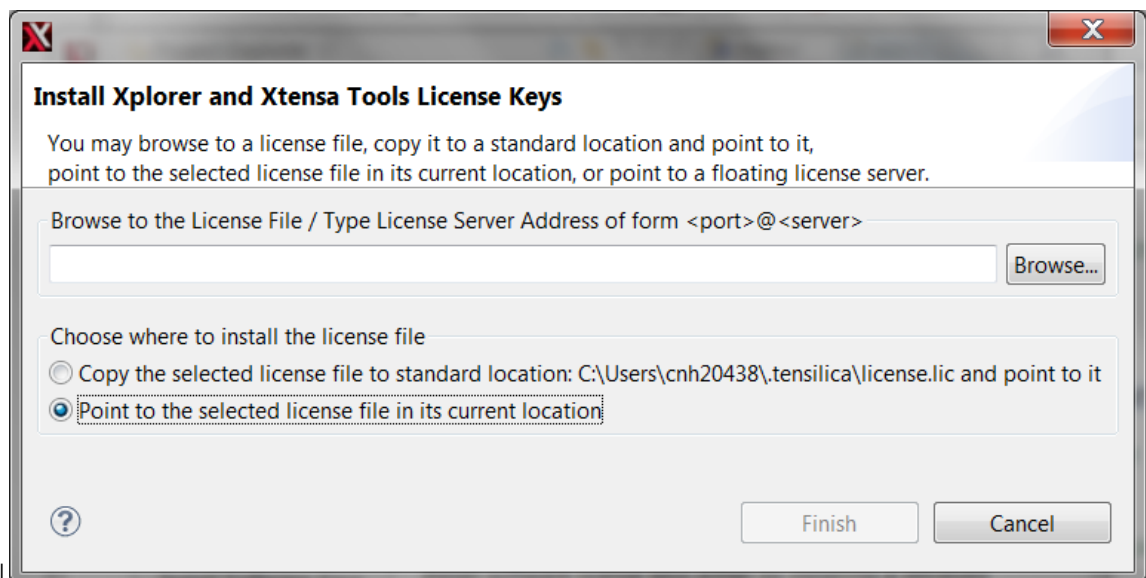
3. Provide the address.

Click to Get a License Key for RT700 HiFi4 SDK

MAC Address (no "-" or "+" or ":" or spaces, please)

Please enter your machine's MAC address. If you have more than one, please use one that is permanently installed. The license checker will confirm that the MAC address is present, even if that particular network interface isn't in use. For example, you can enter the MAC address for your LAN interface, and that will work even if you are using the WiFi interface for your development.

4. Once the license file has been generated and downloaded, open your recently installed Xplorer V10.1.11.
5. Select menu **Help > Xplorer License Keys > Install Software Keys**.
6. Select the license key file.



7. Click the **Finish** button.

Note: The generated license file only supports debug/run on the RT700 device target. It does not support software simulation/Xplorer ISS. If you have special requirements to run the software simulations, contact Cadence directly.

Parent topic:Install License Key

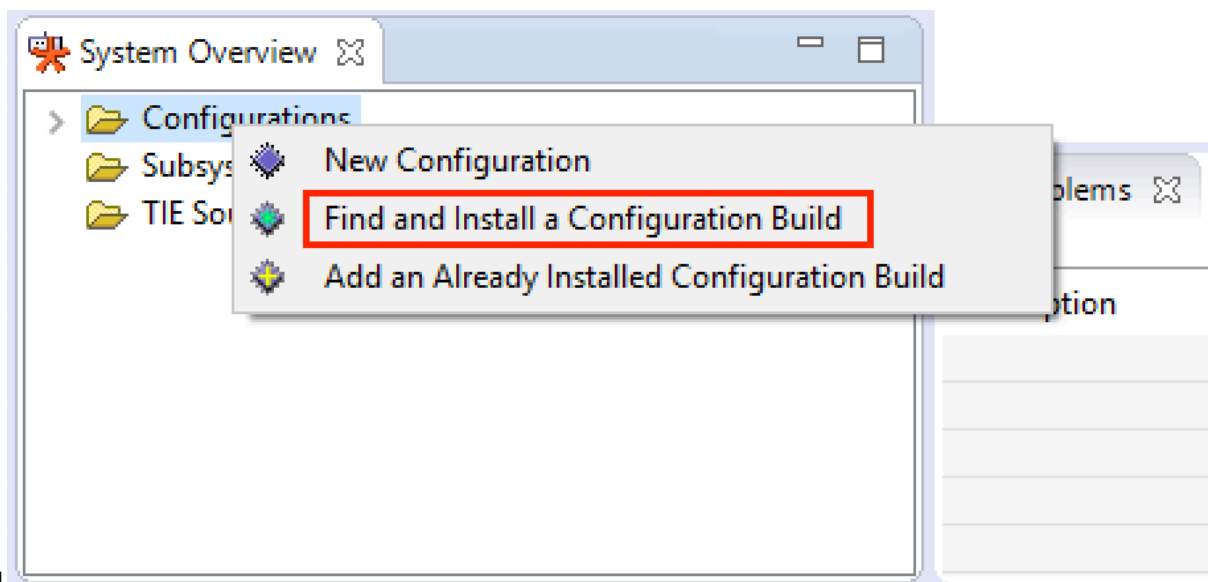
Parent topic:[Install Xplorer Toolchains](#)

Install RT700 DSP Build Configuration ‘*Build Configuration*’ is a term that describes all parameters and necessary build includes for the Tensilica processor implementation for development. It is mandatory to install a specific build configuration before starting development on RT700.

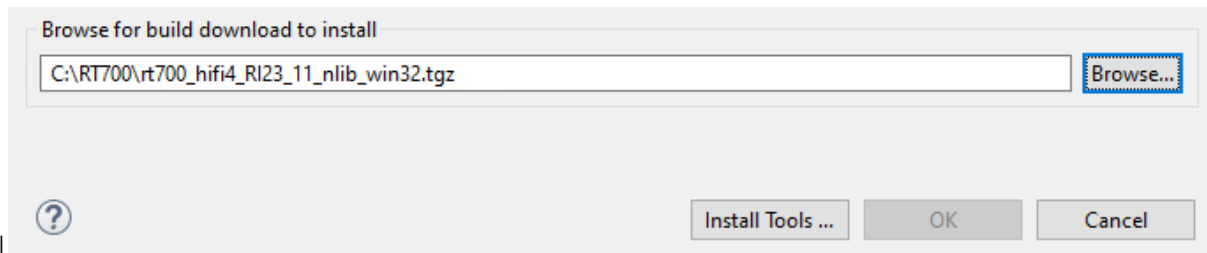
The build configuration is provided by NXP as a binary file and is imported into the Xplorer IDE. The binary file for the OS is available at the Tensilica URL: <https://tensilicatools.com/download/rt700-download-page/>.

- 🔒 HIFI1 DSP CONFIGURATION FOR LINUX (NEWLIB) **V10.1.11**
- 🔒 HIFI1 DSP CONFIGURATION FOR LINUX (XCLIB) **V10.1.11**
- 🔒 HIFI1 DSP CONFIGURATION FOR WINDOWS (NEWLIB) **V10.1.11**
- 🔒 HIFI1 DSP CONFIGURATION FOR WINDOWS (XCLIB) **V10.1.11**
- 🔒 HIFI4 DSP CONFIGURATION FOR LINUX (NEWLIB) **V10.1.11**
- 🔒 HIFI4 DSP CONFIGURATION FOR LINUX (XCLIB) **V10.1.11**
- 🔒 HIFI4 DSP CONFIGURATION FOR WINDOWS (NEWLIB) **V10.1.11**
- 🔒 HIFI4 DSP CONFIGURATION FOR WINDOWS (XCLIB) **V10.1.11**

The build configuration is installed into the IDE using the **System Overview** panel available in the lower left corner, by default. If the **System Overview** panel is not visible, toggle using the **Window > Show View > System Overview** menu item.



Click **OK** for build download to install.



Parent topic: [Install Xplorer Toolchains](#)

Install Xtensa On Chip Debugger Daemon The Xtensa On Chip Debugger Daemon (xt-ocd), is a gdb-based debugging tool but is not installed by default with the Xplorer IDE. For installation, a self-extracting executable installer is included with the IDE, which can be found at the following location:

Windows:

C:\usr\xtensa\XtDevTools\downloads\RI-2023.11\tools\xt-ocd-14.11-windows64-installer.exe

Linux:

~/xtensa/XtDevTools/downloads/RI-2023.11/tools/xt-ocd-14.11-linux64-installer

Currently, xt-ocd supports J-Link and Arm RVI/DSTREAM probes over Serial Wire Debug (SWD) for RT700. xt-ocd installs support for J-Link probes but does not install the required J-Link drivers which must be installed separately. Make sure that the latest version of J-Link software is installed.

Note: For Linux: When installing xt-ocd on Linux, ensure that the symlink is manually added to the installed J-Link driver: `ln -s <jlink-install-dir>libjlinkarm.so.6 <xocd-install-dir>/modules/libjlinkarm.so.6.`

xt-ocd is configured with an XML input file ‘topology.xml’ that modifies to fit the debugger hardware. Using J-link as an example, use the content below to replace the original template for HiFi4 DSP

Note: It is mandatory to replace the ‘usbser’ section with the J-Link serial number on the back of the J-Link hardware in use.

```
<configuration>
<controller id='Controller0' module='jlink' usbser='600116164' type='swd' speed='1000000' locking='1'/>
<driver id='XtensaDriver0' dap='1' xdm-offset='0x80020000' module='xtensa' step-intr='mask,stepover,steps' />
<chain controller='Controller0'>
<tap id='TAP0' irwidth='4' />
</chain>
<system module='jtag'>
<component id='Component0' tap='TAP0' config='trax' />
</system>
<device id='Xtensa0' component='Component0' driver='XtensaDriver0' ap-sel='3'/>
<application id='GDBStub' module='gdbstub' port='20000' sys-reset='0'>
<target device='Xtensa0' />
</application>
</configuration>
```

Below is another topology.xml example for HiFi1 DSP.

```
<configuration>
<controller id='Controller0' module='jlink' usbser='600116164' type='swd' speed='1000000' locking='1'
(continues on next page)
```


(continued from previous page)

```

↩' />

<driver id='XtensaDriver0' dap='1' xdm-offset='0x80030000' module='xtensa' step-intr='mask,stepover,
↩setps' />
<chain controller='Controller0'>
  <tap id='TAP0' irwidth='4' />
</chain>
<system module='jtag'>
  <component id='Component0' tap='TAP0' config='trax' />
</system>
<device id='Xtensa0' component='Component0' driver='XtensaDriver0' ap-sel='3' />
<application id='GDBStub' module='gdbstub' port='20000' sys-reset='0'>
  <target device='Xtensa0' />
</application>
</configuration>

```

Congratulations! All Xplorer toolchains are installed.

For more details on Xtensa software tools, build configurations, or xt-ocd daemon, see the full set of documents in Xplorer menu **Help > PDF Documentation**.

Parent topic: *Install Xplorer Toolchains*

Program MCU-Link Debug Probe with SEGGER J-Link (Optional) In addition to standalone probes, the onboard MCU-Link debug probe can be used to debug HiFi4 DSP over SWD port. The RT700 EVK has an LPC55S69 MCU (top right corner on EVK) and by default has been pre-programmed as CMSIS-DAP probe. CMSIS-DAP is not compatible with HiFi4 the DSPs, but to enable serial logging of Core 1, CMSIS-DAP firmware is required.

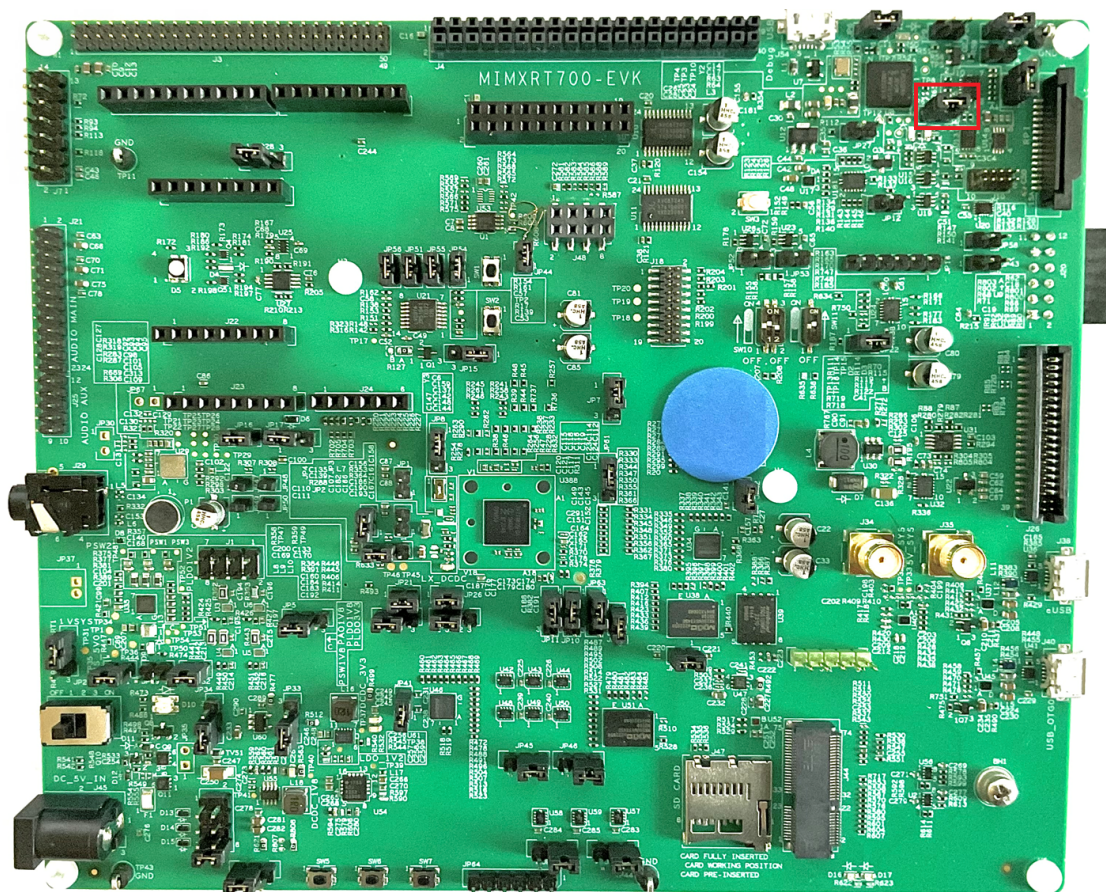
To use the on-board J-Link without Core 1 serial logging, a few extra steps are required to flash it with J-Link firmware.

The steps are:

1. Install MCU-Link, a command-line tool for programming onboard MCU-Link debug probe with the CMSIS-DAP and J-Link firmware. MCU-Link installer is available for download from: <https://www.nxp.com/design/design-center/software/development-software/mcuxpresso-software-and-tools/mcu-link-debug-probe:MCU-LINK#t996>.
2. After the download is complete, run the installer.

Note: During the installation, the DFU, and VCOM drivers are automatically installed for all platforms.

3. To update the MCU-Link debug circuit firmware, unplug the USB cable on J54 and then connect the JP20 jumper. .



4. Reconnect the board to the host computer over the debug link USB connector J54.
5. Go to the scripts folder in the MCU-Link install location: C:\NXP\MCU-LINK_installer_2.263\scripts.

Name	Date modified	Type	Size
 program_CMSIS.cmd	10/4/2021 12:26 PM	Windows Comma...	3 KB
 program_JLINK.cmd	10/4/2021 12:26 PM	Windows Comma...	3 KB

6. In that command shell, run the program_JLINK script to install the JLink debug firmware.

```
<Intall Dir>scripts\program_JLINK
```

****Note:**** File paths in this document use the Windows directory separator, on Linux or Mac OSX. The file paths must be replaced with '/' For Windows users, shortcuts to the scripts are available from the MCU-Link entry on the Start menu.

7. Verify once you select the firmware (in this case J-Link), MCU-Link. The console appears as shown in Figure 4.

```

C:\WINDOWS\system32\cmd.exe
J-Link firmware for MCU-Link programming script v1.0.7 October 2021.

NOTE: J-Link firmware supports MCU-Link Pro and MCU-Link on-board systems
that use an LPC55569 in LQFP100 or BGA98 package.
Although the firmware can be programmed in to MCU-Link and MCU-Link on-board
systems that use LQFP64 package, the firmware will not run.

Place the board in ISP USB mode using the appropriate jumper on your MCU-Link.
Refer to the board documentation for more information.
Connect board via USB then press Space.

Press any key to continue . . .

Programming "Firmware_J-Link-MCU-Link_210930.s19"
Programmed successfully - To use: remove ISP jumper and reboot.

Connect Next Board then press Space (or CTRL-C to Quit)

Press any key to continue . . .

```

8. Open/ Disconnect JP20 and power cycle the board. The onboard MCU-Link is ready to be used as SEGGER J-Link probe.

Every EVK/ MCU-Link has a different J-Link S/N. Therefore, make sure to write down the S/N for xt-ocd and topology.xml as indicated in Install Xtensa On Chip Debugger Daemon.

```

J-Link Commander V7.94j
SEGGER J-Link Commander V7.94j (Compiled Feb 14 2024 15:37:25)
DLL version V7.94j, compiled Feb 14 2024 15:36:06

Connecting to J-Link via USB...Updating firmware: J-Link MCU-Link V1 compiled Dec  4 2023 11:05:21
Replacing firmware: J-Link MCU-Link V1 compiled Sep 30 2021 17:54:41
Waiting for new firmware to boot
New firmware booted successfully
O.K.
Firmware: J-Link MCU-Link V1 compiled Dec  4 2023 11:05:21
Hardware version: V1.00
J-Link uptime (since boot): 0d 00h 00m 00s
S/N: 1066565304
USB speed mode: High speed (480 MBit/s)
VTref=3.300V

Type "connect" to establish a target connection, '?' for help
J-Link>

```

9. MCU-Link debug probe creates a virtual serial port over USB, so the extra UART2USB cable for debugging is not required.



The download link provides the document, demo videos and details on MCU-Link. If you have any questions, or have difficulties to program the probe, see [\[https://www.nxp.com/document/guide/getting-started-with-the-mcu-link:GS-MCU-LINK\]](https://www.nxp.com/document/guide/getting-started-with-the-mcu-link:GS-MCU-LINK) (<https://www.nxp.com/document/guide/getting-started-with-the-mcu-link:GS-MCU-LINK>).

Parent topic: [Install Xplorer Toolchains](#)

Install Xtensa Software Tools without IDE The Xtensa Software Tools can also be installed without the use of the IDE. The installation without the IDE is useful in a command-line only Linux environment, or for better compatibility with an unsupported Linux environment.

The command-line tools package is available as a redistributable zip file that is extracted with an Xplorer IDE install. To gain access to the tools package, the IDE must be installed once in the organization. The tools package is available at: `~/xtensa/XtDevTools/downloads/RI-2023.11/tools/XtensaTools_RI_2023_11_linux.tgz..`

With the tools package and the DSP Build Configuration package available from the [Tensilica Tools download site](#), the toolchain can be set up as follows:

```
# Create Xtensa install root
mkdir -p ~/xtensa/tools
mkdir -p ~/xtensa/builds
# Set up the configuration-independent Xtensa Tool:
tar zxvf XtensaTools_RI_2023_11_linux.tgz -C ~/xtensa/tools
# Set up the configuration-specific core files:
tar zxvf nxp_rt700_RI23_11_newlib_linux_redist.tgz -C ~/xtensa/builds
# Install the Xtensa development toolchain:
cd ~/xtensa
./builds/RI-2023.11-linux/nxp_rt700_RI23_11_newlib/install \
--xtensa-tools./tools/RI-2023.11-linux/XtensaTools \
--registry ./tools/RI-2023.11-linux/XtensaTools/configg
```

Parent topic:[Install Xplorer Toolchains](#)

Install MCUXpresso SDK

This section list the steps to: Download MCUXpresso SDK for RT700.

Download MCUXpresso SDK for RT700 DSP enablement for RT700, including drivers, middle-ware libraries, and demo applications are included with the latest RT700 SDK will be available for download from <https://mcuxpresso.nxp.com>. If you are accessing the site for the first time, make sure to register.

Parent topic:[Install MCUXpresso SDK](#)

Run and Debug DSP Demo using Xplorer IDE

This section lists the steps to:

- Prepare Arm Core for ‘Hello World’
- Start Xtensa Debugger Daemon
- Prepare DSP Core for ‘Hello World’

Prepare Arm Core for ‘Hello World’ Each of the DSP demos included in the MCUXpresso SDK consists of two separate applications that run on the Arm core and DSP core. The Arm core application initializes the DSP core and executes other application-specific functionality.

To debug the ‘Hello World’ DSP application, you must first set up and execute the Arm application using an environment of your choice. It is required to modify the global preprocessor macro, `DSP_IMAGE_COPY_TO_RAM`, to control loading of the DSP binary application.

When this macro is set to ‘0’/FALSE, the Arm application and DSP application are independently loaded and debugged.

- Build and execute the ‘Hello World’ Arm demo located in: <SDK_ROOT>/boards/mimxrt700evk/dsp_examples/hello_world_uart/cm33/.

Preparing an Arm core development environment is outside the scope of this document.

Note: If you are using MCUXpresso, it is highly recommended to upgrade to latest version of the SDK and match the latest EVK board.

Parent topic: [Run and Debug DSP Demo using Xplorer IDE](#)

Start Xtensa Debugger Daemon To debug DSP applications on RT700, ensure that the xt-ocd daemon is running. This application runs a gdb server that the Xtensa core debugger connects to.

Go to the command-line window and change directory (cd) to xt-ocd daemon installation path. The default path on Windows is C:\Program Files (x86)\Tensilica\Xtensa OCD Daemon 14.11.

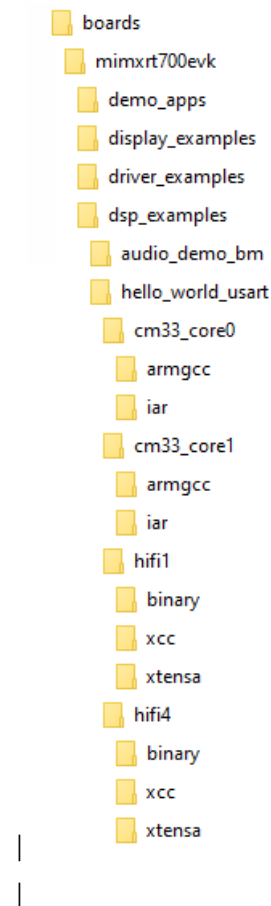
Execute the daemon with the custom topology.

```
**xt-ocd.exe -c topology.xml**
XOCD 14.11 2023-04-06 14:27:20
(c) 1999-2024 Cadence Design Systems Inc. All rights reserved.
[Debug Log 2024-02-19 22:41:53]
Loading module "gdbstub" v2.0.0.12
Loading module "jlink" v2.0.0.2.0
Using JLINK lib v.79410
Jlink USB Serial Number: 851006054
Connected to Jlink Device:
  Name:'SEGGER J-Link'
  S/N:851006054
  Firmware: J-Link V11 compiled Dec  4 2023 10:22:45
  Requested/Set TCK: 1000kHz/1000kHz
Jlink: Select pipelined SWD
SWD-DP with ID 0x6BA02477
Loading module "jtag" v2.0.0.20
Loading module "xtensa" v2.0.0.48
Starting thread 'GDBStub'
Opened GDB socket at port 20000
Initialize XDM driver
Warning: Warning: DAP Reset request failed! Ignoring...
```

Note: Some warning messages are expected and can be ignored. If you receive an error initializing the XDM driver, initialize and start the DSP core before debugging. For details on initializing and debugging, see Initialize DSP Core and Link DSP Profiles.

Parent topic: [Run and Debug DSP Demo using Xplorer IDE](#)

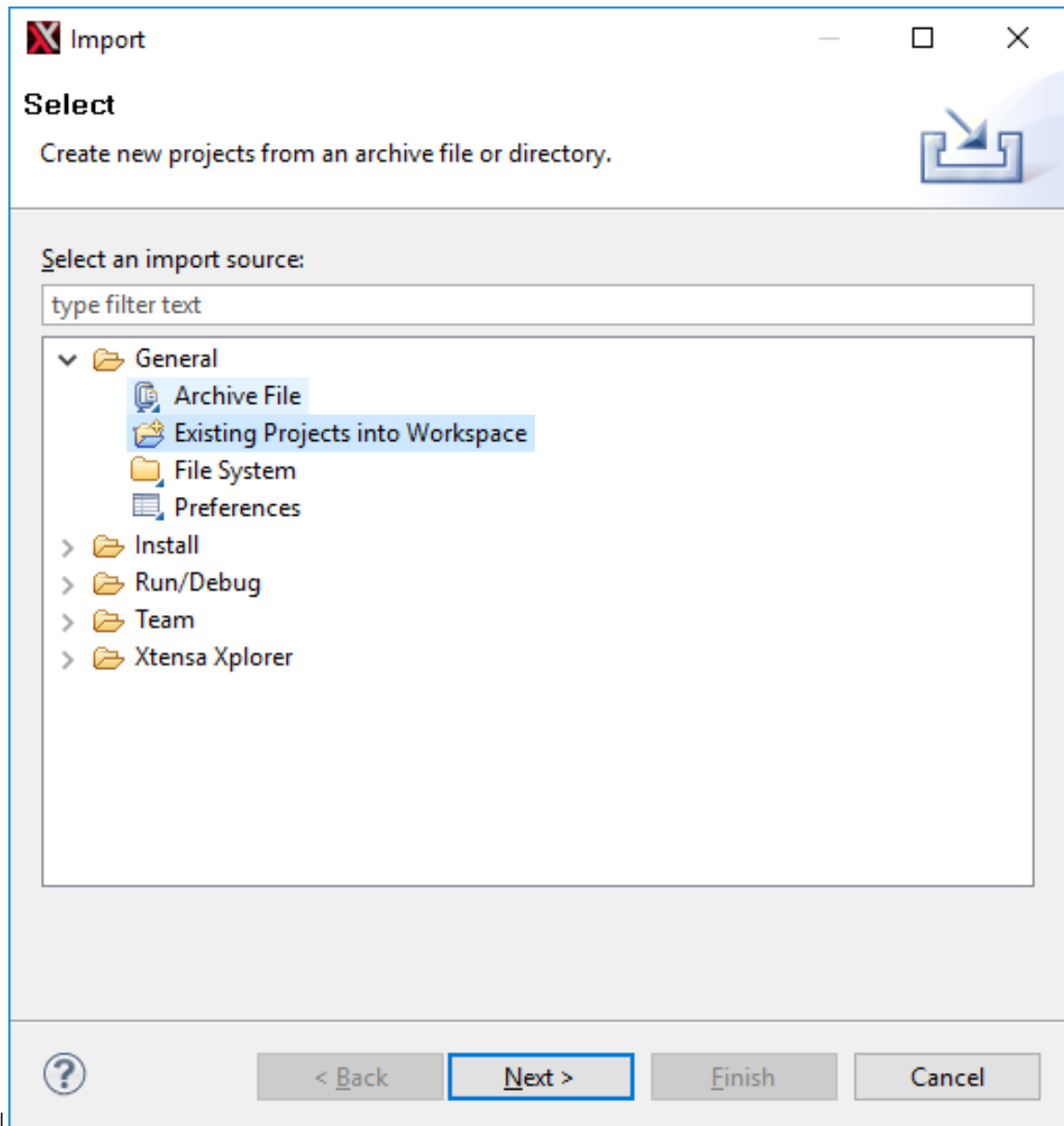
Prepare DSP Core for ‘Hello World’ The RT700 SDK provides a collection of DSP example applications located in boards/mimxrt700evk/dsp_examples/. Each DSP example has two four source directories for cm33_core0, cm33_core1, hifi1, and hifi4 cores. In this guide, HiFi4 example will be explained, but HiFi1 examples can be run with the same steps.



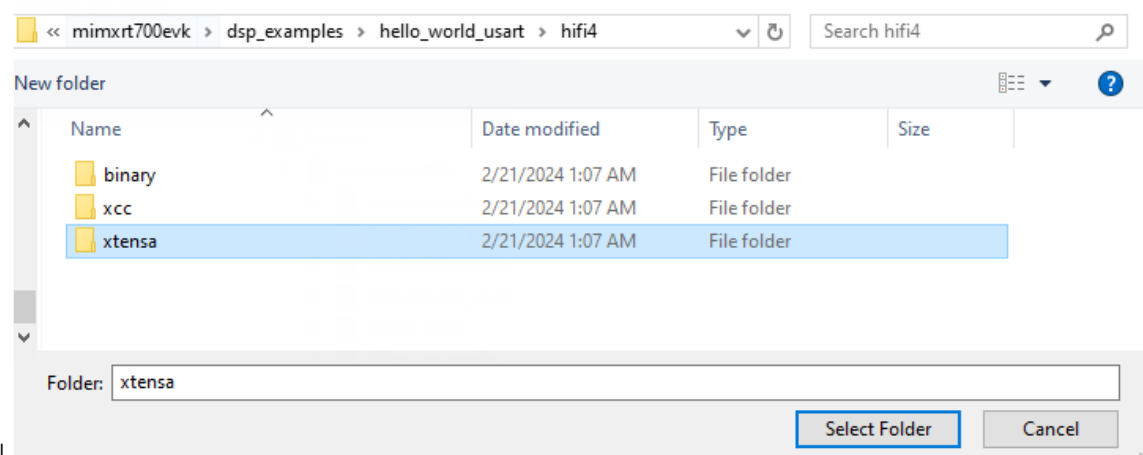
The projects for different supported toolchains are built in the above directories. For the DSP example above, the ‘xcc’ project builds on the command line and the ‘xtensa’ directory is an Xplorer IDE project.

To run the ‘Hello World’ demo, import the SDK sources into the Xplorer IDE.

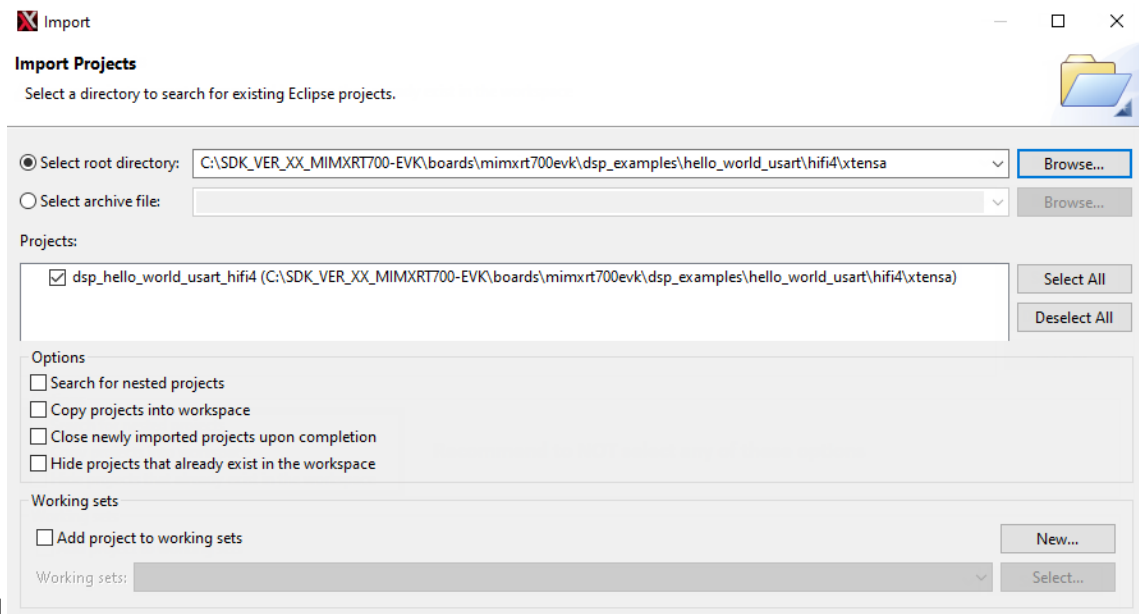
1. Select **File > Import > General > Existing Projects into Workspace**.



2. Select the SDK directory `<SDK_ROOT>\boards\mimxrt700evk\dsp_examples\hello_world_usart\hifi4\xtensa` as root directory.

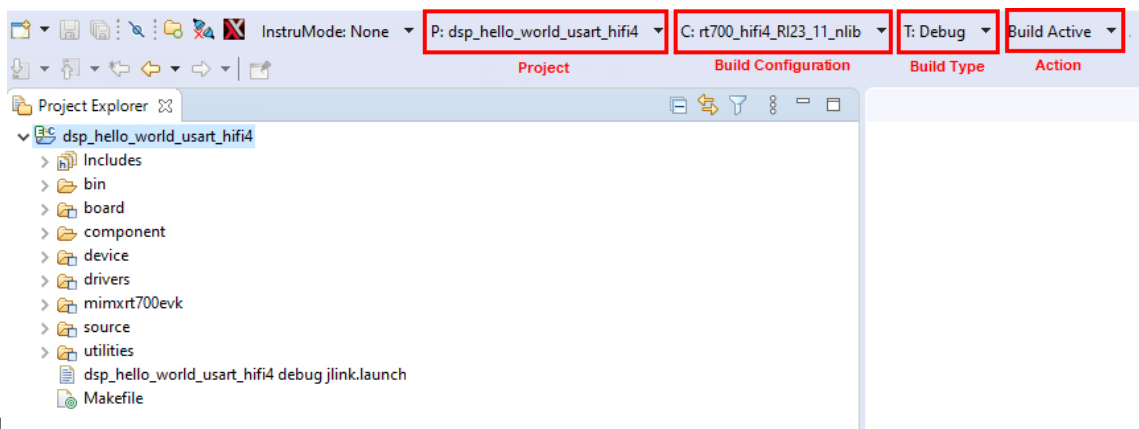


3. Leave all the other check boxes blank.

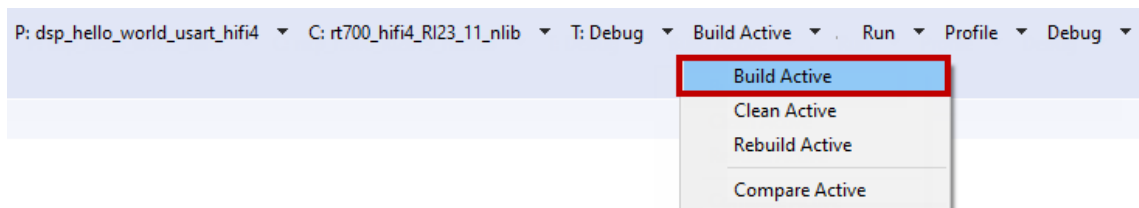


Once imported, the 'dsp_hello_world_usart_hifi4' appears in the Project Explorer.

4. To make a build selection for the project and hardware target configuration, use the drop-down buttons on the menu bar.

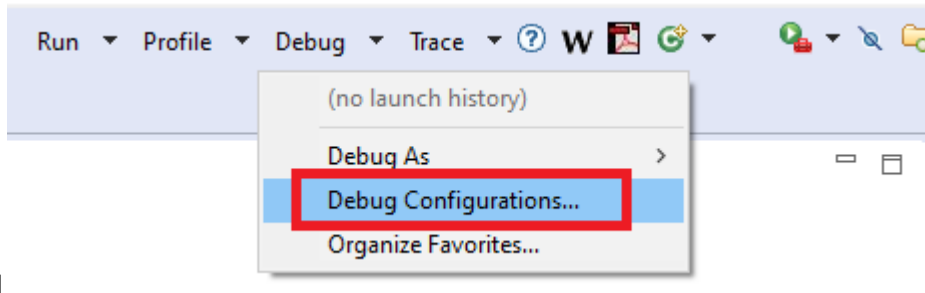


5. To build the project for debug, profile, or trace, use the action buttons on the right side of the menu bar.



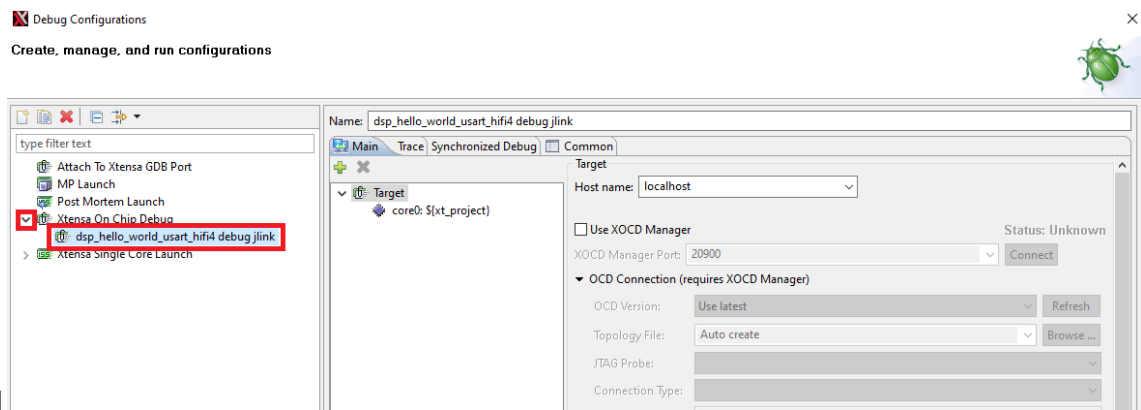
A default debug configuration is provided by the SDK project, which utilizes the on-chip debugger.

- To choose the configuration, select the **Debug Configurations** menu item.

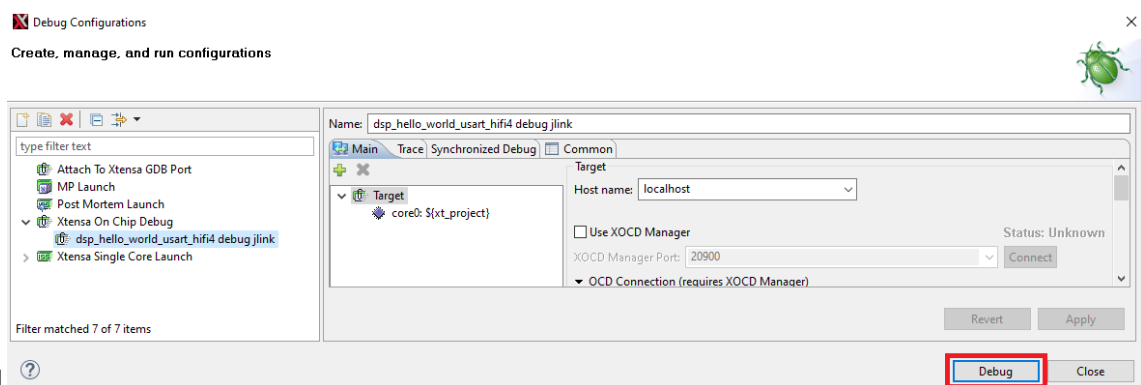


The **Debug Configurations** dialog box appears.

- Expand the **Xtensa On Chip Debug** tree option and select '*dsp_hello_world_usart_hifi4_debug_jlink*'.

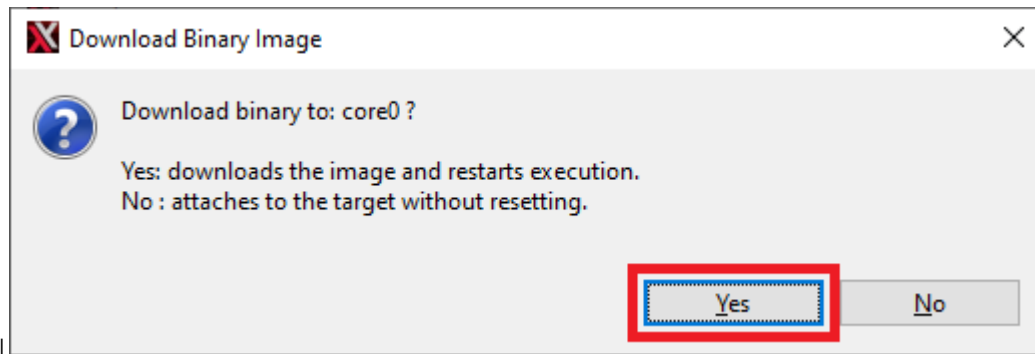


- Click the **Debug** button. The actual debug on the chip initiates.



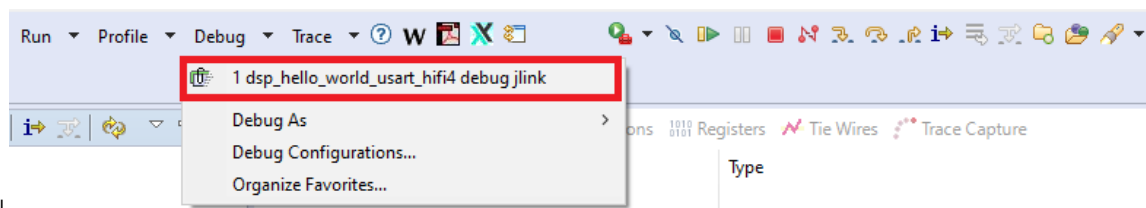
The Xplorer IDE prompts whether binaries should download to the hardware.

- Select **Yes**.



10. The Xplorer IDE transitions to the **Debug** perspective after the binary download.

Note: After initial configuration, it is possible to select the same debug configuration as in Figure 8.



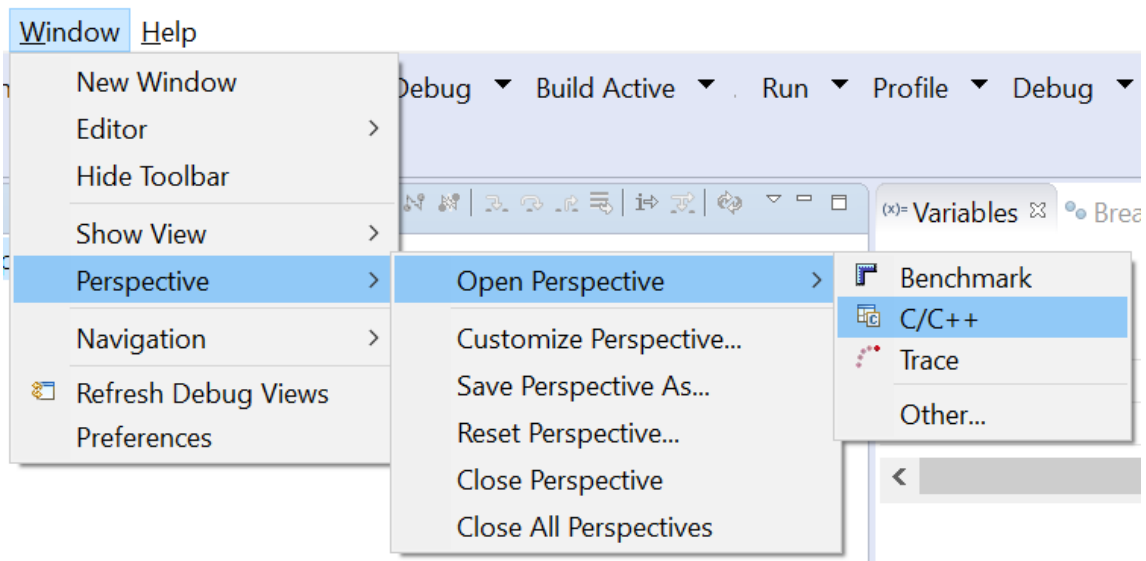
The **Debug** perspective appears as in [Figure 9](prepare_dsp_core_for_hello_world.md#GVDVWQC).

The program stops at the start of `main\(\)` function. To run the program, click the **Resume** or **Stepping through** icon button as shown in [Figure 10](prepare_dsp_core_for_hello_world.md#LKWUEUGG).

11. After resuming / stepping through the 'printf' statement, the following output appears in the **Console** view of the IDE.

```
Hello World running on DSP core 'rt700_hifi4_RI23_11_nlib'
```

To return to the default IDE layout after the debugging completes, select the previous code perspective.



Parent topic: [Run and Debug DSP Demo using Explorer IDE](#)

1.5 Release Notes

1.5.1 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
- Xtensa Xplorer, version is 10.1.11
- Xtensa C Compiler, version is RI-2023.11
- RISC-V LLVM 19.1.7

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- velop- ment boards	MCU devices		
MIMXR' EVK	MIMXRT735SGAWAR, MIMXRT735SGFOB, MIMXRT758SGFOA, MIMXRT798SGAWBR,	MIMXRT735SGAWBR, MIMXRT758SGAWAR, MIMXRT758SGFOB, MIMXRT798SGFOA , MIMXRT798SGFOB	MIMXRT735SGFOA, MIMXRT758SGAWBR, MIMXRT798SGAWAR,

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

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

IoT Sensing Software Development Kit (ISSDK) The IoT Sensing Software Development Kit (ISSDK) is the embedded software framework enabling the NXP digital and analog sensors for IoT applications. ISSDK combines a set of robust sensor drivers and algorithms along with example applications that allow users to get started with using NXP IoT motion & pressure sensors. ISSDK is being offered as a middleware component in MCUXpresso SDK.

coreHTTP coreHTTP

openvg OpenVG library for devices with graphics acceleration hardware

NXP Wi-Fi The MCUXpresso SDK provides driver for NXP Wi-Fi external modules. The Wi-Fi driver is integrated with LWIP TCP/IP 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).

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

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

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

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

TinyCBOR Concise Binary Object Representation (CBOR) Library

PSA Test Suite Arm Platform Security Architecture Test Suite

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

MCU Boot Open source MCU Bootloader.

mbedTLS mbedtls SSL/TLS library v3.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 TCPIP Stack and MCUXpresso SDK Integration User's Guide* (document MCUXSDKLWIPUG).

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

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

eIQ machine learning SDK containing:

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

LVGL LVGL Open Source Graphics Library

llhttp HTTP parser llhttp

LittleFS LittleFS filesystem stack

JPEG library JPEG library

FreeMASTER FreeMASTER communication driver for 32-bit platforms.

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

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

DSP Neural Networks DSP Neural Networks Framework based on Xtensa Neural Networks Library from Cadence Design Systems for Xtensa HiFi Audio Engines.

NatureDSP for Hifi4 Digital Signal Processing for Xtensa Hifi4 DSP Audio Engines.

NatureDSP for Hifi1 Digital Signal Processing for Xtensa Hifi1 DSP Audio Engines.

DSP Audio Streamer DSP Audio Streamer Framework based on Xtensa Audio Framework from Cadence Design Systems for Xtensa DSP Audio Engines.

DSP Codecs Codecs for Cadence DSPs

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

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

NXP ELS PKC ELS PKC crypto library

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

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.

XAF_playback limitation

SBC decoder is not working on the hifi4 core of RT700.

1.6 ChangeLog

1.6.1 MCUXpresso SDK Changelog

Board Support Files

board

[25.06.00]

- Initial version

clock_config

[25.06.00]

- Initial version

pin_mux

[25.06.00]

- Initial version
-

1.7 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.

[MIMXRT798S](#)

1.8 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.

1.8.1 VG-Lite GPU Library

[VGLite Graphics Driver](#)

1.8.2 Multicore

[Multicore SDK](#)

1.8.3 MCU Boot

[mcuboot_opensource](#)

1.8.4 eIQ

[eIQ](#)

1.8.5 FreeMASTER

[freemaster](#)

1.8.6 AWS IoT

[AWS IoT](#)

1.8.7 NXP Wi-Fi

[Wi-Fi, Bluetooth, 802.15.4](#)

1.8.8 FreeRTOS

FreeRTOS

1.8.9 Wireless EdgeFast Bluetooth PAL

edgefast_bluetooth

1.8.10 lwIP

lwIP

1.8.11 File systemFatfs

FatFs

1.8.12 DSP Audio Streamer

Xtensa Audio Framework (XAF)

Chapter 2

MIMXRT798S

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 CACHE: CACHE Memory Controller

uint32_t CACHE64_GetInstance(CACHE64_POLSEL_Type *base)
Returns an instance number given peripheral base address.

Parameters

- base – The peripheral base address.

Returns

CACHE64_POLSEL instance number starting from 0.

uint32_t CACHE64_GetInstanceByAddr(uint32_t address)
brief Returns an instance number given physical memory address.
param address The physical memory address.

Returns

CACHE64_CTRL instance number starting from 0.

status_t CACHE64_Init(CACHE64_POLSEL_Type *base, const *cache64_config_t* *config)

Initializes an CACHE64 instance with the user configuration structure.

This function configures the CACHE64 module with user-defined settings. Call the CACHE64_GetDefaultConfig() function to configure the configuration structure and get the default configuration.

Parameters

- base – CACHE64_POLSEL peripheral base address.
- config – Pointer to a user-defined configuration structure.

Return values

kStatus_Success – CACHE64 initialize succeed

void CACHE64_GetDefaultConfig(*cache64_config_t* *config)

Gets the default configuration structure.

This function initializes the CACHE64 configuration structure to a default value. The default values are first region covers whole cacheable area, and policy set to write back.

Parameters

- config – Pointer to a configuration structure.

void CACHE64_EnableCache(CACHE64_CTRL_Type *base)

Enables the cache.

Parameters

- base – CACHE64_CTRL peripheral base address.

void CACHE64_DisableCache(CACHE64_CTRL_Type *base)

Disables the cache.

Parameters

- base – CACHE64_CTRL peripheral base address.

void CACHE64_InvalidateCache(CACHE64_CTRL_Type *base)

Invalidates the cache.

Parameters

- base – CACHE64_CTRL peripheral base address.

void CACHE64_InvalidateCacheByRange(uint32_t address, uint32_t size_byte)

Invalidates cache by range.

Note: Address and size should be aligned to "CACHE64_LINESIZE_BYTE". The startAddr here will be forced to align to CACHE64_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.

void CACHE64_CleanCache(CACHE64_CTRL_Type *base)

Cleans the cache.

Parameters

- base – CACHE64_CTRL peripheral base address.

void CACHE64_CleanCacheByRange(uint32_t address, uint32_t size_byte)

Cleans cache by range.

Note: Address and size should be aligned to “CACHE64_LINESIZE_BYTE”. The startAddr here will be forced to align to CACHE64_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.

void CACHE64_CleanInvalidateCache(CACHE64_CTRL_Type *base)

Cleans and invalidates the cache.

Parameters

- base – CACHE64_CTRL peripheral base address.

void CACHE64_CleanInvalidateCacheByRange(uint32_t address, uint32_t size_byte)

Cleans and invalidate cache by range.

Note: Address and size should be aligned to “CACHE64_LINESIZE_BYTE”. The startAddr here will be forced to align to CACHE64_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.

void CACHE64_EnableWriteBuffer(CACHE64_CTRL_Type *base, bool enable)

Enables/disables the write buffer.

Parameters

- base – CACHE64_CTRL peripheral base address.
- enable – The enable or disable flag. true - enable the write buffer. false - disable the write buffer.

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 CACHE64_LINESIZE_BYTE due to the cache operation unit FSL_FEATURE_CACHE64_CTRL_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.

```
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 `CACHE64_LINESIZE_BYTE` due to the cache operation unit `FSL_FEATURE_CACHE64_CTRL_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.

```
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 `CACHE64_LINESIZE_BYTE` due to the cache operation unit `FSL_FEATURE_CACHE64_CTRL_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.

```
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 `CACHE64_LINESIZE_BYTE` due to the cache operation unit `FSL_FEATURE_CACHE64_CTRL_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.

```
FSL_CACHE_DRIVER_VERSION
```

cache driver version.

```
enum _cache64_policy
```

Level 2 cache controller way size.

Values:

```
enumerator kCACHE64_PolicyNonCacheable
```

Non-cacheable

```

enumerator kCACHE64_PolicyWriteThrough
    Write through
enumerator kCACHE64_PolicyWriteBack
    Write back
typedef enum _cache64_policy cache64_policy_t
    Level 2 cache controller way size.
typedef struct _cache64_config cache64_config_t
    CACHE64 configuration structure.
CACHE64_LINESIZE_BYTE
    cache line size.
CACHE64_REGION_NUM
    cache region number.
CACHE64_REGION_ALIGNMENT
    cache region alignment.
struct _cache64_config
    #include <fsl_cache.h> CACHE64 configuration structure.

```

Public Members

```

uint32_t boundaryAddr[(3U) - 1]
    < The cache controller can divide whole memory into 3 regions. Boundary address is
    the FlexSPI internal address (start from 0) instead of system address (start from FlexSPI
    AMBA base) to split adjacent regions and must be 1KB aligned. The boundary address
    itself locates in upper region. Cacheable policy for each region.

```

2.3 CDOG

```

status_t CDOG_Init(CDOG_Type *base, cdog_config_t *conf)
    Initialize CDOG.

```

This function initializes CDOG block and setting.

Parameters

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

Returns

Status of the init operation

```

void CDOG_Deinit(CDOG_Type *base)
    Deinitialize CDOG.

```

This function deinitializes CDOG secure counter.

Parameters

- *base* – CDOG peripheral base address

```

void CDOG_GetDefaultConfig(cdog_config_t *conf)
    Sets the default configuration of CDOG.

```

This function initialize CDOG config structure to default values.

Parameters

- `conf` – CDOG configuration structure

`void CDOG_Stop(CDOG_Type *base, uint32_t stop)`

Stops secure counter and instruction timer.

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

Parameters

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

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

Sets secure counter and instruction timer values.

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

Parameters

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

`void CDOG_Check(CDOG_Type *base, uint32_t check)`

Checks secure counter.

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

Parameters

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

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

Sets secure counter and instruction timer values.

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

Parameters

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

`void CDOG_Add(CDOG_Type *base, uint32_t add)`

Add value to secure counter.

This function add specified value to secure counter.

Parameters

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

void CDOG_Add1(CDOG_Type *base)

Add 1 to secure counter.

This function add 1 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Add16(CDOG_Type *base)

Add 16 to secure counter.

This function add 16 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Add256(CDOG_Type *base)

Add 256 to secure counter.

This function add 256 to secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub(CDOG_Type *base, uint32_t sub)

brief Subtract value to secure counter

This function subtract specified value to secure counter.

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

void CDOG_Sub1(CDOG_Type *base)

Subtract 1 from secure counter.

This function subtract specified 1 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub16(CDOG_Type *base)

Subtract 16 from secure counter.

This function subtract specified 16 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_Sub256(CDOG_Type *base)

Subtract 256 from secure counter.

This function subtract specified 256 from secure counter.

Parameters

- base – CDOG peripheral base address.

void CDOG_WritePersistent(CDOG_Type *base, uint32_t value)

Set the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.
- value – The value to be written.

uint32_t CDOG_ReadPersistent(CDOG_Type *base)

Get the CDOG persistent word.

Parameters

- base – CDOG peripheral base address.

Returns

The persistent word.

FSL_CDOG_DRIVER_VERSION

Defines CDOG driver version 2.1.3.

Change log:

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

enum __cdog_debug_Action_ctrl_enum

Values:

enumerator kCDOG_DebugHaltCtrl_Run

enumerator kCDOG_DebugHaltCtrl_Pause

enum __cdog_irq_pause_ctrl_enum

Values:

enumerator kCDOG_IrqPauseCtrl_Run

enumerator kCDOG_IrqPauseCtrl_Pause

enum __cdog_fault_ctrl_enum

Values:

enumerator kCDOG_FaultCtrl_EnableReset

enumerator kCDOG_FaultCtrl_EnableInterrupt

enumerator kCDOG_FaultCtrl_NoAction

```
enum __code_lock_ctrl_enum
```

Values:

```
enumerator kCDOG_LockCtrl_Lock
```

```
enumerator kCDOG_LockCtrl_Unlock
```

```
typedef uint32_t secure_counter_t
```

```
SC_ADD(add)
```

```
SC_ADD1
```

```
SC_ADD16
```

```
SC_ADD256
```

```
SC_SUB(sub)
```

```
SC_SUB1
```

```
SC_SUB16
```

```
SC_SUB256
```

```
SC_CHECK(val)
```

```
struct cdog_config_t
```

```
    #include <fsl_cdog.h>
```

2.4 Clock Driver

```
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_ip_name
```

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

Values:

```
enumerator kCLOCK_IpInvalid
```

Invalid Ip Name.

```
enumerator kCLOCK_Xcache1
```

Clock gate name: Code cache

enumerator kCLOCK_Xcache0
Clock gate name: System cache

enumerator kCLOCK_Ocotp0
Clock gate name: VDD2 OTP0

enumerator kCLOCK_Sleepcon0
Clock gate name: SLEEPCON_CMPT

enumerator kCLOCK_Syscon0
Clock gate name: SYSCON_CMPT

enumerator kCLOCK_Glikey0
Clock gate name: GLIKEY0

enumerator kCLOCK_Glikey3
Clock gate name: GLIKEY3

enumerator kCLOCK_TpiuTraceClkin
Clock gate name: TPIU_TRACECLKIN

enumerator kCLOCK_SWOTraceClkin
Clock gate name: SWO_TRACECLKIN

enumerator kCLOCK_Tsclk
Clock gate name: TRACE

enumerator kCLOCK_Dma0
Clock gate name: DMA0

enumerator kCLOCK_Dma1
Clock gate name: DMA1

enumerator kCLOCK_PkcRam
Clock gate name: PKC RAM

enumerator kCLOCK_Pkc
Clock gate name: PKC

enumerator kCLOCK_Romcp
Clock gate name: ROMCP

enumerator kCLOCK_Xspi0
Clock gate name: XSPI0

enumerator kCLOCK_Xspi1
Clock gate name: XSPI1

enumerator kCLOCK_Cache64ctrl0
Clock gate name: CACHE64_0

enumerator kCLOCK_Cache64ctrl1
Clock gate name: CACHE64_1

enumerator kCLOCK_Puf
Clock gate name: QK_SUBSYS

enumerator kCLOCK_Mmu0
Clock gate name: MMU0

enumerator kCLOCK_Mmu1
Clock gate name: MMU1

enumerator kCLOCK_Gpio0
Clock gate name: GPIO0

enumerator kCLOCK_Gpio1
Clock gate name: GPIO1

enumerator kCLOCK_Gpio2
Clock gate name: GPIO2

enumerator kCLOCK_Gpio3
Clock gate name: GPIO3

enumerator kCLOCK_Gpio4
Clock gate name: GPIO4

enumerator kCLOCK_Gpio5
Clock gate name: GPIO5

enumerator kCLOCK_Gpio6
Clock gate name: GPIO6

enumerator kCLOCK_Gpio7
Clock gate name: GPIO7

enumerator kCLOCK_Sct0
Clock gate name: SCT0

enumerator kCLOCK_Cdog0
Clock gate name: CDOG0

enumerator kCLOCK_Cdog1
Clock gate name: CDOG1

enumerator kCLOCK_Cdog2
Clock gate name: CDOG2

enumerator kCLOCK_LPFlexComm0
Clock gate name: LP_Flexcomm0

enumerator kCLOCK_LPFlexComm1
Clock gate name: LP_Flexcomm1

enumerator kCLOCK_LPUart0
Clock gate name: LPUART0

enumerator kCLOCK_LPUart1
Clock gate name: LPUART1

enumerator kCLOCK_LPI2c0
Clock gate name: LPI2C0

enumerator kCLOCK_LPI2c1
Clock gate name: LPI2C1

enumerator kCLOCK_LPSpi0
Clock gate name: LPSPI0

enumerator kCLOCK_LPSpi1
Clock gate name: LPSPI1

enumerator kCLOCK_LPFlexComm2
Clock gate name: LP_Flexcomm2

enumerator kCLOCK_LPFlexComm3
Clock gate name: LP_Flexcomm3

enumerator kCLOCK_LPFlexComm4
Clock gate name: LP_Flexcomm4

enumerator kCLOCK_LPFlexComm5
Clock gate name: LP_Flexcomm5

enumerator kCLOCK_LPFlexComm6
Clock gate name: LP_Flexcomm6

enumerator kCLOCK_LPFlexComm7
Clock gate name: LP_Flexcomm7

enumerator kCLOCK_LPFlexComm8
Clock gate name: LP_Flexcomm8

enumerator kCLOCK_LPFlexComm9
Clock gate name: LP_Flexcomm9

enumerator kCLOCK_LPFlexComm10
Clock gate name: LP_Flexcomm10

enumerator kCLOCK_LPFlexComm11
Clock gate name: LP_Flexcomm11

enumerator kCLOCK_LPFlexComm12
Clock gate name: LP_Flexcomm12

enumerator kCLOCK_LPFlexComm13
Clock gate name: LP_Flexcomm13

enumerator kCLOCK_LPUart2
Clock gate name: LPUART2

enumerator kCLOCK_LPUart3
Clock gate name: LPUART3

enumerator kCLOCK_LPUart4
Clock gate name: LPUART4

enumerator kCLOCK_LPUart5
Clock gate name: LPUART5

enumerator kCLOCK_LPUart6
Clock gate name: LPUART6

enumerator kCLOCK_LPUart7
Clock gate name: LPUART7

enumerator kCLOCK_LPUart8
Clock gate name: LPUART8

enumerator kCLOCK_LPUart9
Clock gate name: LPUART9

enumerator kCLOCK_LPUart10
Clock gate name: LPUART10

enumerator kCLOCK_LPUart11
Clock gate name: LPUART11

enumerator kCLOCK_LPUart12
Clock gate name: LPUART12

enumerator kCLOCK_LPUart13
Clock gate name: LPUART13

enumerator kCLOCK_LPI2c2
Clock gate name: LPI2C2

enumerator kCLOCK_LPI2c3
Clock gate name: LPI2C3

enumerator kCLOCK_LPI2c4
Clock gate name: LPI2C4

enumerator kCLOCK_LPI2c5
Clock gate name: LPI2C5

enumerator kCLOCK_LPI2c6
Clock gate name: LPI2C6

enumerator kCLOCK_LPI2c7
Clock gate name: LPI2C7

enumerator kCLOCK_LPI2c8
Clock gate name: LPI2C8

enumerator kCLOCK_LPI2c9
Clock gate name: LPI2C9

enumerator kCLOCK_LPI2c10
Clock gate name: LPI2C10

enumerator kCLOCK_LPI2c11
Clock gate name: LPI2C11

enumerator kCLOCK_LPI2c12
Clock gate name: LPI2C12

enumerator kCLOCK_LPI2c13
Clock gate name: LPI2C13

enumerator kCLOCK_LPSpi2
Clock gate name: LPSPI2

enumerator kCLOCK_LPSpi3
Clock gate name: LPSPI3

enumerator kCLOCK_LPSpi4
Clock gate name: LPSPI4

enumerator kCLOCK_LPSpi5
Clock gate name: LPSPI5

enumerator kCLOCK_LPSpi6
Clock gate name: LPSPI6

enumerator kCLOCK_LPSpi7
Clock gate name: LPSPI7

enumerator kCLOCK_LPSpi8
Clock gate name: LPSPI8

enumerator kCLOCK_LPSpi9
Clock gate name: LPSPI9

enumerator kCLOCK_LPSpi10
Clock gate name: LPSPI10

enumerator kCLOCK_LPSpi11
Clock gate name: LPSPI11

enumerator kCLOCK_LPSpi12
Clock gate name: LPSPI12

enumerator kCLOCK_LPSpi13
Clock gate name: LPSPI13

enumerator kCLOCK_Sai0
Clock gate name: SAI0

enumerator kCLOCK_Sai1
Clock gate name: SAI1

enumerator kCLOCK_Sai2
Clock gate name: SAI2

enumerator kCLOCK_I3c0
Clock gate name: I3C0

enumerator kCLOCK_I3c1
Clock gate name: I3C1

enumerator kCLOCK_Crc0
Clock gate name: CRC0

enumerator kCLOCK_Wwdt0
Clock gate name: WWDT0

enumerator kCLOCK_Wwdt1
Clock gate name: WWDT1

enumerator kCLOCK_Ct32b0
Clock gate name: CTIMER0

enumerator kCLOCK_Ct32b1
Clock gate name: CTIMER1

enumerator kCLOCK_Ct32b2
Clock gate name: CTIMER2

enumerator kCLOCK_Ct32b3
Clock gate name: CTIMER3

enumerator kCLOCK_Ct32b4
Clock gate name: CTIMER4

enumerator kCLOCK_Mrt0
Clock gate name: Mrt0

enumerator kCLOCK_Utick0
Clock gate name: Utick0

enumerator kCLOCK_Sema424
Clock gate name: SEMA42_4

enumerator kCLOCK_Mu4
Clock gate name: MU4

enumerator kCLOCK_Pint0
Clock gate name: PINT0

enumerator kCLOCK_Pvts0
Clock gate name: PVT0

enumerator kCLOCK_InputMux0
Clock gate name: PMUX_CMPT_SPLITTER

enumerator kCLOCK_Freqme0
Clock gate name: FREQME0

enumerator kCLOCK_SafoSgi
Clock gate name: SAFO_SGI

enumerator kCLOCK_Trace
Clock gate name: TRACE

enumerator kCLOCK_Prince0
Clock gate name: PRINCE0

enumerator kCLOCK_Prince1
Clock gate name: PRINCE1

enumerator kCLOCK_PrinceExe
Clock gate name: PRINCE_EXE

enumerator kCLOCK_Syspm0
Clock gate name: CMX_PERFMON0

enumerator kCLOCK_Syspm1
Clock gate name: CMX_PERFMON1

enumerator kCLOCK_Hifi4
Clock gate name: HIFI4

enumerator kCLOCK_Npu0
Clock gate name: NPU0

enumerator kCLOCK_CompAccessRamArbiter1
Clock gate name: COMP_ACCESS_RAM_ARBITER1

enumerator kCLOCK_Iopctl0
Clock gate name: IOMUXC_VDD2

enumerator kCLOCK_Hifi4AccessRamArbiter1
Clock gate name: HIFI4_ACCESS_RAM_ARBITER1

enumerator kCLOCK_MediaAccessRamArbiter0
Clock gate name: MEDIA_ACCESS_RAM_ARBITER0

enumerator kCLOCK_Sleepcon1
Clock gate name: SLEEPCONCPU1

enumerator kCLOCK_Syscon1
Clock gate name: SYSCONSENSE1

enumerator kCLOCK_SenseAccessRamArbiter0
Clock gate name: SENSE_ACCESS_RAM_ARBITER0

enumerator kCLOCK_Hifi1
Clock gate name: HIFI1

enumerator kCLOCK_Dma2
Clock gate name: DMA2

enumerator kCLOCK_Dma3
Clock gate name: DMA3

enumerator kCLOCK_LPFlexComm17
Clock gate name: LP_Flexcomm17

enumerator kCLOCK_LPFlexComm18
Clock gate name: LP_Flexcomm18

enumerator kCLOCK_LPFlexComm19
Clock gate name: LP_Flexcomm19

enumerator kCLOCK_LPFlexComm20
Clock gate name: LP_Flexcomm20

enumerator kCLOCK_LPI2c17
Clock gate name: LPI2C17

enumerator kCLOCK_LPI2c18
Clock gate name: LPI2C18

enumerator kCLOCK_LPI2c19
Clock gate name: LPI2C19

enumerator kCLOCK_LPI2c20
Clock gate name: LPI2C20

enumerator kCLOCK_LPSpi17
Clock gate name: LPSPI17

enumerator kCLOCK_LPSpi18
Clock gate name: LPSPI18

enumerator kCLOCK_LPSpi19
Clock gate name: LPSPI19

enumerator kCLOCK_LPSpi20
Clock gate name: LPSPI20

enumerator kCLOCK_LPUart17
Clock gate name: LPUART17

enumerator kCLOCK_LPUart18
Clock gate name: LPUART18

enumerator kCLOCK_LPUart19
Clock gate name: LPUART19

enumerator kCLOCK_LPUart20
Clock gate name: LPUART20

enumerator kCLOCK_Sai3
Clock gate name: SAI3

enumerator kCLOCK_I3c2
Clock gate name: I3C2

enumerator kCLOCK_I3c3
Clock gate name: I3C3

enumerator kCLOCK_Gpio8
Clock gate name: GPIO8

enumerator kCLOCK_Gpio9
Clock gate name: GPIO9

enumerator kCLOCK_Gpio10
Clock gate name: GPIO10

enumerator kCLOCK_Pint1
Clock gate name: PINT1

enumerator kCLOCK_Ct32b5
Clock gate name: CTIMER5

enumerator kCLOCK_Ct32b6
Clock gate name: CTIMER6

enumerator kCLOCK_Ct32b7
Clock gate name: CTIMER7

enumerator kCLOCK_Mrt1
Clock gate name: Mrt1

enumerator kCLOCK_Utick1
Clock gate name: Utick1

enumerator kCLOCK_Cdog3
Clock gate name: CDOG3

enumerator kCLOCK_Cdog4
Clock gate name: CDOG4

enumerator kCLOCK_Mu3
Clock gate name: MU3

enumerator kCLOCK_Sema423
Clock gate name: SEMA42_3

enumerator kCLOCK_Wwdt2
Clock gate name: WWDT2

enumerator kCLOCK_Wwdt3
Clock gate name: WWDT3

enumerator kCLOCK_Pvts1
Clock gate name: PINT1

enumerator kCLOCK_InputMux1
Clock gate name: PMUX_SNS_SPLITTER

enumerator kCLOCK_Syscon2
Clock gate name: SYSCON_COMM

enumerator kCLOCK_Iopctl2
Clock gate name: IOMUXC_VDDN

enumerator kCLOCK_Cpu1
Clock gate name: CPU1

enumerator kCLOCK_Mu0
Clock gate name: MU0

enumerator kCLOCK_Mu1
Clock gate name: MU1

enumerator kCLOCK_Mu2
Clock gate name: MU2

enumerator kCLOCK_OsTimer
Clock gate name: OsTimer

enumerator kCLOCK_Sema420
Clock gate name: SEMA42_0

enumerator kCLOCK_Sdadc0
Clock gate name: SDADC0

enumerator kCLOCK_Adc0
Clock gate name: SARADC0

enumerator kCLOCK_Acmp0
Clock gate name: Acmp0

enumerator kCLOCK_Pdm
Clock gate name: MICFIL(PDM)

enumerator kCLOCK_Glikey4
Clock gate name: GLIKEY_SYSCON1

enumerator kCLOCK_Dbg
Clock gate name: DBG

enumerator kCLOCK_Syscon3
Clock gate name: SYSCON_SENSE0

enumerator kCLOCK_Iopctl1
Clock gate name: IOMUXC_VDD1

enumerator kCLOCK_Glikey1
Clock gate name: GLIKEY1

enumerator kCLOCK_LPI2c15
Clock gate name: LPI2C

enumerator kCLOCK_MediaAccessRamArbiter1
Clock gate name: MEDIA_ACCESS_RAM_ARBITER1

enumerator kCLOCK_Axi0
Clock gate name: AXI0

enumerator kCLOCK_Gpu
Clock gate name: VGPU

enumerator kCLOCK_MipiDsiCtrl
Clock gate name: MIPIDSI

enumerator kCLOCK_LPSpi16
Clock gate name: LPSPI16

enumerator kCLOCK_LPSpi14
Clock gate name: LPSPI14

enumerator kCLOCK_Xspi2
Clock gate name: XSPI2

enumerator kCLOCK_Mmu2
Clock gate name: MMU2

enumerator kCLOCK_Glikey5
Clock gate name: GLIKEY_SYSCON2

enumerator kCLOCK_Flexio
Clock gate name: FLEXIO0

enumerator kCLOCK_Lcdif
Clock gate name: LCDIF(DCN)

enumerator kCLOCK_Syscon4
Clock gate name: SYSCONMEDIA

enumerator kCLOCK_JpgDecoder
Clock gate name: JPG_DECODER

enumerator kCLOCK_PngDecoder
Clock gate name: PNG_DECODER

enumerator kCLOCK_Ezhv
Clock gate name: EZHV

enumerator kCLOCK_AxbsEzh
Clock gate name: AXBS_EZH

enumerator kCLOCK_Glikey2
Clock gate name: GLIKEY2

enumerator kCLOCK_Usb0
Clock gate name: USB0

enumerator kCLOCK_Usb1
Clock gate name: USB1

enumerator kCLOCK_Usdhc0
Clock gate name: USHDC0

enumerator kCLOCK_Usdhc1
Clock gate name: USDHC1

enumerator kCLOCK_Gdet3Ref
Clock gate name: GDET3 Reference clock

enumerator kCLOCK_Rtc
RTC functional clock gating.

enumerator kCLOCK_Gdet3
GDET3 functional clock gating.

enumerator kCLOCK_UsbphyRef
USBPHY reference clock gating.

enum __clock_name
Clock name used to get clock frequency.

Values:

enumerator kCLOCK_CoreSysClk
Core clock (aka system clock)

enumerator kCLOCK_BusClk
Bus clock (AHB/APB clock, aka HCLK)

enumerator kCLOCK_MclkClk
MCLK, to MCLK pin

enumerator kCLOCK_Wdt2Clk
Watchdog1

enumerator kCLOCK_Wdt3Clk
Watchdog1

enumerator kCLOCK_Hifi1CpuClk
Hifi1 DSP clock

enumerator kCLOCK_LPFlexComm17Clk
Flexcomm17Clock

enumerator kCLOCK_LPFlexComm18Clk
Flexcomm18Clock

enumerator kCLOCK_LPFlexComm19Clk
Flexcomm19Clock

enumerator kCLOCK_LPFlexComm20Clk
Flexcomm20Clock

enumerator kCLOCK_Vdd1ClockOutClk
VDD1 CLOCKOUT

enumerator kCLOCK_AdcClk
ADC

enumerator kCLOCK_Xspi2Clk
XSPI1

enumerator kCLOCK_SctClk
SCT

enumerator kCLOCK_SystickClk
Systick

enumerator kCLOCK_Sdio0Clk
SDIO0

enumerator kCLOCK_Sdio1Clk
SDIO1

enumerator kCLOCK_I3cClk
I3C

enumerator kCLOCK_Usb0Clk
USB0

enumerator kCLOCK_Usb1Clk
USB1

enumerator kCLOCK_PdmClk
Digital Mic clock

enumerator kCLOCK_AcmpClk

Acmp clock

enumerator kCLOCK_FlexioClk

FlexIO

enumerator kCLOCK_LPSpi14Clk

LPSPi14

enumerator kCLOCK_LPI2c15Clk

LPI2C15

enumerator kCLOCK_LPSpi16Clk

LPSPi16

enumerator kCLOCK_VgpuClk

VGPU Core

enumerator kCLOCK_LcdifClk

LCDIF Clock

enumerator kCLOCK_MipiDphyClk

MIPI D-PHY Bit Clock

enumerator kCLOCK_MipiDphyEscRxClk

MIPI D-PHY RX Clock

enumerator kCLOCK_MipiDphyEscTxClk

MIPI D-PHY TX Clock

enum _clock_attach_id

The enumerator of clock attach Id for multi sources clock slices. Not all Muxer has MUX output enable control, if no mux output enable control, the mux output will be always enabled.

Values:

enumerator kFRO1_DIV3_to_SENSE_BASE

Attach FRO1 divided-by-3 clock to Sense Base Clock.

enumerator kFRO1_DIV1_to_SENSE_BASE

Attach FRO1 max clock to Sense Base Clock.

enumerator kFRO2_DIV3_to_SENSE_BASE

Attach FRO2 divided-by-3 clock to Sense Base Clock.

enumerator kLPOSC_to_SENSE_BASE

Attach LPOSC to Sense Base Clock.

enumerator kSENSE_BASE_to_SENSE_DSP

Attach Sense base clock to Sense DSP Clock.

enumerator kFRO2_DIV1_to_SENSE_DSP

Attach FRO2 max clock to Sense DSP Clock.

enumerator kAUDIO_PLL_PFD1_to_SENSE_DSP

Attach Audio PLL PFD1 clock to Sense DSP Clock.

enumerator kFRO1_DIV1_to_SENSE_DSP

Attach FRO1 max clock to Sense DSP Clock.

enumerator kNONE_to_SENSE_DSP

Attach NONE to Sense DSP Clock.

enumerator kSENSE_BASE_to_SAI3

Attach Sense base clock to SAI3 Clock.

enumerator kFRO2_DIV8_to_SAI3

Attach FRO2_DIV8 clock to SAI3 Clock.

enumerator kFRO2_DIV1_to_SAI3

Attach FRO2 clock to SAI3 Clock.

enumerator kAUDIO_VDD1_to_SAI3

Attach audio_clk to SAI3 Clock.

enumerator kNONE_to_SAI3

Attach NONE to SAI3 Clock.

enumerator kSENSE_BASE_to_UTICK

Attach Sense base clock to UTICK Functional Clock.

enumerator kLPOSC_to_UTICK

Attach LPOSC clock to UTICK Functional Clock.

enumerator kFRO2_DIV1_to_UTICK

Attach FRO2 max clock to UTICK Functional Clock.

enumerator kFRO1_DIV2_to_UTICK

Attach FRO1_DIV2 clock to UTICK Functional Clock.

enumerator kNONE_to_UTICK

Attach NONE to UTICK Functional Clock.

enumerator kLPOSC_to_WWDT2

Attach LPOSC clock to WWDT2 Functional Clock.

enumerator kNONE_to_WWDT2

Attach NONE to WWDT2 Functional Clock.

enumerator kLPOSC_to_WWDT3

Attach LPOSC clock to WWDT3 Functional Clock.

enumerator kNONE_to_WWDT3

Attach NONE to WWDT3 Functional Clock.

enumerator kSENSE_BASE_to_SYSTICK

Attach Sense base clock to SYSTICK Functional Clock.

enumerator kLPOSC_to_SYSTICK

Attach LPOSC clock to SYSTICK Functional Clock.

enumerator k32KHZ_WAKE_to_SYSTICK

Attach 32 kHz wake clock(switch to other clock source before sense vdd1 enter SRPG mode.) to SYSTICK Functional Clock.

enumerator kOSC_CLK_to_SYSTICK

Attach OSC clock to SYSTICK Functional Clock.

enumerator kNONE_to_SYSTICK

Attach NONE to SYSTICK Functional Clock.

enumerator kSENSE_BASE_to_CTIMER5

Attach Sense base clock to CTIMER5 Clock.

enumerator kAUDIO_VDD1_to_CTIMER5

Attach audio_clk to CTIMER5 Clock.

enumerator kFRO2_DIV1_to_CTIMER5
Attach FRO2 Max clock to CTIMER5 Clock.

enumerator k32KHZ_WAKE_to_CTIMER5
Attach 32KHz wake clock to CTIMER5 Clock.

enumerator kNONE_to_CTIMER5
Attach NONE to CTIMER5 Clock.

enumerator kSENSE_BASE_to_CTIMER6
Attach Sense base clock to CTIMER6 Clock.

enumerator kAUDIO_VDD1_to_CTIMER6
Attach audio_clk to CTIMER6 Clock.

enumerator kFRO2_DIV1_to_CTIMER6
Attach FRO2 Max clock to CTIMER6 Clock.

enumerator k32KHZ_WAKE_to_CTIMER6
Attach 32KHz wake clock to CTIMER6 Clock.

enumerator kNONE_to_CTIMER6
Attach NONE to CTIMER6 Clock.

enumerator kSENSE_BASE_to_CTIMER7
Attach Sense base clock to CTIMER7 Clock.

enumerator kAUDIO_VDD1_to_CTIMER7
Attach audio_clk to CTIMER7 Clock.

enumerator kFRO2_DIV1_to_CTIMER7
Attach FRO2 Max clock to CTIMER7 Clock.

enumerator k32KHZ_WAKE_to_CTIMER7
Attach 32KHz wake clock to CTIMER7 Clock.

enumerator kNONE_to_CTIMER7
Attach NONE to CTIMER7 Clock.

enumerator kSENSE_BASE_to_I3C23
Attach Sense base clock to I3C2 and I3C3 Functional Clock.

enumerator kFRO2_DIV1_to_I3C23
Attach FRO2 max clock to I3C2 and I3C3 Functional Clock.

enumerator kFRO1_DIV8_to_I3C23
Attach FRO2_DIV8 clock to I3C2 and I3C3 Functional Clock.

enumerator kOSC_CLK_to_I3C23
Attach OSC clock to I3C2 and I3C3 Functional Clock.

enumerator kNONE_to_I3C23
Attach NONE to I3C2 and I3C3 Functional Clock.

enumerator kMCLK_to_AUDIO_VDD1
Attach MCLK IN from Pad to Audio VDD1 Clock.

enumerator kOSC_to_AUDIO_VDD1
Attach OSC clock to Audio VDD1 Clock.

enumerator kFRO2_DIV8_to_AUDIO_VDD1
Attach FRO2_DIV8 clock to Audio VDD1 Clock.

enumerator kAUDIO_PLL_PFD3_to_AUDIO_VDD1
Attach AUDIO PLL PFD3 clock to Audio VDD1 Clock.

enumerator kSENSE_BASE_to_FLEXCOMM17
Attach Sense base clock to FLEXCOMM17.

enumerator kFRO2_DIV1_to_FLEXCOMM17
Attach FRO2 max clock to FLEXCOMM17.

enumerator kFRO1_DIV1_to_FLEXCOMM17
Attach FRO1 max clock to FLEXCOMM17.

enumerator k32KHZ_WAKE_to_FLEXCOMM17
Attach 32k_wake_clk to FLEXCOMM17.

enumerator kNONE_to_FLEXCOMM17
Attach NONE to FLEXCOMM17.

enumerator kSENSE_BASE_to_FLEXCOMM18
Attach Sense base clock to FLEXCOMM18.

enumerator kFRO2_DIV1_to_FLEXCOMM18
Attach FRO2 max clock to FLEXCOMM18.

enumerator kFRO1_DIV1_to_FLEXCOMM18
Attach FRO1 max clock to FLEXCOMM18.

enumerator k32KHZ_WAKE_to_FLEXCOMM18
Attach 32k_wake_clk to FLEXCOMM18.

enumerator kNONE_to_FLEXCOMM18
Attach NONE to FLEXCOMM18.

enumerator kSENSE_BASE_to_FLEXCOMM19
Attach Sense base clock to FLEXCOMM19.

enumerator kFRO2_DIV1_to_FLEXCOMM19
Attach FRO2 max clock to FLEXCOMM19.

enumerator kFRO1_DIV1_to_FLEXCOMM19
Attach FRO1 max clock to FLEXCOMM19.

enumerator k32KHZ_WAKE_to_FLEXCOMM19
Attach 32k_wake_clk to FLEXCOMM19.

enumerator kNONE_to_FLEXCOMM19
Attach NONE to FLEXCOMM19.

enumerator kSENSE_BASE_to_FLEXCOMM20
Attach Sense base clock to FLEXCOMM20.

enumerator kFRO2_DIV1_to_FLEXCOMM20
Attach FRO2 max clock to FLEXCOMM20.

enumerator kFRO1_DIV1_to_FLEXCOMM20
Attach FRO1 max clock to FLEXCOMM20.

enumerator k32KHZ_WAKE_to_FLEXCOMM20
Attach 32k_wake_clk to FLEXCOMM20.

enumerator kNONE_to_FLEXCOMM20
Attach NONE to FLEXCOMM20.

enumerator kCOMMON_BASE_to_COMMON_VDDN
Attach Common base clock to Common VDDN Clock.

enumerator kMAIN_PLL_PFD3_to_COMMON_VDDN
Attach Main PLL PFD3 clock to Common VDDN Clock.

enumerator kFRO1_DIV1_to_COMMON_VDDN
Attach FRO1 max clock to Common VDDN Clock.

enumerator kOSC_CLK_to_COMMON_VDDN
Attach OSC clock to Common VDDN Clock.

enumerator kOSC_CLK_to_USB_24MHZ
Attach OSC_CLK clock to 24MHz USB OSC Clock.

enumerator kFRO1_DIV8_to_USB_24MHZ
Attach FRO1_DIV8 clock to 24MHz USB OSC Clock.

enumerator kFRO1_DIV3_to_COMMON_BASE
Attach Fro1 divided-by-3 to Common Base Clock.

enumerator kFRO1_DIV1_to_COMMON_BASE
Attach Fro1 divided-by-1 to Common Base Clock.

enumerator kFRO0_DIV3_to_COMMON_BASE
Attach Fro0 divided-by-3 to Common Base Clock.

enumerator kLPOSC_to_COMMON_BASE
Attach LPOSC to Common Base Clock.

enumerator kOSC_CLK_to_EUSB_24MHZ
Attach OSC_CLK clock to 24MHz eUSB OSC Clock.

enumerator kFRO1_DIV8_to_EUSB_24MHZ
Attach FRO1_DIV8 clock to 24MHz eUSB OSC Clock.

enumerator kFRO1_DIV8_to_MAIN_PLL0
Attach FRO1_DIV8 clock to Main PLL0 Clock.

enumerator kOSC_CLK_to_MAIN_PLL0
Attach OSC_CLK clock to Main PLL0 Clock.

enumerator kFRO1_DIV8_to_AUDIO_PLL0
Attach FRO1_DIV8 to Audio PLL0 Clock.

enumerator kOSC_CLK_to_AUDIO_PLL0
Attach OSC_CLK clock (User-Selectable) to Audio PLL0 Clock.

enumerator kSENSE_BASE_to_SENSE_MAIN
Attach Sense base clock to Sense main clock.

enumerator kFRO2_DIV1_to_SENSE_MAIN
Attach FRO2 max clock to Sense main clock.

enumerator kAUDIO_PLL_PFD3_to_SENSE_MAIN
Attach Audio PLL PFD3 clock to Sense main clock.

enumerator kFRO1_DIV1_to_SENSE_MAIN
Attach FRO1 max clock to Sense main clock.

enumerator kSENSE_BASE_to_SENSE_RAM
Attach Sense base clock to Sense RAM clock.

enumerator kFRO2_DIV1_to_SENSE_RAM
Attach FRO2 max clock to Sense RAM clock.

enumerator kAUDIO_PLL_PFD2_to_SENSE_RAM
Attach Audio PLL PFD2 clock to Sense RAM clock.

enumerator kFRO1_DIV1_to_SENSE_RAM
Attach FRO1 max clock to Sense RAM clock.

enumerator kSENSE_BASE_to_OSTIMER
Attach Sense Base to OSTIMER.

enumerator k32KHZ_WAKE_to_OSTIMER
Attach 32k_wake_clk to OSTIMER.

enumerator kLPOSC_to_OSTIMER
Attach LPOSC to OSTIMER.

enumerator kOSC_CLK_to_OSTIMER
Attach OSC clock to OSTIMER.

enumerator kNONE_to_OSTIMER
Attach NONE to OSTIMER.

enumerator kSENSE_BASE_to_SDADC
Attach Sense base clock to SDADC Functional Clock.

enumerator kFRO2_DIV8_to_SDADC
Attach FRO2_DIV8 clock to SDADC Functional Clock.

enumerator kAUDIO_PLL_to_SDADC
Attach Audio PLL VCO clock to SDADC Functional Clock.

enumerator kAUDIO_VDD1_to_SDADC
Attach audio_clk to SDADC Functional Clock.

enumerator kNONE_to_SDADC
Attach NONE to SDADC Functional Clock.

enumerator kSENSE_BASE_to_ADC
Attach Sense base clock to SARADC Functional Clock.

enumerator kMAIN_PLL_PFD1_to_ADC
Attach main_pll_pfd1 to SARADC Functional Clock.

enumerator kFRO2_DIV1_to_ADC
Attach FRO0 max clock to SARADC Functional Clock.

enumerator kOSC_CLK_to_ADC
Attach osc_clk to SARADC Functional Clock.

enumerator kNONE_to_ADC
Attach NONE to SARADC Functional Clock.

enumerator kOSC32K_to_32K_WAKE
Attach OSC 32K to Wake 32k Clock.

enumerator kLPOSC_DIV32_to_32K_WAKE
Attach LPOSC clock divided by 32 by default to Wake 32k Clock.

enumerator kNONE_to_32K_WAKE
Attach NONE to Wake 32k Clock.

enumerator kSENSE_BASE_to_MICFIL0
Attach Sense base clock to MICFIL0 Functional Clock.

enumerator kAUDIO_PLL_PFD3_to_MICFIL0
Attach Audio PLL PFD3 clock to MICFIL0 Functional Clock.

enumerator kFRO2_DIV1_to_MICFIL0
Attach FRO2 MAX clock to MICFIL0 Functional Clock.

enumerator kAUDIO_VDD1_to_MICFIL0
Attach Audio clock to MICFIL0 Functional Clock.

enumerator kNONE_to_MICFIL0
Attach NONE to MICFIL0 Functional Clock.

enumerator kSENSE_BASE_to_LPI2C15
Attach Sense base clock to LPI2C15 Functional Clock.

enumerator kFRO1_DIV1_to_LPI2C15
Attach FRO1 max clock to LPI2C15 Functional Clock.

enumerator kFRO1_DIV2_to_LPI2C15
Attach FRO1 divided-by-2 to LPI2C15 Functional Clock.

enumerator kFRO2_DIV1_to_LPI2C15
Attach FRO2 max clock to LPI2C15 Functional Clock.

enumerator kNONE_to_LPI2C15
Attach NONE to LPI2C15 Functional Clock.

enumerator kSENSE_BASE_to_VDD1_CLKOUT
Attach Sense VDD1 Base Clock to VDD1 CLKOUT Clock.

enumerator kAUDIO_PLL_PFD3_to_VDD1_CLKOUT
Attach AUDIO PLL PFD3 Clock to VDD1 CLKOUT Clock.

enumerator kFRO2_DIV1_to_VDD1_CLKOUT
Attach FRO2 Max Clock to VDD1 CLKOUT Clock.

enumerator kFRO1_DIV1_to_VDD1_CLKOUT
Attach FRO1 Max Clock to VDD1 CLKOUT Clock.

enumerator kNONE_to_VDD1_CLKOUT
Attach NONE to VDD1 CLKOUT Clock.

enumerator kMEDIA_VDDN_BASE_to_MEDIA_VDDN
Attach MEDIA VDDN base clock to MEDIA VDDN clock.

enumerator kMAIN_PLL_PFD0_to_MEDIA_VDDN
Attach MAIN PLL PFD0 to MEDIA VDDN clock.

enumerator kFRO0_DIV1_to_MEDIA_VDDN
Attach FRO0 max to MEDIA VDDN clock.

enumerator kMAIN_PLL_PFD2_to_MEDIA_VDDN
Attach MAIN PLL PFD2 to MEDIA VDDN clock.

enumerator kMEDIA_VDD2_BASE_to_MEDIA_MAIN
Attach MEDIA VDD2 base clock to MEDIA MAIN clock.

enumerator kMAIN_PLL_PFD0_to_MEDIA_MAIN
Attach Main PLL PFD0 clock to MEDIA MAIN clock.

enumerator kFRO0_DIV1_to_MEDIA_MAIN
Attach FRO0 to MEDIA MAIN clock.

enumerator kMAIN_PLL_PFD2_to_MEDIA_MAIN
Attach Main PLL PFD2 clock to MEDIA MAIN clock.

enumerator kFRO1_DIV3_to_MEDIA_VDDN_BASE
Attach Fro1 divided-by-3 to Media VDDN Base Clock.

enumerator kFRO1_DIV1_to_MEDIA_VDDN_BASE
Attach Fro1 divided-by-1 to Media VDDN Base Clock.

enumerator kFRO0_DIV3_to_MEDIA_VDDN_BASE
Attach Fro0 divided-by-3 to Media VDDN Base Clock.

enumerator kLPOSC_to_MEDIA_VDDN_BASE
Attach LPOSC clock to Media VDDN Base Clock.

enumerator kFRO1_DIV3_to_MEDIA_VDD2_BASE
Attach Fro1 divided-by-3 to Media VDD2 Base Clock.

enumerator kFRO1_DIV1_to_MEDIA_VDD2_BASE
Attach Fro1 divided-by-1 to Media VDD2 Base Clock.

enumerator kFRO0_DIV3_to_MEDIA_VDD2_BASE
Attach Fro0 divided-by-3 to Media VDD2 Base Clock.

enumerator kLPOSC_to_MEDIA_VDD2_BASE
Attach LPOSC clock to Media VDD2 Base Clock.

enumerator kCOMMON_BASE_to_XSPI2
Attach Common VDDN base clock to XSPI2 Functional Clock.

enumerator kAUDIO_PLL_PFD1_to_XSPI2
Attach Audio PLL PFD1 clock to XSPI2 Functional Clock.

enumerator kFRO0_DIV1_to_XSPI2
Attach FRO0 max clock to XSPI2 Functional Clock.

enumerator kMAIN_PLL_PFD3_to_XSPI2
Attach Main PLL PFD3 clock to XSPI2 Functional Clock.

enumerator kNONE_to_XSPI2
Attach NONE to XSPI2 Functional Clock.

enumerator k32KHZ_WAKE_to_USB
Attach Wakeup 32K to USB Functional Clock.

enumerator kLPOSC_to_USB
Attach LPOSC_1M to USB Functional Clock.

enumerator kUSB_24MHZ_to_USB
Attach 24MHz USB OSC clock to USB Functional Clock.

enumerator kNONE_to_USB
Attach NONE to USB Functional Clock.

enumerator k32KHZ_WAKE_to_EUSB
Attach Wakeup 32K to eUSB Functional Clock.

enumerator kLPOSC_to_EUSB
Attach LPOSC_1M to eUSB Functional Clock.

enumerator kEUSB_24MHZ_to_EUSB

Attach 24MHz eUSB OSC clock to eUSB Functional Clock.

enumerator kNONE_to_EUSB

Attach NONE to eUSB Functional Clock.

enumerator kMEDIA_VDDN_BASE_to_SDIO0

Attach Media VDDN base clock to SDIO0 Functional Clock.

enumerator kAUDIO_PLL_PFD0_to_SDIO0

Attach Audio PLL PFD0 clock to SDIO0 Functional Clock.

enumerator kFRO0_DIV1_to_SDIO0

Attach FRO0 max clock to SDIO0 Functional Clock.

enumerator kMAIN_PLL_PFD2_to_SDIO0

Attach Main PLL PFD2 clock to SDIO0 Functional Clock.

enumerator kNONE_to_SDIO0

Attach NONE to SDIO0 Functional Clock.

enumerator kMEDIA_VDDN_BASE_to_SDIO1

Attach Media VDDN base clock to SDIO1 Functional Clock.

enumerator kAUDIO_PLL_PFD0_to_SDIO1

Attach Audio PLL PFD0 clock to SDIO1 Functional Clock.

enumerator kFRO0_DIV1_to_SDIO1

Attach FRO0 max clock to SDIO1 Functional Clock.

enumerator kMAIN_PLL_PFD1_to_SDIO1

Attach Main PLL PFD1 clock to SDIO1 Functional Clock.

enumerator kNONE_to_SDIO1

Attach NONE to SDIO1 Functional Clock.

enumerator kMEDIA_VDD2_BASE_to_MIPI_DSI_HOST_PHY

Attach Media VDD2 base clock to MIPI_DSI_Host PHY Clock.

enumerator kFRO0_DIV1_to_MIPI_DSI_HOST_PHY

Attach FRO0 max clock to MIPI_DSI_Host PHY Clock.

enumerator kAUDIO_PLL_PFD2_to_MIPI_DSI_HOST_PHY

Attach Audio PLL PFD2 clock to MIPI_DSI_Host PHY Clock.

enumerator kNONE_to_MIPI_DSI_HOST_PHY

Attach NONE to MIPI_DSI_Host PHY Clock.

enumerator kMEDIA_VDD2_BASE_to_MIPI_DPHYESC_CLK

Attach Media VDD2 base clock to MIPI_DSI_Host DPHY Escape Mode Clock.

enumerator kMAIN_PLL_PFD1_to_MIPI_DPHYESC_CLK

Attach Main PLL PFD1 clock to MIPI_DSI_Host DPHY Escape Mode Clock.

enumerator kFRO0_DIV1_to_MIPI_DPHYESC_CLK

Attach FRO0 max clock to MIPI_DSI_Host DPHY Escape Mode Clock.

enumerator kAUDIO_PLL_PFD2_to_MIPI_DPHYESC_CLK

Attach Audio PLL PFD2 clock to MIPI_DSI_Host DPHY Escape Mode Clock.

enumerator kNONE_to_MIPI_DPHYESC_CLK

Attach NONE to MIPI_DSI_Host DPHY Escape Mode Clock.

enumerator kMEDIA_VDD2_BASE_to_VGPU
Attach Media VDD2 base clock to VGPU Clock.

enumerator kMAIN_PLL_PFD0_to_VGPU
Attach Main PLL PFD0 clock to VGPU Clock.

enumerator kFRO0_DIV1_to_VGPU
Attach FRO0 max clock to VGPU Clock.

enumerator kMAIN_PLL_PFD2_to_VGPU
Attach Main PLL PFD2 clock to VGPU Clock.

enumerator kNONE_to_VGPU
Attach NONE to VGPU Clock.

enumerator kMEDIA_VDD2_BASE_to_LPSP14
Attach Media VDD2 base clock to LPSP14 Clock.

enumerator kFRO0_DIV1_to_LPSP14
Attach FRO0 max clock to LPSP14 Clock.

enumerator kMAIN_PLL_PFD0_to_LPSP14
Attach Main PLL PFD0 clock to LPSP14 Clock.

enumerator kFRO1_DIV1_to_LPSP14
Attach FRO1 max clock to LPSP14 Clock.

enumerator kNONE_to_LPSP14
Attach NONE to LPSP14 Clock.

enumerator kMEDIA_VDD2_BASE_to_LPSP16
Attach Media VDD2 base clock to LPSP16 Clock.

enumerator kFRO0_DIV1_to_LPSP16
Attach FRO0 max clock to LPSP16 Clock.

enumerator kMAIN_PLL_PFD0_to_LPSP16
Attach Main PLL PFD0 clock to LPSP16 Clock.

enumerator kFRO1_DIV1_to_LPSP16
Attach FRO1 max clock to LPSP16 Clock.

enumerator kNONE_to_LPSP16
Attach NONE to LPSP16 Clock.

enumerator kMEDIA_VDD2_BASE_to_FLEXIO
Attach MEDIA VDD2 base clock to FLEXIO.

enumerator kFRO0_DIV1_to_FLEXIO
Attach FRO0 max clock to FLEXIO.

enumerator kFRO1_DIV1_to_FLEXIO
Attach FRO1 max clock to FLEXIO.

enumerator kMAIN_PLL_PFD3_to_FLEXIO
Attach Main PLL PFD3 clock to FLEXIO.

enumerator kNONE_to_FLEXIO
Attach NONE to FLEXIO.

enumerator kMEDIA_VDD2_BASE_to_LCDIF
Attach MEDIA VDD2 base clock to LCDIF.

enumerator kMAIN_PLL_PFD2_to_LCDIF

Attach Main PLL PFD0 clock to LCDIF.

enumerator kFRO0_DIV1_to_LCDIF

Attach FRO0 max clock to LCDIF.

enumerator kAUDIO_PLL_PFD1_to_LCDIF

Attach Audio PLL PFD1 to LCDIF.

enumerator kNONE_to_LCDIF

Attach NONE to LCDIF.

enum _clock_div_name

Clock dividers.

Values:

enumerator kCLOCK_DivLPFlexComm17Clk

LP_FLEXCOMM17 Clk Divider.

enumerator kCLOCK_DivLPFlexComm18Clk

LP_FLEXCOMM18 Clk Divider.

enumerator kCLOCK_DivLPFlexComm19Clk

LP_FLEXCOMM19 Clk Divider.

enumerator kCLOCK_DivLPFlexComm20Clk

LP_FLEXCOMM20 Clk Divider.

enumerator kCLOCK_DivSenseDspClk

Sense DSP Clk Divider.

enumerator kCLOCK_DivSai3Clk

SAI3 FCLK Clk Divider.

enumerator kCLOCK_DivUtick1Clk

UTICK1 Functional Clk Divider.

enumerator kCLOCK_DivSystickClk

SYSTICK Functional Clk Divider.

enumerator kCLOCK_DivCtimer5Clk

CTIMER5 FCLK Clk Divider.

enumerator kCLOCK_DivCtimer6Clk

CTIMER6 FCLK Clk Divider.

enumerator kCLOCK_DivCtimer7Clk

CTIMER7 FCLK Clk Divider.

enumerator kCLOCK_DivI3c23Clk

I3C2 and I3C3 Functional Clk Divider.

enumerator kCLOCK_DivCommonVddnClk

Common VDDN Clk Divider.

enumerator kCLOCK_DivSenseMainClk

VDD1_SENSE Main Clock Divider.

enumerator kCLOCK_DivSenseRamClk

Senese RAM Clk Divider.

enumerator kCLOCK__DivOstimerClk
OSTIMER Clk Divider.

enumerator kCLOCK__DivSdadcClk
SDADC Clk Divider.

enumerator kCLOCK__DivAdcClk
SARADC Clk Divider.

enumerator kCLOCK__DivMicfil0Clk
DMIC0 Clk Divider.

enumerator kCLOCK__DivLpi2c15Clk
PMIC LPI2C Clk Divider.

enumerator kCLOCK__DivVdd1ClockOut
CLKOUT_VDD1 Clk Divider.

enumerator kCLOCK__DivMediaVddnClk
Media VDDN Clk Divider.

enumerator kCLOCK__DivMediaMainClk
Media Main Clk Divider.

enumerator kCLOCK__DivXspi2Clk
XSPI2 Clk Divider.

enumerator kCLOCK__DivSdio0Clk
SDIO0 Clk Divider.

enumerator kCLOCK__DivSdio1Clk
SDIO1 Clk Divider.

enumerator kCLOCK__DivDphyClk
DPHY Clk Divider.

enumerator kCLOCK__DivDphyEscRxClk
DphyEscRx Clk Divider.

enumerator kCLOCK__DivDphyEscTxClk
DphyEscTx Clk Divider.

enumerator kCLOCK__DivVgpuClk
VGPU Clk Divider.

enumerator kCLOCK__DivLpspi14Clk
LPSPi14 Clk Divider.

enumerator kCLOCK__DivLpspi16Clk
LPSPi16 Clk Divider.

enumerator kCLOCK__DivFlexioClk
FLEXIO Clk Divider.

enumerator kCLOCK__DivLcdifClk
LCDIF Pixel Clk Divider.

enumerator kCLOCK__DivLowFreqClk
Low frequency Clk Divider.

enum _clock_fro_output_en
FRO output enable.

Values:

enumerator kCLOCK_FroDiv1OutEn
Enable Fro Div1 output.

enumerator kCLOCK_FroDiv2OutEn
Enable Fro Div2 output.

enumerator kCLOCK_FroDiv3OutEn
Enable Fro Div3 output.

enumerator kCLOCK_FroDiv6OutEn
Enable Fro Div6 output.

enumerator kCLOCK_FroDiv8OutEn
Enable Fro Div8 output.

enumerator kCLOCK_FroAllOutEn
Enable all Fro output.

enum _clock_fro_interrupt
FRO Interrupt control.

Values:

enumerator kCLOCK_FroTrimUpdateReqInt
Trim Update Request Interrupt Enable.

enumerator kCLOCK_FroTuneErrInt
Tune Error Interrupt Enable.

enumerator kCLOCK_FroLossOfLockInt
Loss-of-Lock Error Interrupt Enable.

enumerator kCLOCK_FroAllInterrupt
All Interrupt Enable.

enum _clock_fro_flag
FRO flags.

Values:

enumerator kCLOCK_FroTuneOnceDone
FRO Tune Once Done Flag.

enumerator kCLOCK_FroTrimLock
FRO Trim Lock Flag.

enumerator kCLOCK_FroTrimUpdateReq
FRO Trim Update Request Flag.

enumerator kCLOCK_FroTuneErr
FRO Tune Error Flag.

enumerator kCLOCK_FroLossOfLockErr
FRO Loss-of-lock Error Flag.

enum _clock_domain_enable
Clock Control for each power domain.

Values:

enumerator kCLOCK_Vdd2CompDomainEnable
Clock Control of VDD2_COMP Domain.

enumerator kCLOCK_Vdd1SenseDomainEnable
Clock Control of VDD1_SENSE Domain.

enumerator kCLOCK_Vdd2DspDomainEnable
Clock Control of VDD2_DSP Domain.

enumerator kCLOCK_Vdd2MediaDomainEnable
Clock Control of VDD2_MEDIA Domain.

enumerator kCLOCK_VddnMediaDomainEnable
Clock Control of VDDN_MEDIA Domain.

enumerator kCLOCK_Vdd2ComDomainEnable
Clock Control of VDD2_COM Domain.

enumerator kCLOCK_VddnComDomainEnable
Clock Control of VDDN_COM Domain.

enumerator kCLOCK_AllDomainEnable
Clock Control of all Domain.

enum _clock_pfd
PLL PFD clock name.

Values:

enumerator kCLOCK_Pfd0
PLL PFD0

enumerator kCLOCK_Pfd1
PLL PFD1

enumerator kCLOCK_Pfd2
PLL PFD2

enumerator kCLOCK_Pfd3
PLL PFD3

enum _main_pll_src
MainPLL Reference Input Clock Source.

Values:

enumerator kCLOCK_MainPllFro1Div8
FRO1_DIV8 clock

enumerator kCLOCK_MainPllOscClk
OSC clock

enum _main_pll_mult
MainPLL Multiplication Factor.

Values:

enumerator kCLOCK_MainPllMult16
Divide by 16

enumerator kCLOCK_MainPllMult17
Divide by 17

enumerator kCLOCK_MainPllMult18
Divide by 18

enumerator kCLOCK__MainPllMult19

Divide by 19

enumerator kCLOCK__MainPllMult20

Divide by 20

enumerator kCLOCK__MainPllMult21

Divide by 21

enumerator kCLOCK__MainPllMult22

Divide by 22

enum __audio_pll_src

AudioPll Reference Input Clock Source.

Values:

enumerator kCLOCK__AudioPllFro1Div8

FRO1_DIV8 clock

enumerator kCLOCK__AudioPllOscClk

OSC clock

enum __audio_pll_mult

AudioPll Multiplication Factor.

Values:

enumerator kCLOCK__AudioPllMult16

Divide by 16

enumerator kCLOCK__AudioPllMult17

Divide by 17

enumerator kCLOCK__AudioPllMult18

Divide by 18

enumerator kCLOCK__AudioPllMult19

Divide by 19

enumerator kCLOCK__AudioPllMult20

Divide by 20

enumerator kCLOCK__AudioPllMult21

Divide by 21

enumerator kCLOCK__AudioPllMult22

Divide by 22

enum __osc32k_cap_trim

Capacitor Trim Value for OSC32KNP.

Values:

enumerator kCLOCK__Osc32kCapPf0

Capacitor Trim Value 0pF.

enumerator kCLOCK__Osc32kCapPf2

Capacitor Trim Value 2pF.

enumerator kCLOCK__Osc32kCapPf4

Capacitor Trim Value 4pF.

enumerator kCLOCK_Osc32kCapPf6

Capacitor Trim Value 6pF.

enumerator kCLOCK_Osc32kCapPf8

Capacitor Trim Value 8pF.

enumerator kCLOCK_Osc32kCapPf10

Capacitor Trim Value 10pF.

enumerator kCLOCK_Osc32kCapPf12

Capacitor Trim Value 12pF.

enumerator kCLOCK_Osc32kCapPf14

Capacitor Trim Value 14pF.

enumerator kCLOCK_Osc32kCapPf16

Capacitor Trim Value 16pF.

enumerator kCLOCK_Osc32kCapPf18

Capacitor Trim Value 18pF.

enumerator kCLOCK_Osc32kCapPf20

Capacitor Trim Value 20pF.

enumerator kCLOCK_Osc32kCapPf22

Capacitor Trim Value 22pF.

enumerator kCLOCK_Osc32kCapPf24

Capacitor Trim Value 24pF.

enumerator kCLOCK_Osc32kCapPf26

Capacitor Trim Value 26pF.

enumerator kCLOCK_Osc32kCapPf28

Capacitor Trim Value 28pF.

enumerator kCLOCK_Osc32kCapPf30

Capacitor Trim Value 30pF.

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_ip_name* clock_ip_name_t

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

typedef enum *_clock_name* clock_name_t

Clock name used to get clock frequency.

typedef enum *_clock_attach_id* clock_attach_id_t

The enumerator of clock attach Id for multi sources clock slices. Not all Muxer has MUX output enable control, if no mux output enable control, the mux output will be always enabled.

typedef enum *_clock_div_name* clock_div_name_t

Clock dividers.

typedef enum *_clock_fro_output_en* clock_fro_output_en_t

FRO output enable.

```
typedef struct _clock_fro_config clock_fro_config_t
```

FRO configuration.

```
typedef enum _clock_domain_enable clock_domain_enable_t
```

Clock Control for each power domain.

```
typedef enum _clock_pfd clock_pfd_t
```

PLL PFD clock name.

```
typedef enum _main_pll_src main_pll_src_t
```

MainPLL Reference Input Clock Source.

```
typedef enum _main_pll_mult main_pll_mult_t
```

MainPLL Multiplication Factor.

```
typedef struct _clock_main_pll_config clock_main_pll_config_t
```

PLL configuration for MAINPLL.

```
typedef enum _audio_pll_src audio_pll_src_t
```

AudioPll Reference Input Clock Source.

```
typedef enum _audio_pll_mult audio_pll_mult_t
```

AudioPll Multiplication Factor.

```
typedef struct _clock_audio_pll_config clock_audio_pll_config_t
```

PLL configuration for Audio PLL.

```
typedef enum _osc32k_cap_trim osc32k_cap_trim_t
```

Capacitor Trim Value for OSC32KNP.

```
typedef struct _clock_osc32k_config_t clock_osc32k_config_t
```

configuration for 32K OSC

```
volatile uint32_t g_xtalFreq
```

External XTAL (SYSOSC) clock frequency.

The XTAL (SYSOSC) clock frequency in Hz, when the clock is setup, use the function `CLOCK_SetXtalFreq` to set the value in to clock driver. For example, if XTAL is 16MHz,

```
CLOCK_SetXtalFreq(16000000);
```

```
volatile uint32_t g_clkinFreq
```

External CLK_IN pin clock frequency (clkin).

The CLK_IN pin (clkin) clock frequency in Hz, when the clock is setup, use the function `CLOCK_SetClkinFreq` to set the value in to clock driver. For example, if CLK_IN is 16MHz,

```
CLOCK_SetClkinFreq(16000000);
```

```
volatile uint32_t g_32kClkinFreq
```

External 32KHz input clock frequency.

The External 32KHz input clock frequency in Hz, used when OSC32KNP in bypass mode, use the function `CLOCK_Set32kClkinFreq` to set the value in to clock driver. For example, if EXTALIN32K input is 32768,

```
CLOCK_Set32kClkinFreq(32768);
```

```
volatile uint32_t g_mclkFreq
```

External MCLK IN clock frequency.

The MCLK IN clock frequency in Hz, when the clock is setup, use the function `CLOCK_SetMclkFreq` to set the value in to clock driver. For example, if MCLK IN is 16MHz,

```
CLOCK_SetMclkFreq(160000000);
```

void CLOCK_EnableClock(*clock_ip_name_t* clk)

Enable the clock for specific IP.

Parameters

- clk – : Clock to be enabled.

Returns

Nothing

void CLOCK_DisableClock(*clock_ip_name_t* clk)

Disable the clock for specific IP.

Parameters

- clk – : Clock to be disabled.

Returns

Nothing

void CLOCK_AttachClk(*clock_attach_id_t* connection)

brief Configure the clock selection muxes.

For some of the muxes, there's SEL_EN bit to gate the mux output to reduce power, using kNONT_to_XXX to gate the mux output. used by any peripheral.

Parameters

- connection – : Clock to be configured.

Returns

Nothing

void CLOCK_SetClkDiv(*clock_div_name_t* div_name, uint32_t divider)

Setup peripheral clock dividers.

Parameters

- div_name – : Clock divider name
- divider – : Value to be divided. Divided clock frequency = Undivided clock frequency / divider.

Returns

Nothing

uint32_t CLOCK_GetFreq(*clock_name_t* clockName)

Return Frequency of selected clock.

Returns

Frequency of selected clock

uint32_t CLOCK_GetSenseAudioClkFreq(void)

Return Frequency of VDD1 audio clk.

Returns

Frequency of audio_clk

uint32_t CLOCK_GetHifi1ClkFreq(void)

Return Frequency of Sense DSP clk.

Returns

Frequency of Sense DSP clk


```
void CLOCK_EnableFroClkOutput(FRO_Type *base, uint32_t divOutEnable)
```

Enable/Disable FRO clock output.

Parameters

- `base` – : base address of FRO.
- `divOutEnable` – : Or'ed value of `clock_fro_output_en_t` to enable certain clock freq output.

```
void CLOCK_ConfigFroTrim(FRO_Type *base, uint16_t trimVal)
```

Configure FRO trim values when FRO is configured in Open loop mode.

Parameters

- `base` – : base address of FRO.
- `trimVal` – : 12bits trim value.

```
void CLOCK_DisableFro(FRO_Type *base)
```

Disable the FRO clock. This API will disable the FRO clock output and power off FRO.

Parameters

- `base` – : base address of FRO.

```
status_t CLOCK_EnableFroAutoTuning(FRO_Type *base, const clock_fro_config_t *config, bool enable)
```

Enable/Disable FRO for close loop mode(autotuner).

Parameters

- `base` – : base address of FRO.
- `config` – : The configuration for FRO.
- `enable` – Enable auto tuning mode or not.

Return values

- `kStatus_Success` – successfully tuned to the target configuration.
- `kStatus_InvalidArgument` – Invalid argument.
- `kStatus_Fail` – failed to lock to the target frequency.

```
void CLOCK_EnableFroClkFreq(FRO_Type *base, uint32_t targetFreq, uint32_t divOutEnable)
```

Enable FRO clock output with specified frequency.

Parameters

- `base` – : base address of FRO.
- `targetFreq` – target fro frequency.
- `divOutEnable` – Or'ed value of `clock_fro_output_en_t` to enable certain clock freq output.

```
status_t CLOCK_EnableFroClkFreqCloseLoop(FRO_Type *base, const clock_fro_config_t *config, uint32_t divOutEnable)
```

Enable FRO clock output with target frequency using FRO close loop mode. For example, to enable FRO2 to output 200MHZ:

```
const clock_fro_config_t config = {
    .targetFreq = 200000000U,
    .range = 50U,
    .trim1DelayUs = 15U,
```

(continues on next page)

(continued from previous page)

```
.trim2DelayUs = 150U,  
.refDiv = 0U,  
.enableInt = 0U,  
.coarseTrimEn = true,  
};  
CLOCK__EnableFroClkFreqCloseLoop(FRO2, &config, kCLOCK__FroAllOutEn);
```

Parameters

- base – : base address of FRO.
- config – : The configuration for FRO.
- divOutEnable – : Or'ed value of clock_fro_output_en_t to enable certain clock freq output.

Return values

- kStatus__Success – successfully tuned to the target configuration.
- kStatus__InvalidArgument – Invalid argument.
- kStatus__Fail – failed to lock to the target frequency.

uint32_t CLOCK__GetFroFlags(FRO_Type *base)

Get FRO flags.

Parameters

- base – : base address of FRO.
- flags – Or'ed value of _clock_fro_flag.

static inline void CLOCK__ClearFroFlags(FRO_Type *base, uint32_t flags)

Clear FRO flags.

Parameters

- base – : base address of FRO.
- flags – Or'ed value of _clock_fro_flag to clear.

static inline void CLOCK__EnableFroFastStartup(FRO_Type *base, bool enable)

Enable/Disable FRO fast startup.

Parameters

- base – : base address of FRO.
- true (enable,) – to enable fast startup, false to disable fast startup.

uint32_t CLOCK__GetFroClkFreq(uint32_t id)

Return Frequency of FRO clk.

Parameters

- id – FRO index

Returns

Frequency of FRO clk

uint32_t CLOCK__GetSenseMainClkFreq(void)

Return Frequency of sense main clk.

Returns

Frequency of main clk

uint32_t CLOCK_GetMainPllFreq(void)

Return Frequency of MAINPLL.

Returns

Frequency of MAINPLL

uint32_t CLOCK_GetMainPfdFreq(*clock_pfd_t* pfd)

Get current output frequency of specific Main PLL PFD.

Parameters

- pfd – : pfd name to get frequency.

Returns

Frequency of MainPLL PFD.

uint32_t CLOCK_GetAudioPllFreq(void)

Return Frequency of AUDIO PLL.

Returns

Frequency of AUDIO PLL

uint32_t CLOCK_GetAudioPfdFreq(*clock_pfd_t* pfd)

Get current output frequency of specific Audio PLL PFD.

Parameters

- pfd – : pfd name to get frequency.

Returns

Frequency of AUDIO PLL PFD.

static inline uint32_t CLOCK_GetXtalInClkFreq(void)

Return Frequency of High-Freq output of FRO.

Return Frequency of sys osc Clock

Returns

Frequency of High-Freq output of FRO

Returns

Frequency of sys osc Clock. Or CLK_IN pin frequency.

uint32_t CLOCK_GetSenseBaseClkFreq(void)

Return Frequency of Sense Base clock.

Returns

Frequency of sense base clk

void CLOCK_EnableSysOscClk(bool enable, bool enableLowPower, uint32_t delay_us)

Enable/Disable sys osc clock from external crystal clock.

Parameters

- enable – : true to enable system osc clock, false to bypass system osc.
- enableLowPower – : true to enable low power mode, false to enable high gain mode.
- delay_us – : Delay time after OSC power up.

uint32_t CLOCK_GetVddnComBaseClkFreq(void)

Return Frequency of VDDN_COM Base Clock.

Returns

Frequency of baseclk_comn

uint32_t CLOCK_GetVddnMediaBaseClkFreq(void)

Return Frequency of VDDN_MEDIA Base Clock.

Returns

Frequency of baseclk_mdn

uint32_t CLOCK_GetVdd2MediaBaseClkFreq(void)

Return Frequency of VDD2_MEDIA Base Clock.

Returns

Frequency of baseclk_md2

uint32_t CLOCK_GetMediaMainClkFreq(void)

Return Frequency of MEDIA_MAIN Clock.

Returns

Frequency of media_main_clk

uint32_t CLOCK_GetMediaVddnClkFreq(void)

Return Frequency of MEDIA_VDDN Clock.

Returns

Frequency of media_vddn_clk

void CLOCK_EnableFro2ClkForDomain(uint32_t domainEnable)

Enable/Disable FRO2 clock for various domains.

Parameters

- domainEnable – : Or'ed value of clock_domain_enable_t to enable DRFO2 max clock for certain domain.

void CLOCK_EnableMainPlLPfdClkForDomain(*clock_pfd_t* pfd, uint32_t domainEnable)

Enable/Disable MainPLL PFD clock for various domains.

Enables PFD clock of MainPLL for various domains. Each PFD clock of MainPLL can be sent to various domain. To reduce power consumption, turn off the PFD in the domain when this PFD is not configured.

Parameters

- pfd – : Which PFD clock to control.
- domainEnable – : Or'ed value of clock_domain_enable_t to enable clock for certain domain.

void CLOCK_EnableAudioPlLPfdClkForDomain(*clock_pfd_t* pfd, uint32_t domainEnable)

Enable/Disable AUDIO PFD clock for various domains.

Enables PFD clock of AUDIO for various domains. Each PFD clock of AUDIO can be sent to various domain. To reduce power consumption, turn off the PFD in the domain when this PFD is not configured.

Parameters

- pfd – : Which PFD clock to control.
- domainEnable – : Or'ed value of clock_domain_enable_t to enable clock for certain domain.

void CLOCK_EnableAudioPlLVcoClkForDomain(uint32_t domainEnable)

Enable/Disable AUDIO VCO clock for various domains.

VCO clock of Audio PLL can be sent to various domains to reduce power consumption when VCO is not set to use in such domain. This VCO can be disabled for such domain.

Parameters

- domainEnable – : Or'ed value of clock_domain_enable_t to enable clock for certain domain.

void CLOCK_InitMainPll(const *clock_main_pll_config_t* *config)

Initialize the Main PLL.

Parameters

- config – : Configuration to set to PLL.

static inline void CLOCK_DeinitMainPll(void)

brief Deinit the Main PLL. param none.

status_t CLOCK_InitMainPfd(*clock_pfd_t* pfd, uint8_t divider)

Initialize the Main PLL PFD.

Note: It is recommended that PFD settings are kept between 12-35.

Parameters

- pfd – : Which PFD clock to enable.
- divider – : The PFD divider value.

Returns

kStatus_Success if successfully, kStatus_Timeout if timeout happen.

static inline void CLOCK_DeinitMainPfd(*clock_pfd_t* pfd)

Disable the Main PLL PFD.

Parameters

- pfd – : Which PFD clock to disable.

void CLOCK_InitAudioPll(const *clock_audio_pll_config_t* *config)

Initialize the audio PLL.

Parameters

- config – : Configuration to set to PLL.

static inline void CLOCK_DeinitAudioPll(void)

Deinit the Audio PLL.

Parameters

- none. –

status_t CLOCK_InitAudioPfd(*clock_pfd_t* pfd, uint8_t divider)

Initialize the audio PLL PFD.

Note: It is recommended that PFD settings are kept between 12-35.

Parameters

- pfd – : Which PFD clock to enable.
- divider – : The PFD divider value.

Returns

kStatus_Success if successfully, kStatus_Timeout if timeout happen.

static inline void CLOCK_DeinitAudioPfd(*clock_pfd_t* pfd)

brief Disable the audio PLL PFD. param pfd : Which PFD clock to disable.

static inline uint32_t CLOCK_GetLpOscFreq(void)

Return Frequency of Lower power osc.

Returns

Frequency of LPOSC

static inline uint32_t CLOCK_GetSysOscFreq(void)

Return Frequency of sys osc Clock.

Returns

Frequency of sys osc Clock. Or CLK_IN pin frequency.

static inline uint32_t CLOCK_GetMclkInClkFreq(void)

Return Frequency of MCLK Input Clock.

Returns

Frequency of MCLK input Clock.

uint32_t CLOCK_GetOsc32KFreq(void)

Return Frequency of 32kHz osc.

Returns

Frequency of 32kHz osc

void CLOCK_EnableOsc32K(*clock_osc32k_config_t* *config)

Enables OSC32KNP.

Parameters

- config – : configuration set to OSC32KNP

static inline void CLOCK_DisableOsc32K(void)

Disable OSC32KNP.

uint32_t CLOCK_GetWakeClk32KFreq(void)

Return Frequency of 32khz wake clk.

Returns

Frequency of 32kHz wake clk

static inline void CLOCK_SetXtalFreq(uint32_t freq)

Set the XTALIN (system OSC) frequency based on board setting. NOTE, when SOSC is used, either CLOCK_SetXtalFreq or CLOCK_SetClkinFreq(But NOT both.) should be called to tell driver the clock frequency connected to SOSC module.

Parameters

- freq – : The XTAL input clock frequency in Hz.

static inline void CLOCK_SetClkinFreq(uint32_t freq)

Set the CLKIN (CLKIN pin) frequency based on board setting.

Parameters

- freq – : The CLK_IN pin input clock frequency in Hz.

static inline void CLOCK_Set32kClkinFreq(uint32_t freq)

Set the 32KHz external input frequency based on board setting.

Parameters

- freq – : The 32KHz external pin input clock frequency in Hz.

static inline void CLOCK_SetMclkFreq(uint32_t freq)

Set the MCLK IN frequency based on board setting.

Parameters

- freq – : The MCLK input clock frequency in Hz.

static inline uint32_t CLOCK_GetCoreSysClkFreq(void)

Return Frequency of Core/system clock.

Returns

Frequency of core or system Clock

uint32_t CLOCK_GetXspiClkFreq(uint32_t id)

Return Frequency of XSPI function clock.

Parameters

- id – : XSPI index to get frequency.

Returns

Frequency of XSPI functional Clock

uint32_t CLOCK_GetUtickClkFreq(void)

Return Frequency of UTICK function clock.

Returns

Frequency of UTICK functional Clock

uint32_t CLOCK_GetSystickClkFreq(void)

Return Frequency of systick clk.

Returns

Frequency of systick clk

uint32_t CLOCK_GetWdtClkFreq(uint32_t id)

Return Frequency of WDT clk.

Parameters

- id – : WDT index to get frequency.

Returns

Frequency of WDT clk

uint32_t CLOCK_GetAcmpClkFreq(void)

Return Frequency of ACMP clk.

Returns

Frequency of ACMP clk

uint32_t CLOCK_GetSaiClkFreq(void)

Return Frequency of SAI clk.

Returns

Frequency of SAI clk

uint32_t CLOCK_GetUsbClkFreq(void)

Return Frequency of USB clk.

Returns

Frequency of USB clk

uint32_t CLOCK_GetI3cClkFreq(void)

Return Frequency of I3C clk.

Returns

Frequency of I3C clk

uint32_t CLOCK_GetLPFlexCommClkFreq(uint32_t id)

Return Frequency of Flexcomm functional Clock.

Parameters

- id – : flexcomm index to get frequency.

Returns

Frequency of Flexcomm functional Clock

uint32_t CLOCK_GetLPI2cClkFreq(uint32_t id)

Return Frequency of LPI2C functional Clock.

Parameters

- id – : LPI2C index to get frequency.

Returns

Frequency of LPI2C functional Clock

uint32_t CLOCK_GetLPSpiClkFreq(uint32_t id)

Return Frequency of LPSPI functional Clock.

Parameters

- id – : LPSPI index to get frequency.

Returns

Frequency of LPSPI functional Clock

uint32_t CLOCK_GetFlexioClkFreq(void)

Return Frequency of Flexio functional Clock.

Returns

Frequency of Flexcomm functional Clock

uint32_t CLOCK_GetOSTimerClkFreq(void)

Return Frequency of OSTIMER functional Clock.

Returns

Frequency of OSTIMER functional Clock

uint32_t CLOCK_GetMicfilClkFreq(void)

Return Frequency of MICFIL functional Clock.

Returns

Frequency of MICFIL functional Clock

uint32_t CLOCK_GetCTimerClkFreq(uint32_t id)

Return Frequency of Ctimer Clock.

Parameters

- id – : ctimer index to get frequency.

Returns

Frequency of Ctimer Clock

uint32_t CLOCK_GetVdd1ClockOutClkFreq(void)

Return Frequency of VDD1 Clock Out.

Returns

Frequency of ClockOut of sense domain

uint32_t CLOCK_GetAdcClkFreq(void)

Return Frequency of Adc Clock.

Returns

Frequency of Adc Clock.

uint32_t CLOCK_GetSdAdcClkFreq(void)

Return Frequency of SDADC Clock.

Returns

Frequency of SDADC Clock.

uint32_t CLOCK_GetVgpuClkFreq(void)

Return Frequency of VGPU functional Clock.

Returns

Frequency of VGPU functional Clock

uint32_t CLOCK_GetLcdifClkFreq(void)

Return Frequency of LCDIF pixel Clock.

Returns

Frequency of LCDIF pixel Clock

uint32_t CLOCK_GetMipiDphyClkFreq(void)

Return Frequency of MIPI DPHY functional Clock.

Returns

Frequency of MIPI DPHY functional Clock

uint32_t CLOCK_GetMipiDphyEscRxClkFreq(void)

Return Frequency of MIPI DPHY Esc RX functional Clock.

Returns

Frequency of MIPI DPHY Esc RX functional Clock

uint32_t CLOCK_GetMipiDphyEscTxClkFreq(void)

Return Frequency of MIPI DPHY Esc Tx functional Clock.

Returns

Frequency of MIPI DPHY Esc Tx functional Clock

uint32_t CLOCK_GetUsdhcClkFreq(uint32_t id)

Return Frequency of USDHC Clock.

Parameters

- id – : uSDHC index to get frequency.

Returns

Frequency of USDHC 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.

param src USB HS PHY PLL clock source. param freq The frequency specified by src. retval true The clock is set successfully. retval false The clock source is invalid to get proper USB HS clock.

bool CLOCK_EnableUsbhs0Clock(*clock_usb_src_t* src, uint32_t freq)

brief Enable USB HS clock.

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

param src USB HS does not care about the clock source, here must be ref kCLOCK_UsbSrcUnused. param freq USB HS does not care about the clock source, so this parameter is ignored. retval true The clock is set successfully. retval false The clock source is invalid to get proper USB HS clock.

`void CLOCK_DisableUsbhs0PhyPllClock(void)`

brief Disable USB HS PHY PLL clock.

This function disables USB HS PHY PLL clock.

`FSL_CLOCK_DRIVER_VERSION`

CLOCK driver version 2.4.2.

`CLOCK_DeinitSysPfd`

`CLOCK_InitSysPfd`

`CDOG_CLOCKS`

Clock ip name array for CDOG.

`FREQME_CLOCKS`

Clock ip name array for FREQME.

`GPU_CLOCKS`

Clock ip name array for GPU.

`MIPI_DSI_HOST_CLOCKS`

Clock ip name array for MIPI DSI.

`LCDIF_CLOCKS`

Clock ip name array for LCDIF.

`SCT_CLOCKS`

Clock ip name array for SCT.

`USB_CLOCKS`

Clock ip name array for USB.

`USBPHY_CLOCKS`

Clock ip name array for USBPHY.

`XSPI_CLOCKS`

Clock ip name array for FlexSPI.

`MMU_CLOCKS`

Clock ip name array for MMU.

`CACHE64_CLOCKS`

Clock ip name array for CACHE64.

`CACHE64POLSEL_CLOCKS`

Clock ip name array for CACHE64_POLSEL.

`LPADC_CLOCKS`

Clock ip name array for ADC.

`SDADC_CLOCKS`

Clock ip name array for SDADC.

`CMP_CLOCKS`

Clock ip name array for ACMP.

`USDHC_CLOCKS`

Clock ip name array for uSDHC.

`WWDT_CLOCKS`

Clock ip name array for WWDT.

UTICK_CLOCKS

Clock ip name array for UTICK.

FLEXIO_CLOCKS

Clock ip name array for FlexIO.

LP_FLEXCOMM_CLOCKS

Clock ip name array for LP_FLEXCOMM.

LPUART_CLOCKS

Clock ip name array for LPUART.

LPI2C_CLOCKS

Clock ip name array for LPI2C.

LPSPi_CLOCKS

Clock ip name array for LSPi.

SAI_CLOCKS

Clock ip name array for SAI.

SEMA42_CLOCKS

Clock ip name array for SEMA.

CRC_CLOCKS

Clock ip name array for MU.

Clock ip name array for CRC.

GPIO_CLOCKS

Clock ip name array for GPIO.

PDM_CLOCKS

Clock ip name array for PDM.

PINT_CLOCKS

Clock ip name array for PINT.

PNGDEC_CLOCKS

Clock ip name array for PNGDEC.

JPEGDEC_CLOCKS

Clock ip name array for JPEGDEC.

I3C_CLOCKS

Clock ip name array for I3C.

MRT_CLOCKS

Clock ip name array for MRT.

CTIMER_CLOCKS

Clock ip name array for CT32B.

OSTIMER_CLOCKS

Clock ip name array for OSTIMER.

RTC_CLOCKS

Clock ip name array for RTC.

CLK_GATE_REG_OFFSET_SHIFT

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

CLK_GATE_REG_OFFSET_MASK

CLK_GATE_BIT_SHIFT_SHIFT

CLK_GATE_BIT_SHIFT_MASK

CLK_GATE_DEFINE(reg_offset, bit_shift)

CLK_GATE_ABSTRACT_REG_OFFSET(x)

CLK_GATE_ABSTRACT_BITS_SHIFT(x)

CLK_CTL0_PSCCTL0

CLK_CTL0_PSCCTL1

CLK_CTL0_PSCCTL2

CLK_CTL0_PSCCTL3

CLK_CTL0_PSCCTL4

CLK_CTL0_PSCCTL5

CLK_CTL1_PSCCTL0

CLK_CTL1_PSCCTL1

CLK_CTL2_PSCCTL0

CLK_CTL3_PSCCTL0

CLK_CTL4_PSCCTL0

CLK_CTL4_PSCCTL1

SYSCON3_SEC_CLK_CTRL

CLKCTL0_ONE_SRC_CLKSLICE_ENABLE

CLKCTL3_ONE_SRC_CLKSLICE_ENABLE

CLKCTL4_ONE_SRC_CLKSLICE_ENABLE

CLK_MUX_INST_INDEX_SHIFT

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

[31-29 14 12:11 10:0] [CLKCTL index]: [Disable MUX output]: [MUXA choice]:[MUXA offset].
MUX offset 0 means end of descriptor.

CLK_MUX_CHOICE_OFFSET_SHIFT

CLK_MUX_DISABLE_OUTPUT_MASK

SENSEBASECLKSEL_OFFSET

SENSESPCPUCLKDIV_OFFSET

SENSESPCPUCLKSEL_OFFSET

SAI3FCLKSEL_OFFSET

SAI3CLKDIV_OFFSET

UTICK1FCLKSEL_OFFSET

UTICK1CLKDIV_OFFSET
WWDT2FCLKSEL_OFFSET
WWDT3FCLKSEL_OFFSET
SYSTICKFCLKSEL_OFFSET
SYSTICKFCLKDIV_OFFSET
CTIMER5FCLKSEL_OFFSET
CTIMER6FCLKSEL_OFFSET
CTIMER7FCLKSEL_OFFSET
CTIMER5CLKDIV_OFFSET
CTIMER6CLKDIV_OFFSET
CTIMER7CLKDIV_OFFSET
I3C23FCLKSEL_OFFSET
I3C23FCLKDIV_OFFSET
FC17FCLKSEL_OFFSET
FC18FCLKSEL_OFFSET
FC19FCLKSEL_OFFSET
FC20FCLKSEL_OFFSET
FC17FCLKDIV_OFFSET
FC18FCLKDIV_OFFSET
FC19FCLKDIV_OFFSET
FC20FCLKDIV_OFFSET
AUDIOVDD1CLKSEL_OFFSET
USBCLKSRC24MCLKSEL_OFFSET
USBCLKSRC24MCLKSEL_OFFSET
COMMONVDDNCLKSEL_OFFSET
COMMONVDDNCLKDIV_OFFSET
COMNBASECLKSEL_OFFSET
EUSBCLKSRC24MCLKSEL_OFFSET
MAINPLL0CLKSEL_OFFSET
MAINPLL0LOCKTIMEDIV2_OFFSET
AUDIOPLL0CLKSEL_OFFSET
AUDIOPLL0LOCKTIMEDIV2_OFFSET
SENSEMAINCLKDIV_OFFSET

SENSE_MAINCLKSEL_OFFSET
SENSE RAMCLKSEL_OFFSET
SENSE RAMCLKDIV_OFFSET
OSEVENTTFCLKSEL_OFFSET
OSEVENTFCLKDIV_OFFSET
SDADCFCLKSEL_OFFSET
SDADCFCLKDIV_OFFSET
SARADCFCLKSEL_OFFSET
SARADCFCLKDIV_OFFSET
WAKE32KCLKSEL_OFFSET
MICFIL0FCLKSEL_OFFSET
MICFIL0FCLKDIV_OFFSET
LPI2CFCLKSEL_OFFSET
LPI2CFCLKDIV_OFFSET
SENSE_CLKOUTCLKSEL_OFFSET
SENSE_CLKOUTCLKDIV_OFFSET
MEDIAVDDNCLKSEL_OFFSET
MEDIAVDDNCLKDIV_OFFSET
MEDIAMAINCLKSEL_OFFSET
MEDIAMAINCLKDIV_OFFSET
MDNBASECLKSEL_OFFSET
MD2BASECLKSEL_OFFSET
XSPI2FCLKSEL_OFFSET
XSPI2FCLKDIV_OFFSET
USBCLKSEL_OFFSET
EUSBCLKSEL_OFFSET
SDIO0FCLKSEL_OFFSET
SDIO0FCLKDIV_OFFSET
SDIO1FCLKSEL_OFFSET
SDIO1FCLKDIV_OFFSET
DPHYCLKSEL_OFFSET
DPHYCLKDIV_OFFSET
DPHYESCCLKSEL_OFFSET

DPHYESCRXCLKDIV_OFFSET

DPHYESCTXCLKDIV_OFFSET

VGPUCLKSEL_OFFSET

VGPUCLKDIV_OFFSET

LPSP114CLKSEL_OFFSET

LPSP114CLKDIV_OFFSET

LPSP116CLKSEL_OFFSET

LPSP116CLKDIV_OFFSET

FLEXIOCLKSEL_OFFSET

FLEXIOCLKDIV_OFFSET

LCDIFPIXELCLKSEL_OFFSET

LCDIFPIXELCLKDIV_OFFSET

LOWFREQCLKDIV_OFFSET

CLKCTL0_INDEX

CLKCTL1_INDEX

CLKCTL2_INDEX

CLKCTL3_INDEX

CLKCTL4_INDEX

CLKCTL0_TUPLE_MUXA(reg, choice)

CLKCTL1_TUPLE_MUXA(reg, choice)

CLKCTL2_TUPLE_MUXA(reg, choice)

CLKCTL3_TUPLE_MUXA(reg, choice)

CLKCTL4_TUPLE_MUXA(reg, choice)

CLKCTL0_TUPLE_MUXA_NONE(reg, choice)

Macro for gated clock mux

CLKCTL1_TUPLE_MUXA_NONE(reg, choice)

CLKCTL2_TUPLE_MUXA_NONE(reg, choice)

CLKCTL3_TUPLE_MUXA_NONE(reg, choice)

CLKCTL4_TUPLE_MUXA_NONE(reg, choice)

CLKCTL_TUPLE_REG(base, tuple)

CLKCTL_TUPLE_SEL(tuple)

uint32_t targetFreq

Target frequency.

uint16_t refDiv

OSC Reference clock divider. 1 for divide ratio 1.

`uint16_t trim1DelayUs`

Trim 1 delay in us, minimum is 15us. Used when running in Closed Loop mode and trim values are updated by 1 decimal unit.

`uint16_t trim2DelayUs`

Trim 2 delay in us. Used at start of closed loop mode when auto tuner is updating trim values by 16 decimal unit steps

`uint8_t range`

Trim Expected Count Range. Specifies the + or - counts that the FRO frequency can be off from TEXPCNT to be considered locked. The value/100 is the % deviation.

`uint32_t enableInt`

Enable interrupts. Bit mask of `_clock_fro_interrupt`.

`bool coarseTrimEn`

Coarse Trim Enable. Set to true to allow autotrimming of the FRO high-byte trim bits.

`bool fastStartupEn`

Fast startup Enable. Enables FRO fast startup.

`main_pll_src_t main_pll_src`

Reference Input Clock Source.

`uint32_t numerator`

30 bit numerator of fractional loop divider.

`uint32_t denominator`

30 bit numerator of fractional loop divider.

`main_pll_mult_t main_pll_mult`

Multiplication Factor.

`audio_pll_src_t audio_pll_src`

Reference Input Clock Source.

`uint32_t numerator`

30 bit numerator of fractional loop divider.

`uint32_t denominator`

30 bit numerator of fractional loop divider.

`audio_pll_mult_t audio_pll_mult`

Multiplication Factor.

`bool enableVcoOut`

Enable VCO output

`bool bypass`

Bypass enable.

`bool monitorEnable`

Clock Monitor Enable.

`bool lowPowerMode`

Low-Power (Nano-Power) mode enable. NOTE, can only change from High-Power mode to Nano-Power mode, and not vice versa.

`osc32k_cap_trim_t cap`

Capacitor Trim Value.

`struct _clock_fro_config`

`#include <fsl_clock.h>` FRO configuration.

struct _clock_main_pll_config

#include <fsl_clock.h> PLL configuration for MAINPLL.

struct _clock_audio_pll_config

#include <fsl_clock.h> PLL configuration for Audio PLL.

struct _clock_osc32k_config_t

#include <fsl_clock.h> configuration for 32K OSC

2.5 CRC: Cyclic Redundancy Check Driver

FSL_CRC_DRIVER_VERSION

CRC driver version. Version 2.0.4.

Current version: 2.0.4

Change log:

- Version 2.0.4
 - Release peripheral from reset if necessary in init function.
- Version 2.0.3
 - Fix MISRA issues
- Version 2.0.2
 - Fix MISRA issues
- Version 2.0.1
 - move DATA and DATALL macro definition from header file to source file

enum _crc_bits

CRC bit width.

Values:

enumerator kCrcBits16

Generate 16-bit CRC code

enumerator kCrcBits32

Generate 32-bit CRC code

enum _crc_result

CRC result type.

Values:

enumerator kCrcFinalChecksum

CRC data register read value is the final checksum. Reflect out and final xor protocol features are applied.

enumerator kCrcIntermediateChecksum

CRC data register read value is intermediate checksum (raw value). Reflect out and final xor protocol feature are not applied. Intermediate checksum can be used as a seed for CRC_Init() to continue adding data to this checksum.

typedef enum _crc_bits crc_bits_t

CRC bit width.

```
typedef enum _crc_result crc_result_t
```

CRC result type.

```
typedef struct _crc_config crc_config_t
```

CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

```
void CRC_Init(CRC_Type *base, const crc_config_t *config)
```

Enables and configures the CRC peripheral module.

This function enables the clock gate in the SIM module for the CRC peripheral. It also configures the CRC module and starts a checksum computation by writing the seed.

Parameters

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

```
static inline void CRC_Deinit(CRC_Type *base)
```

Disables the CRC peripheral module.

This function disables the clock gate in the SIM module for the CRC peripheral.

Parameters

- base – CRC peripheral address.

```
void CRC_GetDefaultConfig(crc_config_t *config)
```

Loads default values to the CRC protocol configuration structure.

Loads default values to the CRC protocol configuration structure. The default values are as follows.

```
config->polynomial = 0x1021;
config->seed = 0xFFFF;
config->reflectIn = false;
config->reflectOut = false;
config->complementChecksum = false;
config->crcBits = kCrcBits16;
config->crcResult = kCrcFinalChecksum;
```

Parameters

- config – CRC protocol configuration structure.

```
void CRC_WriteData(CRC_Type *base, const uint8_t *data, size_t dataSize)
```

Writes data to the CRC module.

Writes input data buffer bytes to the CRC data register. The configured type of transpose is applied.

Parameters

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

```
uint32_t CRC_Get32bitResult(CRC_Type *base)
```

Reads the 32-bit checksum from the CRC module.

Reads the CRC data register (either an intermediate or the final checksum). The configured type of transpose and complement is applied.

Parameters

- base – CRC peripheral address.

Returns

An intermediate or the final 32-bit checksum, after configured transpose and complement operations.

`uint16_t CRC_Get16bitResult(CRC_Type *base)`

Reads a 16-bit checksum from the CRC module.

Reads the CRC data register (either an intermediate or the final checksum). The configured type of transpose and complement is applied.

Parameters

- base – CRC peripheral address.

Returns

An intermediate or the final 16-bit checksum, after configured transpose and complement operations.

`CRC_DRIVER_USE_CRC16_CCIT_FALSE_AS_DEFAULT`

Default configuration structure filled by `CRC_GetDefaultConfig()`. Use CRC16-CCIT-FALSE as default.

`struct _crc_config`

#include <fsl_crc.h> CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

Public Members

`uint32_t polynomial`

CRC Polynomial, MSBit first. Example polynomial: $0x1021 = 1\_0000\_0010\_0001 = x^{12} + x^5 + 1$

`uint32_t seed`

Starting checksum value

`bool reflectIn`

Reflect bits on input.

`bool reflectOut`

Reflect bits on output.

`bool complementChecksum`

True if the result shall be complement of the actual checksum.

`crc_bits_t crcBits`

Selects 16- or 32- bit CRC protocol.

`crc_result_t crcResult`

Selects final or intermediate checksum return from `CRC_Get16bitResult()` or `CRC_Get32bitResult()`

2.6 CTIMER: Standard counter/timers

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

Ungates the clock and configures the peripheral for basic operation.

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

Parameters

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

void CTIMER_Deinit(CTIMER_Type *base)

Gates the timer clock.

Parameters

- base – Ctimer peripheral base address

void CTIMER_GetDefaultConfig(*ctimer_config_t* *config)

Fills in the timers configuration structure with the default settings.

The default values are:

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

Parameters

- config – Pointer to the user configuration structure.

status_t CTIMER_SetupPwmPeriod(CTIMER_Type *base, const *ctimer_match_t* pwmPeriodChannel, *ctimer_match_t* matchChannel, uint32_t pwmPeriod, uint32_t pulsePeriod, bool enableInt)

Configures the PWM signal parameters.

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

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

Parameters

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

Returns

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

```
status_t CTIMER_SetupPwm(CTIMER_Type *base, const ctimer_match_t pwmPeriodChannel,  
                        ctimer_match_t matchChannel, uint8_t dutyCyclePercent, uint32_t  
                        pwmFreq_Hz, uint32_t srcClock_Hz, bool enableInt)
```

Configures the PWM signal parameters.

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

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

Parameters

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

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

Updates the pulse period of an active PWM signal.

Parameters

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

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

Updates the duty cycle of an active PWM signal.

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

Parameters

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

Returns

kStatus_Success on success kStatus_Fail If PWM pulse width register value is larger than 0xFFFFFFFF.

static inline void CTIMER_EnableInterrupts(CTIMER_Type *base, uint32_t mask)

Enables the selected Timer interrupts.

Parameters

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

static inline void CTIMER_DisableInterrupts(CTIMER_Type *base, uint32_t mask)

Disables the selected Timer interrupts.

Parameters

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

static inline uint32_t CTIMER_GetEnabledInterrupts(CTIMER_Type *base)

Gets the enabled Timer interrupts.

Parameters

- base – Ctimer peripheral base address

Returns

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

static inline uint32_t CTIMER_GetStatusFlags(CTIMER_Type *base)

Gets the Timer status flags.

Parameters

- base – Ctimer peripheral base address

Returns

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

static inline void CTIMER_ClearStatusFlags(CTIMER_Type *base, uint32_t mask)

Clears the Timer status flags.

Parameters

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

static inline void CTIMER_StartTimer(CTIMER_Type *base)

Starts the Timer counter.

Parameters

- base – Ctimer peripheral base address

static inline void CTIMER_StopTimer(CTIMER_Type *base)

Stops the Timer counter.

Parameters

- base – Ctimer peripheral base address

FSL_CTIMER_DRIVER_VERSION

Version 2.3.3

enum _ctimer_capture_channel

List of Timer capture channels.

Values:

enumerator kCTIMER_Capture_0

Timer capture channel 0

enumerator kCTIMER_Capture_1

Timer capture channel 1

enumerator kCTIMER_Capture_3

Timer capture channel 3

enum _ctimer_capture_edge

List of capture edge options.

Values:

enumerator kCTIMER_Capture_RiseEdge

Capture on rising edge

enumerator kCTIMER_Capture_FallEdge

Capture on falling edge

enumerator kCTIMER_Capture_BothEdge

Capture on rising and falling edge

enum _ctimer_match

List of Timer match registers.

Values:

enumerator kCTIMER_Match_0

Timer match register 0

enumerator kCTIMER_Match_1

Timer match register 1

enumerator kCTIMER_Match_2

Timer match register 2

enumerator kCTIMER_Match_3

Timer match register 3

enum _ctimer_external_match

List of external match.

Values:

enumerator kCTIMER_External_Match_0

External match 0

enumerator kCTIMER_External_Match_1

External match 1

enumerator kCTIMER_External_Match_2

External match 2

enumerator kCTIMER_External_Match_3

External match 3

enum _ctimer_match_output_control

List of output control options.

Values:

enumerator kCTIMER_Output_NoAction

No action is taken

enumerator kCTIMER_Output_Clear

Clear the EM bit/output to 0

enumerator kCTIMER_Output_Set

Set the EM bit/output to 1

enumerator kCTIMER_Output_Toggle

Toggle the EM bit/output

enum _ctimer_timer_mode

List of Timer modes.

Values:

enumerator kCTIMER_TimerMode

enumerator kCTIMER_IncreaseOnRiseEdge

enumerator kCTIMER_IncreaseOnFallEdge

enumerator kCTIMER_IncreaseOnBothEdge

enum _ctimer_interrupt_enable

List of Timer interrupts.

Values:

enumerator kCTIMER_Match0InterruptEnable

Match 0 interrupt

enumerator kCTIMER_Match1InterruptEnable

Match 1 interrupt

enumerator kCTIMER_Match2InterruptEnable

Match 2 interrupt

enumerator kCTIMER_Match3InterruptEnable

Match 3 interrupt

enum _ctimer_status_flags

List of Timer flags.

Values:

enumerator kCTIMER_Match0Flag

Match 0 interrupt flag

enumerator kCTIMER_Match1Flag

Match 1 interrupt flag

enumerator kCTIMER_Match2Flag

Match 2 interrupt flag

enumerator kCTIMER_Match3Flag

Match 3 interrupt flag

enum `ctimer_callback_type_t`

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

Values:

enumerator `kCTIMER_SingleCallback`

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

enumerator `kCTIMER_MultipleCallback`

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

typedef enum `_ctimer_capture_channel` `ctimer_capture_channel_t`

List of Timer capture channels.

typedef enum `_ctimer_capture_edge` `ctimer_capture_edge_t`

List of capture edge options.

typedef enum `_ctimer_match` `ctimer_match_t`

List of Timer match registers.

typedef enum `_ctimer_external_match` `ctimer_external_match_t`

List of external match.

typedef enum `_ctimer_match_output_control` `ctimer_match_output_control_t`

List of output control options.

typedef enum `_ctimer_timer_mode` `ctimer_timer_mode_t`

List of Timer modes.

typedef enum `_ctimer_interrupt_enable` `ctimer_interrupt_enable_t`

List of Timer interrupts.

typedef enum `_ctimer_status_flags` `ctimer_status_flags_t`

List of Timer flags.

typedef void (`*ctimer_callback_t`)(`uint32_t flags`)

typedef struct `_ctimer_match_config` `ctimer_match_config_t`

Match configuration.

This structure holds the configuration settings for each match register.

typedef struct `_ctimer_config` `ctimer_config_t`

Timer configuration structure.

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

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

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

Setup the match register.

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

Parameters

- `base` – Ctimer peripheral base address
- `matchChannel` – Match register to configure

- `config` – Pointer to the match configuration structure

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

Get the status of output match.

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

Parameters

- `base` – Ctimer peripheral base address
- `matchChannel` – External match channel, user can obtain the status of multiple match channels at the same time by using the logic of “|” enumeration `ctimer_external_match_t`

Returns

The mask of external match channel status flags. Users need to use the `_ctimer_external_match` type to decode the return variables.

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

Setup the capture.

Parameters

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

`static inline uint32_t CTIMER_GetTimerCountValue(CTIMER_Type *base)`

Get the timer count value from TC register.

Parameters

- `base` – Ctimer peripheral base address.

Returns

return the timer count value.

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

Register callback.

This function configures CTimer Callback in following modes:

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

Parameters

- `base` – Ctimer peripheral base address
- `cb_func` – Pointer to callback function pointer

- `cb_type` – callback function type, singular or multiple

static inline void CTIMER_Reset(CTIMER_Type *base)

Reset the counter.

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

Parameters

- `base` – Ctimer peripheral base address

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

Setup the timer prescale value.

Specifies the maximum value for the Prescale Counter.

Parameters

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

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

Get capture channel value.

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

Parameters

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

Returns

The timer count capture value.

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

Enable reset match channel.

Set the specified match channel reset operation.

Parameters

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

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

Enable stop match channel.

Set the specified match channel stop operation.

Parameters

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

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

Enable reload channel falling edge.

Enable the specified match channel reload match shadow value.

Parameters

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

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

Enable capture channel rising edge.

Sets the specified capture channel for rising edge capture.

Parameters

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

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

Enable capture channel falling edge.

Sets the specified capture channel for falling edge capture.

Parameters

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

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

Set the specified match shadow channel.

Parameters

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

```
struct __ctimer_match_config  
#include <fsl_ctimer.h> Match configuration.
```

This structure holds the configuration settings for each match register.

Public Members

uint32_t matchValue

This is stored in the match register

bool enableCounterReset

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

bool enableCounterStop

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

ctimer_match_output_control_t outControl

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

bool outPinInitState

Initial value of the EM bit/output

bool enableInterrupt

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

struct *_ctimer_config*

#include <fsl_ctimer.h> Timer configuration structure.

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

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

Public Members

ctimer_timer_mode_t mode

Timer mode

ctimer_capture_channel_t input

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

uint32_t prescale

Prescale value

2.7 Dsp

enum *_dsp_static_vec_sel*

Fusion DSP vector table select.

Values:

enumerator kDSP_StatVecSel0

enumerator kDSP_StatVecSel1

typedef struct *_dsp_copy_image* dsp_copy_image_t

Structure for DSP copy image to destination address.

Defines start and destination address for copying image with given size.

typedef enum *_dsp_static_vec_sel* dsp_static_vec_sel_t

Fusion DSP vector table select.

void DSP_Init(void)

Initializing DSP core.

Power up DSP TCM Enable DSP clock Reset DSP peripheral

void DSP_Deinit(void)

Deinit DSP core.

Power down DSP TCM Disable DSP clock Set DSP peripheral reset

void DSP_CopyImage(*dsp_copy_image_t* *dspCopyImage)

Copy DSP image to destination address.

Copy DSP image from source address to destination address with given size.

Parameters

- *dspCopyImage* – Structure contains information for DSP copy image to destination address.

static inline void DSP_Start(void)

Start DSP core.

static inline void DSP_Stop(void)

Stop DSP core.

static inline void DSP_SetVecRemap(*dsp_static_vec_sel_t* statVecSel, uint32_t remap)

Set DSP static vector table remap.

Parameters

- *statVecSel* – static vector base address selection
- *remap* – static vector remap, For HiFi1 when *statVecSel* = 0, the valid range is 0~0x3FF, when *statVecSel*=1, the valid range is 0~0x7FF. For HiFi4, the bits value will remap ARADDR[22:10] when [STATVECSELECT] is high and ARADDR hits 1 KB from 2010_0000h.

FSL_DSP_DRIVER_VERSION

DSP driver version 2.0.0.

uint32_t *srcAddr

uint32_t *destAddr

uint32_t size

struct __dsp_copy_image

#include <fsl_dsp.h> Structure for DSP copy image to destination address.

Defines start and destination address for copying image with given size.

2.8 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, &stcd);
```

Note: If nextTcd is not NULL, it means scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the EDMA_ResetChannel.

Parameters

- base – eDMA peripheral base address.
- channel – eDMA channel number.
- config – Pointer to eDMA transfer configuration structure.

- nextTcd – Point to TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

```
void EDMA_SetMinorOffsetConfig(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: $\text{RemainingBytes} = \text{RemainingMajorLoopCount} * \text{NBYTES}(\text{initially configured})$
-

Parameters

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

Returns

Major loop count which has not been transferred yet for the current TCD.

```
static inline uint32_t EDMA_GetErrorStatusFlags(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;
```

(continues on next page)

(continued from previous page)

```
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 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

- the bytesEachRequest should align with the srcWidthOfEachTransfer and the dstWidthOfEachTransfer that is to say bytesEachRequest % srcWidthOfEachTransfer should be 0
- the srcOffsetOfEachTransfer and dstOffsetOfEachTransfer must be aligne with transfer width
- the totalBytes should align with the bytesEachRequest
- 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` 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.

2.9 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

2.10 eDMA soc Driver

void EDMA_EnableRequest(DMA_Type *base, dma_request_source_t requestSource)

Enable the eDMA request.

This function enables the eDMA request controlled by SYSCON.

Parameters

- base – eDMA peripheral base address.
- requestSource – eDMA request source, see “dma_request_source_t”.

void EDMA_DisableRequest(DMA_Type *base, dma_request_source_t requestSource)

Disable the eDMA request.

This function disables the eDMA request controlled by SYSCON.

Parameters

- base – eDMA peripheral base address.
- requestSource – eDMA request source, see “dma_request_source_t”.

FSL_EDMA_SOC_DRIVER_VERSION

Driver version 1.0.0.

FSL_EDMA_SOC_IP_DMA3

DMA IP version.

FSL_EDMA_SOC_IP_DMA4

EDMA_CHANNEL_OFFSET

EDMA base address convert macro.

EDMA_CHANNEL_ARRAY_STEP(base)

2.11 Ezhv

enum _arm2ezhv_intctl

Definition of 4 interrupt requests from ARM to EZH-V.

Values:

enumerator kEZHV_ARM2EZHV_MEI

enumerator kEZHV_ARM2EZHV_SEI

enumerator kEZHV_ARM2EZHV_MSI

enumerator kEZHV_ARM2EZHV_MTI

enum _ezhv2arm_int_chan

EZH-V to ARM interrupt channel.

Values:

enumerator kEZHV_EzhvToArmIntChan0

enumerator kEZHV_EzhvToArmIntChan1

enumerator kEZHV_EzhvToArmIntChan2

enumerator kEZHV_EzhvToArmIntChan3

enumerator kEZHV_EzhvToArmIntChan4

enumerator kEZHV_EzhvToArmIntChan5

enumerator kEZHV_EzhvToArmIntChan6

enumerator kEZHV_EzhvToArmIntChan7

enumerator kEZHV_EzhvToArmIntChan8

enumerator kEZHV_EzhvToArmIntChan9

enumerator kEZHV_EzhvToArmIntChan10

enumerator kEZHV_EzhvToArmIntChan11

enumerator kEZHV_EzhvToArmIntChan12

enumerator kEZHV_EzhvToArmIntChan13

enumerator kEZHV_EzhvToArmIntChan14

enumerator kEZHV_EzhvToArmIntChan15

typedef void (*ezhv_callback_t)(void *userData)

define callback function for EZH-V

This callback function is called in EZH-V interrupt handle.

```
typedef struct _ezhv_copy_image ezhv_copy_image_t
```

Structure for EZH-V copy image to destination address.

Defines source and destination address for copying image with given size.

```
typedef uint32_t ezhv_api_t
```

@Brief List of EZH-V APIs

```
typedef struct _ezhv_param ezhv_param_t
```

parameters used by EZH-V

```
typedef enum _arm2ezhv_intctl arm2ezhv_intctl_t
```

Definition of 4 interrupt requests from ARM to EZH-V.

```
typedef enum _ezhv2arm_int_chan ezhv2arm_int_chan_t
```

EZH-V to ARM interrupt channel.

```
void EZHV_Init(ezhv_copy_image_t *ezhvCopyImage)
```

Initialize the EZH-V.

Parameters

- ezhvCopyImage – The information about the EZH-V image to copy.

```
void EZHV_InitWithoutFirmware(void)
```

Initialize the EZH-V.

This function is similar with EZHV_Init, the difference is this function does not install the firmware, the firmware could be installed using EZHV_InstallFirmware.

```
void EZHV_InstallFirmware(ezhv_copy_image_t *ezhvCopyImage)
```

install EZH-V firmware by given image info

Parameters

- ezhvCopyImage – The information about the EZH-V image to copy.

```
void EZHV_Boot(uint32_t bootAddr)
```

Boot EZH-V from given address bootAddr.

Parameters

- bootAddr – The boot address.

```
void EZHV_Deinit(void)
```

Deinitialize the EZH-V.

```
void EZHV_SetCallback(ezhv_callback_t callback, uint16_t channel, void *userData)
```

Install the EZH-V callback function.

Parameters

- callback – EZH-V callback function pointer.
- channel – interrupt channel index.
- userData – A parameter for the callback function.

```
void EZHV_SetPara(ezhv_param_t *para)
```

Set the parameter used by EZH-V.

Parameters

- para – Parameter written into shared mem between ARM and EZH-V.

uint32_t *EZHV_GetParaAddr(void)

Get shared space address.

Returns

The start address of shared space

void EZHV_WakeUpEzhv(*arm2ezhv_intctl_t* arm2ezhvInt)

Check the wait status and wake up EZH-V.

Parameters

- arm2ezhvInt – The interrupt request which will send to the EZH-V.

static inline void EZHV_EnableArm2EzhvInt(*arm2ezhv_intctl_t* arm2ezhvInt)

Enable interrupt request from ARM core to EZH-V core.

Note: This interrupt can be used to send interrupt request to EZH-V

Parameters

- arm2ezhvInt – The interrupt request which will send to the EZH-V.

static inline void EZHV_DisableArm2EzhvInt(*arm2ezhv_intctl_t* arm2ezhvInt)

Disable interrupt request from ARM core to EZH-V core.

Parameters

- arm2ezhvInt – The interrupt request type.

void EZHV_DriverIRQHandler(void)

EZH-V IRQ handler.

static inline void EZHV_EnableEzhv2ArmIntChan(*ezhv2arm_int_chan_t* chan)

Enable the EZH-V interrupt channel to ARM core.

Parameters

- chan – Ezhv to arm interrupt channel index.

static inline void EZHV_DisableEzhv2ArmIntChan(*ezhv2arm_int_chan_t* chan)

Disable the EZH-V interrupt channel to ARM core.

Parameters

- chan – Ezhv to arm interrupt channel index.

static inline uint32_t EZHV_GetEzhv2ArmIntChan(void)

Get EZH-V interrupt outputs.

static inline void EZHV_ClearEzhv2ArmIntChan(*ezhv2arm_int_chan_t* chan)

Clear EZH-V interrupt outputs.

Parameters

- chan – EZH-V to ARM interrupt channel index.

static inline bool EZHV_GetEzhvStopStatusFlag(void)

Get EZH-V stop status flag.

static inline bool EZHV_GetEzhvHaltStatusFlag(void)

Get EZH-V halt status flag.

static inline bool EZHV_GetEzhvWaitStatusFlag(void)

Get EZH-V wait status flag.

static inline bool EZHV_GetEzhvWakeupStatusFlag(void)

Get EZH-V wakeup status flag.

FSL_EZHV_DRIVER_VERSION

cache driver version.

EZHV_API_MAX_ARG

uint32_t srcAddr

uint32_t destAddr

uint32_t size

ezhv_api_t ezhvApi

uint32_t argc

uint32_t *argv[8U]

EZHV_M_EXT_INT

EZHV inside machine-mode external isr offset.

EZHV_SHARED_DATA_ADDR

shared data space between ARM and EZHV, space size is 256 Bytes

EZHV_INT_CHAN_NUM

definition for active ezhv2arm int channel number

please redefine this macro's value if less channels are enabled

struct _ezhv_copy_image

#include <fsl_ezhv.h> Structure for EZH-V copy image to destination address.

Defines source and destination address for copying image with given size.

struct _ezhv_param

#include <fsl_ezhv.h> parameters used by EZH-V

2.12 FGPIO Driver

2.13 FlexIO: FlexIO Driver

2.14 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 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)

```
static inline void FLEXIO_DisableShifterStatusInterrupts(FLEXIO_Type *base, uint32_t mask)
```

Disables the shifter status interrupt. The interrupt won't generate when the corresponding SSF is set.

Note: For multiple shifter status interrupt enable, for example, two shifter status enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)

```
static inline void FLEXIO_EnableShifterErrorInterrupts(FLEXIO_Type *base, uint32_t mask)
```

Enables the shifter error interrupt. The interrupt generates when the corresponding SEF is set.

Note: For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter error mask which can be calculated by (1 « shifter index)

static inline void FLEXIO_DisableShifterErrorInterrupts(FLEXIO_Type *base, uint32_t mask)

Disables the shifter error interrupt. The interrupt won't generate when the corresponding SEF is set.

Note: For multiple shifter error interrupt enable, for example, two shifter error enable, can calculate the mask by using $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

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

2.15 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

2.16 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

2.17 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

2.18 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.

2.19 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

2.20 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.

2.21 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 __unnamed71__
```

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.
```

2.22 FREQME: Frequency Measurement

2.23 GDET

status_t GDET_Init(GDET_Type *base)

Initialize GDET.

This function initializes GDET block and setting.

Parameters

- base – GDET peripheral base address

Returns

Status of the init operation

void GDET_Deinit(GDET_Type *base)

Deinitialize GDET.

This function deinitializes GDET secure counter.

Parameters

- base – GDET peripheral base address

status_t GDET_Enable(GDET_Type *base)

Enable GDET.

This function enables GDET and interrupts.

Parameters

- base – GDET peripheral base address

Returns

Status of the enable operation

status_t GDET_Disable(GDET_Type *base)

Disable GDET.

This function disables GDET and interrupts.

Parameters

- base – GDET peripheral base address

Returns

Status of the disable operation

status_t GDET_IsolateOn(GDET_Type *base)

Turn on GDET isolation.

This function turns on isolation of GDET peripheral

Parameters

- base – GDET peripheral base address

Returns

Status of the operation

status_t GDET_IsolateOff(GDET_Type *base)

Turn off GDET isolation.

This function turns off isolation of GDET peripheral

Parameters

- base – GDET peripheral base address

Returns

Status of the operation

status_t GDET_ReconfigureVoltageMode(GDET_Type *base, *gdet_core_voltage_t* voltage)

Change expected core voltage.

This function changes core voltage which Glitch detector expect.

Parameters

- base – GDET peripheral base address
- voltage – Expected core voltage

Returns

Status of the GDET reconfiguration operation

FSL_GDET_DRIVER_VERSION

Defines GDET driver version 2.1.0.

Change log:

- Version 2.1.0
 - Update for multiple instances
 - Fix bug in isolation off API
 - Add enable and disable APIs
- 2.0.1
 - Fix MISRA in GDET_ReconfigureVoltageMode()
- Version 2.0.0
 - initial version

typedef uint32_t gdet_core_voltage_t

GDET Core Voltage.

These constants are used to define core voltage argument to be used with GDET_ReconfigureVoltageMode(). Different SoC may support various volatages, refer to documentation.

void GDET_DriverIRQHandler(void)

kGDET_0_9v

Voltage (0.9V)

kGDET_1_0v

Voltage (1.0V)

kGDET_1_1v

Voltage (1.1V)

2.24 Glitch Detect

2.25 GLIKEY

2.26 GLIKEY

Values:

enumerator kStatus_GLIKEY_LockedError

GLIKEY status for locked SFR registers (unexpected) .

enumerator kStatus_GLIKEY_NotLocked

GLIKEY status for unlocked SFR registers.

enumerator kStatus_GLIKEY_Locked

GLIKEY status for locked SFR registers.

enumerator kStatus_GLIKEY_DisabledError

GLIKEY status for disabled error.

FSL_GLIKEY_DRIVER_VERSION

Defines GLIKEY driver version 2.0.1.

Change log:

- Version 2.0.1
 - Implement INIT state recovery from the LOCKED state after a reset when the previous index was locked.
- Version 2.0.0
 - Initial version

GLIKEY_CODEWORD_STEP1

GLIKEY_CODEWORD_STEP2

GLIKEY_CODEWORD_STEP3

GLIKEY_CODEWORD_STEP4

GLIKEY_CODEWORD_STEP5

GLIKEY_CODEWORD_STEP6

GLIKEY_CODEWORD_STEP7

GLIKEY_CODEWORD_STEP_EN

GLIKEY_FSM_WR_DIS

GLIKEY_FSM_INIT

GLIKEY_FSM_STEP1

GLIKEY_FSM_STEP2

GLIKEY_FSM_STEP3

GLIKEY_FSM_STEP4

GLIKEY_FSM_LOCKED

GLIKEY_FSM_WR_EN

GLIKEY_FSM_SSR_RESET

uint32_t GLIKEY_GetStatus(GLIKEY_Type *base)

Retreives the current status of Glikey.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Glikey status information

status_t GLIKEY_IsLocked(GLIKEY_Type *base)

Get if Glikey is locked.

This operation returns the locking status of Glikey.

Return values

- kStatus_GLIKEY_Locked – if locked
- kStatus_GLIKEY_NotLocked – if unlocked

Returns

Status

status_t GLIKEY_CheckLock(GLIKEY_Type *base)

Check if Glikey is locked.

This operation returns the locking status of Glikey.

Return values

- kStatus_GLIKEY_LockedError – if locked
- kStatus_GLIKEY_NotLocked – if unlocked

Returns

Status kStatus_Success if success

status_t GLIKEY_SyncReset(GLIKEY_Type *base)

Perform a synchronous reset of Glikey.

This function performs a synchronounous reset of the Glikey. This results in:

- Glikey will return to the INIT state, unless it is in the LOCK state

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError

status_t GLIKEY_SetIntEnable(GLIKEY_Type *base, uint32_t value)

Set interrupt enable flag of Glikey.

Parameters

- base – **[in]** The base address of the Glikey instance
- value – **[in]** Value to set the interrupt enable flag to, see #[TODO: add reference to constants]

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError

status_t GLIKEY_GetIntEnable(GLIKEY_Type *base, uint32_t *value)

Get interrupt enable flag of Glikey.

Parameters

- base – **[in]** The base address of the Glikey instance
- value – **[out]** Pointer which will be filled with the interrupt enable status, see #[TODO: add reference to constants]

Returns

Status kStatus_Success if success

status_t GLIKEY_ClearIntStatus(GLIKEY_Type *base)

Clear the interrupt status flag of Glikey.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError

status_t GLIKEY_SetIntStatus(GLIKEY_Type *base)

Set the interrupt status flag of Glikey.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError

status_t GLIKEY_Lock(GLIKEY_Type *base)

Lock Glikey SFR (Special Function Registers) interface.

This operation locks the Glikey SFR interface if it is not locked yet.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Status kStatus_Success if success

status_t GLIKEY_LockIndex(GLIKEY_Type *base)

Lock Glikey index.

This operation is used to lock a Glikey index. It can only be executed from the WR_EN state, executing it from any other state will result in Glikey entering WR_DIS state. When this happens Glikey requires a reset (synchronous or asynchronous) to go back to INIT state. If the Glikey SFR lock is active this operation will return an error.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError, kStatus_GLIKEY_DisabledError

status_t GLIKEY_IsIndexLocked(GLIKEY_Type *base, uint32_t index)

Check if Glikey index is locked.

This operation returns the locking status of Glikey index.

Parameters

- base – **[in]** The base address of the Glikey instance
- index – **[in]** The index of the Glikey instance

Returns

kStatus_GLIKEY_Locked if locked, kStatus_GLIKEY_NotLocked if unlocked
Possible errors: kStatus_Fail

status_t GLIKEY_StartEnable(GLIKEY_Type *base, uint32_t index)

Start Glikey enable.

This operation is used to set a new index and start a the sequence to enable it. It needs to be started from the INIT state. If the new index is already locked Glikey will go to LOCKED state, otherwise it will go to STEP1 state. If this operation is used when Glikey is in any state other than INIT Glikey will go to WR_DIS state. It can only recover from this state through a reset (synchronous or asynchronous). If the Glikey SFR lock is active this operation will return an error.

Parameters

- base – **[in]** The base address of the Glikey instance
- index – **[in]** The index of the Glikey instance

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError, kStatus_Fail

status_t GLIKEY_ContinueEnable(GLIKEY_Type *base, uint32_t codeword)

Continue Glikey enable.

This operation is used to progress through the different states of the state machine, starting from STEP1 until the state WR_EN is reached. Each next state of the state machine can only be reached by providing the right codeword to this function. If anything goes wrong the state machine will go to WR_DIS state and can only recover from it through a reset (synchronous or asynchronous). If the Glikey SFR lock is active this operation will return an error.

Parameters

- base – **[in]** The base address of the Glikey instance
- codeword – **[in]** Encoded word for progressing to next FSM state (see GLIKEY_CODEWORD_STEPx/EN)

Returns

Status kStatus_Success if success Possible errors: kStatus_GLIKEY_LockedError, kStatus_Fail, kStatus_GLIKEY_DisabledError

status_t GLIKEY_EndOperation(GLIKEY_Type *base)

End Glikey operation.

This operation is used to end a Glikey operation. It can only be executed from the WR_EN, LOCKED and RESET states. Executing it from any other state will result in Glikey entering WR_DIS state. When this happens Glikey requires a reset (synchronous or asynchronous) to go back to INIT state. After this operation Glikey will go to INIT state or stay in LOCKED state when the index was locked. If the Glikey SFR lock is active this operation will return an error.

Parameters

- base – **[in]** The base address of the Glikey instance

Returns

A code-flow protected error code (see nxpCsslFlowProtection)

Returns

Status `kStatus_Success` if success, `kStatus_GLIKEY_Locked` if index is still locked Possible errors: `kStatus_GLIKEY_LockedError`, `kStatus_GLIKEY_DisabledError`

`status_t` GLIKEY_ResetIndex(GLIKEY_Type *base, uint32_t index)

Reset Glikey index.

This operation is used to reset a Glikey index. It can only be executed from the INIT state, executing it from any other state will result in Glikey entering WR_DIS state. When this happens Glikey requires a reset (synchronous or asynchronous) to go back to INIT state. If the Glikey SFR lock is active or the index is locked this operation will return an error.

Returns

A code-flow protected error code (see `nxpCsslFlowProtection`)

Returns

Status `kStatus_Success` if success, `kStatus_GLIKEY_Locked` if index is still locked Possible errors: `kStatus_GLIKEY_LockedError`, `kStatus_GLIKEY_DisabledError`

2.27 GPIO: General-Purpose Input/Output Driver

`FSL_GPIO_DRIVER_VERSION`

GPIO driver version.

`enum __gpio_pin_direction`

GPIO direction definition.

Values:

enumerator `kGPIO_DigitalInput`

Set current pin as digital input

enumerator `kGPIO_DigitalOutput`

Set current pin as digital output

`enum __gpio_checker_attribute`

GPIO checker attribute.

Values:

enumerator `kGPIO_UsernonsecureRWUsersecureRWPrivilegedsecureRW`

User nonsecure:Read+Write; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator `kGPIO_UsernonsecureRUsersecureRWPrivilegedsecureRW`

User nonsecure:Read; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator `kGPIO_UsernonsecureNUsersecureRWPrivilegedsecureRW`

User nonsecure:None; User Secure:Read+Write; Privileged Secure:Read+Write

enumerator `kGPIO_UsernonsecureRUsersecureRPrivilegedsecureRW`

User nonsecure:Read; User Secure:Read; Privileged Secure:Read+Write

enumerator `kGPIO_UsernonsecureNUsersecureRPrivilegedsecureRW`

User nonsecure:None; User Secure:Read; Privileged Secure:Read+Write

enumerator `kGPIO_UsernonsecureNUsersecureNPrivilegedsecureRW`

User nonsecure:None; User Secure:None; Privileged Secure:Read+Write

enumerator kGPIO_UsernonsecureNUsersecureNPrivilegedsecureR
User nonsecure:None; User Secure:None; Privileged Secure:Read

enumerator kGPIO_UsernonsecureNUsersecureNPrivilegedsecureN
User nonsecure:None; User Secure:None; Privileged Secure:None

enumerator kGPIO_IgnoreAttributeCheck
Ignores the attribute check

enum __gpio_interrupt_config
Configures the interrupt generation condition.

Values:

enumerator kGPIO_InterruptStatusFlagDisabled
Interrupt status flag is disabled.

enumerator kGPIO_DMARisingEdge
ISF flag and DMA request on rising edge.

enumerator kGPIO_DMAFallingEdge
ISF flag and DMA request on falling edge.

enumerator kGPIO_DMAEitherEdge
ISF flag and DMA request on either edge.

enumerator kGPIO_FlagRisingEdge
Flag sets on rising edge.

enumerator kGPIO_FlagFallingEdge
Flag sets on falling edge.

enumerator kGPIO_FlagEitherEdge
Flag sets on either edge.

enumerator kGPIO_InterruptLogicZero
Interrupt when logic zero.

enumerator kGPIO_InterruptRisingEdge
Interrupt on rising edge.

enumerator kGPIO_InterruptFallingEdge
Interrupt on falling edge.

enumerator kGPIO_InterruptEitherEdge
Interrupt on either edge.

enumerator kGPIO_InterruptLogicOne
Interrupt when logic one.

enumerator kGPIO_ActiveHighTriggerOutputEnable
Enable active high-trigger output.

enumerator kGPIO_ActiveLowTriggerOutputEnable
Enable active low-trigger output.

enum __gpio_interrupt_selection
Configures the selection of interrupt/DMA request/trigger output.

Values:

enumerator kGPIO_InterruptOutput0
Interrupt/DMA request/trigger output 0.

enumerator kGPIO_InterruptOutput1
Interrupt/DMA request/trigger output 1.

enum gpio_pin_interrupt_control_t
GPIO pin and interrupt control.

Values:

enumerator kGPIO_PinControlNonSecure
Pin Control Non-Secure.

enumerator kGPIO_InterruptControlNonSecure
Interrupt Control Non-Secure.

enumerator kGPIO_PinControlNonPrivilege
Pin Control Non-Privilege.

enumerator kGPIO_InterruptControlNonPrivilege
Interrupt Control Non-Privilege.

typedef enum _gpio_pin_direction gpio_pin_direction_t
GPIO direction definition.

typedef enum _gpio_checker_attribute gpio_checker_attribute_t
GPIO checker attribute.

typedef struct _gpio_pin_config gpio_pin_config_t
The GPIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, leave the outputConfig unused. Note that in some use cases, the corresponding port property should be configured in advance with the PORT_SetPinConfig().

typedef enum _gpio_interrupt_config gpio_interrupt_config_t
Configures the interrupt generation condition.

typedef enum _gpio_interrupt_selection gpio_interrupt_selection_t
Configures the selection of interrupt/DMA request/trigger output.

typedef struct _gpio_version_info gpio_version_info_t
GPIO version information.

GPIO_FIT_REG(value)

struct _gpio_pin_config
#include <fsl_gpio.h> The GPIO pin configuration structure.

Each pin can only be configured as either an output pin or an input pin at a time. If configured as an input pin, leave the outputConfig unused. Note that in some use cases, the corresponding port property should be configured in advance with the PORT_SetPinConfig().

Public Members

gpio_pin_direction_t pinDirection
GPIO direction, input or output

uint8_t outputLogic
Set a default output logic, which has no use in input

struct _gpio_version_info
#include <fsl_gpio.h> GPIO version information.

Public Members

uint16_t feature

Feature Specification Number.

uint8_t minor

Minor Version Number.

uint8_t major

Major Version Number.

2.28 GPIO Driver

void GPIO_PortInit(GPIO_Type *base)

Initializes the GPIO peripheral.

This function ungates the GPIO clock.

Parameters

- base – GPIO peripheral base pointer.

void GPIO_PortDeinit(GPIO_Type *base)

Deinitializes the GPIO peripheral.

Parameters

- base – GPIO peripheral base pointer.

void GPIO_PinInit(GPIO_Type *base, uint32_t pin, const *gpio_pin_config_t* *config)

Initializes a GPIO pin used by the board.

To initialize the GPIO, define a pin configuration, as either input or output, in the user file. Then, call the GPIO_PinInit() function.

This is an example to define an input pin or an output pin configuration.

```

Define a digital input pin configuration,
gpio_pin_config_t config =
{
    kGPIO_DigitalInput,
    0,
}
Define a digital output pin configuration,
gpio_pin_config_t config =
{
    kGPIO_DigitalOutput,
    0,
}

```

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- pin – GPIO port pin number
- config – GPIO pin configuration pointer

void GPIO_GetVersionInfo(GPIO_Type *base, *gpio_version_info_t* *info)

Get GPIO version information.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)

- info – GPIO version information

```
static inline void GPIO_SecurePrivilegeLock(GPIO_Type *base, gpio_pin_interrupt_control_t mask)
```

lock or unlock secure privilege.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – pin or interrupt macro

```
static inline void GPIO_EnablePinControlNonSecure(GPIO_Type *base, uint32_t mask)
```

Enable Pin Control Non-Secure.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_DisablePinControlNonSecure(GPIO_Type *base, uint32_t mask)
```

Disable Pin Control Non-Secure.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_EnablePinControlNonPrivilege(GPIO_Type *base, uint32_t mask)
```

Enable Pin Control Non-Privilege.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_DisablePinControlNonPrivilege(GPIO_Type *base, uint32_t mask)
```

Disable Pin Control Non-Privilege.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_EnableInterruptControlNonSecure(GPIO_Type *base, uint32_t mask)
```

Enable Interrupt Control Non-Secure.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_DisableInterruptControlNonSecure(GPIO_Type *base, uint32_t mask)
```

Disable Interrupt Control Non-Secure.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline void GPIO_EnableInterruptControlNonPrivilege(GPIO_Type *base, uint32_t mask)
```

Enable Interrupt Control Non-Privilege.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)

- mask – GPIO pin number macro

static inline void GPIO_DisableInterruptControlNonPrivilege(GPIO_Type *base, uint32_t mask)

Disable Interrupt Control Non-Privilege.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_PortInputEnable(GPIO_Type *base, uint32_t mask)

Enable port input.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_PortInputDisable(GPIO_Type *base, uint32_t mask)

Disable port input.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_PinWrite(GPIO_Type *base, uint32_t pin, uint8_t output)

Sets the output level of the multiple GPIO pins to the logic 1 or 0.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- pin – GPIO pin number
- output – GPIO pin output logic level.
 - 0: corresponding pin output low-logic level.
 - 1: corresponding pin output high-logic level.

static inline void GPIO_PortSet(GPIO_Type *base, uint32_t mask)

Sets the output level of the multiple GPIO pins to the logic 1.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_PortClear(GPIO_Type *base, uint32_t mask)

Sets the output level of the multiple GPIO pins to the logic 0.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

static inline void GPIO_PortToggle(GPIO_Type *base, uint32_t mask)

Reverses the current output logic of the multiple GPIO pins.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

```
static inline uint32_t GPIO_PinRead(GPIO_Type *base, uint32_t pin)
```

Reads the current input value of the GPIO port.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- pin – GPIO pin number

Return values

GPIO – port input value

- 0: corresponding pin input low-logic level.
- 1: corresponding pin input high-logic level.

```
static inline void GPIO_SetPinInterruptConfig(GPIO_Type *base, uint32_t pin,  
                                             gpio_interrupt_config_t config)
```

Configures the gpio pin interrupt/DMA request.

Parameters

- base – GPIO peripheral base pointer.
- pin – GPIO pin number.
- config – GPIO pin interrupt configuration.
 - kGPIO_InterruptStatusFlagDisabled: Interrupt/DMA request disabled.
 - kGPIO_DMARisingEdge : DMA request on rising edge(if the DMA requests exit).
 - kGPIO_DMAFallingEdge: DMA request on falling edge(if the DMA requests exit).
 - kGPIO_DMAEitherEdge : DMA request on either edge(if the DMA requests exit).
 - kGPIO_FlagRisingEdge : Flag sets on rising edge(if the Flag states exit).
 - kGPIO_FlagFallingEdge : Flag sets on falling edge(if the Flag states exit).
 - kGPIO_FlagEitherEdge : Flag sets on either edge(if the Flag states exit).
 - kGPIO_InterruptLogicZero : Interrupt when logic zero.
 - kGPIO_InterruptRisingEdge : Interrupt on rising edge.
 - kGPIO_InterruptFallingEdge: Interrupt on falling edge.
 - kGPIO_InterruptEitherEdge : Interrupt on either edge.
 - kGPIO_InterruptLogicOne : Interrupt when logic one.
 - kGPIO_ActiveHighTriggerOutputEnable : Enable active high-trigger output (if the trigger states exit).
 - kGPIO_ActiveLowTriggerOutputEnable : Enable active low-trigger output (if the trigger states exit).

```
static inline void GPIO_SetPinInterruptChannel(GPIO_Type *base, uint32_t pin,  
                                              gpio_interrupt_selection_t selection)
```

Configures the gpio pin interrupt/DMA request/trigger output channel selection.

Parameters

- base – GPIO peripheral base pointer.
- pin – GPIO pin number.
- selection – GPIO pin interrupt output selection.

- kGPIO_InterruptOutput0: Interrupt/DMA request/trigger output 0.
- kGPIO_InterruptOutput1 : Interrupt/DMA request/trigger output 1.

uint32_t GPIO_GpioGetInterruptFlags(GPIO_Type *base)

Read the GPIO interrupt status flags.

Parameters

- base – GPIO peripheral base pointer. (GPIOA, GPIOB, GPIOC, and so on.)

Returns

The current GPIO's interrupt status flag. '1' means the related pin's flag is set, '0' means the related pin's flag not set. For example, the return value 0x00010001 means the pin 0 and 17 have the interrupt pending.

uint32_t GPIO_GpioGetInterruptChannelFlags(GPIO_Type *base, uint32_t channel)

Read the GPIO interrupt status flags based on selected interrupt channel(IRQS).

Parameters

- base – GPIO peripheral base pointer. (GPIOA, GPIOB, GPIOC, and so on.)
- channel – '0' means selete interrupt channel 0, '1' means selete interrupt channel 1.

Returns

The current GPIO's interrupt status flag based on the selected interrupt channel. '1' means the related pin's flag is set, '0' means the related pin's flag not set. For example, the return value 0x00010001 means the pin 0 and 17 have the interrupt pending.

uint8_t GPIO_PinGetInterruptFlag(GPIO_Type *base, uint32_t pin)

Read individual pin's interrupt status flag.

Parameters

- base – GPIO peripheral base pointer. (GPIOA, GPIOB, GPIOC, and so on)
- pin – GPIO specific pin number.

Returns

The current selected pin's interrupt status flag.

void GPIO_GpioClearInterruptFlags(GPIO_Type *base, uint32_t mask)

Clears GPIO pin interrupt status flags.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro

void GPIO_GpioClearInterruptChannelFlags(GPIO_Type *base, uint32_t mask, uint32_t channel)

Clears GPIO pin interrupt status flags based on selected interrupt channel(IRQS).

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- mask – GPIO pin number macro
- channel – '0' means selete interrupt channel 0, '1' means selete interrupt channel 1.

void GPIO_PinClearInterruptFlag(GPIO_Type *base, uint32_t pin)

Clear GPIO individual pin's interrupt status flag.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on).
- pin – GPIO specific pin number.

```
static inline void GPIO_SetMultipleInterruptPinsConfig(GPIO_Type *base, uint32_t mask,  
                                                    gpio_interrupt_config_t config)
```

Sets the GPIO interrupt configuration in PCR register for multiple pins.

Parameters

- base – GPIO peripheral base pointer.
- mask – GPIO pin number macro.
- config – GPIO pin interrupt configuration.
 - kGPIO_InterruptStatusFlagDisabled: Interrupt disabled.
 - kGPIO_DMARisingEdge : DMA request on rising edge(if the DMA requests exit).
 - kGPIO_DMAFallingEdge: DMA request on falling edge(if the DMA requests exit).
 - kGPIO_DMAEitherEdge : DMA request on either edge(if the DMA requests exit).
 - kGPIO_FlagRisingEdge : Flag sets on rising edge(if the Flag states exit).
 - kGPIO_FlagFallingEdge : Flag sets on falling edge(if the Flag states exit).
 - kGPIO_FlagEitherEdge : Flag sets on either edge(if the Flag states exit).
 - kGPIO_InterruptLogicZero : Interrupt when logic zero.
 - kGPIO_InterruptRisingEdge : Interrupt on rising edge.
 - kGPIO_InterruptFallingEdge: Interrupt on falling edge.
 - kGPIO_InterruptEitherEdge : Interrupt on either edge.
 - kGPIO_InterruptLogicOne : Interrupt when logic one.
 - kGPIO_ActiveHighTriggerOutputEnable : Enable active high-trigger output (if the trigger states exit).
 - kGPIO_ActiveLowTriggerOutputEnable : Enable active low-trigger output (if the trigger states exit)..

```
void GPIO_CheckAttributeBytes(GPIO_Type *base, gpio_checker_attribute_t attribute)
```

brief The GPIO module supports a device-specific number of data ports, organized as 32-bit words/8-bit Bytes. Each 32-bit/8-bit data port includes a GACR register, which defines the byte-level attributes required for a successful access to the GPIO programming model. If the GPIO module's GACR register organized as 32-bit words, the attribute controls for the 4 data bytes in the GACR follow a standard little endian data convention.

Parameters

- base – GPIO peripheral base pointer (GPIOA, GPIOB, GPIOC, and so on.)
- attribute – GPIO checker attribute

2.29 I3C: I3C Driver

FSL_I3C_DRIVER_VERSION
I3C driver version.

I3C status return codes.

Values:

enumerator kStatus_I3C_Busy

The master is already performing a transfer.

enumerator kStatus_I3C_Idle

The slave driver is idle.

enumerator kStatus_I3C_Nak

The slave device sent a NAK in response to an address.

enumerator kStatus_I3C_WriteAbort

The slave device sent a NAK in response to a write.

enumerator kStatus_I3C_Term

The master terminates slave read.

enumerator kStatus_I3C_HdrParityError

Parity error from DDR read.

enumerator kStatus_I3C_CrcError

CRC error from DDR read.

enumerator kStatus_I3C_ReadFifoError

Read from M/SRDATA register when FIFO empty.

enumerator kStatus_I3C_WriteFifoError

Write to M/SWDATA register when FIFO full.

enumerator kStatus_I3C_MsgError

Message SDR/DDR mismatch or read/write message in wrong state

enumerator kStatus_I3C_InvalidReq

Invalid use of request.

enumerator kStatus_I3C_Timeout

The module has stalled too long in a frame.

enumerator kStatus_I3C_SlaveCountExceed

The I3C slave count has exceed the definition in I3C_MAX_DEVCNT.

enumerator kStatus_I3C_IBIWon

The I3C slave event IBI or MR or HJ won the arbitration on a header address.

enumerator kStatus_I3C_OverrunError

Slave internal from-bus buffer/FIFO overrun.

enumerator kStatus_I3C_UnderrunError

Slave internal to-bus buffer/FIFO underrun

enumerator kStatus_I3C_UnderrunNak

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kStatus_I3C_InvalidStart

Slave invalid start flag

enumerator kStatus_I3C_SdrParityError

SDR parity error

enumerator kStatus_I3C_S0S1Error
S0 or S1 error

enum _i3c_hdr_mode
I3C HDR modes.

Values:

enumerator kI3C_HDRModeNone

enumerator kI3C_HDRModeDDR

enumerator kI3C_HDRModeTSP

enumerator kI3C_HDRModeTSL

typedef enum _i3c_hdr_mode i3c_hdr_mode_t
I3C HDR modes.

typedef struct _i3c_device_info i3c_device_info_t
I3C device information.

I3C_RETRY_TIMES
Max loops to wait for I3C operation status complete.

This is the maximum number of loops to wait for I3C operation status complete. If set to 0, it will wait indefinitely.

I3C_MAX_DEVCNT

I3C_IBI_BUFF_SIZE

struct _i3c_device_info
#include <fsl_i3c.h> I3C device information.

Public Members

uint8_t dynamicAddr
Device dynamic address.

uint8_t staticAddr
Static address.

uint8_t dcr
Device characteristics register information.

uint8_t bcr
Bus characteristics register information.

uint16_t vendorID
Device vendor ID(manufacture ID).

uint32_t partNumber
Device part number info

uint16_t maxReadLength
Maximum read length.

uint16_t maxWriteLength
Maximum write length.

uint8_t hdrMode
Support hdr mode, could be OR logic in i3c_hdr_mode.

2.30 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.

2.31 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/DAAs 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.

2.32 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.

2.33 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_SlaveBusDAAModeFlag

I3C bus is in ENTDAAMode

enumerator kI3C_SlaveBusHDRModeFlag

I3C bus is in HDR mode

enumerator kI3C_SlaveBusStartFlag

Start/Re-start event is seen since the bus was last cleared

enumerator kI3C_SlaveMatchedFlag

Slave address(dynamic/static) matched since last cleared

enumerator kI3C_SlaveBusStopFlag

Stop event is seen since the bus was last cleared

enumerator kI3C_SlaveRxReadyFlag

Rx data ready in rx buffer flag

enumerator kI3C_SlaveTxReadyFlag

Tx buffer ready for Tx data flag

enumerator kI3C_SlaveDynamicAddrChangedFlag

Slave dynamic address has been assigned, re-assigned, or lost

enumerator kI3C_SlaveReceivedCCCFlag

Slave received Common command code

enumerator kI3C_SlaveErrorFlag

Error occurred flag

enumerator kI3C_SlaveHDRCommandMatchFlag

High data rate command match

enumerator kI3C_SlaveCCCHandledFlag

Slave received Common command code is handled by I3C module

enumerator kI3C_SlaveEventSentFlag

Slave IBI/P2P/MR/HJ event has been sent

enumerator kI3C_SlaveIbiDisableFlag

Slave in band interrupt is disabled.

enumerator kI3C_SlaveMasterRequestDisabledFlag

Slave master request is disabled.

enumerator kI3C_SlaveHotJoinDisabledFlag

Slave Hot-Join is disabled.

enumerator kI3C_SlaveClearFlags

All flags which are cleared by the driver upon starting a transfer.

enumerator kI3C_SlaveAllIrqFlags

enum _i3c_slave_error_flags

I3C slave error flags to indicate the causes.

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

Values:

enumerator kI3C_SlaveErrorOverrunFlag

Slave internal from-bus buffer/FIFO overrun.

enumerator kI3C_SlaveErrorUnderrunFlag

Slave internal to-bus buffer/FIFO underrun

enumerator kI3C_SlaveErrorUnderrunNakFlag

Slave internal from-bus buffer/FIFO underrun and NACK error

enumerator kI3C_SlaveErrorTermFlag

Terminate error from master

enumerator kI3C_SlaveErrorInvalidStartFlag

Slave invalid start flag

enumerator kI3C_SlaveErrorSdrParityFlag

SDR parity error

enumerator kI3C_SlaveErrorHdrParityFlag

HDR parity error

enumerator kI3C_SlaveErrorHdrCRCFlag

HDR-DDR CRC error

enumerator kI3C_SlaveErrorS0S1Flag

S0 or S1 error

enumerator kI3C_SlaveErrorOverreadFlag

Over-read error

enumerator kI3C_SlaveErrorOverwriteFlag

Over-write error

enum _i3c_slave_event

I3C slave.event.

Values:

enumerator kI3C_SlaveEventNormal

Normal mode.

enumerator kI3C_SlaveEventIBI

In band interrupt event.

enumerator kI3C_SlaveEventMasterReq

Master request event.

enumerator kI3C_SlaveEventHotJoinReq

Hot-join event.

enum _i3c_slave_activity_state

I3C slave.activity state.

Values:

enumerator kI3C_SlaveNoLatency

Normal bus operation

enumerator kI3C_SlaveLatency1Ms

1ms of latency.

enumerator kI3C_SlaveLatency100Ms

100ms of latency.

enumerator kI3C_SlaveLatency10S

10s latency.

enum _i3c_slave_transfer_event

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to I3C_SlaveTransferNonBlocking() in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

Values:

enumerator kI3C_SlaveAddressMatchEvent

Received the slave address after a start or repeated start.

enumerator kI3C_SlaveTransmitEvent

Callback is requested to provide data to transmit (slave-transmitter role).

enumerator kI3C_SlaveReceiveEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C_SlaveRequiredTransmitEvent

Callback is requested to provide a buffer in which to place received data (slave-receiver role).

enumerator kI3C_SlaveStartEvent

A start/repeated start was detected.

enumerator kI3C_SlaveHDRCommandMatchEvent

Slave Match HDR Command.

enumerator kI3C_SlaveCompletionEvent

A stop was detected, completing the transfer.

enumerator `kI3C_SlaveRequestSentEvent`

Slave request event sent.

enumerator `kI3C_SlaveReceivedCCCEvent`

Slave received CCC event, need to handle by application.

enumerator `kI3C_SlaveAllEvents`

Bit mask of all available events.

typedef enum `_i3c_slave_event` `i3c_slave_event_t`

I3C slave.event.

typedef enum `_i3c_slave_activity_state` `i3c_slave_activity_state_t`

I3C slave.activity state.

typedef struct `_i3c_slave_config` `i3c_slave_config_t`

Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_SlaveGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

typedef enum `_i3c_slave_transfer_event` `i3c_slave_transfer_event_t`

Set of events sent to the callback for non blocking slave transfers.

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to `I3C_SlaveTransferNonBlocking()` in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

typedef struct `_i3c_slave_transfer` `i3c_slave_transfer_t`

I3C slave transfer structure.

typedef struct `_i3c_slave_handle` `i3c_slave_handle_t`

typedef void (*`i3c_slave_transfer_callback_t`)(`I3C_Type` *base, `i3c_slave_transfer_t` *transfer, void *userData)

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the `I3C_SlaveSetCallback()` function after you have created a handle.

Param base

Base address for the I3C instance on which the event occurred.

Param transfer

Pointer to transfer descriptor containing values passed to and/or from the callback.

Param userData

Arbitrary pointer-sized value passed from the application.

typedef void (*`i3c_slave_isr_t`)(`I3C_Type` *base, void *handle)

Typedef for slave interrupt handler.

struct `_i3c_slave_config`

#include <fsl_i3c.h> Structure with settings to initialize the I3C slave module.

This structure holds configuration settings for the I3C peripheral. To initialize this structure to reasonable defaults, call the `I3C_SlaveGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

The configuration structure can be made constant so it resides in flash.

Public Members

bool enableSlave

Whether to enable slave.

uint8_t staticAddr

Static address.

uint16_t vendorID

Device vendor ID(manufacture ID).

uint32_t partNumber

Device part number info

uint8_t dcr

Device characteristics register information.

uint8_t bcr

Bus characteristics register information.

uint8_t hdrMode

Support hdr mode, could be OR logic in enumeration:`i3c_hdr_mode_t`.

bool nakAllRequest

Whether to reply NAK to all requests except broadcast CCC.

bool ignoreS0S1Error

Whether to ignore S0/S1 error in SDR mode.

bool offline

Whether to wait 60 us of bus quiet or HDR request to ensure slave track SDR mode safely.

bool matchSlaveStartStop

Whether to assert start/stop status only the time slave is addressed.

uint32_t maxWriteLength

Maximum write length.

uint32_t maxReadLength

Maximum read length.

struct `_i3c_slave_transfer`

#include <fsl_i3c.h> I3C slave transfer structure.

Public Members

uint32_t event

Reason the callback is being invoked.

uint8_t *txData

Transfer buffer

size_t txDataSize

Transfer size

uint8_t *rxData

Transfer buffer

size_t rxDataSize

Transfer size

status_t completionStatus

Success or error code describing how the transfer completed. Only applies for kI3C_SlaveCompletionEvent.

size_t transferredCount

Number of bytes actually transferred since start or last repeated start.

struct _i3c_slave_handle

#include <fsl_i3c.h> I3C slave handle structure.

Note: The contents of this structure are private and subject to change.

Public Members

i3c_slave_transfer_t transfer

I3C slave transfer copy.

bool isBusy

Whether transfer is busy.

bool wasTransmit

Whether the last transfer was a transmit.

uint32_t eventMask

Mask of enabled events.

uint32_t transferredCount

Count of bytes transferred.

i3c_slave_transfer_callback_t callback

Callback function called at transfer event.

void *userData

Callback parameter passed to callback.

uint8_t txFifoSize

Tx Fifo size

2.34 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 *txDma-Handle* 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.

2.35 INPUTMUX: Input Multiplexing Driver

`enum _inputmux_connection_t`
INPUTMUX connections type.

Values:

`enumerator kINPUTMUX_GpioPort8Pin0ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin1ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin2ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin3ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin4ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin5ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin6ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin7ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin8ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin9ToPintsel`

`enumerator kINPUTMUX_GpioPort8Pin10ToPintsel`

enumerator kINPUTMUX_GpioPort8Pin11ToPintsel
enumerator kINPUTMUX_GpioPort8Pin12ToPintsel
enumerator kINPUTMUX_GpioPort8Pin13ToPintsel
enumerator kINPUTMUX_GpioPort8Pin14ToPintsel
enumerator kINPUTMUX_GpioPort8Pin15ToPintsel
enumerator kINPUTMUX_GpioPort8Pin16ToPintsel
enumerator kINPUTMUX_GpioPort8Pin17ToPintsel
enumerator kINPUTMUX_GpioPort8Pin18ToPintsel
enumerator kINPUTMUX_GpioPort8Pin19ToPintsel
enumerator kINPUTMUX_GpioPort8Pin20ToPintsel
enumerator kINPUTMUX_GpioPort8Pin21ToPintsel
enumerator kINPUTMUX_GpioPort8Pin22ToPintsel
enumerator kINPUTMUX_GpioPort8Pin23ToPintsel
enumerator kINPUTMUX_GpioPort8Pin24ToPintsel
enumerator kINPUTMUX_GpioPort8Pin25ToPintsel
enumerator kINPUTMUX_GpioPort8Pin26ToPintsel
enumerator kINPUTMUX_GpioPort8Pin27ToPintsel
enumerator kINPUTMUX_GpioPort8Pin28ToPintsel
enumerator kINPUTMUX_GpioPort8Pin29ToPintsel
enumerator kINPUTMUX_GpioPort8Pin30ToPintsel
enumerator kINPUTMUX_GpioPort8Pin31ToPintsel
enumerator kINPUTMUX_GpioPort10Pin0ToPintsel
enumerator kINPUTMUX_GpioPort10Pin1ToPintsel
enumerator kINPUTMUX_GpioPort10Pin2ToPintsel
enumerator kINPUTMUX_GpioPort10Pin3ToPintsel
enumerator kINPUTMUX_GpioPort10Pin4ToPintsel
enumerator kINPUTMUX_GpioPort10Pin5ToPintsel
enumerator kINPUTMUX_GpioPort10Pin6ToPintsel
enumerator kINPUTMUX_GpioPort10Pin7ToPintsel
enumerator kINPUTMUX_GpioPort10Pin8ToPintsel
enumerator kINPUTMUX_GpioPort10Pin9ToPintsel
enumerator kINPUTMUX_GpioPort10Pin10ToPintsel
enumerator kINPUTMUX_GpioPort10Pin11ToPintsel

enumerator kINPUTMUX_GpioPort10Pin12ToPintsel
enumerator kINPUTMUX_GpioPort10Pin13ToPintsel
enumerator kINPUTMUX_GpioPort10Pin14ToPintsel
enumerator kINPUTMUX_GpioPort10Pin15ToPintsel
enumerator kINPUTMUX_GpioPort10Pin16ToPintsel
enumerator kINPUTMUX_GpioPort10Pin17ToPintsel
DSP Interrupt.
enumerator kINPUTMUX_Flexcomm17ToDspInterrupt
enumerator kINPUTMUX_Flexcomm18ToDspInterrupt
enumerator kINPUTMUX_Flexcomm19ToDspInterrupt
enumerator kINPUTMUX_Flexcomm20ToDspInterrupt
enumerator kINPUTMUX_Pmc1ToDspInterrupt
enumerator kINPUTMUX_Gpio8Irq0ToDspInterrupt
enumerator kINPUTMUX_Gpio8Irq1ToDspInterrupt
enumerator kINPUTMUX_Gpio9Irq0ToDspInterrupt
enumerator kINPUTMUX_Gpio9Irq1ToDspInterrupt
enumerator kINPUTMUX_Gpio10Irq0ToDspInterrupt
enumerator kINPUTMUX_Gpio10Irq1ToDspInterrupt
enumerator kINPUTMUX_Wdt2ToDspInterrupt
enumerator kINPUTMUX_Wdt3ToDspInterrupt
enumerator kINPUTMUX_Mu0BToDspInterrupt
enumerator kINPUTMUX_Mu3BToDspInterrupt
enumerator kINPUTMUX_Utick1ToDspInterrupt
enumerator kINPUTMUX_Mrt1ToDspInterrupt
enumerator kINPUTMUX_OsEventTimerToDspInterrupt
enumerator kINPUTMUX_Ctimer5ToDspInterrupt
enumerator kINPUTMUX_Ctimer6ToDspInterrupt
enumerator kINPUTMUX_Ctimer7ToDspInterrupt
enumerator kINPUTMUX_Rtc1AlarmToDspInterrupt
enumerator kINPUTMUX_Rtc1WakeupToDspInterrupt
enumerator kINPUTMUX_I3c2ToDspInterrupt
enumerator kINPUTMUX_I3c3ToDspInterrupt
enumerator kINPUTMUX_MicfilToDspInterrupt

enumerator kINPUTMUX_HwvadToDspInterrupt
enumerator kINPUTMUX_Dma2Irq0ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq1ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq2ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq3ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq4ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq5ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq6ToDspInterrupt
enumerator kINPUTMUX_Dma2Irq7ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq0ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq1ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq2ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq3ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq4ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq5ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq6ToDspInterrupt
enumerator kINPUTMUX_Dma3Irq7ToDspInterrupt
enumerator kINPUTMUX_GpioInt0ToDspInterrupt
enumerator kINPUTMUX_GpioInt1ToDspInterrupt
enumerator kINPUTMUX_GpioInt2ToDspInterrupt
enumerator kINPUTMUX_GpioInt3ToDspInterrupt
enumerator kINPUTMUX_Sai3ToDspInterrupt
enumerator kINPUTMUX_CtInp0ToFlexcomm17
enumerator kINPUTMUX_CtInp1ToFlexcomm17
enumerator kINPUTMUX_CtInp2ToFlexcomm17
enumerator kINPUTMUX_CtInp3ToFlexcomm17
enumerator kINPUTMUX_Ct5Mat3ToFlexcomm17
enumerator kINPUTMUX_Ct6Mat3ToFlexcomm17
enumerator kINPUTMUX_Ct7Mat3ToFlexcomm17
enumerator kINPUTMUX_GpioInt1BMatchToFlexcomm17
enumerator kINPUTMUX_Cmp0OutToFlexcomm17
enumerator kINPUTMUX_Rtc1IrqToFlexcomm17
enumerator kINPUTMUX_CtInp0ToFlexcomm18

enumerator kINPUTMUX_CtInp1ToFlexcomm18
enumerator kINPUTMUX_CtInp2ToFlexcomm18
enumerator kINPUTMUX_CtInp3ToFlexcomm18
enumerator kINPUTMUX_Ct5Mat3ToFlexcomm18
enumerator kINPUTMUX_Ct6Mat3ToFlexcomm18
enumerator kINPUTMUX_Ct7Mat3ToFlexcomm18
enumerator kINPUTMUX_GpioInt1BMatchToFlexcomm18
enumerator kINPUTMUX_Cmp0OutToFlexcomm18
enumerator kINPUTMUX_Rtc1IrqToFlexcomm18
enumerator kINPUTMUX_CtInp0ToFlexcomm19
enumerator kINPUTMUX_CtInp1ToFlexcomm19
enumerator kINPUTMUX_CtInp2ToFlexcomm19
enumerator kINPUTMUX_CtInp3ToFlexcomm19
enumerator kINPUTMUX_Ct5Mat3ToFlexcomm19
enumerator kINPUTMUX_Ct6Mat3ToFlexcomm19
enumerator kINPUTMUX_Ct7Mat3ToFlexcomm19
enumerator kINPUTMUX_GpioInt1BMatchToFlexcomm19
enumerator kINPUTMUX_Cmp0OutToFlexcomm19
enumerator kINPUTMUX_Rtc1IrqToFlexcomm19
enumerator kINPUTMUX_CtInp0ToFlexcomm20
enumerator kINPUTMUX_CtInp1ToFlexcomm20
enumerator kINPUTMUX_CtInp2ToFlexcomm20
enumerator kINPUTMUX_CtInp3ToFlexcomm20
enumerator kINPUTMUX_Ct5Mat3ToFlexcomm20
enumerator kINPUTMUX_Ct6Mat3ToFlexcomm20
enumerator kINPUTMUX_Ct7Mat3ToFlexcomm20
enumerator kINPUTMUX_GpioInt1BMatchToFlexcomm20
enumerator kINPUTMUX_Cmp0OutToFlexcomm20
enumerator kINPUTMUX_Rtc1IrqToFlexcomm20
enumerator kINPUTMUX_Gpio0Irq0ToAdc0
enumerator kINPUTMUX_Gpio1Irq0ToAdc0
enumerator kINPUTMUX_Gpio2Irq0ToAdc0
enumerator kINPUTMUX_Gpio3Irq0ToAdc0

enumerator kINPUTMUX_Gpio4Irq0ToAdc0
enumerator kINPUTMUX_Gpio5Irq0ToAdc0
enumerator kINPUTMUX_Gpio6Irq0ToAdc0
enumerator kINPUTMUX_Gpio7Irq0ToAdc0
enumerator kINPUTMUX_Gpio8Irq0ToAdc0
enumerator kINPUTMUX_Gpio9Irq0ToAdc0
enumerator kINPUTMUX_Gpio10Irq0ToAdc0
enumerator kINPUTMUX_Sct0Out4ToAdc0
enumerator kINPUTMUX_Sct0Out5ToAdc0
enumerator kINPUTMUX_Sct0Out9ToAdc0
enumerator kINPUTMUX_Ct0Mat3ToAdc0
enumerator kINPUTMUX_Ct1Mat3ToAdc0
enumerator kINPUTMUX_Ct2Mat3ToAdc0
enumerator kINPUTMUX_Ct3Mat3ToAdc0
enumerator kINPUTMUX_Ct4Mat3ToAdc0
enumerator kINPUTMUX_Ct5Mat3ToAdc0
enumerator kINPUTMUX_Ct6Mat3ToAdc0
enumerator kINPUTMUX_Ct7Mat3ToAdc0
enumerator kINPUTMUX_Cmp0OutToAdc0
enumerator kINPUTMUX_Cpu0TxeVToAdc0
enumerator kINPUTMUX_Cpu1TxeVToAdc0
enumerator kINPUTMUX_EzhvOutToAdc0
enumerator kINPUTMUX_GpioInt0BmatchToAdc0
enumerator kINPUTMUX_GpioInt1BmatchToAdc0

CTmier5 capture input mux.

enumerator kINPUTMUX_CtInp0ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp1ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp2ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp3ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp4ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp5ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp6ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp7ToTimer5CaptureChannels

enumerator kINPUTMUX_CtInp8ToTimer5CaptureChannels
enumerator kINPUTMUX_CtInp9ToTimer5CaptureChannels
enumerator kINPUTMUX_Sai3TxSyncToTimer5CaptureChannels
enumerator kINPUTMUX_Sai3RxSyncToTimer5CaptureChannels
enumerator kINPUTMUX_Cmp0OutToTimer5CaptureChannels
enumerator kINPUTMUX_Adc0Tcomp0ToTimer5CaptureChannels
enumerator kINPUTMUX_Adc0Tcomp1ToTimer5CaptureChannels
CTmier6 capture input mux.
enumerator kINPUTMUX_CtInp0ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp1ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp2ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp3ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp4ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp5ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp6ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp7ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp8ToTimer6CaptureChannels
enumerator kINPUTMUX_CtInp9ToTimer6CaptureChannels
enumerator kINPUTMUX_Sai3TxSyncToTimer6CaptureChannels
enumerator kINPUTMUX_Sai3RxSyncToTimer6CaptureChannels
enumerator kINPUTMUX_Cmp0OutToTimer6CaptureChannels
enumerator kINPUTMUX_Adc0Tcomp0ToTimer6CaptureChannels
enumerator kINPUTMUX_Adc0Tcomp1ToTimer6CaptureChannels
CTmier7 capture input mux.
enumerator kINPUTMUX_CtInp0ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp1ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp2ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp3ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp4ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp5ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp6ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp7ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp8ToTimer7CaptureChannels
enumerator kINPUTMUX_CtInp9ToTimer7CaptureChannels

enumerator kINPUTMUX__Sai3TxSyncToTimer7CaptureChannels
enumerator kINPUTMUX__Sai3RxSyncToTimer7CaptureChannels
enumerator kINPUTMUX__Cmp0OutToTimer7CaptureChannels
enumerator kINPUTMUX__Adc0Tcomp0ToTimer7CaptureChannels
enumerator kINPUTMUX__Adc0Tcomp1ToTimer7CaptureChannels
CTmier5 input trigger:

enumerator kINPUTMUX__CtInp0ToTimer5Trigger
enumerator kINPUTMUX__CtInp1ToTimer5Trigger
enumerator kINPUTMUX__CtInp2ToTimer5Trigger
enumerator kINPUTMUX__CtInp3ToTimer5Trigger
enumerator kINPUTMUX__CtInp4ToTimer5Trigger
enumerator kINPUTMUX__CtInp5ToTimer5Trigger
enumerator kINPUTMUX__CtInp6ToTimer5Trigger
enumerator kINPUTMUX__CtInp7ToTimer5Trigger
enumerator kINPUTMUX__CtInp8ToTimer5Trigger
enumerator kINPUTMUX__CtInp9ToTimer5Trigger
enumerator kINPUTMUX__Sai3TxSyncToTimer5Trigger
enumerator kINPUTMUX__Sai3RxSyncToTimer5Trigger
enumerator kINPUTMUX__Cmp0OutToTimer5Trigger
enumerator kINPUTMUX__Adc0Tcomp0ToTimer5Trigger
enumerator kINPUTMUX__Adc0Tcomp1ToTimer5Trigger

CTmier6 input trigger:

enumerator kINPUTMUX__CtInp0ToTimer6Trigger
enumerator kINPUTMUX__CtInp1ToTimer6Trigger
enumerator kINPUTMUX__CtInp2ToTimer6Trigger
enumerator kINPUTMUX__CtInp3ToTimer6Trigger
enumerator kINPUTMUX__CtInp4ToTimer6Trigger
enumerator kINPUTMUX__CtInp5ToTimer6Trigger
enumerator kINPUTMUX__CtInp6ToTimer6Trigger
enumerator kINPUTMUX__CtInp7ToTimer6Trigger
enumerator kINPUTMUX__CtInp8ToTimer6Trigger
enumerator kINPUTMUX__CtInp9ToTimer6Trigger
enumerator kINPUTMUX__Sai3TxSyncToTimer6Trigger
enumerator kINPUTMUX__Sai3RxSyncToTimer6Trigger

enumerator kINPUTMUX_Cmp0OutToTimer6Trigger

enumerator kINPUTMUX_Adc0Tcomp0ToTimer6Trigger

enumerator kINPUTMUX_Adc0Tcomp1ToTimer6Trigger
CTmier7 input trigger.

enumerator kINPUTMUX_CtInp0ToTimer7Trigger

enumerator kINPUTMUX_CtInp1ToTimer7Trigger

enumerator kINPUTMUX_CtInp2ToTimer7Trigger

enumerator kINPUTMUX_CtInp3ToTimer7Trigger

enumerator kINPUTMUX_CtInp4ToTimer7Trigger

enumerator kINPUTMUX_CtInp5ToTimer7Trigger

enumerator kINPUTMUX_CtInp6ToTimer7Trigger

enumerator kINPUTMUX_CtInp7ToTimer7Trigger

enumerator kINPUTMUX_CtInp8ToTimer7Trigger

enumerator kINPUTMUX_CtInp9ToTimer7Trigger

enumerator kINPUTMUX_Sai3TxSyncToTimer7Trigger

enumerator kINPUTMUX_Sai3RxSyncToTimer7Trigger

enumerator kINPUTMUX_Cmp0OutToTimer7Trigger

enumerator kINPUTMUX_Adc0Tcomp0ToTimer7Trigger

enumerator kINPUTMUX_Adc0Tcomp1ToTimer7Trigger

typedef enum *inputmux_connection_t* inputmux_connection_t
INPUTMUX connections type.

PINTSEL_PMUX_ID

Periphinmux IDs.

DSP_INT_PMUX_ID

PMUX_SHIFT

FSL_INPUTMUX_DRIVER_VERSION

Group interrupt driver version for SDK.

void INPUTMUX_Init(void *base)

Initialize INPUTMUX peripheral.

This function enables the INPUTMUX clock.

Parameters

- base – Base address of the INPUTMUX peripheral.

Return values

None. –

`void INPUTMUX_AttachSignal(void *base, uint32_t index, inputmux_connection_t connection)`
Attaches a signal.

This function attaches multiplexed signals from INPUTMUX to target signals. For example, to attach GPIO PORT0 Pin 5 to PINT peripheral, do the following:

```
INPUTMUX_AttachSignal(INPUTMUX, 2, kINPUTMUX_GpioPort0Pin5ToPintsel);
```

In this example, INTMUX has 8 registers for PINT, PINT_SEL0~PINT_SEL7. With parameter `index` specified as 2, this function configures register PINT_SEL2.

Parameters

- `base` – Base address of the INPUTMUX peripheral.
- `index` – The serial number of destination register in the group of INPUTMUX registers with same name.
- `connection` – Applies signal from source signals collection to target signal.

Return values

None. –

`void INPUTMUX_Deinit(void *base)`
Deinitialize INPUTMUX peripheral.

This function disables the INPUTMUX clock.

Parameters

- `base` – Base address of the INPUTMUX peripheral.

Return values

None. –

2.36 Iopctl_driver

`typedef struct iopctl_group iopctl_group_t`

Array of IOPCTL pin definitions passed to IOPCTL_SetPinMuxing() must be in this format.

`__STATIC_INLINE void IOPCTL_PinMuxSet (uint8_t port, uint8_t pin, uint32_t modefunc)`

Sets I/O Pad Control pin mux.

Parameters

- `port` – : Port to mux
- `pin` – : Pin to mux
- `modefunc` – : OR'ed values of type IOPCTL_*

Returns

Nothing

`__STATIC_INLINE void IOPCTL_SetPinMuxing (const iopctl_group_t *pinArray, uint32_t arrayLength)`

Set all I/O Control pin muxing.

Parameters

- `pinArray` – : Pointer to array of pin mux selections
- `arrayLength` – : Number of entries in pinArray

Returns

Nothing

LPC_IOPCTL_DRIVER_VERSION

IOPCTL driver version 2.0.3.

IOPCTL_FUNC0

IOPCTL function and mode selection definitions.

Note: See the User Manual for specific modes and functions supported by the various pins.
Selects pin function 0

IOPCTL_FUNC1

Selects pin function 1

IOPCTL_FUNC2

Selects pin function 2

IOPCTL_FUNC3

Selects pin function 3

IOPCTL_FUNC4

Selects pin function 4

IOPCTL_FUNC5

Selects pin function 5

IOPCTL_FUNC6

Selects pin function 6

IOPCTL_FUNC7

Selects pin function 7

IOPCTL_FUNC8

Selects pin function 8

IOPCTL_FUNC9

Selects pin function 9

IOPCTL_FUNC10

Selects pin function 10

IOPCTL_FUNC11

Selects pin function 11

IOPCTL_FUNC12

Selects pin function 12

IOPCTL_FUNC13

Selects pin function 13

IOPCTL_FUNC14

Selects pin function 14

IOPCTL_FUNC15

Selects pin function 15

IOPCTL_PUPD_EN

Enables Pullup / Pulldown

IOPCTL_PULLDOWN_EN

Selects pull-down function

IOPCTL_PULLUP_EN

Selects pull-up function

IOPCTL_INBUF_EN

Enables buffer function on input

IOPCTL_SLEW_RATE

Slew Rate Control

IOPCTL_ANAMUX_EN

Enables analog mux function by setting 0 to bit 7

IOPCTL_PSEDRAIN_EN

Enables pseudo output drain function

IOPCTL_INV_EN

Enables invert function on input

IOPCTL_DRIVE_100OHM

Selects transmitter current drive 100ohm, available for PIO0,1,3

IOPCTL_DRIVE_66OHM

Selects transmitter current drive 66ohm, available for PIO0,1,3

IOPCTL_DRIVE_50OHM

Selects transmitter current drive 50ohm, available for PIO0,1,3

IOPCTL_DRIVE_33OHM

Selects transmitter current drive 33ohm, available for PIO0,1,3

IOPCTL_FULLDRIVE_EN

Selects full drive, available for PIO2,8,9,10. (Unsupported for A0 Silicon)

uint32_t port

uint32_t pin

uint32_t modefunc

FSL_COMPONENT_ID

struct _iopctl_group

#include <fsl_iopctl.h> Array of IOPCTL pin definitions passed to IOPCTL_SetPinMuxing() must be in this format.

2.37 IRTC: IRTC Driver

status_t IRTC_Init(RTC_Type *base, const *irtc_config_t* *config)

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

This function initiates a soft-reset of the IRTC module, this has not effect on DST, calendar-ing, standby time and tamper detect registers.

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

Parameters

- base – IRTC peripheral base address
- config – Pointer to user's IRTC config structure.

Returns

kStatus_Success If the driver is initialized successfully.

Returns

kStatus_Fail if we cannot disable register write protection

Returns

kStatus_InvalidArgument If the input parameters are wrong.

status_t IRTC_Deinit(RTC_Type *base)

Gate the IRTC clock.

Parameters

- base – IRTC peripheral base address

Returns

kStatus_Success If the driver is initialized successfully.

Returns

kStatus_InvalidArgument If the input parameters are wrong.

void IRTC_GetDefaultConfig(*irtc_config_t* *config)

Fill in the IRTC config struct with the default settings.

The default values are:

```
config->wakeupSelect = true;
config->timerStdMask = false;
config->alarmMatch = kRTC_MatchSecMinHr;
```

Parameters

- config – Pointer to user's IRTC config structure.

void IRTC_GetDatetime(RTC_Type *base, *irtc_datetime_t* *datetime)

Gets the IRTC time and stores it in the given time structure.

Parameters

- base – IRTC peripheral base address
- datetime – Pointer to structure where the date and time details are stored.

status_t IRTC_SetAlarm(RTC_Type *base, const *irtc_datetime_t* *alarmTime)

Sets the IRTC alarm time.

Note: weekDay field of alarmTime is not used during alarm match and should be set to 0

Parameters

- base – RTC peripheral base address
- alarmTime – Pointer to structure where the alarm time is stored.

Returns

kStatus_Success: success in setting the alarm
kStatus_InvalidArgument: error in setting the alarm. Error occurs because the alarm datetime format is incorrect.

void IRTC_GetAlarm(RTC_Type *base, *irtc_datetime_t* *datetime)

Returns the IRTC alarm time.

Parameters

- base – RTC peripheral base address

- `datetime` – Pointer to structure where the alarm date and time details are stored.

static inline void IRTC_EnableInterrupts(RTC_Type *base, uint32_t mask)

Enables the selected IRTC interrupts.

Parameters

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

static inline void IRTC_DisableInterrupts(RTC_Type *base, uint32_t mask)

Disables the selected IRTC interrupts.

Parameters

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

static inline uint32_t IRTC_GetEnabledInterrupts(RTC_Type *base)

Gets the enabled IRTC interrupts.

Parameters

- `base` – IRTC peripheral base address

Returns

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

static inline uint32_t IRTC_GetStatusFlags(RTC_Type *base)

Gets the IRTC status flags.

Parameters

- `base` – IRTC peripheral base address

Returns

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

static inline void IRTC_ClearStatusFlags(RTC_Type *base, uint32_t mask)

Clears the IRTC status flags.

Parameters

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

void IRTC_GetDaylightTime(RTC_Type *base, *irtc_daylight_time_t* *datetime)

Gets the IRTC daylight savings time and stores it in the given time structure.

Parameters

- `base` – IRTC peripheral base address
- `datetime` – Pointer to a structure where the date and time details are stored.

static inline void IRTC_EnableSubsecondCounter(RTC_Type *base, bool enable)

Enable the RTC wake-up timer.

1HZ clock out selected via call to API `IRTC_ConfigClockOut` in order for the subsecond counter to synchronize with the `RTC_SECONDS` counter.

Parameters

- base – RTC peripheral base address
- enable – Use/Un-use the sub-second counter.
 - true: Use RTC wake-up timer at the same time.
 - false: Un-use RTC wake-up timer, RTC only use the normal seconds timer by default.

```
static inline uint32_t IRTC_GetSubsecondCount(RTC_Type *base)
```

Read the actual RTC sub-second COUNT value.

Parameters

- base – RTC peripheral base address

Returns

The actual RTC sub-second COUNT value.

```
static inline void IRTC_SetWakeupCount(RTC_Type *base, bool enable1kHzClk, uint32_t wakeupValue)
```

Set countdown value to the RTC wake timer counter register.

Parameters

- base – RTC peripheral base address
- enable1kHzClk – Enable 1kHz clock source for the wake timer, else use the 32kHz clock.
- wakeupValue – The value to be loaded into the WAKE register in wake timer counter.

```
static inline uint32_t IRTC_GetWakeupCount(RTC_Type *base)
```

Read the actual value from the WAKE register value in RTC wake timer.

Parameters

- base – RTC peripheral base address

Returns

The actual value of the WAKE register value in wake timer counter.

```
FSL_IRTC_DRIVER_VERSION
```

```
enum _irtc_clock_select
```

IRTC clock select.

Values:

```
enumerator kIRTC_Clk16K
```

16.384 kHz clock is selected.

```
enumerator kIRTC_Clk32K
```

32.768 kHz clock is selected.

```
enum _irtc_interrupt_enable
```

List of IRTC interrupts.

Values:

```
enumerator kIRTC_AlarmInterruptEnable
```

Alarm Interrupt Enable

```
enumerator kIRTC_DayInterruptEnable
```

Days Interrupt Enable

enumerator kIRTC_HourInterruptEnable
Hours Interrupt Enable

enumerator kIRTC_MinInterruptEnable
Minutes Interrupt Enable

enumerator kIRTC_1hzInterruptEnable
1 Hz interval Interrupt Enable

enumerator kIRTC_2hzInterruptEnable
2 Hz interval Interrupt Enable

enumerator kIRTC_4hzInterruptEnable
4 Hz interval Interrupt Enable

enumerator kIRTC_8hzInterruptEnable
8 Hz interval Interrupt Enable

enumerator kIRTC_16hzInterruptEnable
16 Hz interval Interrupt Enable

enumerator kIRTC_32hzInterruptEnable
32 Hz interval Interrupt Enable

enumerator kIRTC_64hzInterruptEnable
64 Hz interval Interrupt Enable

enumerator kIRTC_128hzInterruptEnable
128 Hz interval Interrupt Enable

enumerator kIRTC_256hzInterruptEnable
256 Hz interval Interrupt Enable

enumerator kIRTC_512hzInterruptEnable
512 Hz interval Interrupt Enable

enumerator kIRTC_WakeTimerInterruptEnable
Wake timer Interrupt Enable

enumerator kIRTC_TamperQueueFullInterruptEnable
Tamper queue full Interrupt Enable

enum _irtc_status_flags

List of IRTC flags.

Values:

enumerator kIRTC_AlarmFlag
Alarm Status flag

enumerator kIRTC_DayFlag
Days Status flag

enumerator kIRTC_HourFlag
Hour Status flag

enumerator kIRTC_MinFlag
Minutes Status flag

enumerator kIRTC_1hzFlag
1 Hz interval status flag

enumerator kIRTC_2hzFlag
2 Hz interval status flag

enumerator kIRTC_4hzFlag
4 Hz interval status flag

enumerator kIRTC_8hzFlag
8 Hz interval status flag

enumerator kIRTC_16hzFlag
16 Hz interval status flag

enumerator kIRTC_32hzFlag
32 Hz interval status flag

enumerator kIRTC_64hzFlag
64 Hz interval status flag

enumerator kIRTC_128hzFlag
128 Hz interval status flag

enumerator kIRTC_256hzFlag
256 Hz interval status flag

enumerator kIRTC_512hzFlag
512 Hz interval status flag

enumerator kIRTC_InvalidFlag
Indicates if time/date counters are invalid

enumerator kIRTC_WriteProtFlag
Write protect enable status flag

enumerator kIRTC_BusErrFlag
Bus error flag

enumerator kIRTC_WakeTimerFlag
Wake timer status flag

enum _irtc_alarm_match
IRTC alarm match options.

Values:

enumerator kRTC_MatchSecMinHr
Only match second, minute and hour

enumerator kRTC_MatchSecMinHrDay
Only match second, minute, hour and day

enumerator kRTC_MatchSecMinHrDayMnth
Only match second, minute, hour, day and month

enumerator kRTC_MatchSecMinHrDayMnthYr
Only match second, minute, hour, day, month and year

enum _irtc_clockout_sel
IRTC clockout select.

Values:

enumerator kIRTC_ClkoutNo
No clock out

enumerator kIRTC_ClkoutFine1Hz
clock out fine 1Hz

enumerator kIRTC_Clkout32kHz
clock out 32.768kHz

enumerator kIRTC_ClkoutCoarse1Hz
clock out coarse 1Hz

typedef enum *_irtc_clock_select* irtc_clock_select_t
IRTC clock select.

typedef enum *_irtc_interrupt_enable* irtc_interrupt_enable_t
List of IRTC interrupts.

typedef enum *_irtc_status_flags* irtc_status_flags_t
List of IRTC flags.

typedef enum *_irtc_alarm_match* irtc_alarm_match_t
IRTC alarm match options.

typedef enum *_irtc_clockout_sel* irtc_clockout_sel_t
IRTC clockout select.

typedef struct *_irtc_datetime* irtc_datetime_t
Structure is used to hold the date and time.

typedef struct *_irtc_daylight_time* irtc_daylight_time_t
Structure is used to hold the daylight saving time.

typedef struct *_irtc_config* irtc_config_t
RTC config structure.

This structure holds the configuration settings for the RTC peripheral. To initialize this structure to reasonable defaults, call the `IRTC_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 IRTC_SetWriteProtection(RTC_Type *base, bool lock)
Locks or unlocks IRTC registers for write access.

Note: When the registers are unlocked, they remain in unlocked state for 2 seconds, after which they are locked automatically. After power-on-reset, the registers come out unlocked and they are locked automatically 15 seconds after power on.

Parameters

- base – IRTC peripheral base address
- lock – true: Lock IRTC registers; false: Unlock IRTC registers.

Returns

kStatus_Success: if lock or unlock operation is successful
kStatus_Fail: if lock or unlock operation fails even after multiple retry attempts

static inline void IRTC_Reset(RTC_Type *base)

Performs a software reset on the IRTC module.

Clears contents of alarm, interrupt (status and enable except tamper interrupt enable bit) registers, STATUS[`CMP_DONE`] and STATUS[`BUS_ERR`]. This has no effect on DST, calendar-ing, standby time and tamper detect registers.

Parameters

- base – IRTC peripheral base address

void IRTC_ConfigClockOut(RTC_Type *base, *irtc_clockout_sel_t* clkOut)

Select which clock to output from RTC.

Select which clock to output from RTC for other modules to use inside SoC, for example, RTC subsystem needs RTC to output 1HZ clock for sub-second counter.

Parameters

- base – IRTC peripheral base address
- clkOut – select clock to use for output,

void IRTC_ConfigClockSelect(RTC_Type *base, *irtc_clock_select_t* clkSelect)

Select which clock is used by RTC.

Select which clock is used by RTC to output to the peripheral and divided to generate a 512 Hz clock and a 1 Hz clock.

Parameters

- base – IRTC peripheral base address
- clkSelect – select clock used by RTC

static inline void IRTC_EnableClockOutputToPeripheral(RTC_Type *base, bool enable)

Determines whether the selected clock is output to other peripherals.

Determines whether the selected clock is output to other peripherals.

Parameters

- base – IRTC peripheral base address
- enable – determine whether the selected clock is output to other peripherals

IRTCT_STATUS_W1C_BITS

struct *_irtc_datetime*

#include <fsl_irtc.h> Structure is used to hold the date and time.

Public Members

uint16_t year

Range from 1984 to 2239.

uint8_t month

Range from 1 to 12.

uint8_t day

Range from 1 to 31 (depending on month).

uint8_t weekDay

Range from 0(Sunday) to 6(Saturday).

uint8_t hour

Range from 0 to 23.

uint8_t minute

Range from 0 to 59.

uint8_t second

Range from 0 to 59.

struct __irtc_daylight_time

#include <fsl_irtc.h> Structure is used to hold the daylight saving time.

Public Members

uint8_t startMonth

Range from 1 to 12

uint8_t endMonth

Range from 1 to 12

uint8_t startDay

Range from 1 to 31 (depending on month)

uint8_t endDay

Range from 1 to 31 (depending on month)

uint8_t startHour

Range from 0 to 23

uint8_t endHour

Range from 0 to 23

struct __irtc_config

#include <fsl_irtc.h> RTC config structure.

This structure holds the configuration settings for the RTC peripheral. To initialize this structure to reasonable defaults, call the IRTC_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

irtc_alarm_match_t alrmMatch

Pick one option from enumeration :: irtc_alarm_match_t

irtc_clock_select_t clockSelect

Pick one option from enumeration :: irtc_clock_select_t

bool disableClockOutput

true: The selected clock is not output to other peripherals; false: The selected clock is output to other peripherals

2.38 ITRC

status_t ITRC_SetActionToEvent(ITRC_Type *base, itrc_out_signals_t out, itrc_input_signals_t in, itrc_lock_t lock, itrc_enable_t enable)

Set ITRC Action to Event.

This function sets input Event signal to corresponding output Action response signal.

Parameters

- base – ITRC peripheral base address

- out – ITRC OUT signal action
- in – ITRC IN signal event
- lock – if set locks INx_SEL configuration. This can be cleared only by PMC Core reset.
- enable – if set input Event will be selected for output Action, otherwise disable (if not already locked).

Returns

kStatus_Success if success, kStatus_InvalidArgument otherwise

void ITRC_SetSWEvent0(ITRC_Type *base)

Trigger ITRC SW Event 0.

This function set SW_EVENT0 register with value !=0 which triggers ITRC SW Event 0.

Parameters

- base – ITRC peripheral base address

void ITRC_SetSWEvent1(ITRC_Type *base)

Trigger ITRC SW Event 1.

This function set SW_EVENT1 register with value !=0 which triggers ITRC SW Event 1.

Parameters

- base – ITRC peripheral base address

uint32_t ITRC_GetStatus(ITRC_Type *base)

Get ITRC Status.

This function returns ITRC register status.

Parameters

- base – ITRC peripheral base address

Returns

Value of ITRC STATUS register

status_t ITRC_ClearStatus(ITRC_Type *base, uint32_t word)

Clear ITRC status.

This function clears corresponding ITRC event or action in STATUS register.

Parameters

- base – ITRC peripheral base address
- word – 32bit word represent corresponding event/action in STATUS register to be cleared (see ITRC_STATUS_INx/OUTx_STATUS)

Returns

kStatus_Success if success, kStatus_InvalidArgument otherwise

status_t ITRC_ClearAllStatus(ITRC_Type *base)

Clear All ITRC status.

This function clears all event and action status.

Parameters

- base – ITRC peripheral base address

Returns

kStatus_Success if success

`status_t ITRC_Init(ITRC_Type *base)`

Initialize ITRC.

This function initializes ITRC by enabling IRQ.

Parameters

- `base` – ITRC peripheral base address
- `conf` – ITRC configuration structure

Returns

Status of the init operation

`void ITRC_Deinit(ITRC_Type *base)`

Deinitialize ITRC.

This function deinitializes ITRC by disabling IRQ.

Parameters

- `base` – ITRC peripheral base address

`FSL_ITRC_DRIVER_VERSION`

Defines ITRC driver version 2.4.0.

Change log:

- Version 2.4.0
 - Rework the input signal definition for better flexibility
- Version 2.3.0
 - Update names of `kITRC_SwEvent1/2` to `kITRC_SwEvent0/1` to align with RM
- Version 2.2.0
 - Update driver to new version and input events
- Version 2.1.0
 - Make SYSCON glitch platform dependent
- Version 2.0.0
 - initial version

`enum __itrc_input_signals`

Values:

`enum __itrc_lock`

Values:

enumerator `kITRC_Unlock`

enumerator `kITRC_Lock`

`enum __itrc_enable`

Values:

enumerator `kITRC_Enable`

enumerator `kITRC_Disable`

`enum __itrc_out_signals`

Values:

enumerator `kITRC_Irq`

```
enumerator kITRC_ElsReset
enumerator kITRC_PufZeroize
enumerator kITRC_RamZeroize
enumerator kITRC_ChipReset
enumerator kITRC_TamperOut
enumerator kITRC_TamperOut1

typedef enum _itrc_input_signals itrc_input_signals_t
typedef enum _itrc_lock itrc_lock_t
typedef enum _itrc_enable itrc_enable_t
typedef enum _itrc_out_signals itrc_out_signals_t

void ITRC0_DriverIRQHandler(void)

ITRC_STATUS_IN2_STATUS_MASK
ITRC_STATUS_IN3_STATUS_MASK
ITRC_STATUS_IN9_STATUS_MASK
ITRC_STATUS1_IN17_STATUS_MASK
ITRC_STATUS1_IN19_STATUS_MASK
ITRC_STATUS1_IN24_21_STATUS_MASK
ITRC_STATUS1_IN32_25_STATUS_MASK
ITRC_STATUS1_IN46_STATUS_MASK
IN_0_15_EVENTS_MASK
OUT_ACTIONS_MASK
ITRC_OUT_COUNT
ITRC
```

2.39 Intrusion and Tamper Response Controller

2.40 JPEGDEC: JPEG decoder Driver

Error codes for the JPEG decoder driver.

Values:

```
enumerator kStatus_JPEGDEC_NotSupported
    Unsupported pixel format or image resolution.
```

```
enum _jpegdec_pixel_format
    JPEG decoding pixel format.
```

Values:

enumerator kJPEGDEC_PixelFormatYUV420
YUV420 format, Y at first plane, UV at second plane.

enumerator kJPEGDEC_PixelFormatYUV422
YUV422, 1 planar in the YUYV sequence.

enumerator kJPEGDEC_PixelFormatRGB
RGB packed format.

enumerator kJPEGDEC_PixelFormatYUV444
YUV444, 1 planar in the YUVYUV sequence.

enumerator kJPEGDEC_PixelFormatGray
8-bit or 12-bit gray scale.

enumerator kJPEGDEC_PixelFormatReserved
Reserved.

enumerator kJPEGDEC_PixelFormatYCCK
YCCK format.

enum __jpegdec_pixel_depth
JPEG decoding pixel depth.

Values:

enumerator kJPEGDEC_PixelDepth8Bit
8-bit per pixel.

enumerator kJPEGDEC_PixelDepth12Bit
12-bit per pixel.

enum __jpegdec_flags
Decoder slot Interrupt status and enable/disable flags.

Values:

enumerator kJPEGDEC_StreamBufferHalfDoneFlag
Slot's bit stream buffer pointer has passed half the size.

enumerator kJPEGDEC_StreamBufferDoneFlag
Slot's bit stream buffer pointer has finished.

enumerator kJPEGDEC_SwitchInFlag
Current slot is switched in.

enumerator kJPEGDEC_DecompleteFlag
Current slot finished decoding.

enumerator kJPEGDEC_DecodeErrorFlag
Current slot has error during decoding.

enumerator kJPEGDEC_DescptReadErrorFlag
Descriptor read error when switching in current slot.

enumerator kJPEGDEC_BitReadErrorFlag
Read JPEG stream error.

enumerator kJPEGDEC_PixelWriteErrorFlag
Write decoded pixel error.

enumerator kJPEGDEC_ErrorFlags

enumerator kJPEGDEC_AllFlags

enum __jpegdec_slots

JPEG decoding Slot.

Values:

enumerator kJPEGDEC_Slot0

Decoding slot 0.

enumerator kJPEGDEC_Slot1

Decoding slot 1.

enumerator kJPEGDEC_Slot2

Decoding slot 2.

enumerator kJPEGDEC_Slot3

Decoding slot 3.

enum __jpegdec_endian_mode

JPEG stream data format.

Values:

enumerator kJPEGDEC_BigEndian

JPEG data format is big endian.

enumerator kJPEGDEC_LittleEndian

JPEG data format is little endian.

typedef enum __jpegdec_pixel_format jpegdec_pixel_format_t

JPEG decoding pixel format.

typedef enum __jpegdec_pixel_depth jpegdec_pixel_depth_t

JPEG decoding pixel depth.

typedef struct __jpegdec_decoder_config jpegdec_decoder_config_t

JPEG decoder configuration.

typedef struct __jpegdec_descpt jpegdec_descpt_t

JPEG decoder descriptor.

This structure is used to configure the linked decoding descriptor for one or more slots in Single Bit Stream Repeat mode or Context Switch mode.

typedef enum __jpegdec_endian_mode jpegdec_endian_mode_t

JPEG stream data format.

typedef struct __jpegdec_config jpegdec_config_t

Configuration for JPEG decoder.

FSL_JPEGDEC_DRIVER_VERSION

JPEG decoder driver version.

void JPEGDEC_GetDefaultConfig(*jpegdec_config_t* *config)

Gets the default configuration for JPEG decoder.

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

Example:

```
config->endianMode = kJPEGDEC_LittleEndian;
config->slots      = 0xFU;
config->enable     = true;
config->enableLp   = false;
```

Parameters

- config – Pointer to JPEG decoder configuration structure.

void JPEGDEC_Init(*JPEG_DECODER_Type* *base, const *jpegdec_config_t* *config)

Initializes the JPEG decoder.

The default configuration can be got by calling JPEGDEC_GetDefaultConfig.

Parameters

- base – JPEG decoder peripheral base address.
- config – Pointer to JPEG decoder configuration structure.

void JPEGDEC_Deinit(*JPEG_DECODER_Type* *base)

Deinitializes the JPEG decoder.

Parameters

- base – JPEG decoder peripheral base address.

static inline void JPEGDEC_EnableInterrupts(*JPEG_DECODER_Type* *base, uint8_t slot, uint32_t mask)

Enables interrupts for certain slot.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.
- mask – Interrupts mask formed by flags OR'ed together. `_jpegdec_flags`.

static inline void JPEGDEC_DisableInterrupts(*JPEG_DECODER_Type* *base, uint8_t slot, uint32_t mask)

Disables interrupts for certain slot.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.
- mask – Interrupts mask formed by flags OR'ed together. `_jpegdec_flags`.

static inline uint32_t JPEGDEC_GetStatusFlags(*JPEG_DECODER_Type* *base, uint8_t slot)

Gets status flags for certain slot.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.

Returns

Status flags asserted mask formed by flags OR'ed together. See “`_jpegdec_flags`”.

static inline void JPEGDEC_ClearStatusFlags(*JPEG_DECODER_Type* *base, uint8_t slot, uint32_t mask)

Clears status flags for certain slot.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.
- mask – Status flags mask formed by flags OR'ed together. See “`_jpegdec_flags`”.

static inline void JPEGDEC_Enable(*JPEG_DECODER_Type* *base, bool enable)

Enables the JPEG decoder module.

Parameters

- base – JPEG decoder peripheral base address.
- enable – True to enable, false to disable.

static inline void JPEGDEC_EnableLp(*JPEG_DECODER_Type* *base, bool enable)

Enables the JPEG decoder core to enter low power mode.

Parameters

- base – JPEG decoder peripheral base address.
- enable – True to enable, false to disable.

static inline void JPEGDEC_Reset(*JPEG_DECODER_Type* *base)

Resets the JPEG decoder.

Parameters

- base – JPEG decoder peripheral base address.

static inline void JPEGDEC_StartDecode(*JPEG_DECODER_Type* *base)

Starts the JPEG decode.

After calling this API the JPEG decoder will start decoding on a frame basis. The decoding process stops after the frame decoding is complete and if there are no other valid descriptors available. Auto-clear.

Parameters

- base – JPEG decoder peripheral base address.

static inline void JPEGDEC_EnableSlots(*JPEG_DECODER_Type* *base, uint8_t slots)

Enables the JPEG decoding slot(s)

Parameters

- base – JPEG decoder peripheral base address.
- slot – Masks of the enabled slot, *_jpegdec_slots*.

status_t JPEGDEC_GetActiveSlot(*JPEG_DECODER_Type* *base, uint8_t *slot)

Gets the current active slot.

Parameters

- base – JPEG decoder peripheral base address.
- slot – **[out]** Pointer to the variable that stores the enabled slot.

Return values

- kStatus_Success – Successfully get the current active slot.
- kStatus_Fail – Current JPEG decoder is idle, no slot is active.

static inline void JPEGDEC_SetEndian(*JPEG_DECODER_Type* *base, *jpegdec_endian_mode_t* mode)

Sets the JPEG decoder endian mode for decoded data.

Parameters

- base – JPEG decoder peripheral base address.
- mode – Endian mode.

void JPEGDEC_SetJpegBuffer(*jpegdec_decoder_config_t* *config, uint8_t *buffer, size_t length)
Sets the address and length of the JPEG image.

Parameters

- config – **[out]** Decoder configuration.
- data – Start address of the buffer of the raw JPEG image, shall be 8-byte aligned.
- length – Size of the buffer.

void JPEGDEC_SetOutputBuffer(*jpegdec_decoder_config_t* *config, uint8_t *imageData0, uint8_t *imageData1)

Sets the address of the decoded data.

Parameters

- config – **[out]** Decoder configuration.
- imageData0 – Address of the output buffer0, shall be 16-byte aligned.
- imageData1 – Address of the output buffer1, only used when output format is YUV420, shall be 16-byte aligned.

status_t JPEGDEC_ParseHeader(*jpegdec_decoder_config_t* *config)

Parses the JPEG header and stores the info in the decoder configuration structure.

Parameters

- config – **[out]** Decoder configuration.

Return values

- kStatus_Success – Header parsing success.
- kStatus_Fail – JPEG header parsing failed due corrupted header.
- kStatus_JPEGDEC_NotSupported – Header parsing failed due to the image pixel format is not supported or image width/height is larger than 8k or image width/height is not 8-byte aligned.

void JPEGDEC_SetDecodeOption(*jpegdec_decoder_config_t* *config, uint16_t pitch, bool clearStreamBuf, bool autoStart)

Sets the decode option.

Parameters

- config – **[out]** Decoder configuration.
- pitch – Output buffer pitch.
- clearStreamBuf – Set to true to clear the saved bit stream buffer, not used in single frame mode.
- autoStart – Set to true to automatically start the decoding when this descriptor is switched on, not used in single frame mode.

void JPEGDEC_ConfigDecoder(*JPEG_DECODER_Type* *base, const *jpegdec_decoder_config_t* *config)

Sets JPEG decoder configuration.

Call this API to set the decoder configuration and then call JPEGDEC_StartDecode to start decode. Need to enable at least one slot in *jpegdec_config_t* first.

Parameters

- base – JPEG decoder peripheral base address.
- config – Decoder configuration.


```
void JPEGDEC_SetSlotNextDescpt(JPEG_DECODER_Type *base, uint8_t slot, jpegdec_descpt_t *descriptor)
```

Sets the address of the next decoder descriptor for certain slot.

Call this API to set the decoder descriptor for certain slot, and then call JPEGDEC_EnableSlotNextDescpt to enable the descriptor. If the decode configuration of this descriptor has enabled autoStart then decode will start automatically. Otherwise user has to call JPEGDEC_StartDecode manually. Need to enable the slot in jpegdec_config_t first.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.
- descriptor – Pointer to the descriptor structure.

```
static inline void JPEGDEC_EnableSlotNextDescpt(JPEG_DECODER_Type *base, uint8_t slot)
```

Enables the next decoder descriptor for certain slot.

Call this API after calling JPEGDEC_SetSlotNextDescpt to set valid descriptor for certain slot. User can also call JPEGDEC_EnableLinkedDescpt before calling JPEGDEC_SetSlotNextDescpt, then the descriptor will be loaded automatically.

Parameters

- base – JPEG decoder peripheral base address.
- slot – Slot number.

```
static inline void JPEGDEC_EnableLinkedDescpt(jpegdec_descpt_t *descriptor)
```

Enables the next linked descriptor.

Call this API before calling JPEGDEC_SetSlotNextDescpt, then the descriptor will be loaded automatically. Otherwise call JPEGDEC_EnableSlotNextDescpt after calling JPEGDEC_SetSlotNextDescpt.

Parameters

- descriptor – **[out]** Pointer to the descriptor structure.

```
void JPEGDEC_DescptReset(jpegdec_descpt_t *descriptor)
```

Sets all fields to default values for the descriptor structure.

Note: This function enables the auto start feature.

Parameters

- descriptor – Pointer to the descriptor structure.

```
JPEGDEC_Type *core
```

Pointer to decoder core.

```
JPGDECWRP_Type *wrapper
```

Pointer to decoder wrapper.

```
uint32_t outBufAddr0
```

Base address for output frame buffer0. 16-byte aligned(4 LSBs are zero).

```
uint32_t outBufAddr1
```

Base address for output frame buffer1, only used for YUV420 second plane. 16-byte aligned(4 LSBs are zero).

uint32_t outBufPitch

Output buffer pitch.

uint32_t __pad0__

Reserved.

uint32_t jpegBufAddr

Base address of the JPEG stream buffer for decoding. 16-byte aligned(4 LSBs are zero).

uint32_t jpegBufSize

Size of the JPEG stream buffer. 1k-byte aligned(10 LSBs are zero).

uint32_t height

Image height in pixel. Max supported is 8K(2000h), must be integer times of 8.

uint32_t __pad1__

Reserved.

uint32_t width

Image width in pixel. Max supported is 8K(2000h), must be integer times of 8.

uint32_t __pad2__

Reserved.

uint32_t __pad3__

Reserved.

uint32_t pixelDepth

Pixel depth, jpegdec_pixel_depth_t.

uint32_t pixelFormat

The image pixel format, jpegdec_pixel_format_t.

uint32_t clearStreamBuf

Set to true to clear the saved bit stream buffer.

uint32_t autoStart

Set to true to automatically start the decoding when this descriptor is switched on.

uint32_t __pad4__

Reserved.

uint32_t nextDescptAddr

Address of the next decoding descriptor.

jpegdec_decoder_config_t config

The decoding configuration for this descriptor.

bool enable

Enables the decode IP.

bool enableLp

Enables the core to enter low power mode.

jpegdec_endian_mode_t endianMode

Endian mode for the source/decoded image.

uint8_t slots

Mask of enabled slots _jpegdec_slots.

JPEG_ALIGN_SIZE(size, align)

struct JPEG_DECODER_Type

#include <fsl_jpegdec.h> JPEG decoder structure definition.

struct __jpegdec_decoder_config

#include <fsl_jpegdec.h> JPEG decoder configuration.

struct __jpegdec_descpt

#include <fsl_jpegdec.h> JPEG decoder descriptor.

This structure is used to configure the linked decoding descriptor for one or more slots in Single Bit Stream Repeat mode or Context Switch mode.

struct __jpegdec_config

#include <fsl_jpegdec.h> Configuration for JPEG decoder.

2.41 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_UART

Debug console based on LPC_USART.

DEBUG_CONSOLE_DEVICE_TYPE_SWO

Debug console based on SWO.

DEBUG_CONSOLE_DEVICE_TYPE_QSCI

Debug console based on QSCI.

MIN(a, b)

Computes the minimum of *a* and *b*.

MAX(a, b)

Computes the maximum of *a* and *b*.

UINT16_MAX

Max value of uint16_t type.

UINT32_MAX

Max value of uint32_t type.

SDK_ATOMIC_LOCAL_ADD(addr, val)

Add value *val* from the variable at address *address*.

SDK_ATOMIC_LOCAL_SUB(addr, val)

Subtract value *val* to the variable at address *address*.

SDK_ATOMIC_LOCAL_SET(addr, bits)

Set the bits specified by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR(addr, bits)

Clear the bits specified by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_TOGGLE(addr, bits)

Toggle the bits specified by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR_AND_SET(addr, clearBits, setBits)

For the variable at address *address*, clear the bits specified by *clearBits* and set the bits specified by *setBits*.

SDK_ATOMIC_LOCAL_COMPARE_AND_SET(addr, expected, newValue)

For the variable at address *address*, check whether the value equal to *expected*. If value same as *expected* then update *newValue* to address and return **true** , else return **false** .

SDK_ATOMIC_LOCAL_TEST_AND_SET(addr, newValue)

For the variable at address *address*, set as *newValue* value and return old value.

USEC_TO_COUNT(us, clockFreqInHz)

Macro to convert a microsecond period to raw count value

COUNT_TO_USEC(count, clockFreqInHz)

Macro to convert a raw count value to microsecond

MSEC_TO_COUNT(ms, clockFreqInHz)

Macro to convert a millisecond period to raw count value

COUNT_TO_MSEC(count, clockFreqInHz)

Macro to convert a raw count value to millisecond

SDK_ISR_EXIT_BARRIER

SDK_L1DCACHE_ALIGN(var)

Macro to define a variable with L1 d-cache line size alignment

SDK_SIZEALIGN(var, alignbytes)

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value

CACHE_LINE_DATA

enum __status_groups

Status group numbers.

Values:

enumerator kStatusGroup_Generic

Group number for generic status codes.

enumerator kStatusGroup_FLASH
Group number for FLASH status codes.

enumerator kStatusGroup_LPSPI
Group number for LPSPI status codes.

enumerator kStatusGroup_FLEXIO_SPI
Group number for FLEXIO SPI status codes.

enumerator kStatusGroup_DSPI
Group number for DSPI status codes.

enumerator kStatusGroup_FLEXIO_UART
Group number for FLEXIO UART status codes.

enumerator kStatusGroup_FLEXIO_I2C
Group number for FLEXIO I2C status codes.

enumerator kStatusGroup_LPI2C
Group number for LPI2C status codes.

enumerator kStatusGroup_UART
Group number for UART status codes.

enumerator kStatusGroup_I2C
Group number for UART status codes.

enumerator kStatusGroup_LPSCI
Group number for LPSCI status codes.

enumerator kStatusGroup_LPUART
Group number for LPUART status codes.

enumerator kStatusGroup_SPI
Group number for SPI status code.

enumerator kStatusGroup_XRDC
Group number for XRDC status code.

enumerator kStatusGroup_SEMA42
Group number for SEMA42 status code.

enumerator kStatusGroup_SDHC
Group number for SDHC status code

enumerator kStatusGroup_SDMMC
Group number for SDMMC status code

enumerator kStatusGroup_SAI
Group number for SAI status code

enumerator kStatusGroup_MCG
Group number for MCG status codes.

enumerator kStatusGroup_SCG
Group number for SCG status codes.

enumerator kStatusGroup_SDSPI
Group number for SDSPI status codes.

enumerator kStatusGroup_FLEXIO_I2S
Group number for FLEXIO I2S status codes

enumerator kStatusGroup_FLEXIO_MCULCD
Group number for FLEXIO LCD status codes

enumerator kStatusGroup_FLASHIAP
Group number for FLASHIAP status codes

enumerator kStatusGroup_FLEXCOMM_I2C
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup_I2S
Group number for I2S status codes

enumerator kStatusGroup_IUART
Group number for IUART status codes

enumerator kStatusGroup_CSI
Group number for CSI status codes

enumerator kStatusGroup_MIPI_DSI
Group number for MIPI DSI status codes

enumerator kStatusGroup_SDRAMC
Group number for SDRAMC status codes.

enumerator kStatusGroup_POWER
Group number for POWER status codes.

enumerator kStatusGroup_ENET
Group number for ENET status codes.

enumerator kStatusGroup_PHY
Group number for PHY status codes.

enumerator kStatusGroup_TRGMUX
Group number for TRGMUX status codes.

enumerator kStatusGroup_SMARTCARD
Group number for SMARTCARD status codes.

enumerator kStatusGroup_LMEM
Group number for LMEM status codes.

enumerator kStatusGroup_QSPI
Group number for QSPI status codes.

enumerator kStatusGroup_DMA
Group number for DMA status codes.

enumerator kStatusGroup_EDMA
Group number for EDMA status codes.

enumerator kStatusGroup_DMAMGR
Group number for DMAMGR status codes.

enumerator kStatusGroup_FLEXCAN
Group number for FlexCAN status codes.

enumerator kStatusGroup_LTC
Group number for LTC status codes.

enumerator kStatusGroup_FLEXIO_CAMERA
Group number for FLEXIO CAMERA status codes.

enumerator kStatusGroup_LPC_SPI
Group number for LPC_SPI status codes.

enumerator kStatusGroup_LPC_USART
Group number for LPC_USART status codes.

enumerator kStatusGroup_DMIC
Group number for DMIC status codes.

enumerator kStatusGroup_SDIF
Group number for SDIF status codes.

enumerator kStatusGroup_SPIFI
Group number for SPIFI status codes.

enumerator kStatusGroup_OTP
Group number for OTP status codes.

enumerator kStatusGroup_MCAN
Group number for MCAN status codes.

enumerator kStatusGroup_CAAM
Group number for CAAM status codes.

enumerator kStatusGroup_ECSPI
Group number for ECSPI status codes.

enumerator kStatusGroup_USDHC
Group number for USDHC status codes.

enumerator kStatusGroup_LPC_I2C
Group number for LPC_I2C status codes.

enumerator kStatusGroup_DCP
Group number for DCP status codes.

enumerator kStatusGroup_MSCAN
Group number for MSCAN status codes.

enumerator kStatusGroup_ESAI
Group number for ESAI status codes.

enumerator kStatusGroup_FLEXSPI
Group number for FLEXSPI status codes.

enumerator kStatusGroup_MMDC
Group number for MMDC status codes.

enumerator kStatusGroup_PDM
Group number for MIC status codes.

enumerator kStatusGroup_SDMA
Group number for SDMA status codes.

enumerator kStatusGroup_ICS
Group number for ICS status codes.

enumerator kStatusGroup_SPDIF
Group number for SPDIF status codes.

enumerator kStatusGroup_LPC_MINISPI
Group number for LPC_MINISPI status codes.

enumerator kStatusGroup_HASHCRYPT
Group number for Hashcrypt status codes

enumerator kStatusGroup_LPC_SPI_SSP
Group number for LPC_SPI_SSP status codes.

enumerator kStatusGroup_I3C
Group number for I3C status codes

enumerator kStatusGroup_LPC_I2C_1
Group number for LPC_I2C_1 status codes.

enumerator kStatusGroup_NOTIFIER
Group number for NOTIFIER status codes.

enumerator kStatusGroup_DebugConsole
Group number for debug console status codes.

enumerator kStatusGroup_SEMC
Group number for SEMC status codes.

enumerator kStatusGroup_ApplicationRangeStart
Starting number for application groups.

enumerator kStatusGroup_IAP
Group number for IAP status codes

enumerator kStatusGroup_SFA
Group number for SFA status codes

enumerator kStatusGroup_SPC
Group number for SPC status codes.

enumerator kStatusGroup_PUF
Group number for PUF status codes.

enumerator kStatusGroup_TOUCH_PANEL
Group number for touch panel status codes

enumerator kStatusGroup_VBAT
Group number for VBAT status codes

enumerator kStatusGroup_XSPI
Group number for XSPI status codes

enumerator kStatusGroup_PNGDEC
Group number for PNGDEC status codes

enumerator kStatusGroup_JPEGDEC
Group number for JPEGDEC status codes

enumerator kStatusGroup_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__SDIOSLV
Group number for SDIOSLV status codes.

enumerator kStatusGroup__MECC
Group number for MECC status codes.

enumerator kStatusGroup__ENET__QOS
Group number for ENET_QOS status codes.

enumerator kStatusGroup__LOG
Group number for LOG status codes.

enumerator kStatusGroup__I3CBUS
Group number for I3CBUS status codes.

enumerator kStatusGroup__QSCI
Group number for QSCI status codes.

enumerator kStatusGroup__ELEMU
Group number for ELEMU status codes.

enumerator kStatusGroup__QUEUEDSPI
Group number for QSPI status codes.

enumerator kStatusGroup__POWER__MANAGER
Group number for POWER_MANAGER status codes.

enumerator kStatusGroup__IPED
Group number for IPED status codes.

enumerator kStatusGroup__ELS__PKC
Group number for ELS PKC status codes.

enumerator kStatusGroup__CSS__PKC
Group number for CSS PKC status codes.

enumerator kStatusGroup__HOSTIF
Group number for HOSTIF status codes.

enumerator kStatusGroup__CLIF
Group number for CLIF status codes.

enumerator kStatusGroup__BMA
Group number for BMA status codes.

enumerator kStatusGroup__NETC
Group number for NETC status codes.

enumerator kStatusGroup__ELE
Group number for ELE status codes.

enumerator kStatusGroup__GLIKEY
Group number for GLIKEY status codes.

enumerator kStatusGroup__AON__POWER
Group number for AON_POWER status codes.

enumerator kStatusGroup_AON_COMMON
Group number for AON_COMMON status codes.

enumerator kStatusGroup_ENDAT3
Group number for ENDAT3 status codes.

enumerator kStatusGroup_HIPERFACE
Group number for HIPERFACE status codes.

enumerator kStatusGroup_NPX
Group number for NPX status codes.

enumerator kStatusGroup_ELA_CSEC
Group number for ELA_CSEC status codes.

enumerator kStatusGroup_FLEXIO_T_FORMAT
Group number for T-format status codes.

enumerator kStatusGroup_FLEXIO_A_FORMAT
Group number for A-format status codes.

Generic status return codes.

Values:

enumerator kStatus_Success
Generic status for Success.

enumerator kStatus_Fail
Generic status for Fail.

enumerator kStatus_ReadOnly
Generic status for read only failure.

enumerator kStatus_OutOfRange
Generic status for out of range access.

enumerator kStatus_InvalidArgument
Generic status for invalid argument check.

enumerator kStatus_Timeout
Generic status for timeout.

enumerator kStatus_NoTransferInProgress
Generic status for no transfer in progress.

enumerator kStatus_Busy
Generic status for module is busy.

enumerator kStatus_NoData
Generic status for no data is found for the operation.

typedef int32_t status_t
Type used for all status and error return values.

void *SDK_Malloc(size_t size, size_t alignbytes)
Allocate memory with given alignment and aligned size.

This is provided to support the dynamically allocated memory used in cache-able region.

Parameters

- size – The length required to malloc.

- alignbytes – The alignment size.

Return values

The – allocated memory.

void SDK_Free(void *ptr)

Free memory.

Parameters

- ptr – The memory to be release.

void SDK_DelayAtLeastUs(uint32_t delayTime_us, uint32_t coreClock_Hz)

Delay at least for some time. Please note that, this API uses while loop for delay, different run-time environments make the time not precise, if precise delay count was needed, please implement a new delay function with hardware timer.

Parameters

- delayTime_us – Delay time in unit of microsecond.
- coreClock_Hz – Core clock frequency with Hz.

static inline *status_t* EnableIRQ(IRQn_Type interrupt)

Enable specific interrupt.

Enable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only enables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt enabled successfully
- kStatus_Fail – Failed to enable the interrupt

static inline *status_t* DisableIRQ(IRQn_Type interrupt)

Disable specific interrupt.

Disable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only disables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt disabled successfully
- kStatus_Fail – Failed to disable the interrupt

static inline *status_t* EnableIRQWithPriority(IRQn_Type interrupt, uint8_t priNum)

Enable the IRQ, and also set the interrupt priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the

LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to Enable.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

```
static inline status_t IRQ_SetPriority(IRQn_Type interrupt, uint8_t priNum)
```

Set the IRQ priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to set.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

```
static inline status_t IRQ_ClearPendingIRQ(IRQn_Type interrupt)
```

Clear the pending IRQ flag.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The flag which IRQ to clear.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

```
static inline uint32_t DisableGlobalIRQ(void)
```

Disable the global IRQ.

Disable the global interrupt and return the current primask register. User is required to provided the primask register for the EnableGlobalIRQ().

Returns

Current primask value.

static inline void EnableGlobalIRQ(uint32_t primask)

Enable the global IRQ.

Set the primask register with the provided primask value but not just enable the primask. The idea is for the convenience of integration of RTOS. some RTOS get its own management mechanism of primask. User is required to use the EnableGlobalIRQ() and DisableGlobalIRQ() in pair.

Parameters

- primask – value of primask register to be restored. The primask value is supposed to be provided by the DisableGlobalIRQ().

static inline bool _SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t newValue)

static inline uint32_t _SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)

FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ

Macro to use the default weak IRQ handler in drivers.

MAKE_STATUS(group, code)

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

MAKE_VERSION(major, minor, bugfix)

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms(such as Cortex M) and 16-bit platforms(such as DSC).

Unused		Major Version				Minor Version		Bug Fix	
31	25	24	17	16	9	8	0		

ARRAY_SIZE(x)

Computes the number of elements in an array.

UINT64_H(X)

Macro to get upper 32 bits of a 64-bit value

UINT64_L(X)

Macro to get lower 32 bits of a 64-bit value

SUPPRESS_FALL_THROUGH_WARNING()

For switch case code block, if case section ends without “break;” statement, there 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.

2.42 LCDIF: LCD interface

status_t LCDIF_Init(LCDIF_Type *base)

Initialize the LCDIF.

This function initializes the LCDIF to work.

Parameters

- base – LCDIF peripheral base address.

Return values

kStatus_Success – Initialize successfully.

void LCDIF_Deinit(LCDIF_Type *base)

De-initialize the LCDIF.

This function disables the LCDIF peripheral clock.

Parameters

- base – LCDIF peripheral base address.

void LCDIF_DpiModeGetDefaultConfig(*lcdif_dpi_config_t* *config)

Get the default configuration for to initialize the LCDIF.

The default configuration value is:

```
config->panelWidth = 0;
config->panelHeight = 0;
config->hsw = 0;
config->hfp = 0;
config->hbp = 0;
config->vsw = 0;
config->vfp = 0;
config->vbp = 0;
config->polarityFlags = kLCDIF_VsyncActiveLow | kLCDIF_HsyncActiveLow | kLCDIF_
↪DataEnableActiveHigh |
kLCDIF_DriveDataOnFallingClkEdge; config->format = kLCDIF_Output24Bit;
```

Parameters

- config – Pointer to the LCDIF configuration.

status_t LCDIF_DpiModeSetConfig(LCDIF_Type *base, uint8_t displayIndex, const *lcdif_dpi_config_t* *config)

Initialize the LCDIF to work in DPI mode.

This function configures the LCDIF DPI display.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- config – Pointer to the configuration structure.

Return values

- kStatus_Success – Initialize successfully.
- kStatus_InvalidArgument – Initialize failed because of invalid argument.

status_t LCDIF_DbiModeSetConfig(LCDIF_Type *base, uint8_t displayIndex, const *lcdif_dbi_config_t* *config)

Initialize the LCDIF to work in DBI mode.

This function configures the LCDIF DBI display.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- config – Pointer to the configuration structure.

Return values

- kStatus_Success – Initialize successfully.
- kStatus_InvalidArgument – Initialize failed because of invalid argument.

void LCDIF_DbiModeGetDefaultConfig(*lcdif_dbi_config_t* *config)

Get the default configuration to initialize the LCDIF DBI mode.

The default configuration value is:

```
config->swizzle      = kLCDIF_DbiOutSwizzleRGB;
config->format        = kLCDIF_DbiOutD8RGB332;
config->acTimeUnit    = 0;
config->type          = kLCDIF_DbiTypeA_ClockedE;
config->reversePolarity = false;
config->writeWRPeriod  = 3U;
config->writeWRAssert  = 0U;
config->writeCSAssert  = 0U;
config->writeWRDeassert = 0U;
config->writeCSDeassert = 0U;
config->typeCTas       = 1U;
config->typeCSCLTwrl   = 1U;
config->typeCSCLTwrh   = 1U;
```

Parameters

- config – Pointer to the LCDIF DBI configuration.

static inline void LCDIF_DbiReset(LCDIF_Type *base, uint8_t displayIndex)

Reset the DBI module.

Parameters

- displayIndex – Display index.
- base – LCDIF peripheral base address.

static inline bool LCDIF_DbiIsTypeCFifoFull(LCDIF_Type *base, uint8_t displayIndex)

Check whether the FIFO is full in DBI mode type C.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.

Return values

- true – FIFO full.
- false – FIFO not full.

void LCDIF_DbiSelectArea(LCDIF_Type *base, uint8_t displayIndex, uint16_t startX, uint16_t startY, uint16_t endX, uint16_t endY, bool isTiled)

Select the update area in DBI mode.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- startX – X coordinate for start pixel.

- startY – Y coordinate for start pixel.
- endX – X coordinate for end pixel.
- endY – Y coordinate for end pixel.
- isTiled – true if the pixel data is tiled.

```
static inline void LCDIF__DbiSendCommand(LCDIF_Type *base, uint8_t displayIndex, uint8_t cmd)
```

Send command to DBI port.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- cmd – the DBI command to send.

```
void LCDIF__DbiSendData(LCDIF_Type *base, uint8_t displayIndex, const uint8_t *data, uint32_t dataLen_Byte)
```

brief Send data to DBI port.

Can be used to send light weight data to panel. To send pixel data in frame buffer, use LCDIF_DbiWriteMem.

param base LCDIF peripheral base address. param displayIndex Display index. param data pointer to data buffer. param dataLen_Byte data buffer length in byte.

```
void LCDIF__DbiSendCommandAndData(LCDIF_Type *base, uint8_t displayIndex, uint8_t cmd, const uint8_t *data, uint32_t dataLen_Byte)
```

Send command followed by data to DBI port.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- cmd – the DBI command to send.
- data – pointer to data buffer.
- dataLen_Byte – data buffer length in byte.

```
static inline void LCDIF__DbiWriteMem(LCDIF_Type *base, uint8_t displayIndex)
```

Send pixel data in frame buffer to panel controller memory.

This function starts sending the pixel data in frame buffer to panel controller, user can monitor interrupt kLCDIF_Display0FrameDoneInterrupt to know when then data sending finished.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.

```
void LCDIF__SetFrameBufferConfig(LCDIF_Type *base, uint8_t displayIndex, const lcdif_fb_config_t *config)
```

Configure the LCDIF frame buffer.

@Note: For LCDIF of version DC8000 there can be 3 layers in the pre-processing, compared with the older version. Apart from the video layer, there are also 2 overlay layers which shares the same configurations. Use this API to configure the legacy video layer, and use LCDIF_SetOverlayFrameBufferConfig to configure the overlay layers.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- config – Pointer to the configuration structure.

void LCDIF_FrameBufferGetDefaultConfig(*lcdif_fb_config_t* *config)

Get default frame buffer configuration.

@Note: For LCDIF of version DC8000 there can be 3 layers in the pre-processing, compared with the older version. Apart from the video layer, there are also 2 overlay layers which shares the same configurations. Use this API to get the default configuration for all the 3 layers.

The default configuration is

```
config->enable = true;
config->enableGamma = false;
config->format = kLCDIF_PixelFormatRGB565;
```

Parameters

- config – Pointer to the configuration structure.

static inline void LCDIF_SetFrameBufferAddr(LCDIF_Type *base, uint8_t displayIndex, uint32_t address)

Set the frame buffer to LCDIF.

Note: The address must be 128 bytes aligned.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- address – Frame buffer address.

void LCDIF_SetFrameBufferStride(LCDIF_Type *base, uint8_t displayIndex, uint32_t strideBytes)

Set the frame buffer stride.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- strideBytes – The stride in byte.

static inline void LCDIF_SetFrameBufferUVAddr(LCDIF_Type *base, uint8_t displayIndex, uint32_t address)

Set the frame buffer to LCDIF for UV plane when the input format is YUV420.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- address – Frame buffer address.

static inline void LCDIF_SetFrameBufferUVStride(LCDIF_Type *base, uint8_t displayIndex, uint32_t strideBytes)

```
void LCDIF_SetFrameBufferPosition(LCDIF_Type *base, uint8_t displayIndex, uint16_t topLeftX,  
                                uint16_t topLeftY, uint16_t width, uint16_t height)
```

Configure the video layer position.

@Note: For LCDIF of version DC8000 there can be 3 layers in the pre-processing, compared with the older version. Apart from the video layer, there are also 2 overlay layers which shares the same configurations. Use this API to configure the legacy video layer, and use LCDIF_SetOverlayLayerPosition to configure the overlay layers.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- topLeftX – The x value of the top-left coordinate.
- topLeftY – The y value of the top-left coordinate.
- width – The width of the layer.
- height – The height of the layer.

```
void LCDIF_SetOverlayLayerConfig(LCDIF_Type *base, uint8_t displayIndex, const  
                                lcdif_fb_config_t *config, uint8_t layerIndex)
```

Configure the overlay layers for LCDIF frame buffer.

@Note: For LCDIF of version DC8000 there can be 3 layers in the pre-processing, compared with the older version. Apart from the video layer, there are also 2 overlay layers which shares the same configurations. Use this API to configure the overlay layers, and use LCDIF_SetFrameBufferConfig to configure the legacy video layer.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- config – Pointer to the configuration structure.
- layerIndex – Pointer to the configuration structure.

```
void LCDIF_SetOverlayLayerPosition(LCDIF_Type *base, uint8_t displayIndex, uint16_t topLeftX,  
                                uint16_t topLeftY, uint16_t width, uint16_t height, uint8_t  
                                layerIndex)
```

Configure the overlay layer position.

@Note: For LCDIF of version DC8000 there can be 3 layers in the pre-processing, compared with the older version. Apart from the video layer, there are also 2 overlay layers which shares the same configurations. Use this API to configure the overlay layers, and use LCDIF_SetFrameBufferPosition to configure the legacy video layer.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- topLeftX – The x value of the top-left coordinate.
- topLeftY – The y value of the top-left coordinate.
- width – The width of the layer.
- height – The height of the layer.
- layerIndex – Pointer to the configuration structure.

```
void LCDIF__SetOverlayLayerAddr(LCDIF_Type *base, uint8_t displayIndex, uint32_t address,
                                uint8_t layerIndex)
```

Sets the frame buffer address for overlay layer.

Note: The address must be 64 bytes aligned.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- address – Frame buffer address.
- layerIndex – Which layer to configure.

```
void LCDIF__SetOverlayLayerStride(LCDIF_Type *base, uint8_t displayIndex, uint32_t
                                   strideBytes, uint8_t layerIndex)
```

Sets the frame buffer stride for overlay layer.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- strideBytes – The stride in byte.
- layerIndex – Which layer to configure.

```
static inline void LCDIF__SetOverlayLayerUVAddr(LCDIF_Type *base, uint8_t displayIndex,
                                                  uint32_t address)
```

Sets the frame buffer address for overlay layer 0 for UV plane when the input format is YUV420.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- address – Frame buffer address.

```
static inline void LCDIF__SetOverlayLayerUVStride(LCDIF_Type *base, uint8_t displayIndex,
                                                    uint32_t strideBytes)
```

```
static inline void LCDIF__SetFrameBufferBackground(LCDIF_Type *base, uint8_t displayIndex,
                                                    uint32_t color)
```

Sets the color for background layer.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- color – Background color in ARGB8888 format.

```
status_t LCDIF__GetPorterDuffConfig(lcdif_porter_duff_blend_mode_t mode,
                                     lcdif_layer_alpha_blend_config_t *config)
```

brief Get the alpha blend configuration by porter duff blend mode.

param mode The blend mode. param config Pointer to the configuration. retval kStatus_Success Successfully get the configuration. retval kStatus_InvalidArgument The blend mode not supported.

`void LCDIF_PanelGetDefaultConfig(lcdif_panel_config_t *config)`

Gets default panel configuration.

The default configuration is

```
config->enable = true;
config->enableGamma = false;
config->order    = kLCDIF_VideoOverlay0Overlay1;
config->endian   = kLCDIF_NoSwap;
```

Parameters

- config – Pointer to the configuration structure.

`void LCDIF_SetPanelConfig(LCDIF_Type *base, uint8_t displayIndex, const lcdif_panel_config_t *config)`

Configure the LCDIF panel.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- config – Pointer to the configuration structure.

`static inline void LCDIF_SetLayerOrder(LCDIF_Type *base, uint8_t displayIndex, lcdif_layer_order_t order)`

Sets the layer order for the color key and alpha blend precess.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- order – The order of the 3 configurable layers.

`static inline void LCDIF_SetEndianMode(LCDIF_Type *base, uint8_t displayIndex, lcdif_endian_mode_t mode)`

Sets the endian mode.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- mode – The byte order for the endian mode.

`static inline void LCDIF_EnableUpdate(LCDIF_Type *base, bool enable)`

Enables the module to update the new set of configuration in the next frame's VBLANK.

Parameters

- base – LCDIF peripheral base address.
- enable – True to enable, false to disable.

`static inline void LCDIF_EnableGamma(LCDIF_Type *base, bool enable)`

Enables the gamma correction.

Parameters

- base – LCDIF peripheral base address.
- enable – True to enable, false to disable.

static inline void LCDIF_EnablePanel(LCDIF_Type *base, bool enable)

Enables the panel output.

When disables, all pixels will be black which allows a panel to have correct timing without any pixels.

Parameters

- base – LCDIF peripheral base address.
- enable – True to enable, false to disable.

static inline void LCDIF_Start(LCDIF_Type *base)

Starts the interface mode transfer. Self-clear.

All registers will be copied to the working set and resets the pixel counter.

Parameters

- base – LCDIF peripheral base address.

static inline void LCDIF_Reset(LCDIF_Type *base)

Resets the module. Self-clear.

Parameters

- base – LCDIF peripheral base address.

static inline void LCDIF_SetUpdateReady(LCDIF_Type *base)

Set the update of the double buffer register ready.

Call this API after updating any double buffered register to let the change take effect in next v-blank.

Parameters

- base – LCDIF peripheral base address.

void LCDIF_SetDitherConfig(LCDIF_Type *base, uint8_t displayIndex, const *lcdif_dither_config_t* *config)

Set the dither configuration.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Index to configure.
- config – Pointer to the configuration structure.

void LCDIF_SetGammaData(LCDIF_Type *base, uint8_t displayIndex, uint16_t startIndex, const uint32_t *gamma, uint16_t gammaLen)

Set the gamma translation values to the LCDIF gamma table.

Parameters

- base – LCDIF peripheral base address.
- displayIndex – Display index.
- startIndex – Start index in the gamma table that the value will be set to.
- gamma – The gamma values to set to the gamma table in LCDIF, could be defined using LCDIF_MAKE_GAMMA_VALUE.
- gammaLen – The length of the gamma.

```
static inline void LCDIF_EnableInterrupts(LCDIF_Type *base, uint32_t mask)
```

Enables LCDIF interrupt requests.

Parameters

- base – LCDIF peripheral base address.
- mask – The interrupts to enable, pass in as OR'ed value of `_lcdif_interrupt`.

```
static inline void LCDIF_DisableInterrupts(LCDIF_Type *base, uint32_t mask)
```

Disable LCDIF interrupt requests.

Parameters

- base – LCDIF peripheral base address.
- mask – The interrupts to disable, pass in as OR'ed value of `_lcdif_interrupt`.

```
static inline uint32_t LCDIF_GetAndClearInterruptPendingFlags(LCDIF_Type *base)
```

Get and clear LCDIF interrupt pending status.

Note: The interrupt must be enabled, otherwise the interrupt flags will not assert.

Parameters

- base – LCDIF peripheral base address.

Returns

The interrupt pending status.

```
void LCDIF_CursorGetDefaultConfig(lcdif_cursor_config_t *config)
```

Get the hardware cursor default configuration.

The default configuration values are:

```
config->enable = true;
config->format = kLCDIF_CursorMasked;
config->hotspotOffsetX = 0;
config->hotspotOffsetY = 0;
```

Parameters

- config – Pointer to the hardware cursor configuration structure.

```
void LCDIF_SetCursorConfig(LCDIF_Type *base, const lcdif_cursor_config_t *config)
```

Configure the cursor.

Parameters

- base – LCDIF peripheral base address.
- config – Cursor configuration.

```
static inline void LCDIF_SetCursorHotspotPosition(LCDIF_Type *base, uint16_t x, uint16_t y)
```

Set the cursor hotspot position.

Parameters

- base – LCDIF peripheral base address.
- x – X coordinate of the hotspot, range 0 ~ 8191.
- y – Y coordinate of the hotspot, range 0 ~ 8191.

static inline void LCDIF_SetCursorBufferAddress(LCDIF_Type *base, uint32_t address)

Set the cursor memory address.

Parameters

- base – LCDIF peripheral base address.
- address – Memory address.

void LCDIF_SetCursorColor(LCDIF_Type *base, uint32_t background, uint32_t foreground)

Set the cursor color.

Parameters

- base – LCDIF peripheral base address.
- background – Background color, could be defined use LCDIF_MAKE_CURSOR_COLOR
- foreground – Foreground color, could be defined use LCDIF_MAKE_CURSOR_COLOR

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enum _lcdif_polarity_flags

LCDIF signal polarity flags.

Values:

enumerator kLCDIF_VsyncActiveLow
VSYNC active low.

enumerator kLCDIF_VsyncActiveHigh
VSYNC active high.

enumerator kLCDIF_HsyncActiveLow
HSYNC active low.

enumerator kLCDIF_HsyncActiveHigh
HSYNC active high.

enumerator kLCDIF_DataEnableActiveLow
Data enable line active low.

enumerator kLCDIF_DataEnableActiveHigh
Data enable line active high.

enumerator kLCDIF_DriveDataOnFallingClkEdge
Drive data on falling clock edge, capture data on rising clock edge.

enumerator kLCDIF_DriveDataOnRisingClkEdge
Drive data on falling clock edge, capture data on rising clock edge.

enum _lcdif_output_format

LCDIF DPI output format.

Values:

enumerator kLCDIF_Output16BitConfig1
16-bit configuration 1. RGB565: XXXXXXXX_RRRRRGGG_GGGBBBBB.

enumerator kLCDIF_Output16BitConfig2
16-bit configuration 2. RGB565: XXXRRRRR_XXGGGGGG_XXXBBBBB.

enumerator kLCDIF_Output16BitConfig3
16-bit configuration 3. RGB565: XXRRRRRX_XXGGGGGG_XXBBBBBX.

enumerator kLCDIF__Output18BitConfig1
18-bit configuration 1. RGB666: XXXXXXRR_RRRRGGGG_GGBBBBBB.

enumerator kLCDIF__Output18BitConfig2
18-bit configuration 2. RGB666: XXRRRRRR_XXGGGGGG_XXBBBBBB.

enumerator kLCDIF__Output24Bit
24-bit.

enum _lcdif_fb_format
LCDIF frame buffer pixel format.

Values:

enumerator kLCDIF__PixelFormatARGB4444
ARGB4444, 16-bit each pixel, 4-bit each element.

enumerator kLCDIF__PixelFormatARGB1555
ARGB1555, 16-bit each pixel, 5-bit each element.

enumerator kLCDIF__PixelFormatRGB565
RGB565, 16-bit each pixel.

enumerator kLCDIF__PixelFormatARGB8888
ARGB8888, 32-bit each pixel, 8-bit each element.

enumerator kLCDIF__PixelFormatRGB888
RGB888, 24-bit each pixel, 8-bit each element.

enumerator kLCDIF__PixelFormatARGB8565
ARGB8565, 24-bit each pixel.

enumerator kLCDIF__PixelFormatARGB8888Tiled
ARGB8888, 32-bit each pixel, 8-bit each element in tiled format, not supported in overlay layer 1.

enumerator kLCDIF__PixelFormatYUV422Tiled
YUV422, component order V-Y-U-Y, in tiled format, not supported in overlay layer 1.

enumerator kLCDIF__PixelFormatYUV420Tiled
YUV420, in tiled format, need 2 plane, not supported in overlay layer 1.

enumerator kLCDIF__PixelFormatRGB888Tiled
RGB888, 24-bit each pixel, 8-bit each element in tiled format, not supported in overlay layer 1.

enumerator kLCDIF__PixelFormatARGB8565Tiled
ARGB8565, 24-bit each pixel in tiled format, not supported in overlay layer 1.

enum _lcdif_layer_input_order
LCDIF layer input pixel order.

Values:

enumerator kLCDIF__PixelFormatInputOrderARGB
Input order ARGB.

enumerator kLCDIF__PixelFormatInputOrderRGBA
Input order RGBA.

enumerator kLCDIF__PixelFormatInputOrderABGR
Input order ABGR.

enumerator kLCDIF_PixelInputOrderBGRA
Input order BGRA.

enum _lcdif_layer_rotate_flip
LCDIF layer rotation or flip configuration.

Values:

enumerator kLCDIF_Rotate0
Clock wise rotate 0 degree.

enumerator kLCDIF_Rotate90
Clock wise rotate 90 degree, not supported yet.

enumerator kLCDIF_Rotate180
Clock wise rotate 180 degree.

enumerator kLCDIF_Rotate270
Clock wise rotate 270 degree, not supported yet.

enumerator kLCDIF_FlipHorizontal
Horizontal flip.

enumerator kLCDIF_FlipVertical
Vertical flip.

enum _lcdif_layer_decompress_mode
LCDIF layer input data decompress mode.

Values:

enumerator kLCDIF-DecompressNone
Decompression disabled. The input is straight RGB/YUV data.

enumerator kLCDIF-DecompressDECNanoNoneSample
DECNano decompression with none sample.

enumerator kLCDIF-DecompressDECNanoHSample
DECNano decompression with horizontal sample.

enumerator kLCDIF-DecompressDECNanoHVSsample
DECNano decompression with both horizontal and vertical sample.

enumerator kLCDIF-DecompressETC2
ETC2 decompression.

Alpha blend alpha component mode. .

Values:

enumerator kLCDIF_AlphaStraight
Use straight alpha, s0_alpha' = s0_alpha.

enumerator kLCDIF_AlphaInversed
Use inversed alpha, s0_alpha' = 0xFF - s0_alpha.

LCDIF layer global alpha mode for alpha blend. .

Values:

enumerator kLCDIF_AlphaLocal
Use the alpha(or inversed alpha) component directly.

enumerator kLCDIF__AlphaGlobal

Use the global alpha instead.

enumerator kLCDIF__AlphaScaled

Multiply the alpha(or inversed alpha) component by the global alpha.

Alpha blend factor mode. .

Values:

enumerator kLCDIF__AlphaFactorZero

Use 0 as the blending factor.

enumerator kLCDIF__AlphaFactorOne

Use 1 as the blending factor.

enumerator kLCDIF__AlphaFactorStraight

Use the modified alpha component(As'' for source layer or Ad'' for destination layer) as the blending factor.

enumerator kLCDIF__AlphaFactorInversed

Use the inversed alpha component(1-As'' for source layer or 1-Ad'' for destination layer) as the blending factor.

enum _lcdif_porter_duff_blend_mode

LCDIF Porter Duff blend mode. Note: don't change the enum item value.

Values:

enumerator kLCDIF__PorterDuffSrc

Source Only

enumerator kLCDIF__PorterDuffAtop

Source Atop

enumerator kLCDIF__PorterDuffOver

Source Over

enumerator kLCDIF__PorterDuffIn

Source In.

enumerator kLCDIF__PorterDuffOut

Source Out.

enumerator kLCDIF__PorterDuffDst

Destination Only.

enumerator kLCDIF__PorterDuffDstAtop

Destination Atop.

enumerator kLCDIF__PorterDuffDstOver

Destination Over.

enumerator kLCDIF__PorterDuffDstIn

Destination In.

enumerator kLCDIF__PorterDuffDstOut

Destination Out.

enumerator kLCDIF__PorterDuffPlus

Clear.

enumerator kLCDIF__PorterDuffXor
XOR.

enumerator kLCDIF__PorterDuffClear
Clear.

enumerator kLCDIF__PorterDuffMax

enum _lcdif_layer_convert_standard

LCDIF Color space convert standard between RGB and YUV when the input format is tiled YUV.

Values:

enumerator kLCDIF__ConvertBT601
Use standard BT601.

enumerator kLCDIF__ConvertBT709
Use standard BT709.

enum _lcdif_layer_order

LCDIF the layer order from bottom to top.

There are 5 layers in total, apart from the background layer fixed in the bottom, and the cursor layer on top that does not participate in the color key and alpha blend, the order of the other 3 layers video/graphic layer, overlay layer 0 and 1 can be changed. During color key or alpha blend process, between 2 adjacent layers, the lower layer is considered as destination layer and the upper layer is considered as source layer. The process is performed from bottom to top, after processing 2 layers, the generated new layer will be considered as destination layer then participate in the next process with the next upper layer.

Values:

enumerator kLCDIF__VideoOverlay0Overlay1
In the order of video, overlay0, overlay1.

enumerator kLCDIF__VideoOverlay1Overlay0
In the order of video, overlay1, overlay0.

enumerator kLCDIF__Overlay0VideoOverlay1
In the order of overlay0, video, overlay1.

enumerator kLCDIF__Overlay0Overlay1Video
In the order of overlay0, overlay1, video.

enumerator kLCDIF__Overlay1VideoOverlay0
In the order of overlay1, video, overlay0.

enumerator kLCDIF__Overlay1Overlay0Video
In the order of overlay1, overlay0, video.

enum _lcdif_endian_mode

LCDIF the pixel source endian mode.

Values:

enumerator kLCDIF__NoSwap
No swap.

enumerator kLCDIF__HalfWordSwap
16-bit boundary swap, from 0123 to 1032.

enumerator kLCDIF__WordSwap
32-bit boundary swap, from 0123 to 3210.

enum _lcdif_interrupt

LCDIF interrupt and status.

Values:

enumerator kLCDIF_Display0FrameDoneInterrupt

The last pixel of visible area in frame is shown.

enumerator kLCDIF_Display0DbiConfigErrorInterrupt

The DBI command is illegal.

enumerator kLCDIF_PanelUnderflowInterrupt

The AXI clock and pixel clock mismatch causing data supply insufficient.

enumerator kLCDIF_SoftwareResetDoneInterrupt

A software reset has completed.

enumerator kLCDIF_BusErrorInterrupt

An AXI bus transfer error occurs.

enum _lcdif_cursor_format

LCDIF cursor format.

Values:

enumerator kLCDIF_CursorMasked

Masked format.

enumerator kLCDIF_CursorARGB8888

ARGB8888.

enum _lcdif_dbi_cmd_flag

LCDIF DBI command flag.

Values:

enumerator kLCDIF_DbiCmdAddress

Send address (or command).

enumerator kLCDIF_DbiCmdWriteMem

Start write memory.

enumerator kLCDIF_DbiCmdData

Send data.

enumerator kLCDIF_DbiCmdReadMem

Start read memory.

enum _lcdif_dbi_out_format

LCDIF DBI output format.

Values:

enumerator kLCDIF_DbiOutD8RGB332

8-bit data bus width, pixel RGB332. For type A or B. 1 pixel sent in 1 cycle.

enumerator kLCDIF_DbiOutD8RGB444

8-bit data bus width, pixel RGB444. For type A or B. 2 pixels sent in 3 cycles.

enumerator kLCDIF_DbiOutD8RGB565

8-bit data bus width, pixel RGB565. For type A or B. 1 pixel sent in 2 cycles.

enumerator kLCDIF_DbiOutD8RGB666

8-bit data bus width, pixel RGB666. For type A or B. 1 pixel sent in 3 cycles, data bus 2 LSB not used.

enumerator kLCDIF_DbiOutD8RGB888

8-bit data bus width, pixel RGB888. For type A or B. 1 pixel sent in 3 cycles.

enumerator kLCDIF_DbiOutD9RGB666

9-bit data bus width, pixel RGB666. For type A or B. 1 pixel sent in 2 cycles.

enumerator kLCDIF_DbiOutD16RGB332

16-bit data bus width, pixel RGB332. For type A or B. 2 pixels sent in 1 cycle.

enumerator kLCDIF_DbiOutD16RGB444

16-bit data bus width, pixel RGB444. For type A or B. 1 pixel sent in 1 cycle, data bus 4 MSB not used.

enumerator kLCDIF_DbiOutD16RGB565

16-bit data bus width, pixel RGB565. For type A or B. 1 pixel sent in 1 cycle.

enumerator kLCDIF_DbiOutD16RGB666Option1

16-bit data bus width, pixel RGB666. For type A or B. 2 pixels sent in 3 cycles.

enumerator kLCDIF_DbiOutD16RGB666Option2

16-bit data bus width, pixel RGB666. For type A or B. 1 pixel sent in 2 cycles.

enumerator kLCDIF_DbiOutD16RGB888Option1

16-bit data bus width, pixel RGB888. For type A or B. 2 pixels sent in 3 cycles.

enumerator kLCDIF_DbiOutD16RGB888Option2

16-bit data bus width, pixel RGB888. For type A or B. 1 pixel sent in 2 cycles.

enumerator kLCDIF_DbiOutD1RGB565Option1

1-bit data bus width, pixel RGB565. For type C option 1, use extra bit to distinguish Data and Command (DC).

enumerator kLCDIF_DbiOutD1RGB565Option2

1-bit data bus width, pixel RGB565. For type C option 2, use extra byte to distinguish Data and Command (DC).

enumerator kLCDIF_DbiOutD1RGB565Option3

1-bit data bus width, pixel RGB565. For type C option 3, use extra DC line to distinguish Data and Command (DC).

enumerator kLCDIF_DbiOutD1RGB888Option1

1-bit data bus width, pixel RGB888. For type C option 1, use extra bit to distinguish Data and Command (DC).

enumerator kLCDIF_DbiOutD1RGB888Option2

1-bit data bus width, pixel RGB888. For type C option 2, use extra byte to distinguish Data and Command (DC).

enumerator kLCDIF_DbiOutD1RGB888Option3

1-bit data bus width, pixel RGB888. For type C option 3, use extra DC line to distinguish Data and Command (DC).

enum _lcdif_dbi_type

LCDIF DBI type.

Values:

enumerator kLCDIF_DbiTypeA_FixedE

Selects DBI type A fixed E mode, 68000, Motorola mode.

enumerator kLCDIF_DbiTypeA_ClockedE

Selects DBI Type A Clocked E mode, 68000, Motorola mode.

```

enumerator kLCDIF_DbiTypeB
    Selects DBI type B, 8080, Intel mode.
enumerator kLCDIF_DbiTypeC
    Selects DBI type C, SPI mode.
enum _lcdif_dbi_out_swizzle
    LCDIF DBI output swizzle.
    Values:
    enumerator kLCDIF_DbiOutSwizzleRGB
        RGB
    enumerator kLCDIF_DbiOutSwizzleBGR
        BGR
typedef enum _lcdif_output_format lcdif_output_format_t
    LCDIF DPI output format.
typedef struct _lcdif_dpi_config lcdif_dpi_config_t
    Configuration for LCDIF module to work in DBI mode.
typedef enum _lcdif_fb_format lcdif_fb_format_t
    LCDIF frame buffer pixel format.
typedef enum _lcdif_layer_input_order lcdif_layer_input_order_t
    LCDIF layer input pixel order.
typedef enum _lcdif_layer_rotate_flip lcdif_layer_rotate_flip_t
    LCDIF layer rotation or flip configuration.
typedef struct _lcdif_layer_colorkey lcdif_layer_colorkey_t
    LCDIF layer color key configuration.
typedef enum _lcdif_layer_decompress_mode lcdif_layer_decompress_mode_t
    LCDIF layer input data decompress mode.
typedef enum _lcdif_porter_duff_blend_mode lcdif_porter_duff_blend_mode_t
    LCDIF Porter Duff blend mode. Note: don't change the enum item value.
typedef enum _lcdif_layer_convert_standard lcdif_layer_convert_standard_t
    LCDIF Color space convert standard between RGB and YUV when the input format is tiled YUV.
typedef struct _lcdif_fb_config lcdif_fb_config_t
    LCDIF frame buffer configuration.

    For LCDIF of DC8000 version, there are 3 layers in the pre-processing, all shares the same
    frame buffer configuration.
typedef enum _lcdif_layer_order lcdif_layer_order_t
    LCDIF the layer order from bottom to top.

    There are 5 layers in total, apart from the background layer fixed in the bottom, and the
    cursor layer on top that does not participate in the color key and alpha blend, the order of
    the other 3 layers video/graphic layer, overlay layer 0 and 1 can be changed. During color
    key or alpha blend process, between 2 adjacent layers, the lower layer is considered as des-
    tination layer and the upper layer is considered as source layer. The precess is performed
    from bottom to top, after processing 2 layes, the generated new layer will be considered as
    destination layer then participate in the next process with the next upper layer.

```

typedef enum *_lcdif_endian_mode* lcdif_endian_mode_t

LCDIF the pixel source endian mode.

typedef struct *_lcdif_panel_config* lcdif_panel_config_t

LCDIF panel configuration.

typedef enum *_lcdif_cursor_format* lcdif_cursor_format_t

LCDIF cursor format.

typedef struct *_lcdif_cursor_config* lcdif_cursor_config_t

LCDIF cursor configuration.

typedef struct *_lcdif_dither_config* lcdif_dither_config_t

LCDIF dither configuration.

- a. Decide which bit of pixel color to enhance. This is configured by the `lcdif_dither_config_t::redSize`, `lcdif_dither_config_t::greenSize`, and `lcdif_dither_config_t::blueSize`. For example, setting `redSize=6` means it is the 6th bit starting from the MSB that we want to enhance, in other words, it is the `RedColor[2]` bit from `RedColor[7:0]`. `greenSize` and `blueSize` function in the same way.
- b. Create the look-up table. a. The Look-Up Table includes 16 entries, 4 bits for each. b. The Look-Up Table provides a value `U[3:0]` through the index `X[1:0]` and `Y[1:0]`. c. The color value `RedColor[3:0]` is used to compare with this `U[3:0]`. d. If `RedColor[3:0] > U[3:0]`, and `RedColor[7:2]` is not 6'b111111, then the final color value is: `NewRedColor = RedColor[7:2] + 1'b1`. e. If `RedColor[3:0] <= U[3:0]`, then `NewRedColor = RedColor[7:2]`.

typedef enum *_lcdif_dbi_out_format* lcdif_dbi_out_format_t

LCDIF DBI output format.

typedef enum *_lcdif_dbi_type* lcdif_dbi_type_t

LCDIF DBI type.

typedef enum *_lcdif_dbi_out_swizzle* lcdif_dbi_out_swizzle_t

LCDIF DBI output swizzle.

typedef struct *_lcdif_dbi_config* lcdif_dbi_config_t

LCDIF DBI configuration.

LCDIF_MAKE_CURSOR_COLOR(r, g, b)

Construct the cursor color, every element should be in the range of 0 ~ 255.

LCDIF_MAKE_GAMMA_VALUE(r, g, b)

Construct the gamma value set to LCDIF gamma table, every element should be in the range of 0~255.

LCDIF_MAKE_BACKGROUND_VALUE(a, r, g, b)

Construct the colour value for the background layer.

LCDIF_ALIGN_ADDR(addr, align)

Calculate the aligned address for LCDIF buffer.

LCDIF_FB_ALIGN

The frame buffer should be 128 byte aligned.

LCDIF_FB_UV_ALIGN

LCDIF_GAMMA_INDEX_MAX

Gamma index max value.

LCDIF_CURSOR_SIZE

The cursor size is 32 x 32.

LCDIF_FRAMEBUFFERCONFIG0_OUTPUT_MASK

LCDIF_ADDR_CPU_2_IP(addr)

struct _lcdif_dpi_config

#include <fsl_lcdif.h> Configuration for LCDIF module to work in DBI mode.

Public Members

uint16_t panelWidth

Display panel width, pixels per line.

uint16_t panelHeight

Display panel height, how many lines per panel.

uint8_t hsw

HSYNC pulse width.

uint8_t hfp

Horizontal front porch.

uint8_t hbp

Horizontal back porch.

uint8_t vsw

VSYNC pulse width.

uint8_t vfp

Vertical front porch.

uint8_t vbp

Vertical back porch.

uint32_t polarityFlags

OR'ed value of _lcdif_polarity_flags, used to control the signal polarity.

lcdif_output_format_t format

DPI output format.

struct _lcdif_layer_colorkey

#include <fsl_lcdif.h> LCDIF layer color key configuration.

Public Members

bool enable

Enable the color keying.

struct lcdif_layer_alpha_blend_config_t

#include <fsl_lcdif.h> LCDIF frame buffer alpha blend configuration.

The alpha blending formula is $C = F_s \times C_s + F_d \times C_d$, and $A = F_s \times A_s' + F_d \times A_d'$. C/A: generated final color/alpha component, C_s/C_d : original color component for source and destination layer, A_s'/A_d' : modified alpha component for source and destination layer, take A_s' as example, $A_s' = A_s$ or $(1 - A_s)$, chosen by srcAlphaMode $A_s' = A_s'$ or A_g or $(A_s' \times A_g)$, chosen by srcGlobalAlphaMode, A_g configured by srcGlobalAlpha F_s/F_d : blending factor for source/destination layer, take F_s as example, $F_s = 0$ or 1 or A_s' or $(1 - A_s')$, chosen by srcFactorMode

Public Members

uint32_t enable

Enables or disables alpha blend configuration.

uint32_t srcAlphaMode

Use the straight(As) or inversed(1-As) alpha value for modified alpha for the source layer, see `lcdif_layer_alpha_mode_t`.

uint32_t srcGlobalAlphaMode

Source layer global alpha mode, see `lcdif_layer_global_alpha_mode_t`.

uint32_t srcFactorMode

Source layer blend factor mode, see `lcdif_layer_alpha_factor_mode_t`.

uint32_t useSrcAlpha

Set to true to use source alpha for the source blending factor, otherwise use the destination alpha.

uint32_t dstAlphaMode

Use the straight(Ad) or inversed(1-Ad) alpha value for modified alpha for the destination layer, see `lcdif_layer_alpha_mode_t`.

uint32_t dstGlobalAlphaMode

Destination layer global alpha mode, see `lcdif_layer_global_alpha_mode_t`.

uint32_t dstFactorMode

Destination layer blend factor mode, see `lcdif_layer_alpha_factor_mode_t`.

uint32_t useDstAlpha

Set to true to use destination alpha for the destination blending factor, otherwise use the source alpha.

uint32_t srcGlobalAlpha

Source layer global alpha value, 0~255.

uint32_t dstGlobalAlpha

Destination layer global alpha value, 0~255.

struct `_lcdif_fb_config`

#include <fsl_lcdif.h> LCDIF frame buffer configuration.

For LCDIF of DC8000 version, there are 3 layers in the pre-processing, all shares the same frame buffer configuration.

Public Members

bool enable

Enable the layer output.

bool enableClear

Enable the color clear for this layer, onve enabled, the whole layer will be filled with the color configured in `clearValue`.

uint32_t clearValue

The value used for layer clear.

lcdif_fb_format_t format

Frame buffer output pixel format.

lcdif_layer_convert_standard_t standard

Color space convert standard, not used for overlay layer 1 since it does not support tile YUV input.

bool enableUVSwizzle

Swizzle the U/V components, not used for overlay layer 1 since it does not support tile YUV input.

lcdif_layer_input_order_t inOrder

Color component order of the input pixel.

lcdif_layer_colorkey_t colorkey

Color key configuration.

lcdif_layer_decompress_mode_t decompress

LCDIF layer input data decompress mode.

lcdif_layer_rotate_flip_t rotateFlipMode

LCDIF frame buffer rotation or flip configuration.

lcdif_layer_alpha_blend_config_t alpha

The alpha blending configuration.

uint16_t topLeftX

The x value of the top-left coordinate.

uint16_t topLeftY

The y value of the top-left coordinate.

uint16_t width

The width of the layer.

uint16_t height

The height of the layer.

struct _lcdif_panel_config

#include <fsl_lcdif.h> LCDIF panel configuration.

Public Members

bool enable

Enable the frame buffer output.

bool enableGamma

Enable the gamma correction.

lcdif_layer_order_t order

Layer order.

lcdif_endian_mode_t endian

Pixel source endian mode.

struct _lcdif_cursor_config

#include <fsl_lcdif.h> LCDIF cursor configuration.

Public Members

bool enable

Enable the cursor or not.

lcdif_cursor_format_t format

Cursor format.

uint8_t hotspotOffsetX

Offset of the hotspot to top left point, range 0 ~ 31

uint8_t hotspotOffsetY

Offset of the hotspot to top left point, range 0 ~ 31

struct _lcdif_dither_config

#include <fsl_lcdif.h> LCDIF dither configuration.

- a. Decide which bit of pixel color to enhance. This is configured by the `lcdif_dither_config_t::redSize`, `lcdif_dither_config_t::greenSize`, and `lcdif_dither_config_t::blueSize`. For example, setting `redSize=6` means it is the 6th bit starting from the MSB that we want to enhance, in other words, it is the `RedColor[2]` bit from `RedColor[7:0]`. `greenSize` and `blueSize` function in the same way.
- b. Create the look-up table.
 - a. The Look-Up Table includes 16 entries, 4 bits for each.
 - b. The Look-Up Table provides a value `U[3:0]` through the index `X[1:0]` and `Y[1:0]`.
 - c. The color value `RedColor[3:0]` is used to compare with this `U[3:0]`.
 - d. If `RedColor[3:0] > U[3:0]`, and `RedColor[7:2]` is not 6'b111111, then the final color value is: `NewRedColor = RedColor[7:2] + 1'b1`.
 - e. If `RedColor[3:0] <= U[3:0]`, then `NewRedColor = RedColor[7:2]`.

Public Members

bool enable

Enable or not.

uint32_t low

Low part of the look up table.

uint32_t high

High part of the look up table.

struct _lcdif_dbi_config

#include <fsl_lcdif.h> LCDIF DBI configuration.

Public Members

lcdif_dbi_out_swizzle_t swizzle

Swizzle.

lcdif_dbi_out_format_t format

Output format.

uint8_t acTimeUnit

Time unit for AC characteristics.

lcdif_dbi_type_t type

DBI type.

bool reversePolarity

Reverse the DC pin polarity.

uint16_t writeWRPeriod

WR signal period, Cycle number = `writeWRPeriod * (acTimeUnit + 1)`, must be no less than 3. Only for type A and type b.

uint8_t writeWRAssert

Cycle number = writeWRAssert * (acTimeUnit + 1), only for type A and type B. With kLCDIF_DbiTypeA_FixedE: Not used. With kLCDIF_DbiTypeA_ClockedE: Time to assert E. With kLCDIF_DbiTypeB: Time to assert WRX.

uint8_t writeCSAssert

Cycle number = writeCSAssert * (acTimeUnit + 1), only for type A and type B. With kLCDIF_DbiTypeA_FixedE: Time to assert CSX. With kLCDIF_DbiTypeA_ClockedE: Not used. With kLCDIF_DbiTypeB: Time to assert CSX.

uint16_t writeWRDeassert

Cycle number = writeWRDeassert * (acTimeUnit + 1), only for type A and type B. With kLCDIF_DbiTypeA_FixedE: Not used. With kLCDIF_DbiTypeA_ClockedE: Time to de-assert E. With kLCDIF_DbiTypeB: Time to de-assert WRX.

uint16_t writeCSDeassert

Cycle number = writeCSDeassert * (acTimeUnit + 1), only for type A and type B. With kLCDIF_DbiTypeA_FixedE: Time to de-assert CSX. With kLCDIF_DbiTypeA_ClockedE: Not used. With kLCDIF_DbiTypeB: Time to de-assert CSX.

uint8_t typeCTas

How many sdaClk cycles in Tas phase, only for Type C option 3, at least 1.

uint8_t typeCSCLTwrl

How many sdaClk cycles in Twrl phase, only for Type C, at least 1.

uint8_t typeCSCLTwrh

How many sdaClk cycles in Twrh phase, only for Type C, at least 1.

2.43 LPADC: 12-bit SAR Analog-to-Digital Converter Driver

enum _lpadc_status_flags

Define hardware flags of the module.

Values:

enumerator kLPADC_ResultFIFO0OverflowFlag

Indicates that more data has been written to the Result FIFO 0 than it can hold.

enumerator kLPADC_ResultFIFO0ReadyFlag

Indicates when the number of valid datawords in the result FIFO 0 is greater than the setting watermark level.

enumerator kLPADC_TriggerExceptionFlag

Indicates that a trigger exception event has occurred.

enumerator kLPADC_TriggerCompletionFlag

Indicates that a trigger completion event has occurred.

enumerator kLPADC_CalibrationReadyFlag

Indicates that the calibration process is done.

enumerator kLPADC_ActiveFlag

Indicates that the ADC is in active state.

enumerator kLPADC_ResultFIFOOverflowFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowFlag as instead.

enumerator kLPADC_ResultFIFOReadyFlag

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0ReadyFlag as instead.

enum __lpadc_interrupt_enable

Define interrupt switchers of the module.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_ResultFIFO0OverflowInterruptEnable

Configures ADC to generate overflow interrupt requests when FOF0 flag is asserted.

enumerator kLPADC_FIFO0WatermarkInterruptEnable

Configures ADC to generate watermark interrupt requests when RDY0 flag is asserted.

enumerator kLPADC_ResultFIFOOverflowInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_ResultFIFO0OverflowInterruptEnable as instead.

enumerator kLPADC_FIFOWatermarkInterruptEnable

To compilitable with old version, do not recommend using this, please use kLPADC_FIFO0WatermarkInterruptEnable as instead.

enumerator kLPADC_TriggerExceptionInterruptEnable

Configures ADC to generate trigger exception interrupt.

enumerator kLPADC_Trigger0CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 0 completion.

enumerator kLPADC_Trigger1CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 1 completion.

enumerator kLPADC_Trigger2CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 2 completion.

enumerator kLPADC_Trigger3CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 3 completion.

enumerator kLPADC_Trigger4CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 4 completion.

enumerator kLPADC_Trigger5CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 5 completion.

enumerator kLPADC_Trigger6CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 6 completion.

enumerator kLPADC_Trigger7CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 7 completion.

enumerator kLPADC_Trigger8CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 8 completion.

enumerator kLPADC_Trigger9CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 9 completion.

enumerator kLPADC_Trigger10CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 10 completion.

enumerator kLPADC_Trigger11CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 11 completion.

enumerator kLPADC_Trigger12CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 12 completion.

enumerator kLPADC_Trigger13CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 13 completion.

enumerator kLPADC_Trigger14CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 14 completion.

enumerator kLPADC_Trigger15CompletionInterruptEnable

Configures ADC to generate interrupt when trigger 15 completion.

enum _lpadc_trigger_status_flags

The enumerator of lpadc trigger status flags, including interrupted flags and completed flags.

Note: LPADC of different chips supports different number of trigger sources, please check the Reference Manual for details.

Values:

enumerator kLPADC_Trigger0InterruptedFlag

Trigger 0 is interrupted by a high priority exception.

enumerator kLPADC_Trigger1InterruptedFlag

Trigger 1 is interrupted by a high priority exception.

enumerator kLPADC_Trigger2InterruptedFlag

Trigger 2 is interrupted by a high priority exception.

enumerator kLPADC_Trigger3InterruptedFlag

Trigger 3 is interrupted by a high priority exception.

enumerator kLPADC_Trigger4InterruptedFlag

Trigger 4 is interrupted by a high priority exception.

enumerator kLPADC_Trigger5InterruptedFlag

Trigger 5 is interrupted by a high priority exception.

enumerator kLPADC_Trigger6InterruptedFlag

Trigger 6 is interrupted by a high priority exception.

enumerator kLPADC_Trigger7InterruptedFlag

Trigger 7 is interrupted by a high priority exception.

enumerator kLPADC_Trigger8InterruptedFlag

Trigger 8 is interrupted by a high priority exception.

enumerator kLPADC_Trigger9InterruptedFlag

Trigger 9 is interrupted by a high priority exception.

enumerator kLPADC_Trigger10InterruptedFlag

Trigger 10 is interrupted by a high priority exception.

enumerator kLPADC_Trigger11InterruptedFlag

Trigger 11 is interrupted by a high priority exception.

enumerator kLPADC_Trigger12InterruptedFlag

Trigger 12 is interrupted by a high priority exception.

enumerator kLPADC_Trigger13InterruptedFlag

Trigger 13 is interrupted by a high priority exception.

enumerator kLPADC_Trigger14InterruptedFlag

Trigger 14 is interrupted by a high priority exception.

enumerator kLPADC_Trigger15InterruptedFlag

Trigger 15 is interrupted by a high priority exception.

enumerator kLPADC_Trigger0CompletedFlag

Trigger 0 is completed and trigger 0 has enabled completion interrupts.

enumerator kLPADC_Trigger1CompletedFlag

Trigger 1 is completed and trigger 1 has enabled completion interrupts.

enumerator kLPADC_Trigger2CompletedFlag

Trigger 2 is completed and trigger 2 has enabled completion interrupts.

enumerator kLPADC_Trigger3CompletedFlag

Trigger 3 is completed and trigger 3 has enabled completion interrupts.

enumerator kLPADC_Trigger4CompletedFlag

Trigger 4 is completed and trigger 4 has enabled completion interrupts.

enumerator kLPADC_Trigger5CompletedFlag

Trigger 5 is completed and trigger 5 has enabled completion interrupts.

enumerator kLPADC_Trigger6CompletedFlag

Trigger 6 is completed and trigger 6 has enabled completion interrupts.

enumerator kLPADC_Trigger7CompletedFlag

Trigger 7 is completed and trigger 7 has enabled completion interrupts.

enumerator kLPADC_Trigger8CompletedFlag

Trigger 8 is completed and trigger 8 has enabled completion interrupts.

enumerator kLPADC_Trigger9CompletedFlag

Trigger 9 is completed and trigger 9 has enabled completion interrupts.

enumerator kLPADC_Trigger10CompletedFlag

Trigger 10 is completed and trigger 10 has enabled completion interrupts.

enumerator kLPADC_Trigger11CompletedFlag

Trigger 11 is completed and trigger 11 has enabled completion interrupts.

enumerator kLPADC_Trigger12CompletedFlag

Trigger 12 is completed and trigger 12 has enabled completion interrupts.

enumerator kLPADC_Trigger13CompletedFlag

Trigger 13 is completed and trigger 13 has enabled completion interrupts.

enumerator kLPADC_Trigger14CompletedFlag

Trigger 14 is completed and trigger 14 has enabled completion interrupts.

enumerator kLPADC_Trigger15CompletedFlag

Trigger 15 is completed and trigger 15 has enabled completion interrupts.

enum __lpadc_sample_scale_mode

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level

at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

Values:

enumerator kLPADC__SamplePartScale

Use divided input voltage signal. (For scale select, please refer to the reference manual).

enumerator kLPADC__SampleFullScale

Full scale (Factor of 1).

enum __lpadc_sample_channel_mode

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

Values:

enumerator kLPADC__SampleChannelSingleEndSideA

Single-end mode, only A-side channel is converted.

enumerator kLPADC__SampleChannelSingleEndSideB

Single-end mode, only B-side channel is converted.

enumerator kLPADC__SampleChannelDiffBothSideAB

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC__SampleChannelDiffBothSideBA

Differential mode, the ADC result is (CHnB-CHnA).

enumerator kLPADC__SampleChannelDiffBothSide

Differential mode, the ADC result is (CHnA-CHnB).

enumerator kLPADC__SampleChannelDualSingleEndBothSide

Dual-Single-Ended Mode. Both A side and B side channels are converted independently.

enum __lpadc_hardware_average_mode

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

Values:

enumerator kLPADC__HardwareAverageCount1

Single conversion.

enumerator kLPADC__HardwareAverageCount2

2 conversions averaged.

enumerator kLPADC__HardwareAverageCount4

4 conversions averaged.

enumerator kLPADC__HardwareAverageCount8

8 conversions averaged.

enumerator kLPADC_HardwareAverageCount16
16 conversions averaged.

enumerator kLPADC_HardwareAverageCount32
32 conversions averaged.

enumerator kLPADC_HardwareAverageCount64
64 conversions averaged.

enumerator kLPADC_HardwareAverageCount128
128 conversions averaged.

enum _lpadc_sample_time_mode

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

Values:

enumerator kLPADC_SampleTimeADCK3
3 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK5
5 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK7
7 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK11
11 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK19
19 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK35
35 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK67
69 ADCK cycles total sample time.

enumerator kLPADC_SampleTimeADCK131
131 ADCK cycles total sample time.

enum _lpadc_hardware_compare_mode

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

Values:

enumerator kLPADC_HardwareCompareDisabled
Compare disabled.

enumerator kLPADC_HardwareCompareStoreOnTrue
Compare enabled. Store on true.

enumerator kLPADC_HardwareCompareRepeatUntilTrue
Compare enabled. Repeat channel acquisition until true.

enum _lpadc_conversion_resolution_mode

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to lpadc_sample_channel_mode_t

Values:

enumerator kLPADC_ConversionResolutionStandard

Standard resolution. Single-ended 12-bit conversion, Differential 13-bit conversion with 2's complement output.

enumerator kLPADC_ConversionResolutionHigh

High resolution. Single-ended 16-bit conversion; Differential 16-bit conversion with 2's complement output.

enum _lpadc_conversion_average_mode

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of CAL_AVGS field in CTRL register.

Values:

enumerator kLPADC_ConversionAverage1

Single conversion.

enumerator kLPADC_ConversionAverage2

2 conversions averaged.

enumerator kLPADC_ConversionAverage4

4 conversions averaged.

enumerator kLPADC_ConversionAverage8

8 conversions averaged.

enumerator kLPADC_ConversionAverage16

16 conversions averaged.

enumerator kLPADC_ConversionAverage32

32 conversions averaged.

enumerator kLPADC_ConversionAverage64

64 conversions averaged.

enumerator kLPADC_ConversionAverage128

128 conversions averaged.

enum _lpadc_reference_voltage_mode

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

Values:

enumerator kLPADC_ReferenceVoltageAlt1

Option 1 setting.

enumerator kLPADC_ReferenceVoltageAlt2

Option 2 setting.

enumerator kLPADC_ReferenceVoltageAlt3

Option 3 setting.

enum _lpadc_power_level_mode

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

Values:

enumerator kLPADC_PowerLevelAlt1

Lowest power setting.

enumerator kLPADC_PowerLevelAlt2

Next lowest power setting.

enumerator kLPADC_PowerLevelAlt3

...

enumerator kLPADC_PowerLevelAlt4

Highest power setting.

enum _lpadc_offset_calibration_mode

Define enumeration of offset calibration mode.

Values:

enumerator kLPADC_OffsetCalibration12bitMode

12 bit offset calibration mode.

enumerator kLPADC_OffsetCalibration16bitMode

16 bit offset calibration mode.

enum _lpadc_trigger_priority_policy

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: **kLPADC_TriggerPriorityPreemptSubsequently** is not available on some devices, mainly depends on the size of TPRICTRL field in CFG register.

Values:

enumerator kLPADC_ConvPreemptImmediatelyNotAutoResumed

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion is not automatically resumed or restarted.

enumerator kLPADC_ConvPreemptSoftlyNotAutoResumed

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion is not resumed or restarted.

enumerator kLPADC_ConvPreemptImmediatelyAutoRestarted

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptSoftlyAutoRestarted`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will automatically be restarted.

enumerator `kLPADC_ConvPreemptImmediatelyAutoResumed`

If a higher priority trigger is detected during command processing, the current conversion is aborted and the new command specified by the trigger is started, when higher priority conversion finishes, the preempted conversion will automatically be resumed.

enumerator `kLPADC_ConvPreemptSoftlyAutoResumed`

If a higher priority trigger is received during command processing, the current conversion is completed (including averaging iterations and compare function if enabled) and stored to the result FIFO before the higher priority trigger/command is initiated, when higher priority conversion finishes, the preempted conversion will be automatically be resumed.

enumerator `kLPADC_TriggerPriorityPreemptImmediately`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityPreemptSoftly`

Legacy support is not recommended as it only ensures compatibility with older versions.

enumerator `kLPADC_TriggerPriorityExceptionDisabled`

High priority trigger exception disabled.

typedef enum `_lpadc_sample_scale_mode` `lpadc_sample_scale_mode_t`

Define enumeration of sample scale mode.

The sample scale mode is used to reduce the selected ADC analog channel input voltage level by a factor. The maximum possible voltage on the ADC channel input should be considered when selecting a scale mode to ensure that the reducing factor always results voltage level at or below the VREFH reference. This reducing capability allows conversion of analog inputs higher than VREFH. A-side and B-side channel inputs are both scaled using the scale mode.

typedef enum `_lpadc_sample_channel_mode` `lpadc_sample_channel_mode_t`

Define enumeration of channel sample mode.

The channel sample mode configures the channel with single-end/differential/dual-single-end, side A/B.

typedef enum `_lpadc_hardware_average_mode` `lpadc_hardware_average_mode_t`

Define enumeration of hardware average selection.

It Selects how many ADC conversions are averaged to create the ADC result. An internal storage buffer is used to capture temporary results while the averaging iterations are executed.

Note: Some enumerator values are not available on some devices, mainly depends on the size of AVGS field in CMDH register.

typedef enum `_lpadc_sample_time_mode` `lpadc_sample_time_mode_t`

Define enumeration of sample time selection.

The shortest sample time maximizes conversion speed for lower impedance inputs. Extending sample time allows higher impedance inputs to be accurately sampled. Longer sample

times can also be used to lower overall power consumption when command looping and sequencing is configured and high conversion rates are not required.

`typedef enum _lpadc_hardware_compare_mode` `lpadc_hardware_compare_mode_t`

Define enumeration of hardware compare mode.

After an ADC channel input is sampled and converted and any averaging iterations are performed, this mode setting guides operation of the automatic compare function to optionally only store when the compare operation is true. When compare is enabled, the conversion result is compared to the compare values.

`typedef enum _lpadc_conversion_resolution_mode` `lpadc_conversion_resolution_mode_t`

Define enumeration of conversion resolution mode.

Configure the resolution bit in specific conversion type. For detailed resolution accuracy, see to `lpadc_sample_channel_mode_t`

`typedef enum _lpadc_conversion_average_mode` `lpadc_conversion_average_mode_t`

Define enumeration of conversion averages mode.

Configure the conversion average number for auto-calibration.

Note: Some enumerator values are not available on some devices, mainly depends on the size of `CAL_AVGS` field in `CTRL` register.

`typedef enum _lpadc_reference_voltage_mode` `lpadc_reference_voltage_source_t`

Define enumeration of reference voltage source.

For detail information, need to check the SoC's specification.

`typedef enum _lpadc_power_level_mode` `lpadc_power_level_mode_t`

Define enumeration of power configuration.

Configures the ADC for power and performance. In the highest power setting the highest conversion rates will be possible. Refer to the device data sheet for power and performance capabilities for each setting.

`typedef enum _lpadc_offset_calibration_mode` `lpadc_offset_calibration_mode_t`

Define enumeration of offset calibration mode.

`typedef enum _lpadc_trigger_priority_policy` `lpadc_trigger_priority_policy_t`

Define enumeration of trigger priority policy.

This selection controls how higher priority triggers are handled.

Note: `kLPADC_TriggerPriorityPreemptSubsequently` is not available on some devices, mainly depends on the size of `TPRCTRL` field in `CFG` register.

`typedef struct _lpadc_calibration_value` `lpadc_calibration_value_t`

A structure of calibration value.

`LPADC_CONVERSION_COMPLETE_TIMEOUT`

Max loops to wait for LPADC conversion complete.

When doing calibration, driver will wait for the completion of conversion. This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

LPADC_CALIBRATION_READY_TIMEOUT

Max loops to wait for LPADC calibration ready.

Before doing calibration, driver will wait for the calibration ready. This parameter defines how many loops to check the calibration ready. If defined as 0, driver will wait forever until ready.

LPADC_GAIN_CAL_READY_TIMEOUT

Max loops to wait for LPADC gain calibration GAIN_CAL ready.

Before doing calibration, driver will wait for the gain calibration GAIN_CAL ready. This parameter defines how many loops to check the gain calibration GAIN_CAL ready. If defined as 0, driver will wait forever until ready.

LPADC_GET_ACTIVE_COMMAND_STATUS(statusVal)

Define the MACRO function to get command status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

LPADC_GET_ACTIVE_TRIGGER_STATUE(statusVal)

Define the MACRO function to get trigger status from status value.

The statusVal is the return value from LPADC_GetStatusFlags().

void LPADC_Init(ADC_Type *base, const *lpadc_config_t* *config)

Initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.
- config – Pointer to configuration structure. See “*lpadc_config_t*”.

void LPADC_GetDefaultConfig(*lpadc_config_t* *config)

Gets an available pre-defined settings for initial configuration.

This function initializes the converter configuration structure with an available settings. The default values are:

```
config->enableInDozeMode      = true;
config->enableAnalogPreliminary = false;
config->powerUpDelay           = 0x80;
config->referenceVoltageSource = kLPADC_ReferenceVoltageAlt1;
config->powerLevelMode         = kLPADC_PowerLevelAlt1;
config->triggerPriorityPolicy   = kLPADC_TriggerPriorityPreemptImmediately;
config->enableConvPause        = false;
config->convPauseDelay          = 0U;
config->FIFOWatermark          = 0U;
```

Parameters

- config – Pointer to configuration structure.

void LPADC_Deinit(ADC_Type *base)

De-initializes the LPADC module.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_Enable(ADC_Type *base, bool enable)

Switch on/off the LPADC module.

Parameters

- base – LPADC peripheral base address.

- enable – switcher to the module.

static inline void LPADC_DoResetFIFO(ADC_Type *base)

Do reset the conversion FIFO.

Parameters

- base – LPADC peripheral base address.

static inline void LPADC_DoResetConfig(ADC_Type *base)

Do reset the module's configuration.

Reset all ADC internal logic and registers, except the Control Register (ADCx_CTRL).

Parameters

- base – LPADC peripheral base address.

static inline uint32_t LPADC_GetStatusFlags(ADC_Type *base)

Get status flags.

Parameters

- base – LPADC peripheral base address.

Returns

status flags' mask. See to `_lpadc_status_flags`.

static inline void LPADC_ClearStatusFlags(ADC_Type *base, uint32_t mask)

Clear status flags.

Only the flags can be cleared by writing ADCx_STATUS register would be cleared by this API.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for flags to be cleared. See to `_lpadc_status_flags`.

static inline uint32_t LPADC_GetTriggerStatusFlags(ADC_Type *base)

Get trigger status flags to indicate which trigger sequences have been completed or interrupted by a high priority trigger exception.

Parameters

- base – LPADC peripheral base address.

Returns

The OR'ed value of `_lpadc_trigger_status_flags`.

static inline void LPADC_ClearTriggerStatusFlags(ADC_Type *base, uint32_t mask)

Clear trigger status flags.

Parameters

- base – LPADC peripheral base address.
- mask – The mask of trigger status flags to be cleared, should be the OR'ed value of `_lpadc_trigger_status_flags`.

static inline void LPADC_EnableInterrupts(ADC_Type *base, uint32_t mask)

Enable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.


```
static inline void LPADC_DisableInterrupts(ADC_Type *base, uint32_t mask)
```

Disable interrupts.

Parameters

- base – LPADC peripheral base address.
- mask – Mask value for interrupt events. See to `_lpadc_interrupt_enable`.

```
static inline void LPADC_EnableFIFOWatermarkDMA(ADC_Type *base, bool enable)
```

Switch on/off the DMA trigger for FIFO watermark event.

Parameters

- base – LPADC peripheral base address.
- enable – Switcher to the event.

```
static inline uint32_t LPADC_GetConvResultCount(ADC_Type *base)
```

Get the count of result kept in conversion FIFO.

Parameters

- base – LPADC peripheral base address.

Returns

The count of result kept in conversion FIFO.

```
bool LPADC_GetConvResult(ADC_Type *base, lpadc_conv_result_t *result)
```

Get the result in conversion FIFO.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

Returns

Status whether FIFO entry is valid.

```
void LPADC_GetConvResultBlocking(ADC_Type *base, lpadc_conv_result_t *result)
```

Get the result in conversion FIFO using blocking method.

Parameters

- base – LPADC peripheral base address.
- result – Pointer to structure variable that keeps the conversion result in conversion FIFO.

```
void LPADC_SetConvTriggerConfig(ADC_Type *base, uint32_t triggerId, const  
                                lpadc_conv_trigger_config_t *config)
```

Configure the conversion trigger source.

Each programmable trigger can launch the conversion command in command buffer.

Parameters

- base – LPADC peripheral base address.
- triggerId – ID for each trigger. Typically, the available value range is from 0.
- config – Pointer to configuration structure. See to `lpadc_conv_trigger_config_t`.

void LPADC_GetDefaultConvTriggerConfig(*lpadc_conv_trigger_config_t* *config)

Gets an available pre-defined settings for trigger's configuration.

This function initializes the trigger's configuration structure with an available settings. The default values are:

```
config->targetCommandId    = 0U;  
config->delayPower         = 0U;  
config->priority           = 0U;  
config->channelAFIFOSelect = 0U;  
config->channelBFIFOSelect = 0U;  
config->enableHardwareTrigger = false;
```

Parameters

- config – Pointer to configuration structure.

static inline void LPADC_DoSoftwareTrigger(ADC_Type *base, uint32_t triggerIdMask)

Do software trigger to conversion command.

Parameters

- base – LPADC peripheral base address.
- triggerIdMask – Mask value for software trigger indexes, which count from zero.

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.
```

2.44 Lpc_freqme

```
void FREQME_Init(FREQME_Type *base, const freq_measure_config_t *config)
    Initialize freqme module, set operate mode, operate mode attribute and initialize measurement cycle.
```

Parameters

- base – FREQME peripheral base address.
- config – The pointer to module basic configuration, please refer to `freq_measure_config_t`.

```
void FREQME_GetDefaultConfig(freq_measure_config_t *config)
    Get default configuration.
```

```
config->operateMode = kFREQME_FreqMeasurementMode;
config->operateModeAttribute.refClkScaleFactor = 0U;
config->enableContinuousMode                = false;
config->startMeasurement                     = false;
```

Parameters

- config – The pointer to module basic configuration, please refer to `freq_measure_config_t`.

```
static inline void FREQME_StartMeasurementCycle(FREQME_Type *base)
    Start frequency or pulse width measurement process.
```

Parameters

- base – FREQME peripheral base address.

```
static inline void FREQME_TerminateMeasurementCycle(FREQME_Type *base)
    Force the termination of any measurement cycle currently in progress and resets RESULT or just reset RESULT if the module in idle state.
```

Parameters

- base – FREQME peripheral base address.

static inline void `FREQME_EnableContinuousMode(FREQME_Type *base, bool enable)`

Enable/disable Continuous mode.

Parameters

- `base` – FREQME peripheral base address.
- `enable` – Used to enable/disable continuous mode,
 - **true** Enable Continuous mode.
 - **false** Disable Continuous mode.

static inline bool `FREQME_CheckContinuousMode(FREQME_Type *base)`

Check whether continuous mode is enabled.

Parameters

- `base` – FREQME peripheral base address.

Return values

- **True** – Continuous mode is enabled, the measurement is performed continuously.
- **False** – Continuous mode is disabled.

static inline void `FREQME_SetOperateMode(FREQME_Type *base, freqme_operate_mode_t operateMode)`

Set operate mode of freqme module.

Parameters

- `base` – FREQME peripheral base address.
- `operateMode` – The operate mode to be set, please refer to `freqme_operate_mode_t`.

static inline bool `FREQME_CheckOperateMode(FREQME_Type *base)`

Check module's operate mode.

Parameters

- `base` – FREQME peripheral base address.

Return values

- **True** – Pulse width measurement mode.
- **False** – Frequency measurement mode.

static inline void `FREQME_SetMinExpectedValue(FREQME_Type *base, uint32_t minValue)`

Set the minimum expected value for the measurement result.

Parameters

- `base` – FREQME peripheral base address.
- `minValue` – The minimum value to set, please note that this value is 31 bits width.

static inline void `FREQME_SetMaxExpectedValue(FREQME_Type *base, uint32_t maxValue)`

Set the maximum expected value for the measurement result.

Parameters

- `base` – FREQME peripheral base address.
- `maxValue` – The maximum value to set, please note that this value is 31 bits width.

uint32_t FREQME_CalculateTargetClkFreq(FREQME_Type *base, uint32_t refClkFrequency)
Calculate the frequency of selected target clock

Note: The formula: $F_{\text{target}} = (\text{RESULT} - 2) * F_{\text{reference}} / 2^{\text{REF\_SCALE}}$.

Note: This function only useful when the operate mode is selected as frequency measurement mode.

Parameters

- base – FREQME peripheral base address.
- refClkFrequency – The frequency of reference clock.

Returns

The frequency of target clock the unit is Hz, if the output result is 0, please check the module's operate mode.

static inline uint8_t FREQME_GetReferenceClkScaleValue(FREQME_Type *base)
Get reference clock scaling factor.

Parameters

- base – FREQME peripheral base address.

Returns

Reference clock scaling factor, the reference count cycle is $2^{\text{ref\_scale}}$.

static inline void FREQME_SetPulsePolarity(FREQME_Type *base, *freqme_pulse_polarity_t* pulsePolarity)

Set pulse polarity when operate mode is selected as Pulse Width Measurement mode.

Parameters

- base – FREQME peripheral base address.
- pulsePolarity – The pulse polarity to be set, please refer to *freqme_pulse_polarity_t*.

static inline bool FREQME_CheckPulsePolarity(FREQME_Type *base)
Check pulse polarity when the operate mode is selected as pulse width measurement mode.

Parameters

- base – FREQME peripheral base address.

Return values

- True – Low period.
- False – High period.

static inline uint32_t FREQME_GetMeasurementResult(FREQME_Type *base)
Get measurement result, if operate mode is selected as pulse width measurement mode this function can be used to calculate pulse width.

Note: Pulse width = counter result / Frequency of target clock.

Parameters

- base – FREQME peripheral base address.

Returns

Measurement result.

```
static inline uint32_t FREQME_GetInterruptStatusFlags(FREQME_Type *base)
```

Get interrupt status flags, such as overflow interrupt status flag, underflow interrupt status flag, and so on.

Parameters

- base – FREQME peripheral base address.

Returns

Current interrupt status flags, should be the OR'ed value of `_freqme_interrupt_status_flags`.

```
static inline void FREQME_ClearInterruptStatusFlags(FREQME_Type *base, uint32_t statusFlags)
```

Clear interrupt status flags.

Parameters

- base – FREQME peripheral base address.
- statusFlags – The combination of interrupt status flags to clear, should be the OR'ed value of `_freqme_interrupt_status_flags`.

```
static inline void FREQME_EnableInterrupts(FREQME_Type *base, uint32_t masks)
```

Enable interrupts, such as result ready interrupt, overflow interrupt and so on.

Parameters

- base – FREQME peripheral base address.
- masks – The mask of interrupts to enable, should be the OR'ed value of `_freqme_interrupt_enable`.

```
static inline void FREQME_DisableInterrupts(FREQME_Type *base, uint32_t masks)
```

Disable interrupts, such as result ready interrupt, overflow interrupt and so on.

Parameters

- base – FREQME peripheral base address.
- masks – The mask of interrupts to disable, should be the OR'ed value of `_freqme_interrupt_enable`.

```
FSL_FREQME_DRIVER_VERSION
```

FREQME driver version 2.1.2.

```
enum _freqme_interrupt_status_flags
```

The enumeration of interrupt status flags. .

Values:

```
enumerator kFREQME_UnderflowInterruptStatusFlag
```

Indicate the measurement is just done and the result is less than minimum value.

```
enumerator kFREQME_OverflowInterruptStatusFlag
```

Indicate the measurement is just done and the result is greater than maximum value.

```
enumerator kFREQME_ReadyInterruptStatusFlag
```

Indicate the measurement is just done and the result is ready to read.

```
enumerator kFREQME_AllInterruptStatusFlags
```

All interrupt status flags.

enum *_freqme_interrupt_enable*

The enumeration of interrupts, including underflow interrupt, overflow interrupt, and result ready interrupt. .

Values:

enumerator kFREQME_UnderflowInterruptEnable

Enable interrupt when the result is less than minimum value.

enumerator kFREQME_OverflowInterruptEnable

Enable interrupt when the result is greater than maximum value.

enumerator kFREQME_ReadyInterruptEnable

Enable interrupt when a measurement completes and the result is ready.

enum *_freqme_operate_mode*

FREQME module operate mode enumeration, including frequency measurement mode and pulse width measurement mode.

Values:

enumerator kFREQME_FreqMeasurementMode

The module works in the frequency measurement mode.

enumerator kFREQME_PulseWidthMeasurementMode

The module works in the pulse width measurement mode.

enum *_freqme_pulse_polarity*

The enumeration of pulse polarity.

Values:

enumerator kFREQME_PulseHighPeriod

Select high period of the reference clock.

enumerator kFREQME_PulseLowPeriod

Select low period of the reference clock.

typedef enum *_freqme_operate_mode* freqme_operate_mode_t

FREQME module operate mode enumeration, including frequency measurement mode and pulse width measurement mode.

typedef enum *_freqme_pulse_polarity* freqme_pulse_polarity_t

The enumeration of pulse polarity.

typedef union *_freqme_mode_attribute* freqme_mode_attribute_t

The union of operate mode attribute.

Note: If the operate mode is selected as frequency measurement mode the member **refClkScaleFactor** should be used, if the operate mode is selected as pulse width measurement mode the member **pulsePolarity** should be used.

typedef struct *_freq_measure_config* freq_measure_config_t

The structure of freqme module basic configuration, including operate mode, operate mode attribute and so on.

union *_freqme_mode_attribute*

#include <fsl_freqme.h> The union of operate mode attribute.

Note: If the operate mode is selected as frequency measurement mode the member **refClkScaleFactor** should be used, if the operate mode is selected as pulse width measurement mode the member **pulsePolarity** should be used.

Public Members

`uint8_t refClkScaleFactor`

Only useful in frequency measurement operate mode, used to set the reference clock counter scaling factor.

`freqme_pulse_polarity_t pulsePolarity`

Only Useful in pulse width measurement operate mode, used to set period polarity.

`struct _freq_measure_config`

`#include <fsl_freqme.h>` The structure of freqme module basic configuration, including operate mode, operate mode attribute and so on.

Public Members

`freqme_operate_mode_t operateMode`

Select operate mode, please refer to `freqme_operate_mode_t`.

`freqme_mode_attribute_t operateModeAttribute`

Used to set the attribute of the selected operate mode, if the operate mode is selected as `kFREQME_FreqMeasurementMode` set `freqme_mode_attribute_t::refClkScaleFactor`, if operate mode is selected as `kFREOME_PulseWidthMeasurementMode`, please set `freqme_mode_attribute_t::pulsePolarity`.

`bool enableContinuousMode`

Enable/disable continuous mode, if continuous mode is enable, the measurement is performed continuously and the result for the last completed measurement is available in the result register.

2.45 LPFLEXCOMM: LPFLEXCOMM Driver

2.46 LPFLEXCOMM Driver

`FSL_LP_FLEXCOMM_DRIVER_VERSION`

FlexCOMM driver version.

`enum LP_FLEXCOMM_PERIPH_T`

LP_FLEXCOMM peripheral modes.

Values:

enumerator `LP_FLEXCOMM_PERIPH_NONE`

No peripheral

enumerator `LP_FLEXCOMM_PERIPH_LPUART`

LPUART peripheral

enumerator `LP_FLEXCOMM_PERIPH_LPSPI`

LPSPI Peripheral

enumerator LP_FLEXCOMM_PERIPH_LPI2C

LPI2C Peripheral

enumerator LP_FLEXCOMM_PERIPH_LPI2CAndLPUART

LPI2C and LPUART Peripheral

enum _lpflexcomm_interrupt_flag

LP_FLEXCOMM interrupt source flags.

Values:

enumerator kLPFLEXCOMM_I2cSlaveInterruptFlag

enumerator kLPFLEXCOMM_I2cMasterInterruptFlag

enumerator kLPFLEXCOMM_SpiInterruptFlag

enumerator kLPFLEXCOMM_UartRxInterruptFlag

enumerator kLPFLEXCOMM_UartTxInterruptFlag

enumerator kLPFLEXCOMM_AllInterruptFlag

typedef void (*lpflexcomm_irq_handler_t)(uint32_t instance, void *handle)

Typedef for interrupt handler.

IRQn_Type const kFlexcommIrqs[]

Array with IRQ number for each LP_FLEXCOMM module.

uint32_t LP_FLEXCOMM_GetInstance(void *base)

Returns instance number for LP_FLEXCOMM module with given base address.

uint32_t LP_FLEXCOMM_GetBaseAddress(uint32_t instance)

Returns for LP_FLEXCOMM base address.

uint32_t LP_FLEXCOMM_GetInterruptStatus(uint32_t instance)

brief Returns for LP_FLEXCOMM interrupt source, see _lpflexcomm_interrupt_flag.

status_t LP_FLEXCOMM_Init(uint32_t instance, LP_FLEXCOMM_PERIPH_T periph)

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

void LP_FLEXCOMM_Deinit(uint32_t instance)

Deinitializes LP_FLEXCOMM.

void LP_FLEXCOMM_SetIRQHandler(uint32_t instance, lpflexcomm_irq_handler_t handler,
void *lpflexcommHandle, LP_FLEXCOMM_PERIPH_T
periph)

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

2.47 LPI2C: Low Power Inter-Integrated Circuit Driver

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.

I2C_RETRY_TIMES

Retry times for waiting flag.

2.48 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)
```

```
status_t LPI2C_CheckForBusyBus(LPI2C_Type *base)
```

```
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.

Return values

- `kStatus_Success` – A transaction was successfully aborted.
- `kStatus_LPI2C_Idle` – There is not a non-blocking transaction currently in progress.

`void LPI2C_MasterTransferHandleIRQ(uint32_t instance, 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

- `instance` – The LPI2C instance.
- `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`

typedef struct `_lpi2c_master_handle` `lpi2c_master_handle_t`

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 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`)(`uint32_t` `instance`, 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.

2.49 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
```

```
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[10]
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.

2.50 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.

Return values

- `kStatus__Success` –
- `kStatus__LPI2C_Idle` –

`void LPI2C_SlaveTransferHandleIRQ(uint32_t instance, void *lpi2cSlaveHandle)`

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

- `instance` – The LPI2C instance.
- `lpi2cSlaveHandle` – 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. When this event is set, the driver will no longer decide to reply to ack/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

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.

`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.

2.51 LPSPI: Low Power Serial Peripheral Interface

2.52 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(*uint32_t* instance, *lpspi_master_handle_t* *handle)

LPSPI Master IRQ handler function.

This function processes the LPSPI transmit and receive IRQ.

Parameters

- instance – LPSPI instance.
- 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(uint32_t instance, *lpspi_slave_handle_t* *handle)

LPSPI Slave IRQ handler function.

This function processes the LPSPI transmit and receives an IRQ.

Parameters

- instance – LPSPI instance index.
- handle – pointer to *lpspi_slave_handle_t* structure which stores the transfer state.

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_pcs_function_config
LPSPi cs function configuration.

Values:

enumerator kLPSPi_PcsAsCs
PCS pin select as cs function

enumerator kLPSPi_PcsAsData
PCS pin select as date function

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_MasterWidth1

LPSPI master width shift macro, internal used LPSPI master transfer 1bit

enumerator kLPSPI_MasterWidth2

LPSPI master width shift macro, internal used LPSPI master transfer 2bit

enumerator kLPSPI_MasterWidth4

LPSPI master width shift macro, internal used LPSPI master transfer 4bit

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 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_pcs_function_config` `lpspi_pcs_function_config_t`

LPSPI cs function 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_MASTER_WIDTH_SHIFT
```

LPSPI master width shift macro, internal used

```
LPSPI_MASTER_WIDTH_MASK
```

LPSPI master width shift mask, 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_pcs_function_config_t pcsFunc

Configures cs pins function.

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 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.

2.53 LPSPI eDMA Driver

`FSL_LPSPi_EDMA_DRIVER_VERSION`
LPSPI EDMA driver version.

`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.

`uint32_t totalByteCount`
Number of transfer bytes

`uint8_t nbytes`
eDMA minor byte transfer count initially configured.

`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 int8_t oneFifoBlockRxWatermark`
Used to change RXWATER in FCR for DMA purpose.

`volatile int8_t lastBytesRxWatermark`
Used to change RXWATER in FCR for DMA purpose.

`volatile uint8_t state`
LPSPI transfer state , `_lpspi_transfer_state`.

`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[6]`
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

`uint32_t totalByteCount`
Number of transfer bytes

`uint8_t nbytes`
eDMA minor byte transfer count initially configured.

`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 int8_t oneFifoBlockRxWatermark`

Used to change RXWATER in FCR for DMA purpose.

`volatile int8_t lastBytesRxWatermark`

Used to change RXWATER in FCR for DMA purpose.

`volatile uint8_t state`

LPSPI transfer state.

`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[5]`

SoftwareTCD, internal used

2.54 LPUART: Low Power Universal Asynchronous Receiver/Transmitter Driver

2.55 LPUART Driver

`static inline void LPUART_SoftwareReset(LPUART_Type *base)`

Resets the LPUART using software.

This function resets all internal logic and registers except the Global Register. Remains set until cleared by software.

Parameters

- `base` – LPUART peripheral base address.

`status_t LPUART_Init(LPUART_Type *base, const lpuart_config_t *config, uint32_t srcClock_Hz)`

Initializes an LPUART instance with the user configuration structure and the peripheral clock.

This function configures the LPUART module with user-defined settings. Call the `LPUART_GetDefaultConfig()` function to configure the configuration structure and get the default configuration. The example below shows how to use this API to configure the LPUART.

```
lpuart_config_t lpuartConfig;
lpuartConfig.baudRate_Bps = 115200U;
lpuartConfig.parityMode = kLPUART_ParityDisabled;
lpuartConfig.dataBitsCount = kLPUART_EightDataBits;
lpuartConfig.isMsb = false;
lpuartConfig.stopBitCount = kLPUART_OneStopBit;
lpuartConfig.txFifoWatermark = 0;
lpuartConfig.rxFifoWatermark = 1;
LPUART_Init(LPUART1, &lpuartConfig, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- config – Pointer to a user-defined configuration structure.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – LPUART initialize succeed

void LPUART_Deinit(LPUART_Type *base)

Deinitializes a LPUART instance.

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

- base – LPUART peripheral base address.

void LPUART_GetDefaultConfig(*lpuart_config_t* *config)

Gets the default configuration structure.

This function initializes the LPUART configuration structure to a default value. The default values are: lpuartConfig->baudRate_Bps = 115200U; lpuartConfig->parityMode = kLPUART_ParityDisabled; lpuartConfig->dataBitsCount = kLPUART_EightDataBits; lpuartConfig->isMsb = false; lpuartConfig->stopBitCount = kLPUART_OneStopBit; lpuartConfig->txFifoWatermark = 0; lpuartConfig->rxFifoWatermark = 1; lpuartConfig->rxIdleType = kLPUART_IdleTypeStartBit; lpuartConfig->rxIdleConfig = kLPUART_IdleCharacter1; lpuartConfig->enableTx = false; lpuartConfig->enableRx = false;

Parameters

- config – Pointer to a configuration structure.

status_t LPUART_SetBaudRate(LPUART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the LPUART instance baudrate.

This function configures the LPUART module baudrate. This function is used to update the LPUART module baudrate after the LPUART module is initialized by the LPUART_Init.

```
LPUART_SetBaudRate(LPUART1, 115200U, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- baudRate_Bps – LPUART baudrate to be set.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not supported in the current clock source.
- kStatus_Success – Set baudrate succeeded.

void LPUART_Enable9bitMode(LPUART_Type *base, bool enable)

Enable 9-bit data mode for LPUART.

This function set the 9-bit mode for LPUART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – LPUART peripheral base address.
- enable – true to enable, 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_NoiseErrorInRxDataRegFlag`, `kLPUART_ParityErrorInRxDataRegFlag`, `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 the enumeration `_uart_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 uint32_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(uint32_t instance, void *irqHandle)

LPUART IRQ handle function.

This function handles the LPUART transmit and receive IRQ request.

Parameters

- instance – LPUART instance.
- 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.

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_CtsStateChangeInterruptEnable

Change of state on CTS_B pin. bit 0

enumerator kLPUART_DsrStateChangeInterruptEnable

Change of state on DSR_B pin. bit 1

enumerator kLPUART_RinStateChangeInterruptEnable

Change of state on RIN_B pin. bit 2

enumerator kLPUART_DcdStateChangeInterruptEnable
Change of state on DCD_B pin. bit 3

enumerator kLPUART_RxActiveEdgeInterruptEnable
Receive Active Edge. bit 6

enumerator kLPUART_LinBreakInterruptEnable
LIN break detect. bit 7

enumerator kLPUART_RxFifoUnderflowInterruptEnable
Receive FIFO Underflow. bit 8

enumerator kLPUART_TxFifoOverflowInterruptEnable
Transmit FIFO Overflow. bit 9

enumerator kLPUART_RxCounter0TimeoutInterruptEnable
Receiver counter0 timeout. bit 10

enumerator kLPUART_RxCounter1TimeoutInterruptEnable
Receiver counter1 timeout. bit 11

enumerator kLPUART_TxCounter0TimeoutInterruptEnable
Transmitter counter0 timeout. bit 12

enumerator kLPUART_TxCounter1TimeoutInterruptEnable
Transmitter counter1 timeout. bit 13

enumerator kLPUART_DataMatch2InterruptEnable
The next character to be read from LPUART_DATA matches MA2. bit 14

enumerator kLPUART_DataMatch1InterruptEnable
The next character to be read from LPUART_DATA matches MA1. bit 15

enumerator kLPUART_IdleLineInterruptEnable
Idle line. bit 20

enumerator kLPUART_RxDataRegFullInterruptEnable
Receiver data register full. bit 21

enumerator kLPUART_TransmissionCompleteInterruptEnable
Transmission complete. bit 22

enumerator kLPUART_TxDataRegEmptyInterruptEnable
Transmit data register empty. bit 23

enumerator kLPUART_ParityErrorInterruptEnable
Parity error flag. bit 24

enumerator kLPUART_FramingErrorInterruptEnable
Framing error flag. bit 25

enumerator kLPUART_NoiseErrorInterruptEnable
Noise error flag. bit 26

enumerator kLPUART_RxOverrunInterruptEnable
Receiver Overrun. bit 27

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_RxFifoUnderflowFlag
RXUF bit, sets if receive buffer underflow occurred. bit 0

enumerator kLPUART_TxFifoOverflowFlag
TXOF bit, sets if transmit buffer overflow occurred. bit 1

enumerator kLPUART_RxFifoEmptyFlag
RXEMPT bit, sets if receive buffer is empty. bit 6

enumerator kLPUART_TxFifoEmptyFlag
TXEMPT bit, sets if transmit buffer is empty. bit 7

enumerator kLPUART_CtsStateChangeFlag
Change of state on CTS_B pin. bit 2

enumerator kLPUART_DsrStateChangeFlag
Change of state on DSR_B pin. bit 3

enumerator kLPUART_RinStateChangeFlag
Change of state on RIN_B pin. bit 4

enumerator kLPUART_DcdStateChangeFlag
Change of state on DCD_B pin. bit 5

enumerator kLPUART_RxCounter0TimeoutFlag
Receiver counter0 timeout. bit 10

enumerator kLPUART_RxCounter1TimeoutFlag
Receiver counter1 timeout. bit 11

enumerator kLPUART_TxCounter0TimeoutFlag
Transmitter counter0 timeout. bit 12

enumerator kLPUART_TxCounter1TimeoutFlag
Transmitter counter1 timeout. bit 13

enumerator kLPUART_DataMatch2Flag
The next character to be read from LPUART_DATA matches MA2. bit 14

enumerator kLPUART_DataMatch1Flag
The next character to be read from LPUART_DATA matches MA1. bit 15

enumerator kLPUART_ParityErrorFlag
If parity enabled, sets upon parity error detection. bit 16

enumerator kLPUART_FramingErrorFlag
Frame error flag, sets if logic 0 was detected where stop bit expected. bit 17

enumerator kLPUART_NoiseErrorFlag
Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets. bit 18

enumerator kLPUART_RxOverrunFlag
Receive Overrun, sets when new data is received before data is read from receive register. bit 19

enumerator kLPUART_IdleLineFlag
Idle line detect flag, sets when idle line detected. bit 20

enumerator kLPUART_RxDataRegFullFlag
Receive data register full flag, sets when the receive data buffer is full. bit 21

enumerator kLPUART_TransmissionCompleteFlag

Transmission complete flag, sets when transmission activity complete. bit 22

enumerator kLPUART_TxDataRegEmptyFlag

Transmit data register empty flag, sets when transmit buffer is empty. bit 23

enumerator kLPUART_RxActiveFlag

Receiver Active Flag (RAF), sets at beginning of valid start. bit 24

enumerator kLPUART_RxActiveEdgeFlag

Receive pin active edge interrupt flag, sets when active edge detected. bit 30

enumerator kLPUART_LinBreakFlag

LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled. bit 31

enumerator kLPUART_AllClearFlags

enumerator kLPUART_AllFlags

enum _lpuart_timeout_condition

LPUART timeout condition. This structure defines the conditions when the counter timeout occur.

Values:

enumerator kLPUART_TimeoutAfterCharacters

Timeout occurs when the number of characters specified by timeoutValue are received.

enumerator kLPUART_TimeoutAfterIdle

Timeout occurs when rx/tx remains idle for timeoutValue of bit clocks after idle condition is detected.

enumerator kLPUART_TimeoutAfterNext

Timeout occurs when rx/tx remains idle for timeoutValue of bit clocks after next character is received/transmitted.

enumerator kLPUART_TimeoutAfterIdleBeforeExtended

Timeout occurs when tx/rx is idle for larger than timeoutValue of bit clocks and smaller than tx/rx extended timeout value.

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 enum *_lpuart_timeout_condition* lpuart_timeout_condition_t
LPUART timeout condition. This structure defines the conditions when the counter timeout occur.

typedef struct *_lpuart_timeout_counter_config* lpuart_timeout_counter_config_t
LPUART timeout counter configuration structure.

typedef struct *_lpuart_timeout_config* lpuart_timeout_config_t
LPUART timeout configuration structure.

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_irq_handler_t)(uint32_t instance, void *handle)

const IRQn_Type s_lpuartIRQ[]

UART_RETRY_TIMES
Retry times for waiting flag.

struct *_lpuart_timeout_counter_config*
#include <fsl_lpuart.h> LPUART timeout counter configuration structure.

Public Members

bool enableCounter
Eneble the timeout counter.

lpuart_timeout_condition_t timeoutCondition
Timeout condition.

uint16_t timeoutValue
Timeout value.

struct *_lpuart_timeout_config*
#include <fsl_lpuart.h> LPUART timeout configuration structure.

Public Members

uint16_t rxExtendedTimeoutValue
The number of bits since the last stop bit that is required for an idle condition to be detected. Enable this will disable rxIdleType and rxIdleConfig. Set to 0 to disable.

uint16_t txExtendedTimeoutValue
The transmitter idle time in number of bits (baud rate) whenever an idle character is queued through the transmit FIFO.

lpuart_timeout_counter_config_t rxCounter0
Rx counter 0 configuration.

lpuart_timeout_counter_config_t rxCounter1

Rx counter 1 configuration.

lpuart_timeout_counter_config_t txCounter0

Tx counter 0 configuration.

lpuart_timeout_counter_config_t txCounter1

Tx counter 1 configuration.

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.

lpuart_timeout_config_t timeoutConfig

Timeout configuration.

bool enableSingleWire

Use TXD pin as the source for the receiver. When enabled the TXD pin should be configured as open drain.

uint8_t rtsDelay

Delay the negation of RTS by the configured number of bit clocks.

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 __unnamed78__

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 __unnamed80__

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 __unnamed82__

Public Members

uint8_t *volatile rxData
Address of remaining data to receive.

uint16_t *volatile rxData16
Address of remaining data to receive.

union __unnamed84__

Public Members

uint8_t *rxRingBuffer
Start address of the receiver ring buffer.

uint16_t *rxRingBuffer16
Start address of the receiver ring buffer.

2.56 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(uint32_t instance, 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

- instance – LPUART peripheral index.
- 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

2.57 MIPI DSI Driver

void DSI_Init(MIPI_DSI_HOST_Type *base, const *dsi_config_t* *config)

Initializes an MIPI DSI host with the user configuration.

This function initializes the MIPI DSI host with the configuration, it should be called first before other MIPI DSI driver functions.

Parameters

- base – MIPI DSI host peripheral base address.
- config – Pointer to a user-defined configuration structure.

void DSI_Deinit(MIPI_DSI_HOST_Type *base)

Deinitializes an MIPI DSI host.

This function should be called after all bother MIPI DSI driver functions.

Parameters

- base – MIPI DSI host peripheral base address.

void DSI_GetDefaultConfig(*dsi_config_t* *config)

Get the default configuration to initialize the MIPI DSI host.

The default value is:

```
config->numLanes = 4;
config->enableNonContinuousHsClk = false;
config->enableTxUlps = false;
config->autoInsertEoTp = true;
config->numExtraEoTp = 0;
config->htxTo_ByteClk = 0;
config->lrxHostTo_ByteClk = 0;
config->btaTo_ByteClk = 0;
```

Parameters

- config – Pointer to a user-defined configuration structure.

void DSI_SetDpiConfig(MIPI_DSI_HOST_Type *base, const *dsi_dpi_config_t* *config, uint8_t numLanes, uint32_t dpiPixelClkFreq_Hz, uint32_t dsiHsBitClkFreq_Hz)

Configure the DPI interface core.

This function sets the DPI interface configuration, it should be used in video mode.

Parameters

- base – MIPI DSI host peripheral base address.
- config – Pointer to the DPI interface configuration.
- numLanes – Lane number, should be same with the setting in *dsi_dpi_config_t*.
- dpiPixelClkFreq_Hz – The DPI pixel clock frequency in Hz.
- dsiHsBitClkFreq_Hz – The DSI high speed bit clock frequency in Hz. It is the same with DPHY PLL output.

uint32_t DSI_InitDphy(MIPI_DSI_HOST_Type *base, const *dsi_dphy_config_t* *config, uint32_t refClkFreq_Hz)

Initializes the D-PHY.

This function configures the D-PHY timing and setups the D-PHY PLL based on user configuration. The configuration structure could be got by the function *DSI_GetDphyDefaultConfig*.

For some platforms there is not dedicated D-PHY PLL, indicated by the macro *FSL_FEATURE_MIPI_DSI_NO_DPHY_PLL*. For these platforms, the *refClkFreq_Hz* is useless.

Parameters

- base – MIPI DSI host peripheral base address.
- config – Pointer to the D-PHY configuration.
- refClkFreq_Hz – The REFCLK frequency in Hz.

Returns

The actual D-PHY PLL output frequency. If could not configure the PLL to the target frequency, the return value is 0.

```
void DSI_DeinitDphy(MIPI_DSI_HOST_Type *base)
```

Deinitializes the D-PHY.

Power down the D-PHY PLL and shut down D-PHY.

Parameters

- base – MIPI DSI host peripheral base address.

```
void DSI_GetDphyDefaultConfig(dsi_dphy_config_t *config, uint32_t txHsBitClk_Hz, uint32_t txEscClk_Hz)
```

Get the default D-PHY configuration.

Gets the default D-PHY configuration, the timing parameters are set according to D-PHY specification. User could use the configuration directly, or change some parameters according to the special device.

Parameters

- config – Pointer to the D-PHY configuration.
- txHsBitClk_Hz – High speed bit clock in Hz.
- txEscClk_Hz – Esc clock in Hz.

```
static inline void DSI_SetUlpsStatus(MIPI_DSI_HOST_Type *base, uint8_t ulpsStatus)
```

Sets the ULPS status for one clock lane and 4 data lanes.

Use status in `_dsi_ulps_status` as OR'ed mask value for `ulpsStatus`. Release the lanes from ULPS state before transfer.

Parameters

- base – MIPI DSI host peripheral base address.
- ulpsStatus – The ULPS status to set to the bus.

```
static inline uint8_t DSI_GetUlpsStatus(MIPI_DSI_HOST_Type *base)
```

Gets the ULPS status for one clock lane and 4 data lanes.

Parameters

- base – MIPI DSI host peripheral base address.

Returns

The current ULPS status.

```
static inline void DSI_EnableInterrupts(MIPI_DSI_HOST_Type *base, uint32_t intGroup1, uint32_t intGroup2)
```

Enable the interrupts.

The interrupts to enable are passed in as OR'ed mask value of `_dsi_interrupt`.

Parameters

- base – MIPI DSI host peripheral base address.
- intGroup1 – Interrupts to enable in group 1.
- intGroup2 – Interrupts to enable in group 2.

```
static inline void DSI_DisableInterrupts(MIPI_DSI_HOST_Type *base, uint32_t intGroup1, uint32_t intGroup2)
```

Disable the interrupts.

The interrupts to disable are passed in as OR'ed mask value of `_dsi_interrupt`.

Parameters

- base – MIPI DSI host peripheral base address.

- intGroup1 – Interrupts to disable in group 1.
- intGroup2 – Interrupts to disable in group 2.

```
static inline void DSI_GetAndClearInterruptStatus(MIPI_DSI_HOST_Type *base, uint32_t
                                                *intGroup1, uint32_t *intGroup2)
```

Get and clear the interrupt status.

Parameters

- base – MIPI DSI host peripheral base address.
- intGroup1 – Group 1 interrupt status.
- intGroup2 – Group 2 interrupt status.

```
static inline void DSI_SetDbiPixelFormat(MIPI_DSI_HOST_Type *base, dsi_dbi_pixel_format_t
                                         format)
```

Configure the DBI pixel format.

param base MIPI DSI host peripheral base address. param format of the pixel.

```
static inline void DSI_SetDbiPixelFifoSendLevel(MIPI_DSI_HOST_Type *base, uint16_t
                                                sendLevel)
```

Configure the DBI pixel FIFO send level.

This controls the level at which the DBI Host bridge begins sending pixels

Parameters

- base – MIPI DSI host peripheral base address.
- sendLevel – Send level value set to register.

```
static inline void DSI_SetDbiPixelPayloadSize(MIPI_DSI_HOST_Type *base, uint16_t payloadSize)
```

Configure the DBI pixel payload size.

Configures maximum number of pixels that should be sent as one DSI packet. Recommended to be evenly divisible by the line size (in pixels).

Parameters

- base – MIPI DSI host peripheral base address.
- payloadSize – Payload size value set to register.

```
void DSI_SetApbPacketControl(MIPI_DSI_HOST_Type *base, uint16_t wordCount, uint8_t
                             virtualChannel, dsi_tx_data_type_t dataType, uint8_t flags)
```

Configure the APB packet to send.

This function configures the next APB packet transfer. After configuration, the packet transfer could be started with function DSI_SendApbPacket. If the packet is long packet, Use DSI_WriteApbTxPayload to fill the payload before start transfer.

Parameters

- base – MIPI DSI host peripheral base address.
- wordCount – For long packet, this is the byte count of the payload. For short packet, this is (data1 « 8) | data0.
- virtualChannel – Virtual channel.
- dataType – The packet data type, (DI).
- flags – The transfer control flags, see _dsi_transfer_flags.

```
void DSI_WriteApbTxPayload(MIPI_DSI_HOST_Type *base, const uint8_t *payload, uint16_t  
                          payloadSize)
```

Fill the long APB packet payload.

Write the long packet payload to TX FIFO.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.

```
void DSI_WriteApbTxPayloadExt(MIPI_DSI_HOST_Type *base, const uint8_t *payload, uint16_t  
                             payloadSize, bool sendDcsCmd, uint8_t dcsCmd)
```

Extended function to fill the payload to TX FIFO.

Write the long packet payload to TX FIFO. This function could be used in two ways

- a. Include the DCS command in parameter `payload`. In this case, the DCS command is the first byte of `payload`. The parameter `sendDcsCmd` is set to `false`, the `dcsCmd` is not used. This function is the same as `DSI_WriteApbTxPayload` when used in this way.
- b. The DCS command is not in parameter `payload`, but specified by parameter `dcsCmd`. In this case, the parameter `sendDcsCmd` is set to `true`, the `dcsCmd` is the DCS command to send. The payload is sent after `dcsCmd`.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.
- sendDcsCmd – If set to `true`, the DCS command is specified by `dcsCmd`, otherwise the DCS command is included in the `payload`.
- dcsCmd – The DCS command to send, only used when `sendDcsCmd` is `true`.

```
void DSI_ReadApbRxPayload(MIPI_DSI_HOST_Type *base, uint8_t *payload, uint16_t  
                          payloadSize)
```

Read the long APB packet payload.

Read the long packet payload from RX FIFO. This function reads directly but does not check the RX FIFO status. Upper layer should make sure there are available data.

Parameters

- base – MIPI DSI host peripheral base address.
- payload – Pointer to the payload.
- payloadSize – Payload size in byte.

```
static inline void DSI_SendApbPacket(MIPI_DSI_HOST_Type *base)
```

Trigger the controller to send out APB packet.

Send the packet set by `DSI_SetApbPacketControl`.

Parameters

- base – MIPI DSI host peripheral base address.


```
static inline uint32_t DSI_GetApbStatus(MIPI_DSI_HOST_Type *base)
```

Get the APB status.

The return value is OR'ed value of `_dsi_apb_status`.

Parameters

- `base` – MIPI DSI host peripheral base address.

Returns

The APB status.

```
static inline uint32_t DSI_GetRxErrorStatus(MIPI_DSI_HOST_Type *base)
```

Get the error status during data transfer.

The return value is OR'ed value of `_dsi_rx_error_status`.

Parameters

- `base` – MIPI DSI host peripheral base address.

Returns

The error status.

```
static inline uint8_t DSI_GetEccRxErrorPosition(uint32_t rxErrorStatus)
```

Get the one-bit RX ECC error position.

When one-bit ECC RX error detected using `DSI_GetRxErrorStatus`, this function could be used to get the error bit position.

```
uint8_t eccErrorPos;
uint32_t rxErrorStatus = DSI_GetRxErrorStatus(MIPI_DSI);
if (kDSI_RxErrorEccOneBit & rxErrorStatus)
{
    eccErrorPos = DSI_GetEccRxErrorPosition(rxErrorStatus);
}
```

Parameters

- `rxErrorStatus` – The error status returned by `DSI_GetRxErrorStatus`.

Returns

The 1-bit ECC error position.

```
static inline uint32_t DSI_GetAndClearHostStatus(MIPI_DSI_HOST_Type *base)
```

Get and clear the DSI host status.

The host status are returned as mask value of `_dsi_host_status`.

Parameters

- `base` – MIPI DSI host peripheral base address.

Returns

The DSI host status.

```
static inline uint32_t DSI_GetRxPacketHeader(MIPI_DSI_HOST_Type *base)
```

Get the RX packet header.

Parameters

- `base` – MIPI DSI host peripheral base address.

Returns

The RX packet header.

static inline *dsi_rx_data_type_t* DSI_GetRxPacketType(uint32_t rxPktHeader)

Extract the RX packet type from the packet header.

Extract the RX packet type from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

The RX packet type.

static inline uint16_t DSI_GetRxPacketWordCount(uint32_t rxPktHeader)

Extract the RX packet word count from the packet header.

Extract the RX packet word count from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

For long packet, return the payload word count (byte). For short packet, return the (data0 « 8) | data1.

static inline uint8_t DSI_GetRxPacketVirtualChannel(uint32_t rxPktHeader)

Extract the RX packet virtual channel from the packet header.

Extract the RX packet virtual channel from the packet header get by DSI_GetRxPacketHeader.

Parameters

- rxPktHeader – The RX packet header get by DSI_GetRxPacketHeader.

Returns

The virtual channel.

status_t DSI_TransferBlocking(MIPI_DSI_HOST_Type *base, *dsi_transfer_t* *xfer)

APB data transfer using blocking method.

Perform APB data transfer using blocking method. This function waits until all data send or received, or timeout happens.

When using this API to read data, the actually read data count could be got from xfer->rxDataSize.

Parameters

- base – MIPI DSI host peripheral base address.
- xfer – Pointer to the transfer structure.

Return values

- kStatus_Success – Data transfer finished with no error.
- kStatus_Timeout – Transfer failed because of timeout.
- kStatus_DSI_RxDataError – RX data error, user could use DSI_GetRxErrorStatus to check the error details.
- kStatus_DSI_ErrorReportReceived – Error Report packet received, user could use DSI_GetAndClearHostStatus to check the error report status.
- kStatus_DSI_NotSupported – Transfer format not supported.
- kStatus_DSI_Fail – Transfer failed for other reasons.

```
status_t DSI_TransferCreateHandle(MIPI_DSI_HOST_Type *base, dsi_handle_t *handle,
                                dsi_callback_t callback, void *userData)
```

Create the MIPI DSI handle.

This function initializes the MIPI DSI handle which can be used for other transactional APIs.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – Handle pointer.
- callback – Callback function.
- userData – User data.

```
status_t DSI_TransferNonBlocking(MIPI_DSI_HOST_Type *base, dsi_handle_t *handle,
                                dsi_transfer_t *xfer)
```

APB data transfer using interrupt method.

Perform APB data transfer using interrupt method, when transfer finished, upper layer could be informed through callback function.

When using this API to read data, the actually read data count could be got from handle->xfer->rxDataSize after read finished.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.
- xfer – Pointer to the transfer structure.

Return values

- kStatus_Success – Data transfer started successfully.
- kStatus_DSI_Busy – Failed to start transfer because DSI is busy with previous transfer.
- kStatus_DSI_NotSupported – Transfer format not supported.

```
void DSI_TransferAbort(MIPI_DSI_HOST_Type *base, dsi_handle_t *handle)
```

Abort current APB data transfer.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.

```
void DSI_TransferHandleIRQ(MIPI_DSI_HOST_Type *base, dsi_handle_t *handle)
```

Interrupt handler for the DSI.

Parameters

- base – MIPI DSI host peripheral base address.
- handle – pointer to dsi_handle_t structure which stores the transfer state.

```
FSL_MIPI_DSI_DRIVER_VERSION
```

Error codes for the MIPI DSI driver.

Values:

enumerator kStatus_DSI_Busy

DSI is busy.

enumerator kStatus_DSI_RxDataError

Read data error.

enumerator kStatus_DSI_ErrorReportReceived

Error report package received.

enumerator kStatus_DSI_NotSupported

The transfer type not supported.

enum _dsi_dbi_pixel_format

MIPI DBI pixel format.

Values:

enumerator kDSI_DbiNoMapping

No pixel to bit mapping.

enumerator kDSI_DbiRGB888

Send data to interface as RGB888 format.

enumerator kDSI_DbiRGB666

Send data to interface as RGB666 format.

enumerator kDSI_DbiRGB565

Send data to interface as RGB565 format.

enumerator kDSI_DbiRGB444

Send data to interface as RGB444 format.

enumerator kDSI_DbiRGB332

Send data to interface as RGB332 format.

enum _dsi_dpi_color_coding

MIPI DPI interface color coding.

Values:

enumerator kDSI_Dpi16BitConfig1

16-bit configuration 1. RGB565: XXXXXXXX_RRRRRGGG_GGGBBBBB.

enumerator kDSI_Dpi16BitConfig2

16-bit configuration 2. RGB565: XXXRRRRR_XXGGGGGG_XXBBBBBB.

enumerator kDSI_Dpi16BitConfig3

16-bit configuration 3. RGB565: XXRRRRRX_XXGGGGGG_XXBBBBBX.

enumerator kDSI_Dpi18BitConfig1

18-bit configuration 1. RGB666: XXXXXXRR_RRRRGGGG_GGBBBBBB.

enumerator kDSI_Dpi18BitConfig2

18-bit configuration 2. RGB666: XXRRRRRR_XXGGGGGG_XXBBBBBB.

enumerator kDSI_Dpi24Bit

24-bit.

enum _dsi_dpi_pixel_packet

MIPI DSI pixel packet type send through DPI interface.

Values:

enumerator kDSI_PixelPacket16Bit

16 bit RGB565.

enumerator kDSI_PixelPacket18Bit

18 bit RGB666 packed.

enumerator kDSI_PixelPacket18BitLoosely

18 bit RGB666 loosely packed into three bytes.

enumerator kDSI_PixelPacket24Bit

24 bit RGB888, each pixel uses three bytes.

_dsi_dpi_polarity_flag DPI signal polarity.

Values:

enumerator kDSI_DpiVsyncActiveLow

VSYNC active low.

enumerator kDSI_DpiHsyncActiveLow

HSYNC active low.

enumerator kDSI_DpiVsyncActiveHigh

VSYNC active high.

enumerator kDSI_DpiHsyncActiveHigh

HSYNC active high.

enum _dsi_dpi_video_mode

DPI video mode.

Values:

enumerator kDSI_DpiNonBurstWithSyncPulse

Non-Burst mode with Sync Pulses.

enumerator kDSI_DpiNonBurstWithSyncEvent

Non-Burst mode with Sync Events.

enumerator kDSI_DpiBurst

Burst mode.

enum _dsi_dpi_bllp_mode

Behavior in BLLP (Blanking or Low-Power Interval).

Values:

enumerator kDSI_DpiBllpLowPower

LP mode used in BLLP periods.

enumerator kDSI_DpiBllpBlanking

Blanking packets used in BLLP periods.

enumerator kDSI_DpiBllpNull

Null packets used in BLLP periods.

_dsi_apb_status Status of APB to packet interface.

Values:

enumerator kDSI_ApbNotIdle

State machine not idle

enumerator kDSI_ApbTxDone

Tx packet done

enumerator kDSI_ApbRxControl
DPHY direction 0 - tx had control, 1 - rx has control

enumerator kDSI_ApbTxOverflow
TX fifo overflow

enumerator kDSI_ApbTxUnderflow
TX fifo underflow

enumerator kDSI_ApbRxOverflow
RX fifo overflow

enumerator kDSI_ApbRxUnderflow
RX fifo underflow

enumerator kDSI_ApbRxHeaderReceived
RX packet header has been received

enumerator kDSI_ApbRxPacketReceived
All RX packet payload data has been received

_dsi_rx_error_status Host receive error status.

Values:

enumerator kDSI_RxErrorEccOneBit
ECC single bit error detected.

enumerator kDSI_RxErrorEccMultiBit
ECC multi bit error detected.

enumerator kDSI_RxErrorCrc
CRC error detected.

enumerator kDSI_RxErrorHtxTo
High Speed forward TX timeout detected.

enumerator kDSI_RxErrorLrxTo
Reverse Low power data receive timeout detected.

enumerator kDSI_RxErrorBtaTo
BTA timeout detected.

enum _dsi_host_status
DSI host controller status (status_out)

Values:

enumerator kDSI_HostSoTError
SoT error from peripheral error report.

enumerator kDSI_HostSoTSyncError
SoT Sync error from peripheral error report.

enumerator kDSI_HostEoTSyncError
EoT Sync error from peripheral error report.

enumerator kDSI_HostEscEntryCmdError
Escape Mode Entry Command Error from peripheral error report.

enumerator kDSI_HostLpTxSyncError
Low-power transmit Sync Error from peripheral error report.

enumerator kDSI_HostPeriphToError

Peripheral timeout error from peripheral error report.

enumerator kDSI_HostFalseControlError

False control error from peripheral error report.

enumerator kDSI_HostContentionDetected

Contention detected from peripheral error report.

enumerator kDSI_HostEccErrorOneBit

Single bit ECC error (corrected) from peripheral error report.

enumerator kDSI_HostEccErrorMultiBit

Multi bit ECC error (not corrected) from peripheral error report.

enumerator kDSI_HostChecksumError

Checksum error from peripheral error report.

enumerator kDSI_HostInvalidDataType

DSI data type not recognized.

enumerator kDSI_HostInvalidVcId

DSI VC ID invalid.

enumerator kDSI_HostInvalidTxLength

Invalid transmission length.

enumerator kDSI_HostProtocalViolation

DSI protocol violation.

enumerator kDSI_HostResetTriggerReceived

Reset trigger received.

enumerator kDSI_HostTearTriggerReceived

Tear effect trigger receive.

enumerator kDSI_HostAckTriggerReceived

Acknowledge trigger message received.

_dsi_ulps_status Status of APB to packet interface.

Values:

enumerator kDSI_ClockLaneUlpsEnable

Clock lane in ULPS mode.

enumerator kDSI_DataLane0UlpsEnable

Data lane 0 in ULPS mode.

enumerator kDSI_DataLane1UlpsEnable

Data lane 1 in ULPS mode.

enumerator kDSI_DataLane2UlpsEnable

Data lane 2 in ULPS mode.

enumerator kDSI_DataLane3UlpsEnable

Data lane 3 in ULPS mode.

_dsi_interrupt DSI interrupt.

Values:

enumerator kDSI_InterruptGroup1ApbNotIdle
State machine not idle

enumerator kDSI_InterruptGroup1ApbTxDone
Tx packet done

enumerator kDSI_InterruptGroup1ApbRxControl
DPHY direction 0 - tx control, 1 - rx control

enumerator kDSI_InterruptGroup1ApbTxOverflow
TX fifo overflow

enumerator kDSI_InterruptGroup1ApbTxUnderflow
TX fifo underflow

enumerator kDSI_InterruptGroup1ApbRxOverflow
RX fifo overflow

enumerator kDSI_InterruptGroup1ApbRxUnderflow
RX fifo underflow

enumerator kDSI_InterruptGroup1ApbRxHeaderReceived
RX packet header has been received

enumerator kDSI_InterruptGroup1ApbRxPacketReceived
All RX packet payload data has been received

enumerator kDSI_InterruptGroup1SoTError
SoT error from peripheral error report.

enumerator kDSI_InterruptGroup1SoTSyncError
SoT Sync error from peripheral error report.

enumerator kDSI_InterruptGroup1EoTSyncError
EoT Sync error from peripheral error report.

enumerator kDSI_InterruptGroup1EscEntryCmdError
Escape Mode Entry Command Error from peripheral error report.

enumerator kDSI_InterruptGroup1LpTxSyncError
Low-power transmit Sync Error from peripheral error report.

enumerator kDSI_InterruptGroup1PeriphToError
Peripheral timeout error from peripheral error report.

enumerator kDSI_InterruptGroup1FalseControlError
False control error from peripheral error report.

enumerator kDSI_InterruptGroup1ContentionDetected
Contention detected from peripheral error report.

enumerator kDSI_InterruptGroup1EccErrorOneBit
Single bit ECC error (corrected) from peripheral error report.

enumerator kDSI_InterruptGroup1EccErrorMultiBit
Multi bit ECC error (not corrected) from peripheral error report.

enumerator kDSI_InterruptGroup1ChecksumError
Checksum error from peripheral error report.

enumerator kDSI_InterruptGroup1InvalidDataType
DSI data type not recognized.

enumerator kDSI__InterruptGroup1InvalidVcId
DSI VC ID invalid.

enumerator kDSI__InterruptGroup1InvalidTxLength
Invalid transmission length.

enumerator kDSI__InterruptGroup1ProtocalViolation
DSI protocal violation.

enumerator kDSI__InterruptGroup1ResetTriggerReceived
Reset trigger received.

enumerator kDSI__InterruptGroup1TearTriggerReceived
Tear effect trigger receive.

enumerator kDSI__InterruptGroup1AckTriggerReceived
Acknowledge trigger message received.

enumerator kDSI__InterruptGroup1HtxTo
High speed TX timeout.

enumerator kDSI__InterruptGroup1LrxTo
Low power RX timeout.

enumerator kDSI__InterruptGroup1BtaTo
Host BTA timeout.

enumerator kDSI__InterruptGroup2EccOneBit
Sinle bit ECC error.

enumerator kDSI__InterruptGroup2EccMultiBit
Multi bit ECC error.

enumerator kDSI__InterruptGroup2CrcError
CRC error.

enum _dsi_tx_data_type
DSI TX data type.

Values:

enumerator kDSI__TxDataVsyncStart
V Sync start.

enumerator kDSI__TxDataVsyncEnd
V Sync end.

enumerator kDSI__TxDataHsyncStart
H Sync start.

enumerator kDSI__TxDataHsyncEnd
H Sync end.

enumerator kDSI__TxDataEoTp
End of transmission packet.

enumerator kDSI__TxDataCmOff
Color mode off.

enumerator kDSI__TxDataCmOn
Color mode on.

enumerator kDSI_TxDataShutDownPeriph
Shut down peripheral.

enumerator kDSI_TxDataTurnOnPeriph
Turn on peripheral.

enumerator kDSI_TxDataGenShortWrNoParam
Generic Short WRITE, no parameters.

enumerator kDSI_TxDataGenShortWrOneParam
Generic Short WRITE, one parameter.

enumerator kDSI_TxDataGenShortWrTwoParam
Generic Short WRITE, two parameter.

enumerator kDSI_TxDataGenShortRdNoParam
Generic Short READ, no parameters.

enumerator kDSI_TxDataGenShortRdOneParam
Generic Short READ, one parameter.

enumerator kDSI_TxDataGenShortRdTwoParam
Generic Short READ, two parameter.

enumerator kDSI_TxDataDcsShortWrNoParam
DCS Short WRITE, no parameters.

enumerator kDSI_TxDataDcsShortWrOneParam
DCS Short WRITE, one parameter.

enumerator kDSI_TxDataDcsShortRdNoParam
DCS Short READ, no parameters.

enumerator kDSI_TxDataSetMaxReturnPktSize
Set the Maximum Return Packet Size.

enumerator kDSI_TxDataNull
Null Packet, no data.

enumerator kDSI_TxDataBlanking
Blanking Packet, no data.

enumerator kDSI_TxDataGenLongWr
Generic long write.

enumerator kDSI_TxDataDcsLongWr
DCS Long Write/write_LUT Command Packet.

enumerator kDSI_TxDataLooselyPackedPixel20BitYCbCr
Loosely Packed Pixel Stream, 20-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel24BitYCbCr
Packed Pixel Stream, 24-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel16BitYCbCr
Packed Pixel Stream, 16-bit YCbCr, 4:2:2 Format.

enumerator kDSI_TxDataPackedPixel30BitRGB
Packed Pixel Stream, 30-bit RGB, 10-10-10 Format.

enumerator kDSI_TxDataPackedPixel36BitRGB
Packed Pixel Stream, 36-bit RGB, 12-12-12 Format.

enumerator kDSI_TxDataPackedPixel12BitYCrCb
Packed Pixel Stream, 12-bit YCbCr, 4:2:0 Format.

enumerator kDSI_TxDataPackedPixel16BitRGB
Packed Pixel Stream, 16-bit RGB, 5-6-5 Format.

enumerator kDSI_TxDataPackedPixel18BitRGB
Packed Pixel Stream, 18-bit RGB, 6-6-6 Format.

enumerator kDSI_TxDataLooselyPackedPixel18BitRGB
Loosely Packed Pixel Stream, 18-bit RGB, 6-6-6 Format.

enumerator kDSI_TxDataPackedPixel24BitRGB
Packed Pixel Stream, 24-bit RGB, 8-8-8 Format.

enum _dsi_rx_data_type
DSI RX data type.

Values:

enumerator kDSI_RxDataAckAndErrorReport
Acknowledge and Error Report

enumerator kDSI_RxDataEoTp
End of Transmission packet.

enumerator kDSI_RxDataGenShortRdResponseOneByte
Generic Short READ Response, 1 byte returned.

enumerator kDSI_RxDataGenShortRdResponseTwoByte
Generic Short READ Response, 2 byte returned.

enumerator kDSI_RxDataGenLongRdResponse
Generic Long READ Response.

enumerator kDSI_RxDataDcsLongRdResponse
DCS Long READ Response.

enumerator kDSI_RxDataDcsShortRdResponseOneByte
DCS Short READ Response, 1 byte returned.

enumerator kDSI_RxDataDcsShortRdResponseTwoByte
DCS Short READ Response, 2 byte returned.

_dsi_transfer_flags DSI transfer control flags.

Values:

enumerator kDSI_TransferUseHighSpeed
Use high speed mode or not.

enumerator kDSI_TransferPerformBTA
Perform BTA or not.

typedef enum _dsi_dbi_pixel_format dsi_dbi_pixel_format_t
MIPI DBI pixel format.

typedef struct _dsi_config dsi_config_t
MIPI DSI controller configuration.

typedef enum _dsi_dpi_color_coding dsi_dpi_color_coding_t
MIPI DPI interface color coding.

typedef enum *_dsi_dpi_pixel_packet* dsi_dpi_pixel_packet_t
MIPI DSI pixel packet type send through DPI interface.

typedef enum *_dsi_dpi_video_mode* dsi_dpi_video_mode_t
DPI video mode.

typedef enum *_dsi_dpi_bllp_mode* dsi_dpi_bllp_mode_t
Behavior in BLLP (Blanking or Low-Power Interval).

typedef struct *_dsi_dpi_config* dsi_dpi_config_t
MIPI DSI controller DPI interface configuration.

typedef struct *_dsi_dphy_config* dsi_dphy_config_t
MIPI DSI D-PHY configuration.

typedef enum *_dsi_tx_data_type* dsi_tx_data_type_t
DSI TX data type.

typedef enum *_dsi_rx_data_type* dsi_rx_data_type_t
DSI RX data type.

typedef struct *_dsi_transfer* dsi_transfer_t
Structure for the data transfer.

typedef struct *_dsi_handle* dsi_handle_t
MIPI DSI transfer handle.

typedef void (*dsi_callback_t)(MIPI_DSI_HOST_Type *base, dsi_handle_t *handle, status_t status, void *userData)

MIPI DSI callback for finished transfer.

When transfer finished, one of these status values will be passed to the user:

- kStatus_Success Data transfer finished with no error.
- kStatus_Timeout Transfer failed because of timeout.
- kStatus_DSI_RxDataError RX data error, user could use DSI_GetRxErrorStatus to check the error details.
- kStatus_DSI_ErrorReportReceived Error Report packet received, user could use DSI_GetAndClearHostStatus to check the error report status.
- kStatus_Fail Transfer failed for other reasons.

FSL_DSI_TX_MAX_PAYLOAD_BYTE

FSL_DSI_RX_MAX_PAYLOAD_BYTE

struct _dsi_config
#include <fsl_mipi_dsi.h> MIPI DSI controller configuration.

Public Members

uint8_t numLanes
Number of lanes.

bool enableNonContinuousHsClk
In enabled, the high speed clock will enter low power mode between transmissions.

bool enableTxUlps
Enable the TX ULPS.

`bool autoInsertEoTp`

Insert an EoTp short package when switching from HS to LP.

`uint8_t numExtraEoTp`

How many extra EoTp to send after the end of a packet.

`uint32_t htxTo_ByteClk`

HS TX timeout count (HTX_TO) in byte clock.

`uint32_t lrxHostTo_ByteClk`

LP RX host timeout count (LRX-H_TO) in byte clock.

`uint32_t btaTo_ByteClk`

Bus turn around timeout count (TA_TO) in byte clock.

`struct _dsi_dpi_config`

#include <fsl_mipi_dsi.h> MIPI DSI controller DPI interface configuration.

Public Members

`uint16_t pixelPayloadSize`

Maximum number of pixels that should be sent as one DSI packet. Recommended that the line size (in pixels) is evenly divisible by this parameter.

`dsi_dpi_color_coding_t dpiColorCoding`

DPI color coding.

`dsi_dpi_pixel_packet_t pixelPacket`

Pixel packet format.

`dsi_dpi_video_mode_t videoMode`

Video mode.

`dsi_dpi_bllp_mode_t bllpMode`

Behavior in BLLP.

`uint8_t polarityFlags`

OR'ed value of `_dsi_dpi_polarity_flag` controls signal polarity.

`uint16_t hfp`

Horizontal front porch, in dpi pixel clock.

`uint16_t hbp`

Horizontal back porch, in dpi pixel clock.

`uint16_t hsw`

Horizontal sync width, in dpi pixel clock.

`uint8_t vfp`

Number of lines in vertical front porch.

`uint8_t vbp`

Number of lines in vertical back porch.

`uint16_t panelHeight`

Line number in vertical active area.

`uint8_t virtualChannel`

Virtual channel.

`struct _dsi_dphy_config`

#include <fsl_mipi_dsi.h> MIPI DSI D-PHY configuration.

Public Members

uint32_t txHsBitClk_Hz

The generated HS TX bit clock in Hz.

uint8_t tClkPre_ByteClk

TLPX + TCLK-PREPARE + TCLK-ZERO + TCLK-PRE in byte clock. Set how long the controller will wait after enabling clock lane for HS before enabling data lanes for HS.

uint8_t tClkPost_ByteClk

TCLK-POST + T_CLK-TRAIL in byte clock. Set how long the controller will wait before putting clock lane into LP mode after data lanes detected in stop state.

uint8_t tHsExit_ByteClk

THS-EXIT in byte clock. Set how long the controller will wait after the clock lane has been put into LP mode before enabling clock lane for HS again.

uint32_t tWakeup_EscClk

Number of clk_esc clock periods to keep a clock or data lane in Mark-1 state after exiting ULPS.

uint8_t tHsPrepare_HalfEscClk

THS-PREPARE in clk_esc/2. Set how long to drive the LP-00 state before HS transmissions, available values are 2, 3, 4, 5.

uint8_t tClkPrepare_HalfEscClk

TCLK-PREPARE in clk_esc/2. Set how long to drive the LP-00 state before HS transmissions, available values are 2, 3.

uint8_t tHsZero_ByteClk

THS-ZERO in clk_byte. Set how long that controller drives data lane HS-0 state before transmit the Sync sequence. Available values are 6, 7, ..., 37.

uint8_t tClkZero_ByteClk

TCLK-ZERO in clk_byte. Set how long that controller drives clock lane HS-0 state before transmit the Sync sequence. Available values are 3, 4, ..., 66.

uint8_t tHsTrail_ByteClk

THS-TRAIL + 4*UI in clk_byte. Set the time of the flipped differential state after last payload data bit of HS transmission burst. Available values are 0, 1, ..., 15.

uint8_t tClkTrail_ByteClk

TCLK-TRAIL + 4*UI in clk_byte. Set the time of the flipped differential state after last payload data bit of HS transmission burst. Available values are 0, 1, ..., 15.

struct _dsi_transfer

#include <fsl_mipi_dsi.h> Structure for the data transfer.

Public Members

uint8_t virtualChannel

Virtual channel.

dsi_tx_data_type_t txDataType

TX data type.

uint8_t flags

Flags to control the transfer; see _dsi_transfer_flags.

const uint8_t *txData

The TX data buffer.

uint8_t *rxData

The RX data buffer.

uint16_t txDataSize

Size of the TX data.

uint16_t rxDataSize

Size of the RX data.

bool sendDscCmd

If set to true, the DCS command is specified by dscCmd, otherwise the DCS command is included in the txData.

uint8_t dscCmd

The DCS command to send, only valid when sendDscCmd is true.

struct _dsi_handle

#include <fsl_mipi_dsi.h> MIPI DSI transfer handle structure.

Public Members

volatile bool isBusy

MIPI DSI is busy with APB data transfer.

dsi_transfer_t xfer

Transfer information.

dsi_callback_t callback

DSI callback

void *userData

Callback parameter

2.58 MIPI_DSI: MIPI DSI Host Controller

2.59 MMU: Memory Map Unit

void MMU_Init(MMU_Type *base, const mmu_config_t *config)

Initialize MMU:

- a. Enable MMU clock;
- b. Define the basic unit that is used in the memory map;
- c. Configure valid address range;
- d. Fill LUT SRAM;
- e. Enable MMU remap function.

Parameters

- base – MMU peripheral base address.
- config – Pointer to the user defined variable in type of mmu_config_t.

void MMU_Deinit(MMU_Type *base)

De-initialize MMU:

- a. Disable MMU remap function;
- b. Reset MMU logic;
- c. Disable MMU clock.

Parameters

- base –

void MMU_GetDefaultConfig(*mmu_config_t* *config)

Get default configurations of MMU module.

```
config->unitSize = kMMU_UnitSize4KB;
config->pageMode = kMMU_1PageMode;
config->invalidAddrMode = kMMU_InvalidAddrRespondError;
config->baseAddr    = 0x0UL;
config->maxAddr     = 0x0UL;
config->operationToWrite = kMMU_LUTBurstWrite;
config->ptrLutWord    = NULL;
config->countOfWordToWrite = 0U;
config->startPointer = 0U;
```

Parameters

- config – Pointer to the user defined variable in type of *mmu_config_t*.

void MMU_SetupSimpleMap(MMU_Type *base, uint32_t virt, uint32_t phys)

Map one physical unit to the virtual unit.

Parameters

- base – MMU peripheral base address.
- virt – The unit-aligned virtual address.
- phys – The unit-aligned virtual address.

void MMU_TearDownSimpleMap(MMU_Type *base, uint32_t virt)

Remove mapping for one unit of provided virtual address.

Parameters

- base – MMU peripheral base address.
- virt – The unit-aligned virtual address.

void MMU_SetupRegionMap(MMU_Type *base, uint32_t virt, uint32_t phys, size_t regionSize)

Map a region of physical memory into the virtual address space.

Parameters

- base – MMU peripheral base address.
- virt – The unit-aligned destination virtual address to map.
- phys – The unit-aligned source physical address to map.
- regionSize – Unit-aligned size of mapped memory region in bytes.

void MMU_TearDownRegionMap(MMU_Type *base, uint32_t virt, size_t regionSize)

Remove mapping for a provided virtual address region.

Parameters

- base – MMU peripheral base address.
- virt – The unit-aligned virtual address.
- regionSize – The unit-aligned size of region in bytes.

```
void MMU__RemapRegion(MMU_Type *base, uint32_t oldVirt, uint32_t newVirt, size_t  
                    regionSize)
```

Remap old virtual region into new address.

Parameters

- base – MMU peripheral base address.
- oldVirt – The unit-aligned old virtual address.
- newVirt – The unit-aligned new virtual address.
- regionSize – The unit-aligned size of region in bytes.

```
void MMU__MoveRegion(MMU_Type *base, uint32_t oldVirt, uint32_t newVirt, uint32_t newPhys,  
                    size_t regionSize)
```

Physically move region of memory, with copy.

Maps a region of physical memory into the new virtual address space, and copy region of size from the old virtual address space. The new virtual memory region is mapped from physical memory starting newPhys of size regionSize.

Parameters

- base – MMU peripheral base address.
- oldVirt – Unit-aligned old virtual region address.
- newVirt – Unit-aligned new virtual region address.
- newPhys – Unit-aligned new physical region address which will map to new virtual region address.
- regionSize – Unit-aligned size of region in bytes.

```
void MMU__SetupArrayMap(MMU_Type *base, uint32_t *ptrVirts, uint32_t *ptrPhys, uint32_t  
                      count)
```

Map an array of physical memory address into an array of virtual memory address.

Parameters

- base – MMU peripheral base address.
- ptrVirts – Pointer to the array which contain unit-aligned virtual address.
- ptrPhys – Pointer to the array which contain unit-aligned physical address.
- count – Count of array elements.

```
void MMU__TearDownArrayMap(MMU_Type *base, uint32_t *ptrVirts, uint32_t count)
```

Remove mapping of an array of virtual address.

Parameters

- base – MMU peripheral base address.
- ptrVirts – Pointer to the array which contains unit-aligned virtual address.
- count – Count of array elements.

```
void MMU__MoveArray(MMU_Type *base, uint32_t *ptrOldVirts, uint32_t *ptrNewVirts, uint32_t  
                  *ptrNewPhys, uint32_t count)
```

Physical move array of memory, with copy.

Maps an array of physical memory into the new array of virtual address space(`ptrNewVirts`), and copy an unit size of data from old array of virtual address to new array of virtual address.

Parameters

- `base` – MMU peripheral base address.
- `ptrOldVirts` – Pointer to the array which contain old unit-aligned virtual address.
- `ptrNewVirts` – Pointer to the array which contain new unit-aligned virtual address.
- `ptrNewPhys` – Pointer to the array which contain new unit-aligned physical address.
- `count` – Count of array elements.

```
void MMU_GetPhyAddr(MMU_Type *base, uint32_t virt, uint32_t *ptrPtrs)
```

Get mapped physical address from input virtual address.

Parameters

- `base` – MMU peripheral base address.
- `virt` – The virtual address.
- `ptrPtrs` – **[out]** Pointer to the variable to store mapped physical address.

```
static inline void MMU_EnableMemoryMap(MMU_Type *base, bool enable)
```

Enable/disable memory map.

Parameters

- `base` – MMU peripheral base address.
- `enable` – Used to enable/disable memory map:
 - **true** Enable memory map, the addresses of the AHB transaction are remapped by looking up LUT SRAM.
 - **false** Disable memory map, the AHB transaction passes through MMU without address remapping.

```
static inline void MMU_UpdateUnitSize(MMU_Type *base, mmu_unit_size_t unitSize)
```

Update the basic size of the unit that is used in the memory map.

Parameters

- `base` – MMU peripheral base address.
- `unitSize` – Used to specify the basic size of unit in type of `mmu_unit_size_t`.

```
void MMU_DoSoftwareReset(MMU_Type *base)
```

Trigger a software reset to reset the MMU logic.

Parameters

- `base` – MMU peripheral base address.

```
static inline void MMU_UpdateValidAddressRange(MMU_Type *base, uint16_t baseAddr, uint16_t maxAddr)
```

Update the valid address range.

To set AHB address from 0x51000000UL to 0x511FFFFFFF are valid:
 MMU_UpdateValidAddressRange(MMU0, 0x5100U, 0x511FU);

Note: Both baseAddr and maxAddr mean the upper 16 bits of a valid address.

Parameters

- base – MMU peripheral base address.
- baseAddr – Upper 16 bits of valid range's base address.
- maxAddr – Upper 16 bits of valid range's maximum address.

static inline void MMU_ChangePageOption(MMU_Type *base, mmu_page_option_t pageOpt)
 Change page mode, the MMU module supports #kMMU_1PageMode and #kMMU_4PageMode.

Parameters

- base – MMU peripheral base address.
- pageMode – Page mode to use, please refer to mmu_page_option_t.

void MMU_UpdateLUTBlocking(MMU_Type *base, uint16_t startPointer, mmu_lut_word_t
 *ptrLutWord, uint16_t countOfWords,
 mmu_lut_write_operation_t writeOperation)

Use the blocking method to update LUT SRAM with user-defined words.

Note: This function only return when all words that #ptrLutWord refers are set into LUT SRAM.

Note: This function supports both single write and burst write described in RM, please note that burst write is only useful when to fill continuous value into continuous addresses.

Note: startPointer + countOfWords should not exceed the maximum size of LUT SRAM(8192).

Fill continuous values into continuous addresses (E.g: initialize LUT SRAM address 2 and 3 with value 0x12 and 0x13)

```
mmu_lut_word_t startLutWord = {
    .mappedValue = 0x12U;
    .valid = 1U;
};
MMU_UpdateLUTBlocking(MMU0, 2U, &startLutWord, 2U, kMMU_LUTBurstWrite);
```

Fill discontinuous values into continuous addresses(E.g: initialize LUT SRAM address 2 and 3 with value 0x12 and 0x34)

```
mmu_lut_word_t lutWordArray[2] = {
    {
        .mappedValue = 0x12U;
        .valid = 1U;
    },
    {
        .mappedValue = 0x34U;
        .valid = 1U;
    }
};
```

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```
};
MMU_UpdateLUTBlocking(MMU0, 2U, lutWordArray, 2U, kMMU_LUTSingleWrite);
```

Fill discontinuous values into discontinuous addresses(E.g: initialize LUT SRAM address 2 and 5 with ↪ value 0x12 and 0x34):

```
mmu_lut_word_t addr2LutWord = { .mappedValue = 0x12U; .valid      = 1U;
};
MMU_UpdateLUTBlocking(MMU0, 2U, &addr2LutWord, 1U, kMMU_LUTSingleWrite);

mmu_lut_word_t addr5LutWord = {
    .mappedValue = 0x34U;
    .valid      = 1U;
};
MMU_UpdateLUTBlocking(MMU0, 5U, &addr5LutWord, 1U, kMMU_LUTSingleWrite);
```

Parameters

- base – MMU peripheral base address.
- startPoint – Start pointer of LUT SRAM to fill new mapping words, range from 0 to 8191.
- ptrLutWord – Pointer to new lut words: if **writeOperation** is selected as **kMMU_LUTBurstWrite** this parameter should be a pointer to the variable which represents the first LUT word to set; if **writeOperation** is selected as **kMMU_LUTSingleWrite** this parameter can be set as a pointer to the array that contains all new LUT words to set or set as a pointer to one variable when only want to update one word into LUT's specific pointer.
- countOfWord – Count to new word to update into LUT SRAM, range from 1 to 8192.
- writeOperation – Specify the write operation, the meaning of #ptrLutWord is different for different write operations.

```
void MMU_ReadLUT(MMU_Type *base, uint16_t startPoint, mmu_lut_word_t
                 *ptrWordReadBuffer, uint16_t count)
```

Read the specified number of LUT content from the specified pointer into the user-defined buffer.

Note: #startPoint + #count should not exceed maximum size of LUT SRAM(8192).

Parameters

- base – MMU peripheral base address.
- startPoint – Specify start address to read in LUT SRAM, range from 0 to 8191.
- ptrWordReadBuffer – Pointer of a buffer that record read out words.
- count – Specify number of continuous address in LUT SRAM to read, range from 1 to 8192.

```
void MMU_TriggerLUTVerificationBlocking(MMU_Type *base, uint16_t startPoint,
                                       mmu_lut_word_t goldenWordToCheck, uint16_t
                                       count)
```

Trigger the specified number of read operations from LUT SRAM, compare with the input golden word, the read address and golden data are increased automatically each time.

Note: This function only return when all read-verify operations are complete.

Parameters

- `base` – MMU peripheral base address.
- `startPointer` – The pointer of LUT SRAM which start to check, range from 0 to 8191.
- `goldenWordToCheck` – The first golden word to check, in following read-verify operation, the golden data will increase automatically.
- `count` – Specify number of continuous address in LUT SRAM to check, range from 1 to 8192.

static inline void MMU_LockLUT(MMU_Type *base)

Lock LUT SRAM to avoid an accidental update.

Note: If locked, writing to LUT SRAM will trigger `kMMU_LockErrorFlag`.

Parameters

- `base` – MMU peripheral base address.

static inline void MMU_UnlockLUT(MMU_Type *base)

Unlock LUT SRAM.

Note: To update LUT SRAM, please ensure LUT is unlocked.

Parameters

- `base` – MMU peripheral base address.

static inline uint32_t MMU_GetStatusFlags(MMU_Type *base)

Get status flags.

Parameters

- `base` – MMU peripheral base address.

Returns

All status flags asserted, should be the OR'ed value of `mmu_status_flags_t`.

static inline void MMU_ClearStatusFlags(MMU_Type *base, uint32_t mask)

Clear status flags.

Parameters

- `base` – MMU peripheral base address.
- `mask` – The mask of flags to clear, should be the OR'ed value of `mmu_status_flags_t`.

static inline uint16_t MMU_GetIPSReadErrorAddress(MMU_Type *base)

Get the LUT SRAM address when an error is detected for the IPS read operation (including IPS read parity error and read-verify mismatch error).

Parameters

- `base` – MMU peripheral base address.

Returns

The pointer in LUT SRAM, range from 0 to 8191.

void MMU_GetAHBErrorRecord(MMU_Type *base, mmu_ahb_error_record_t *ptrRecord)

Get a record of AHB information when an error happens.

Parameters

- base – MMU peripheral base address.
- ptrRecord – Pointer to user-defined mmu_ahb_error_record_t variable which used to store current AHB error information.

Returns

The record of AHB information when an error happens, please refer to mmu_ahb_error_record_t for details.

static inline bool MMU_CheckMMUBusy(MMU_Type *base)

Check if MMU is in the Busy state.

Note: There are some possible reasons to make MMU is busy state:

- Initialization sequence
 - Burst-write operation
 - Read-verify operation
-

Parameters

- base – MMU peripheral base address.

Return values

- false – MMU not in the busy state.
- true – MMU is in the busy state, wait for it is not busy before taking an action.

static inline void MMU_EnableInterrupts(MMU_Type *base, uint32_t mask)

Enabled interrupts.

Parameters

- base – MMU peripheral base address.
- mask – Mask of interrupts to enable, should be the OR'ed value of mmu_interrupt_enable_t.

static inline void MMU_DisableInterrupts(MMU_Type *base, uint32_t mask)

Disable interrupts.

Parameters

- base – MMU peripheral base address.
- mask – Mask of interrupts to disable, should be the OR'ed value of mmu_interrupt_enable_t.

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enum __mmu_status_flags

The enumeration of MMU status flags,.

Values:

enumerator kMMU__BusyFlag

MMU is in Busy state, wait for it to clear before taking action.

enumerator kMMU__LUTInvalidFlag

Indicate whether the valid bit in the access address is 0, which means the access operation is invalid in LUT.

enumerator kMMU__AddressInvalidFlag

The AHB access address is out of the valid address range.

enumerator kMMU__ParityErrorFlag

A parity error is detected in the access address.

enumerator kMMU__LockErrorFlag

A lock error is detected when writing to LUT SRAM.

enumerator kMMU__IpsReadErrorFlag

Indicate whether an IPS read error is detected when read LUT SRAM, including IPS read parity error and read-verify mismatch error.

enumerator kMMU__AllFlags

All flags.

enum __mmu_interrupt_enable

The enumeration of MMU interrupts,.

Values:

enumerator kMMU__LUTInvalidInterruptEnable

Enable the interrupt for kMMU__LUTInvalidFlag.

enumerator kMMU__AddressInvalidInterruptEnable

Enable the interrupt for kMMU__AddressInvalidFlag.

enumerator kMMU__ParityErrorInterruptEnable

Enable the interrupt for kMMU__ParityErrorFlag.

enumerator kMMU__LockErrorInterruptEnable

Enable the interrupt for kMMU__LockErrorFlag.

enumerator kMMU__IpsReadErrorInterruptEnable

Enable the interrupt for kMMU__IpsReadErrorFlag.

enumerator kMMU__AllInterruptsEnable

Enable all interrupts.

enum __mmu_unit_size

The enumeration of unit size, available selections are 4KB, 8KB, 16KB, 32KB, and 64KB.

Values:

enumerator kMMU__UnitSize4KB

Specify the basic size of unit is 4KB.

enumerator kMMU__UnitSize8KB

Specify the basic size of unit is 8KB.

enumerator kMMU__UnitSize16KB

Specify the basic size of unit is 16KB.

enumerator kMMU__UnitSize32KB

Specify the basic size of unit is 32KB.

enumerator kMMU_UnitSize64KB

Specify the basic size of unit is 64KB.

enum _mmu_ahb_access_type

The enumeration of AHB access type, available selections are read access and write access.

Values:

enumerator kMMU_ReadAccess

The access type of the AHB transfer is read.

enumerator kMMU_WriteAccess

The access type of the AHB transfer is write.

enum _mmu_ahb_error_type

The enumeration of error type in case of AHB transfer, available selections are LUT invalid error, address invalid error, and parity error.

Values:

enumerator kMMU_LUTInvalidError

The error type information of the transfer is LUT invalid error.

enumerator kMMU_AddrInvalidError

The error type information of the transfer is address invalid error.

enumerator kMMU_ParityError

The error type information of the transfer is parity error.

enum _mmu_page_option

The MMU module supports two different page mode: 1 page mode and 4 pages mode.

Note: In 4 pages mode, each page contains 2K word. Different page can contain different mapping schema.

Values:

enumerator kMMU_PageOpt_1Page

MMU takes LUT SRAM as 1 page for address remapping.

enumerator kMMU_PageOpt_4Page_Low2KWordSelected

MMU takes LUT SRAM as 4 pages for address remapping, in this page mode the whole LUT is divided into 4 pages, use LUT SRAM low 2K words for address remapping.

enumerator kMMU_PageOpt_4Page_MidLow2KWordSelected

MMU takes LUT SRAM as 4 pages for address remapping, in this page mode the whole LUT is divided into 4 pages, use LUT SRAM mid-low 2K words for address remapping.

enumerator kMMU_PageOpt_4Page_MidHigh2KWordSelected

MMU takes LUT SRAM as 4 pages for address remapping, in this page mode the whole LUT is divided into 4 pages, use LUT SRAM mid-high 2K words for address remapping.

enumerator kMMU_PageOpt_4Page_High2KWordSelected

MMU takes LUT SRAM as 4 pages for address remapping, in this page mode the whole LUT is divided into 4 pages, use LUT SRAM mid-low 2K words for address remapping.

enum _mmu_lut_write_operation

The enumeration of LUT SRAM write operation, both burst-write and single-write are supported.

Values:

enumerator kMMU_LUTSingleWrite

In this operation, words to write in consequent LUT pointer may not consequent. It is possible to write discontinuous value into discontinuous address.

enumerator kMMU_LUTBurstWrite

In this operation, words to write in consequence LUT pointer must be consequent. write continuous value into continuous address.

enum _mmu_invalid_address_mode

The behavior when an invalid address is detected is programmable.

Values:

enumerator kMMU_InvalidAddrRespondError

MMU responds with a transfer error when a invalid address is detected.

enumerator kMMU_InvalidAddrAllowed

MMU allows transfer when an invalid address is detected.

typedef enum _mmu_unit_size mmu_unit_size_t

The enumeration of unit size, available selections are 4KB, 8KB, 16KB, 32KB, and 64KB.

typedef enum _mmu_ahb_access_type mmu_ahb_access_type_t

The enumeration of AHB access type, available selections are read access and write access.

typedef enum _mmu_ahb_error_type mmu_ahb_error_type_t

The enumeration of error type in case of AHB transfer, available selections are LUT invalid error, address invalid error, and parity error.

typedef enum _mmu_page_option mmu_page_option_t

The MMU module supports two different page mode: 1 page mode and 4 pages mode.

Note: In 4 pages mode, each page contains 2K word. Different page can contain different mapping schema.

typedef enum _mmu_lut_write_operation mmu_lut_write_operation_t

The enumeration of LUT SRAM write operation, both burst-write and single-write are supported.

typedef enum _mmu_invalid_address_mode mmu_invalid_address_mode_t

The behavior when an invalid address is detected is programmable.

typedef struct _mmu_ahb_error_record mmu_ahb_error_record_t

The record of AHB information when an error happens.

typedef struct _mmu_lut_word mmu_lut_word_t

The word in LUT SRAM, there are 8K words exist in LUT SRAM.

typedef struct _mmu_config mmu_config_t

The structure used to initialize the MMU instance includes unit size, page mode, address range, and LUT content.

mmu_unit_size_t g_selectedUnitSize

mmu_page_option_t g_selectedPageOpt

MMU_NUM_OF_UNIT_SIZE

MMU_PAGE_OPT_MASK

MMU_PAGE_OPT_SHIFT

MMU_PAGE_OPT(x)

struct _mmu_ahb_error_record

#include <fsl_mmu.h> The record of AHB information when an error happens.

Public Members

uint32_t masterId

Indicate the master ID of the transfer.

uint32_t protectionInfo

Indicate the protection information of the transfer.

mmu_ahb_access_type_t accessType

Indicate the access type of the transfer.

mmu_ahb_error_type_t errorType

Indicate the error type of the transfer.

uint32_t failAddr

Indicates the LUT address where an error happens.

struct _mmu_lut_word

#include <fsl_mmu.h> The word in LUT SRAM, there are 8K words exist in LUT SRAM.

Public Members

uint16_t mappedValue

The mapped value to set, should be index of unit in valid address range not specific AHB address.

uint16_t valid

Specify whether the mapped value is valid: 1b1 means valid, 1b0 means invalid.

struct _mmu_config

#include <fsl_mmu.h> The structure used to initialize the MMU instance includes unit size, page mode, address range, and LUT content.

Public Members

mmu_unit_size_t unitSize

Specify the basic size of unit that is used in the memory map.

mmu_page_option_t pageOpt

Specify the behavior of page option.

mmu_invalid_address_mode_t invalidAddrMode

Specify MMU behavior when an invalid address is detected.

uint16_t baseAddr

Upper 16 bits of valid range's base address.

uint16_t maxAddr

Upper 16 bits of valid range's maximum address.

uint32_t *ptrPhyAddrArray

Pointer to the physical address array used for array mapping.

uint32_t *ptrVirtualAddrArray

Pointer to the virtual address array used for array mapping.

uint16_t countOfAddr

Count of array elements

bool enableMMP

Enable/disable memory map feature, once enabled all AHB access to corresponding address are remapped by LUT SRAM.

2.60 MRT: Multi-Rate Timer

void MRT_Init(MRT_Type *base, const *mrt_config_t* *config)

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

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

Parameters

- base – Multi-Rate timer peripheral base address
- config – Pointer to user's MRT config structure. If MRT has MULTITASK bit field in MODCFG register, param config is useless.

void MRT_Deinit(MRT_Type *base)

Gate the MRT clock.

Parameters

- base – Multi-Rate timer peripheral base address

static inline void MRT_GetDefaultConfig(*mrt_config_t* *config)

Fill in the MRT config struct with the default settings.

The default values are:

```
config->enableMultiTask = false;
```

Parameters

- config – Pointer to user's MRT config structure.

static inline void MRT_SetupChannelMode(MRT_Type *base, *mrt_chnl_t* channel, const *mrt_timer_mode_t* mode)

Sets up an MRT channel mode.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Channel that is being configured.
- mode – Timer mode to use for the channel.

static inline void MRT_EnableInterrupts(MRT_Type *base, *mrt_chnl_t* channel, uint32_t mask)

Enables the MRT interrupt.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number

- `mask` – The interrupts to enable. This is a logical OR of members of the enumeration `mrt_interrupt_enable_t`

static inline void MRT_DisableInterrupts(MRT_Type *base, *mrt_chnl_t* channel, uint32_t mask)

Disables the selected MRT interrupt.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number
- `mask` – The interrupts to disable. This is a logical OR of members of the enumeration `mrt_interrupt_enable_t`

static inline uint32_t MRT_GetEnabledInterrupts(MRT_Type *base, *mrt_chnl_t* channel)

Gets the enabled MRT interrupts.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

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

static inline uint32_t MRT_GetStatusFlags(MRT_Type *base, *mrt_chnl_t* channel)

Gets the MRT status flags.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

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

static inline void MRT_ClearStatusFlags(MRT_Type *base, *mrt_chnl_t* channel, uint32_t mask)

Clears the MRT status flags.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number
- `mask` – The status flags to clear. This is a logical OR of members of the enumeration `mrt_status_flags_t`

void MRT_UpdateTimerPeriod(MRT_Type *base, *mrt_chnl_t* channel, uint32_t count, bool immediateLoad)

Used to update the timer period in units of count.

The new value will be immediately loaded or will be loaded at the end of the current time interval. For one-shot interrupt mode the new value will be immediately loaded.

Note: User can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

- `count` – Timer period in units of ticks
- `immediateLoad` – `true`: Load the new value immediately into the TIMER register; `false`: Load the new value at the end of current timer interval

static inline uint32_t MRT_GetCurrentTimerCount(MRT_Type *base, *mrt_chnl_t* channel)

Reads the current timer counting value.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: User can call the utility macros provided in `fsl_common.h` to convert ticks to usec or msec

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

Current timer counting value in ticks

static inline void MRT_StartTimer(MRT_Type *base, *mrt_chnl_t* channel, uint32_t count)

Starts the timer counting.

After calling this function, timers load period value, counts down to 0 and depending on the timer mode it will either load the respective start value again or stop.

Note: User can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number.
- `count` – Timer period in units of ticks. Count can contain the LOAD bit, which control the force load feature.

static inline void MRT_StopTimer(MRT_Type *base, *mrt_chnl_t* channel)

Stops the timer counting.

This function stops the timer from counting.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number.

static inline uint32_t MRT_GetIdleChannel(MRT_Type *base)

Find the available channel.

This function returns the lowest available channel number.

Parameters

- `base` – Multi-Rate timer peripheral base address

static inline void MRT_ReleaseChannel(MRT_Type *base, *mrt_chnl_t* channel)

Release the channel when the timer is using the multi-task mode.

In multi-task mode, the INUSE flags allow more control over when MRT channels are released for further use. The user can hold on to a channel acquired by calling

MRT_GetIdleChannel() for as long as it is needed and release it by calling this function. This removes the need to ask for an available channel for every use.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.

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enum _mrt_chnl

List of MRT channels.

Values:

enumerator kMRT_Channel_0

MRT channel number 0

enumerator kMRT_Channel_1

MRT channel number 1

enumerator kMRT_Channel_2

MRT channel number 2

enumerator kMRT_Channel_3

MRT channel number 3

enum _mrt_timer_mode

List of MRT timer modes.

Values:

enumerator kMRT_RepeatMode

Repeat Interrupt mode

enumerator kMRT_OneShotMode

One-shot Interrupt mode

enumerator kMRT_OneShotStallMode

One-shot stall mode

enum _mrt_interrupt_enable

List of MRT interrupts.

Values:

enumerator kMRT_TimerInterruptEnable

Timer interrupt enable

enum _mrt_status_flags

List of MRT status flags.

Values:

enumerator kMRT_TimerInterruptFlag

Timer interrupt flag

enumerator kMRT_TimerRunFlag

Indicates state of the timer

typedef enum _mrt_chnl mrt_chnl_t

List of MRT channels.

typedef enum _mrt_timer_mode mrt_timer_mode_t

List of MRT timer modes.

```
typedef enum _mrt_interrupt_enable mrt_interrupt_enable_t
```

List of MRT interrupts.

```
typedef enum _mrt_status_flags mrt_status_flags_t
```

List of MRT status flags.

```
typedef struct _mrt_config mrt_config_t
```

MRT configuration structure.

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

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

```
struct _mrt_config
```

#include <fsl_mrt.h> MRT configuration structure.

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

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

Public Members

```
bool enableMultiTask
```

true: Timers run in multi-task mode; false: Timers run in hardware status mode

2.61 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)
```

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```

{
    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)
{
}
if (kMU_GeneralPurposeInterrupt3 & flags)
```

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```
{
}
```

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)
{
    Previous general purpose interrupt 0 or general purpose interrupt 2
```

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```

    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.

2.62 This type defines status return values used by NBOOT functions that are not easily

kStatus_NBOOT_Success

Operation completed successfully.

kStatus_NBOOT_Fail

Operation failed.

kStatus_NBOOT_InvalidArgument

Invalid argument passed to the function.

kStatus_NBOOT_RequestTimeout

Operation timed out.

kStatus_NBOOT_KeyNotLoaded

The requested key is not loaded.

kStatus_NBOOT_AuthFail

Authentication failed.

kStatus_NBOOT_OperationNotAvailable

Operation not available on this HW.

kStatus_NBOOT_KeyNotAvailable

Key is not available.

kStatus_NBOOT_IvCounterOverflow

Overflow of IV counter (PRINCE/IPED).

kStatus_NBOOT_SelftestFail

FIPS self-test failure.

kStatus_NBOOT_InvalidDataFormat

Invalid data format for example antipole

kStatus_NBOOT_IskCertUserDataTooBig

Size of User data in ISK certificate is greater than 96 bytes

kStatus_NBOOT_IskCertSignatureOffsetTooSmall

Signature offset in ISK certificate is smaller than expected

kStatus_NBOOT_MemcpyFail

Unexpected error detected during nboot_memcpy()

2.63 OSTIMER: OS Event Timer Driver

void OSTIMER_Init(OSTIMER_Type *base)

Initializes an OSTIMER by turning its bus clock on.

void OSTIMER_Deinit(OSTIMER_Type *base)

Deinitializes a OSTIMER instance.

This function shuts down OSTIMER bus clock

Parameters

- base – OSTIMER peripheral base address.

uint64_t OSTIMER_GrayToDecimal(uint64_t gray)

Translate the value from gray-code to decimal.

Parameters

- gray – The gray value input.

Returns

The decimal value.

static inline uint64_t OSTIMER_DecimalToGray(uint64_t dec)

Translate the value from decimal to gray-code.

Parameters

- dec – The decimal value.

Returns

The gray code of the input value.

uint32_t OSTIMER_GetStatusFlags(OSTIMER_Type *base)

Get OSTIMER status Flags.

This returns the status flag. Currently, only match interrupt flag can be got.

Parameters

- base – OSTIMER peripheral base address.

Returns

status register value

```
void OSTIMER_ClearStatusFlags(OSTIMER_Type *base, uint32_t mask)
```

Clear Status Interrupt Flags.

This clears intrrupt status flag. Currently, only match interrupt flag can be cleared.

Parameters

- *base* – OSTIMER peripheral base address.
- *mask* – Clear bit mask.

Returns

none

```
status_t OSTIMER_SetMatchRawValue(OSTIMER_Type *base, uint64_t count, ostimer_callback_t cb)
```

Set the match raw value for OSTIMER.

This function will set a match value for OSTIMER with an optional callback. And this callback will be called while the data in dedicated pair match register is equals to the value of central EVTIMER. Please note that, the data format may be gray-code, if so, please using OSTIMER_SetMatchValue().

Parameters

- *base* – OSTIMER peripheral base address.
- *count* – OSTIMER timer match value.(Value may be gray-code format)
- *cb* – OSTIMER callback (can be left as NULL if none, otherwise should be a void func(void)).

Return values

- *kStatus_Success* -- Set match raw value and enable interrupt Successfully.
- *kStatus_Fail* -- Set match raw value fail.

```
status_t OSTIMER_SetMatchValue(OSTIMER_Type *base, uint64_t count, ostimer_callback_t cb)
```

Set the match value for OSTIMER.

This function will set a match value for OSTIMER with an optional callback. And this callback will be called while the data in dedicated pair match register is equals to the value of central OS TIMER.

Parameters

- *base* – OSTIMER peripheral base address.
- *count* – OSTIMER timer match value.(Value is decimal format, and this value will be translate to Gray code in API if the IP counter is gray encoded.)
- *cb* – OSTIMER callback (can be left as NULL if none, otherwise should be a void func(void)).

Return values

- *kStatus_Success* -- Set match value and enable interrupt Successfully.
- *kStatus_Fail* -- Set match value fail.

```
static inline void OSTIMER_SetMatchRegister(OSTIMER_Type *base, uint64_t value)
```

Set value to OSTIMER MATCH register directly.

This function writes the input value to OSTIMER MATCH register directly, it does not touch any other registers. Note that, the data format is gray-code. The function OSTIMER_DecimalToGray could convert decimal value to gray code.

Parameters

- base – OSTIMER peripheral base address.
- value – OSTIMER timer match value (Value is gray-code format).

static inline uint64_t OSTIMER_GetMatchRegister(OSTIMER_Type *base)

Get the match value from OSTIMER.

This function will get the match value from OSTIMER. The value of timer match is gray code format.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of match register, data format is gray code.

static inline uint64_t OSTIMER_GetMatchValue(OSTIMER_Type *base)

Get the match value from OSTIMER.

This function will get a match value from OSTIMER.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of match register.

static inline void OSTIMER_EnableMatchInterrupt(OSTIMER_Type *base)

Enable the OSTIMER counter match interrupt.

Enable the timer counter match interrupt. The interrupt happens when OSTIMER counter matches the value in MATCH registers.

Parameters

- base – OSTIMER peripheral base address.

static inline void OSTIMER_DisableMatchInterrupt(OSTIMER_Type *base)

Disable the OSTIMER counter match interrupt.

Disable the timer counter match interrupt. The interrupt happens when OSTIMER counter matches the value in MATCH registers.

Parameters

- base – OSTIMER peripheral base address.

static inline uint64_t OSTIMER_GetCurrentTimerRawValue(OSTIMER_Type *base)

Get current timer raw count value from OSTIMER.

This function will get the timer count value from OS timer register. The raw value of timer count may be gray code format.

Parameters

- base – OSTIMER peripheral base address.

Returns

Raw value of OSTIMER, may be gray code format.

uint64_t OSTIMER_GetCurrentTimerValue(OSTIMER_Type *base)

Get current timer count value from OSTIMER.

This function will get a decimal timer count value. If the RAW value of timer count is gray code format, it will be translated to decimal data internally.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of OSTIMER which will be formatted to decimal value.

static inline uint64_t OSTIMER_GetCaptureRawValue(OSTIMER_Type *base)

Get the capture value from OSTIMER.

This function will get a captured value from OSTIMER. The Raw value of timer capture may be gray code format.

Parameters

- base – OSTIMER peripheral base address.

Returns

Raw value of capture register, data format may be gray code.

uint64_t OSTIMER_GetCaptureValue(OSTIMER_Type *base)

Get the capture value from OSTIMER.

This function will get a capture decimal-value from OSTIMER. If the RAW value of timer count is gray code format, it will be translated to decimal data internally.

Parameters

- base – OSTIMER peripheral base address.

Returns

Value of capture register, data format is decimal.

void OSTIMER_HandleIRQ(OSTIMER_Type *base, *ostimer_callback_t* cb)

OS timer interrupt Service Handler.

This function handles the interrupt and refers to the callback array in the driver to callback user (as per request in OSTIMER_SetMatchValue()). if no user callback is scheduled, the interrupt will simply be cleared.

Parameters

- base – OS timer peripheral base address.
- cb – callback scheduled for this instance of OS timer

Returns

none

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OSTIMER driver version.

enum __ostimer_flags

OSTIMER status flags.

Values:

enumerator kOSTIMER_MatchInterruptFlag

Match interrupt flag bit, sets if the match value was reached.

typedef void (*ostimer_callback_t)(void)

ostimer callback function.

2.64 PDM: Microphone Interface

2.65 PDM Driver


```
void PDM_Init(PDM_Type *base, const pdm_config_t *config)
```

Initializes the PDM peripheral.

Ungates the PDM clock, resets the module, and configures PDM with a configuration structure. The configuration structure can be custom filled or set with default values by `PDM_GetDefaultConfig()`.

Note: This API should be called at the beginning of the application to use the PDM driver. Otherwise, accessing the PDM module can cause a hard fault because the clock is not enabled.

Parameters

- base – PDM base pointer
- config – PDM configuration structure.

```
void PDM_Deinit(PDM_Type *base)
```

De-initializes the PDM peripheral.

This API gates the PDM clock. The PDM module can't operate unless `PDM_Init` is called to enable the clock.

Parameters

- base – PDM base pointer

```
static inline void PDM_Reset(PDM_Type *base)
```

Resets the PDM module.

Parameters

- base – PDM base pointer

```
static inline void PDM_Enable(PDM_Type *base, bool enable)
```

Enables/disables PDM interface.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is enabled, false means PDM interface is disabled.

```
static inline void PDM_EnableDebugMode(PDM_Type *base, bool enable)
```

Enables/disables debug mode for PDM. The PDM interface cannot enter debug mode once in Disable/Low Leakage or Low Power mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface enter debug mode, false means PDM interface in normal mode.

```
static inline void PDM_EnableInDebugMode(PDM_Type *base, bool enable)
```

Enables/disables PDM interface in debug mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is enabled debug mode, false means PDM interface is disabled after after completing the current frame in debug mode.

```
static inline void PDM_EnterLowLeakageMode(PDM_Type *base, bool enable)
```

Enables/disables PDM interface disable/Low Leakage mode.

Parameters

- base – PDM base pointer
- enable – True means PDM interface is in disable/low leakage mode, False means PDM interface is in normal mode.

```
static inline void PDM_EnableChannel(PDM_Type *base, uint8_t channel, bool enable)
```

Enables/disables the PDM channel.

Parameters

- base – PDM base pointer
- channel – PDM channel number need to enable or disable.
- enable – True means enable PDM channel, false means disable.

```
void PDM_SetChannelConfig(PDM_Type *base, uint32_t channel, const pdm_channel_config_t *config)
```

PDM one channel configurations.

Parameters

- base – PDM base pointer
- config – PDM channel configurations.
- channel – channel number. after completing the current frame in debug mode.

```
status_t PDM_SetSampleRateConfig(PDM_Type *base, uint32_t sourceClock_HZ, uint32_t sampleRate_HZ)
```

PDM set sample rate.

Note: This function is depend on the configuration of the PDM and PDM channel, so the correct call sequence is

```
PDM_Init(base, pdmConfig)
PDM_SetChannelConfig(base, channel, &channelConfig)
PDM_SetSampleRateConfig(base, source, sampleRate)
```

Parameters

- base – PDM base pointer
- sourceClock_HZ – PDM source clock frequency.
- sampleRate_HZ – PDM sample rate.

```
status_t PDM_SetSampleRate(PDM_Type *base, uint32_t enableChannelMask,
                             pdm_df_quality_mode_t qualityMode, uint8_t osr, uint32_t clkDiv)
```

PDM set sample rate.

Deprecated:

Do not use this function. It has been superceded by PDM_SetSampleRateConfig

Parameters

- base – PDM base pointer

- enableChannelMask – PDM channel enable mask.
- qualityMode – quality mode.
- osr – cic oversample rate
- clkDiv – clock divider

uint32_t PDM_GetInstance(PDM_Type *base)

Get the instance number for PDM.

Parameters

- base – PDM base pointer.

static inline uint32_t PDM_GetStatus(PDM_Type *base)

Gets the PDM internal status flag. Use the Status Mask in `_pdm_internal_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

PDM status flag value.

static inline uint32_t PDM_GetFifoStatus(PDM_Type *base)

Gets the PDM FIFO status flag. Use the Status Mask in `_pdm_fifo_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

FIFO status.

static inline uint32_t PDM_GetRangeStatus(PDM_Type *base)

Gets the PDM Range status flag. Use the Status Mask in `_pdm_range_status` to get the status value needed.

Parameters

- base – PDM base pointer

Returns

output status.

static inline void PDM_ClearStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status between `kPDM_StatusFrequencyLow` and `kPDM_StatusCh7FifoDataAvaliable`.

static inline void PDM_ClearFIFOStatus(PDM_Type *base, uint32_t mask)

Clears the PDM Tx status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status in `_pdm_fifo_status`.

```
static inline void PDM_ClearRangeStatus(PDM_Type *base, uint32_t mask)
```

Clears the PDM range status.

Parameters

- base – PDM base pointer
- mask – State mask. It can be a combination of the status in `_pdm_range_status`.

```
void PDM_EnableInterrupts(PDM_Type *base, uint32_t mask)
```

Enables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - `kPDM_ErrorInterruptEnable`
 - `kPDM_FIFOInterruptEnable`

```
static inline void PDM_DisableInterrupts(PDM_Type *base, uint32_t mask)
```

Disables the PDM interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - `kPDM_ErrorInterruptEnable`
 - `kPDM_FIFOInterruptEnable`

```
static inline void PDM_EnableDMA(PDM_Type *base, bool enable)
```

Enables/disables the PDM DMA requests.

Parameters

- base – PDM base pointer
- enable – True means enable DMA, false means disable DMA.

```
static inline uint32_t PDM_GetDataRegisterAddress(PDM_Type *base, uint32_t channel)
```

Gets the PDM data register address.

This API is used to provide a transfer address for the PDM DMA transfer configuration.

Parameters

- base – PDM base pointer.
- channel – Which data channel used.

Returns

data register address.

```
void PDM_ReadFifo(PDM_Type *base, uint32_t startChannel, uint32_t channelNums, void  
                 *buffer, size_t size, uint32_t dataWidth)
```

PDM read fifo.

Note: : This function support 16 bit only for IP version that only supports 16bit.

Parameters

- base – PDM base pointer.
- startChannel – start channel number.
- channelNums – total enabled channelnums.
- buffer – received buffer address.
- size – number of samples to read.
- dataWidth – sample width.

void PDM_SetChannelGain(PDM_Type *base, uint32_t channel, *pdm_df_output_gain_t* gain)

Set the PDM channel gain.

Please note for different quality mode, the valid gain value is different, reference RM for detail.

Parameters

- base – PDM base pointer.
- channel – PDM channel index.
- gain – channel gain, the register gain value range is 0 - 15.

void PDM_SetHwvadConfig(PDM_Type *base, const *pdm_hwvad_config_t* *config)

Configure voice activity detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector configure structure pointer .

static inline void PDM_ForceHwvadOutputDisable(PDM_Type *base, bool enable)

PDM hwvad force output disable.

Parameters

- base – PDM base pointer
- enable – true is output force disable, false is output not force.

static inline void PDM_ResetHwvad(PDM_Type *base)

PDM hwvad reset. It will reset VADNDATA register and will clean all internal buffers, should be called when the PDM isn't running.

Parameters

- base – PDM base pointer

static inline void PDM_EnableHwvad(PDM_Type *base, bool enable)

Enable/Disable Voice activity detector. Should be called when the PDM isn't running.

Parameters

- base – PDM base pointer.
- enable – True means enable voice activity detector, false means disable.

static inline void PDM_EnableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Enables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kPDM_HWVADErrorInterruptEnable

– kPDM_HWVADInterruptEnable

static inline void PDM_DisableHwvadInterrupts(PDM_Type *base, uint32_t mask)

Disables the PDM Voice Detector interrupt requests.

Parameters

- base – PDM base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
- kPDM_HWVADErrorInterruptEnable
- kPDM_HWVADInterruptEnable

static inline void PDM_ClearHwvadInterruptStatusFlags(PDM_Type *base, uint32_t mask)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer
- mask – State mask, reference `_pdm_hwvad_int_status`.

static inline uint32_t PDM_GetHwvadInterruptStatusFlags(PDM_Type *base)

Clears the PDM voice activity detector status flags.

Parameters

- base – PDM base pointer

Returns

status, reference `_pdm_hwvad_int_status`

static inline uint32_t PDM_GetHwvadInitialFlag(PDM_Type *base)

Get the PDM voice activity detector initial flags.

Parameters

- base – PDM base pointer

Returns

initial flag.

static inline void PDM_EnableHwvadSignalFilter(PDM_Type *base, bool enable)

Enables/disables voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enable – True means enable signal filter, false means disable.

void PDM_SetHwvadSignalFilterConfig(PDM_Type *base, bool enableMaxBlock, uint32_t signalGain)

Configure voice activity detector signal filter.

Parameters

- base – PDM base pointer
- enableMaxBlock – If signal maximum block enabled.
- signalGain – Gain value for the signal energy.

void PDM_SetHwvadNoiseFilterConfig(PDM_Type *base, const *pdm_hwvad_noise_filter_t* *config)

Configure voice activity detector noise filter.

Parameters

- base – PDM base pointer
- config – Voice activity detector noise filter configure structure pointer .

static inline void PDM_EnableHwvadZeroCrossDetector(PDM_Type *base, bool enable)

Enables/disables voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- enable – True means enable zero cross detector, false means disable.

void PDM_SetHwvadZeroCrossDetectorConfig(PDM_Type *base, const
pdm_hwvad_zero_cross_detector_t *config)

Configure voice activity detector zero cross detector.

Parameters

- base – PDM base pointer
- config – Voice activity detector zero cross detector configure structure pointer .

static inline uint16_t PDM_GetNoiseData(PDM_Type *base)

Reads noise data.

Parameters

- base – PDM base pointer.

Returns

Data in PDM noise data register.

static inline void PDM_SetHwvadInternalFilterStatus(PDM_Type *base,
pdm_hwvad_filter_status_t status)

set hwvad internal filter status . Note: filter initial status should be asserted for two more cycles, then set it to normal operation.

Parameters

- base – PDM base pointer.
- status – internal filter status.

void PDM_SetHwvadInEnvelopeBasedMode(PDM_Type *base, const pdm_hwvad_config_t
*hwvadConfig, const pdm_hwvad_noise_filter_t
*noiseConfig, const
pdm_hwvad_zero_cross_detector_t *zcdConfig,
uint32_t signalGain)

set HWVAD in envelope based mode . 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,
```

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```
.enableNoiseMin      = true,
.enableNoiseDecimation = true,
.noiseFilterAdjustment = 0U,
.noiseGain           = 7U,
.enableNoiseDetectOR  = true,
};
```

Parameters

- base – PDM base pointer.
- hwvadConfig – internal filter status.
- noiseConfig – Voice activity detector noise filter configure structure pointer.
- zcdConfig – Voice activity detector zero cross detector configure structure pointer .
- signalGain – signal gain value.

```
void PDM_SetHwvadInEnergyBasedMode(PDM_Type *base, const pdm_hwvad_config_t
                                   *hwvadConfig, const pdm_hwvad_noise_filter_t
                                   *noiseConfig, const pdm_hwvad_zero_cross_detector_t
                                   *zcdConfig, uint32_t signalGain)
```

brief set HWVAD in energy based mode . Recommand configurations, code static const *pdm_hwvad_config_t* hwvadConfig = { .channel = 0, .initializeTime = 10U, .cicOverSampleRate = 0U, .inputGain = 0U, .frameTime = 10U, .cutOffFreq = kPDM_HwvadHpfBypassed, .enableFrameEnergy = true, .enablePreFilter = true, };

static const *pdm_hwvad_noise_filter_t* noiseFilterConfig = { .enableAutoNoiseFilter = true, .enableNoiseMin = false, .enableNoiseDecimation = false, .noiseFilterAdjustment = 0U, .noiseGain = 7U, .enableNoiseDetectOR = false, }; code param base PDM base pointer. param hwvadConfig internal filter status. param noiseConfig Voice activity detector noise filter configure structure pointer. param zcdConfig Voice activity detector zero cross detector configure structure pointer . param signalGain signal gain value, signal gain value should be properly according to application.

```
void PDM_EnableHwvadInterruptCallback(PDM_Type *base, pdm_hwvad_callback_t vadCallback,
                                     void *userData, bool enable)
```

Enable/Disable hwvad callback.

This function enable/disable the hwvad interrupt for the selected PDM peripheral.

Parameters

- base – Base address of the PDM peripheral.
- vadCallback – callback Pointer to store callback function, should be NULL when disable.
- userData – user data.
- enable – true is enable, false is disable.

Return values

None. –

```
void PDM_TransferCreateHandle(PDM_Type *base, pdm_handle_t *handle,
                             pdm_transfer_callback_t callback, void *userData)
```

Initializes the PDM handle.

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

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

status_t PDM_TransferSetChannelConfig(PDM_Type *base, *pdm_handle_t* *handle, uint32_t channel, const *pdm_channel_config_t* *config, uint32_t format)

PDM set channel transfer config.

Parameters

- base – PDM base pointer.
- handle – PDM handle pointer.
- channel – PDM channel.
- config – channel config.
- format – data format, support data width configurations, *_pdm_data_width*.

Return values

kStatus__PDM_ChannelConfig_Failed – or *kStatus_Success*.

status_t PDM_TransferReceiveNonBlocking(PDM_Type *base, *pdm_handle_t* *handle, *pdm_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on PDM.

Note: This API returns immediately after the transfer initiates. Call the *PDM_RxGetTransferStatusIRQ* to poll the transfer status and check whether the transfer is finished. If the return status is not *kStatus_PDM_Busy*, the transfer is finished.

Parameters

- base – PDM base pointer
- handle – Pointer to the *pdm_handle_t* structure which stores the transfer state.
- xfer – Pointer to the *pdm_transfer_t* structure.

Return values

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

void PDM_TransferAbortReceive(PDM_Type *base, *pdm_handle_t* *handle)

Aborts the current IRQ receive.

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

Parameters

- base – PDM base pointer
- handle – Pointer to the *pdm_handle_t* structure which stores the transfer state.

void PDM_TransferHandleIRQ(PDM_Type *base, *pdm_handle_t* *handle)

Tx interrupt handler.

Parameters

- base – PDM base pointer.
- handle – Pointer to the *pdm_handle_t* structure.

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PDM return status.

Values:

enumerator kStatus_PDM_Busy

PDM is busy.

enumerator kStatus_PDM_CLK_LOW

PDM clock frequency low

enumerator kStatus_PDM_FIFO_ERROR

PDM FIFO underrun or overflow

enumerator kStatus_PDM_QueueFull

PDM FIFO underrun or overflow

enumerator kStatus_PDM_Idle

PDM is idle

enumerator kStatus_PDM_Output_ERROR

PDM is output error

enumerator kStatus_PDM_ChannelConfig_Failed

PDM channel config failed

enumerator kStatus_PDM_HWVAD_VoiceDetected

PDM hwvad voice detected

enumerator kStatus_PDM_HWVAD_Error

PDM hwvad error

enum _pdm_interrupt_enable

The PDM interrupt enable flag.

Values:

enumerator kPDM_ErrorInterruptEnable

PDM channel error interrupt enable.

enumerator kPDM_FIFOInterruptEnable

PDM channel FIFO interrupt

enum _pdm_internal_status

The PDM status.

Values:

enumerator kPDM_StatusDfBusyFlag

Decimation filter is busy processing data

enumerator kPDM_StatusFrequencyLow

Mic app clock frequency not high enough

enumerator kPDM_StatusCh0FifoDataAvaliable
channel 0 fifo data reached watermark level

enumerator kPDM_StatusCh1FifoDataAvaliable
channel 1 fifo data reached watermark level

enumerator kPDM_StatusCh2FifoDataAvaliable
channel 2 fifo data reached watermark level

enumerator kPDM_StatusCh3FifoDataAvaliable
channel 3 fifo data reached watermark level

enum __pdm_channel_enable_mask
PDM channel enable mask.

Values:

enumerator kPDM_EnableChannel0
channgel 0 enable mask

enumerator kPDM_EnableChannel1
channgel 1 enable mask

enumerator kPDM_EnableChannel2
channgel 2 enable mask

enumerator kPDM_EnableChannel3
channgel 3 enable mask

enumerator kPDM_EnableChannelAll

enum __pdm_fifo_status
The PDM fifo status.

Values:

enumerator kPDM_FifoStatusUnderflowCh0
channel0 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh1
channel1 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh2
channel2 fifo status underflow

enumerator kPDM_FifoStatusUnderflowCh3
channel3 fifo status underflow

enumerator kPDM_FifoStatusOverflowCh0
channel0 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh1
channel1 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh2
channel2 fifo status overflow

enumerator kPDM_FifoStatusOverflowCh3
channel3 fifo status overflow

enum __pdm_range_status
The PDM output status.

Values:

enumerator kPDM_RangeStatusUnderFlowCh0
channel0 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh1
channel1 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh2
channel2 range status underflow

enumerator kPDM_RangeStatusUnderFlowCh3
channel3 range status underflow

enumerator kPDM_RangeStatusOverFlowCh0
channel0 range status overflow

enumerator kPDM_RangeStatusOverFlowCh1
channel1 range status overflow

enumerator kPDM_RangeStatusOverFlowCh2
channel2 range status overflow

enumerator kPDM_RangeStatusOverFlowCh3
channel3 range status overflow

enum __pdm_dc_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 medium

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_quality_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 removal configurations.
typedef enum __pdm_df_quality_mode pdm_df_quality_mode_t
    PDM decimation filter quality mode.
typedef enum __pdm_df_output_gain pdm_df_output_gain_t
    PDM decimation filter output gain.
typedef struct __pdm_channel_config pdm_channel_config_t
    PDM channel configurations.
typedef struct __pdm_config pdm_config_t
    PDM user configuration structure.
typedef enum __pdm_hwvad_hpf_config pdm_hwvad_hpf_config_t
    High pass filter configure cut-off frequency.
typedef enum __pdm_hwvad_filter_status pdm_hwvad_filter_status_t
    HWVAD internal filter status.
typedef struct __pdm_hwvad_config pdm_hwvad_config_t
    PDM voice activity detector user configuration structure.
typedef struct __pdm_hwvad_noise_filter pdm_hwvad_noise_filter_t
    PDM voice activity detector noise filter user configuration structure.
typedef enum __pdm_hwvad_zcd_result pdm_hwvad_zcd_result_t
    PDM voice activity detector zero cross detector result.
typedef struct __pdm_hwvad_zero_cross_detector pdm_hwvad_zero_cross_detector_t
    PDM voice activity detector zero cross detector configuration structure.
typedef struct __pdm_transfer pdm_transfer_t
    PDM SDMA transfer structure.
typedef struct __pdm_handle pdm_handle_t
    PDM handle.
typedef void (*pdm_transfer_callback_t)(PDM_Type *base, pdm_handle_t *handle, status_t
status, void *userData)
    PDM transfer callback prototype.
typedef void (*pdm_hwvad_callback_t)(status_t status, void *userData)
    PDM HWVAD callback prototype.
typedef struct __pdm_hwvad_notification pdm_hwvad_notification_t
    PDM HWVAD notification structure.

```

PDM_XFER_QUEUE_SIZE
PDM XFER QUEUE SIZE.

struct __pdm_channel_config
#include <fsl_pdm.h> PDM channel configurations.

Public Members

pdm_dc_remover_t 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 fileter automatically activated, true means enable

bool enableNoiseMin
If Noise minimum block enabled, true means enabled

bool enableNoiseDecimation
If enable noise input decimation

bool enableNoiseDetectOR
Enables a OR logic in the output of minimum noise estimator block

uint32_t noiseFilterAdjustment
The adjustment value of the noise filter

uint32_t noiseGain
Gain value for the noise energy or envelope estimated

struct __pdm_hwvad_zero_cross_detector
#include <fsl_pdm.h> PDM voice activity detector zero cross detector configuration structure.

Public Members

bool enableAutoThreshold
If ZCD auto-threshold enabled, true means enabled.

pdm_hwvad_zcd_result_t zcdAnd
Is ZCD result is AND'ed with energy-based detection, false means OR'ed

uint32_t threshold
The adjustment value of the noise filter

uint32_t adjustmentThreshold
Gain value for the noise energy or envelope estimated

struct __pdm_transfer
#include <fsl_pdm.h> PDM SDMA transfer structure.

Public Members

volatile uint8_t *data
Data start address to transfer.

volatile size_t dataSize
Total Transfer bytes size.

```
struct __pdm_hwvad_notification
    #include <fsl_pdm.h> PDM HWVAD notification structure.

struct __pdm_handle
    #include <fsl_pdm.h> PDM handle structure.
```

Public Members

```
uint32_t state
    Transfer status

pdm_transfer_callback_t callback
    Callback function called at transfer event

void *userData
    Callback parameter passed to callback function

pdm_transfer_t pdmQueue[(4U)]
    Transfer queue storing queued transfer

size_t transferSize[(4U)]
    Data bytes need to transfer

volatile uint8_t queueUser
    Index for user to queue transfer

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

uint32_t format
    data format

uint8_t watermark
    Watermark value

uint8_t startChannel
    end channel

uint8_t channelNums
    Enabled channel number
```

2.66 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.

- Scatter gather case: This function support dynamic scatter gather and static scatter gather, a. for the dynamic scatter gather case: Application should call `PDM_TransferReceiveEDMA` function continuously to make sure new receive request is submit before the previous one finish. b. for the static scatter gather case: Application should use the link transfer feature and make sure a loop link transfer is provided, such as:

```
pdm_edma_transfer_t pdmXfer[2] =
{
    {
        .data = s_buffer,
        .dataSize = BUFFER_SIZE,
        .linkTransfer = &pdmXfer[1],
    },

    {
        .data = &s_buffer[BUFFER_SIZE],
        .dataSize = BUFFER_SIZE,
        .linkTransfer = &pdmXfer[0]
    },
};
```

- b. Multi channel case: This function support receive multi pdm channel data, for example, if two channel is requested,

```
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↳ENABLE_CHANNEL_0, &channelConfig);
PDM_TransferSetChannelConfigEDMA(DEMO_PDM, &s_pdmRxHandle_0, DEMO_PDM_
↳ENABLE_CHANNEL_1, &channelConfig);
PDM_TransferReceiveEDMA(DEMO_PDM, &s_pdmRxHandle_0, pdmXfer);
```

The output data will be formatted as below if handle->interleaveType =

Note: This interface returns immediately after the transfer initiates. Call the PDM_GetReceiveRemainingBytes to poll the transfer status and check whether the PDM transfer is finished.

void PDM_TransferTerminateReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Terminate all PDM receive.

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

Parameters

- base – PDM base pointer.
- handle – PDM eDMA handle pointer.

void PDM_TransferAbortReceiveEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle)

Aborts a PDM receive using eDMA.

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

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.

status_t PDM_TransferGetReceiveCountEDMA(PDM_Type *base, *pdm_edma_handle_t* *handle, size_t *count)

Gets byte count received by PDM.

Parameters

- base – PDM base pointer
- handle – PDM eDMA handle pointer.

- `count` – Bytes count received by PDM.

Return values

- `kStatus_Success` – Succeed get the transfer count.
- `kStatus_NoTransferInProgress` – There is no non-blocking transaction in progress.

FSL_PDM_EDMA_DRIVER_VERSION
Version 2.6.5

enum `_pdm_edma_multi_channel_interleave`
pdm multi channel interleave type

Values:

enumerator `kPDM_EDMAMultiChannelInterleavePerChannelSample`

enumerator `kPDM_EDMAMultiChannelInterleavePerChannelBlock`

typedef struct `_pdm_edma_handle` `pdm_edma_handle_t`
PDM edma handler.

typedef enum `_pdm_edma_multi_channel_interleave` `pdm_edma_multi_channel_interleave_t`
pdm multi channel interleave type

typedef struct `_pdm_edma_transfer` `pdm_edma_transfer_t`
PDM edma transfer.

typedef void (*`pdm_edma_callback_t`)(`PDM_Type` *`base`, `pdm_edma_handle_t` *`handle`, `status_t` `status`, void *`userData`)

PDM eDMA transfer callback function for finish and error.

MCUX_SDK_PDM_EDMA_PDM_ENABLE_INTERNAL
the PDM enable position When calling `PDM_TransferReceiveEDMA`

struct `_pdm_edma_transfer`
`#include <fsl_pdm_edma.h>` PDM edma transfer.

Public Members

volatile `uint8_t` *`data`
Data start address to transfer.

volatile `size_t` `dataSize`
Total Transfer bytes size.

struct `_pdm_edma_transfer` *`linkTransfer`
linked transfer configurations

struct `_pdm_edma_handle`
`#include <fsl_pdm_edma.h>` PDM DMA transfer handle, users should not touch the content of the handle.

Public Members

`edma_handle_t` *`dmaHandle`
DMA handler for PDM send

`uint8_t` `count`
The transfer data count in a DMA request

`uint32_t` receivedBytes
total transfer count

`uint32_t` state
Internal state for PDM eDMA transfer

`pdm_edma_callback_t` callback
Callback for users while transfer finish or error occurs

`bool` isLoopTransfer
loop transfer

`void *userData`
User callback parameter

`edma_tcd_t` *tcd
TCD pool for eDMA transfer.

`uint32_t` tcdNum
TCD number

`uint32_t` tcdUser
Index for user to queue transfer.

`uint32_t` tcdDriver
Index for driver to get the transfer data and size

`volatile uint32_t` tcdUsedNum
Index for user to queue transfer.

`pdm_edma_multi_channel_interleave_t` interleaveType
multi channel transfer interleave type

`uint8_t` endChannel
The last enabled channel

`uint8_t` channelNums
total channel numbers

2.67 PINT: Pin Interrupt and Pattern Match Driver

FSL_PINT_DRIVER_VERSION

`enum` __pint__pin__enable

PINT Pin Interrupt enable type.

Values:

`enumerator` kPINT_PinIntEnableNone

Do not generate Pin Interrupt

`enumerator` kPINT_PinIntEnableRiseEdge

Generate Pin Interrupt on rising edge

`enumerator` kPINT_PinIntEnableFallEdge

Generate Pin Interrupt on falling edge

`enumerator` kPINT_PinIntEnableBothEdges

Generate Pin Interrupt on both edges

enumerator kPINT_PinIntEnableLowLevel

Generate Pin Interrupt on low level

enumerator kPINT_PinIntEnableHighLevel

Generate Pin Interrupt on high level

enum __pint__int

PINT Pin Interrupt type.

Values:

enumerator kPINT_PinInt0

Pin Interrupt 0

enum __pint__pmatch__input__src

PINT Pattern Match bit slice input source type.

Values:

enumerator kPINT_PatternMatchInp0Src

Input source 0

enumerator kPINT_PatternMatchInp1Src

Input source 1

enumerator kPINT_PatternMatchInp2Src

Input source 2

enumerator kPINT_PatternMatchInp3Src

Input source 3

enumerator kPINT_PatternMatchInp4Src

Input source 4

enumerator kPINT_PatternMatchInp5Src

Input source 5

enumerator kPINT_PatternMatchInp6Src

Input source 6

enumerator kPINT_PatternMatchInp7Src

Input source 7

enumerator kPINT_SecPatternMatchInp0Src

Input source 0

enumerator kPINT_SecPatternMatchInp1Src

Input source 1

enum __pint__pmatch__bslice

PINT Pattern Match bit slice type.

Values:

enumerator kPINT_PatternMatchBSlice0

Bit slice 0

enum __pint__pmatch__bslice__cfg

PINT Pattern Match configuration type.

Values:

enumerator kPINT_PatternMatchAlways

Always Contributes to product term match

enumerator kPINT_PatternMatchStickyRise
Sticky Rising edge

enumerator kPINT_PatternMatchStickyFall
Sticky Falling edge

enumerator kPINT_PatternMatchStickyBothEdges
Sticky Rising or Falling edge

enumerator kPINT_PatternMatchHigh
High level

enumerator kPINT_PatternMatchLow
Low level

enumerator kPINT_PatternMatchNever
Never contributes to product term match

enumerator kPINT_PatternMatchBothEdges
Either rising or falling edge

typedef enum *_pint_pin_enable* pint_pin_enable_t
PINT Pin Interrupt enable type.

typedef enum *_pint_int* pint_pin_int_t
PINT Pin Interrupt type.

typedef enum *_pint_pmatch_input_src* pint_pmatch_input_src_t
PINT Pattern Match bit slice input source type.

typedef enum *_pint_pmatch_bslice* pint_pmatch_bslice_t
PINT Pattern Match bit slice type.

typedef enum *_pint_pmatch_bslice_cfg* pint_pmatch_bslice_cfg_t
PINT Pattern Match configuration type.

typedef struct *_pint_status* pint_status_t
PINT event status.

typedef void (*pint_cb_t)(pint_pin_int_t pintr, pint_status_t *status)
PINT Callback function.

typedef struct *_pint_pmatch_cfg* pint_pmatch_cfg_t

void PINT_Init(PINT_Type *base)
Initialize PINT peripheral.

This function initializes the PINT peripheral and enables the clock.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

void PINT_SetCallback(PINT_Type *base, pint_cb_t callback)
Set PINT callback.

This function set the callback for PINT interrupt handler.

Parameters

- base – Base address of the PINT peripheral.
- callback – Callback.

Return values

None. –

```
void PINT_PinInterruptConfig(PINT_Type *base, pint_pin_int_t intr, pint_pin_enable_t enable)
```

Configure PINT peripheral pin interrupt.

This function configures a given pin interrupt.

Parameters

- base – Base address of the PINT peripheral.
- intr – Pin interrupt.
- enable – Selects detection logic.

Return values

None. –

```
void PINT_PinInterruptGetConfig(PINT_Type *base, pint_pin_int_t pintr, pint_pin_enable_t *enable)
```

Get PINT peripheral pin interrupt configuration.

This function returns the configuration of a given pin interrupt.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.
- enable – Pointer to store the detection logic.

Return values

None. –

```
void PINT_PinInterruptClrStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt status only when the pin was triggered by edge-sensitive.

This function clears the selected pin interrupt status.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Get Selected pin interrupt status.

This function returns the selected pin interrupt status.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

status – = 0 No pin interrupt request. = 1 Selected Pin interrupt request active.

```
void PINT_PinInterruptClrStatusAll(PINT_Type *base)
```

Clear all pin interrupts status only when pins were triggered by edge-sensitive.

This function clears the status of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

static inline uint32_t PINT_PinInterruptGetStatusAll(PINT_Type *base)

Get all pin interrupts status.

This function returns the status of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

status – Each bit position indicates the status of corresponding pin interrupt.
= 0 No pin interrupt request. = 1 Pin interrupt request active.

static inline void PINT_PinInterruptClrFallFlag(PINT_Type *base, *pint_pin_int_t* pintr)

Clear Selected pin interrupt fall flag.

This function clears the selected pin interrupt fall flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

None. –

static inline uint32_t PINT_PinInterruptGetFallFlag(PINT_Type *base, *pint_pin_int_t* pintr)

Get selected pin interrupt fall flag.

This function returns the selected pin interrupt fall flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

flag – = 0 Falling edge has not been detected. = 1 Falling edge has been detected.

static inline void PINT_PinInterruptClrFallFlagAll(PINT_Type *base)

Clear all pin interrupt fall flags.

This function clears the fall flag for all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

static inline uint32_t PINT_PinInterruptGetFallFlagAll(PINT_Type *base)

Get all pin interrupt fall flags.

This function returns the fall flag of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

flags – Each bit position indicates the falling edge detection of the corresponding pin interrupt. 0 Falling edge has not been detected. = 1 Falling edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlag(PINT_Type *base, pintr)
```

Clear Selected pin interrupt rise flag.

This function clears the selected pin interrupt rise flag.

Parameters

- *base* – Base address of the PINT peripheral.
- *pintr* – Pin interrupt.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlag(PINT_Type *base, pintr)
```

Get selected pin interrupt rise flag.

This function returns the selected pin interrupt rise flag.

Parameters

- *base* – Base address of the PINT peripheral.
- *pintr* – Pin interrupt.

Return values

flag – = 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlagAll(PINT_Type *base)
```

Clear all pin interrupt rise flags.

This function clears the rise flag for all pin interrupts.

Parameters

- *base* – Base address of the PINT peripheral.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlagAll(PINT_Type *base)
```

Get all pin interrupt rise flags.

This function returns the rise flag of all pin interrupts.

Parameters

- *base* – Base address of the PINT peripheral.

Return values

flags – Each bit position indicates the rising edge detection of the corresponding pin interrupt. 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
void PINT_PatternMatchConfig(PINT_Type *base, bslice, cfg)
```

Configure PINT pattern match.

This function configures a given pattern match bit slice.

Parameters

- *base* – Base address of the PINT peripheral.
- *bslice* – Pattern match bit slice number.
- *cfg* – Pointer to bit slice configuration.

Return values

None. –

```
void PINT_PatternMatchGetConfig(PINT_Type *base, pint_pmatch_bslice_t bslice,  
                                pint_pmatch_cfg_t *cfg)
```

Get PINT pattern match configuration.

This function returns the configuration of a given pattern match bit slice.

Parameters

- base – Base address of the PINT peripheral.
- bslice – Pattern match bit slice number.
- cfg – Pointer to bit slice configuration.

Return values

None. –

```
static inline uint32_t PINT_PatternMatchGetStatus(PINT_Type *base, pint_pmatch_bslice_t  
                                                  bslice)
```

Get pattern match bit slice status.

This function returns the status of selected bit slice.

Parameters

- base – Base address of the PINT peripheral.
- bslice – Pattern match bit slice number.

Return values

status – = 0 Match has not been detected. = 1 Match has been detected.

```
static inline uint32_t PINT_PatternMatchGetStatusAll(PINT_Type *base)
```

Get status of all pattern match bit slices.

This function returns the status of all bit slices.

Parameters

- base – Base address of the PINT peripheral.

Return values

status – Each bit position indicates the match status of corresponding bit slice.
= 0 Match has not been detected. = 1 Match has been detected.

```
uint32_t PINT_PatternMatchResetDetectLogic(PINT_Type *base)
```

Reset pattern match detection logic.

This function resets the pattern match detection logic if any of the product term is matching.

Parameters

- base – Base address of the PINT peripheral.

Return values

pmstatus – Each bit position indicates the match status of corresponding bit slice.
= 0 Match was detected. = 1 Match was not detected.

```
static inline void PINT_PatternMatchEnable(PINT_Type *base)
```

Enable pattern match function.

This function enables the pattern match function.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

static inline void PINT_PatternMatchDisable(PINT_Type *base)

Disable pattern match function.

This function disables the pattern match function.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

static inline void PINT_PatternMatchEnableRXEV(PINT_Type *base)

Enable RXEV output.

This function enables the pattern match RXEV output.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

static inline void PINT_PatternMatchDisableRXEV(PINT_Type *base)

Disable RXEV output.

This function disables the pattern match RXEV output.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

void PINT_EnableCallback(PINT_Type *base)

Enable callback.

This function enables the interrupt for the selected PINT peripheral. Although the pin(s) are monitored as soon as they are enabled, the callback function is not enabled until this function is called.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

void PINT_DisableCallback(PINT_Type *base)

Disable callback.

This function disables the interrupt for the selected PINT peripheral. Although the pins are still being monitored but the callback function is not called.

Parameters

- base – Base address of the peripheral.

Return values

None. –

void PINT_Deinit(PINT_Type *base)

Deinitialize PINT peripheral.

This function disables the PINT clock.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

`void PINT_EnableCallbackByIndex(PINT_Type *base, pint_pin_int_t pintIdx)`
enable callback by pin index.

This function enables callback by pin index instead of enabling all pins.

Parameters

- base – Base address of the peripheral.
- pintIdx – pin index.

Return values

None. –

`void PINT_DisableCallbackByIndex(PINT_Type *base, pint_pin_int_t pintIdx)`
disable callback by pin index.

This function disables callback by pin index instead of disabling all pins.

Parameters

- base – Base address of the peripheral.
- pintIdx – pin index.

Return values

None. –

`PINT_USE_LEGACY_CALLBACK`

`PININT_BITSLICE_SRC_START`

`PININT_BITSLICE_SRC_MASK`

`PININT_BITSLICE_CFG_START`

`PININT_BITSLICE_CFG_MASK`

`PININT_BITSLICE_ENDP_MASK`

`PINT_PIN_INT_LEVEL`

`PINT_PIN_INT_EDGE`

`PINT_PIN_INT_FALL_OR_HIGH_LEVEL`

`PINT_PIN_INT_RISE`

`PINT_PIN_RISE_EDGE`

`PINT_PIN_FALL_EDGE`

`PINT_PIN_BOTH_EDGE`

`PINT_PIN_LOW_LEVEL`

`PINT_PIN_HIGH_LEVEL`

`struct __pint_status`

#include <fsl_pint.h> PINT event status.

`struct __pint_pmatch_cfg`

#include <fsl_pint.h>

2.68 PNGDEC: PNG decoder Driver

Error codes for the PNGDEC driver.

Values:

enumerator kStatus_PNGDEC_NotSupported

Interlace data chunk is not supported.

enumerator kStatus_PNGDEC_WidthTooLarge

The image width is larger than 1024.

enum __pngdec_interrupt_enable

Interrupt enable/disable mask.

Values:

enumerator kPNGDEC_ChecksumErrorFlag

ADLER-32 checksum error status and interrupt enable.

enumerator kPNGDEC_CrcErrorFlag

CRC error status and interrupt enable.

enumerator kPNGDEC_HeaderErrorFlag

Header error status and interrupt enable.

enumerator kPNGDEC_BtypeErrorFlag

B type error status and interrupt enable. TODO

enumerator kPNGDEC_ZlibHeaderErrorFlag

Zlib header error status and interrupt enable.

enumerator kPNGDEC_BitDepthErrorFlag

Bit depth error status and interrupt enable. Bit depth less than 8 bit not supported.

enumerator kPNGDEC_InterlaceErrorFlag

Interlace error status and interrupt enable. Interlace is not supported.

enumerator kPNGDEC_WidthErrorFlag

Width error status and interrupt enable. Max image width 1024.

enumerator kPNGDEC_EncodeDataDoneFlag

Data encoding done status and interrupt enable.

enumerator kPNGDEC_DecompilePixelDoneFlag

Pixel data decoding done status and interrupt enable.

enumerator kPNGDEC_DecompileAncillaryDoneFlag

Ancillary data decoding done status and interrupt enable.

enumerator kPNGDEC_ErrorFlags

enum __pngdec_endian_mode

PNG decode endian mode.

Values:

enumerator kPNGDEC_LittleEndian

Little endian.

enumerator kPNGDEC_BigEndian

Big endian.

enum *_pngdec_color_type*

PNG color type.

Values:

enumerator *kPNGDEC_PixelFormatY8*

8-bit monochrome(gray scale).

enumerator *kPNGDEC_PixelFormatYA88*

16-bit monochrome(gray scale) with alpha.

enumerator *kPNGDEC_PixelFormatRGB888*

24-bit RGB true color, 8-bit each palette.

enumerator *kPNGDEC_PixelFormatRGBA8888*

32-bit RGBA true color with alpha, 8-bit each palette.

enumerator *kPNGDEC_PixelFormatRGB16_16_16*

48-bit RGB true color, 16-bit each palette.

enumerator *kPNGDEC_PixelFormatRGBA16_16_16_16*

64-bit RGBA true color with alpha, 16-bit each palette.

enumerator *kPNGDEC_PixelFormatLUT8*

8-bit Indexed Color.

typedef enum *_pngdec_endian_mode* *pngdec_endian_mode_t*

PNG decode endian mode.

typedef struct *_pngdec_config* *pngdec_config_t*

Configuration for PNGDEC.

typedef enum *_pngdec_color_type* *pngdec_color_type_t*

PNG color type.

typedef struct *_pngdec_image* *pngdec_image_t*

The decoded image info structure.

FSL_PNGDEC_DRIVER_VERSION

PNGDEC driver version.

void PNGDEC_Init(PNGDEC_Type *base, const *pngdec_config_t* *config)

Initializes the PNGDEC.

The default configuration can be got by calling PNGDEC_GetDefaultConfig().

Parameters

- base – PNGDEC peripheral base address.
- config – Pointer to PNGDEC configuration structure.

void PNGDEC_Deinit(PNGDEC_Type *base)

Deinitializes the PNGDEC.

Parameters

- base – PNGDEC peripheral base address.

void PNGDEC_GetDefaultConfig(*pngdec_config_t* *config)

Gets the default configuration for PNGDEC.

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

Example:


```
config->enableAncillary = false;
config->enable = false;
```

Parameters

- config – Pointer to PNGDEC configuration structure.

static inline void PNGDEC_EnableInterrupts(PNGDEC_Type *base, uint32_t mask)
Enables interrupts.

Parameters

- base – PNGDEC peripheral base address.
- mask – Interrupts mask. See “_pngdec_interrupt_enable”.

static inline void PNGDEC_DisableInterrupts(PNGDEC_Type *base, uint32_t mask)
Disables interrupts.

Parameters

- base – PNGDEC peripheral base address.
- mask – Interrupts mask. See “_pngdec_interrupt_enable”.

static inline uint32_t PNGDEC_GetStatusFlags(PNGDEC_Type *base)
Gets status flags.

Parameters

- base – PNGDEC peripheral base address.

Returns

Status flags asserted mask. See “_pngdec_status_flags”.

static inline void PNGDEC_ClearStatusFlags(PNGDEC_Type *base, uint32_t mask)
Clears status flags.

Parameters

- base – PNGDEC peripheral base address.
- mask – Status flags mask. See “_pngdec_status_flags”.

static inline void PNGDEC_Reset(PNGDEC_Type *base)
Resets the PNGDEC code and DMA logic.

Parameters

- base – PNGDEC peripheral base address.

static inline void PNGDEC_Enable(PNGDEC_Type *base, bool enable)
Enables or disables the PNGDEC.

Parameters

- base – PNGDEC peripheral base address.
- enable – True to enable the PNGDEC.

static inline void PNGDEC_EnableAncillary(PNGDEC_Type *base, bool enable)
Enables or disables the PNGDEC ancillary drop.

Parameters

- base – PNGDEC peripheral base address.
- enable – True to enable the PNGDEC ancillary drop.

static inline void PNGDEC_StartDecode(PNGDEC_Type *base)

Starts the PNG decode.

Parameters

- base – PNGDEC peripheral base address.

void PNGDEC_SetPngBuffer(PNGDEC_Type *base, uint8_t *buffer, size_t length)

Sets the address and length of the raw PNG image.

Parameters

- base – PNGDEC peripheral base address.
- data – Start address of the buffer of the raw PNG image, shall be 8-byte aligned.
- length – Size of the buffer.

static inline void PNGDEC_SetOutputBuffer(PNGDEC_Type *base, uint8_t *imageData, uint8_t *ancillaryData)

Sets the address of the decoded data.

Parameters

- base – PNGDEC peripheral base address.
- imageData – Start address of the buffer for the decoded image data, shall be 8-byte aligned.
- ancillaryData – Start address of the buffer for the decoded ancillary data, shall be 8-byte aligned.

status_t PNGDEC_ParseHeader(pngdec_image_t *image, uint8_t *pngBuf)

Parses the PNG header and stores the info in the decoded image info structure.

Parameters

- image – Pointer to PNGDEC decoded image info structure.
- pngBuf – Pointer to PNG file buffer.

Return values

- kStatus_Success – Header parsing success.
- kStatus_Fail – PNG header parsing failed due corrupted header.
- kStatus_PNGDEC_WidthTooLarge – Header parsing failed due to the image width is larger than 1024.
- kStatus_PNGDEC_NotSupported – Header parsing failed due to the image is interlaced or the bit depth is less than 8.

status_t PNGDEC_Decode(PNGDEC_Type *base, pngdec_image_t *image, uint32_t *status)

Decodes the PNG image.

This function performs the PNG decoding in blocking way and stores the decoded info in decoded image info structure.

Parameters

- base – PNGDEC peripheral base address.
- image – Pointer to PNGDEC decoded image info structure.
- status – Pointer to decoded status. When retval is kStatus_Fail, Checksum/Crc/Header/Btype/ZlibHeader error may occur due to PNG file corruption, user can check which error(s) occurred if necessary.

Return values

- `kStatus_Success` – PNG decoding success.
- `kStatus_Fail` – PNG decoding failed due to CRC/header/B type/Alder error or invalid PNG file.
- `kStatus_PNGDEC_WidthTooLarge` – PNG decoding failed due to the image width is larger than 1024.
- `kStatus_PNGDEC_NotSupported` – PNG decoding failed due to the image is interlaced or the bit depth is less than 8.

`bool enableAncillary`

Enable ancillary data drop.

`bool enable`

Enables the decode IP.

`uint32_t width`

Decoded image width.

`uint32_t height`

Decoded image height.

`pngdec_color_type_t colorType`

Color type for the generated image.

`uint8_t *imageData`

Pointer to the buffer for decoded image data.

`uint8_t *ancillaryData`

Pointer to the buffer for decoded ancillary data.

`uint32_t ancillaryLength`

Length of the ancillary data.

`struct _pngdec_config`

#include <fsl_pngdec.h> Configuration for PNGDEC.

`struct _pngdec_image`

#include <fsl_pngdec.h> The decoded image info structure.

2.69 Power Driver

`enum pd_bits`

Power down control bits defined in SLEEPCON and PMC.

Values:

`enumerator kPDRUNCFG_SHUT_SENSEP_MAINCLK`

The Private Part in VDD1_SENSE Main Clock Shut Off.

`enumerator kPDRUNCFG_SHUT_SENSES_MAINCLK`

The Shared Part in VDD1_SENSE Main Clock Shut Off.

`enumerator kPDRUNCFG_SHUT_RAM0_CLK`

Main Clock of RAM Arbiter 0 Shut Off.

`enumerator kPDRUNCFG_SHUT_RAM1_CLK`

Main Clock of RAM Arbiter 1 shut off.

enumerator kPDRUNCFG_SHUT_COMNN_MAINCLK
VDDN_COM Domain Main Clock Shut Off.

enumerator kPDRUNCFG_SHUT_MEDIA_MAINCLK
VDD2_MEDIA and VDDN_MEDIA Domains Main Clock of Shut Off.

enumerator kPDRUNCFG_PD_SYSXTAL
Xtal Oscillator Power Down.

enumerator kPDRUNCFG_PD_FRO2
FRO2 Power Down.

enumerator kPDRUNCFG_PD_LPOSC
LPOSC Power Down.

enumerator kPDRUNCFG_PD_PLLANA
Main PLL Analog Function Power Down.

enumerator kPDRUNCFG_PD_PLLLDO
Main PLL Internal Regulator Power Down.

enumerator kPDRUNCFG_PD_AUDPLLANA
Audio PLL Analog Function Power Down.

enumerator kPDRUNCFG_PD_AUDPLLLDO
Audio PLL Internal Regulator Power Down.

enumerator kPDRUNCFG_PD_ADC0
ADC0 Power Down, 1 - Applies gating.

enumerator kPDRUNCFG_GATE_FRO2
FRO2 Gating, 1 - Applies gating.

enumerator kPDRUNCFG_DSR_VDD2N_MEDIA
Power Switch and DSR Enable for the VDD2_MEDIA and VDDN_MEDIA domains.

enumerator kPDRUNCFG_DSR_VDDN_COM
Power Switch and DSR Enable for the VDDN_COM domain.

enumerator kPDRUNCFG_PD_VDD2_DSP
Power switch for the HiFi4 DSP.

enumerator kPDRUNCFG_PD_VDD2_MIPI
Power Switch for the MIPI PHY.

enumerator kPDRUNCFG_PD_RBB_VDD1
Power Down RBB in VDD1.

enumerator kPDRUNCFG_PD_AFBB_VDD1
Power Down AFBB in VDD1 Domain.

enumerator kPDRUNCFG_PD_RBB_VDD2
Power Down RBB in VDD2 Domain.

enumerator kPDRUNCFG_PD_AFBB_VDD2
Power Down AFBB in VDD2 Domain.

enumerator kPDRUNCFG_PD_RBB_VDDN
Power Down RBB in VDDN Domain.

enumerator kPDRUNCFG_PD_AFBB_VDDN
Power Down RBB in VDDN Domain.

enumerator kPDRUNCFG_PD_SRAM_RBB_VDD1

Power Down SRAM RBB in VDD1 Domain.

enumerator kPDRUNCFG_PD_SRAM_RBB_VDD2

Power Down SRAM RBB in VDD2 Domain.

enumerator kPDRUNCFG_PD_SRAM_AFBB_VDD2

Power Down SRAM AFBB in VDD2 Domain.

enumerator kPDRUNCFG_PD_PMC_TEMPSNS

Power Down PMC Temperature Sensor.

enumerator kPDRUNCFG_LP_PMCREF

PMC References in Low-Power Mode.

enumerator kPDRUNCFG_PD_HVD1V8

HVD Power Down.

enumerator kPDRUNCFG_LP_POR_VDD1

POR Low-Power Mode in VDD1 Domain.

enumerator kPDRUNCFG_LP_LVD_VDD1

LVD Low-Power Mode in VDD1 Domain.

enumerator kPDRUNCFG_PD_HVD_VDD1

Power Down HVD in VDD1 Domain.

enumerator kPDRUNCFG_PD_AGDET_VDD1

Power Down AGDET in VDD1 Domain.

enumerator kPDRUNCFG_LP_POR_VDD2

POR Low-Power Mode in VDD2 Domain.

enumerator kPDRUNCFG_LP_LVD_VDD2

LVD Low-Power Mode in VDD2 Domain.

enumerator kPDRUNCFG_PD_HVD_VDD2

Power Down HVD in VDD2 Domain.

enumerator kPDRUNCFG_PD_AGDET_VDD2

Power Down AGDET in VDD2 Domain.

enumerator kPDRUNCFG_LP_POR_VDDN

POR Low-Power Mode in VDDN Domain.

enumerator kPDRUNCFG_LP_LVD_VDDN

LVD Low-Power Mode in VDDN Domain.

enumerator kPDRUNCFG_PD_HVD_VDDN

Power Down HVD in VDDN Domain.

enumerator kPDRUNCFG_PD_OTP

Power Down OTP.

enumerator kPDRUNCFG_PD_ROM

Power Down ROM.

enumerator kPDRUNCFG_APD_SRAM1

RAM Partition 1 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM2

RAM Partition 2 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM3
RAM Partition 3 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM4
RAM Partition 4 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM5
RAM Partition 5 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM6
RAM Partition 6 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM7
RAM Partition 7 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM8
RAM Partition 8 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM9
RAM Partition 9 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM10
RAM Partition 10 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM11
RAM Partition 11 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM12
RAM Partition 12 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM13
RAM Partition 13 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM14
RAM Partition 14 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM15
RAM Partition 15 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM16
RAM Partition 16 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM17
RAM Partition 17 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM18
RAM Partition 18 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM19
RAM Partition 19 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM20
RAM Partition 20 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM21
RAM Partition 21 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM22
RAM Partition 22 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM23
RAM Partition 23 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM24
RAM Partition 24 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM25
RAM Partition 25 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM26
RAM Partition 26 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM27
RAM Partition 27 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM28
RAM Partition 28 Array Power Down.

enumerator kPDRUNCFG_APD_SRAM29
RAM Partition 29 Array Power Down.

enumerator kPDRUNCFG_PPD_SRAM1
RAM Partition 1 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM2
RAM Partition 2 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM3
RAM Partition 3 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM4
RAM Partition 4 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM5
RAM Partition 5 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM6
RAM Partition 6 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM7
RAM Partition 7 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM8
RAM Partition 8 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM9
RAM Partition 9 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM10
RAM Partition 10 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM11
RAM Partition 11 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM12
RAM Partition 12 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM13
RAM Partition 13 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM14
RAM Partition 14 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM15
RAM Partition 15 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM16
RAM Partition 16 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM17
RAM Partition 17 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM18
RAM Partition 18 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM19
RAM Partition 19 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM20
RAM Partition 20 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM21
RAM Partition 21 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM22
RAM Partition 22 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM23
RAM Partition 23 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM24
RAM Partition 24 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM25
RAM Partition 25 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM26
RAM Partition 26 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM27
RAM Partition 27 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM28
RAM Partition 28 Periphery Power Down.

enumerator kPDRUNCFG_PPD_SRAM29
RAM Partition 29 Periphery Power Down.

enumerator kPDRUNCFG_APD_SDHC0_SRAM
uSDHC0 SRAM array Power Down.

enumerator kPDRUNCFG_APD_SDHC1_SRAM
uSDHC1 SRAM array Power Down.

enumerator kPDRUNCFG_APD_USB0_SRAM
USB0 SRAM array Power Down.

enumerator kPDRUNCFG_APD_USB1_SRAM
USB1 SRAM array Power Down.

enumerator kPDRUNCFG_APD_JPEGDEC
Powers down JPEGDEC RAMs array.

enumerator kPDRUNCFG_APD_PNGDEC
Powers down PNGDEC RAMs array.

enumerator kPDRUNCFG_APD_MIPIDSI
Powers down MIPI PHY RAMs array.

enumerator kPDRUNCFG_APD_GPU
Powers down VGPU RAMs array.

enumerator kPDRUNCFG_APD_DMA2_3
Powers down DMA2 and DMA3 RAMs array.

enumerator kPDRUNCFG_APD_DMA0_1_PKC ETF
Powers down DMA0-1, PKC, and ETF RAMs array.

enumerator kPDRUNCFG_APD_CPU0_CODE_CACHE
Powers down CPU0 code cache RAMs array.

enumerator kPDRUNCFG_APD_CPU0_SYSTEM_CACHE
Powers down CPU0 system cache RAMs array.

enumerator kPDRUNCFG_APD_DSP_ICACHE
Powers down HiFi4 instruction cache RAMs array.

enumerator kPDRUNCFG_APD_DSP_DCACHE
Powers down HiFi4 data cache RAMs array.

enumerator kPDRUNCFG_APD_DSP_ITCM
Powers down HiFi4 instruction TCM RAMs array.

enumerator kPDRUNCFG_APD_DSP_DTCM
Powers down HiFi4 data TCM RAMs array.

enumerator kPDRUNCFG_APD_EZHV_TCM
Powers down EZH-V TCM RAMs array.

enumerator kPDRUNCFG_APD_NPU
Powers down NPU RAMs array.

enumerator kPDRUNCFG_APD_XSPI0
Powers down XSPI0, MMU0, and cache RAMs array.

enumerator kPDRUNCFG_APD_XSPI1
Powers down XSPI1, MMU1, and cache RAMs array.

enumerator kPDRUNCFG_APD_XSPI2
Powers down XSPI2 and MMU2 RAMs array.

enumerator kPDRUNCFG_APD_LCDIF
Powers down LCDIF controller RAMs array.

enumerator kPDRUNCFG_APD_OCOTP
Powers down OCOTP shadow RAMs array.

enumerator kPDRUNCFG_PPD_SDHC0_SRAM
Powers down uSDHC0 RAMs periphery.

enumerator kPDRUNCFG_PPD_SDHC1_SRAM
Powers down uSDHC1 RAMs periphery.

enumerator kPDRUNCFG_PPD_USB0_SRAM
Powers down USB0 RAMs periphery.

enumerator kPDRUNCFG_PPD_USB1_SRAM
Powers down USB1 RAMs periphery.

enumerator kPDRUNCFG_PPD_JPEGDEC
Powers down JPEGDEC RAMs periphery.

enumerator kPDRUNCFG_PPD_PNGDEC
Powers down PNGDEC RAMs periphery.

enumerator kPDRUNCFG_PPD_MIPIDSI
Powers down MIPI PHY RAMs periphery.

enumerator kPDRUNCFG_PPD_GPU
Powers down VGPU RAMs periphery.

enumerator kPDRUNCFG_PPD_DMA2_3
Powers down DMA2 and DMA3 RAMs periphery.

enumerator kPDRUNCFG_PPD_DMA0_1_PKC ETF
Powers down DMA0-1, PKC, and ETF RAMs periphery.

enumerator kPDRUNCFG_PPD_CPU0_CODE_CACHE
Powers down CPU0 code cache RAMs periphery.

enumerator kPDRUNCFG_PPD_CPU0_SYSTEM_CACHE
Powers down CPU0 system cache RAMs periphery.

enumerator kPDRUNCFG_PPD_DSP_ICACHE
Powers down HiFi4 instruction cache RAMs periphery.

enumerator kPDRUNCFG_PPD_DSP_DCACHE
Powers down HiFi4 data cache RAMs periphery.

enumerator kPDRUNCFG_PPD_DSP_ITCM
Powers down HiFi4 instruction TCM RAMs periphery.

enumerator kPDRUNCFG_PPD_DSP_DTCM
Powers down HiFi4 data TCM RAMs periphery.

enumerator kPDRUNCFG_PPD_EZHV_TCM
Powers down EZH-V TCM RAMs periphery.

enumerator kPDRUNCFG_PPD_NPU
Powers down NPU RAMs periphery.

enumerator kPDRUNCFG_PPD_XSPI0
Powers down XSPI0, MMU0, and cache RAMs periphery.

enumerator kPDRUNCFG_PPD_XSPI1
Powers down XSPI1, MMU1, and cache RAMs periphery.

enumerator kPDRUNCFG_PPD_XSPI2
Powers down XSPI2 and MMU2 RAMs periphery.

enumerator kPDRUNCFG_PPD_LCDIF
Powers down LCDIF controller RAMs periphery.

enumerator kPDRUNCFG_PPD_OCOTP
Powers down OCOTP shadow RAMs periphery.

enumerator kPDRUNCFG_ForceUnsigned

enum lp_bits

low power control bits for modules. Bits used for modules to requesting low-power.

Values:

enumerator kPower_VGPU_LPREQ
VGPU low power request.

enumerator kPower_EZHV_STOP
EZHV stop request.

enumerator kPower_EZHV_HALT
EZHV halt request.

enumerator kPower_EZHV_EXIT_WAIT
EZHV exit wait request.

enumerator kPower_XSPI2_STOP
XSPI2 stop request.

enumerator kPower_LPSPI14_B_LPREQ
LPSPI14 bus low power request.

enumerator kPower_LPSPI14_F_LPREQ
LPSPI14 function low power request.

enumerator kPower_LPSPI16_B_LPREQ
LPSPI16 bus low power request.

enumerator kPower_LPSPI16_F_LPREQ
LPSPI16 function low power request.

enumerator kPower_FLEXIO_B_LPREQ
FLEXIO bus low power request.

enumerator kPower_FLEXIO_F_LPREQ
FLEXIO function low power request.

enumerator kPower_NIC0_LPREQ
NIC0 low power request.

enumerator kPower_NIC1_LPREQ
NIC1 low power request.

enumerator kPower_ADC0_STOP
ADC0 stop request.

enumerator kPower_ACMP0_STOP
ACMP0 stop request.

enumerator kPower_MICFIL_STOP
MICFIL stop request.

enumerator kPower_LPI2C15_B_LPREQ
LPI2C15 bus low power request.

enumerator kPower_LPI2C15_F_LPREQ
LPI2C15 function low power request.

enumerator kPower_GDET3_LPREQ
GDET3 low power request.

enumerator kPower_RTC_STOP
RTC0 and RTC1 stop request.

enumerator kPower_EDMA2_STOP
EDMA2 stop request.

enumerator kPower_EDMA3_STOP
EDMA3 stop request.

enumerator kPower_FC17_B_LPREQ
LP_FLEXCOMM17 bus low power request.

enumerator kPower_FC18_B_LPREQ
LP_FLEXCOMM18 bus low power request.

enumerator kPower_FC19_B_LPREQ
LP_FLEXCOMM19 bus low power request.

enumerator kPower_FC20_B_LPREQ
LP_FLEXCOMM20 bus low power request.

enumerator kPower_FC17_F_LPREQ
LP_FLEXCOMM17 function low power request.

enumerator kPower_FC18_F_LPREQ
LP_FLEXCOMM18 function low power request.

enumerator kPower_FC19_F_LPREQ
LP_FLEXCOMM19 function low power request.

enumerator kPower_FC20_F_LPREQ
LP_FLEXCOMM20 function low power request.

enumerator kPower_SAI3_LPREQ
SAI3 low power request.

enumerator kPower_GPIO8_LPREQ
GPIO8 low power request.

enumerator kPower_GPIO9_LPREQ
GPIO9 low power request.

enumerator kPower_GPIO10_LPREQ
GPIO10 low power request.

enumerator kPower_I3C2_STOP
I3C2 low power request.

enumerator kPower_I3C3_STOP
I3C3 low power request.

enum __pmic_mode_reg
PMIC mode pin configuration API parameter.

Values:

enumerator kCfg_Run
PDRUNCFG0 register offset.

enumerator kCfg_Sleep
PDSLEEPCFG0 register offset.

enum __power_mode_config
Power mode configuration API parameter.

Values:

enumerator kPower_Sleep
Sleep mode.

enumerator kPower_DeepSleep
Deep Sleep mode.

enumerator kPower_DeepSleepRetention
Deep Sleep Retention(DSR) mode.

enumerator kPower_DeepPowerDown
Deep Power Down(DPD) mode.

enumerator kPower_FullDeepPowerDown
Full Deep Power Down(FDPD) mode.

enum __power_hwwake_src
DMA Wakeup sources.

Values:

enumerator kPower_HWWakeSrcFlexio
Enables DMA to wakeup by FLEXIO DMA request.

enumerator kPower_HWWakeSrcLpFlexcomm
Enables DMA to wakeup by LP_FLEXCOMM0-13(CPU0), LP_FLEXCOMM17-20(CPU1)
DMA request.

enumerator kPower_HWWakeSrcSai
Enables DMA to wakeup by SAI0-2(CPU0), SAI3(CPU1) request.

enum __power_shared_resource_mask
Definition for shared resources.

Values:

enumerator kPower_MaskAdc0
ADC0 mask.

enumerator kPower_MaskAcmp0
ACMP0 mask.

enumerator kPower_MaskMicfil
MICFIL mask.

enumerator kPower_MaskLpi2c15
LPI2C15 mask.

enumerator kPower_MaskGdet3
GDET3 mask.

enumerator kPower_MaskRtc
RTC mask.

enumerator kPower_MaskVgpu
VGPU mask.

enumerator kPower_MaskEzhv
EZHV mask.

enumerator kPower_MaskXspi2
XSPI2 mask.

enumerator kPower_MaskLpspi14
LPSPI14 mask.

enumerator kPower_MaskLpspi16
LPSPI16 mask.

enumerator kPower_MaskFlexio
FlexIO mask.

enumerator kPower__MaskNic0
NIC0 mask.

enumerator kPower__MaskNic1
NIC1 mask.

enumerator kPower__MaskAll
Mask all shared modules.

enum __power__pad__vrange__val
pad voltage range value for the 3V capable IOs. To reduce power the IOs can be configured for 1.8V or 3.3V operation, powering down the detector, but requiring the application to restrict the IO supply voltage to the selected range.

Values:

enumerator kPadVol__Continuous
Continuous mode, VDDE detector on.

enumerator kPadVol__171__198
Voltage from 1.71V to 1.98V. supply detector off.

enumerator kPadVol__300__360
Voltage from 3.00V to 3.60V. supply detector off.

enum __body__bias__domain
Body Bias domain definition.

Values:

enumerator kPower__BodyBiasVdd2Sram
VDD2 domain RAMs.

enumerator kPower__BodyBiasVdd1Sram
VDD1 domain RAMs.

enumerator kPower__BodyBiasVddn
VDDN domain.

enumerator kPower__BodyBiasVdd2
VDD2 domain.

enumerator kPower__BodyBiasVdd1
VDD1 domain.

enum __power__regulator
Regulator definition for Regulator and LVD configuration.

Values:

enumerator kRegulator__DCDC
DCDC used for VDDN.

enumerator kRegulator__Vdd2LDO
VDD2 LDO.

enumerator kRegulator__Vdd1LDO
VDD1 LDO.

enum __power__ldo__mode
LDO mode definition.

Values:

enumerator kPower_LDOMode_Bypass
LDO Bypass mode.

enumerator kPower_LDOMode_HP
LDO High Power mode.

enumerator kPower_LDOMode_LP
LDO Low Power mode.

enum _power_dcdc_mode
DCDC mode definition.

Values:

enumerator kPower_DCDCMode_HP
DCDC High Power mode.

enumerator kPower_DCDCMode_LP
DCDC Low Power mode.

enumerator kPower_DCDCMode_ULP
DCDC Ultra Low Power mode. A0 Silicon does not support this mode and will default to low power mode when configured.

enum _power_vdd_src
VDDN, VDD1 or VDD2 supply source.

Values:

enumerator kVddSrc_PMC
Supplied by onchip regulator in PMC, DCDC for VDDN, LDO1 for VDD1, LDO2 for VDD2.

enumerator kVddSrc_PMIC
Supplied by external PMIC.

typedef enum *pd_bits* pd_bit_t
Power down control bits defined in SLEEPCON and PMC.

typedef enum *lp_bits* lp_bit_t
low power control bits for modules. Bits used for modules to requesting low-power.

typedef enum *_pmic_mode_reg* pmic_mode_reg_t
PMIC mode pin configuration API parameter.

typedef enum *_power_mode_config* power_mode_cfg_t
Power mode configuration API parameter.

typedef enum *_power_pad_vrange_val* power_pad_vrange_val_t
pad voltage range value for the 3V capable IOs. To reduce power the IOs can be configured for 1.8V or 3.3V operation, powering down the detector, but requiring the application to restrict the IO supply voltage to the selected range.

typedef enum *_power_regulator* power_regulator_t
Regulator definition for Regulator and LVD configuration.

typedef union *_power_regulator_voltage* power_regulator_voltage_t
Regulator voltage configuraton. Configure the regulator voltage in uV.

typedef enum *_power_vdd_src* power_vdd_src_t
VDDN, VDD1 or VDD2 supply source.

typedef union *_power_lvd_voltage* power_lvd_voltage_t
LVD voltage configuraton. Configure the LVD voltage in uV. Falling trip = 0.5V + 10 mV * bitfield value.

void POWER__EnablePD(*pd_bit_t* en)

API to enable PDRUNCFG bit in the SLEEPCON and PMC. Note that enabling the bit powers down the peripheral.

Parameters

- en – peripheral for which to enable the PDRUNCFG bit

void POWER__DisablePD(*pd_bit_t* en)

API to disable PDRUNCFG bit in the SLEEPCON and PMC. Note that disabling the bit powers up the peripheral.

Parameters

- en – peripheral for which to disable the PDRUNCFG bit

status_t POWER__ModuleEnterLPRequest(*lp_bit_t* en)

API to request a module entering low power. This API send low power/stop requests to a module and wait the acknowledgement from the module. For peripherals that are being used by a domain, using this low power request handshake is recommended to make sure the module is fully stopped before the module is powered down or clock gated.

Parameters

- en – peripheral for which to enable the low power request.

Returns

kStatus_Success for succeed, kStatus_Timeout for tiemout.

void POWER__ModuleExitLPRequest(*lp_bit_t* en)

API to negate low power/stop requests to a module(module resume regular operation).

Parameters

- en – peripheral for which to disable the low power request.

void POWER__SetPmicMode(uint32_t mode, *pmic_mode_reg_t* reg)

Set PMIC_MODE pins configure value.

Parameters

- mode – : PMIC MODE pin value. This field is aggregated low.
- reg – : PDSLEEPCFG0 or PDRUNCFG0 register offset

Returns

PMIC_MODE pins value in PDSLEEPCFG0

uint32_t POWER__GetPmicMode(*pmic_mode_reg_t* reg)

Get PMIC_MODE pins configure value.

Parameters

- reg – : PDSLEEPCFG0 or PDRUNCFG0 register offset

Returns

PMIC_MODE pins value in PDSLEEPCFG0 or PDRUNCFG0

static inline void POWER__EnableDeepSleep(void)

API to enable deep sleep bit in the ARM Core.

static inline void POWER__DisableDeepSleep(void)

API to disable deep sleep bit in the ARM Core.

void POWER__ApplyPD(void)

API to apply updated PMC PDRUNCFG bits in the Sysctl0.

void POWER_ClearEventFlags(uint32_t statusMask)

Clears the PMC event flags state.

Parameters

- statusMask – : A bitmask of event flags that are to be cleared.

uint32_t POWER_GetEventFlags(void)

Get the PMC event flags state.

Returns

PMC FLAGS register value

void POWER_EnableInterrupts(uint32_t interruptMask)

Enable the PMC interrupt requests.

Parameters

- interruptMask – : A bitmask of interrupts to enable.

void POWER_DisableInterrupts(uint32_t interruptMask)

Disable the PMC interrupt requests.

Parameters

- interruptMask – : A bitmask of interrupts to disable.

void POWER_EnableResets(uint32_t resetMask)

Enable the PMC reset requests.

Parameters

- resetMask – : A bitmask of Reset to enable, refer to PMC CTRL register description in RM.

void POWER_DisableResets(uint32_t resetMask)

Disable the PMC reset requests.

Parameters

- resetMask – : A bitmask of Reset to disable, refer to PMC CTRL register description in RM.

void EnableDeepSleepIRQ(IRQn_Type interrupt)

Enable specific interrupt for wake-up from deep-sleep mode. Enable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

Note: This function also enables the interrupt in the NVIC (EnableIRQ) is called internally).

Parameters

- interrupt – The IRQ number.

void DisableDeepSleepIRQ(IRQn_Type interrupt)

Disable specific interrupt for wake-up from deep-sleep mode. Disable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

Note: This function also disables the interrupt in the NVIC (DisableIRQ) is called internally).

Parameters

- interrupt – The IRQ number.

void POWER_EnableDMAHWWake(uint32_t sources)

Enable specific DMA channels to generate a wake-up from deep-sleep mode. DMA wakeup is an automatic hardware mechanism that handles DMA transactions for selected modules without the need for core processing. Software can configure individual DMA channels to generate a wakeup when they receive a DMA request. The DMA wakeup triggers an exit from Deep Sleep mode except the core, which remains sleeping.

Parameters

- sources – The bits mask for eDMA wakeup sources. Refers _power_hwwake_src.

void POWER_DisableDMAHWWake(uint32_t sources)

Disable specific DMA channels to generate a wake-up from deep-sleep mode. Disable the DMA channels for wake-up from deep sleep mode.

Parameters

- sources – The bits mask for eDMA wakeup sources. Refers _power_hwwake_src.

void POWER_EnableAutoWake(uint16_t ticks)

Configure PMC for auto wakeup. This feature allows PMC to wake up some amount of time after the domain enters Deep Sleep. The timer is clocked by PMC's internal 16 MHz clock. If both timers in compute and sense are enabled at the same time, wake-up will occur after BOTH timers time out (i.e. the max timeout value between the two is used).

Parameters

- ticks – : The ticks of 16MHz PMC internal clock to wait before waking up the domain after it goes to DeepSleep.

void POWER_EnableLPRequestMask(uint32_t mask)

Enable low power request masking for shared modules. Enabling the mask will relinquish the caller domain's control over the module, and give the other domain exclusive control over low-power requests to the module. NOTE, The masking of a shared module must NOT be disabled in both Compute and Sense domain.

Parameters

- mask – An OR'd bitmask of shared modules to be masked from low power request, ref _power_shared_resource_mask and SLEEPCON SHARED_MASK0 register in the RM. DeepSleep.

void POWER_DisableLPRequestMask(uint32_t mask)

Disable low power request masking for shared modules. Disabling the mask means this domain will own the module. Only one domain should own each shared module.

Parameters

- mask – An OR'd bitmask of shared modules to be enabled from low power request, ref _power_shared_resource_mask and SLEEPCON SHARED_MASK0 register in the RM. DeepSleep.

void POWER_EnableRunAFBB(uint32_t mask)

Enable AFBB mode for various domains in active mode. Note, users should call POWER_ApplyPD() to make the change take effect.

Parameters

- mask – : A bitmask of domains to enable AFBB mode, refer to _body_bias_domain and PMC_PDRUNCFG0 register description in RM.

void POWER_EnableRunRBB(uint32_t mask)

Enable RBB mode for various domains in active mode. This function should only be used when one CPU will not be making use of one of the voltage domains. Configuring the unused voltages for RBB will allow the other domain to have full control of the body bias mode for the voltages even when both domains are in run mode. Note, users should call POWER_ApplyPD() to make the change take effect.

Parameters

- mask – : A bitmask of domains to enable RBB mode, refer to _body_bias_domain and PMC_PDRUNCFG0 register description in RM.

void POWER_EnableSleepRBB(uint32_t mask)

Enable RBB mode for various domains in deep sleep mode.

Parameters

- mask – : A bitmask of domains to enable RBB mode, refer to _body_bias_domain and PMC_PDSLEEPCFG0 register description in RM.

void POWER_EnableRunNBB(uint32_t mask)

Enable NBB mode for various domains in active mode. NBB can be a lower power option than RBB if the domain enters and exits low-power modes frequently since the wells don't charge and discharge as much on every entry/exit.

Parameters

- mask – : A bitmask of domains to enable NBB mode, refer to _body_bias_domain and PMC_PDRUNCFG0 register description in RM.

void POWER_EnableSleepNBB(uint32_t mask)

Enable NBB mode for various domains in deep sleep mode. NBB can be a lower power option than RBB if the domain enters and exits low-power modes frequently since the wells don't charge and discharge as much on every entry/exit.

Parameters

- mask – : A bitmask of domains to enable NBB mode, refer to _body_bias_domain and PMC_PDSLEEPCFG0 register description in RM.

uint32_t POWER_CalcVoltLevel(*power_regulator_t* regulator, uint32_t maxFreqHz, uint32_t miniVoltUV)

Get the minimum operative(active) voltage for VDD1 or VDD2 with the given maximum main clock frequency in the domain.

Parameters

- maxFreqHz – the maximum main clock frequency in Hz will be used for the domain.
- miniVoltUV – the minimum voltage in microvolt(uV) for VDD1 or VDD2. Should <= 1100000uV, 0 means use the main clock frequency to calculate voltage.

Returns

the calculated operative voltage in uV. 0xFFFFFFFFU means exceeded max supported value.

```
status_t POWER_ConfigRegulatorSetpointsForFreq(power_regulator_t regulator, uint32_t
                                              *maxFreqHz, uint32_t *miniVoltUV, uint32_t
                                              startPoint, uint32_t num)
```

Configure the setpoint operation for on-chip regulators(LDO1/LDO2) and LVD. This function can configure both the target output voltages and LVD to suitable values per the desired frequency for the specific setpoints. The setpoint that is actually selected is controlled by the aggregated value of PDRUNCFG[xxx_VSEL] and PDSLEEPCFG0[xxx_VSEL]. Use the POWER_SelectRunSetpoint() or POWER_SelectSleepSetpoint() to configure the setpoint selections. The voltage selected for each regulator must also be in ascending order (VSEL0 <= VSEL1 <= VSEL2 <= VSEL3).

Parameters

- maxFreqHz – the maximum main clock frequency in Hz will be used for the domain. 0 means use the miniVolt defined value and can be used to configure setpoint for DeepSleep.
- miniVolt – the minimum voltage in microvolt(uV) for VDD1 or VDD2. Should <= 1100000uV, 0 means use the main clock frequency to calculate voltage.
- startPoint – the start setpoint to be configured.
- num – the count of setpoints to be configured, the startPoint+num should not larger than 4.

Returns

kStatus_Success for successful configuration, kStatus_InvalidArgument for wrong parameter.

```
status_t POWER_ConfigRegulatorSetpoints(power_regulator_t regulator, const
                                        power_regulator_voltage_t *volt, const
                                        power_lvd_voltage_t *lvd)
```

Configure the setpoint operation for on-chip regulators and LVD. This function can configure both the target output voltages and LVD levels for each setpoint. The setpoint that is actually selected is controlled by the aggregated value of PDRUNCFG[xxx_VSEL] and PDSLEEPCFG0[xxx_VSEL]. Use the POWER_SelectRunSetpoint() or POWER_SelectSleepSetpoint() to configure the setpoint selections. The voltages selected for each regulator must also be in ascending order (VSEL0 <= VSEL1 <= VSEL2 <= VSEL3). The voltages selected for each LVD must also be in ascending order (LVL0 <= LVL1 <= LVL2 <= LVL3).

NOTE, Only valid regulator for sense domain is VDD1 LDO. Note, LDOVDD1VSEL and LVD-VDD1CTRL are shared between the compute and sense domains. There is no aggregation to combine the values. Whichever domain wrote the register last determines the value. It is recommended that only one domain be used to configure VDD1 setpoints.

```
const power_regulator_voltage_t regulator = {
    .LDO.vsel0 = 700000,
    .LDO.vsel1 = 800000,
    .LDO.vsel2 = 900000,
    .LDO.vsel3 = 1000000,
};
const power_lvd_voltage_t lvd = {
    .VDD12.lvl0 = 600000,
    .VDD12.lvl1 = 700000,
    .VDD12.lvl2 = 800000,
    .VDD12.lvl3 = 900000,
};

ret = POWER_ConfigRegulatorSetpoints(kRegulator_Vdd1LDO, &regulator, &lvd);
```

Parameters

- `regulator` – which regulator or power domain to configure, refer to `power_regulator_t`.
- `volt` – regulator configuration pointer, refer to `power_regulator_voltage_t`. Note, only two setpoints are available for DCDC.
- `lvd` – LVD voltage configuration, refer to `power_lvd_voltage_t`.

Returns

`kStatus_Success` for succeed, `kStatus_InvalidArgument` for wrong arguments.

```
status_t POWER_ConfigLvdSetpoints(power_regulator_t regulator, const power_lvd_voltage_t *lvd)
```

Configure the setpoint operation for LVD. This function can configure LVD levels for each setpoint. The setpoint that is actually selected is controlled by the aggregated value of `PDRUNCFG[xxx_VSEL]` and `PDSLEEPCFG0[xxx_VSEL]`. Use the `POWER_SelectRunSetpoint()` or `POWER_SelectSleepSetpoint()` to configure the setpoint selections. The voltages selected for each LVD must be in ascending order (`LVL0 <= LVL1 <= LVL2 <= LVL3`).

NOTE, Only valid regulator for sense domain is VDD1 LDO. Note, `LDOVDD1VSEL` and `LVD-VDD1CTRL` are shared between the compute and sense domains. There is no aggregation to combine the values. Whichever domain wrote the register last determines the value. It is recommended that only one domain be used to configure VDD1 setpoints.

```
const power_lvd_voltage_t lvd = {
    .VDD12.lv10 = 600000,
    .VDD12.lv11 = 700000,
    .VDD12.lv12 = 800000,
    .VDD12.lv13 = 900000,
};

ret = POWER_ConfigLvdSetpoints(kRegulator_Vdd1LDO, &lvd);
```

Parameters

- `regulator` – which regulator or power domain to configure, refer to `power_regulator_t`.
- `lvd` – LVD voltage configuration, refer to `power_lvd_voltage_t`.

Returns

`kStatus_Success` for succeed, `kStatus_InvalidArgument` for wrong arguments.

```
void POWER_GetLvdSetpoints(power_regulator_t regulator, power_lvd_voltage_t *lvd)
```

Get the LVD setpoints configurations. This function can get the LVD levels for each setpoint. The setpoint that is actually selected is controlled by the aggregated value of `PDRUNCFG[xxx_VSEL]` and `PDSLEEPCFG0[xxx_VSEL]`.

NOTE, Only valid regulator for sense domain is VDD1 LDO.

Parameters

- `regulator` – which regulator or power domain to get, refer to `power_regulator_t`.
- `lvd` – LVD voltage configuration, refer to `power_lvd_voltage_t`.

```
void POWER_SelectRunSetpoint(power_regulator_t regulator, uint32_t setpoint)
```

Select the setpoint(target voltage and LVD threshold) for active mode. The requests from the compute and sense domains are aggregated, so depending on the other domain's configuration the setpoint might not change or might change later (when the other domain also

requests a setpoint change). Note, users should call POWER_ApplyPD() to make the change take effect.

Parameters

- *regulator* – which regulator or power domain to configure, refer to *power_regulator_t*.
- *setpoint* – select which setpoint is used. Valid options for DCDC are 0-1. Valid options for VDD1/VDD2 are 0-3.

void POWER_SelectSleepSetpoint(*power_regulator_t* regulator, uint32_t setpoint)

Select setpoint(target voltage and LVD threshold) in Deep Sleep (or lower) mode. Use POWER_ConfigRegulatorSetpoints() to change the target voltage and/or LVD threshold value corresponding to each setpoint. The requests from the compute and sense domains are aggregated,.

Parameters

- *regulator* – which regulator or power domain to configure, refer to *power_regulator_t*.
- *setpoint* – select which setpoint is used. Valid options for DCDC are 0-1. Valid options for VDD1/VDD2 are 0-3.

void POWER_SetRunRegulatorMode(*power_regulator_t* regulator, uint32_t mode)

Set the on-chip regulator mode in Run/Active mode. The requests from the compute and sense domains are aggregated.

Parameters

- *regulator* – which regulator or power domain to configure, refer to *power_regulator_t*.
- *mode* – set the workmode. Refer to *_power_dcdc_mode* for available DCDC modes, refer to *_power_ldo_mode* for LDO available modes.

void POWER_SetSleepRegulatorMode(*power_regulator_t* regulator, uint32_t mode)

Set the on-chip regulator mode in Deep Sleep mode. The requests from the compute and sense domains are aggregated.

Parameters

- *regulator* – which regulator or power domain to configure, refer to *power_regulator_t*.
- *mode* – set the workmode. Refer to *_power_dcdc_mode* for available DCDC modes, refer to *_power_ldo_mode* for LDO available modes.

void POWER_ResetIOBank(uint32_t mask)

Reset the IO bank. Sets the IO bank reset which tristates the ports. Intended to be used prior to powering off the VDDIO supplies.

Parameters

- *mask* – A bitmask of IO Banks to be reseted, *power_io_bank_t* and PMC PADCFG register. The register reset by cold reset.

void POWER_IOBankIsolationHold(uint32_t mask)

IO Bank Isolation Hold. Maintains IO bank isolation state after wake-up from FDSR/DPD modes. If clear, the IO bank's state will be retained during FDSR & DPD modes, but will be controllable after wake-up. If set, the IO bank will remain in retain mode until ISOCTRL cleared by software.

Parameters

- *mask* – A bitmask of IO Banks to be set, *power_io_bank_t* and PMC PADCFG register. The register reset by cold reset.

void POWER_IOBankClearIsolationHold(uint32_t mask)

Clear the IO bank Isolation Hold and regain state control. This bit cannot be cleared if associated domain is not powered.

Parameters

- mask – A bitmask of IO Banks to be clear, power_io_bank_t and PMC PAD-CFG register. The register reset by cold reset.

void POWER_EnterSleep(void)

Configures and enters in SLEEP low power mode.

void POWER_EnterDeepSleep(const uint32_t exclude_from_pd[7])

PMC Deep Sleep function call.

NOTE, the body bias and DCDC, LDO configurations in PMC_PDSLEEPCFG0 is not covered by this API, please use POWER_EnableSleepRBB or POWER_EnableSleepNBB and POWER_SelectSleepSetpoint for those settings.

NOTE, the MAINPLL and AUDIO PLL need special power up sequence, so it can't be power down/on automatically during the mode change. Application need turn off the PLL before the low power mode entry and re-initialize the PLL after wakeup.

Parameters

- exclude_from_pd – Bit mask of the SLEEPCON_SLEEPCFG and PMC_PDSLEEPCFG0 ~ PMC_PDSLEEPCFG5 that needs to be powered on during Deep Sleep mode. The configuration for PMC from Compute domain and Sense domain are aggregated, and the higher power mode always wins.

void POWER_RequestDSR(const uint32_t exclude_from_pd[7])

Sense domain requests entering Deep Sleep Retention mode API. Deep Sleep Retention (DSR) mode is a deeper low power state than Deep Sleep mode. DSR mode allows significant portions of the chip to be powered-down while maintaining some level of state retention. The Sense domain can enter DSR mode only when all other domains are in DSR mode. If the condition is false, the sense domain will be in a shallower power mode (Deep sleep mode).

NOTE, the body bias and DCDC, LDO configurations in PMC_PDSLEEPCFG0 is not covered by this API, please use POWER_EnableSleepRBB or POWER_EnableSleepNBB and POWER_SelectSleepSetpoint for those settings.

Parameters

- exclude_from_pd – Bit mask of the SLEEPCON_SLEEPCFG and PMC_PDSLEEPCFG0 ~ PMC_PDSLEEPCFG5 that needs to be powered on (bits cleared) during the power mode. The configuration for PMC from Compute domain and Sense domain are aggregated, and the higher power mode always wins.

void POWER_RequestDeepPowerDown(const uint32_t exclude_from_pd[7])

The domain requests to enter Deep Power Down mode. The Deep Power Down and Full Deep Power Down can occur only when both domains signal their intent to enter these lower power modes. The configuration for PMC from Compute domain and Sense domain are aggregated, and the higher power mode always wins.

Parameters

- exclude_from_pd – Bit mask of the SLEEPCON_SLEEPCFG and PMC_PDSLEEPCFG0 ~ PMC_PDSLEEPCFG5 that needs to be powered on during Deep Power Down.

void POWER_RequestFullDeepPowerDown(const uint32_t exclude_from_pd[7])

The domain requests to enter Full Deep Power Down mode. The Deep Power Down and Full Deep Power Down can occur only when both domains signal their intent to enter these

lower power modes. The configuration for PMC from Compute domain and Sense domain are aggregated, and the higher power mode always wins.

Parameters

- `exclude_from_pd` – Bit mask of the `SLEEPCON_SLEEPCFG` and `PMC_PDSLEEPCFG0 ~ PMC_PDSLEEPCFG5` that needs to be powered on during Deep Power Down.

`void POWER_EnterPowerMode(power_mode_cfg_t mode, const uint32_t exclude_from_pd[7])`

Power Library API to request entering different power mode. This API is used for requesting entering the target mode, the final SOC power mode depends on hardware aggregation. Note, the Sense domain can enter DSR mode only when Compute domain is in DSR. The SOC enters DPD or FDPD when both domain requested entering DPD or FDPD.

Parameters

- `mode` – Power mode to enter.
- `exclude_from_pd` – Bit mask of the `SLEEPCON_SLEEPCFG` and `PMC_PDSLEEPCFG0 ~ PMC_PDSLEEPCFG5` that needs to be powered on during power mode selected.

`uint32_t POWER_GetLibVersion(void)`

Power Library API to return the library version.

Returns

version number of the power library

`FSL_POWER_DRIVER_VERSION`

power driver version 2.4.2.

`POWER_DEFAULT_PMICMODE_DS`

`POWER_DEFAULT_PMICMODE_DSR`

`POWER_DEFAULT_PMICMODE_DPD`

`POWER_DEFAULT_PMICMODE_FDPD`

`POWER_DEFAULT_LVD_VOLT`

`MAKE_PD_BITS(reg, slot)`

`GET_PD_REG_FROM_BITS(bit)`

`SLEEPCON_RCFG`

`PMC_PDRCFG0`

`PMC_PDRCFG1`

`PMC_PDRCFG2`

`PMC_PDRCFG3`

`PMC_PDRCFG4`

`PMC_PDRCFG5`

`SHA_MED_CCTRL0_OFFSET`

`SHA_MED_TCTRL0_OFFSET`

`SHA_SEN_TCTRL0_OFFSET`

PRIVATE_CCTRL0_OFFSET

PRIVATE_TCTRL0_OFFSET

PRIVATE_TCTRL1_OFFSET

PRIVATE_TCTRL2_OFFSET

SHA_MED_CSTAT0_OFFSET

SHA_MEDSEN_TSTAT0_OFFSET

PRIVATE_CSTAT0_OFFSET

PRIVATE_TSTAT0_OFFSET

PRIVATE_TSTAT1_OFFSET

POWER_LP_REQ_CTRL_REG_OFFSET

POWER_LP_REQ_STATE_REG_OFFSET

POWER_LP_REQ_STATE_BIT_OFFSET

POWER_MAKE_LP_BITS(ctrl_reg, ctrl_bit, state_reg, state_bit)

GET_LP_CTRL_REG_FROM_BITS(bit)

GET_LP_CTRL_BIT_FROM_BITS(bit)

GET_LP_STATE_REG_FROM_BITS(bit)

GET_LP_STATE_BIT_FROM_BITS(bit)

uint32_t vsel0

DCDC VSEL0. Voltage = 0.5 V + 6.25 mV * value of vsel0. Maximum value = 1150000uV.

uint32_t vsel1

DCDC VSEL1. Voltage = 0.5 V + 6.25 mV * value of vsel1. Maximum value = 1150000uV.

struct *_power_regulator_voltage* DCDC

uint32_t vsel0

LDO VSEL0. Voltage = 0.45 V + 12.5 mV * vsel0. Maximum value = 1150000uV.

uint32_t vsel1

LDO VSEL1. Voltage = 0.45 V + 12.5 mV * vsel1. Maximum value = 1150000uV.

uint32_t vsel2

LDO VSEL2. Voltage = 0.45 V + 12.5 mV * vsel2. Maximum value = 1150000uV.

uint32_t vsel3

LDO VSEL3. Voltage = 0.45 V + 12.5 mV * vsel3. Maximum value = 1150000uV.

struct *_power_regulator_voltage* LDO

uint32_t vsel[4]

uint32_t lvl0

VDDN LVD level0, uV.

uint32_t lvl1

VDDN LVD level1, uV.

struct *_power_lvd_voltage* VDDN

```
uint32_t lvl0
    VDD1/2 LVD level0, uV.
uint32_t lvl1
    VDD1/2 LVD level1, uV.
uint32_t lvl2
    VDD1/2 LVD level2, uV.
uint32_t lvl3
    VDD1/2 LVD level3, uV.
struct _power_lvd_voltage VDD12
uint32_t lvl[4]
union _power_regulator_voltage
    #include <fsl_power.h> Regulator voltage configuraton. Configure the regulator voltage in
    uV.
union _power_lvd_voltage
    #include <fsl_power.h> LVD voltage configuraton. Configure the LVD voltage in uV. Falling
    trip = 0.5V + 10 mV * bitfield value.
struct DCDC
```

Public Members

```
uint32_t vsel0
    DCDC VSEL0. Voltage = 0.5 V + 6.25 mV * value of vsel0. Maximum value = 1150000uV.
uint32_t vsel1
    DCDC VSEL1. Voltage = 0.5 V + 6.25 mV * value of vsel1. Maximum value = 1150000uV.
struct LDO
```

Public Members

```
uint32_t vsel0
    LDO VSEL0. Voltage = 0.45 V + 12.5 mV * vsel0. Maximum value = 1150000uV.
uint32_t vsel1
    LDO VSEL1. Voltage = 0.45 V + 12.5 mV * vsel1. Maximum value = 1150000uV.
uint32_t vsel2
    LDO VSEL2. Voltage = 0.45 V + 12.5 mV * vsel2. Maximum value = 1150000uV.
uint32_t vsel3
    LDO VSEL3. Voltage = 0.45 V + 12.5 mV * vsel3. Maximum value = 1150000uV.
struct VDDN
```

Public Members

```
uint32_t lvl0
    VDDN LVD level0, uV.
uint32_t lvl1
    VDDN LVD level1, uV.
struct VDD12
```

Public Members

uint32_t lvl0
VDD1/2 LVD level0, uV.

uint32_t lvl1
VDD1/2 LVD level1, uV.

uint32_t lvl2
VDD1/2 LVD level2, uV.

uint32_t lvl3
VDD1/2 LVD level3, uV.

2.70 PUF: Physical Unclonable Function

2.71 Puf_v3_driver

FSL_PUF_V3_DRIVER_VERSION

PUFv3 driver version. Version 2.0.3.

Current version: 2.0.3

Change log:

- 2.0.3
 - Update for various PUF CTRL wrapper
- 2.0.2
 - Fix MISRA issue in driver.
- 2.0.1
 - Fix PUF initialization issue and update driver to reflect SoC header changes.
- 2.0.0
 - Initial version.

Values:

enumerator kStatus_PUF_OperationNotAllowed

enumerator kStatus_PUF_AcNotForThisProductPhase1

enumerator kStatus_PUF_AcNotForThisProductPhase2

enumerator kStatus_PUF_AcCorruptedPhase1

enumerator kStatus_PUF_AcCorruptedPhase2

enumerator kStatus_PUF_AcAuthFailedPhase1

enumerator kStatus_PUF_NBOOT_AcAuthFailedPhase2

enumerator kStatus_PUF_QualityVerificationFail

enumerator kStatus_PUF_ContextIncorrect

enumerator kStatus_PUF_DestinationNotAllowed

```
enumerator kStatus_PUF_Failure
typedef uint32_t puf_endianness_t
typedef uint32_t puf_key_dest_t
typedef uint32_t puf_key_scope_t
typedef uint32_t puf_result_code_t
typedef uint32_t puf_sec_level_t
puf_endianness_t dataEndianness
uint8_t CKGATING
puf_key_scope_t keyScopeStarted
puf_key_scope_t keyScopeEnrolled
uint32_t userCtx0
uint32_t userCtx1
void PUF_GetDefaultConfig(puf_config_t *conf)
    brief Sets the default configuration of PUF
    This function initialize PUF config structure to default values.
```

Parameters

- *conf* – PUF configuration structure

```
status_t PUF_Init(PUF_Type *base, puf_config_t *conf)
    brief Initialize PUF
    This function enables power to PUF block and waits until the block initializes.
```

Parameters

- *conf* – PUF configuration structure

Returns

Status of the init operation

```
void PUF_Deinit(PUF_Type *base, puf_config_t *conf)
    brief Denitalize PUF
    This function disables power to PUF SRAM and peripheral clock.
```

Parameters

- *base* – PUF peripheral base address
- *conf* – PUF configuration structure

```
status_t PUF_Enroll(PUF_Type *base, uint8_t *activationCode, size_t activationCodeSize,
    uint8_t *score)
    brief Enroll PUF
```

This function derives a digital fingerprint, generates the corresponding Activation Code (AC) and returns it to be stored in an NVM or a file. This step needs to be performed only once for each device. This function may be permanently disallowed by a fuse.

Parameters

- *base* – PUF peripheral base address

- `activationCode` – **[out]** Word aligned address of the resulting activation code.
- `activationCodeSize` – Size of the `activationCode` buffer in bytes. Shall be `FSL_FEATURE_PUF_ACTIVATION_CODE_SIZE` bytes.
- `score` – Value of the PUF Score that was obtained during the enroll operation.

Returns

Status of enroll operation.

`status_t` PUF_Start(PUF_Type *base, const uint8_t *activationCode, size_t activationCodeSize, uint8_t *score)

brief Start PUF

The Activation Code generated during the Enroll operation is used to reconstruct the digital fingerprint. This needs to be done after every power-up and reset.

Parameters

- `base` – PUF peripheral base address
- `activationCode` – **[in]** Word aligned address of the input activation code.
- `activationCodeSize` – Size of the `activationCode` buffer in bytes. Shall be `FSL_FEATURE_PUF_ACTIVATION_CODE_SIZE` bytes.
- `score` – Value of the PUF Score that was obtained during the start operation.
return Status of start operation.

`status_t` PUF_Stop(PUF_Type *base)

brief Stop PUF

The Stop operation removes all key material from PUF flipflops and PUF SRAM, and sets PUF to the Stopped state.

Parameters

- `base` – PUF peripheral base address

Returns

Status of stop operation.

`status_t` PUF_GetKey(PUF_Type *base, puf_key_ctx_t *keyCtx, puf_key_dest_t keyDest, uint8_t *key, size_t keySize)

brief PUF Get Key

The Get Key operation derives a key from the intrinsic PUF key and externally provided context.

Parameters

- `base` – PUF peripheral base address
- `keyCtx` – PUF key context struct
- `keyDest` – output destination of the derived PUF key
- `key` – **[out]** Word aligned address of output key (only used when `kPUF_KeyDestRegister`).
- `keySize` – Size of the derived key in bytes.

Returns

Status of get key operation.

```
status_t PUF_WrapGeneratedRandom(PUF_Type *base, puf_key_ctx_t *keyCtx, size_t keySize,
                                uint8_t *keyCode, size_t keyCodeSize)
```

brief PUF Wrap generated random

The Wrap Generated Random operation wraps a random key into a Key Code (KC).

Parameters

- base – PUF peripheral base address
- keyCtx – PUF key context struct
- keySize – Size of the key to be generated in bytes.
- keyCode – **[out]** Word aligned address of the resulting key code.
- keyCodeSize – Size of the output keycode in bytes.

Returns

Status of wrap generated random operation.

```
status_t PUF_Wrap(PUF_Type *base, puf_key_ctx_t *keyCtx, uint8_t *userKey, size_t
                 userKeySize, uint8_t *keyCode, size_t keyCodeSize)
```

brief PUF Wrap user key

The Wrap operation wraps a user defined key into a Key Code (KC).

Parameters

- base – PUF peripheral base address
- keyCtx – PUF key context struct.
- userKey – Word aligned address of input user key.
- userKeySize – Size of the key to be wrapped in bytes.
- keyCode – **[out]** Word aligned address of the resulting key code.
- keyCodeSize – Size of the output keycode in bytes.

Returns

Status of wrap operation.

```
status_t PUF_Unwrap(PUF_Type *base, puf_key_dest_t keyDest, uint8_t *keyCode, size_t
                  keyCodeSize, uint8_t *key, size_t keySize)
```

brief PUF Unwrap user key

The unwrap operation unwraps the key from a previously created Key Code (KC)

Parameters

- base – PUF peripheral base address
- keyDest – output destination of the unwrapped PUF key
- keyCode – **[in]** Word aligned address of the input key code.
- keyCodeSize – Size of the input keycode in bytes.
- key – Word aligned address of output key (only used when kPUF_KeyDestRegister).
- keySize – Size of the key to be generated in bytes.

Returns

Status of unwrap operation.

status_t PUF_GenerateRandom(PUF_Type *base, uint8_t *data, size_t size)

brief Generate Random

The Generate Random operation outputs the requested amount of random data as specified in a provided context.

Parameters

- base – PUF peripheral base address
- size – Size of random data to be generated in bytes.

Returns

Status of generate random operation.

status_t PUF_Zeroize(PUF_Type *base)

brief Zeroize PUF

This function clears all PUF internal logic and puts the PUF to zeroized state.

Parameters

- base – PUF peripheral base address

Returns

Status of the zeroize operation.

status_t PUF_Test(PUF_Type *base, uint8_t *score)

brief Test PUF

With the Test PUF operation, diagnostics about the PUF quality is collected and presented in a PUF score.

Parameters

- base – PUF peripheral base address
- score – Value of the PUF Score that was obtained during the enroll operation.

Returns

Status of the test operation.

static inline void PUF_BlockCommand(PUF_Type *base, uint32_t mask)

Blocks specified PUF commands.

This function blocks PUF commands specified by mask parameter.

Parameters

- base – PUF peripheral base address
- mask – Mask of parameters which should be blocked until power-cycle.

Returns

Status of the test operation.

status_t PUF_SetLock(PUF_Type *base, *puf_sec_level_t* securityLevel)

brief Set lock of PUF operation

Lock the security level of PUF block until key generate, wrap or unwrap operation is completed. Note: Only security level defined in SEC_LOCK register can use PUFv3 or change its security level. Default setting after leaving ROM is Secure-Privilege

Parameters

- base – PUF peripheral base address
- securityLevel – Security level of PUF block.

Returns

Status of the test operation.

status_t PUF_SetCtxMask(PUF_Type *base, uint32_t appCtxMask)

brief Set App Context mask

This function sets Application defined context mask used in conjunction with key user context 2. Whenever bit in this register is 1, corresponding bit in user context 2 provided during key code creation should be zero only.

This register is only modifiable by task running at secure-privilege level.

Parameters

- base – PUF peripheral base address
- appCtxMask – Value of the Application defined context mask.

Returns

Status of the test operation.

kPUF_EndianLittle

kPUF_EndianBig

kPUF_KeyDestRegister

kPUF_KeyDestKeyBus

kPUF_KeyDestInvalid

kPUF_KeyAllowRegister

kPUF_KeyAllowKeyBus

kPUF_KeyAllowAll

kPUF_ResultOK

kPUF_AcNotForThisProductPhase1

kPUF_AcNotForThisProductPhase2

kPUF_AcCorruptedPhase1

kPUF_AcCorruptedPhase2

kPUF_AcAuthFailedPhase1

kPUF_AcAuthFailedPhase2

kPUF_QualityVerificationFail

kPUF_ContextIncorrect

kPUF_DestinationNotAllowed

kPUF_Failure

kPUF_NonsecureUser

kPUF_NonsecurePrivilege

kPUF_SecureUser

kPUF_SecurePrivilege

PUF_ACTIVATION_CODE_SIZE

PUF_GET_KEY_CODE_SIZE_FOR_KEY_SIZE(x)

SEC_LOCK_PATTERN

```
struct puf_config_t
    #include <fsl_puf_v3.h>
struct puf_key_ctx_t
    #include <fsl_puf_v3.h>
```

2.72 Reset Driver

enum _rstctl_reset_source

Enumeration for system reset status bits.

Defines the enumeration for system reset status bits in SYSRSTSTAT register

Values:

enumerator kRSTCTL_SourceVddPor
VDD Power-On Reset(POR)

enumerator kRSTCTL_SourcePad
PPAD Reset

enumerator kRSTCTL_SourceIspAp
ISP_AP reset Reset

enumerator kRSTCTL_SourceItrcSw
ITRC_SW (Intrusion and Tamper Response Controller SW) Reset

enumerator kRSTCTL_SourceCpu0
VDD2_COMP Core Reset

enumerator kRSTCTL_SourceCpu1
VDD1_SENSE Core Reset

enumerator kRSTCTL_SourceWwdt0
WatchDog Timer 0 Reset

enumerator kRSTCTL_SourceWwdt1
WatchDog Timer 1 Reset

enumerator kRSTCTL_SourceWwdt2
WatchDog Timer 2 Reset

enumerator kRSTCTL_SourceWwdt3
WatchDog Timer 3 Reset

enumerator kRSTCTL_SourceCdog0
Code WatchDog Timer 0 Reset

enumerator kRSTCTL_SourceCdog1
Code WatchDog Timer 1 Reset

enumerator kRSTCTL_SourceCdog2
Code WatchDog Timer 2 Reset

enumerator kRSTCTL_SourceCdog3

Code WatchDog Timer 3 Reset

enumerator kRSTCTL_SourceCdog4

Code WatchDog Timer 4 Reset

enumerator kRSTCTL_SourceAll

enum _RSTCTL_RSTn

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in RSTCLTx registers

Values:

enumerator kIOPCTL0_RST_SHIFT_RSTn

IOPCTL0 reset control

enumerator kELS_RST_SHIFT_RSTn

ELS S50 reset control

enumerator kDMA0_RST_SHIFT_RSTn

eDMA0 reset control

enumerator kDMA1_RST_SHIFT_RSTn

eDMA1 reset control

enumerator kPKC_RST_SHIFT_RSTn

PKC reset control

enumerator kXSPI0_RST_SHIFT_RSTn

XSPI0 reset control

enumerator kXSPI1_RST_SHIFT_RSTn

XSPI1 reset control

enumerator kGPIO0_RST_SHIFT_RSTn

GPIO0 reset control

enumerator kGPIO1_RST_SHIFT_RSTn

GPIO1 reset control

enumerator kGPIO2_RST_SHIFT_RSTn

GPIO2 reset control

enumerator kGPIO3_RST_SHIFT_RSTn

GPIO3 reset control

enumerator kGPIO4_RST_SHIFT_RSTn

GPIO4 reset control

enumerator kGPIO5_RST_SHIFT_RSTn

GPIO5 reset control

enumerator kGPIO6_RST_SHIFT_RSTn

GPIO6 reset control

enumerator kGPIO7_RST_SHIFT_RSTn

GPIO7 reset control

enumerator kSCT0_RST_SHIFT_RSTn

SCT0 reset control

enumerator kFC0_RST_SHIFT_RSTn
LP_FLEXCOMM0 reset control

enumerator kFC1_RST_SHIFT_RSTn
LP_FLEXCOMM1 reset control

enumerator kFC2_RST_SHIFT_RSTn
LP_FLEXCOMM2 reset control

enumerator kFC3_RST_SHIFT_RSTn
LP_FLEXCOMM3 reset control

enumerator kFC4_RST_SHIFT_RSTn
LP_FLEXCOMM4 reset control

enumerator kFC5_RST_SHIFT_RSTn
LP_FLEXCOMM5 reset control

enumerator kFC6_RST_SHIFT_RSTn
LP_FLEXCOMM6 reset control

enumerator kFC7_RST_SHIFT_RSTn
LP_FLEXCOMM7 reset control

enumerator kFC8_RST_SHIFT_RSTn
LP_FLEXCOMM8 reset control

enumerator kFC9_RST_SHIFT_RSTn
LP_FLEXCOMM9 reset control

enumerator kFC10_RST_SHIFT_RSTn
LP_FLEXCOMM10 reset control

enumerator kFC11_RST_SHIFT_RSTn
LP_FLEXCOMM11 reset control

enumerator kFC12_RST_SHIFT_RSTn
LP_FLEXCOMM12 reset control

enumerator kFC13_RST_SHIFT_RSTn
LP_FLEXCOMM13 reset control

enumerator kSAI0_RST_SHIFT_RSTn
SAI0 reset control

enumerator kSAI1_RST_SHIFT_RSTn
SAI1 reset control

enumerator kSAI2_RST_SHIFT_RSTn
SAI2 reset control

enumerator kI3C0_RST_SHIFT_RSTn
I3C0 reset control

enumerator kI3C1_RST_SHIFT_RSTn
I3C1 reset control

enumerator kCRC0_RST_SHIFT_RSTn
CRC0 reset control

enumerator kCTIMER0_RST_SHIFT_RSTn
CTIMER0 reset control

enumerator kCTIMER1_RST_SHIFT_RSTn
CTIMER1 reset control

enumerator kCTIMER2_RST_SHIFT_RSTn
CTIMER2 reset control

enumerator kCTIMER3_RST_SHIFT_RSTn
CTIMER3 reset control

enumerator kCTIMER4_RST_SHIFT_RSTn
CTIMER4 reset control

enumerator kMRT0_RST_SHIFT_RSTn
MRT0 reset control

enumerator kUTICK0_RST_SHIFT_RSTn
UTICK0 reset control

enumerator kSEMA424_RST_SHIFT_RSTn
SEMA42_4 reset control

enumerator kMU4_RST_SHIFT_RSTn
MU4 reset control

enumerator kSYSPM2_RST_SHIFT_RSTn
SYSPM_XSPI0 reset control

enumerator kSYSPM3_RST_SHIFT_RSTn
SYSPM_XSPI1 reset control

enumerator kSAFO_SGI_RST_SHIFT_RSTn
SAFO_SGI reset control

enumerator kINPUTMUX0_RST_SHIFT_RSTn
INPUTMUX0 reset control

enumerator kFREQME_RST_SHIFT_RSTn
FREQME0 reset control

enumerator kSYSPM0_RST_SHIFT_RSTn
SYSPM_PC reset control

enumerator kSYSPM1_RST_SHIFT_RSTn
SYSPM_PS reset control

enumerator kNPU0_RST_SHIFT_RSTn
NPU0 reset control

enumerator kHIFI4_RST_SHIFT_RSTn
HiFi4 reset control

enumerator kHIFI4_DEBUG_RST_SHIFT_RSTn
HiFi4 Debug reset control

enumerator kHIFI1_RST_SHIFT_RSTn
HiFi1 reset control

enumerator kHIFI1_DEBUG_RST_SHIFT_RSTn
HiFi1 Debug reset control

enumerator kDMA2_RST_SHIFT_RSTn
eDMA2 reset control

enumerator kDMA3_RST_SHIFT_RSTn
eDMA3 reset control

enumerator kFC17_RST_SHIFT_RSTn
LP_FLEXCOMM17 reset control

enumerator kFC18_RST_SHIFT_RSTn
LP_FLEXCOMM18 reset control

enumerator kFC19_RST_SHIFT_RSTn
LP_FLEXCOMM19 reset control

enumerator kFC20_RST_SHIFT_RSTn
LP_FLEXCOMM20 reset control

enumerator kSAI3_RST_SHIFT_RSTn
SAI3 reset control

enumerator kI3C2_RST_SHIFT_RSTn
I3C2 reset control

enumerator kI3C3_RST_SHIFT_RSTn
I3C3 reset control

enumerator kGPIO8_RST_SHIFT_RSTn
GPIO8 reset control

enumerator kGPIO9_RST_SHIFT_RSTn
GPIO9 reset control

enumerator kGPIO10_RST_SHIFT_RSTn
GPIO10 reset control

enumerator kCTIMER5_RST_SHIFT_RSTn
CTIMER5 reset control

enumerator kCTIMER6_RST_SHIFT_RSTn
CTIMER6 reset control

enumerator kCTIMER7_RST_SHIFT_RSTn
CTIMER7 reset control

enumerator kMRT1_RST_SHIFT_RSTn
MRT1 reset control

enumerator kUTICK1_RST_SHIFT_RSTn
UTICK1 reset control

enumerator kMU3_RST_SHIFT_RSTn
MU3 reset control

enumerator kSEMA423_RST_SHIFT_RSTn
SEMA42_3 reset control

enumerator kPVTS1_RST_SHIFT_RSTn
PVTS1 reset control

enumerator kIOPCTL2_RST_SHIFT_RSTn
IOPCTL2 reset control

enumerator kIOPCTL1_RST_SHIFT_RSTn
IOPCTL1 reset control

enumerator kCPU1_RST_SHIFT_RSTn
CPU1 reset control

enumerator kMU0_RST_SHIFT_RSTn
MU0 reset control

enumerator kMU1_RST_SHIFT_RSTn
MU1 reset control

enumerator kMU2_RST_SHIFT_RSTn
MU2 reset control

enumerator kSEMA420_RST_SHIFT_RSTn
SEMA42_0 reset control

enumerator kADC0_RST_SHIFT_RSTn
ADC0 reset control

enumerator kSDADC0_RST_SHIFT_RSTn
SDADC0 reset control

enumerator kACMP0_RST_SHIFT_RSTn
ACMP0 reset control

enumerator kPDM_RST_SHIFT_RSTn
MICFIL/PDM reset control

enumerator kINPUTMUX1_RST_SHIFT_RSTn
INPUTMUX1 reset control

enumerator kLPI2C15_RST_SHIFT_RSTn
LPI2C15 reset control

enumerator kVGPU_RST_SHIFT_RSTn
VGPU reset control

enumerator kLCDIF_RST_SHIFT_RSTn
LCDIF reset control

enumerator kMIPI_DSI_CTRL_RST_SHIFT_RSTn
MIPIDSI reset control

enumerator kEZHV_RST_SHIFT_RSTn
EZHV reset control

enumerator kJPEGDEC_RST_SHIFT_RSTn
JPEGDEC reset control

enumerator kPNGDEC_RST_SHIFT_RSTn
PNGDEC reset control

enumerator kXSPI2_RST_SHIFT_RSTn
XSPI2 and MMU2 reset control

enumerator kLPSPi14_RST_SHIFT_RSTn
LPSPi14 reset control

enumerator kLPSPi16_RST_SHIFT_RSTn
LPSPi16 reset control

enumerator kFLEXIO0_RST_SHIFT_RSTn
FLEXIO0 reset control

enumerator kUSB0_RST_SHIFT_RSTn

USB0 reset control

enumerator kUSBPHY0_RST_SHIFT_RSTn

USBPHY0 reset control

enumerator kUSB1_RST_SHIFT_RSTn

USB1 reset control

enumerator kUSDHC0_RST_SHIFT_RSTn

USDHC0 reset control

enumerator kUSDHC1_RST_SHIFT_RSTn

USDHC1 reset control

Flash device current running mode.

Values:

enumerator kFlashInstMode_ExtendedSpi

enumerator kFlashInstMode_0_4_4_SDR

enumerator kFlashInstMode_0_4_4_DDR

enumerator kFlashInstMode_DPI_SDR

enumerator kFlashInstMode_DPI_DDR

enumerator kFlashInstMode_QPI_SDR

enumerator kFlashInstMode_QPI_DDR

enumerator kFlashInstMode_OPI_SDR

enumerator kFlashInstMode_OPI_DDR

flash reset sequence of standard SPI mode.

Values:

enumerator kRestoreSequence_None

enumerator kRestoreSequence_QPI_4_0xFFs

enumerator kRestoreSequence_QPI_Mode_0x00

enumerator kRestoreSequence_Send_F0

enumerator kRestoreSequence_Send_66_99

enumerator kRestoreSequence_Send_6699_9966

enumerator kRestoreSequence_Send_06_FF

enumerator kRestoreSequence_QPI_5_0xFFs

enumerator kRestoreSequence_Send_QPI_8_0xFFs

enumerator kRestoreSequence_Wakep_0xAB

enumerator kRestoreSequence_Wakep_0xAB_54

typedef enum *_rstctl_reset_source* rstctl_reset_source_t

Enumeration for system reset status bits.

Defines the enumeration for system reset status bits in SYSRSTSTAT register

typedef enum *_RSTCTL_RSTn* RSTCTL_RSTn_t

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in RSTCLTx registers

typedef union *_FLASH_run_context_t* FLASH_run_context_t

Flash context.

Defines the flash context parameter used by ROM.

typedef *RSTCTL_RSTn_t* reset_ip_name_t

IP reset handle.

void RESET_SetPeripheralReset(*reset_ip_name_t* peripheral)

Assert reset to peripheral.

Asserts reset signal to specified peripheral module.

Parameters

- peripheral – Assert reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

void RESET_ClearPeripheralReset(*reset_ip_name_t* peripheral)

Clear reset to peripheral.

Clears reset signal to specified peripheral module, allows it to operate.

Parameters

- peripheral – Clear reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

void RESET_PeripheralReset(*reset_ip_name_t* peripheral)

Reset peripheral module.

Reset peripheral module.

Parameters

- peripheral – Peripheral to reset. The enum argument contains encoding of reset register and reset bit position in the reset register.

static inline void RESET_ReleasePeripheralReset(*reset_ip_name_t* peripheral)

Release peripheral module.

Release peripheral module.

Parameters

- peripheral – Peripheral to release. The enum argument contains encoding of reset register and reset bit position in the reset register.

static inline uint32_t RESET_GetPreviousResetSources(void)

Gets the reset source status which caused a previous reset.

This function gets the status of the latest reset event. Use source masks defined in the *rstctl_reset_source_t* to get the desired source status.

Returns

All reset source status bit map.

static inline void RESET_ClearResetSources(uint32_t sourceMasks)

Clears the reset source status.

This function clears the system reset flags indicated by source masks.

Parameters

- sourceMasks – reset source status bit map

static inline uint32_t RESET_GetDomainResetStatus(void)

Gets the reset status of domains.

This function gets the reset status of domains.

Returns

All reset source status bit map.

FSL_RESET_DRIVER_VERSION

reset driver version 2.1.0.

RST_CTL0_PSCCTL0

Reset control registers index.

RST_CTL0_PSCCTL1

RST_CTL0_PSCCTL2

RST_CTL0_PSCCTL3

RST_CTL0_PSCCTL4

RST_CTL0_PSCCTL5

RST_CTL1_PSCCTL0

RST_CTL2_PSCCTL0

RST_CTL3_PSCCTL0

RST_CTL3_PSCCTL1

RST_CTL4_PSCCTL0

RST_CTL4_PSCCTL1

ADC_RSTS

Array initializers with peripheral reset bits

SDADC_RSTS

CRC_RSTS

CTIMER_RSTS

MIPI_DSI_RSTS

LCDIF_RSTS

LP_FLEXCOMM_RSTS

FLEXIO_RSTS

FREQME_RSTS_N

XSPI_RSTS

GPIO_RSTS

I3C_RSTS

MRT_RSTS

PINT_RSTS

PNGDEC_RSTS

JPEGDEC_RSTS

SCT_RSTS

SEMA42_RSTS

SAI_RSTS

USDHC_RSTS

UTICK_RSTS

uint8_t reseverd0

Reserved.

uint8_t current_mode

Flash device current running mode.

uint8_t reserved1

Reserved.

uint8_t restore_sequence

Flash reset sequence of standard SPI mode.

struct *_FLASH_run_context_t* B

uint32_t U

union *_FLASH_run_context_t*

#include <fsl_reset.h> Flash context.

Defines the flash context parameter used by ROM.

struct B

Public Members

uint8_t reseverd0

Reserved.

uint8_t current_mode

Flash device current running mode.

uint8_t reserved1

Reserved.

uint8_t restore_sequence

Flash reset sequence of standard SPI mode.

2.73 Runbootloader

```
typedef struct _user_app_boot_invoke_option user_app_boot_invoke_option_t
```

```
void bootloader_user_entry(void *arg)
```

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

Parameters

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

```
uint32_t bootloader_version(void)
```

Get Bootloader version.

Return values

Bootloader – version.

```
const char *bootloader_copyright(void)
```

Get Bootloader Copyright.

Return values

Pointer – to Bootloader copyright header

```
uint32_t reserved0
```

```
uint32_t recovery_boot_cfg0
```

```
uint32_t recovery_boot_cfg1
```

```
uint32_t reserved1
```

```
uint32_t instance
```

```
uint32_t boot_interface
```

```
uint32_t mode
```

```
uint32_t tag
```

```
struct _user_app_boot_invoke_option B
```

```
uint32_t U
```

```
union _user_app_boot_invoke_option option
```

```
struct _user_app_boot_invoke_option
```

```
#include <fsl_romapi.h>
```

```
union option
```

Public Members

```
struct _user_app_boot_invoke_option B
```

```
uint32_t U
```

```
struct B
```

2.74 SAI: Serial Audio Interface

2.75 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 Rx status flag state.

Parameters

- base – SAI base pointer

Returns

SAI Rx status flag value. Use the Status Mask to get the status value needed.

```
static inline void SAI_RxClearStatusFlags(I2S_Type *base, uint32_t mask)
```

Clears the SAI Rx status flag state.

Parameters

- base – SAI base pointer
- mask – State mask. It can be a combination of the following sources if defined.
 - kSAI_WordStartFlag
 - kSAI_SyncErrorFlag
 - kSAI_FIFOErrorFlag

```
void SAI_TxSoftwareReset(I2S_Type *base, sai_reset_type_t resetType)
```

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Tx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like TCR1~TCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

void SAI_RxSoftwareReset(I2S_Type *base, *sai_reset_type_t* resetType)

Do software reset or FIFO reset .

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Rx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like RCR1~RCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

- base – SAI base pointer
- resetType – Reset type, FIFO reset or software reset

void SAI_TxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)

Set the Tx channel FIFO enable mask.

Parameters

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

void SAI_RxSetChannelFIFOMask(I2S_Type *base, uint8_t mask)

Set the Rx channel FIFO enable mask.

Parameters

- base – SAI base pointer
- mask – Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

void SAI_TxSetDataOrder(I2S_Type *base, *sai_data_order_t* order)

Set the Tx data order.

Parameters

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI_RxSetDataOrder(I2S_Type *base, *sai_data_order_t* order)

Set the Rx data order.

Parameters

- base – SAI base pointer
- order – Data order MSB or LSB

void SAI_TxSetBitClockPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Tx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_RxSetBitClockPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Rx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_TxSetFrameSyncPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Tx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_RxSetFrameSyncPolarity(I2S_Type *base, *sai_clock_polarity_t* polarity)

Set the Rx data order.

Parameters

- base – SAI base pointer
- polarity –

void SAI_TxSetFIFOPacking(I2S_Type *base, *sai_fifo_packing_t* pack)

Set Tx FIFO packing feature.

Parameters

- base – SAI base pointer.
- pack – FIFO pack type. It is element of *sai_fifo_packing_t*.

void SAI_RxSetFIFOPacking(I2S_Type *base, *sai_fifo_packing_t* pack)

Set Rx FIFO packing feature.

Parameters

- base – SAI base pointer.
- pack – FIFO pack type. It is element of *sai_fifo_packing_t*.

static inline void SAI_TxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)

Set Tx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in TCSR register.

Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

static inline void SAI_RxSetFIFOErrorContinue(I2S_Type *base, bool isEnabled)

Set Rx FIFO error continue.

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in RCSR register.

Parameters

- base – SAI base pointer.
- isEnabled – Is FIFO error continue enabled, true means enable, false means disable.

static inline void SAI_TxEnableInterrupts(I2S_Type *base, uint32_t mask)

Enables the SAI Tx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.

- kSAI_WordStartInterruptEnable
- kSAI_SyncErrorInterruptEnable
- kSAI_FIFOWarningInterruptEnable
- kSAI_FIFORequestInterruptEnable
- kSAI_FIFOErrorInterruptEnable

static inline void SAI_RxEnableInterrupts(I2S_Type *base, uint32_t mask)

Enables the SAI Rx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kSAI_WordStartInterruptEnable
 - kSAI_SyncErrorInterruptEnable
 - kSAI_FIFOWarningInterruptEnable
 - kSAI_FIFORequestInterruptEnable
 - kSAI_FIFOErrorInterruptEnable

static inline void SAI_TxDisableInterrupts(I2S_Type *base, uint32_t mask)

Disables the SAI Tx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kSAI_WordStartInterruptEnable
 - kSAI_SyncErrorInterruptEnable
 - kSAI_FIFOWarningInterruptEnable
 - kSAI_FIFORequestInterruptEnable
 - kSAI_FIFOErrorInterruptEnable

static inline void SAI_RxDisableInterrupts(I2S_Type *base, uint32_t mask)

Disables the SAI Rx interrupt requests.

Parameters

- base – SAI base pointer
- mask – interrupt source The parameter can be a combination of the following sources if defined.
 - kSAI_WordStartInterruptEnable
 - kSAI_SyncErrorInterruptEnable
 - kSAI_FIFOWarningInterruptEnable
 - kSAI_FIFORequestInterruptEnable
 - kSAI_FIFOErrorInterruptEnable

```
static inline void SAI_TxEnableDMA(I2S_Type *base, uint32_t mask, bool enable)
```

Enables/disables the SAI Tx DMA requests.

Parameters

- base – SAI base pointer
- mask – DMA source The parameter can be combination of the following sources if defined.
 - kSAI_FIFOWarningDMAEnable
 - kSAI_FIFORequestDMAEnable
- enable – True means enable DMA, false means disable DMA.

```
static inline void SAI_RxEnableDMA(I2S_Type *base, uint32_t mask, bool enable)
```

Enables/disables the SAI Rx DMA requests.

Parameters

- base – SAI base pointer
- mask – DMA source The parameter can be a combination of the following sources if defined.
 - kSAI_FIFOWarningDMAEnable
 - kSAI_FIFORequestDMAEnable
- enable – True means enable DMA, false means disable DMA.

```
static inline uintptr_t SAI_TxGetDataRegisterAddress(I2S_Type *base, uint32_t channel)
```

Gets the SAI Tx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

- base – SAI base pointer.
- channel – Which data channel used.

Returns

data register address.

```
static inline uintptr_t SAI_RxGetDataRegisterAddress(I2S_Type *base, uint32_t channel)
```

Gets the SAI Rx data register address.

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

- base – SAI base pointer.
- channel – Which data channel used.

Returns

data register address.

```
void SAI_WriteBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer,  
                      uint32_t size)
```

Sends data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.

- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

```
void SAI_WriteMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask,  
                                  uint32_t bitWidth, uint8_t *buffer, uint32_t size)
```

Sends data to multi channel using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be written.
- size – Bytes to be written.

```
static inline void SAI_WriteData(I2S_Type *base, uint32_t channel, uint32_t data)
```

Writes data into SAI FIFO.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- data – Data needs to be written.

```
void SAI_ReadBlocking(I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer,  
                     uint32_t size)
```

Receives data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

```
void SAI_ReadMultiChannelBlocking(I2S_Type *base, uint32_t channel, uint32_t channelMask,  
                                  uint32_t bitWidth, uint8_t *buffer, uint32_t size)
```

Receives multi channel data using a blocking method.

Note: This function blocks by polling until data is ready to be sent.

Parameters

- base – SAI base pointer.
- channel – Data channel used.
- channelMask – channel mask.
- bitWidth – How many bits in an audio word; usually 8/16/24/32 bits.
- buffer – Pointer to the data to be read.
- size – Bytes to be read.

```
static inline uint32_t SAI_ReadData(I2S_Type *base, uint32_t channel)
```

Reads data from the SAI FIFO.

Parameters

- base – SAI base pointer.
- channel – Data channel used.

Returns

Data in SAI FIFO.

```
void SAI_TransferTxCreateHandle(I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t  
callback, void *userData)
```

Initializes the SAI Tx handle.

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

Parameters

- base – SAI base pointer
- handle – SAI handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function

```
void SAI_TransferRxCreateHandle(I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t  
callback, void *userData)
```

Initializes the SAI Rx handle.

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

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.
- callback – Pointer to the user callback function.
- userData – User parameter passed to the callback function.

```
void SAI_TransferTxSetConfig(I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)  
SAI transmitter transfer configurations.
```

This function initializes the Tx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.

- config – transmitter configurations.

void SAI_TransferRxSetConfig(I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)
SAI receiver transfer configurations.

This function initializes the Rx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

- base – SAI base pointer.
- handle – SAI handle pointer.
- config – receiver configurations.

status_t SAI_TransferSendNonBlocking(I2S_Type *base, sai_handle_t *handle, sai_transfer_t *xfer)

Performs an interrupt non-blocking send transfer on SAI.

Note: This API returns immediately after the transfer initiates. Call the SAI_TxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SAI_Busy, the transfer is finished.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- xfer – Pointer to the sai_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_SAI_TxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SAI_TransferReceiveNonBlocking(I2S_Type *base, sai_handle_t *handle, sai_transfer_t *xfer)

Performs an interrupt non-blocking receive transfer on SAI.

Note: This API returns immediately after the transfer initiates. Call the SAI_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SAI_Busy, the transfer is finished.

Parameters

- base – SAI base pointer
- handle – Pointer to the sai_handle_t structure which stores the transfer state.
- xfer – Pointer to the sai_transfer_t structure.

Return values

- kStatus_Success – Successfully started the data receive.
- kStatus_SAI_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t SAI_TransferGetSendCount(I2S_Type *base, *sai_handle_t* *handle, *size_t* *count)

Gets a set byte count.

Parameters

- base – SAI base pointer.
- handle – Pointer to the *sai_handle_t* structure which stores the transfer state.
- count – Bytes count sent.

Return values

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

status_t SAI_TransferGetReceiveCount(I2S_Type *base, *sai_handle_t* *handle, *size_t* *count)

Gets a received byte count.

Parameters

- base – SAI base pointer.
- handle – Pointer to the *sai_handle_t* structure which stores the transfer state.
- count – Bytes count received.

Return values

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

void SAI_TransferAbortSend(I2S_Type *base, *sai_handle_t* *handle)

Aborts the current send.

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

Parameters

- base – SAI base pointer.
- handle – Pointer to the *sai_handle_t* structure which stores the transfer state.

void SAI_TransferAbortReceive(I2S_Type *base, *sai_handle_t* *handle)

Aborts the current IRQ receive.

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

Parameters

- base – SAI base pointer
- handle – Pointer to the *sai_handle_t* structure which stores the transfer state.

void SAI_TransferTerminateSend(I2S_Type *base, sai_handle_t *handle)

Terminate all SAI send.

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

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferTerminateReceive(I2S_Type *base, sai_handle_t *handle)

Terminate all SAI receive.

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

Parameters

- base – SAI base pointer.
- handle – SAI eDMA handle pointer.

void SAI_TransferTxHandleIRQ(I2S_Type *base, sai_handle_t *handle)

Tx interrupt handler.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure.

void SAI_TransferRxHandleIRQ(I2S_Type *base, sai_handle_t *handle)

Tx interrupt handler.

Parameters

- base – SAI base pointer.
- handle – Pointer to the sai_handle_t structure.

void SAI_DriverIRQHandler(uint32_t instance)

SAI driver IRQ handler common entry.

This function provides the common IRQ request entry for SAI.

Parameters

- instance – SAI instance.

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_sai_status_t, SAI return status.

Values:

enumerator kStatus_SAI_TxBusy
SAI Tx is busy.

enumerator kStatus_SAI_RxBusy
SAI Rx is busy.

enumerator kStatus_SAI_TxError
SAI Tx FIFO error.

enumerator kStatus_SAI_RxError
SAI Rx FIFO error.

enumerator kStatus_SAI_QueueFull
SAI transfer queue is full.

enumerator kStatus_SAI_TxIdle
SAI Tx is idle

enumerator kStatus_SAI_RxIdle
SAI Rx is idle

_sai_channel_mask, sai channel mask value, actual channel numbers is depend soc specific

Values:

enumerator kSAI_Channel0Mask
channel 0 mask value

enumerator kSAI_Channel1Mask
channel 1 mask value

enumerator kSAI_Channel2Mask
channel 2 mask value

enumerator kSAI_Channel3Mask
channel 3 mask value

enumerator kSAI_Channel4Mask
channel 4 mask value

enumerator kSAI_Channel5Mask
channel 5 mask value

enumerator kSAI_Channel6Mask
channel 6 mask value

enumerator kSAI_Channel7Mask
channel 7 mask value

enum _sai_protocol
Define the SAI bus type.

Values:

enumerator kSAI_BusLeftJustified
Uses left justified format.

enumerator kSAI_BusRightJustified
Uses right justified format.

enumerator kSAI_BusI2S
Uses I2S format.

enumerator kSAI_BusPCMA
Uses I2S PCM A format.

enumerator kSAI_BusPCMB
Uses I2S PCM B format.

enum _sai_master_slave
Master or slave mode.

Values:

enumerator kSAI_Master

Master mode include bclk and frame sync

enumerator kSAI_Slave

Slave mode include bclk and frame sync

enumerator kSAI_Bclk_Master_FrameSync_Slave

bclk in master mode, frame sync in slave mode

enumerator kSAI_Bclk_Slave_FrameSync_Master

bclk in slave mode, frame sync in master mode

enum _sai_mono_stereo

Mono or stereo audio format.

Values:

enumerator kSAI_Stereo

Stereo sound.

enumerator kSAI_MonoRight

Only Right channel have sound.

enumerator kSAI_MonoLeft

Only left channel have sound.

enum _sai_data_order

SAI data order, MSB or LSB.

Values:

enumerator kSAI_DataLSB

LSB bit transferred first

enumerator kSAI_DataMSB

MSB bit transferred first

enum _sai_clock_polarity

SAI clock polarity, active high or low.

Values:

enumerator kSAI_PolarityActiveHigh

Drive outputs on rising edge

enumerator kSAI_PolarityActiveLow

Drive outputs on falling edge

enumerator kSAI_SampleOnFallingEdge

Sample inputs on falling edge

enumerator kSAI_SampleOnRisingEdge

Sample inputs on rising edge

enum _sai_sync_mode

Synchronous or asynchronous mode.

Values:

enumerator kSAI_ModeAsync

Asynchronous mode

enumerator kSAI_ModeSync

Synchronous mode (with receiver or transmit)

enumerator kSAI_ModeSyncWithOtherTx
Synchronous with another SAI transmit

enumerator kSAI_ModeSyncWithOtherRx
Synchronous with another SAI receiver

enum _sai_bclk_source
Bit clock source.

Values:

enumerator kSAI_BclkSourceBusclk
Bit clock using bus clock

enumerator kSAI_BclkSourceMclkOption1
Bit clock MCLK option 1

enumerator kSAI_BclkSourceMclkOption2
Bit clock MCLK option2

enumerator kSAI_BclkSourceMclkOption3
Bit clock MCLK option3

enumerator kSAI_BclkSourceMclkDiv
Bit clock using master clock divider

enumerator kSAI_BclkSourceOtherSai0
Bit clock from other SAI device

enumerator kSAI_BclkSourceOtherSai1
Bit clock from other SAI device

_sai_interrupt_enable_t, The SAI interrupt enable flag

Values:

enumerator kSAI_WordStartInterruptEnable
Word start flag, means the first word in a frame detected

enumerator kSAI_SyncErrorInterruptEnable
Sync error flag, means the sync error is detected

enumerator kSAI_FIFOWarningInterruptEnable
FIFO warning flag, means the FIFO is empty

enumerator kSAI_FIFOErrorInterruptEnable
FIFO error flag

enumerator kSAI_FIFORequestInterruptEnable
FIFO request, means reached watermark

_sai_dma_enable_t, The DMA request sources

Values:

enumerator kSAI_FIFOWarningDMAEnable
FIFO warning caused by the DMA request

enumerator kSAI_FIFORequestDMAEnable
FIFO request caused by the DMA request

_sai_flags, The SAI status flag

Values:

enumerator kSAI_WordStartFlag

Word start flag, means the first word in a frame detected

enumerator kSAI_SyncErrorFlag

Sync error flag, means the sync error is detected

enumerator kSAI_FIFOErrorFlag

FIFO error flag

enumerator kSAI_FIFORequestFlag

FIFO request flag.

enumerator kSAI_FIFOWarningFlag

FIFO warning flag

enum _sai_reset_type

The reset type.

Values:

enumerator kSAI_ResetTypeSoftware

Software reset, reset the logic state

enumerator kSAI_ResetTypeFIFO

FIFO reset, reset the FIFO read and write pointer

enumerator kSAI_ResetAll

All reset.

enum _sai_fifo_packing

The SAI packing mode The mode includes 8 bit and 16 bit packing.

Values:

enumerator kSAI_FifoPackingDisabled

Packing disabled

enumerator kSAI_FifoPacking8bit

8 bit packing enabled

enumerator kSAI_FifoPacking16bit

16bit packing enabled

enum _sai_sample_rate

Audio sample rate.

Values:

enumerator kSAI_SampleRate8KHz

Sample rate 8000 Hz

enumerator kSAI_SampleRate11025Hz

Sample rate 11025 Hz

enumerator kSAI_SampleRate12KHz

Sample rate 12000 Hz

enumerator kSAI_SampleRate16KHz

Sample rate 16000 Hz

enumerator kSAI_SampleRate22050Hz

Sample rate 22050 Hz

enumerator kSAI_SampleRate24KHz

Sample rate 24000 Hz

enumerator kSAI_SampleRate32KHz

Sample rate 32000 Hz

enumerator kSAI_SampleRate44100Hz

Sample rate 44100 Hz

enumerator kSAI_SampleRate48KHz

Sample rate 48000 Hz

enumerator kSAI_SampleRate96KHz

Sample rate 96000 Hz

enumerator kSAI_SampleRate192KHz

Sample rate 192000 Hz

enumerator kSAI_SampleRate384KHz

Sample rate 384000 Hz

enum _sai_word_width

Audio word width.

Values:

enumerator kSAI_WordWidth8bits

Audio data width 8 bits

enumerator kSAI_WordWidth16bits

Audio data width 16 bits

enumerator kSAI_WordWidth24bits

Audio data width 24 bits

enumerator kSAI_WordWidth32bits

Audio data width 32 bits

enum _sai_data_pin_state

sai data pin state definition

Values:

enumerator kSAI_DataPinStateTriState

transmit data pins are tri-stated when slots are masked or channels are disabled

enumerator kSAI_DataPinStateOutputZero

transmit data pins are never tri-stated and will output zero when slots are masked or channel disabled

enum _sai_fifo_combine

sai fifo combine mode definition

Values:

enumerator kSAI_FifoCombineDisabled

sai TX/RX fifo combine mode disabled

enumerator kSAI_FifoCombineModeEnabledOnRead

sai TX fifo combine mode enabled on FIFO reads

enumerator kSAI_FifoCombineModeEnabledOnWrite
sai TX fifo combine mode enabled on FIFO write

enumerator kSAI_RxFifoCombineModeEnabledOnWrite
sai RX fifo combine mode enabled on FIFO write

enumerator kSAI_RXFifoCombineModeEnabledOnRead
sai RX fifo combine mode enabled on FIFO reads

enumerator kSAI_FifoCombineModeEnabledOnReadWrite
sai TX/RX fifo combined mode enabled on FIFO read/writes

enum __sai_transceiver_type
sai transceiver type

Values:

enumerator kSAI_Transmitter
sai transmitter

enumerator kSAI_Receiver
sai receiver

enum __sai_frame_sync_len
sai frame sync len

Values:

enumerator kSAI_FrameSyncLenOneBitClk
1 bit clock frame sync len for DSP mode

enumerator kSAI_FrameSyncLenPerWordWidth
Frame sync length decided by word width

typedef enum __sai_protocol sai_protocol_t
Define the SAI bus type.

typedef enum __sai_master_slave sai_master_slave_t
Master or slave mode.

typedef enum __sai_mono_stereo sai_mono_stereo_t
Mono or stereo audio format.

typedef enum __sai_data_order sai_data_order_t
SAI data order, MSB or LSB.

typedef enum __sai_clock_polarity sai_clock_polarity_t
SAI clock polarity, active high or low.

typedef enum __sai_sync_mode sai_sync_mode_t
Synchronous or asynchronous mode.

typedef enum __sai_bclk_source sai_bclk_source_t
Bit clock source.

typedef enum __sai_reset_type sai_reset_type_t
The reset type.

typedef enum __sai_fifo_packing sai_fifo_packing_t
The SAI packing mode The mode includes 8 bit and 16 bit packing.

typedef struct __sai_config sai_config_t
SAI user configuration structure.


```
typedef enum _sai_sample_rate sai_sample_rate_t
    Audio sample rate.

typedef enum _sai_word_width sai_word_width_t
    Audio word width.

typedef enum _sai_data_pin_state sai_data_pin_state_t
    sai data pin state definition

typedef enum _sai_fifo_combine sai_fifo_combine_t
    sai fifo combine mode definition

typedef enum _sai_transceiver_type sai_transceiver_type_t
    sai transceiver type

typedef enum _sai_frame_sync_len sai_frame_sync_len_t
    sai frame sync len

typedef struct _sai_transfer_format sai_transfer_format_t
    sai transfer format

typedef struct _sai_master_clock sai_master_clock_t
    master clock configurations

typedef struct _sai_fifo sai_fifo_t
    sai fifo configurations

typedef struct _sai_bit_clock sai_bit_clock_t
    sai bit clock configurations

typedef struct _sai_frame_sync sai_frame_sync_t
    sai frame sync configurations

typedef struct _sai_serial_data sai_serial_data_t
    sai serial data configurations

typedef struct _sai_transceiver sai_transceiver_t
    sai transceiver configurations

typedef struct _sai_transfer sai_transfer_t
    SAI transfer structure.

typedef struct _sai_handle sai_handle_t

typedef void (*sai_transfer_callback_t)(I2S_Type *base, sai_handle_t *handle, status_t status,
void *userData)
    SAI transfer callback prototype.

SAI_XFER_QUEUE_SIZE
    SAI transfer queue size, user can refine it according to use case.

FSL_SAI_HAS_FIFO_EXTEND_FEATURE
    sai fifo feature

struct _sai_config
    #include <fsl_sai.h> SAI user configuration structure.
```

Public Members

sai_protocol_t protocol
Audio bus protocol in SAI

sai_sync_mode_t syncMode

SAI sync mode, control Tx/Rx clock sync

bool mclkOutputEnable

Master clock output enable, true means master clock divider enabled

sai_bclk_source_t bclkSource

Bit Clock source

sai_master_slave_t masterSlave

Master or slave

struct *_sai_transfer_format*

#include <fsl_sai.h> sai transfer format

Public Members

uint32_t sampleRate_Hz

Sample rate of audio data

uint32_t bitWidth

Data length of audio data, usually 8/16/24/32 bits

sai_mono_stereo_t stereo

Mono or stereo

uint32_t masterClockHz

Master clock frequency in Hz

uint8_t watermark

Watermark value

uint8_t channel

Transfer start channel

uint8_t channelMask

enabled channel mask value, reference *_sai_channel_mask*

uint8_t endChannel

end channel number

uint8_t channelNums

Total enabled channel numbers

sai_protocol_t protocol

Which audio protocol used

bool isFrameSyncCompact

True means Frame sync length is configurable according to bitWidth, false means frame sync length is 64 times of bit clock.

struct *_sai_master_clock*

#include <fsl_sai.h> master clock configurations

Public Members

bool mclkOutputEnable

master clock output enable

```
uint32_t mclkHz
    target mclk frequency
uint32_t mclkSourceClkHz
    mclk source frequency
struct __sai_fifo
    #include <fsl_sai.h> sai fifo configurations
```

Public Members

```
bool fifoContinueOnError
    fifo continues when error occur
sai_fifo_combine_t fifoCombine
    fifo combine mode
sai_fifo_packing_t fifoPacking
    fifo packing mode
uint8_t fifoWatermark
    fifo watermark
struct __sai_bit_clock
    #include <fsl_sai.h> sai bit clock configurations
```

Public Members

```
bool bclkInputDelay
    bit clock actually used by the transmitter is delayed by the pad output delay, this has
    effect of decreasing the data input setup time, but increasing the data output valid time
    .
sai_clock_polarity_t bclkPolarity
    bit clock polarity
sai_bclk_source_t bclkSource
    bit Clock source
struct __sai_frame_sync
    #include <fsl_sai.h> sai frame sync configurations
```

Public Members

```
uint8_t frameSyncWidth
    frame sync width in number of bit clocks
bool frameSyncEarly
    TRUE is frame sync assert one bit before the first bit of frame FALSE is frame sync
    assert with the first bit of the frame
bool frameSyncGenerateOnDemand
    internal frame sync is generated when FIFO waring flag is clear
sai_clock_polarity_t frameSyncPolarity
    frame sync polarity
struct __sai_serial_data
    #include <fsl_sai.h> sai serial data configurations
```

Public Members

sai_data_pin_state_t dataMode
sai data pin state when slots masked or channel disabled

sai_data_order_t dataOrder
configure whether the LSB or MSB is transmitted first

uint8_t dataWord0Length
configure the number of bits in the first word in each frame

uint8_t dataWordNLength
configure the number of bits in the each word in each frame, except the first word

uint8_t dataWordLength
used to record the data length for dma transfer

uint8_t dataFirstBitShifted
Configure the bit index for the first bit transmitted for each word in the frame

uint8_t dataWordNum
configure the number of words in each frame

uint32_t dataMaskedWord
configure whether the transmit word is masked

struct *_sai_transceiver*
#include <fsl_sai.h> sai transceiver configurations

Public Members

sai_serial_data_t serialData
serial data configurations

sai_frame_sync_t frameSync
ws configurations

sai_bit_clock_t bitClock
bit clock configurations

sai_fifo_t fifo
fifo configurations

sai_master_slave_t masterSlave
transceiver is master or slave

sai_sync_mode_t syncMode
transceiver sync mode

uint8_t startChannel
Transfer start channel

uint8_t channelMask
enabled channel mask value, reference *_sai_channel_mask*

uint8_t endChannel
end channel number

uint8_t channelNums
Total enabled channel numbers

struct *_sai_transfer*
#include <fsl_sai.h> SAI transfer structure.

Public Members

uint8_t *data
Data start address to transfer.

size_t dataSize
Transfer size.

struct __sai_handle
#include <fsl_sai.h> SAI handle structure.

Public Members

I2S_Type *base
base address

uint32_t state
Transfer status

sai_transfer_callback_t callback
Callback function called at transfer event

void *userData
Callback parameter passed to callback function

uint8_t bitWidth
Bit width for transfer, 8/16/24/32 bits

uint8_t channel
Transfer start channel

uint8_t channelMask
enabled channel mask value, refernece *_sai_channel_mask*

uint8_t endChannel
end channel number

uint8_t channelNums
Total enabled channel numbers

sai_transfer_t saiQueue[(4U)]
Transfer queue storing queued transfer

size_t transferSize[(4U)]
Data bytes need to transfer

volatile uint8_t queueUser
Index for user to queue transfer

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

uint8_t watermark
Watermark value

2.76 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,

- for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
- 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

2.77 Sbloader

`enum __sectionType`
sb3 section definitions
section type
Values:

`enumerator kSectionNone`
end or invalid

`enumerator kSectionDataRange`

`enumerator kSectionDiffUpdate`

`enumerator kSectionDDRConfig`

`enumerator kSectionRegister`

Values:

`enumerator kFwVerChk_Id_none`

enumerator kFwVerChk_Id_nonsecure

enumerator kFwVerChk_Id_secure

enum _loader_command_sb3

loader command enum

Values:

enumerator kSB3_CmdInvalid

enumerator kSB3_CmdErase

enumerator kSB3_CmdLoad

enumerator kSB3_CmdExecute

enumerator kSB3_CmdCall

enumerator kSB3_CmdProgramFuse

enumerator kSB3_CmdProgramIFR

enumerator kSB3_CmdLoadCmac

enumerator kSB3_CmdCopy

enumerator kSB3_CmdLoadHashLocking

enumerator kSB3_CmdLoadKeyBlob

enumerator kSB3_CmdConfigMem

enumerator kSB3_CmdFillMem

enumerator kSB3_CmdFwVerCheck

enum kb_operation_t

Details of the operation to be performed by the ROM.

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

Values:

enumerator kRomAuthenticateImage

Authenticate a signed image.

enumerator kRomLoadImage

Load SB file.

enumerator kRomOperationCount

typedef uint8_t chunk_v3_t[16]

typedef struct _ldr_buf ldr_buf_t

typedef struct _ldr_Context_v3 ldr_Context_v3_t

Provides forward reference to the loader context definition.

typedef status_t (*pLdrFnc_v3_t)(ldr_Context_v3_t *content)

Function pointer definition for all loader action functions.

```
typedef enum _sectionType section_type_t
    sb3 section definitions
    section type
typedef struct range_header sb3_data_range_header_t
    section data range structure
typedef struct range_header_expansion sb3_data_range_expansion_t
typedef struct copy_memory_expansion sb3_copy_memory_expansion_t
typedef struct copy sb3_copy_memory_t
typedef struct load_keyblob sb3_load_keyblob_t
typedef struct fill_memory_expansion sb3_fill_memory_expansion_t
typedef struct fill_memory sb3_fill_memory_t
typedef struct config_memory sb3_config_memory_t
typedef struct fw_ver_check sb3_fw_ver_check_t
typedef struct section_header sb3_section_header_t
    sb3 DATA section header format
typedef enum _loader_command_sb3 sb3_cmd_t
    loader command enum
SB3_BYTES_PER_CHUNK
    Defines the number of bytes in a cipher block (chunk). This is dictated by the encryption
    algorithm.
SB3_DATA_RANGE_HEADER_FLAGS_ERASE_MASK
    bit 0
SB3_DATA_RANGE_HEADER_FLAGS_LOAD_MASK
    bit 1
SBLOADER_V3_CMD_SET_ALL
    The all of the allowed command.
SBLOADER_V3_CMD_SET_IN_ISP_MODE
    The allowed command set in ISP mode.
SBLOADER_V3_CMD_SET_IN_REC_MODE
    The allowed command set in recovery mode.
SB3_DATA_BUFFER_SIZE_IN_BYTE
struct _ldr_buf
    #include <fsl_sbloader_v3.h>
struct range_header
    #include <fsl_sbloader_v3.h> section data range structure
struct range_header_expansion
    #include <fsl_sbloader_v3.h>
struct copy_memory_expansion
    #include <fsl_sbloader_v3.h>
```

```
struct copy
    #include <fsl_sbloader_v3.h>
struct load_keyblob
    #include <fsl_sbloader_v3.h>
struct fill_memory_expansion
    #include <fsl_sbloader_v3.h>
```

Public Members

```
uint32_t pattern
    word to be used as pattern
struct fill_memory
    #include <fsl_sbloader_v3.h>
struct config_memory
    #include <fsl_sbloader_v3.h>
```

Public Members

```
uint32_t address
    address of config blob
struct fw_ver_check
    #include <fsl_sbloader_v3.h>
struct section_header
    #include <fsl_sbloader_v3.h> sb3 DATA section header format
struct kb_region_t
    #include <fsl_sbloader_v3.h> Memory region definition.
struct kb_load_sb_t
    #include <fsl_sbloader_v3.h>
struct kb_authenticate_t
    #include <fsl_sbloader_v3.h>
struct kb_options_t
    #include <fsl_sbloader_v3.h>
```

Public Members

```
uint32_t version
    Should be set to #kKbootApiVersion.
uint8_t *buffer
    Caller-provided buffer used by Kboot.
struct _ldr_Context_v3
    #include <fsl_sbloader_v3.h> Loader context definition.
```

Public Members

pLdrFnc_v3_t Action
pointer to loader action function

uint32_t *block_size*
size of each block in bytes

uint32_t *block_data_size*
data size in bytes (NBOOT_SB3_CHUNK_SIZE_IN_BYTES)

uint32_t *block_data_total*
data max size in bytes (*block_size* * *data_size*)

uint32_t *block_buffer_size*
block0 and block size

uint32_t *processedBlocks*
will be used for both block0 and blockx

bool *in_data_block*
data block offset in a block. in progress of handling a data block within a block

bool *in_data_section*
in progress of handling a data section within a data block

bool *in_data_range*
in progress of handling a data range within a data section

uint32_t *commandSet*
support command set during sb file handling

uint8_t *data_buffer*[(*MAX*(128, NBOOT_KEY_BLOB_SIZE_IN_BYTE_MAX))]
temporary data buffer

kb_options_t *fromAPI*
options from ROM API

union *__unnamed92__*

Public Members

kb_authenticate_t *authenticate*
Settings for #kKbootAuthenticate operation.

kb_load_sb_t *loadSB*
Settings for #kKbootLoadSB operation.

2.78 SCTimer: SCTimer/PWM (SCT)

status_t *SCTIMER_Init*(*SCT_Type* **base*, const *sctimer_config_t* **config*)
Un gates the SCTimer clock and configures the peripheral for basic operation.

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

Parameters

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

Returns

kStatus_Success indicates success; Else indicates failure.

void SCTIMER_Deinit(SCT_Type *base)

Gates the SCTimer clock.

Parameters

- base – SCTimer peripheral base address

void SCTIMER_GetDefaultConfig(sctimer_config_t *config)

Fills in the SCTimer configuration structure with the default settings.

The default values are:

```
config->enableCounterUnify = true;
config->clockMode = kSCTIMER_System_ClockMode;
config->clockSelect = kSCTIMER_Clock_On_Rise_Input_0;
config->enableBidirection_l = false;
config->enableBidirection_h = false;
config->prescale_l = 0U;
config->prescale_h = 0U;
config->outInitState = 0U;
config->inputsync = 0xFU;
```

Parameters

- config – Pointer to the user configuration structure.

status_t SCTIMER_SetupPwm(SCT_Type *base, const sctimer_pwm_signal_param_t *pwmParams, sctimer_pwm_mode_t mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz, uint32_t *event)

Configures the PWM signal parameters.

Call this function to configure the PWM signal period, mode, duty cycle, and edge. This function will create 2 events; one of the events will trigger on match with the pulse value and the other will trigger when the counter matches the PWM period. The PWM period event is also used as a limit event to reset the counter or change direction. Both events are enabled for the same state. The state number can be retrieved by calling the function SCTIMER_GetCurrentStateNumber(). The counter is set to operate as one 32-bit counter (unify bit is set to 1). The counter operates in bi-directional mode when generating a center-aligned PWM.

Note: When setting PWM output from multiple output pins, they all should use the same PWM mode i.e all PWM's should be either edge-aligned or center-aligned. When using this API, the PWM signal frequency of all the initialized channels must be the same. Otherwise all the initialized channels' PWM signal frequency is equal to the last call to the API's pwmFreq_Hz.

Parameters

- base – SCTimer peripheral base address
- pwmParams – PWM parameters to configure the output
- mode – PWM operation mode, options available in enumeration sctimer_pwm_mode_t
- pwmFreq_Hz – PWM signal frequency in Hz

- `srcClock_Hz` – SCTimer counter clock in Hz
- `event` – Pointer to a variable where the PWM period event number is stored

Returns

`kStatus_Success` on success `kStatus_Fail` If we have hit the limit in terms of number of events created or if an incorrect PWM duty cycle is passed in.

```
void SCTIMER_UpdatePwmDutycycle(SCT_Type *base, sctimer_out_t output, uint8_t  
                                dutyCyclePercent, uint32_t event)
```

Updates the duty cycle of an active PWM signal.

Before calling this function, the counter is set to operate as one 32-bit counter (unify bit is set to 1).

Parameters

- `base` – SCTimer peripheral base address
- `output` – The output to configure
- `dutyCyclePercent` – New PWM pulse width; the value should be between 1 to 100
- `event` – Event number associated with this PWM signal. This was returned to the user by the function `SCTIMER_SetupPwm()`.

```
static inline void SCTIMER_EnableInterrupts(SCT_Type *base, uint32_t mask)
```

Enables the selected SCTimer interrupts.

Parameters

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

```
static inline void SCTIMER_DisableInterrupts(SCT_Type *base, uint32_t mask)
```

Disables the selected SCTimer interrupts.

Parameters

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

```
static inline uint32_t SCTIMER_GetEnabledInterrupts(SCT_Type *base)
```

Gets the enabled SCTimer interrupts.

Parameters

- `base` – SCTimer peripheral base address

Returns

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

```
static inline uint32_t SCTIMER_GetStatusFlags(SCT_Type *base)
```

Gets the SCTimer status flags.

Parameters

- `base` – SCTimer peripheral base address

Returns

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

```
static inline void SCTIMER_ClearStatusFlags(SCT_Type *base, uint32_t mask)
```

Clears the SCTimer status flags.

Parameters

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

```
static inline void SCTIMER_StartTimer(SCT_Type *base, uint32_t countertoStart)
```

Starts the SCTimer counter.

Note: In 16-bit mode, we can enable both Counter_L and Counter_H, In 32-bit mode, we only can select Counter_U.

Parameters

- base – SCTimer peripheral base address
- countertoStart – The SCTimer counters to enable. This is a logical OR of members of the enumeration `sctimer_counter_t`.

```
static inline void SCTIMER_StopTimer(SCT_Type *base, uint32_t countertoStop)
```

Halts the SCTimer counter.

Parameters

- base – SCTimer peripheral base address
- countertoStop – The SCTimer counters to stop. This is a logical OR of members of the enumeration `sctimer_counter_t`.

```
status_t SCTIMER_CreateAndScheduleEvent(SCT_Type *base, sctimer_event_t howToMonitor,  
                                         uint32_t matchValue, uint32_t whichIO,  
                                         sctimer_counter_t whichCounter, uint32_t *event)
```

Create an event that is triggered on a match or IO and schedule in current state.

This function will configure an event using the options provided by the user. If the event type uses the counter match, then the function will set the user provided match value into a match register and put this match register number into the event control register. The event is enabled for the current state and the event number is increased by one at the end. The function returns the event number; this event number can be used to configure actions to be done when this event is triggered.

Parameters

- base – SCTimer peripheral base address
- howToMonitor – Event type; options are available in the enumeration `sctimer_interrupt_enable_t`
- matchValue – The match value that will be programmed to a match register
- whichIO – The input or output that will be involved in event triggering. This field is ignored if the event type is “match only”
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Pointer to a variable where the new event number is stored

Returns

`kStatus_Success` on success `kStatus_Error` if we have hit the limit in terms of number of events created or if we have reached the limit in terms of number of match registers

`void SCTIMER_ScheduleEvent(SCT_Type *base, uint32_t event)`

Enable an event in the current state.

This function will allow the event passed in to trigger in the current state. The event must be created earlier by either calling the function `SCTIMER_SetupPwm()` or function `SCTIMER_CreateAndScheduleEvent()`.

Parameters

- `base` – SCTimer peripheral base address
- `event` – Event number to enable in the current state

`status_t SCTIMER_IncreaseState(SCT_Type *base)`

Increase the state by 1.

All future events created by calling the function `SCTIMER_ScheduleEvent()` will be enabled in this new state.

Parameters

- `base` – SCTimer peripheral base address

Returns

`kStatus_Success` on success `kStatus_Error` if we have hit the limit in terms of states used

`uint32_t SCTIMER_GetCurrentState(SCT_Type *base)`

Provides the current state.

User can use this to set the next state by calling the function `SCTIMER_SetupNextStateAction()`.

Parameters

- `base` – SCTimer peripheral base address

Returns

The current state

`static inline void SCTIMER_SetCounterState(SCT_Type *base, sctimer_counter_t whichCounter, uint32_t state)`

Set the counter current state.

The function is to set the state variable bit field of STATE register. Writing to the STATE_L, STATE_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

Parameters

- `base` – SCTimer peripheral base address
- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- `state` – The counter current state number (only support range from 0~31).

`static inline uint16_t SCTIMER_GetCounterState(SCT_Type *base, sctimer_counter_t whichCounter)`

Get the counter current state value.

The function is to get the state variable bit field of STATE register.

Parameters

- `base` – SCTimer peripheral base address
- `whichCounter` – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.

Returns

The the counter current state value.

```
status_t SCTIMER_SetupCaptureAction(SCT_Type *base, sctimer_counter_t whichCounter,  
                                   uint32_t *captureRegister, uint32_t event)
```

Setup capture of the counter value on trigger of a selected event.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- captureRegister – Pointer to a variable where the capture register number will be returned. User can read the captured value from this register when the specified event is triggered.
- event – Event number that will trigger the capture

Returns

kStatus_Success on success kStatus_Error if we have hit the limit in terms of number of match/capture registers available

```
void SCTIMER_SetCallback(SCT_Type *base, sctimer_event_callback_t callback, uint32_t event)
```

Receive notification when the event trigger an interrupt.

If the interrupt for the event is enabled by the user, then a callback can be registered which will be invoked when the event is triggered

Parameters

- base – SCTimer peripheral base address
- event – Event number that will trigger the interrupt
- callback – Function to invoke when the event is triggered

```
static inline void SCTIMER_SetupStateLdMethodAction(SCT_Type *base, uint32_t event, bool  
                                                    fgLoad)
```

Change the load method of transition to the specified state.

Change the load method of transition, it will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- event – Event number that will change the method to trigger the state transition
- fgLoad – The method to load highest-numbered event occurring for that state to the STATE register.
 - true: Load the STATEV value to STATE when the event occurs to be the next state.
 - false: Add the STATEV value to STATE when the event occurs to be the next state.

```
static inline void SCTIMER_SetupNextStateActionwithLdMethod(SCT_Type *base, uint32_t  
                                                           nextState, uint32_t event, bool  
                                                           fgLoad)
```

Transition to the specified state with Load method.

This transition will be triggered by the event number that is passed in by the user, the method decide how to load the highest-numbered event occurring for that state to the STATE register.

Parameters

- base – SCTimer peripheral base address
- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition
- fgLoad – The method to load the highest-numbered event occurring for that state to the STATE register.
 - true: Load the STATEV value to STATE when the event occurs to be the next state.
 - false: Add the STATEV value to STATE when the event occurs to be the next state.

```
static inline void SCTIMER_SetupNextStateAction(SCT_Type *base, uint32_t nextState, uint32_t event)
```

Transition to the specified state.

Deprecated:

Do not use this function. It has been superceded by SCTIMER_SetupNextStateActionwithLdMethod

This transition will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition

```
static inline void SCTIMER_SetupEventActiveDirection(SCT_Type *base,
                                                    sctimer_event_active_direction_t
                                                    activeDirection, uint32_t event)
```

Setup event active direction when the counters are operating in BIDIR mode.

Parameters

- base – SCTimer peripheral base address
- activeDirection – Event generation active direction, see sctimer_event_active_direction_t.
- event – Event number that need setup the active direction.

```
static inline void SCTIMER_SetupOutputSetAction(SCT_Type *base, uint32_t whichIO, uint32_t event)
```

Set the Output.

This output will be set when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to set
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupOutputClearAction(SCT_Type *base, uint32_t whichIO,
                                                  uint32_t event)
```

Clear the Output.

This output will be cleared when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to clear
- event – Event number that will trigger the output change

```
void SCTIMER_SetupOutputToggleAction(SCT_Type *base, uint32_t whichIO, uint32_t event)
```

Toggle the output level.

This change in the output level is triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to toggle
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupCounterLimitAction(SCT_Type *base, sctimer_counter_t  
                                                    whichCounter, uint32_t event)
```

Limit the running counter.

The counter is limited when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be limited

```
static inline void SCTIMER_SetupCounterStopAction(SCT_Type *base, sctimer_counter_t  
                                                    whichCounter, uint32_t event)
```

Stop the running counter.

The counter is stopped when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be stopped

```
static inline void SCTIMER_SetupCounterStartAction(SCT_Type *base, sctimer_counter_t  
                                                    whichCounter, uint32_t event)
```

Re-start the stopped counter.

The counter will re-start when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to re-start

```
static inline void SCTIMER_SetupCounterHaltAction(SCT_Type *base, sctimer_counter_t
                                                whichCounter, uint32_t event)
```

Halt the running counter.

The counter is disabled (halted) when the event number that is passed in by the user is triggered. When the counter is halted, all further events are disabled. The HALT condition can only be removed by calling the SCTIMER_StartTimer() function.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be halted

```
static inline void SCTIMER_SetupDmaTriggerAction(SCT_Type *base, uint32_t dmaNumber,
                                                uint32_t event)
```

Generate a DMA request.

DMA request will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- dmaNumber – The DMA request to generate
- event – Event number that will trigger the DMA request

```
static inline void SCTIMER_SetCOUNTValue(SCT_Type *base, sctimer_counter_t whichCounter,
                                           uint32_t value)
```

Set the value of counter.

The function is to set the value of Count register, Writing to the COUNT_L, COUNT_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- value – the counter value update to the COUNT register.

```
static inline uint32_t SCTIMER_GetCOUNTValue(SCT_Type *base, sctimer_counter_t
                                              whichCounter)
```

Get the value of counter.

The function is to read the value of Count register, software can read the counter registers at any time..

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.

Returns

The value of counter selected.

```
static inline void SCTIMER_SetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Set the state mask bit field of EV_STATE register.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be set.
- state – The state value in which the event is enabled to occur.

static inline void SCTIMER_ClearEventInState(SCT_Type *base, uint32_t event, uint32_t state)
Clear the state mask bit field of EV_STATE register.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be clear.
- state – The state value in which the event is disabled to occur.

static inline bool SCTIMER_GetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
Get the state mask bit field of EV_STATE register.

Note: This function is to check whether the event is enabled in a specific state.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be read.
- state – The state value.

Returns

The the state mask bit field of EV_STATE register.

- true: The event is enable in state.
- false: The event is disable in state.

static inline uint32_t SCTIMER_GetCaptureValue(SCT_Type *base, *sctimer_counter_t*
whichCounter, uint8_t capChannel)

Get the value of capture register.

This function returns the captured value upon occurrence of the events selected by the corresponding Capture Control registers occurred.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- capChannel – SCTimer capture register of capture channel.

Returns

The SCTimer counter value at which this register was last captured.

void SCTIMER_EventHandleIRQ(SCT_Type *base)
SCTimer interrupt handler.

Parameters

- base – SCTimer peripheral base address.

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enum _sctimer_pwm_mode

SCTimer PWM operation modes.

Values:

enumerator kSCTIMER_EdgeAlignedPwm

Edge-aligned PWM

enumerator kSCTIMER_CenterAlignedPwm

Center-aligned PWM

enum _sctimer_counter

SCTimer counters type.

Values:

enumerator kSCTIMER_Counter_L

16-bit Low counter.

enumerator kSCTIMER_Counter_H

16-bit High counter.

enumerator kSCTIMER_Counter_U

32-bit Unified counter.

enum _sctimer_input

List of SCTimer input pins.

Values:

enumerator kSCTIMER_Input_0

SCTIMER input 0

enumerator kSCTIMER_Input_1

SCTIMER input 1

enumerator kSCTIMER_Input_2

SCTIMER input 2

enumerator kSCTIMER_Input_3

SCTIMER input 3

enumerator kSCTIMER_Input_4

SCTIMER input 4

enumerator kSCTIMER_Input_5

SCTIMER input 5

enumerator kSCTIMER_Input_6

SCTIMER input 6

enumerator kSCTIMER_Input_7

SCTIMER input 7

enum _sctimer_out

List of SCTimer output pins.

Values:

enumerator kSCTIMER_Out_0

SCTIMER output 0

enumerator kSCTIMER_Out_1

SCTIMER output 1

enumerator kSCTIMER_Out_2

SCTIMER output 2

enumerator kSCTIMER_Out_3

SCTIMER output 3

enumerator kSCTIMER_Out_4

SCTIMER output 4

enumerator kSCTIMER_Out_5

SCTIMER output 5

enumerator kSCTIMER_Out_6

SCTIMER output 6

enumerator kSCTIMER_Out_7

SCTIMER output 7

enumerator kSCTIMER_Out_8

SCTIMER output 8

enumerator kSCTIMER_Out_9

SCTIMER output 9

enum _sctimer_pwm_level_select

SCTimer PWM output pulse mode: high-true, low-true or no output.

Values:

enumerator kSCTIMER_LowTrue

Low true pulses

enumerator kSCTIMER_HighTrue

High true pulses

enum _sctimer_clock_mode

SCTimer clock mode options.

Values:

enumerator kSCTIMER_System_ClockMode

System Clock Mode

enumerator kSCTIMER_Sampled_ClockMode

Sampled System Clock Mode

enumerator kSCTIMER_Input_ClockMode

SCT Input Clock Mode

enumerator kSCTIMER_Asynchronous_ClockMode

Asynchronous Mode

enum _sctimer_clock_select

SCTimer clock select options.

Values:

enumerator kSCTIMER_Clock_On_Rise_Input_0

Rising edges on input 0

enumerator kSCTIMER_Clock_On_Fall_Input_0

Falling edges on input 0

enumerator kSCTIMER_Clock_On_Rise_Input_1

Rising edges on input 1

enumerator kSCTIMER_Clock_On_Fall_Input_1

Falling edges on input 1

enumerator kSCTIMER_Clock_On_Rise_Input_2

Rising edges on input 2

enumerator kSCTIMER_Clock_On_Fall_Input_2

Falling edges on input 2

enumerator kSCTIMER_Clock_On_Rise_Input_3

Rising edges on input 3

enumerator kSCTIMER_Clock_On_Fall_Input_3

Falling edges on input 3

enumerator kSCTIMER_Clock_On_Rise_Input_4

Rising edges on input 4

enumerator kSCTIMER_Clock_On_Fall_Input_4

Falling edges on input 4

enumerator kSCTIMER_Clock_On_Rise_Input_5

Rising edges on input 5

enumerator kSCTIMER_Clock_On_Fall_Input_5

Falling edges on input 5

enumerator kSCTIMER_Clock_On_Rise_Input_6

Rising edges on input 6

enumerator kSCTIMER_Clock_On_Fall_Input_6

Falling edges on input 6

enumerator kSCTIMER_Clock_On_Rise_Input_7

Rising edges on input 7

enumerator kSCTIMER_Clock_On_Fall_Input_7

Falling edges on input 7

enum _sctimer_conflict_resolution

SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

Values:

enumerator kSCTIMER_ResolveNone

No change

enumerator kSCTIMER_ResolveSet

Set output

enumerator kSCTIMER_ResolveClear

Clear output

enumerator kSCTIMER_ResolveToggle

Toggle output

enum _sctimer_event_active_direction

List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

Values:

enumerator kSCTIMER_ActiveIndependent

This event is triggered regardless of the count direction.

enumerator kSCTIMER_ActiveInCountUp

This event is triggered only during up-counting when BIDIR = 1.

enumerator kSCTIMER_ActiveInCountDown

This event is triggered only during down-counting when BIDIR = 1.

enum _sctimer_event

List of SCTimer event types.

Values:

enumerator kSCTIMER_InputLowOrMatchEvent

enumerator kSCTIMER_InputRiseOrMatchEvent

enumerator kSCTIMER_InputFallOrMatchEvent

enumerator kSCTIMER_InputHighOrMatchEvent

enumerator kSCTIMER_MatchEventOnly

enumerator kSCTIMER_InputLowEvent

enumerator kSCTIMER_InputRiseEvent

enumerator kSCTIMER_InputFallEvent

enumerator kSCTIMER_InputHighEvent

enumerator kSCTIMER_InputLowAndMatchEvent

enumerator kSCTIMER_InputRiseAndMatchEvent

enumerator kSCTIMER_InputFallAndMatchEvent

enumerator kSCTIMER_InputHighAndMatchEvent

enumerator kSCTIMER_OutputLowOrMatchEvent

enumerator kSCTIMER_OutputRiseOrMatchEvent

enumerator kSCTIMER_OutputFallOrMatchEvent

enumerator kSCTIMER_OutputHighOrMatchEvent

enumerator kSCTIMER_OutputLowEvent

enumerator kSCTIMER_OutputRiseEvent

enumerator kSCTIMER_OutputFallEvent

enumerator kSCTIMER_OutputHighEvent

enumerator kSCTIMER_OutputLowAndMatchEvent

enumerator kSCTIMER_OutputRiseAndMatchEvent

enumerator kSCTIMER_OutputFallAndMatchEvent

enumerator kSCTIMER_OutputHighAndMatchEvent

enum _sctimer_interrupt_enable

List of SCTimer interrupts.

Values:

enumerator kSCTIMER_Event0InterruptEnable

Event 0 interrupt

enumerator kSCTIMER_Event1InterruptEnable

Event 1 interrupt

enumerator kSCTIMER_Event2InterruptEnable

Event 2 interrupt

enumerator kSCTIMER_Event3InterruptEnable

Event 3 interrupt

enumerator kSCTIMER_Event4InterruptEnable

Event 4 interrupt

enumerator kSCTIMER_Event5InterruptEnable

Event 5 interrupt

enumerator kSCTIMER_Event6InterruptEnable

Event 6 interrupt

enumerator kSCTIMER_Event7InterruptEnable

Event 7 interrupt

enumerator kSCTIMER_Event8InterruptEnable

Event 8 interrupt

enumerator kSCTIMER_Event9InterruptEnable

Event 9 interrupt

enumerator kSCTIMER_Event10InterruptEnable

Event 10 interrupt

enumerator kSCTIMER_Event11InterruptEnable

Event 11 interrupt

enumerator kSCTIMER_Event12InterruptEnable

Event 12 interrupt

enum _sctimer_status_flags

List of SCTimer flags.

Values:

enumerator kSCTIMER_Event0Flag

Event 0 Flag

enumerator kSCTIMER_Event1Flag

Event 1 Flag

enumerator kSCTIMER_Event2Flag

Event 2 Flag

enumerator kSCTIMER_Event3Flag

Event 3 Flag

enumerator `kSCTIMER_Event4Flag`
Event 4 Flag

enumerator `kSCTIMER_Event5Flag`
Event 5 Flag

enumerator `kSCTIMER_Event6Flag`
Event 6 Flag

enumerator `kSCTIMER_Event7Flag`
Event 7 Flag

enumerator `kSCTIMER_Event8Flag`
Event 8 Flag

enumerator `kSCTIMER_Event9Flag`
Event 9 Flag

enumerator `kSCTIMER_Event10Flag`
Event 10 Flag

enumerator `kSCTIMER_Event11Flag`
Event 11 Flag

enumerator `kSCTIMER_Event12Flag`
Event 12 Flag

enumerator `kSCTIMER_BusErrorLFlag`
Bus error due to write when L counter was not halted

enumerator `kSCTIMER_BusErrorHFlag`
Bus error due to write when H counter was not halted

typedef enum `_sctimer_pwm_mode` `sctimer_pwm_mode_t`
SCTimer PWM operation modes.

typedef enum `_sctimer_counter` `sctimer_counter_t`
SCTimer counters type.

typedef enum `_sctimer_input` `sctimer_input_t`
List of SCTimer input pins.

typedef enum `_sctimer_out` `sctimer_out_t`
List of SCTimer output pins.

typedef enum `_sctimer_pwm_level_select` `sctimer_pwm_level_select_t`
SCTimer PWM output pulse mode: high-true, low-true or no output.

typedef struct `_sctimer_pwm_signal_param` `sctimer_pwm_signal_param_t`
Options to configure a SCTimer PWM signal.

typedef enum `_sctimer_clock_mode` `sctimer_clock_mode_t`
SCTimer clock mode options.

typedef enum `_sctimer_clock_select` `sctimer_clock_select_t`
SCTimer clock select options.

typedef enum `_sctimer_conflict_resolution` `sctimer_conflict_resolution_t`
SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

`typedef enum _sctimer_event_active_direction` `sctimer_event_active_direction_t`

List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

`typedef enum _sctimer_event` `sctimer_event_t`

List of SCTimer event types.

`typedef void (*sctimer_event_callback_t)(void)`

SCTimer callback typedef.

`typedef enum _sctimer_interrupt_enable` `sctimer_interrupt_enable_t`

List of SCTimer interrupts.

`typedef enum _sctimer_status_flags` `sctimer_status_flags_t`

List of SCTimer flags.

`typedef struct _sctimer_config` `sctimer_config_t`

SCTimer configuration structure.

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

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

`SCT_EV_STATE_STATEMSKn(x)`

`struct _sctimer_pwm_signal_param`

`#include <fsl_sctimer.h>` Options to configure a SCTimer PWM signal.

Public Members

`sctimer_out_t` output

The output pin to use to generate the PWM signal

`sctimer_pwm_level_select_t` level

PWM output active level select.

`uint8_t` dutyCyclePercent

PWM pulse width, value should be between 0 to 100 0 = always inactive signal (0% duty cycle) 100 = always active signal (100% duty cycle).

`struct _sctimer_config`

`#include <fsl_sctimer.h>` SCTimer configuration structure.

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

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

Public Members

`bool` enableCounterUnify

true: SCT operates as a unified 32-bit counter; false: SCT operates as two 16-bit counters. User can use the 16-bit low counter and the 16-bit high counters at the same time; for Hardware limit, user can not use unified 32-bit counter and any 16-bit low/high counter at the same time.

`sctimer_clock_mode_t` clockMode

SCT clock mode value

sctimer_clock_select_t clockSelect

SCT clock select value

bool enableBidirection_l

true: Up-down count mode for the L or unified counter false: Up count mode only for the L or unified counter

bool enableBidirection_h

true: Up-down count mode for the H or unified counter false: Up count mode only for the H or unified counter. This field is used only if the enableCounterUnify is set to false

uint8_t prescale_l

Prescale value to produce the L or unified counter clock

uint8_t prescale_h

Prescale value to produce the H counter clock. This field is used only if the enableCounterUnify is set to false

uint8_t outInitState

Defines the initial output value

uint8_t inputsync

SCT INSYNC value, INSYNC field in the CONFIG register; from bit9 to bit 16. it is used to define synchronization for input N: bit 9 = input 0 bit 10 = input 1 bit 11 = input 2 bit 12 = input 3 All other bits are reserved (bit13 ~bit 16). How User to set the the value for the member inputsync. IE: delay for input0, and input 1, bypasses for input 2 and input 3 MACRO definition in user level. #define INPUTSYNC0 (0U) #define INPUTSYNC1 (1U) #define INPUTSYNC2 (2U) #define INPUTSYNC3 (3U) User Code. sctimerInfo.inputsync = (1 « INPUTSYNC2) | (1 « INPUTSYNC3);

2.79 SDADC: SDADC Module

void SDADC_GetDefaultConfig(*sdadc_config_t* *config)

This function is used to get available predefined configurations for the SDADC initialization.

Parameters

- config – Pointer to the SDADC configuration structure, please refer to *sdadc_config_t* for details.

void SDADC_Init(SDADC_Type *base, const *sdadc_config_t* *config)

This function is used to initialize the SDADC.

Parameters

- base – SDADC peripheral base address.
- config – Pointer to the SDADC configuration structure, please refer to *sdadc_config_t* for details.

void SDADC_Deinit(SDADC_Type *base, const *sdadc_config_t* *config)

This function is used to de-initialize the SDADC.

Parameters

- base – SDADC peripheral base address.
- config – Pointer to the SDADC configuration structure, please refer to *sdadc_config_t* for details.

```
void SDADC_DoInitPowerUp(SDADC_Type *base, sdadc_config_t *config, uint32_t clock)
```

This function is used to power up the SDADC in the initialization state.

Parameters

- base – SDADC peripheral base address.
- config – Pointer to the SDADC configuration structure, please refer to *sdadc_config_t* for details.
- clock – Core clock frequency with Hz.

```
static inline void SDADC_ControlModulatorPowerEnable(SDADC_Type *base,  
                                                    sdadc_channel_number_t number,  
                                                    sdadc_channel_type_t type, bool enable)
```

This function is used to enable or disable SDADC specific channel's P-Side or/and N-Side sigma-delta modulator power.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer *sdadc_channel_number_t* for details.
- type – channel type, refer *sdadc_channel_type_t* for details.
- enable – Decides whether to enable or disable.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC_ControlReferencePowerEnable(SDADC_Type *base, bool enable)
```

This function is used to enable or disable the reference power.

Parameters

- base – SDADC peripheral base address.
- enable – Indicates enable or disable the reference power.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC_ConfigureReferenceMode(SDADC_Type *base, sdadc_ref_mode_t  
                                              referenceMode)
```

This function is used to configure the reference mode.

Note: Setting the reference to fast charge mode is mainly used during startup where fast startup is required, the current consumption in this mode is the largest, so, it is recommended to switch to other modes to minimize current consumption. If the ADC works on the single-end mode, recommend switching to the low-noise mode, if the ADC works on the differential mode, recommend switching to the retain mode.

Parameters

- base – SDADC peripheral base address.
- referenceMode – Reference mode to be configured, see *sdadc_ref_mode_t* for details.

```
static inline void SDADC_ControlLdoPowerEnable(SDADC_Type *base, bool enable)
```

This function is used to enable or disable the LDO power.

Parameters

- `base` – SDADC peripheral base address.
- `enable` – Indicates enable or disable the LDO power.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC__ConfigureLdoDriveCapability(SDADC_Type *base,  
                                                    sdadc_ldo_drive_capability_t capability)
```

This function is used to configure the drive capability.

Parameters

- `base` – SDADC peripheral base address.
- `capability` – SDADC LDO drive capability to be set, see `sdadc_ldo_drive_capability_t` for details.

```
static inline void SDADC__ConfigureChannelMode(SDADC_Type *base, sdadc_channel_number_t  
                                              number, sdadc_channel_mode_t mode)
```

This function is used to configure the channel mode.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `mode` – channel mode, refer `sdadc_channel_mode_t` for details.

```
static inline void SDADC__ControlDacCompensationEnable(SDADC_Type *base,  
                                                       sdadc_channel_number_t number,  
                                                       sdadc_channel_type_t type, bool  
                                                       enable)
```

This function is used to enable or disable the DAC compensation function.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `enable` – Decides whether to enable or disable.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC__ControlModulatorDcLoopEnable(SDADC_Type *base,  
                                                       sdadc_channel_number_t number,  
                                                       sdadc_channel_type_t type, bool  
                                                       enable)
```

This function is used to enable or disable the modulator DC Loop function.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `enable` – Decides whether to enable or disable.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC__ControlDecimatorDcFilterEnable(SDADC_Type *base,  
                                                         sdadc_channel_number_t number,  
                                                         sdadc_channel_type_t type, bool  
                                                         enable)
```

This function is used to enable or disable the decimator DC Filter function.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer *sdadc_channel_number_t* for details.
- type – channel type, refer *sdadc_channel_type_t* for details.
- enable – Decides whether to enable or disable.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC__ControlDecimatorOutputInvertEnable(SDADC_Type *base,  
                                                            sdadc_channel_number_t  
                                                            number, sdadc_channel_type_t  
                                                            type, bool enable)
```

This function is used to enable or disable the decimator output invert.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer *sdadc_channel_number_t* for details.
- type – channel type, refer *sdadc_channel_type_t* for details.
- enable – Decides whether to enable or disable.
 - **true** Enable
 - **false** Disable

```
static inline void SDADC__ConfigureDecimatorVolume(SDADC_Type *base,  
                                                    sdadc_channel_number_t number,  
                                                    sdadc_channel_type_t type,  
                                                    sdadc_volume_control_t volume)
```

This function is used to configure the decimator volume.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer *sdadc_channel_number_t* for details.
- type – channel type, refer *sdadc_channel_type_t* for details.
- volume – Volume level, see *sdadc_volume_control_t* for details.

```
static inline void SDADC__ConfigureDecimatorSampleRate(SDADC_Type *base,  
                                                        sdadc_channel_number_t number,  
                                                        sdadc_channel_type_t type,  
                                                        sdadc_sample_rate_t sampleRate)
```

This function is used to configure the decimator sample rate.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer *sdadc_channel_number_t* for details.
- type – channel type, refer *sdadc_channel_type_t* for details.

- `sampleRate` – Sample rate, see `sdadc_sample_rate_t` for details.

```
static inline void SDADC__ConfigureDitherAmplitude(SDADC_Type *base,  
                                                  sdadc_channel_number_t number, uint8_t  
                                                  ditherAmplitude)
```

This function is used to set the dither amplitude.

In the ADC conversion process, adding dither can improve the ADC dynamic performance, but too large a dither will cause the input signal to overflow, the user needs to set the appropriate dither amplitude according to their own needs.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `ditherAmplitude` – The dither amplitude that will be introduced, the range is from 000b to 111b, 000b means disable the dither.

```
static inline void SDADC__ControlModulatorReset(SDADC_Type *base, sdadc_channel_number_t  
                                                number, sdadc_channel_type_t type, bool reset)
```

This function is used to reset or release reset for the SDADC specific channel's P-Side or N-Side sigma-delta modulator.

Note: Needs to be reset for at least 15us after start-up, and then release the reset.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `reset` – Indicates reset or release reset for the sigma-delta modulator.
 - **true** Reset
 - **false** Release reset

```
static inline void SDADC__ControlDecimatorReset(SDADC_Type *base, sdadc_channel_number_t  
                                                number, sdadc_channel_type_t type, bool reset)
```

This function is used to reset or release reset for the SDADC channeln's P-Side or/and N-Side decimator.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `reset` – Indicates reset or release reset for the decimator.
 - **true** Reset
 - **false** Release reset

```
static inline void SDADC__ConfigureModulatorDcLoopReset(SDADC_Type *base,  
                                                        sdadc_channel_number_t number,  
                                                        sdadc_channel_type_t type, bool  
                                                        reset)
```

This function is used to reset or release reset for the SDADC channeln's P-Side or/and N-Side madulator DC Loop.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer `sdadc_channel_number_t` for details.
- type – channel type, refer `sdadc_channel_type_t` for details.
- reset – Indicates whether reset or release reset for the modulator DC Loop.
 - **true** Reset
 - **false** Release reset

static inline void SDADC_ControlGlobalFifoIntEnable(SDADC_Type *base, bool enable)

This function is used to enable or disable the global FIFO full interrupt.

Parameters

- base – SDADC peripheral base address.
- enable – Indicates whether enable or disable the global FIFO full interrupt.
 - **true** Enable interrupt
 - **false** Disable interrupt

static inline bool SDADC_CheckGlobalFifoInterrupted(SDADC_Type *base)

This function is used to check whether the FIFO full interrupt has occurred.

Parameters

- base – SDADC peripheral base address.

Returns

The FIFO full interrupt status flag.

- **true** The FIFO full interrupt has occurred.
- **false** The FIFO full interrupt has not occurred.

static inline void SDADC_ClearGlobalFifoIntStatusFlag(SDADC_Type *base)

This function is used to clear the FIFO full interrupt status flag.

Parameters

- base – SDADC peripheral base address.

static inline void SDADC_ControlFifoIntEnable(SDADC_Type *base, uint32_t mask, bool enable)

This function is used to enable or disable the FIFO full interrupt.

Parameters

- base – SDADC peripheral base address.
- mask – Mask value to enable or disable interrupt, please refer to `_sdadc_fifo_int_enable` for details.
- enable – Indicates enable or disable the FIFO full interrupt.
 - **true** Enable interrupt
 - **false** Disable interrupt

static inline void SDADC_ControlFifoWatermarkEnable(SDADC_Type *base, uint32_t mask, bool enable)

This function is used to enable or disable the FIFO watermark.

Parameters

- base – SDADC peripheral base address.

- `mask` – Mask value to enable or disable watermark, please refer to `_sdadc_fifo_watermark_enable` for details.
- `enable` – Indicates enable or disable the FIFO watermark.
 - **true** Enable watermark
 - **false** Disable watermark

static inline uint8_t SDADC_GetFifoIntStatusFlags(SDADC_Type *base)

This function is used to get the FIFO full interrupt status flags.

Parameters

- `base` – SDADC peripheral base address.

Returns

Status flags of the FIFO full interrupt.

static inline uint8_t SDADC_GetFifoWatermarkStatusFlags(SDADC_Type *base)

This function is used to get the FIFO watermark status flags.

Parameters

- `base` – SDADC peripheral base address.

Returns

Status flags of the FIFO watermark.

static inline void SDADC_ConfigureFifoWatermark(SDADC_Type *base, *sdadc_channel_number_t* number, *sdadc_channel_type_t* type, *sdadc_watermark_t* waterMark)

This function is used to configure FIFO watermark.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `waterMark` – WaterMark value, see `sdadc_watermark_t` for details.

static inline void SDADC_ControlFifoReadWriteReset(SDADC_Type *base, *sdadc_channel_number_t* number, *sdadc_channel_type_t* type, *sdadc_fifo_reset_operation_t* operation)

This function is used to reset the specific channel side FIFO's read or/and write pointer.

Parameters

- `base` – SDADC peripheral base address.
- `number` – channel number, refer `sdadc_channel_number_t` for details.
- `type` – channel type, refer `sdadc_channel_type_t` for details.
- `operation` – Indicates which reset operation to do, refer `sdadc_fifo_reset_operation_t` for details.

static inline uint8_t SDADC_GetConvChannelFifoAvailableEntries(SDADC_Type *base, *sdadc_channel_number_t* number, *sdadc_channel_type_t* type)

This function is used to get the specific channel side FIFO's available entries.

Note: In the differential mode, the bit stream is converted to 24bit data (FIFO_x_P[23:0]) by the P-Side decimator, the output of N-Side decimator (FIFO_x_N[23:0]) is not valid.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer `sdadc_channel_number_t` for details.
- type – channel type, refer `sdadc_channel_type_t` for details.

Returns

The available entries of the specified FIFO, note that only the lower 5 bits of the returned data are valid.

```
static inline uint32_t SDADC_GetConvChannelFifoRawData(SDADC_Type *base,
                                                       sdadc_channel_number_t number,
                                                       sdadc_channel_type_t type)
```

This function is used to get the specific channel side FIFO's raw data.

Note: In the differential mode, the bit stream is converted to 24bit data (FIFO_x_P[23:0]) by the P-Side decimator, the output of N-Side decimator (FIFO_x_N[23:0]) is not valid. So the type that needs to be passed in differential mode is `kSDADC_Channel_PSide_Type`.

Parameters

- base – SDADC peripheral base address.
- number – channel number, refer `sdadc_channel_number_t` for details.
- type – channel type, refer `sdadc_channel_type_t` for details.

Returns

The raw data of the specified FIFO.

```
void SDADC_CopyConvChannelFifoToBuffer(SDADC_Type *base, sdadc_channel_group *group,
                                       uint8_t count, void *buffer)
```

This function is used to copy specific conversion channels' data from FIFO to buffer.

Note: This function will copy all 16 entries in the specified FIFO.

Parameters

- base – SDADC peripheral base address.
- group – Indicates which group of channels data to obtain.
- count – Indicates how many channels in the specified group.
- buffer – The buffer which stores conversion data.

```
FSL_SDADC_DRIVER_VERSION
SDADC driver version 2.0.1.
```

```
enum _sdadc_fifo_int_enable
```

This enumeration provides the mask for the SDADC channel P-Side and N-Side FIFO full interrupt enable/disable.

Values:

enumerator kSDADC_Channel0_PSide_FifoFullIntEnable

enumerator kSDADC_Channel0_NSide_FifoFullIntEnable

enumerator kSDADC_Channel1_PSide_FifoFullIntEnable

enumerator kSDADC_Channel1_NSide_FifoFullIntEnable

enumerator kSDADC_Channel2_PSide_FifoFullIntEnable

enumerator kSDADC_Channel2_NSide_FifoFullIntEnable

enumerator kSDADC_Channel3_PSide_FifoFullIntEnable

enumerator kSDADC_Channel3_NSide_FifoFullIntEnable

enum _sdadc_fifo_watermark_enable

This enumeration provides the mask for the SDADC channel P-Side and N-Side FIFO watermark enable/disable.

Values:

enumerator kSDADC_Channel0_PSide_FifoWatermarkEnable

enumerator kSDADC_Channel0_NSide_FifoWatermarkEnable

enumerator kSDADC_Channel1_PSide_FifoWatermarkEnable

enumerator kSDADC_Channel1_NSide_FifoWatermarkEnable

enumerator kSDADC_Channel2_PSide_FifoWatermarkEnable

enumerator kSDADC_Channel2_NSide_FifoWatermarkEnable

enumerator kSDADC_Channel3_PSide_FifoWatermarkEnable

enumerator kSDADC_Channel3_NSide_FifoWatermarkEnable

enum _sdadc_fifo_int_status_flag

This enumeration provides the mask for the SDADC channel P-Side and N-Side FIFO full interrupt status flag.

Values:

enumerator kSDADC_Channel0_PSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel0_NSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel1_PSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel1_NSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel2_PSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel2_NSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel3_PSide_FifoFullIntStatusFlag

enumerator kSDADC_Channel3_NSide_FifoFullIntStatusFlag

enum _sdadc_fifo_watermark_status_flag

This enumeration provides the mask for the SDADC channel P-Side and N-Side FIFO watermark status flag.

Values:

enumerator kSDADC_Channel0_PSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel0_NSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel1_PSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel1_NSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel2_PSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel2_NSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel3_PSide_FifoWatermarkStatusFlag

enumerator kSDADC_Channel3_NSide_FifoWatermarkStatusFlag

enum _sdadc_channel_mode

This enumeration provides the selection of the SDADC channel mode.

Values:

enumerator kSDADC_SingleEnd_Mode

Single-end mode.

enumerator kSDADC_Differential_Mode

Differential mode.

enum _sdadc_channel_number

This enumeration provides the selection of the SDADC channel number.

Values:

enumerator kSDADC_Channel0

SDADC channel 0.

enumerator kSDADC_Channel1

SDADC channel 1.

enumerator kSDADC_Channel2

SDADC channel 2.

enumerator kSDADC_Channel3

SDADC channel 3.

enum _sdadc_channel_type

This enumeration provides the selection of the SDADC channel type.

Values:

enumerator kSDADC_Channel_NSide_Type

N-side selected.

enumerator kSDADC_Channel_PSide_Type

P-side selected.

enumerator kSDADC_Channel_NandPSide_Type

N- and P-side selected.

enum _sdadc_decimator_sample_rate

This enumeration provides the selection of the SDADC decimator sample rate.

Values:

enumerator kSDADC_DecimatorSampleRate48kHz

48kHz decimator sample rate.

enumerator kSDADC_DecimatorSampleRate32kHz

32kHz decimator sample rate.

enumerator kSDADC_DecimatorSampleRate16kHz

16kHz decimator sample rate.

enum _sdadc_ldo_drive_capability

This enumeration provides the selection of the SDADC LDO drive capability.

Values:

enumerator kSDADC_LdoLowPower

To drive 1 single-end mode or 1 differential mode SDADC.

enumerator kSDADC_LdoHighPower

To drive more than 1 SDADC

enum _sdadc_ref_mode

This enumeration provides the selection of the SDADC reference mode.

The SDADC reference module has four modes, these modes are controlled via REF_CTL register 'fast_ref_enable' and 'pwr_fast_ref_enable' bitfields. 1.Retain mode: pwr_fast_ref_enable = 0b, fast_ref_enable = 0b. 2.Low noise mode: pwr_fast_ref_enable = 0b, fast_ref_enable = 1b. 3.Low power mode: pwr_fast_ref_enable = 1b, fast_ref_enable = 0b. 4.Fast charge mode: pwr_fast_ref_enable = 1b, fast_ref_enable = 1b.

Values:

enumerator kSDADC_RefRetainMode

Reference in retain mode.

enumerator kSDADC_RefLowNoiseMode

Reference in low noise mode.

enumerator kSDADC_RefLowPowerMode

Reference in low power mode.

enumerator kSDADC_RefFastChargeMode

Reference in fast charge mode.

enum _sdadc_fifo_reset_operation

This enumeration provides the selection of the SDADC FIFO write or/and read operation.

Values:

enumerator kSDADC_FifoWriteReset

FIFO write reset.

enumerator kSDADC_FifoReadReset

FIFO read reset.

enumerator kSDADC_FifoWriteAndReadReset

FIFO write and read reset.

typedef enum _sdadc_channel_mode sdadc_channel_mode_t

This enumeration provides the selection of the SDADC channel mode.

typedef enum _sdadc_channel_number sdadc_channel_number_t

This enumeration provides the selection of the SDADC channel number.

typedef enum _sdadc_channel_type sdadc_channel_type_t

This enumeration provides the selection of the SDADC channel type.

typedef enum *_sdadc_decimator_sample_rate* sdadc_decimator_sample_rate_t

This enumeration provides the selection of the SDADC decimator sample rate.

typedef enum *_sdadc_ldo_drive_capability* sdadc_ldo_drive_capability_t

This enumeration provides the selection of the SDADC LDO drive capability.

typedef enum *_sdadc_ref_mode* sdadc_ref_mode_t

This enumeration provides the selection of the SDADC reference mode.

The SDADC reference module has four modes, these modes are controlled via REF_CTL register 'fast_ref_enable' and 'pwr_fast_ref_enable' bitfields. 1.Retain mode: pwr_fast_ref_enable = 0b, fast_ref_enable = 0b. 2.Low noise mode: pwr_fast_ref_enable = 0b, fast_ref_enable = 1b. 3.Low power mode: pwr_fast_ref_enable = 1b, fast_ref_enable = 0b. 4.Fast charge mode: pwr_fast_ref_enable = 1b, fast_ref_enable = 1b.

typedef enum *_sdadc_fifo_reset_operation* sdadc_fifo_reset_operation_t

This enumeration provides the selection of the SDADC FIFO write or/and read operation.

typedef struct *_sdadc_volume* sdadc_volume_control_t

This structure is used to configure the decimator volume (gain).

Note: The gain setting is not applicable for the channel N-Side when executing the differential mode. For the specific gain setting value please refer to the reference manual.

typedef struct *_sdadc_sample_rate* sdadc_sample_rate_t

This structure is used to configure the decimator sample rate.

typedef struct *_sdadc_watermark* sdadc_watermark_t

This structure is used to configure the FIFO watermark.

Note: In the differential mode, the bitstream is converted to 24bit data (FIFO_x_P[23:0]) by P-Side decimator, the output of N-Side decimator (FIFO_x_N[23:0]) is not valid.

typedef struct *_sdadc_channel_config* sdadc_channel_config_t

This structure is used to configure the SDADC channels.

typedef struct *_sdadc_config* sdadc_config_t

This structure is used to configure the SDADC module.

typedef struct *_sdadc_channel_group* sdadc_channel_group

This structure is used to construct channel groups.

SDADC_DECIMATOR_VOL_CTRL_P_MASK(offset)

Macros are used to configure decimator volume.

SDADC_DECIMATOR_VOL_CTRL_P_SHIFT(offset)

SDADC_DECIMATOR_VOL_CTRL_P(volume, offset)

SDADC_DECIMATOR_VOL_CTRL_N_MASK(offset)

SDADC_DECIMATOR_VOL_CTRL_N_SHIFT(offset)

SDADC_DECIMATOR_VOL_CTRL_N(volume, offset)

SDADC_DECIMATOR_SET_SPEED_P_MASK(offset)

Macros are used to configure decimator sample rate.

SDADC_DECIMATOR_SET_SPEED_P_SHIFT(offset)

SDADC_DECIMATOR_SET_SPEED_P(rate, offset)

SDADC_DECIMATOR_SET_SPEED_N_MASK(offset)

SDADC_DECIMATOR_SET_SPEED_N_SHIFT(offset)

SDADC_DECIMATOR_SET_SPEED_N(rate, offset)

SDADC_ADC_CTL_2_SET_DITHER_MASK(offset)

Macros are used to configure the dither amplitude.

SDADC_ADC_CTL_2_SET_DITHER_SHIFT(offset)

SDADC_ADC_CTL_2_SET_DITHER(val, offset)

SDADC_FIFO_WATERMARK_CTL_P_MASK(offset)

Macros are used to configure FIFO watermark.

SDADC_FIFO_WATERMARK_CTL_P_SHIFT(offset)

SDADC_FIFO_WATERMARK_CTL_P(watermark, offset)

SDADC_FIFO_WATERMARK_CTL_N_MASK(offset)

SDADC_FIFO_WATERMARK_CTL_N_SHIFT(offset)

SDADC_FIFO_WATERMARK_CTL_N(watermark, offset)

SDADC_FIFO_WATERMARK_STATUS_MASK

Macros are used for FIFO operations.

SDADC_FIFO_WATERMARK_STATUS_SHIFT

SDADC_FIFO_FULL_INT_STATUS_MASK

SDADC_FIFO_FULL_INT_STATUS_SHIFT

SDADC_FIFO_MASK

SDADC_FIFO_SHIFT

SDADC_FIFO_ENTRIES_AVAIL_MASK

SDADC_FIFO_DEPTH

SDADC_FIFO_WIDTH

struct _sdadc_volume

#include <fsl_sdadc.h> This structure is used to configure the decimator volume (gain).

Note: The gain setting is not applicable for the channel N-Side when executing the differential mode. For the specific gain setting value please refer to the reference manual.

Public Members

uint8_t pSideVolume

Sets the gain for the P-Side decimator.

uint8_t nSideVolume

Sets the gain for the N-Side decimator.

struct _sdadc_sample_rate

#include <fsl_sdadc.h> This structure is used to configure the decimator sample rate.

Public Members

sdadc_decimator_sample_rate_t pSideSampleRate

Sets the P-Side decimator sample rate.

sdadc_decimator_sample_rate_t nSideSampleRate

Sets the N-Side decimator sample rate.

struct *_sdadc_watermark*

#include <fsl_sdadc.h> This structure is used to configure the FIFO watermark.

Note: In the differential mode, the bitstream is converted to 24bit data (FIFO_x_P[23:0]) by P-Side decimator, the output of N-Side decimator (FIFO_x_N[23:0]) is not valid.

Public Members

uint8_t pSideWatermark

Sets the channel N-Side FIFO watermark.

uint8_t nSideWatermark

Sets the channel P-Side FIFO watermark.

struct *_sdadc_channel_config*

#include <fsl_sdadc.h> This structure is used to configure the SDADC channels.

Public Members

sdadc_channel_mode_t mode

Sets channel mode.

sdadc_channel_number_t number

Sets channel number.

sdadc_channel_type_t type

Sets channel type.

sdadc_volume_control_t volume

Sets N- and P-side decimator volume.

sdadc_sample_rate_t samplerate

Sets N- and P-side decimator samplerate.

sdadc_watermark_t watermark

Sets N- and P-side FIFO watermark.

bool enableDacCompensation

Decides whether to enable the compensation feature for the ADCp[3:0] or/and ADCn[3:0] in the single-end mode, is used to avoid large data-dependent ripple on LDO output which will impact the ADC performance.

bool enableDCLoop

In some cases of the single-end mode, the microphone output is connected directly to ADC input without the coupling capacitor, DC Loop is activated to regulate input common-mode voltage of the ADCp[3:0] or/and ADCn[3:0]. In the single-end mode, there is the possibility to connect MEMS or JFET microphone directly to the input (DC-coupled). In this configuration, DC Loop mode needs to be activated to establish the correct common mode input voltage level at the input pin. The DC Loop function should disabled in the differential mode.

bool enableDcFilter

Decides whether to enable the decimator DC Filter to remove DC components.

bool enablePolarityInvert

Decides whether to enable the polarity invert function, for example: if the input to ADC is a pure sinus signal, then if the polarity invert is enabled, the decimation output will be a sinus signal 180 out of phase with the input.

struct __sdadc_config

#include <fsl_sdadc.h> This structure is used to configure the SDADC module.

Public Members

uint8_t channelCount

Indicates how many channels to execute the conversion.

sdadc_channel_config_t *channelConfig

SDADC channels configuration.

struct __sdadc_channel_group

#include <fsl_sdadc.h> This structure is used to construct channel groups.

Public Members

sdadc_channel_number_t number

Channel number.

sdadc_channel_type_t type

Channel type.

2.80 SEMA42: Hardware Semaphores Driver

FSL_SEMA42_DRIVER_VERSION

SEMA42 driver version.

SEMA42 status return codes.

Values:

enumerator kStatus_SEMA42_Busy

SEMA42 gate has been locked by other processor.

enumerator kStatus_SEMA42_Reseting

SEMA42 gate resetting is ongoing.

enum __sema42_gate_status

SEMA42 gate lock status.

Values:

enumerator kSEMA42_Unlocked

The gate is unlocked.

enumerator kSEMA42_LockedByProc0

The gate is locked by processor 0.

enumerator kSEMA42_LockedByProc1

The gate is locked by processor 1.

enumerator kSEMA42_LockedByProc2

The gate is locked by processor 2.

enumerator kSEMA42_LockedByProc3

The gate is locked by processor 3.

enumerator kSEMA42_LockedByProc4

The gate is locked by processor 4.

enumerator kSEMA42_LockedByProc5

The gate is locked by processor 5.

enumerator kSEMA42_LockedByProc6

The gate is locked by processor 6.

enumerator kSEMA42_LockedByProc7

The gate is locked by processor 7.

enumerator kSEMA42_LockedByProc8

The gate is locked by processor 8.

enumerator kSEMA42_LockedByProc9

The gate is locked by processor 9.

enumerator kSEMA42_LockedByProc10

The gate is locked by processor 10.

enumerator kSEMA42_LockedByProc11

The gate is locked by processor 11.

enumerator kSEMA42_LockedByProc12

The gate is locked by processor 12.

enumerator kSEMA42_LockedByProc13

The gate is locked by processor 13.

enumerator kSEMA42_LockedByProc14

The gate is locked by processor 14.

typedef enum *_sema42_gate_status* sema42_gate_status_t
SEMA42 gate lock status.

void SEMA42_Init(SEMA42_Type *base)

Initializes the SEMA42 module.

This function initializes the SEMA42 module. It only enables the clock but does not reset the gates because the module might be used by other processors at the same time. To reset the gates, call either SEMA42_ResetGate or SEMA42_ResetAllGates function.

Parameters

- base – SEMA42 peripheral base address.

void SEMA42_Deinit(SEMA42_Type *base)

De-initializes the SEMA42 module.

This function de-initializes the SEMA42 module. It only disables the clock.

Parameters

- base – SEMA42 peripheral base address.

status_t SEMA42_TryLock(SEMA42_Type *base, uint8_t gateNum, uint8_t procNum)

Tries to lock the SEMA42 gate.

This function tries to lock the specific SEMA42 gate. If the gate has been locked by another processor, this function returns an error code.

Parameters

- base – SEMA42 peripheral base address.
- gateNum – Gate number to lock.
- procNum – Current processor number.

Return values

- kStatus_Success – Lock the sema42 gate successfully.
- kStatus_SEMA42_Busy – Sema42 gate has been locked by another processor.

status_t SEMA42_Lock(SEMA42_Type *base, uint8_t gateNum, uint8_t procNum)

Locks the SEMA42 gate.

This function locks the specific SEMA42 gate. If the gate has been locked by other processors, this function waits until it is unlocked and then lock it.

If SEMA42_BUSY_POLL_COUNT is defined and non-zero, the function will timeout after the specified number of polling iterations and return kStatus_Timeout.

Parameters

- base – SEMA42 peripheral base address.
- gateNum – Gate number to lock.
- procNum – Current processor number.

Return values

- kStatus_Success – The gate was successfully locked.
- kStatus_Timeout – Timeout occurred while waiting for the gate to be unlocked.

Returns

status_t

static inline void SEMA42_Unlock(SEMA42_Type *base, uint8_t gateNum)

Unlocks the SEMA42 gate.

This function unlocks the specific SEMA42 gate. It only writes unlock value to the SEMA42 gate register. However, it does not check whether the SEMA42 gate is locked by the current processor or not. As a result, if the SEMA42 gate is not locked by the current processor, this function has no effect.

Parameters

- base – SEMA42 peripheral base address.
- gateNum – Gate number to unlock.

static inline *sema42_gate_status_t* SEMA42_GetGateStatus(SEMA42_Type *base, uint8_t gateNum)

Gets the status of the SEMA42 gate.

This function checks the lock status of a specific SEMA42 gate.

Parameters

- base – SEMA42 peripheral base address.

- gateNum – Gate number.

Returns

status Current status.

status_t SEMA42_ResetGate(SEMA42_Type *base, uint8_t gateNum)

Resets the SEMA42 gate to an unlocked status.

This function resets a SEMA42 gate to an unlocked status.

Parameters

- base – SEMA42 peripheral base address.
- gateNum – Gate number.

Return values

- kStatus_Success – SEMA42 gate is reset successfully.
- kStatus_SEMA42_Reseting – Some other reset process is ongoing.

static inline *status_t* SEMA42_ResetAllGates(SEMA42_Type *base)

Resets all SEMA42 gates to an unlocked status.

This function resets all SEMA42 gate to an unlocked status.

Parameters

- base – SEMA42 peripheral base address.

Return values

- kStatus_Success – SEMA42 is reset successfully.
- kStatus_SEMA42_Reseting – Some other reset process is ongoing.

SEMA42_GATE_NUM_RESET_ALL

The number to reset all SEMA42 gates.

SEMA42_GATEn(base, n)

SEMA42 gate n register address.

The SEMA42 gates are sorted in the order 3, 2, 1, 0, 7, 6, 5, 4, ... not in the order 0, 1, 2, 3, 4, 5, 6, 7, ... The macro SEMA42_GATEn gets the SEMA42 gate based on the gate index.

The input gate index is XOR'ed with 3U: $0 \wedge 3 = 3$ $1 \wedge 3 = 2$ $2 \wedge 3 = 1$ $3 \wedge 3 = 0$ $4 \wedge 3 = 7$ $5 \wedge 3 = 6$ $6 \wedge 3 = 5$ $7 \wedge 3 = 4$...

SEMA42_BUSY_POLL_COUNT

Maximum polling iterations for SEMA42 waiting loops.

This parameter defines the maximum number of iterations for any polling loop in the SEMA42 driver code before timing out and returning an error.

It applies to all waiting loops in SEMA42 driver, such as waiting for a gate to be unlocked, waiting for a reset to complete, or waiting for a resource to become available.

This is a count of loop iterations, not a time-based value.

If defined as 0, polling loops will continue indefinitely until their exit condition is met, which could potentially cause the system to hang if hardware doesn't respond or if a resource is never released.

2.81 Soc_mipi_dsi

FSL_SOC_MIPI_DSI_DRIVER_VERSION

Driver version.

DSI_DPHY_PLL_VCO_MAX

DSI_DPHY_PLL_VCO_MIN

FSL_COMPONENT_ID

2.82 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 start/stop 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

2.83 TRNG: True Random Number Generator

FSL_TRNG_DRIVER_VERSION

TRNG driver version 2.0.18.

Current version: 2.0.18

Change log:

- version 2.0.18
 - TRNG health checks now done in software on RT5xx and RT6xx.
- version 2.0.17
 - Added support for RT700.
- version 2.0.16
 - Added support for Dual oscillator mode.
- version 2.0.15
 - Changed TRNG_USER_CONFIG_DEFAULT_XXX values according to latest recommended by design team.
- version 2.0.14
 - add support for RW610 and RW612
- version 2.0.13
 - After deepsleep it might return error, added clearing bits in TRNG_GetRandomData() and generating new entropy.
 - Modified reloading entropy in TRNG_GetRandomData(), for some data length it doesn't reloading entropy correctly.
- version 2.0.12
 - For KW34A4_SERIES, KW35A4_SERIES, KW36A4_SERIES set TRNG_USER_CONFIG_DEFAULT_OSC_DIV to kTRNG_RingOscDiv8.
- version 2.0.11
 - Add clearing pending errors in TRNG_Init().
- version 2.0.10
 - Fixed doxygen issues.

- version 2.0.9
 - Fix HIS_CCM metrics issues.
- version 2.0.8
 - For K32L2A41A_SERIES set TRNG_USER_CONFIG_DEFAULT_OSC_DIV to kTRNG_RingOscDiv4.
- version 2.0.7
 - Fix MISRA 2004 issue rule 12.5.
- version 2.0.6
 - For KW35Z4_SERIES set TRNG_USER_CONFIG_DEFAULT_OSC_DIV to kTRNG_RingOscDiv8.
- version 2.0.5
 - Add possibility to define default TRNG configuration by device specific preprocessor macros for FRQMIN, FRQMAX and OSCDIV.
- version 2.0.4
 - Fix MISRA-2012 issues.
- Version 2.0.3
 - update TRNG_Init to restart entropy generation
- Version 2.0.2
 - fix MISRA issues
- Version 2.0.1
 - add support for KL8x and KL28Z
 - update default OSCDIV for K81 to divide by 2

enum _trng_sample_mode

TRNG sample mode. Used by trng_config_t.

Values:

enumerator kTRNG_SampleModeVonNeumann

Use von Neumann data in both Entropy shifter and Statistical Checker.

enumerator kTRNG_SampleModeRaw

Use raw data into both Entropy shifter and Statistical Checker.

enumerator kTRNG_SampleModeVonNeumannRaw

Use von Neumann data in Entropy shifter. Use raw data into Statistical Checker.

enum _trng_clock_mode

TRNG clock mode. Used by trng_config_t.

Values:

enumerator kTRNG_ClockModeRingOscillator

Ring oscillator is used to operate the TRNG (default).

enumerator kTRNG_ClockModeSystem

System clock is used to operate the TRNG. This is for test use only, and indeterminate results may occur.

enum *trng_ring_osc_div*

TRNG ring oscillator divide. Used by *trng_config_t*.

Values:

enumerator *kTRNG_RingOscDiv0*

Ring oscillator with no divide

enumerator *kTRNG_RingOscDiv2*

Ring oscillator divided-by-2.

enumerator *kTRNG_RingOscDiv4*

Ring oscillator divided-by-4.

enumerator *kTRNG_RingOscDiv8*

Ring oscillator divided-by-8.

enum *trng_oscillator_mode_t*

TRNG oscillator mode . Used by *trng_config_t*.

Values:

enumerator *kTRNG_SingleOscillatorModeOsc1*

Single oscillator mode, using OSC1 (default)

enumerator *kTRNG_DualOscillatorMode*

Dual oscillator mode

enumerator *kTRNG_SingleOscillatorModeOsc2*

Single oscillator mode, using OSC2

typedef enum *trng_sample_mode* *trng_sample_mode_t*

TRNG sample mode. Used by *trng_config_t*.

typedef enum *trng_clock_mode* *trng_clock_mode_t*

TRNG clock mode. Used by *trng_config_t*.

typedef enum *trng_ring_osc_div* *trng_ring_osc_div_t*

TRNG ring oscillator divide. Used by *trng_config_t*.

typedef enum *trng_oscillator_mode_t* *trng_oscillator_mode_t*

TRNG oscillator mode . Used by *trng_config_t*.

typedef struct *trng_statistical_check_limit* *trng_statistical_check_limit_t*

Data structure for definition of statistical check limits. Used by *trng_config_t*.

typedef struct *trng_user_config* *trng_config_t*

Data structure for the TRNG initialization.

This structure initializes the TRNG by calling the *TRNG_Init()* function. It contains all TRNG configurations.

status_t *TRNG_GetDefaultConfig(trng_config_t *userConfig)*

Initializes the user configuration structure to default values.

This function initializes the configuration structure to default values. The default values are platform dependent.

Parameters

- *userConfig* – User configuration structure.

Returns

If successful, returns the *kStatus_TRNG_Success*. Otherwise, it returns an error.

status_t TRNG_Init(TRNG_Type *base, const *trng_config_t* *userConfig)

Initializes the TRNG.

This function initializes the TRNG. When called, the TRNG entropy generation starts immediately.

Parameters

- base – TRNG base address
- userConfig – Pointer to the initialization configuration structure.

Returns

If successful, returns the *kStatus_TRNG_Success*. Otherwise, it returns an error.

void TRNG_Deinit(TRNG_Type *base)

Shuts down the TRNG.

This function shuts down the TRNG.

Parameters

- base – TRNG base address.

status_t TRNG_GetRandomData(TRNG_Type *base, void *data, *size_t* dataSize)

Gets random data.

This function gets random data from the TRNG.

Parameters

- base – TRNG base address.
- data – Pointer address used to store random data.
- dataSize – Size of the buffer pointed by the data parameter.

Returns

random data

struct *_trng_statistical_check_limit*

#include <fsl_trng.h> Data structure for definition of statistical check limits. Used by *trng_config_t*.

Public Members

uint32_t maximum

Maximum limit.

int32_t minimum

Minimum limit.

struct *_trng_user_config*

#include <fsl_trng.h> Data structure for the TRNG initialization.

This structure initializes the TRNG by calling the *TRNG_Init()* function. It contains all TRNG configurations.

Public Members

bool lock

Disable programmability of TRNG registers.

trng_clock_mode_t clockMode

Clock mode used to operate TRNG.

trng_ring_osc_div_t ringOscDiv

Ring oscillator divide used by TRNG.

trng_sample_mode_t sampleMode

Sample mode of the TRNG ring oscillator.

trng_oscillator_mode_t oscillatorMode

TRNG oscillator mode .

trng_ring_osc_div_t ringOsc2Div

Divider used for Ring oscillator 2.

uint16_t entropyDelay

Entropy Delay. Defines the length (in system clocks) of each Entropy sample taken.

uint16_t sampleSize

Sample Size. Defines the total number of Entropy samples that will be taken during Entropy generation.

uint16_t sparseBitLimit

Sparse Bit Limit which defines the maximum number of consecutive samples that may be discarded before an error is generated. This limit is used only for during von Neumann sampling (enabled by `TRNG_HAL_SetSampleMode()`). Samples are discarded if two consecutive raw samples are both 0 or both 1. If this discarding occurs for a long period of time, it indicates that there is insufficient Entropy.

uint8_t retryCount

Retry count. It defines the number of times a statistical check may fails during the TRNG Entropy Generation before generating an error.

uint8_t longRunMaxLimit

Largest allowable number of consecutive samples of all 1, or all 0, that is allowed during the Entropy generation.

trng_statistical_check_limit_t monobitLimit

Maximum and minimum limits for statistical check of number of ones/zero detected during entropy generation.

trng_statistical_check_limit_t runBit1Limit

Maximum and minimum limits for statistical check of number of runs of length 1 detected during entropy generation.

trng_statistical_check_limit_t runBit2Limit

Maximum and minimum limits for statistical check of number of runs of length 2 detected during entropy generation.

trng_statistical_check_limit_t runBit3Limit

Maximum and minimum limits for statistical check of number of runs of length 3 detected during entropy generation.

trng_statistical_check_limit_t runBit4Limit

Maximum and minimum limits for statistical check of number of runs of length 4 detected during entropy generation.

trng_statistical_check_limit_t runBit5Limit

Maximum and minimum limits for statistical check of number of runs of length 5 detected during entropy generation.

trng_statistical_check_limit_t runBit6PlusLimit

Maximum and minimum limits for statistical check of number of runs of length 6 or more detected during entropy generation.

trng_statistical_check_limit_t pokerLimit

Maximum and minimum limits for statistical check of “Poker Test”.

trng_statistical_check_limit_t frequencyCountLimit

Maximum and minimum limits for statistical check of entropy sample frequency count.

2.84 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 manual tuning.

Deprecated:

Do not use this function. It has been superseded by `USDHC_SetTuningDelay`

Parameters

- `base` – USDHC peripheral base address.
- `delay` – setting configuration

Return values

- `kStatus_Fail` – config the delay setting fail

- kStatus_Success – config the delay setting success

static inline void USDHC_SetStandardTuningCounter(USDHC_Type *base, uint8_t counter)

set tuning counter tuning.

Parameters

- base – USDHC peripheral base address.
- counter – tuning counter

Return values

- kStatus_Fail – config the delay setting fail
- kStatus_Success – config the delay setting success

void USDHC_EnableStandardTuning(USDHC_Type *base, uint32_t tuningStartTap, uint32_t step, bool enable)

The enable standard tuning function. The standard tuning window and tuning counter using the default config tuning cmd is sent by the software, user need to check whether the tuning result can be used for SDR50, SDR104, and HS200 mode tuning.

Parameters

- base – USDHC peripheral base address.
- tuningStartTap – start tap
- step – tuning step
- enable – enable/disable flag

static inline uint32_t USDHC_GetExecuteStdTuningStatus(USDHC_Type *base)

Gets execute STD tuning status.

Parameters

- base – USDHC peripheral base address.

static inline uint32_t USDHC_CheckStdTuningResult(USDHC_Type *base)

Checks STD tuning result.

Parameters

- base – USDHC peripheral base address.

static inline uint32_t USDHC_CheckTuningError(USDHC_Type *base)

Checks tuning error.

Parameters

- base – USDHC peripheral base address.

void USDHC_EnableDDRMode(USDHC_Type *base, bool enable, uint32_t nibblePos)

The enable/disable DDR mode.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag
- nibblePos – nibble position

static inline void USDHC_EnableHS400Mode(USDHC_Type *base, bool enable)

The enable/disable HS400 mode.

Parameters

- base – USDHC peripheral base address.

- enable – enable/disable flag

static inline void USDHC_ResetStrobeDLL(USDHC_Type *base)

Resets the strobe DLL.

Parameters

- base – USDHC peripheral base address.

static inline void USDHC_EnableStrobeDLL(USDHC_Type *base, bool enable)

Enables/disables the strobe DLL.

Parameters

- base – USDHC peripheral base address.
- enable – enable/disable flag

void USDHC_ConfigStrobeDLL(USDHC_Type *base, uint32_t delayTarget, uint32_t updateInterval)

Configures the strobe DLL delay target and update interval.

Parameters

- base – USDHC peripheral base address.
- delayTarget – delay target
- updateInterval – update interval

static inline void USDHC_SetStrobeDllOverride(USDHC_Type *base, uint32_t delayTaps)

Enables manual override for slave delay chain using **STROBE_SLV_OVERRIDE_VAL**.

Parameters

- base – USDHC peripheral base address.
- delayTaps – Valid delay taps range from 1 - 128 taps. A value of 0 selects tap 1, and a value of 0x7F selects tap 128.

static inline uint32_t USDHC_GetStrobeDLLStatus(USDHC_Type *base)

Gets the strobe DLL status.

Parameters

- base – USDHC peripheral base address.

void USDHC_SetDataConfig(USDHC_Type *base, *usdhc_transfer_direction_t* dataDirection, uint32_t blockCount, uint32_t blockSize)

USDHC data configuration.

Parameters

- base – USDHC peripheral base address.
- dataDirection – Data direction, tx or rx.
- blockCount – Data block count.
- blockSize – Data block size.

void USDHC_TransferCreateHandle(USDHC_Type *base, *usdhc_handle_t* *handle, const *usdhc_transfer_callback_t* *callback, void *userData)

Creates the USDHC handle.

Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle pointer.

- callback – Structure pointer to contain all callback functions.
- userData – Callback function parameter.

status_t USDHC_TransferNonBlocking(USDHC_Type *base, *usdhc_handle_t* *handle, *usdhc_adma_config_t* *dmaConfig, *usdhc_transfer_t* *transfer)

Transfers the command/data using an interrupt and an asynchronous method.

This function sends a command and data and returns immediately. It doesn't wait for the transfer to complete or to encounter an error. The application must not call this API in multiple threads at the same time. Because of that this API doesn't support the re-entry mechanism.

Note: Call API USDHC_TransferCreateHandle when calling this API.

Parameters

- base – USDHC peripheral base address.
- handle – USDHC handle.
- dmaConfig – ADMA configuration.
- transfer – Transfer content.

Return values

- kStatus_InvalidArgument – Argument is invalid.
- kStatus_USDHC_BusyTransferring – Busy transferring.
- kStatus_USDHC_PrepareAdmaDescriptorFailed – Prepare ADMA descriptor failed.
- kStatus_Success – Operate successfully.

status_t USDHC_TransferBlocking(USDHC_Type *base, *usdhc_adma_config_t* *dmaConfig, *usdhc_transfer_t* *transfer)

Transfers the command/data using a blocking method.

This function waits until the command response/data is received or the USDHC encounters an error by polling the status flag.

The application must not call this API in multiple threads at the same time. Because this API doesn't support the re-entry mechanism.

Note: There is no need to call API USDHC_TransferCreateHandle when calling this API.

Parameters

- base – USDHC peripheral base address.
- dmaConfig – adma configuration
- transfer – Transfer content.

Return values

- kStatus_InvalidArgument – Argument is invalid.
- kStatus_USDHC_PrepareAdmaDescriptorFailed – Prepare ADMA descriptor failed.

- `kStatus_USDHC_SendCommandFailed` – Send command failed.
- `kStatus_USDHC_TransferDataFailed` – Transfer data failed.
- `kStatus_Success` – Operate successfully.

`void USDHC_TransferHandleIRQ(USDHC_Type *base, usdhc_handle_t *handle)`
IRQ handler for the USDHC.

This function deals with the IRQs on the given host controller.

Parameters

- `base` – USDHC peripheral base address.
- `handle` – USDHC handle.

`FSL_USDHC_DRIVER_VERSION`

Driver version 2.8.5.

`Enum_usdhc_status`. USDHC status.

Values:

enumerator `kStatus_USDHC_BusyTransferring`
Transfer is on-going.

enumerator `kStatus_USDHC_PrepareAdmaDescriptorFailed`
Set DMA descriptor failed.

enumerator `kStatus_USDHC_SendCommandFailed`
Send command failed.

enumerator `kStatus_USDHC_TransferDataFailed`
Transfer data failed.

enumerator `kStatus_USDHC_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 filed in ADMA1's descriptor.

USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK

The mask for LENGTH field in ADMA1's descriptor.

USDHC_ADMA1_DESCRIPTOR_MAX_LENGTH_PER_ENTRY

The maximum value of LENGTH filed in ADMA1's descriptor. Since the max transfer size ADMA1 support is 65535 which is indivisible by 4096, so to make sure a large data load transfer (>64KB) continuously (require the data address be always align with 4096), software will set the maximum data length for ADMA1 to (64 - 4)KB.

USDHC_ADMA2_DESCRIPTOR_LENGTH_SHIFT

The bit shift for LENGTH field in ADMA2's descriptor.

Address field	Length	Reserved	Attribute					
63 32	31 16	15 06	05	04	03	02	01	00
32-bit address	16-bit length	0000000000	Act2	Act1	0	Int	End	Valid

Act2	Act1	Comment	Operation
0	0	No op	Don't care
0	1	Reserved	Read this line and go to next one
1	0	Transfer data	Transfer data with address and length set in this descriptor line
1	1	Link descriptor	Link to another descriptor

USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK

The bit mask for LENGTH field in ADMA2's descriptor.

USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY

The maximum value of LENGTH field in ADMA2's descriptor.

struct __usdhc_adma2_descriptor

#include <fsl_usdhc.h> Defines the ADMA2 descriptor structure.

Public Members

uint32_t attribute

The control and status field.

uint32_t address

The address field.

struct __usdhc_capability

#include <fsl_usdhc.h> USDHC capability information.

Defines a structure to save the capability information of USDHC.

Public Members

uint32_t sdVersion

Support SD card/sdio version.

uint32_t mmcVersion

Support EMMC card version.

uint32_t maxBlockLength

Maximum block length united as byte.

uint32_t maxBlockCount

Maximum block count can be set one time.

uint32_t flags

Capability flags to indicate the support information(__usdhc_capability_flag).

struct __usdhc_boot_config

#include <fsl_usdhc.h> Data structure to configure the MMC boot feature.

Public Members

uint32_t ackTimeoutCount

Timeout value for the boot ACK. The available range is 0 ~ 15.

usdhc_boot_mode_t bootMode

Boot mode selection.

uint32_t blockCount

Stop at block gap value of automatic mode. Available range is 0 ~ 65535.

size_t blockSize

Block size.

bool enableBootAck

Enable or disable boot ACK.

bool enableAutoStopAtBlockGap

Enable or disable auto stop at block gap function in boot period.

struct __usdhc_config

#include <fsl_usdhc.h> Data structure to initialize the USDHC.

Public Members

uint32_t dataTimeout

Data timeout value.

usdhc_endian_mode_t endianMode

Endian mode.

uint8_t readWatermarkLevel

Watermark level for DMA read operation. Available range is 1 ~ 128.

uint8_t writeWatermarkLevel

Watermark level for DMA write operation. Available range is 1 ~ 128.

struct __usdhc_command

#include <fsl_usdhc.h> Card command descriptor.

Defines card command-related attribute.

Public Members

uint32_t index

Command index.

uint32_t argument

Command argument.

usdhc_card_command_type_t type

Command type.

usdhc_card_response_type_t responseType

Command response type.

uint32_t response[4U]

Response for this command.

uint32_t responseErrorFlags

Response error flag, which need to check the command response.

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> USDMHC 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.

2.85 UTICK: MictoTick Timer Driver

`void UTICK_Init(UTICK_Type *base)`

Initializes an UTICK by turning its bus clock on.

`void UTICK_Deinit(UTICK_Type *base)`

Deinitializes a UTICK instance.

This function shuts down Utick bus clock

Parameters

- `base` – UTICK peripheral base address.

`uint32_t UTICK_GetStatusFlags(UTICK_Type *base)`

Get Status Flags.

This returns the status flag

Parameters

- `base` – UTICK peripheral base address.

Returns

status register value

`void UTICK_ClearStatusFlags(UTICK_Type *base)`

Clear Status Interrupt Flags.

This clears intr status flag

Parameters

- `base` – UTICK peripheral base address.

Returns

none

`void UTICK_SetTick(UTICK_Type *base, utick_mode_t mode, uint32_t count, utick_callback_t cb)`

Starts UTICK.

This function starts a repeat/onetime countdown with an optional callback

Parameters

- `base` – UTICK peripheral base address.
- `mode` – UTICK timer mode (ie `kUTICK_onetime` or `kUTICK_repeat`)
- `count` – UTICK timer mode (ie `kUTICK_onetime` or `kUTICK_repeat`)
- `cb` – UTICK callback (can be left as `NULL` if none, otherwise should be a `void func(void)`)

Returns

none

`void UTICK_HandleIRQ(UTICK_Type *base, utick_callback_t cb)`

UTICK Interrupt Service Handler.

This function handles the interrupt and refers to the callback array in the driver to callback user (as per request in `UTICK_SetTick()`). if no user callback is scheduled, the interrupt will simply be cleared.

Parameters

- `base` – UTICK peripheral base address.

- `cb` – callback scheduled for this instance of UTICK

Returns

none

FSL_UTICK_DRIVER_VERSION

UTICK driver version 2.0.5.

enum `_utick_mode`

UTICK timer operational mode.

Values:

enumerator `kUTICK_Onetime`

Trigger once

enumerator `kUTICK_Repeat`

Trigger repeatedly

typedef enum `_utick_mode` `utick_mode_t`

UTICK timer operational mode.

typedef void (`*utick_callback_t`)(void)

UTICK callback function.

2.86 WWDT: Windowed Watchdog Timer Driver

void WWDT_GetDefaultConfig(`wwdt_config_t` *config)

Initializes WWDT configure structure.

This function initializes the WWDT configure structure to default value. The default value are:

```
config->enableWwdt = true;
config->enableWatchdogReset = false;
config->enableWatchdogProtect = false;
config->enableLockOscillator = false;
config->windowValue = 0xFFFFFfU;
config->timeoutValue = 0xFFFFFfU;
config->warningValue = 0;
```

See also:

`wwdt_config_t`

Parameters

- `config` – Pointer to WWDT config structure.

void WWDT_Init(WWDT_Type *base, const `wwdt_config_t` *config)

Initializes the WWDT.

This function initializes the WWDT. When called, the WWDT runs according to the configuration.

Example:

```
wwdt_config_t config;
WWDT_GetDefaultConfig(&config);
config.timeoutValue = 0x7ffU;
WWDT_Init(wwdt_base,&config);
```

Parameters

- base – WWDT peripheral base address
- config – The configuration of WWDT

void WWDT_Deinit(WWDT_Type *base)

Shuts down the WWDT.

This function shuts down the WWDT.

Parameters

- base – WWDT peripheral base address

static inline void WWDT_Enable(WWDT_Type *base)

Enables the WWDT module.

This function write value into WWDT_MOD register to enable the WWDT, it is a write-once bit; once this bit is set to one and a watchdog feed is performed, the watchdog timer will run permanently.

Parameters

- base – WWDT peripheral base address

static inline void WWDT_Disable(WWDT_Type *base)

Disables the WWDT module.

Deprecated:

Do not use this function. It will be deleted in next release version, for once the bit field of WDEN written with a 1, it can not be re-written with a 0.

This function write value into WWDT_MOD register to disable the WWDT.

Parameters

- base – WWDT peripheral base address

static inline uint32_t WWDT_GetStatusFlags(WWDT_Type *base)

Gets all WWDT status flags.

This function gets all status flags.

Example for getting Timeout Flag:

```
uint32_t status;
status = WWDT_GetStatusFlags(wwdt_base) & kWWDT_TimeoutFlag;
```

Parameters

- base – WWDT peripheral base address

Returns

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

void WWDT_ClearStatusFlags(WWDT_Type *base, uint32_t mask)

Clear WWDT flag.

This function clears WWDT status flag.

Example for clearing warning flag:

```
WWDT_ClearStatusFlags(wwdt_base, kWWDT_WarningFlag);
```

Parameters

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

`static inline void WWDT_SetWarningValue(WWDT_Type *base, uint32_t warningValue)`

Set the WWDT warning value.

The WDWARNINT register determines the watchdog timer counter value that will generate a watchdog interrupt. When the watchdog timer counter is no longer greater than the value defined by WARNINT, an interrupt will be generated after the subsequent WDCLK.

Parameters

- `base` – WWDT peripheral base address
- `warningValue` – WWDT warning value.

`static inline void WWDT_SetTimeoutValue(WWDT_Type *base, uint32_t timeoutCount)`

Set the WWDT timeout value.

This function sets the timeout value. Every time a feed sequence occurs the value in the TC register is loaded into the Watchdog timer. Writing a value below 0xFF will cause 0xFF to be loaded into the TC register. Thus the minimum time-out interval is $TWDCLK * 256 * 4$. If `enableWatchdogProtect` flag is true in `wwdt_config_t` config structure, any attempt to change the timeout value before the watchdog counter is below the warning and window values will cause a watchdog reset and set the WDTOF flag.

Parameters

- `base` – WWDT peripheral base address
- `timeoutCount` – WWDT timeout value, count of WWDT clock tick.

`static inline void WWDT_SetWindowValue(WWDT_Type *base, uint32_t windowValue)`

Sets the WWDT window value.

The WINDOW register determines the highest TV value allowed when a watchdog feed is performed. If a feed sequence occurs when timer value is greater than the value in WINDOW, a watchdog event will occur. To disable windowing, set `windowValue` to 0xFFFFFFFF (maximum possible timer value) so windowing is not in effect.

Parameters

- `base` – WWDT peripheral base address
- `windowValue` – WWDT window value.

`void WWDT_Refresh(WWDT_Type *base)`

Refreshes the WWDT timer.

This function feeds the WWDT. This function should be called before WWDT timer is in timeout. Otherwise, a reset is asserted.

Parameters

- `base` – WWDT peripheral base address

`FSL_WWDT_DRIVER_VERSION`

Defines WWDT driver version.

`WWDT_FIRST_WORD_OF_REFRESH`

First word of refresh sequence

`WWDT_SECOND_WORD_OF_REFRESH`

Second word of refresh sequence

enum __wwdt_status_flags_t

WWDT status flags.

This structure contains the WWDT status flags for use in the WWDT functions.

Values:

enumerator kWWDT_TimeoutFlag

Time-out flag, set when the timer times out

enumerator kWWDT_WarningFlag

Warning interrupt flag, set when timer is below the value WDWARNINT

typedef struct __wwdt_config wwdt_config_t

Describes WWDT configuration structure.

struct __wwdt_config

#include <fsl_wwdt.h> Describes WWDT configuration structure.

Public Members

bool enableWwdt

Enables or disables WWDT

bool enableWatchdogReset

true: Watchdog timeout will cause a chip reset false: Watchdog timeout will not cause a chip reset

bool enableWatchdogProtect

true: Enable watchdog protect i.e timeout value can only be changed after counter is below warning & window values false: Disable watchdog protect; timeout value can be changed at any time

uint32_t windowValue

Window value, set this to 0xFFFFFFFF if windowing is not in effect

uint32_t timeoutValue

Timeout value

uint32_t warningValue

Watchdog time counter value that will generate a warning interrupt. Set this to 0 for no warning

uint32_t clockFreq_Hz

Watchdog clock source frequency.

2.87 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.

2.88 XSPI: Serial Peripheral Interface Driver

Status structure of XSPI.

Values:

enumerator kStatus_XSPI_Busy

XSPI is Busy

enumerator kStatus_XSPI_IpCommandUsageError

XSPI Ip Command Usage Error

enumerator kStatus_XSPI_IpCommandtriggerError

XSPI Ip Command Trigger Error

enumerator kStatus_XSPI_IllegalInstructionError

XSPI Illegal Instruction Error

enumerator kStatus_XSPI_SequenceExecutionTimeout

XSPI Sequence Execution Timeout

enumerator kStatus_XSPI_FradCheckError

XSPI Frad Check Error

enumerator kStatus_XSPI_TgQueueWritingError

XSPI Tg Queue Writing Error

enumerator kStatus_XSPI_IpsBusTransError

XSPI Ip Bus Transfer Error

enumerator kStatus_XSPI_AhbReadAccessAsserted

AHB read access is asserted.

enumerator kStatus_XSPI_AhbWriteAccessAsserted

AHB write access is asserted.

enumerator kStatus_XSPI_IPAccessAsserted

IP access is asserted.

enumerator kStatus_XSPI_AhbSubBufferFactorError

Wrong sub buffer factor input.

enumerator kStatus_XSPI_RegWriteLocked

Fail to write register due to write operation is locked.

enumerator kStatus_XSPI_WaterMarkIllegal

The watermark value to set is not in multiple of 4 bytes.

enumerator kStatus_XSPI_PageProgramWaitFlagAsserted

The page program wait flag already asserted.

enumerator kStatus_XSPI_IpAccessAddrSettingInvalid

The input address for Ip access is invalid.

enumerator kStatus_XSPI_RxBufferEntriesCountError

The count of entries of RX buffer is incorrect.

enumerator kStatus_XSPI_IpAccessIPCRInvalid

Access attributes to write IPCR are not correct.

enumerator kStatus_XSPI_IpAccessNotGranted

IP request not granted by arbiter.

enumerator kStatus_XSPI_IpReadFinished

Finish IP read all data stored in buffer.

enumerator kStatus_XSPI_IpWriteFinished

Finish IP write operation.

enumerator kStatus_XSPI_TxBufferUnderrun

XSPI attempted to pull data when the TX buffer is empty.

enumerator kStatus_XSPI_ArbiterGranted

XSPI arbiter granted.

enum _xspi_lut_instr

CMD definition of XSPI, use to form LUT instruction, xspi_lut_instr_t.

Values:

enumerator kXSPI_Command_STOP

Stop execution, de-assert CS.

enumerator kXSPI_Command_SDR

Transmit Command code to Flash, using SDR mode.

enumerator kXSPI_Command_RADDR_SDR
Transmit Row Address to Flash, using SDR mode.

enumerator kXSPI_Command_DUMMY_SDR
Leave data lines un-driven by xSPI controller, using SDR mode.

enumerator kXSPI_Command_MODE_SDR
Transmit 8-bit Mode bits to Flash, using SDR mode.

enumerator kXSPI_Command_MODE2_SDR
Transmit 2-bit Mode bits to Flash, using SDR mode.

enumerator kXSPI_Command_MODE4_SDR
Transmit 4-bit Mode bits to Flash, using SDR mode.

enumerator kXSPI_Command_READ_SDR
Receive Read Data from Flash, using SDR mode.

enumerator kXSPI_Command_WRITE_SDR
Transmit Programming Data to Flash, using SDR mode.

enumerator kXSPI_Command_JMP_ON_CS
Stop execution, de-assert CS and save operand[7:0] as the instruction start pointer for next sequence

enumerator kXSPI_Command_RADDR_DDR
Transmit Row Address to Flash, using DDR mode.

enumerator kXSPI_Command_MODE_DDR
Transmit 8-bit Mode bits to Flash, using DDR mode.

enumerator kXSPI_Command_MODE2_DDR
Transmit 2-bit Mode bits to Flash, using DDR mode.

enumerator kXSPI_Command_MODE4_DDR
Transmit 4-bit Mode bits to Flash, using DDR mode.

enumerator kXSPI_Command_READ_DDR
Receive Read Data from Flash, using DDR mode.

enumerator kXSPI_Command_WRITE_DDR
Transmit Programming Data to Flash, using DDR mode.

enumerator kXSPI_Command_LEARN_DDR
Receive Read Data or Preamble bit from Flash, DDR mode.

enumerator kXSPI_Command_DDR
Transmit Command code to Flash, using DDR mode.

enumerator kXSPI_Command_CADDR_SDR
Transmit Column Address to Flash, using SDR mode.

enumerator kXSPI_Command_CADDR_DDR
Transmit Column Address to Flash, using DDR mode.

enumerator kXSPI_Command_JUMP_TO_SEQ
Jump the LUT sequence pointed to by the operand.

enum _xspi_pad
pad definition of XSPI, use to form LUT instruction.

Values:

enumerator kXSPI_1PAD

Transmit command/address and transmit/receive data only through DATA0/DATA1.

enumerator kXSPI_2PAD

Transmit command/address and transmit/receive data only through DATA[1:0].

enumerator kXSPI_4PAD

Transmit command/address and transmit/receive data only through DATA[3:0].

enumerator kXSPI_8PAD

Transmit command/address and transmit/receive data only through DATA[7:0].

enum __xspi_flags

XSPI interrupt status flags.

Deprecated:

For Error flag please use `xspi_error_flag_t` as instead, for cmd execution and arbitration flag please use `xspi_cmd_execution_arbitration_flag_t` as instead.

Values:

enumerator kXSPI_DataLearningFailedFlag

Data learning failed.

enumerator kXSPI_DllAbortFlag

DLL Abort.

enumerator kXSPI_DllUnlockFlag

This field is set whenever DLL unlock event occurs, irrespective of flash memory access.

enumerator kXSPI_TxBufferFillFlag

If the field remains cleared, the TX buffer can be considered as full.

enumerator kXSPI_TxBufferUnderrunFlag

This field is set if the module tries to pull data when the TX buffer is empty

enumerator kXSPI_RxBufferOverflowFlag

This field is set when no more data can be pushed into the RX buffer from the serial flash memory device.

enumerator kXSPI_RxBufferDrainFlag

This field is set if SR[RXWE] is asserted.

enumerator kXSPI_AhbAbortErrorFlag

This flag can be set when AHB transaction error

enumerator kXSPI_AhbIllegalTransactionErrorFlag

enumerator kXSPI_AhbIllegalBurstSizeErrorFlag

The total burst size is more than prefetch size.

enumerator kXSPI_AhbBufferOverflowFlag

The size of the AHB access exceed the size of the AHB buffer.

enumerator kXSPI_AhbPerformanceMonitorOverflowFlag

AHB performance hit or miss counter overflow.

enumerator kXSPI_AhbReadAddressErrorFlag

The master send an AHB read address to that buffer is not within the address range of any sub-buffers or the address within multiple sub-buffers.

enumerator kXSPI_IllegalInstructionErrorFlag

This field is set when an illegal instruction is encountered by the controller in any of the sequences.

enumerator kXSPI_IpCmdtriggerErrorFlag

Write access to Rx buffer control reg when IP-triggered command is executing.

enumerator kXSPI_PageProgramWaitFlag

Indicates assertion of the page-program wait flag after writing to flash memory.

enumerator kXSPI_IpCommandExecutionDoneFlag

Indicates XSPI has completed a running IP command.

enumerator kXSPI_SequenceExecutionTimeoutFlag

Sequence execution timeout.

enumerator kXSPI_FradMatchErrorFlag

enumerator kXSPI_Frad0AccessErrorFlag

enumerator kXSPI_Frad1AccessErrorFlag

enumerator kXSPI_Frad2AccessErrorFlag

enumerator kXSPI_Frad3AccessErrorFlag

enumerator kXSPI_Frad4AccessErrorFlag

enumerator kXSPI_Frad5AccessErrorFlag

enumerator kXSPI_Frad6AccessErrorFlag

enumerator kXSPI_Frad7AccessErrorFlag

enumerator kXSPI_FradnAccErrorFlag

ORed value of all frad error flag,.

enumerator kXSPI_IpsErrorFlag

enumerator kXSPI_Tg0SfarErrorFlag

enumerator kXSPI_Tg1SfarErrorFlag

enumerator kXSPI_TgnIpcrErrorFlag

enumerator kXSPI_LockRegErrorFlag

enumerator kXSPI_ArbLockTimeoutFlag

enumerator kXSPI_ArbWinEventFlag

enum _xspi_error_flag

The enumeration of error flags. .

Values:

enumerator kXSPI_ErrorNoFradMatch

The transaction address does not lie within the address range of any FRAD.

enumerator kXSPI_ErrorFrad0Access

The transaction address lies within the address range of the FRAD0 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad1Access

The transaction address lies within the address range of the FRAD1 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad2Access

The transaction address lies within the address range of the FRAD2 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad3Access

The transaction address lies within the address range of the FRAD3 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad4Access

The transaction address lies within the address range of the FRAD4 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad5Access

The transaction address lies within the address range of the FRAD5 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad6Access

The transaction address lies within the address range of the FRAD6 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorFrad7Access

The transaction address lies within the address range of the FRAD7 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock by another manager.

enumerator kXSPI_ErrorIpBusTransfer

A common error has occurred and XSPI has generated an IPS bus transfer error.

enumerator kXSPI_ErrorTg0Sfar

An SFAR write trigger an error while written to the TG0.

enumerator kXSPI_ErrorTg1Sfar

An SFAR write trigger an error while written to the TG1.

enumerator kXSPI_ErrorTg0Ipcr

An IPCR write trigger an error while written to the TG0.

enumerator kXSPI_ErrorTg1Ipcr

An IPCR write trigger an error while written to the TG1.

enumerator kXSPI_ErrorTimeout

A flash memory transaction has triggered a timeout error and has been terminated by SFP.

enumerator kXSPI_ArbitrationWin

The target group request was granted access.

enumerator kXSPI_ErrorArbitrationLock

Arbitration lock has timed out.

enumerator kXSPI_ErrorWriteLockedReg

An attempt to write a locked register.

enum _xspi_cmd_execution_arbitration_flag

The enumeration of cmd execution and arbitration. .

Values:

enumerator kXSPI_FlagIpCmdFinished

IP command transaction finished flag.

enumerator kXSPI_FlagAhbReadAddrError

Wrong AHB read address, XSPI return AHB error payload.

enumerator kXSPI_FlagAhbPerformanceMonitorOverflow

Buffer hit or miss counter overflow.

enumerator kXSPI_FlagIpCmdTriggerFail

Fail when set IP RX buffer watermark.

enumerator kXSPI_FlagPageProgramWait

Indicate assertion of the page-program wait flag after writing to flash memory.

enumerator kXSPI_FlagAhbBufferOverflow

The size of the AHB access exceeds the size of AHB buffer.

enumerator kXSPI_FlagAhbIllegalBurstSizeError

The total burst size of the AHB transacton is greater than the prefetch data size.

enumerator kXSPI_FlagAhbIllegalTransactionError

XSPI has not generated a response to the AHB bus due to an illegal transaction and expiration of the watchdog timer.

enumerator kXSPI_FlagAhbTransactionError

AHB transaction error.

enumerator kXSPI_FlagRxBufferWatermarkExceeded

The RX buffer watermark has been exceeded.

enumerator kXSPI_FlagRxBufferOverflow

The RX buffer cannot receive any more data from the SFM device.

enumerator kXSPI_FlagIllegalInstrError

The xspi encountered an illegal instruction in any sequence.

enumerator kXSPI_FlagDllUnlock

DLL unlock.

enumerator kXSPI_FlagTxBufferUnderRun

XSPI attempt to pull data when the TX buffer is empty.

enumerator kXSPI_FlagTxBufferFill

The TX buffer is filling.

enumerator kXSPI_FlagDllAbort

DLL terminate.

enumerator kXSPI_FlagDataLearningPatternFailure

The XSPI encountered a DATA_LEARN instruction in a sequence, but no sampling point is found for the data learning pattern.

enum _xspi_interrupt_enable

Values:

enumerator kXSPI_TransactionFinishIntEnable

Enable generation of an interrupt when an IP command transaction completes.

enumerator kXSPI_AhbReadAddrErrorIntEnable

Enable generation of an interrupt on occurrence of an AHB read address error.

enumerator kXSPI_AhbPerformanceMonitorOverflowIntEnable

Enable generation of an interrupt on a buffer hit or miss counter overflow.

enumerator kXSPI_IpCmdTrigFailErrorIntEnable

IP command trigger fail error interrupt enable.

enumerator kXSPI_PageProgramWaitIntEnable

Enable generation of an interrupt on page-program wait.

enumerator kXSPI_AhbBufferOverflowIntEnable

Enable generation of an interrupt on occurrence of an AHB buffer overflow.

enumerator kXSPI_AhbIllegalBurstSizeErrorIntEnable

Enable generation of an interrupt on occurrence of an AHB illegal burst size error.

enumerator kXSPI_AhbIllegalTransactionErrorIntEnable

Enable generation of an interrupt of an AHB illegal transaction error.

enumerator kXSPI_AhbAbortErrorIntEnable

Enable generation of an interrupt on occurrence of an AHB abort error.

enumerator kXSPI_RxBufferDrainIntEnable

Enable generation of an interrupt on occurrence of RX buffer drain.

enumerator kXSPI_RxBufferOverflowIntEnable

Enable generation of an interrupt on occurrence of RX buffer overflow.

enumerator kXSPI_IllegalInstrErrorIntEnable

Enable generation of an interrupt on occurrence of an illegal instruction error.

enumerator kXSPI_DLLUnlockIntEnable

Enable generation of an interrupt on a DLL unlock event.

enumerator kXSPI_TxBufferUnderrunIntEnable

Enable generation of an interrupt on TX buffer underrun.

enumerator kXSPI_TxBufferFillIntEnable

Enable generation of an interrupt on TX buffer fill.

enumerator kXSPI_DataLearningPatternFailIntEnable

Enable generation of an interrupt on data learning pattern failure.

enumerator kXSPI_NoFradMatchErrorIntEnable

Enable the interrupt generated when the transaction address does not lie within the address range of any FRAD.

enumerator kXSPI_Frad0AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD0 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad1AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD1 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad2AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD2 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad3AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD3 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad4AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD4 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad5AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD5 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad6AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD6 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_Frad7AccessErrorIntEnable

Enable the interrupt generated when the transaction address lies within the address range of the FRAD7 but it does not pass the access permission checks for the FRAD or the FRAD is under exclusive lock.

enumerator kXSPI_IpsErrIntEnable

Enable the interrupt generated when a common error has occurred an XSPI has generated an IPS bus transfer error.

enumerator kXSPI_Tg0SfarErrIntEnable

Enable the interrupt generated when an SFAR write triggers an error while being written to the target group 0.

enumerator kXSPI_Tg1SfarErrIntEnable

Enable the interrupt generated when an SFAR write triggers an error while being written to the target group 1.

enumerator kXSPI_Tg0IpcrErrIntEnable

Enable the interrupt generated when an IPCR write triggers an error while being written to the target group 0.

enumerator kXSPI_Tg1IpcrErrIntEnable

Enable the interrupt generated when an IPCR write triggers an error while being written to the target group 1.

enumerator kXSPI_TimeoutErrIntEnable

Enable the interrupt generated when a flash memory transaction triggers a timeout error and has been terminated by SFP.

enumerator kXSPI_ArbitrationWinIntEnable

Enable the interrupt generated when the target group queue request is granted access.

enumerator kXSPI_ArbitrationLockTimeoutErrIntEnable

Enable the interrupt generated when a flash memory transaction triggers a timeout error and has been terminated by SFP.

enumerator kXSPI_LockRegWriteErrIntEnable

Enable the interrupt generated by an attempt to write a locked register.

enum _xspi_external_signal

The enumeration of Idle signal drive IOFA[3] and IOFA[2].

Values:

enumerator XSPI_SignalIOFA2

Idle signal drive IOFA[2].

enumerator XSPI_SignalIOFA3

Idle signal drive IOFA[3].

enum _xspi_dll_mode

Dll Mode enumerations.

Values:

enumerator kXSPI_AutoUpdateMode

Dll mode : Auto update mode.

enumerator kXSPI_BypassMode

Dll mode : Bypass mode.

enum _xspi_sample_clk_source

The enumeration of sample clock source which is used to sample data from external devices.

Note: If external device support Data strobe signal, the sample clock should selected as kXSPI_SampleClkFromExternalDQS.

Values:

enumerator kXSPI_SampleClkFromNonInvertedFullySpeedDummyPadLoopback

Sample clock from non inverted fully speed dummy pad loopback.

enumerator kXSPI_SampleClkFromInvertedFullySpeedDummyPadLoopback

Sample clock from inverted fully speed dummy pad loopback.

enumerator kXSPI_SampleClkFromHalfSpeedDummyPadLoopback

Sample clock from half fully speed dummy pad loopback.

enumerator kXSPI_SampleClkFromDqsPadLoopback

Sample clock from Dqs pad loopback.

enumerator kXSPI_SampleClkFromExternalDQS

Sample clock from external DQS signal.

enum _xspi_data_learning_pad_select

The selection of data learning pad.

Values:

enumerator kXSPI_OnlyIO1

IO1 selected as pad to use for pattern matching IO.

enumerator kXSPI_BothIO1IO3

IO1 and IO3 selected as pad to use for pattern matching IO.

enum _xspi_device_addr_mode

External device's address mode.

Values:

enumerator kXSPI_DeviceByteAddressable

Byte addressable.

enumerator kXSPI_Device2ByteAddressable

Two bytes addressable.

enumerator kXSPI_Device4ByteAddressable

Four bytes addressable.

enum __xspi_device_interface_type

The enumeration of external device's interface type, hyper bus or SPI(including standard and extended).

Note: Different interface result different settings.

Values:

enumerator kXSPI_StandardExtendedSPI

External device follow SPI protocol, DQS_OUT_EN must be 0

enumerator kXSPI_HyperBus

External device follow hyper Bus protocol, DQS_OUT_EN must be 1

enum __xspi_hyper_bus_x16_mode

The enumeration of hyper bus X16 mode.

Values:

enumerator kXSPI_x16ModeDisable

X16 mode is disabled.

enumerator kXSPI_x16ModeEnabledOnlyData

X16 mode is enabled only for data.

enumerator kXSPI_x16ModeEnabledAddrCmdData

X16 mode is enabled for address, command, and data.

enum __xspi_ddr_data_aligned_clk

Enumeration defining the alignment modes of XSPI DDR data with respect to the internal reference clock.

Values:

enumerator kXSPI_DDRDataAlignedWithInternalRefClk

DDR data aligned with internal reference clock.

enumerator kXSPI_DDRDataAlignedWith2xInternalRefClk

DDR data aligned with 2X internal reference clock.

enum __xspi_command_type

Command type.

Values:

enumerator kXSPI_Command

XSPI operation: Only command, both TX and Rx buffer are ignored.

enumerator kXSPI_Config

XSPI operation: Configure device mode, the TX fifo size is fixed in LUT.

enumerator kXSPI_Read

XSPI operation: Read, only Rx Buffer is effective.

enumerator kXSPI_Write

XSPI operation: Read, only Tx Buffer is effective.

enum _xspi_mdad_mask_type

The enumeration of SFP MDAD mask type.

Values:

enumerator kXSPI_MdadMaskTypeAnd

Target master is mask & reference.

enumerator kXSPI_MdadMaskTypeOr

Target master is mask | reference.

enum _xspi_mdad_error_reason

The enumeration of MDAD error reasons.

Values:

enumerator kXSPI_ErrorOnlyDataSize

Error reason: Only Data size without required attributes.

enumerator kXSPI_ErrorOnlySeqId

Error reason: Only sequence ID without required attributes.

enumerator kXSPI_ErrorBothDataSizeSeqId

Error reason: Both Data size and sequence ID without required attributes.

enum _xspi_exclusive_access_lock_mode

Exclusive access lock.

Values:

enumerator kXSPI_ExclusiveAccessLockDisabled

Write permissions available for all masters based on their MDxACP evaluation.

enumerator kXSPI_ExclusiveAccessLockEnabled

Write permissions revoked for all domains, Any write transaction coming to this flash address will result in an error.

enumerator kXSPI_ExclusiveAccessLockExceptMasterId

Write permissions are revoked for all masters except the master ID specified by FRADn_WORD2[EALO] fields.

enum _xspi_secure_attribute

XSPI defines the secure attribute selection criteria for entry into descriptor queue...

Values:

enumerator kXSPI_AttributeMasterNonsecureOnly

Allow the bus attribute for this master to non-secure only

enumerator kXSPI_AttributeMasterSecureOnly

Allow the bus attribute for this master to secure only

enumerator kXSPI_AttributeMasterNonsecureSecureBoth

Allow the bus master's attribute: Both secure and non-secure

enum _xspi_descriptor_lock

Descriptor lock.

Values:

enumerator kXSPI_DescriptorLockDisabled

Descriptor registers can be written by any master

enumerator kXSPI_DescriptorLockEnabledTillHardReset

FRAD descriptor is read-only till next hard reset.

enumerator kXSPI_DescriptorLockEnabledExceptMasterId

Descriptors are read-only. MDnACP fields can be programmed only by the master with ID matching the MID.

enumerator kXSPI_DescriptorLockEnabled

Descriptor registers are read-only.

enum __xspi_target_group

The enumeration of target group.

Values:

enumerator kXSPI_TargetGroup0

Target groupe queue 0

enumerator kXSPI_TargetGroup1

Target groupe queue 1

enum __xspi_subbuffer_division_factor

Subbuffer division factor.

Values:

enumerator kXSPI_Division0

division factor 0

enumerator kXSPI_Division2

division factor 2 subbuffer size/2

enumerator kXSPI_Division4

division factor 4 subbuffer size/4

enumerator kXSPI_Division8

division factor 8 subbuffer size/8

enumerator kXSPI_Division16

division factor 16 subbuffer size/16

enum __xspi_ahb_sub_buffer_status

The enumeration of sub buffer status, empty, full, or partially full.

Values:

enumerator kXSPI_AhbSubBufferEmpty

Current sub buffer is empty.

enumerator kXSPI_AhbSubBufferFull

Current sub buffer is full.

enumerator kXSPI_AhbSubBufferPartiallyFull

Current sub buffer contains some entries.

enum __xspi_ppw_flag_clear_policy

The enumeration of XSPI page program waiting flag clear policy.

Values:

enumerator kXSPI_SoftwareClearPPWFlag

Application should clear the flag manually, after check the WIP of external flag is cleared.

enumerator kXSPI_HardwareClearPPWFlag

The flag is cleared by hardware automatically, the variable in type of xspi_device_status_reg_info_t should be defined.

enum _xspi_ahb_split_size

XSPI AHB Split Size These bits are used to control the split size when split function is enabled BFGENCR[SPLITEN] is '1'.

Values:

enumerator kXSPI_AhbSplitSize8b

Enable AHB transaction split and split size is 8 bytes.

enumerator kXSPI_AhbSplitSize16b

Enable AHB transaction split and split size is 16 bytes.

enumerator kXSPI_AhbSplitSize32b

Enable AHB transaction split and split size is 32 bytes.

enumerator kXSPI_AhbSplitSize64b

Enable AHB transaction split and split size is 64 bytes.

enumerator kXSPI_AhbSplitSizeDisabled

Disable AHB Transaction Split feature.

enum _xspi_ahb_alignment

XSPI AHB access towards flash is broken if this AHB alignment boundary is crossed. This field is only supported XSPI0 XSPI1.

Values:

enumerator kXSPI_AhbAlignmentNoLimit

no limit

enumerator kXSPI_AhbAlignment256BLimit

256B limit

enumerator kXSPI_AhbAlignment512BLimit

512B limit

enumerator kXSPI_AhbAlignment1KBLimit

1KB limit

enum _xspi_ahb_request_suspend_state

The enumeration of AHB request suspend state.

Values:

enumerator kXSPI_AhbRequestNoSuspended

None of AHB request is suspended.

enumerator kXSPI_AhbRequestSuspended

The AHB request is suspended.

enumerator kXSPI_AhbRequestNotApplicable

The AHB request is not applicable.

enumerator kXSPI_AhbRequestResumed

The AHB request is resumed.

enum _xspi_otfad_prefetch_boundary

The enumeration of OTFAD prefetch address boundary.

Values:

enumerator kXSPI_OTFADPrefetchNoBoundary

No prefetch address boundary.

enumerator kXSPI_OTFADPrefetchBoundary1K

Prefetch address boundary is 1K.

enum __xspi_byte_order

Byte ordering endianness.

Values:

enumerator kXSPI_64BitBE

64 bit big endian

enumerator kXSPI_32BitLE

32 bit little endian

enumerator kXSPI_32BitBE

32 bit big endian

enumerator kXSPI_64BitLE

64 bit little endian

enum __xspi_cache64_policy

The enumeration of cache64 policy.

Values:

enumerator kXSPI_Cache64PolicyNonCacheable

Non-cacheable.

enumerator kXSPI_Cache64PolicyWriteThrough

Write through.

enumerator kXSPI_Cache64PolicyWriteBack

Write back.

typedef enum __xspi_lut_instr xspi_lut_instr_t

CMD definition of XSPI, use to form LUT instruction, xspi_lut_instr_t.

typedef enum __xspi_pad xspi_pad_t

pad definition of XSPI, use to form LUT instruction.

typedef enum __xspi_flags xspi_flags_t

XSPI interrupt status flags.

Deprecated:

For Error flag please use xspi_error_flag_t as instead, for cmd execution and arbitration flag please use xspi_cmd_execution_arbitration_flag_t as instead.

typedef struct __xspi_device_status_reg_info xspi_device_status_reg_info_t

The structure of external device's status register information(location, priority).

Note: Only useful when AHB write to flash device is enabled, and use hardware to clear ppw flag.

typedef enum __xspi_dll_mode xspi_dll_mode_t

Dll Mode enumerations.

typedef union *_xspi_dll_para* xspi_dll_para_t

The union of user custommed DLL parameters, in case of kXSPI_BypassMode bypassMod-ePara is used, in case of kXSPI_AutoUpdateMode autoUpdateModoPara is used.

typedef struct *_xspi_dll_config* xspi_dll_config_t

The structure of Delay-lock-loop configuration.

typedef enum *_xspi_sample_clk_source* xspi_sample_clk_source_t

The enumeration of sample clock source which is used to sample data from external de-vices.

Note: If external device support Data strobe signal, the sample clock should selected as kXSPI_SampleClkFromExternalDQS.

typedef enum *_xspi_data_learning_pad_select* xspi_data_learning_pad_select_t

The selection of data learning pad.

typedef struct *_xspi_data_learning_config* xspi_data_learning_config_t

The configuration of data learning.

Note: Data learning feature only supported in the DQS sampling method(kXSPI_SampleClkFromExternalDQS).

typedef struct *_xspi_sample_clk_config* xspi_sample_clk_config_t

Sample clock configuration, which used to sample data from external device.

typedef enum *_xspi_device_addr_mode* xspi_device_addr_mode_t

External device's address mode.

typedef enum *_xspi_device_interface_type* xspi_device_interface_type_t

The enumeration of external device's interface type, hyper bus or SPI(including standard and extended).

Note: Different interface result different settings.

typedef enum *_xspi_hyper_bus_x16_mode* xspi_hyper_bus_x16_mode_t

The enumeration of hyper bus X16 mode.

typedef union *_xspi_device_interface_settings* xspi_device_interface_settings_t

The union of external device's settings, if external device following hyper bus protocol #hy-perBusSettings take effects, if external device following SPI protocol #strandardExtended-SPISettings take effects.

typedef enum *_xspi_ddr_data_aligned_clk* xspi_ddr_data_aligned_clk_t

Enumeration defining the alignment modes of XSPI DDR data with respect to the internal reference clock.

typedef struct *_xspi_device_ddr_config* xspi_device_ddr_config_t

The structure of device DDR configuration.

typedef struct *_xspi_device_config* xspi_device_config_t

External device configuration items.

typedef enum *_xspi_command_type* xspi_command_type_t

Command type.

`typedef enum _xspi_mdad_mask_type xspi_mdad_mask_type_t`

The enumeration of SFP MDAD mask type.

`typedef enum _xspi_mdad_error_reason xspi_mdad_error_reason_t`

The enumeration of MDAD error reasons.

`typedef enum _xspi_exclusive_access_lock_mode xspi_exclusive_access_lock_mode_t`

Exclusive access lock.

`typedef enum _xspi_secure_attribute xspi_secure_attribute_t`

XSPI defines the secure attribute selection criteria for entry into descriptor queue...

`typedef struct _xspi_mdad_config xspi_mdad_config_t`

MDAD configuration.

`typedef struct _xspi_sfp_mdad_config xspi_sfp_mdad_config_t`

The structure of SFP MDAD configurations for all target groups.

`typedef enum _xspi_descriptor_lock xspi_descriptor_lock_t`

Descriptor lock.

`typedef struct _xspi_frad_config_t xspi_frad_config_t`

FRAD configuration.

`typedef struct _xspi_sfp_frad_config xspi_sfp_frad_config_t`

The structure of SFP FRAD configurations.

`typedef struct _xspi_frad_transaction_info xspi_frad_transaction_info_t`

The structure of latest FRAD transaction information.

`typedef struct _xspi_ip_access_config xspi_ip_access_config_t`

Configurations of IP access(including IP read and write).

`typedef enum _xspi_target_group xspi_target_group_t`

The enumeration of target group.

`typedef struct _xspi_tg_add_write_status xspi_tg_add_write_status_t`

The status of latest target group address write operation.

`typedef struct _xspi_transfer xspi_transfer_t`

Transfer structure used for XSPI functional interface.

`typedef struct _xspi_handle xspi_handle_t`

`typedef void (*xspi_transfer_callback_t)(XSPI_Type *base, xspi_handle_t *handle, status_t status, void *userData)`

XSPI transfer callback function.

`typedef enum _xspi_subbuffer_division_factor xspi_subbuffer_division_factor_t`

Subbuffer division factor.

`typedef struct _xspi_ahbBuffer_sub_buffer_config xspi_ahbBuffer_sub_buffer_config_t`

The structure of sub-buffer configurations.

`typedef struct _xspi_ahbBuffer_config xspi_ahbBuffer_config_t`

Structure of AHB buffer configurations.

Note: When an AHB read access comes it is assigned to a buffer based on its master ID. Then it further assigned to a sub-buffer based on which sub-buffer address range this transaction lies into.

Note: When sub-buffer division is hit, in case of a buffer miss the controller will fetch the data equal to the size of that sub-buffer.

Note: If sub-buffer division is enabled for a buffer the hit/miss check is done at sub-buffer level. And if prefetch is enable, the prefetch takes place for individual sub-buffers.

typedef enum *_xspi_ahb_sub_buffer_status* xspi_ahb_sub_buffer_status_t

The enumeration of sub buffer status, empty, full, or partially full.

typedef struct *_xspi_ahbBuffer_perf_monitor_result* xspi_ahbBuffer_perf_monitor_result_t

The result of AHB buffer performance monitor, including buffer miss count and buffer hit count.

typedef enum *_xspi_ppw_flag_clear_policy* xspi_ppw_flag_clear_policy_t

The enumeration of XSPI page program waiting flag clear policy.

typedef struct *_xspi_ahb_write_config* xspi_ahb_write_config_t

The configuration of AHB write access.

typedef enum *_xspi_ahb_split_size* xspi_ahb_split_size_t

XSPI AHB Split Size These bits are used to control the split size when split function is enabled BFGENCR[SPLITEN] is '1'.

typedef enum *_xspi_ahb_alignment* xspi_ahb_alignment_t

XSPI AHB access towards flash is broken if this AHB alignment boundary is crossed. This field is only supported XSPI0 XSPI1.

typedef struct *_xspi_ahb_access_config* xspi_ahb_access_config_t

The structure of AHB access configurations, including AHB buffer settings, AHB Read Seq ID, AHB write settings.

typedef struct *_xspi_ahb_read_error_info* xspi_ahb_read_error_info_t

The structure of information when AHB read error occur.

typedef enum *_xspi_ahb_request_suspend_state* xspi_ahb_request_suspend_state_t

The enumeration of AHB request suspend state.

typedef struct *_xspi_ahb_request_suspend_info* xspi_ahb_request_suspend_info_t

The structure of information when AHB request is suspended.

typedef enum *_xspi_otfad_prefetch_boundary* xspi_otfad_prefetch_boundary_t

The enumeration of OTFAD prefetch address boundary.

typedef enum *_xspi_byte_order* xspi_byte_order_t

Byte ordering endianness.

typedef struct *_xspi_config* xspi_config_t

XSPI configuration structure.

typedef enum *_xspi_cache64_policy* xspi_cache64_policy_t

The enumeration of cache64 policy.

typedef struct *_xspi_cache64_config* xspi_cache64_region_config_t

The structure of cache64 configuration.

Region0 range from base address to region0TopAddr[28:10] + 0x3FF, region1 range from region0TopAddr[28:10] + 0x400 to region1TopAddr[28:10] + 0x3FF, region1TopAddr[28:10] + 0x400 to end address.

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XSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)

Formula to form XSPI instructions in LUT table.

XSPI_TARGET_GROUP_COUNT

XSPI_SFP_FRAD_COUNT

XSPI_IP_RX_BUFFER_SIZE

XSPI_IP_TX_BUFFER_SIZE

uint32_t XSPI_GetInstance(XSPI_Type *base)

Get the instance number for XSPI.

Parameters

- base – XSPI base pointer.

status_t XSPI_CheckAndClearError(XSPI_Type *base, uint32_t status)

Check and clear IP command execution errors.

Parameters

- base – XSPI base pointer.
- status – interrupt status.

void XSPI_Init(XSPI_Type *base, const xspi_config_t *ptrConfig)

Initializes the XSPI module and internal state.

This function configures the XSPI with the input configure parameters. Users should call this function before any XSPI operations.

Parameters

- base – XSPI peripheral base address.
- ptrConfig – XSPI configure structure.

void XSPI_GetDefaultConfig(xspi_config_t *ptrConfig)

Gets default settings for XSPI.

Warning: The parameter **devconfig** will be removed in next release.

Parameters

- base – XSPI peripheral base address.
- ptrConfig – XSPI configuration structure.

void XSPI_Deinit(XSPI_Type *base)

Deinitialize the XSPI module.

Clears the XSPI state and XSPI module registers.

Parameters

- base – XSPI peripheral base address.
- devconfig – Flash configuration parameters.

void XSPI_UpdateLUT(XSPI_Type *base, uint8_t index, const uint32_t *cmd, uint8_t count)

Updates the LUT table.

Parameters

- base – XSPI 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 10 instructions and occupy 5*32-bit memory.
- cmd – Command sequence array.
- count – Number of instruction-operand pairs

static inline void XSPI_SetOTFADPrefetchBoundary(XSPI_Type *base,
xspi_otfad_prefetch_boundary_t boundary)

Set OTFAD prefetch boundary.

Parameters

- base – XSPI peripheral base address.
- boundary – Prefetch boundary to set, in type of xspi_otfad_prefetch_boundary_t.

static inline void XSPI_UpdateByteOrder(XSPI_Type *base, xspi_byte_order_t byteOrder)

static inline void XSPI_EnableModule(XSPI_Type *base, bool enable)

Enable or disable the XSPI module.

Parameters

- base – XSPI peripheral base address.
- enable – true means enable XSPI, false means disable.

static inline bool XSPI_CheckModuleEnabled(XSPI_Type *base)

Check if the XSPI module is enabled.

Parameters

- base – XSPI peripheral base address.

Return values

- true – XSPI module is enabled.
- false – XSPI module is disabled.

void XSPI_ResetSfmAndAhbDomain(XSPI_Type *base)

Reset Serial flash memory domain and AHB domain at the same time.

Note: Resetting only the Serial flash memory domain and AHB domain may cause undesirable side effects.

Parameters

- base – XSPI peripheral base address.

static inline void XSPI_ResetTgQueue(XSPI_Type *base)

Reset IPS target group queue.

Parameters

- base – XSPI peripheral base address.

static inline void XSPI_SoftwareReset(XSPI_Type *base)

Software reset flash memory domain, AHB domain, and Target group at the same time.

Parameters

- base – XSPI peripheral base address.

static inline bool XSPI_CheckGlobalConfigLocked(XSPI_Type *base)

Check if write access to registers(MGC, MRC, MTO, SFP_ARB_TIMEOUT, SFP_LUT_ENn, LUTn, BFGENCR) is locked.

Parameters

- base – XSPI peripheral base address.

Return values

- false – Write access to listed registers is not locked.
- true – Write access to listed registers is locked.

void XSPI_SetHyperBusX16Mode(XSPI_Type *base, *xspi_hyper_bus_x16_mode_t* x16Mode)

Set Hyper bus X16 mode.

Parameters

- base – XSPI peripheral base address.
- x16Mode – Specify X16 mode.

status_t XSPI_UpdateDeviceAddrMode(XSPI_Type *base, *xspi_device_addr_mode_t* addrMode)

Update address mode to access external device.

Parameters

- base – XSPI peripheral base address.
- addrMode – Specify the address mode to update.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail to update address mode due to AHB read access asserted.
- kStatus_XSPI_IPAccessAsserted – Fail to update address mode due to a IP access already asserted.
- kStatus_XSPI_AhbWriteAccessAsserted – Fail to update address mode due to AHB write access asserted.
- kStatus_Success – Successfully to update address mode.

static inline void XSPI_EnableVariableLatency(XSPI_Type *base, bool enable)

Enable/disable variable latency for XSPI.

Note: Only useful for hyper bus device.

Note: It is application responsibility to enable variable latency for external hyper bus device(by change device's register).

Parameters

- base – XSPI peripheral base address.
- enable – Specify operation:

- **true** Enable variable latency;
- **false** Disable variable latency.

static inline void XSPI_EnableDozeMode(XSPI_Type *base, bool enable)

Enable/disable Doze mode for XSPI controller.

Note: Once doze mode is enabled, the XSPI controller will enter disable mode when system in low power modes.

Parameters

- base – XSPI peripheral base address
- enable – Specify operation:
 - **true** Enable Doze mode;
 - **false** Disable Doze mode.

static inline void XSPI_SetSignalOutputValue(XSPI_Type *base, uint32_t signalMask, bool outputLogic)

Specify the logic level of the XSPI IOFA[3] and IOFA[2] output in the inactive state.

Parameters

- base – XSPI peripheral base address
- signalMask – Should be the OR'ed value of `_xspi_external_signal`.
- outputLogic – Output logic of selected signals,
 - **false** Output logic 0;
 - **true** Output logic 1.

static inline void XSPI_EnableInvertedSerialClockOutput(XSPI_Type *base, bool enable)

Enable/disable inverted serial clock output for XSPI controller.

Note: It is application responsibility to enable CLK_n for external device (by change device's register).

Parameters

- base – **[in]** XSPI peripheral base address
- enable – **[in]** Enable/disable inverted serial clock output:
 - **true** Enable inverted serial clock output;
 - **false** Disable inverted serial clock output.

void XSPI_UpdateDllValue(XSPI_Type *base, *xspi_dll_config_t* *ptrDllConfig, bool enableDDR, bool enableX16Mode, uint32_t xspiRootClk)

Update DLL configuration.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrDllConfig – **[in]** Pointer to the DLL configuration.
- enableDDR – **[in]** DDR mode is enabled or not.
- enableX16Mode – **[in]** X16 mode is enabled or not.

- xspiRootClk – **[in]** The frequency of xspi root clock, the unit is Hz.

status_t XSPI_SetDataLearningConfig(XSPI_Type *base, *xspi_data_learning_config_t* *ptrDataLearningConfig)

Set Data learning configurations.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrDataLearningConfig – **[in]** Pointer to data learning configuration.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail to set data learning configuration due to AHB read access asserted.
- kStatus_XSPI_IPAccessAsserted – Fail to set data learning configuration due to a IP access already asserted.
- kStatus_XSPI_AhbWriteAccessAsserted – Fail to set data learning configuration due to AHB write access asserted.
- kStatus_Success – Successfully to set Data learning configurations.

static inline bool XSPI_CheckDataLearningFailure(XSPI_Type *base)

Check if data learning failure has detected.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – Data learning has failed.
- false – Data learning not fail.

static inline void XSPI_GetDataLearningEdgeMatchSignature(XSPI_Type *base, uint8_t *posEdgeMatch, uint8_t *negEdgeMatch)

Get data learning positive and negative edge match signature.

Parameters

- base – **[in]** XSPI peripheral base address.
- posEdgeMatch – **[out]** Pointer to the memory to store positive edge match signature.
- negEdgeMatch – **[out]** Pointer to the memory to store negative edge match signature.

status_t XSPI_SetDeviceConfig(XSPI_Type *base, *xspi_device_config_t* *devConfig)

Set device configuration.

Parameters

- base – **[in]** XSPI peripheral base address.
- devConfig – **[in]** Pointer to device configuration.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail to set device configuration due to AHB read access asserted.
- kStatus_XSPI_IPAccessAsserted – Fail to set device configuration due to a IP access already asserted.

- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail to set device configuration due to AHB write access asserted.
- `kStatus_Success` – Successfully to set device configurations.

`static inline void XSPI_EnableInterrupts(XSPI_Type *base, uint64_t mask)`

Enables the XSPI interrupts.

Parameters

- `base` – XSPI peripheral base address.
- `mask` – XSPI interrupt source, should be the OR'ed value of `xspi_interrupt_enable_t`.

`static inline void XSPI_DisableInterrupts(XSPI_Type *base, uint64_t mask)`

Disables the XSPI interrupts.

Parameters

- `base` – XSPI peripheral base address.
- `mask` – XSPI interrupt source, should be the OR'ed value of `xspi_interrupt_enable_t`.

`static inline void XSPI_EnableTxDMA(XSPI_Type *base, bool enable)`

Enables or disables XSPI IP Tx FIFO DMA requests.

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `enable` – **[in]** Enable flag for transmit DMA request. Pass true for enable, false for disable.

`static inline void XSPI_EnableRxDMA(XSPI_Type *base, bool enable)`

Enables or disables XSPI IP Rx FIFO DMA requests.

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `enable` – **[in]** Enable flag for receive DMA request. Pass true for enable, false for disable.

`static inline uint32_t XSPI_GetTxFifoAddress(XSPI_Type *base)`

Gets XSPI IP tx fifo address for DMA transfer.

Parameters

- `base` – **[in]** XSPI peripheral base address.

Returns

The tx fifo address.

`static inline uint32_t XSPI_GetRxFifoAddress(XSPI_Type *base)`

Gets XSPI IP rx fifo address for DMA transfer.

Parameters

- `base` – **[in]** XSPI peripheral base address.

Returns

The rx fifo address.

`static inline uint32_t XSPI_GetErrorStatusFlags(XSPI_Type *base)`

Get error status flags.

Parameters

- base – SPC peripheral base address.

Returns

All asserted error status flags, should be the OR'ed value of XSPI_GetErrorStatusFlags.

```
static inline void XSPI_ClearErrorStatusFlags(XSPI_Type *base, uint32_t flags)
```

Clear input error status flags.

Parameters

- base – SPC peripheral base address.
- flags – Error flags to clear, the OR'ed value of XSPI_GetErrorStatusFlags.

```
static inline uint32_t XSPI_GetInterruptStatusFlags(XSPI_Type *base)
```

Get the XSPI interrupt status flags.

Deprecated:

Please use XSPI_GetErrorStatusFlags() as instead.

Parameters

- base – **[in]** XSPI peripheral base address.

Returns

interrupt status flag, use status flag to AND xspi_flags_t could get the related status.

```
static inline bool XSPI_CheckIpRequestGranted(XSPI_Type *base)
```

Check if the IP access request was granted access if enable corresponding interrupt source, the XSPI IRQ will be asserted.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – Ip request granted.
- false – Ip request not granted.

```
static inline bool XSPI_GetBusIdleStatus(XSPI_Type *base)
```

Return whether the bus is idle.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – Bus is idle.
- false – Bus is busy.

```
static inline bool XSPI_CheckAhbReadAccessAsserted(XSPI_Type *base)
```

Check if AHB read access has been requested or is ongoing.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – AHB read access is requested or is ongoing.
- false – AHB read access is not requested and is not ongoing.

static inline bool XSPI_CheckAhbWriteAccessAsserted(XSPI_Type *base)

Check if AHB write access has been requested or is ongoing.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – AHB read access is requested or is ongoing.
- false – AHB read access is not requested and is not ongoing.

static inline uint32_t XSPI_GetCmdExecutionArbitrationStatusFlags(XSPI_Type *base)

Get asserted flags about SFM command execution and arbitration.

Parameters

- base – **[in]** XSPI peripheral base address.

Returns

The assert flags about SFM command execution and arbitration, should be the OR'ed value of xspi_cmd_execution_arbitration_flag_t.

static inline void XSPI_ClearCmdExecutionArbitrationStatusFlags(XSPI_Type *base, uint32_t flags)

Clear asserted flags about SFM command execution and arbitration.

Parameters

- base – **[in]** XSPI peripheral base address.
- flags – **[in]** The mask of flags to clear, should be the OR'ed value of xspi_cmd_execution_arbitration_flag_t.

static inline void XSPI_ResetTxRxBuffer(XSPI_Type *base, bool txFifo, bool rxFifo)

Clear the XSPI IP TX/RX buffer logic.

Parameters

- base – **[in]** XSPI peripheral base address.
- txFifo – **[in]** Pass true to reset TX FIFO.
- rxFifo – **[in]** Pass true to reset RX FIFO.

static inline void XSPI_ClearTxBuffer(XSPI_Type *base)

Clear TX buffer.

Parameters

- base – **[in]** XSPI peripheral base address.

status_t XSPI_UpdateTxBufferWaterMark(XSPI_Type *base, uint32_t waterMark)

Update watermark for TX buffer.

Parameters

- base – **[in]** XSPI peripheral base address.
- waterMark – **[in]** The watermark to set, the unit is byte, should be the multiple of 4 byte.

Return values

- kStatus_XSPI_IPAccessAsserted – Fail to update watermark for Tx buffer, due to IP access is asserted.
- kStatus_XSPI_WaterMarkIllegal – Fail to update watermark for Tx buffer, due to input watermark is not the multiple of 4 bytes.

- kStatus_Success – Successful to update watermark.

static inline bool XSPI_CheckTxBuffLockOpen(XSPI_Type *base)

Check if IP manager can write to TX buffer.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – Tx buffer lock is open.
- false – Tx buffer lock is not open.

static inline void XSPI_WriteTxBuffer(XSPI_Type *base, uint32_t data)

Writes data into IPS TX Buffer.

Parameters

- base – **[in]** XSPI peripheral base address
- data – **[in]** The data bytes to send.

static inline void XSPI_ClearRxBuffer(XSPI_Type *base)

Clear RX buffer.

Parameters

- base – **[in]** XSPI peripheral base address.

static inline uint32_t XSPI_ReadRxBuffer(XSPI_Type *base, uint8_t fifoIndex)

Receive data from IPX RX FIFO.

Parameters

- base – **[in]** XSPI peripheral base address
- fifoIndex – **[in]** Source fifo index.

Returns

The data in the FIFO.

static inline void XSPI_TriggerRxBufferPopEvent(XSPI_Type *base)

Trigger a pop event for RX buffer pop event.

Note: Each pop event discard watermark + 1 enties from RX buffer.

Parameters

- base – **[in]** XSPI peripheral base address.

status_t XSPI_UpdateRxBufferWaterMark(XSPI_Type *base, uint32_t waterMark)

Update watermark for RX buffer.

Set watermark as 4 bytes:
XSPI_UpdateRxBufferWaterMark(XSPI0, 4UL);
Set watermark as 8 bytes:
XSPI_UpdateRxBufferWaterMark(XSPI0, 8UL);

Parameters

- base – **[in]** XSPI peripheral base address.
- waterMark – **[in]** Specify the number of bytes in the RX buffer which causes XSPI to assert the watermark exceeded flag, should be in multiple of 4 bytes.

Return values

- `kStatus_XSPI_IPAccessAsserted` – Fail to update watermark for Rx buffer, due to IP access is asserted.
- `kStatus_XSPI_WaterMarkIllegal` – Fail to update watermark for Tx buffer, due to input watermark is not the multiple of 4 bytes.
- `kStatus_Success` – Successful to update watermark.

```
static inline bool XSPI_CheckRxBufferWaterMarkExceed(XSPI_Type *base)
```

Check if RX buffer watermark is exceed.

Parameters

- `base` – **[in]** XSPI peripheral base address.

Return values

- `true` – The RX buffer watermark has been exceeded.
- `false` – The RX buffer watermark has not been exceeded.

```
static inline uint32_t XSPI_GetRxBufferAvailableBytesCount(XSPI_Type *base)
```

Get RX buffer available bytes count.

Parameters

- `base` – **[in]** XSPI peripheral base address.

Returns

The available counts if bytes in RX buffer.

```
static inline uint32_t XSPI_GetRxBufferRemovedBytesCount(XSPI_Type *base)
```

Get counts of bytes already removed from RX buffer.

Parameters

- `base` – **[in]** XSPI peripheral base address.

Returns

Counts of removed bytes.

```
void XSPI_SetSFPFradEALMode(XSPI_Type *base, xspi_exclusive_access_lock_mode_t ealMode,  
                             uint8_t fradId)
```

Set exclusive access lock mode for the specific frad..

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `ealMode` – **[in]** Specify the exclusive access lock mode.
- `fradId` – **[in]** Specify the frad.

```
void XSPI_UpdateSFPConfig(XSPI_Type *base, xspi_sfp_mdad_config_t *ptrSfpMdadConfig,  
                           xspi_sfp_frad_config_t *ptrSfpFradConfig)
```

Update SFP configurations, including MDAD configurations and FRAD configurations.

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `ptrMdadConfig` – **[in]** Pointer to the SFP MDAD configuration.
- `ptrFradConfig` – **[in]** Pointer to the SFP FRAD configuration.

static inline bool XSPI_CheckSFPFradEnabled(XSPI_Type *base)

Check if SFP FRAD check is enabled for IP write access.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- false – SFP FRAD check is disabled.
- true – SFP FRAD check is enabled for IP write access.

xspi_mdad_error_reason_t XSPI_GetMdadErrorReason(XSPI_Type *base, *xspi_target_group_t* tgId)

Get MDAD check error reason for specific target group.

Parameters

- base – **[in]** XSPI peripheral base address.
- tgId – **[in]** Specify the target group.

Returns

The details of MDAD error reason, in type of *xspi_mdad_error_reason_t*.

void XSPI_GetFradLastTransactionsInfo(XSPI_Type *base, *xspi_frad_transaction_info_t* *ptrInfo, uint8_t fradId)

Get FARD latest transaction information.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrInfo – **[out]** Pointer to the variable in type of *xspi_frad_transaction_info_t* to store information.
- fradId – **[in]** Specify the frad Id.

status_t XSPI_UpdateSFPArbitrationLockTimeoutCounter(XSPI_Type *base, uint32_t countValue)

Update SFP arbitration lock timeout counter.

Note: The SFP arbitration lock time out counter starts when Page program wait flag asserted.

Parameters

- base – **[in]** XSPI peripheral base address.
- countValue – **[in]** The count value, specify the time in IPS clock cycles.

Return values

- kStatus_XSPI_RegWriteLocked – Write operation to related register is locked.
- kStatus_Success – Success to update timeout counter.

void XSPI_ClearTgAddrWriteStatus(XSPI_Type *base, *xspi_target_group_t* tgId)

Clear address write status for specific target group.

Parameters

- base – **[in]** XSPI peripheral base address.
- tgId – **[in]** Specify the target group to clear address write status.

```
void XSPI_GetTgAddrWriteStatus(XSPI_Type *base, xspi_target_group_t tgId,  
                             xspi_tg_add_write_status_t *ptrStatus)
```

Get address write status for specific target group.

Parameters

- base – **[in]** XSPI peripheral base address.
- tgId – **[in]** Specify the target group.
- ptrStatus – **[out]** Pointer to the variable in type of xspi_tg_add_write_status_t to store address write status.

```
void XSPI_UnlockIpAccessArbitration(XSPI_Type *base, xspi_target_group_t tgId)
```

Unlock Ip access arbitration.

Parameters

- base – **[in]** XSPI peripheral base address.
- tgId – **[in]** Specify the target group.

```
static inline bool XSPI_CheckIPAccessAsserted(XSPI_Type *base)
```

Check if IP access is asserted.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- false – The Access triggered by IP bus is not asserted.
- true – The Access triggered by IP bus is asserted.

```
static inline void XSPI_ClearIPAccessSeqPointer(XSPI_Type *base)
```

Clear Ip access sequence pointer.

Parameters

- base – **[in]** XSPI peripheral base address.

```
status_t XSPI_UpdateIPAccessTimeoutCounter(XSPI_Type *base, uint32_t countValue)
```

Update the count of SFP access timeout counter.

Note: The counter starts when any IP access pass SFP check(if enabled), and request is granted by XSPI arbiter and XSPI is IDLE.

Note: The counter does not start in case of IP access was granted by XSPI is not IDLE.

Parameters

- base – XSPI peripheral base address.
- countValue – The count value, specify the time in IPS clock cycles.

Return values

- kStatus_XSPI_RegWriteLocked – Write operation to related register is locked.
- kStatus_Success – Success to update timeout counter.

static inline bool XSPI_CheckIPAccessGranted(XSPI_Type *base)

Check if IP access is granted by XSPI arbitration.

Deprecated:

Use XSPI_CheckIpRequestGranted() as instead

Parameters

- base – XSPI peripheral base address.

Return values

- true – The IP access is granted arbitration.
- false – No IP access is queued.

static inline bool XSPI_CheckIpWriteTriggered(XSPI_Type *base)

Check if IP write access is triggered.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – The IP write access is granted arbitration.
- false – No IP write access is queued.

static inline bool XSPI_CheckIpReadTriggered(XSPI_Type *base)

Check if IP read access is triggered.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – The IP read access is granted arbitration.
- false – No IP read access is queued.

static inline bool XSPI_CheckFSMValid(XSPI_Type *base)

Check if IPS transfer is granted arbitration or execution.

Note: The FSMSTAT[VLD] goes to 0 once the IPS transfer is completed and XSPI is IDLE.

Parameters

- base – **[in]** XSPI peripheral base address.

Return values

- true – Valid, the IPS transfer is granted arbitration or execution.
- false – Not valid, no IPS transfer is queued.

status_t XSPI_StartIpAccess(XSPI_Type *base, uint32_t addr, uint8_t seqIndex, size_t byteSize,
xspi_target_group_t tgId, bool lockArbitration)

Start IP access(including read and write) in blocking way.

Parameters

- base – **[in]** XSPI peripheral base address.
- addr – **[in]** Address of external device to read/write.

- seqIndex – **[in]** Sequence Id of the pre-programmed LUT.
- byteSize – **[in]** Size of data to read/write, the unit of byte.
- tgId – **[in]** Specify the target group used to write/read.
- lockArbitration – **[in]** Lock arbitration or not.

Return values

- kStatus_XSPI_IpAccessAddrSettingInvalid – Wrong Address input.
- kStatus_XSPI_IpAccessIPCRInvalid – Wrong seqindex or bytesize input.
- kStatus_Success – Success to start Ip access.

status_t XSPI_StartIpAccessNonBlocking(XSPI_Type *base, uint32_t addr, uint8_t seqIndex, size_t byteSize, *xspi_target_group_t* tgId, bool lockArbitration)

Start IP access in non-blocking way.

Parameters

- base – **[in]** XSPI peripheral base address.
- addr – **[in]** Address of external device to read/write.
- seqIndex – **[in]** Sequence Id of the pre-programmed LUT.
- byteSize – **[in]** Size of data to transfer, the unit of byte.
- tgId – **[in]** Specify the target group to use.
- lockArbitration – **[in]** Lock arbitration or not.

Return values

- kStatus_Success – Success to start Ip access.
- kStatus_XSPI_IpAccessIPCRInvalid – Invalid to set IPCR register.
- kStatus_XSPI_IpAccessAddrSettingInvalid – Invalid to set SFAR register.

status_t XSPI_SetIpAccessConfig(XSPI_Type *base, *xspi_ip_access_config_t* *ptrIpAccessConfig)

Set IP access configurations, including SFP configurations, sfp arbitration lock timeout value, Ip access timeout value.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrIpAccessConfig – **[in]** Pointer to the variable which contains Ip access configurations.

Return values

- kStatus_XSPI_RegWriteLocked – Write operation to related register is locked.
- kStatus_Success – Success to update timeout counter.

status_t XSPI_WriteBlocking(XSPI_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 – **[in]** XSPI peripheral base address
- buffer – **[in]** Pointer to the buffer to send.

- size – **[in]** The number of data bytes to send

Return values

- kStatus__Success – write success without error
- kStatus__XSPI__SequenceExecutionTimeout – sequence execution timeout
- kStatus__XSPI__IpCommandSequenceError – IP command sequence error detected
- kStatus__XSPI__IpCommandGrantTimeout – IP command grant timeout detected

status_t XSPI_ReadBlocking(XSPI_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 – **[in]** XSPI peripheral base address
- buffer – **[out]** Pointer to the buffer to store read data.
- size – **[in]** The number of data bytes to receive

Return values

- kStatus__Success – read success without error
- kStatus__XSPI__SequenceExecutionTimeout – sequence execution timeout
- kStatus__XSPI__IpCommandSequenceError – IP command sequence error detected
- kStatus__XSPI__IpCommandGrantTimeout – IP command grant timeout detected

status_t XSPI_TransferBlocking(XSPI_Type *base, *xspi_transfer_t* *xfer)

Execute command to transfer a buffer data bytes using a blocking method.

Note: In case of flash page program, if WEL(Write enable) automatically cleared after program operation, then WEL should be asserted before invoking this API and the transfer size should not bigger than page size.

Parameters

- base – **[in]** XSPI peripheral base address
- xfer – **[in]** pointer to the transfer structure.

Return values

- kStatus__Success – command transfer success without error
- kStatus__XSPI__SequenceExecutionTimeout – sequence execution timeout
- kStatus__XSPI__IpCommandSequenceError – IP command sequence error detected
- kStatus__XSPI__IpCommandGrantTimeout – IP command grant timeout detected


```
void XSPI_TransferCreateHandle(XSPI_Type *base, xspi_handle_t *handle,
                             xspi_transfer_callback_t callback, void *userData)
```

Initialize the XSPI handle which is used in transactional functions.

Parameters

- base – **[in]** XSPI peripheral base address.
- handle – **[in]** pointer to xspi_handle_t structure to store the transfer state.
- callback – **[in]** pointer to user callback function.
- userData – **[in]** user parameter passed to the callback function.

```
status_t XSPI_TransferNonBlocking(XSPI_Type *base, xspi_handle_t *handle, xspi_transfer_t
                                *xfer)
```

Perform a interrupt non-blocking transfer on the XSPI bus.

Note: Calling the API returns immediately after transfer initiates. The user needs to call XSPI_GetTransferCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_XSPI_Busy, the transfer is finished. For XSPI_Read, the dataSize should be multiple of rx watermark level, or XSPI could not read data properly.

Parameters

- base – **[in]** XSPI peripheral base address.
- handle – **[in]** pointer to xspi_handle_t structure which stores the transfer state.
- xfer – **[in]** pointer to xspi_transfer_t structure.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_XSPI_Busy – Previous transmission still not finished.

```
status_t XSPI_TransferGetCount(XSPI_Type *base, xspi_handle_t *handle, size_t *count)
```

Get the master transfer status during a interrupt non-blocking transfer.

Parameters

- base – **[in]** XSPI peripheral base address.
- handle – **[in]** pointer to xspi_handle_t structure which stores the transfer state.
- count – **[out]** 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 XSPI_TransferAbort(XSPI_Type *base, xspi_handle_t *handle)
```

Abort 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 – **[in]** XSPI peripheral base address.
- handle – **[in]** pointer to `xspi_handle_t` structure which stores the transfer state

static inline void XSPI_ClearAhbBuffer(XSPI_Type *base)

Blocks to clear AHB buffer and abort ongoing prefetch transaction(if prefetch is enabled.)

Note: The function return only after all AHB buffer pointers are cleared.

Parameters

- base – **[in]** XSPI peripheral base address.

status_t XSPI_EnableAhbBufferWriteFlush(XSPI_Type *base, bool enable)

Enable/disable the clearing of AHB read prefetch buffers when the same flash address is written by an AHB or IP command.

Parameters

- base – **[in]** XSPI peripheral base address.
- enable – **[in]** Used to enable/disable write flush.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted.
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted.
- `kStatus_Success` – Successfully to enable/disable AHB buffer write flush.

status_t XSPI_SetAhbBufferConfig(XSPI_Type *base, *xspi_ahbBuffer_config_t* *ptrBuffer0Config, *xspi_ahbBuffer_config_t* *ptrBuffer1Config, *xspi_ahbBuffer_config_t* *ptrBuffer2Config, *xspi_ahbBuffer_config_t* *ptrBuffer3Config)

Set AHB buffer configurations.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrBuffer0Config – **[in]** Pointer to the variable which contain buffer0 configurations.
- ptrBuffer1Config – **[in]** Pointer to the variable which contain buffer1 configurations.
- ptrBuffer2Config – **[in]** Pointer to the variable which contain buffer2 configurations.
- ptrBuffer3Config – **[in]** Pointer to the variable which contain buffer3 configurations.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted.
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted.
- `kStatus_Success` – Success to set AHB buffer configurations.

```
status_t XSPI_UpdateAhbBufferSize(XSPI_Type *base, uint16_t buf0Size, uint16_t buf1Size,  
                                uint16_t buf2Size, uint16_t buf3Size)
```

Set Buffer size for all 4 AHB buffers.

Parameters

- base – **[in]** XSPI peripheral base address.
- buf0Size – **[in]** Specify size of AHB buffer0, range of 512, 256, 128, 64, 32, 16, 8, 4, 2, 0.
- buf1Size – **[in]** Specify size of AHB buffer1, range of 512, 256, 128, 64, 32, 16, 8, 4, 2, 0.
- buf2Size – **[in]** Specify size of AHB buffer2, range of 512, 256, 128, 64, 32, 16, 8, 4, 2, 0.
- buf3Size – **[in]** Specify size of AHB buffer3, range of 512, 256, 128, 64, 32, 16, 8, 4, 2, 0.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted.
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted.
- kStatus_Success – Success to set AHB buffer size.

```
xspi_ahb_sub_buffer_status_t XSPI_GetAhbSubBufferStatus(XSPI_Type *base, uint8_t  
                                                         ahbBufferId, uint8_t subBufferId)
```

Get status of AHB sub buffer.

Note: This function only useful when sub-division feature of the selected AHB buffer is enabled.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** The Id of AHB buffer, range from 0 to 3.
- subBufferId – **[in]** The Id of AHB buffer sub division, range from 0 to 3.

Returns

Current status of selected AHB sub buffer, in type of `xspi_ahb_sub_buffer_status_t`.

```
static inline void XSPI_StartAhbBufferPerfMonitor(XSPI_Type *base)
```

Start AHB buffer performance monitor.

Parameters

- base – **[in]** XSPI peripheral base address.

```
void XSPI_EnableAhbBufferPerfMonitor(XSPI_Type *base, uint8_t ahbBufferId, uint8_t  
                                    subBufferId)
```

Enable AHB buffer performance monitor for selected AHB buffer's sub buffer.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** Specify the selected AHB buffer.
- subBufferId – **[in]** Specify the selected sub-buffer.

static inline void XSPI_DisableAhbBufferPerfMonitor(XSPI_Type *base, uint8_t ahbBufferId)
Disable AHB buffer performance monitor for selected AHB buffer.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** Specify the selected AHB buffer.

static inline void XSPI_StopAhbBufferPerfMonitor(XSPI_Type *base)
Stop AHB buffer performance monitor.

Parameters

- base – **[in]** XSPI peripheral base address.

static inline void XSPI_GetAhbBufferPerfMonitorResult(XSPI_Type *base, uint8_t ahbBufferId,
xspi_ahbBuffer_perf_monitor_result_t
*ptrPerfMonitorResult)

Get AHB buffer performance monitor result.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** Specify AHB buffer Id.
- ptrPerfMonitorResult – **[out]** Pointer to the variable to store selected AHB buffer's performance monitor result.

static inline bool XSPI_CheckAhbBufferPerfMonitorTimeCounterOverflow(XSPI_Type *base)
Check if AHB buffer performance monitor timeout counter is overflow.

Parameters

- base – XSPI peripheral base address.

Return values

- false – AHB buffer performance monitor timeout counter is not overflow.
- true – AHB buffer performance monitor timeout counter is overflow.

static inline bool XSPI_CheckAhbBufferPerfMonitorHitOverflow(XSPI_Type *base, uint8_t
ahbBufferId)

Check if AHB buffer performance monitor buffer hit counter is overflow.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** Specify the AHB buffer Id.

Return values

- false – Overflow not detected.
- true – Overflow is detected.

static inline bool XSPI_CheckAhbBufferPerfMonitorMissOverflow(XSPI_Type *base, uint8_t
ahbBufferId)

Check if AHB buffer performance monitor buffer miss counter is overflow.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbBufferId – **[in]** Specify the AHB buffer Id.

Return values

- false – Overflow not detected.
- true – Overflow is detected.

static inline uint32_t XSPI_GetAhbBufferPerfMonitorTimeCounter(XSPI_Type *base)

Get AHB buffer performance monitor timeout value.

Parameters

- base – **[in]** XSPI peripheral base address.

Returns

The value of time counter, in AHB clock cycles, since the performance monitor was running.

status_t XSPI_SetAhbAccessSplitSize(XSPI_Type *base, xspi_ahb_split_size_t ahbSplitSize)

Set AHB transaction(read/write) split size.

Note: For AHB write, if enable split feature(ahbSplitSize not set as kXSPI_AhbSplitSizeDisabled), XSPI will split one single AHB write burst into smaller bursts on external device side.

Note: For AHB read, if enable split feature, HW will realign the prefetch size to split size and in that way split a single read burst into smaller bursts.

Parameters

- base – **[in]** XSPI peripheral base address.
- ahbSplitSize – **[in]** Specify the AHB split size.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted
- kStatus_XSPI_RegWriteLocked – Fail due to write operation to related registers is locked.
- kStatus_Success – Success to set AHB access split size.

status_t XSPI_SetAhbAccessBoundary(XSPI_Type *base, xspi_ahb_alignment_t alignment)

Set AHB transaction(read/write) boundary.

Note: For AHB write, XSPI keeps track of the start address and then compares it with the address of subsequent transaction receive on the AHB bus, when the input alignment is reached, XSPI negates AHB HREADY to block new accesses. This signal will be kept low until all the previous received write data is written to external memory and chip select is de-asserted. After that it allows next AHB write data to be received by making HREADY high thus ensuring that transaction is split at address boundary on external memory.

Note: For AHB read, XSPI checks the start address and end address to see if it is crossing the address boundary specified by input alignment. If the transaction crosses the address boundary, then it reduces the transaction size such that the data pre-fetch is stopped before the address boundary. Now if the AHB master is reading the data sequentially it will get buffer hits up to the input alignment boundary. When it reaches the next address boundary

it will get a buffer miss and a new data pre-fetch will be launched towards the external memory device.

Parameters

- base – **[in]** XSPI peripheral base address.
- alignment – **[in]** Specify the AHB alignment, in type of `xspi_ahb_alignment_t`.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_RegWriteLocked` – Fail due to write operation to related registers is locked.
- `kStatus_Success` – Success to set AHB access boundary.

status_t XSPI_SetAhbReadDataSeqId(XSPI_Type *base, uint8_t seqId)

Set AHB read sequence Id.

Parameters

- base – **[in]** XSPI peripheral base address.
- seqId – **[in]** Specify the sequence Id in LUT used for AHB read.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_RegWriteLocked` – Fail due to write operation to related registers is locked.
- `kStatus_Success` – Success to set AHB read sequence Id.

status_t XSPI_SetAhbWriteDataSeqId(XSPI_Type *base, uint8_t seqId)

Set AHB write sequence Id.

Parameters

- base – **[in]** XSPI peripheral base address.
- seqId – **[in]** Specify the sequence Id in LUT used for AHB write.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_RegWriteLocked` – Fail due to write operation to related registers is locked.
- `kStatus_Success` – Success to set AHB write sequence Id.

status_t XSPI_UpdateAhbHreadyTimeOutValue(XSPI_Type *base, uint16_t timeoutValue)

Specify how long XSPI can hold HEADY low while waiting for response to an AHB transfer.

Note: If the specified time out value expired, an AHB illegal transaction error will be triggered.

Parameters

- base – **[in]** XSPI peripheral base address.
- timeoutValue – **[in]** In multiples of 50000 AHB clock cycles, default value is 3, it means waiting for 150000 AHB clock cycles.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted
- kStatus_Success – Success to set AHB HREADY timeout value.

status_t XSPI_SetAhbErrorPayload(XSPI_Type *base, uint32_t highPayload, uint32_t lowPayload)

Pre-define error payload which will be provided on the read data bus when the HEADY timeout counter expires.

Note: If the incoming AHB read request master is not mapped to any of the AHB buffer, the XSPI will keep the AHB HREADY signal low and will provided this pre-defined error payload on the AHB read data bus when the HEADY timeout counter expires.

Parameters

- base – **[in]** XSPI peripheral base address.
- highPayload – **[in]** High 32bits payload to set.
- lowPayload – **[in]** Low 32bits payload to set.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted
- kStatus_Success – Success to set AHB HREADY timeout value.

xspi_ahb_read_error_info_t XSPI_ReturnAhbReadErrorInfo(XSPI_Type *base)

Return AHB read error information.

Parameters

- base – **[in]** XSPI peripheral base address.

Returns

Latest AHB read error information, in type of *xspi_ahb_read_error_info_t*.

static inline void XSPI_ClearAhbAccessSeqPointer(XSPI_Type *base)

Clear AHB access sequence pointer.

Parameters

- base – **[in]** XSPI peripheral base address.

```
void XSPI_GetAhbRequestSuspendInfo(XSPI_Type *base, xspi_ahb_request_suspend_info_t  
                                *ptrSuspendInfo)
```

Get Ahb request suspend information if priority mechanism is enabled.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrSuspendInfo – **[out]** Contain latest suspend info, the value may be 0xFF if the item is invalid in current suspend state.

```
static inline void XSPI_EnableAhbReadPrefetch(XSPI_Type *base, bool enable)
```

Enable/disable AHB Read Prefetch feature.

Parameters

- base – **[in]** XSPI peripheral base address.
- enable – **[in]** Used to enable/disable AHB read prefetch:
 - **false** Disable AHB read prefetch;
 - **true** Enable AHB read prefetch.

```
status_t XSPI_BlockAccessAfterAhbWrite(XSPI_Type *base, bool blockSequentWrite, bool  
                                       blockRead)
```

Block access(write and read) after the AHB write operation.

Note: If external flash support RWW, read should not be blocked:

```
XSPI_BlockAccessAfterAhbWrite(XSPI0, true, false);
```

Note: If either of access is blocked, the page program wait flag will be asserted after an AHB write sequence completed. The assertion of flag will lock the arbitration and all access to the external memory are blocked. And the internal “page wait time” counter starts(Invoke XSPI_UpdatePageWaitTimeCounter to update counter value). After this counter reaches the value, a read is triggered by the XSPI module to read external device’s status register(The seq id should be pre-defined by XSPI_SetAhbReadStatusRegSeqId), and the value is stored in the XSPI internal register. And there are two options(Invoke XSPI_SelectPPWFlagClearPolicy to select) to clear the asserted page program wait flag.

- a. Automatic cleared by XSPI hardware;
 - b. Cleared by software.
-

Note:

As soon as the page program wait flag is asserted, another counter(SFP arbitration lock counter) also started, if the flag not cleared in desired counter value the arbitration lock timeout error will be generated.

Parameters

- base – **[in]** XSPI peripheral base address.
- blockSequentWrite – **[in]** Block sequence write or not.
- blockRead – **[in]** Block read or not.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_Success` – Success to set related registers..

status_t XSPI_SelectPPWFlagClearPolicy(XSPI_Type *base, *xspi_ppw_flag_clear_policy_t* policy)
Set Page program wait flag clear policy.

Note: If set as hardware policy, the device's WIP information should be set by invoking `XSPI_SetSFMStatusRegInfo()`

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `policy` – **[in]** Specify the policy to clear page program wait flag.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_RegWriteLocked` – Fail due to write operation to related registers is locked.
- `kStatus_Success` – Success to set PPW flag clear policy.

status_t XSPI_UpdatePageWaitTimeCounter(XSPI_Type *base, *uint32_t* countValue)
Update page wait timeout counter.

Parameters

- `base` – **[in]** XSPI peripheral base address.
- `countValue` – **[in]** The value of counter, in AHB clock cycles.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_PageProgramWaitFlagAsserted` – Page program wait flag already asserted.
- `kStatus_Success` – Successfully to update page wait timeout counter.

status_t XSPI_SetAhbReadStatusRegSeqId(XSPI_Type *base, *uint8_t* seqId)
Set AHB read status register sequence Id.

Note: The read status sequence only triggered when the page wait time counter expired.

Parameters

- `base` – **[in]** XSPI peripheral base address.

- seqId – **[in]** Specify the sequence Id in LUT used for AHB read status register.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted
- kStatus_XSPI_RegWriteLocked – Fail due to write operation to related registers is locked.
- kStatus_Success – Success to set AHB read status register sequence Id.

```
static inline uint16_t XSPI_GetSFMStatusRegValue(XSPI_Type *base)
```

Get external serial flash's status register value.

Note: This function is only useful after the Page program wait flag is asserted due to either wait/read access is blocked after the AHB write operation.

Parameters

- base – **[in]** XSPI peripheral base address.

Returns

The status register value of external device.

```
status_t XSPI_SetSFMStatusRegInfo(XSPI_Type *base, xspi_device_status_reg_info_t  
                                *ptrStatusRegInfo)
```

Set Serial flash memory status register information.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrStatusRegInfo – **[in]** Pointer to the variable which contain status register information.

Return values

- kStatus_XSPI_AhbReadAccessAsserted – Fail due to an AHB read access already asserted
- kStatus_XSPI_AhbWriteAccessAsserted – Fail due to an AHB write access already asserted
- kStatus_XSPI_PageProgramWaitFlagAsserted – Page program wait flag already asserted.
- kStatus_Success – Successfully to set status register information.

```
status_t XSPI_SetAhbAccessConfig(XSPI_Type *base, xspi_ahb_access_config_t  
                                *ptrAhbAccessConfig)
```

Set AHB access configuration.

Parameters

- base – **[in]** XSPI peripheral base address.
- ptrAhbAccessConfig – **[in]** Pointer to the variable which contains AHB access configurations.

Return values

- `kStatus_XSPI_AhbReadAccessAsserted` – Fail due to an AHB read access already asserted
- `kStatus_XSPI_AhbWriteAccessAsserted` – Fail due to an AHB write access already asserted
- `kStatus_XSPI_RegWriteLocked` – Fail due to write operation to related registers is locked.
- `kStatus_Success` – Success to set AHB read status register sequence Id.

```
void XSPI_Cache64_SetRegionConfig(CACHE64_POLSEL_Type *base,  
                                xspi_cache64_region_config_t *config)
```

Set policy of cache regions.

Parameters

- `base` – CACHE64_POLSEL peripheral base address.
- `config` – Pointer to the structure `xspi_cache64_region_config_t`.

```
struct _xspi_device_status_reg_info
```

#include <fsl_xspi.h> The structure of external device's status register information(location, priority).

Note: Only useful when AHB write to flash device is enabled, and use hardware to clear ppw flag.

Public Members

```
uint8_t wipLocation
```

WIP bit field's location.

```
bool upperHalfWordSelected
```

Specify which half word(upper or lower) is selected.

```
bool value1Expired
```

Specify the value to be check o selected wip location to determine if the page progame wait period is expired, true means expected value is 1, false means expected value is 0.

```
union _xspi_dll_para
```

#include <fsl_xspi.h> The union of user custommed DLL parameters, in case of `kXSPI_BypassMode` `bypassModePara` is used, in case of `kXSPI_AutoUpdateMode` `autoUpdateModoPara` is used.

Public Members

```
struct _xspi_dll_para bypassModePara
```

```
struct _xspi_dll_para autoUpdateModoPara
```

```
struct _xspi_dll_config
```

#include <fsl_xspi.h> The structure of Delay-lock-loop configuration.

Public Members

xspi_dll_mode_t dllMode

Dll mode auto update mode or bypass mode

bool useRefValue

Specify to use reference value or not, if the reference code do not satisfy the specific usecase, it is application's responsibility to set custom parameters

- **true:** following inputs are ignored, use the reference values provided by NXP as instead;
- **false:** following inputs take effect.

xspi_dll_para_t dllCustomPara

User custommed parameter to configure DLL, different DLL mode corresponding to different parameters, please refer to the union *xspi_dll_para_t*.

uint8_t dllCustomDelayTapNum

User custommed number of delay elements for each delay tap.

bool enableCdl8

Enable course delay line 8.

struct *_xspi_data_learning_config*

#include <fsl_xspi.h> The configuration of data learning.

Note: Data learning feature only supported in the DQS sampling method(*kXSPI_SampleClkFromExternalDQS*).

Public Members

uint32_t pattern

Pre-defiend pattern to match.

bool deviceSupported

Specify if external device support data learning feature.

xspi_data_learning_pad_select_t padSelected

Used to select pad which use for pattern matching IO.

struct *_xspi_sample_clk_config*

#include <fsl_xspi.h> Sample clock configuration, which used to sample data from external device.

Public Members

xspi_sample_clk_source_t sampleClkSource

Specify the sample clock source.

bool enableDQSLatency

Enable DQS latency or not.

xspi_dll_config_t dllConfig

Specify the DLL configuration, to improve data accuracy, please adjust DLL settings based on specific use.

union *_xspi_device_interface_settings*

#include <fsl_xspi.h> The union of external device's settings, if external device following hyper bus protocol *hyperBusSettings* take effects, if external device following SPI protocol *strandardExtendedSPISettings* take effects.

Public Members

struct *_xspi_device_interface_settings* standardExtendedSPISettings

struct *_xspi_device_interface_settings* hyperBusSettings

struct *_xspi_device_ddr_config*

#include <fsl_xspi.h> The structure of device DDR configuration.

Public Members

bool enableDdr

Used to enable/disable DDR mode.

xspi_ddr_data_aligned_clk_t ddrDataAlignedClk

Specify the DDR data aligned clock.

bool enableByteSwapInOctalMode

Swap byte order in octal mode.

struct *_xspi_device_config*

#include <fsl_xspi.h> External device configuration items.

Public Members

uint32_t xspiRootClk

XSPI serial root clock.

bool enableCknPad

Enable/disable clock on differential CKN pad for flash memory A.

xspi_device_interface_type_t deviceInterface

Type of external device's interface: hyperBus or Standard/Extended SPI.

xspi_device_interface_settings_t interfaceSettings

Settings of specified interface.

uint8_t CSHoldTime

CS line hold time.

uint8_t CSSetupTime

CS line setup time.

xspi_sample_clk_config_t sampleClkConfig

Configuration of sample clock.

xspi_device_ddr_config_t *ptrDeviceDdrConfig

Set as NULL to set device as SDR mode, to change to DDR mode, this member should be populated.

xspi_device_addr_mode_t addrMode

Address mode of external device.

uint8_t columnAddrWidth

Width of column address.

bool enableCASInterleaving

Usually enabled in dual-die device.

uint32_t deviceSize[XSPI_SFAD_COUNT2]

Size of external device, the unit is KB.

xspi_device_status_reg_info_t *ptrDeviceRegInfo

Pointer to the structure to store external device's WIP register information, should set as NULL if AHB page write is not used or if AHB page write is used but use software policy to clear flag.

struct __xspi_mdad_config

#include <fsl_xspi.h> MDAD configuration.

Public Members

bool assignIsValid

Specify if the MDAD configuration for the target group is valid

bool enableDescriptorLock

This field provides a means to make the MDAD descriptor read-only. Once written '1' this field will remain '1' until hard reset

uint8_t maskType

0b - ANDed mask 1b - ORed mask

uint8_t mask

Defines the 6-bit mask value for the ID-Match comparison

uint8_t masterIdReference

Specifies the reference value of the Master-ID for MID-comparison

xspi_secure_attribute_t secureAttribute

Defines the secure attribute selection criteria for entry into descriptor queue

struct __xspi_sfp_mdad_config

#include <fsl_xspi.h> The structure of SFP MDAD configurations for all target groups.

Public Members

xspi_mdad_config_t tgMdad[(2U)]

Specify MDAD configurations for each target group.

struct __xspi_frad_config_t

#include <fsl_xspi.h> FRAD configuration.

Public Members

uint32_t startAddress

Specifies the specific flash memory region starting address

uint32_t endAddress

Specifies the specific flash memory region end address

uint8_t tg0MasterAccess

This field define the access restrictions for respective Master Domain corresponding to this FRAD region. Access permissions are decided based on secure an privilege attributes of current transaction. Read access is not restricted.

bool assignIsValid

This field indicates whether the FRAD Descriptor for a specific flash region is valid.

xspi_descriptor_lock_t descriptorLock

This field enables masking of accidental write on FRAD registers. Lock is enabled/disabled by Secure/ Privileged master.

xspi_exclusive_access_lock_mode_t exclusiveAccessLock

This field provides exclusive write lock over a FRAD region based on MDnACP.

struct *_xspi_sfp_frad_config*

#include <fsl_xspi.h> The structure of SFP FRAD configurations.

Public Members

xspi_frad_config_t fradConfig[(8U)]

Specify FRAD configuration for each item.

struct *_xspi_frad_transaction_info*

#include <fsl_xspi.h> The structure of latest FRAD transaction information.

Public Members

uint32_t startAddr

Latest IP access start address.

uint8_t masterId

Latest IP access master Id.

bool isSecureAccess

Latest IP access is secure access or not.

bool isPrivilegeAccess

Latest IP access is privilege access or not.

bool isCompError

Indicates the error status of the flash region specific comparison check for the latest transaction.

bool isCompValid

Indicates availability of the result or status of a flash region-specific comparison check.

struct *_xspi_ip_access_config*

#include <fsl_xspi.h> Configurations of IP access(including IP read and write).

Public Members

xspi_sfp_mdad_config_t *ptrSfpMdadConfig

Pointer to the variable in type of *xspi_sfp_mdad_config_t* to set SFP MDAD feature, set as NULL to disable SFP MDAD feature.

xspi_sfp_frad_config_t *ptrSfpFradConfig

Pointer to the variable in type of *xspi_sfp_frad_config_t* to set SFP FRAD feature, set as NULL to disable SFP FRAD

uint32_t sfpArbitrationLockTimeoutValue

Specify the time in IPS clock cycles before an unreleased arbitration triggers a timeout error.

uint32_t ipAccessTimeoutValue

Specify the maximum time in IPS clock cycles for XSPI to wait for an ongoing write or read command to complete before terminating the command.

struct __xspi_tg_add_write_status

#include <fsl_xspi.h> The status of latest target group address write operation.

Public Members

uint8_t managerId

Manager Id of TG address write operation.

bool secureWrite

TG address write operation is secure write.

bool privilegedWrite

TG address write operation is privileged.

struct __xspi_transfer

#include <fsl_xspi.h> Transfer structure used for XSPI functional interface.

Public Members

uint32_t deviceAddress

Operation device address.

xspi_command_type_t cmdType

Execution command type.

uint8_t seqIndex

Sequence ID for command.

uint32_t *data

Data buffer.

size_t dataSize

Data size in bytes.

xspi_target_group_t targetGroup

Target group. include targetGroup[0] targetGroup[1]

struct __xspi_handle

#include <fsl_xspi.h> Transfer handle structure for XSPI.

Public Members

uint32_t state

Internal state for XSPI transfer

uint8_t *data

Data buffer.

size_t dataSize

Remaining Data size in bytes.

size_t transferTotalSize

Total Data size in bytes.

xspi_transfer_callback_t completionCallback
Callback for users while transfer finish or error occurred

void *userData
XSPI callback function parameter.

size_t curTransferSize
Transfer size of current IP access.

struct __xspi_ahbBuffer_sub_buffer_config
#include <fsl_xspi.h> The structure of sub-buffer configurations.

Public Members

xspi_subbuffer_division_factor_t divFactor
Specify the divide factor for current sub-buffer.

uint32_t startAddr
Specify the start address of current sub-buffer.

uint32_t endAddr
Specify the end address of current sub-buffer.

bool enableAhbMonitor
Enable/disable AHB performance monitor for current sub-buffer.

struct __xspi_ahbBuffer_config
#include <fsl_xspi.h> Structure of AHB buffer configurations.

Note: When an AHB read access comes it is assigned to a buffer based on its master ID. Then it further assigned to a sub-buffer based on which sub-buffer address range this transaction lies into.

Note: When sub-buffer division is hit, in case of a buffer miss the controller will fetch the data equal to the size of that sub-buffer.

Note: If sub-buffer division is enabled for a buffer the hit/miss check is done at sub-buffer level. And if prefetch is enable, the prefetch takes place for individual sub-buffers.

Public Members

uint8_t masterId
Specify the ID of the AHB master to be associated with buffer.

xspi_ahbBuffer_sub_buffer_config_t *ptrSubBuffer0Config
Pointer to sub buffer0's configuration.

xspi_ahbBuffer_sub_buffer_config_t *ptrSubBuffer1Config
Pointer to sub buffer1's configuration.

xspi_ahbBuffer_sub_buffer_config_t *ptrSubBuffer2Config
Pointer to sub buffer2's configuration.

xspi_ahbBuffer_sub_buffer_config_t *ptrSubBuffer3Config

Pointer to sub buffer3's configuration.

struct *_xspi_ahbBuffer_perf_monitor_result*

#include <fsl_xspi.h> The result of AHB buffer performance monitor, including buffer miss count and buffer hit count.

Public Members

uint16_t bufferMissCount

Count of AHB read buffer miss events.

uint16_t bufferHitCount

Count of AHB read buffer hit events.

struct *_xspi_ahb_write_config*

#include <fsl_xspi.h> The configuration of AHB write access.

Public Members

bool blockSequenceWrite

Enable/disable sequence write operation after page program start.

bool blockRead

Enable/disable read operation after page program start, can be false for RWW extern device.

xspi_ppw_flag_clear_policy_t policy

Specify the policy to clear ppw flag, hardware or software.

uint32_t pageWaitTimeoutValue

Specify, in AHB clock cycles, how long XSPI waits before triggering a read of the device status register, only useful in hardware policy.

uint8_t AWRSeqIndex

Specify the sequence index for AHB write.

uint8_t ARDSRSeqIndex

Specify the sequence index for AHB read status, only useful if either sequence write or read is blocked.

struct *_xspi_ahb_access_config*

#include <fsl_xspi.h> The structure of AHB access configurations, including AHB buffer settings, AHB Read Seq ID, AHB write settings.

Public Members

xspi_ahbBuffer_config_t buffer[4]

AHB buffer size.

uint8_t ARDSeqIndex

Specify the sequence index for AHB read data.

bool enableAHBPrefetch

Enable/disable AHB read prefetch feature, when enabled, XSPI will fetch more data than current AHB burst.

bool enableAHBBufferWriteFlush

Set true to enable flush of AHB buffer, due to either AHB write or IP access to avoid stable data in AHB buffer.

xspi_ahb_split_size_t ahbSplitSize

Specify ahb split size, set as kXSPI_AhbSplitSizeDisabled if do not want to use this feature.

xspi_ahb_alignment_t ahbAlignment

AHB access towards flash is broken if this AHB alignment boundary is crossed, only support XSPI0 XSPI1

xspi_ahb_write_config_t *ptrAhbWriteConfig

Set as NULL if AHB write feature is not used.

struct __xspi_ahb_read_error_info

#include <fsl_xspi.h> The structure of information when AHB read error occur.

Public Members

uint32_t errorAddr

AHB read error address.

uint8_t errMasterId

AHB read error master Id.

struct __xspi_ahb_request_suspend_info

#include <fsl_xspi.h> The structure of information when AHB request is suspended.

Public Members

xspi_ahb_request_suspend_state_t state

Current AHB request state.

uint8_t subBufferId

Suspended AHB request's sub buffer Id.

uint8_t ahbBufferId

Suspended AHB request's buffer Id.

uint16_t dataLeft

How many data left to transfer.

uint32_t address

Current address of suspended AHB request.

struct __xspi_config

#include <fsl_xspi.h> XSPI configuration structure.

Public Members

xspi_byte_order_t byteOrder

Byte ordering endianness

bool enableDoze

Enable/disable doze mode support.

xspi_ahb_access_config_t *ptrAhbAccessConfig

Pointer to AHB access configuration, can be NULL is AHB access is not used.

xspi_ip_access_config_t *ptrIpAccessConfig

Pointer to IP access configuration, can be NULL is IP access is not used.

struct *_xspi_cache64_config*

#include <fsl_xspi.h> The structure of cache64 configuration.

Region0 range from base address to region0TopAddr[28:10] + 0x3FF, region1 range from region0TopAddr[28:10] + 0x400 to region1TopAddr[28:10] + 0x3FF, region1TopAddr[28:10] + 0x400 to end address.

Public Members

uint32_t region0TopAddr

Top address of region0, bit0-bit9 ignored.

xspi_cache64_policy_t region0Policy

Policy of region0.

uint32_t region1TopAddr

Top address of region1, bit0-bit9 ignored.

xspi_cache64_policy_t region1Policy

Policy of region1.

xspi_cache64_policy_t region2Policy

Policy of region2.

struct *bypassModePara*

Public Members

uint16_t delayElementCoarseValue

Delay element coarse adjustment value, range from 0 to 15.

uint16_t delayElementFineValue

Delay element fine adjustment value, range from 0 to 7.

uint16_t offsetDelayElementCount

Specify the number of offset delay elements, range from 0 to 15.

uint16_t enableHighFreq

If set as true, high frequency used for delay chain operations, otherwise low frequency is used.

uint16_t bypassModeReserved

Reserved.

struct *autoUpdateModoPara*

Public Members

uint16_t referenceCounter

Specify count of interval for DLL phase detection, range from 0 to 15.

uint16_t resolution

Specify minimum resolution for the DLL phase detector, range from 0 to 15.

uint16_t offsetDelayElementCount

Specify the number of offset delay elements, range from 0 to 15.

uint16_t tDiv16OffsetDelayElementCount

Specify the number of T/16 offset elements in the incoming DQS, range from 0 to 15.

uint16_t enableHighFreq

If set as true, high frequency used for delay chain operations, otherwise low frequency is used.

struct standardExtendedSPISettings

Public Members

uint32_t pageSize

The size of page to program, the unit is byte.

struct hyperBusSettings

Public Members

xspi_hyper_bus_x16_mode_t x16Mode

Specify hyper bus X16 mode.

bool enableVariableLatency

If enabled, the count of latency is depends on hyper bus device.

bool forceBit10To1

Force bit 10 to logic one or not.

uint32_t pageSize

The size of page to program, the unit is byte.

union enaPri

Public Members

bool enablePriority

High Priority Enable, it can be written '1' only when OTFAD is disabled, the AHB prefetch feature must be enabled if priority mechanism is enabled.

bool enableAllMaster

When set, buffer3 acts as an all-master buffer.buffer[i] routed to buffer3

struct ahbErrorPayload

Public Members

uint32_t highPayload

High 32bit error payload.

uint32_t lowPayload

Low 32bit error payload.

2.89 XSPI eDMA Driver

enum `_xspi_edma_ntransfer_size`

eDMA transfer configuration

Values:

enumerator `kXSPI_EDMA_nSize1Bytes`

Source/Destination data transfer size is 1 byte every time

enumerator `kXSPI_EDMA_nSize2Bytes`

Source/Destination data transfer size is 2 bytes every time

enumerator `kXSPI_EDMA_nSize4Bytes`

Source/Destination data transfer size is 4 bytes every time

enumerator `kXSPI_EDMA_nSize8Bytes`

Source/Destination data transfer size is 8 bytes every time

enumerator `kXSPI_EDMA_nSize32Bytes`

Source/Destination data transfer size is 32 bytes every time

typedef struct `_xspi_edma_handle` `xspi_edma_handle_t`

typedef void (*`xspi_edma_callback_t`)(`XSPI_Type` *`base`, `xspi_edma_handle_t` *`handle`, `status_t` `status`, void *`userData`)

XSPI eDMA transfer callback function for finish and error.

typedef enum `_xspi_edma_ntransfer_size` `xspi_edma_transfer_nsize_t`

eDMA transfer configuration

`FSL_XSPI_EDMA_DRIVER_VERSION`

XSPI EDMA driver version 2.0.2.

void `XSPI_TransferCreateHandleEDMA`(`XSPI_Type` *`base`, `xspi_edma_handle_t` *`handle`, `xspi_edma_callback_t` `callback`, void *`userData`, `edma_handle_t` *`txDmaHandle`, `edma_handle_t` *`rxDmaHandle`)

Initializes the XSPI handle for transfer which is used in transactional functions and set the callback.

Parameters

- `base` – XSPI peripheral base address
- `handle` – Pointer to `xspi_edma_handle_t` structure
- `callback` – XSPI 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 `XSPI_TransferUpdateSizeEDMA`(`XSPI_Type` *`base`, `xspi_edma_handle_t` *`handle`, `xspi_edma_transfer_nsize_t` `nsize`)

Update XSPI EDMA transfer source data transfer size(SSIZE) and destination data transfer size(DSIZE).

See also:

`xspi_edma_transfer_nsize_t`.

Parameters

- base – XSPI peripheral base address
- handle – Pointer to `xspi_edma_handle_t` structure
- nsize – XSPI DMA transfer data transfer size(SSIZE/DSIZE), by default the size is `kFLEXPSI_EDMASize1Bytes`(one byte).

`status_t` XSPI_TransferEDMA(XSPI_Type *base, *xspi_edma_handle_t* *handle, *xspi_transfer_t* *xfer)

Transfers XSPI data using an eDMA non-blocking method.

This function writes/receives data to/from the XSPI transmit/receive FIFO. This function is non-blocking.

Parameters

- base – XSPI peripheral base address.
- handle – Pointer to `xspi_edma_handle_t` structure
- xfer – XSPI transfer structure.

Return values

- `kStatus_XSPI_Busy` – XSPI is busy transfer.
- `kStatus_InvalidArgument` – The watermark configuration is invalid, the watermark should be power of 2 to do successfully EDMA transfer.
- `kStatus_Success` – XSPI successfully start edma transfer.

`void` XSPI_TransferAbortEDMA(XSPI_Type *base, *xspi_edma_handle_t* *handle)

Aborts the transfer data using eDMA.

This function aborts the transfer data using eDMA.

Parameters

- base – XSPI peripheral base address.
- handle – Pointer to `xspi_edma_handle_t` structure

`status_t` XSPI_TransferGetTransferCountEDMA(XSPI_Type *base, *xspi_edma_handle_t* *handle, `size_t` *count)

Gets the transferred counts of transfer.

Parameters

- base – XSPI peripheral base address.
- handle – Pointer to `xspi_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.

edma_handle_t *txDmaHandle

eDMA handler for XSPI Tx.

edma_handle_t *rxDmaHandle

eDMA handler for XSPI Rx.

size_t transferSize

Bytes need to transfer.

xspi_edma_transfer_nsize_t nsize

eDMA SSIZE/DSIZE in each transfer.

uint32_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 XSPI eDMA transfer.

xspi_edma_callback_t completionCallback

A callback function called after the eDMA transfer is finished.

void *userData

User callback parameter

struct __xspi_edma_handle

#include <fsl_xspi_edma.h> XSPI DMA transfer handle, users should not touch the content of the handle.

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
<code>OtaState_t</code> <code>OTA_Shutdown(</code> <code>uint32_t tick-</code> <code>sToWait);</code>	<code>OtaState_t</code> <code>OTA_Shutdown(</code> <code>uint32_t ticksToWait,</code> <code>uint8_t unsubscribeFlag</code> <code>);</code>	<code>unsubscribeFlag</code> 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

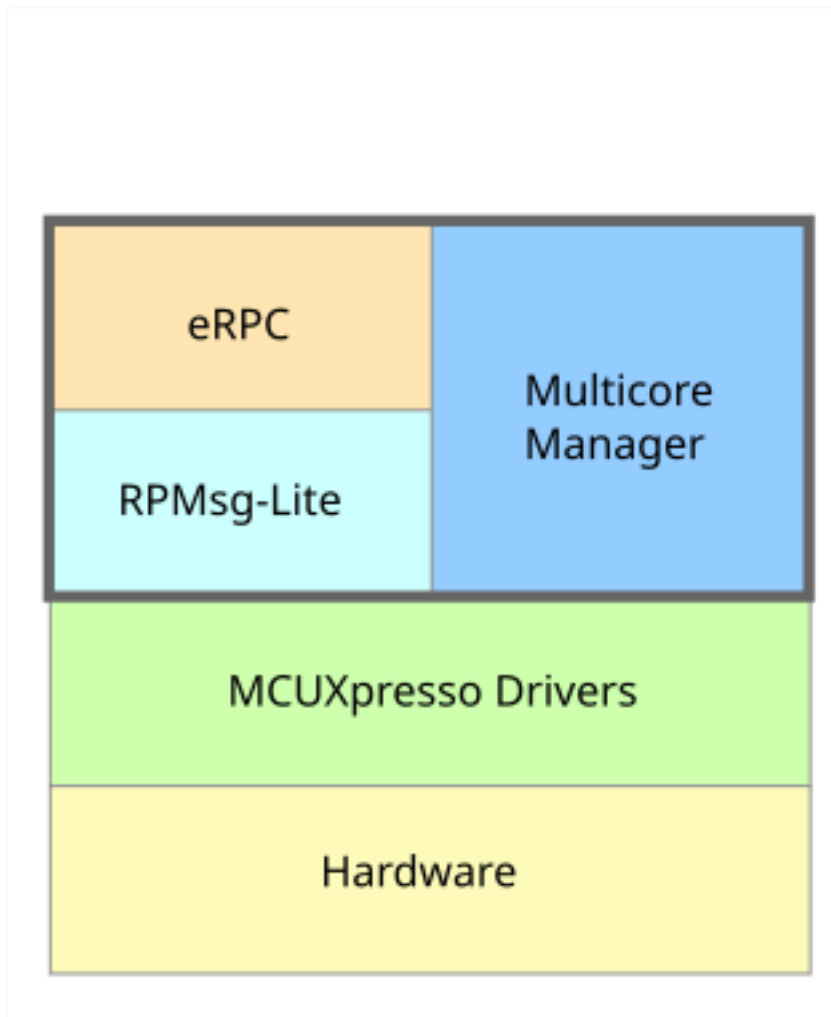
the <MCUXpressoSDK_install_dir>/examples/multiprocessor_examples subdirectories.

- 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.

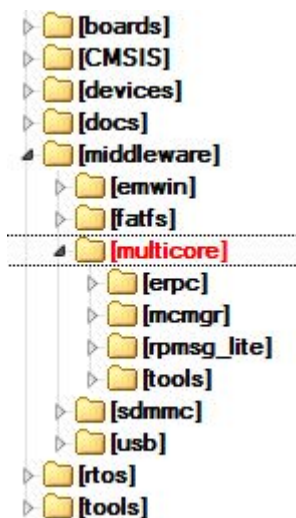


All the MCSDK-related files are located in `<MCUXpressoSDK_install_dir>/middleware/multicore` folder.

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.

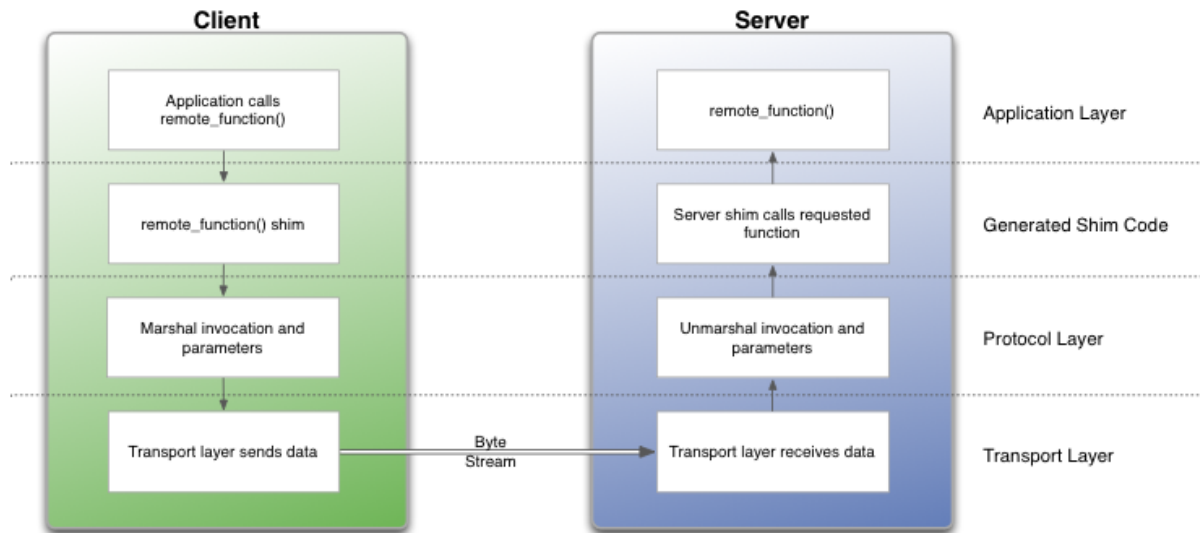
Multicore SDK (MCSDK) components The MCSDK consists of the following software components:

- **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.

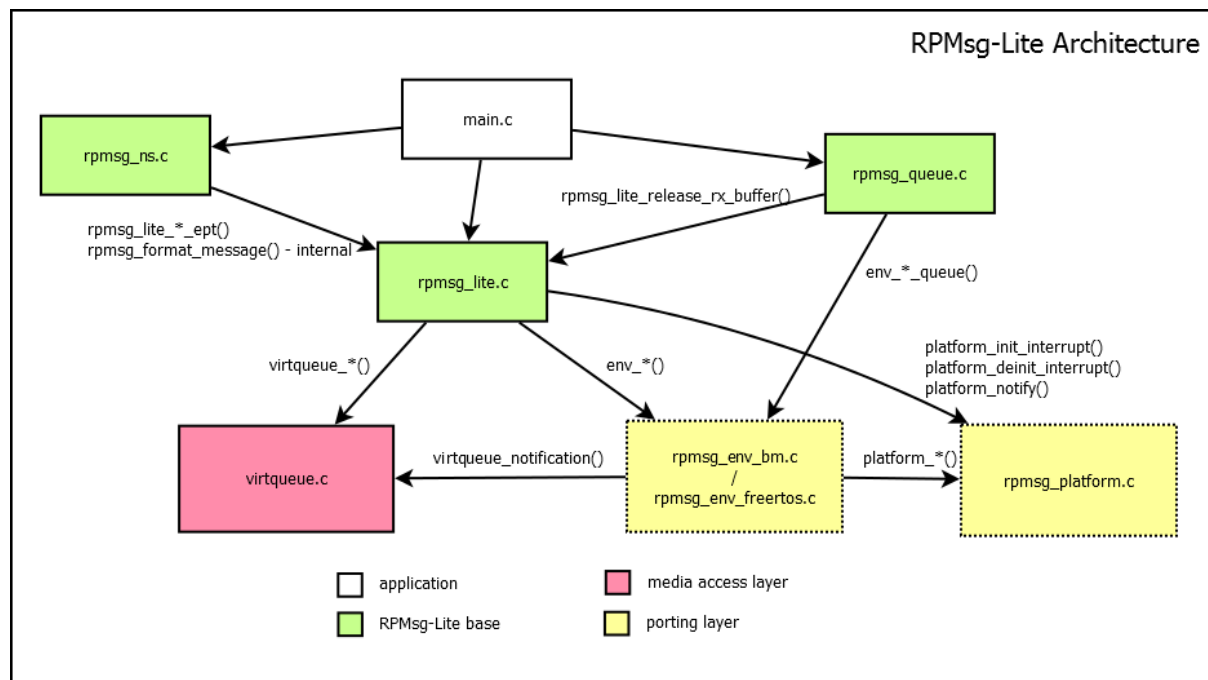
Small MCU-based systems often do not implement dynamic memory allocation. The creation of static API in RPMsg-Lite enables another reduction of resource usage. Not only does the dynamic allocation adds another 5 KB of code size, but also communication is slower and less deterministic, which is a property 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%

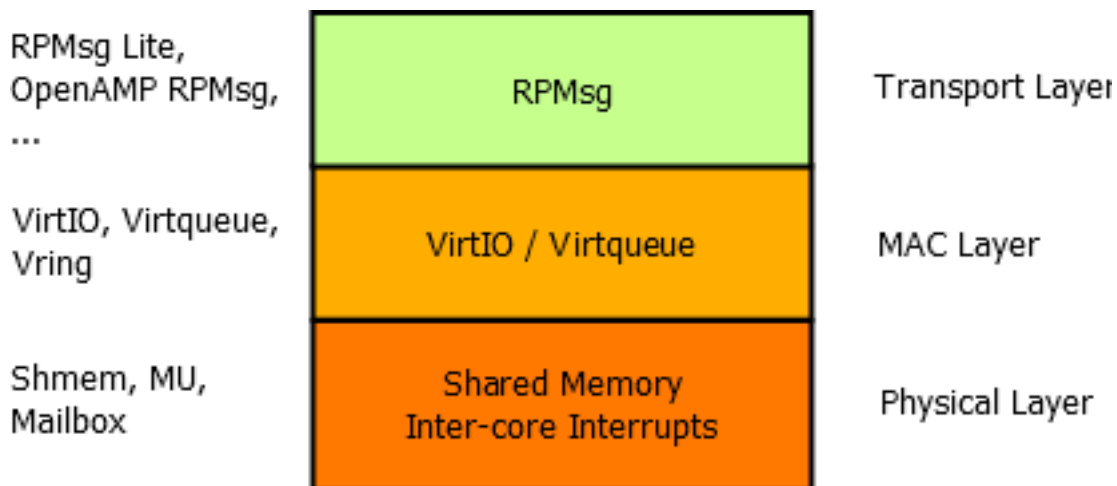
Implementation The implementation of RPMsg-Lite can be divided into three sub-components, from which two are optional. The core component is situated in `rpmsg_lite.c`. Two optional components are used to implement a blocking receive API (in `rpmsg_queue.c`) and dynamic “named” endpoint creation and 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 `/rpsmsg_lite/lib/include` directory to the include path and in the application, include either the `rpsmsg_lite.h` header file, or optionally also include the `rpsmsg_queue.h` and/or `rpsmsg_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, `rpsmsg_env_myrtos.c`) and to include it in the project build.

The initialization of the stack is done by calling the `rpsmsg_lite_master_init()` on the master side and the `rpsmsg_lite_remote_init()` on the remote side. This initialization function must be called prior to any RPMsg-Lite API call. After the init, it is wise to create a communication endpoint, otherwise communication is not possible. This can be done by calling the `rpsmsg_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 `rpsmsg_queue_create()` function must be called before calling `rpsmsg_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 `rpsmsg_queue_rx_cb()`. Then, it is possible to use `rpsmsg_queue_receive()` function to listen on a queue object for incoming messages. The `rpsmsg_lite_send()` function is used to send messages to the other side.

The RPMsg-Lite also implements no-copy mechanisms for both sending and receiving operations. These methods require specifics that have to be considered when used in an application.

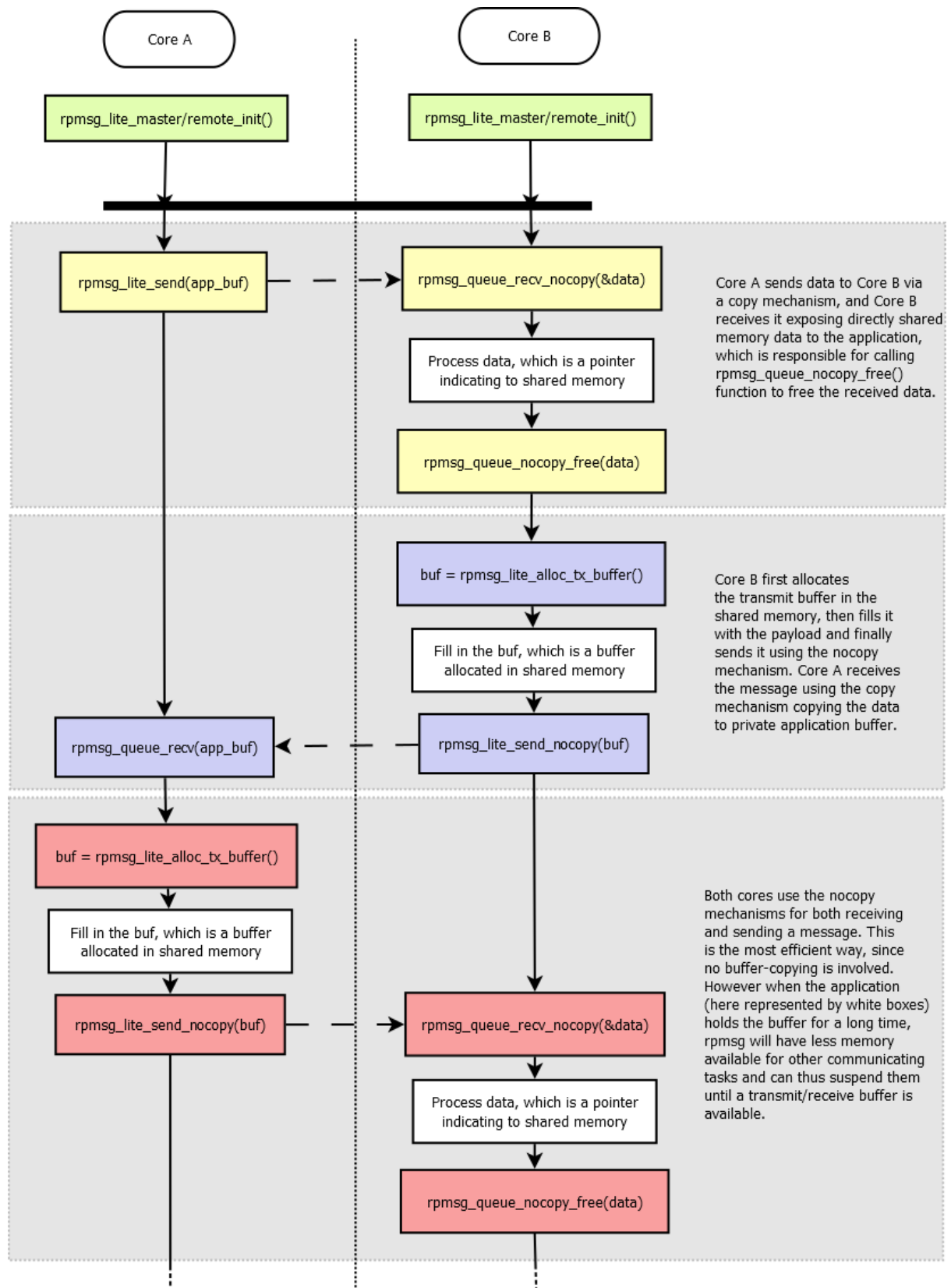
no-copy-send mechanism: This mechanism allows sending messages without the cost for copying data from the application buffer to the RPMsg/virtio buffer in the shared memory. The sequence of no-copy sending steps to be performed is as follows:

- Call the `rpsmsg_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 `rpsmsg_lite_alloc_tx_buffer()` size output parameter).
- Call the `rpsmsg_lite_send_nocopy()` function to send the message to the destination endpoint. Consider the cache functionality and the virtio buffer alignment. See the `rpsmsg_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 `rpsmsg_queue_rcv_nocopy()` function to get the virtio buffer pointer to the received data.
- Read received data directly from the shared memory.
- Call the `rpsmsg_queue_nocopy_free()` function to release the virtio buffer and to make it available for the next data transfer.

The user is responsible for destroying any RPMsg-Lite objects he has created in case of deinitialization. In order to do this, the function `rpsmsg_queue_destroy()` is used to destroy a queue, `rpsmsg_lite_destroy_ept()` is used to destroy an endpoint and finally, `rpsmsg_lite_deinit()` is used to deinitialize the RPMsg-Lite intercore communication stack. Deinitialize all endpoints using a queue before deinitializing the queue. Otherwise, you are actively invalidating the used queue handle, which is not allowed. RPMsg-Lite does not check this internally, since its main aim is to be lightweight.



Examples RPMsg_Lite multicore examples are part of NXP MCUXpressoSDK packages. Visit <https://mcuxpresso.nxp.com> to configure, build and download these packages. To get the board list with multicore support (RPMsg_Lite included) use filtering based on Middleware and search for 'multicore' string. Once the selected package with the multicore middleware is downloaded,

see

<MCUXpressoSDK_install_dir>/boards/<board_name>/multicore_examples for RPMsg_Lite multicore examples with 'rpmsg_lite_' name prefix.

Another way of getting NXP MCUXpressoSDK RPMsg_Lite multicore examples is using the [mcuxsdk-manifests](#) Github repo. Follow the description how to use the West tool to clone and update the mcuxsdk-manifests repo in [readme section](#). Once done the armgcc rpmsg_lite examples can be found in

mcuxsdk/examples/_<board_name>/multicore_examples

You can use the evkmimxrt1170 as the board_name for instance. Similar to MCUXpressoSDK packages the RPMsg_Lite examples use the 'rpmsg_lite_' name prefix.

Notes

Environment layers implementation Several environment layers are provided in lib/rpmsg_lite/porting/environment folder. Not all of them are fully tested however. Here is the list of environment layers that passed testing:

- rpmsg_env_bm.c
- rpmsg_env_freertos.c
- rpmsg_env_xos.c
- rpmsg_env_threadx.c

The rest of environment layers has been created and used in some experimental projects, it has been running well at the time of creation but due to the lack of unit testing there is no guarantee it is still fully functional.

Shared memory configuration It is important to correctly initialize/configure the shared memory for data exchange in the application. The shared memory must be accessible from both the master and the remote core and it needs to be configured as Non-Cacheable memory. Dedicated shared memory section in 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 RPMsg-Lite can be configured at the compile time. The default configuration is defined in the rpmsg_default_config.h header file. This configuration can be customized by the user by including rpmsg_config.h file with custom settings. The following table summarizes all possible RPMsg-Lite configuration options.

Config- uration option	De- fault value	Usage
RL_MS_PE (1)		Delay in milliseconds used in non-blocking API functions for polling.
RL_BUFFE (496)		Size of the buffer payload, it must be equal to (240, 496, 1008, ...) [$2^n - 16$]
RL_BUFFE (2)		Number of the buffers, it must be power of two (2, 4, ...)
RL_API_H (1)		Zero-copy API functions enabled/disabled.
RL_USE_S' (0)		Static API functions (no dynamic allocation) enabled/disabled.
RL_USE_D (0)		Memory cache management of shared memory. Use in case of data cache is enabled for shared memory.
RL_CLEAF (0)		Clearing used buffers before returning back to the pool of free buffers enabled/disabled.
RL_USE_M (0)		When enabled IPC interrupts are managed by the Multicore Manager (IPC interrupts router), when disabled RPMsg-Lite manages IPC interrupts by itself.
RL_USE_E (0)		When enabled the environment layer uses its own context. Required for some environments (QNX). The default value is 0 (no context, saves some RAM).
RL_DEBU (0)		When enabled buffer pointers passed to <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](#)

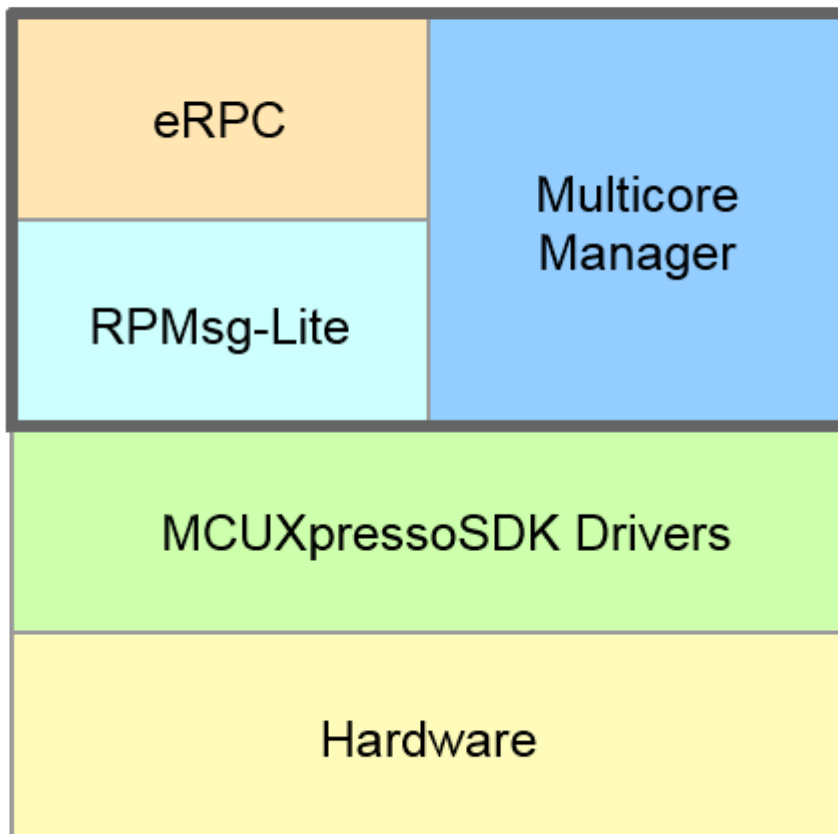
Visit [Multicore Manager - Documentation](#) to review details on the contents in this sub-repo.

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)

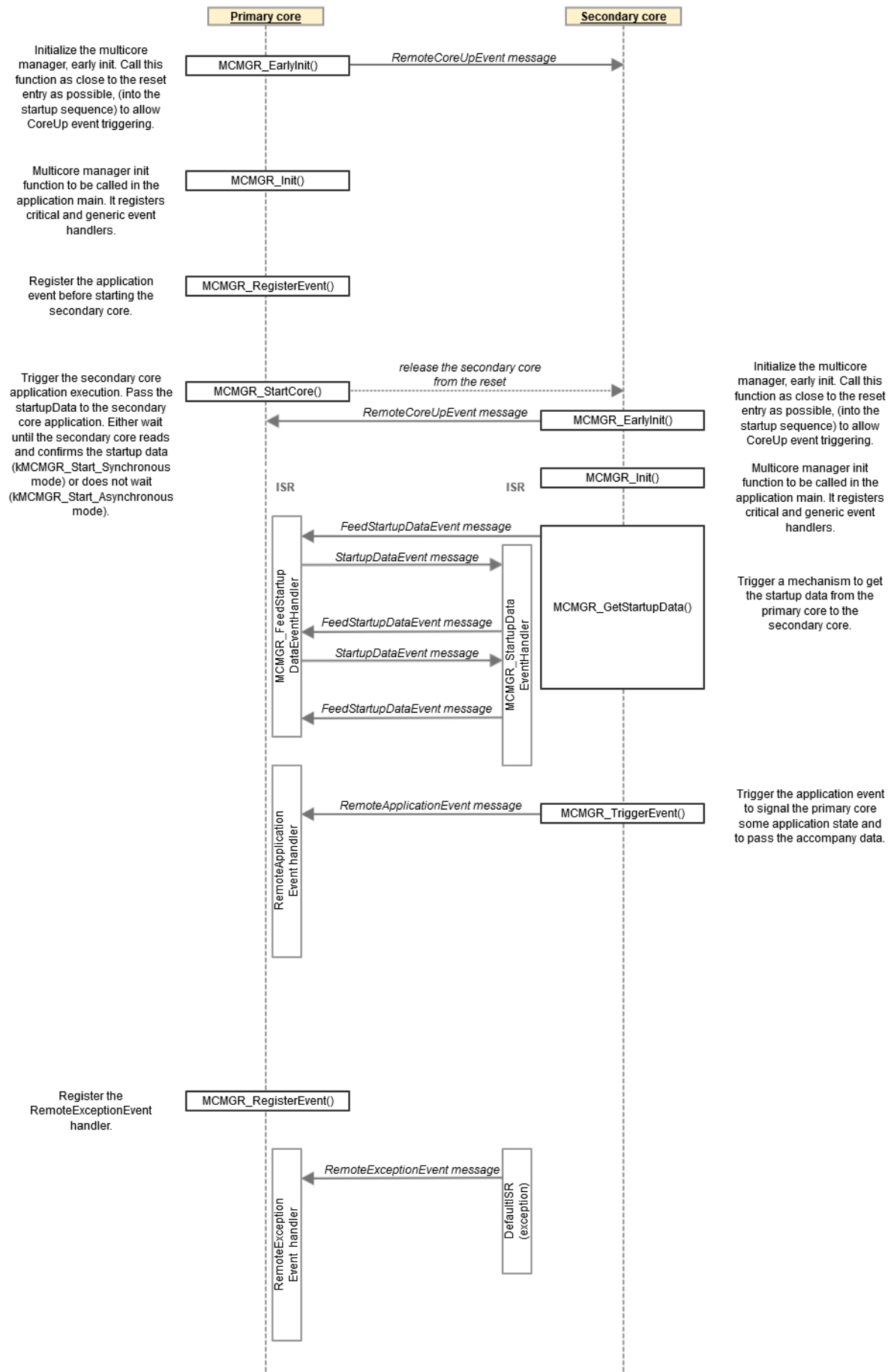
void main()
{
    /* Initialize MCMGR - low level multicore management library.
       Call this function as close to the reset entry as possible,
       (into the startup sequence) to allow CoreUp event triggering. */
    MCMGR_EarlyInit();

    /* 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 then two cores. Breaking API change by adding parameter `coreNum` specifying core number in functions bellow.
 - MCMGR_GetStartupData(uint32_t *startupData, mcmgr_core_t coreNum)
 - MCMGR_TriggerEvent(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
 - MCMGR_TriggerEventForce(mcmgr_event_type_t type, uint16_t eventData, mcmgr_core_t coreNum)
 - typedef void (*mcmgr_event_callback_t)(uint16_t data, void *context, mcmgr_core_t coreNum);

When registering the event with function MCMGR_RegisterEvent() user now needs to provide `callbackData` pointer to array of elements per every core in system (see README.md for example). In case of systems with only two cores the `coreNum` in callback can be ignored as events can arrive only from one core. Please see Porting guide for more details: Porting-GuideTo_v5.md

- Updated all porting files to support new MCMGR API.
- Added new platform specific include file `mcmgr_platform.h`. It will contain common platform specific macros that can be then used in `mcmgr` and application. e.g. platform core count MCMGR_CORECOUNT 4.
- Move all header files to new `inc` directory.
- Added new platform-specific include files `inc/platform/<platform_name>/mcmgr_platform.h`.

Added

- Add MCXL20 porting layer and unit testing

v4.1.7

Fixed

- `mcmgr_stop_core_internal()` function now returns `kStatus_MCMGR_NotImplemented` status code instead of `kStatus_MCMGR_Success` when device does not support stop of secondary core. Ports affected: kw32w1, kw45b41, kw45b42, mcxw716, mcxw727.

[v4.1.6]

Added

- Multicore Manager moved to standalone repository.
- Add porting layers for imxrt700, mcmxw727, kw47b42.
- New `MCMGR_ProcessDeferredRxIsr()` API added.

[v4.1.5]

Added

- Add notification into `MCMGR_EarlyInit` and `mcmgr_early_init_internal` functions to avoid using uninitialized data in their implementations.

[v4.1.4]

Fixed

- Avoid calling tx isr callbacks when respective Messaging Unit Transmit Interrupt Enable flag is not set in the CR/TCR register.
- Messaging Unit RX and status registers are cleared after the initialization.

[v4.1.3]

Added

- Add porting layers for imxrt1180.

Fixed

- `mu_isr()` updated to avoid calling tx isr callbacks when respective Transmit Interrupt Enable flag is not set in the CR/TCR register.
- `mcmgr_mu_internal.c` code adaptation to new supported SoCs.

[v4.1.2]

Fixed

- Update `mcmgr_stop_core_internal()` implementations to set core state to `kMCMGR_ResetCoreState`.

[v4.1.0]

Fixed

- Code adjustments to address MISRA C-2012 Rules

[v4.0.3]

Fixed

- Documentation updated to describe handshaking in a graphic form.
- Minor code adjustments based on static analysis tool findings

[v4.0.2]

Fixed

- Align porting layers to the updated MCUXpressoSDK feature files.

[v4.0.1]

Fixed

- Code formatting, removed unused code

[v4.0.0]

Added

- Add new MCMGR_TriggerEventForce() API.

[v3.0.0]

Removed

- Removed MCMGR_LoadApp(), MCMGR_MapAddress() and MCMGR_SignalReady()

Modified

- Modified MCMGR_GetStartupData()

Added

- Added MCMGR_EarlyInit(), MCMGR_RegisterEvent() and MCMGR_TriggerEvent()
- Added the ability for remote core monitoring and event handling

[v2.0.1]

Fixed

- Updated to be Misra compliant.

[v2.0.0]

Added

- Support for lpcxpresso54114 board.

[v1.1.0]

Fixed

- Ported to KSDK 2.0.0.

[v1.0.0]

Added

- Initial release.

eRPC

MCUXpresso SDK : mcuxsdk-middleware-erpc

Overview This repository is for MCUXpresso SDK eRPC middleware delivery and it contains eRPC component officially provided in NXP MCUXpresso SDK. This repository is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository [mcuxsdk](#) for the complete delivery of MCUXpresso SDK to be able to build and run eRPC examples that are based on mcux-sdk-middleware-erpc component.

Documentation Overall details can be reviewed here: [MCUXpresso SDK Online Documentation](#)

Visit [eRPC - Documentation](#) to review details on the contents in this sub-repo.

Setup Instructions on how to install the MCUXpresso SDK provided from GitHub via west manifest [Getting Started with SDK - Detailed Installation Instructions](#)

Contribution We welcome and encourage the community to submit patches directly to the eRPC project placed on github. Contributing can be managed via pull-requests. Before a pull-request is created the code should be tested and properly formatted.

eRPC

- [MCUXpresso SDK : mcuxsdk-middleware-erpc](#)

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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.

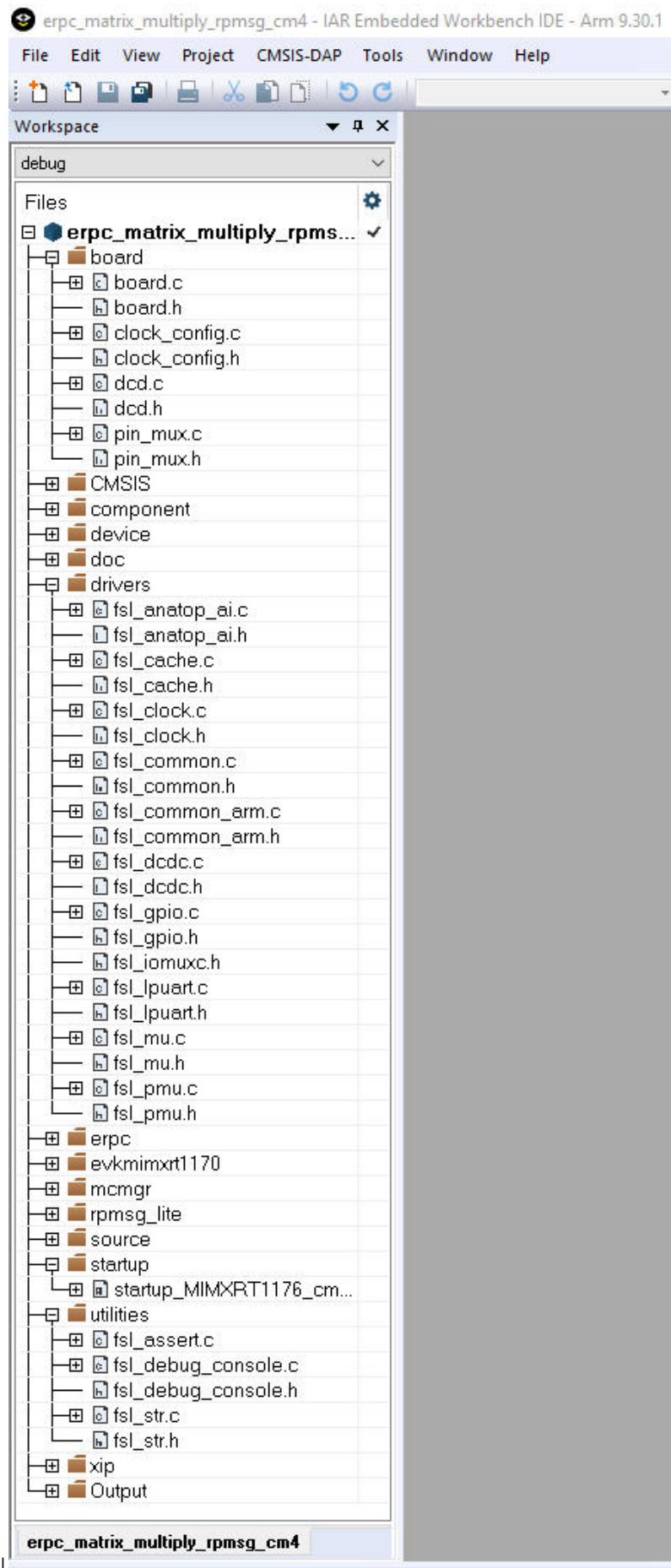
Multicore server application The “Matrix multiply” eRPC server project is located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpm4/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>/`



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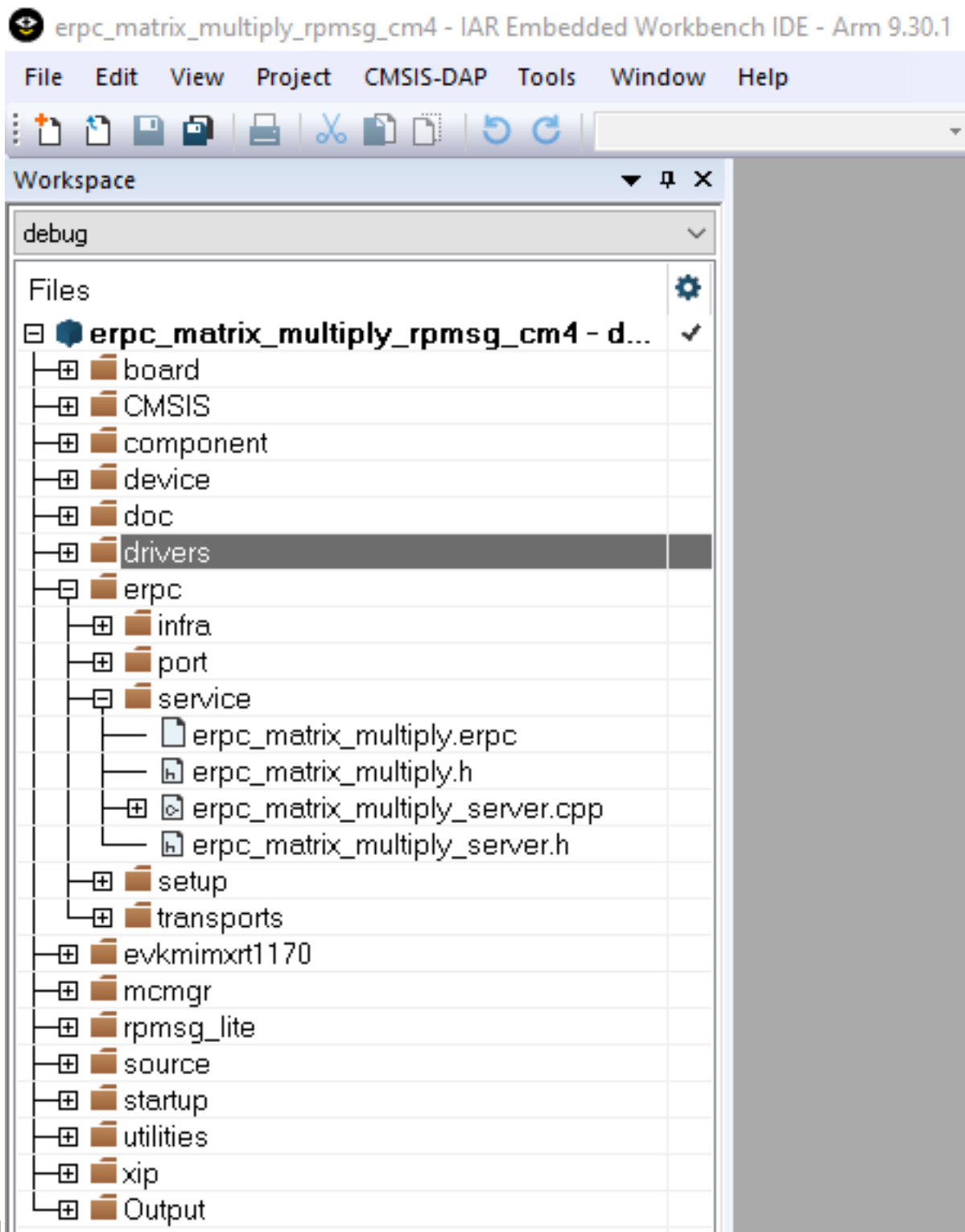
Parent topic:Multicore server application

Server related generated files The server-related generated files are:

- erpc__matric__multiply.h
- erpc__matrix__multiply__server.h
- erpc__matrix__multiply__server.cpp

The server-related generated files contain the shim code for functions and data types declared in the IDL file. These files also contain functions for the identification of client requested functions, data deserialization, calling requested function's implementations, and data serialization and return, if requested by the client. These shim code files can be found in the following folder:

<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/



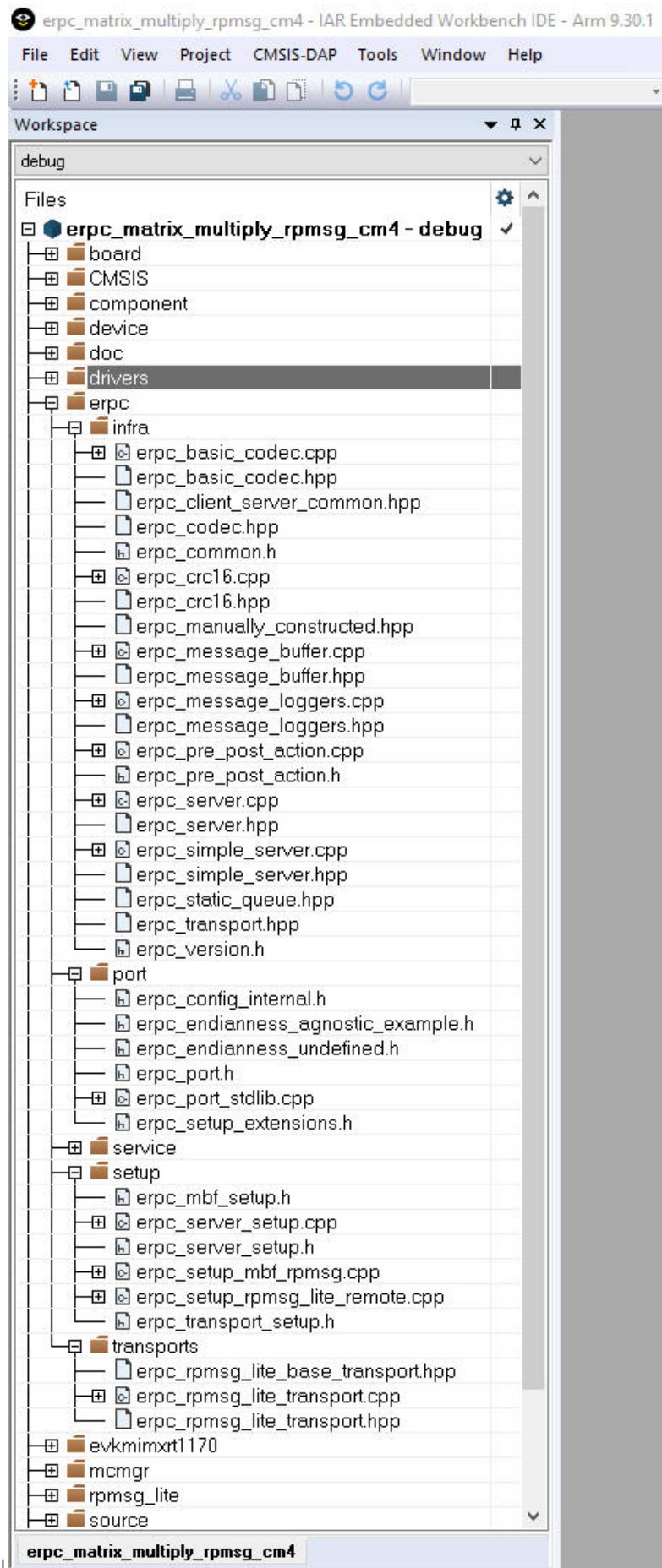
Parent topic: Multicore server application

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.



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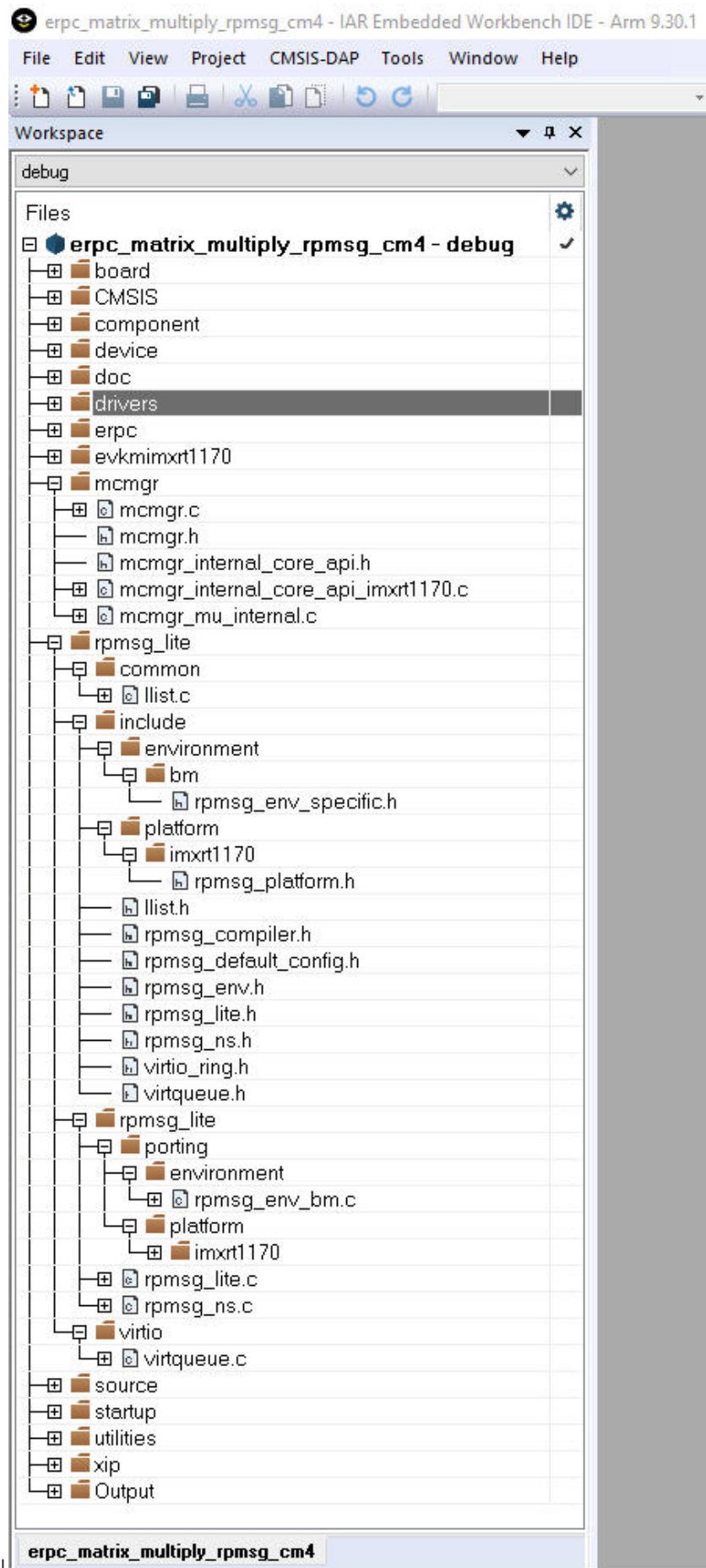
Parent topic: Multicore server application

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/`



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Parent topic: Multicore server application

Server user code The server's user code is stored in the `main_core1.c` file, located in the following folder:

`<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_matrix_multiply_rpmsg/cm4`

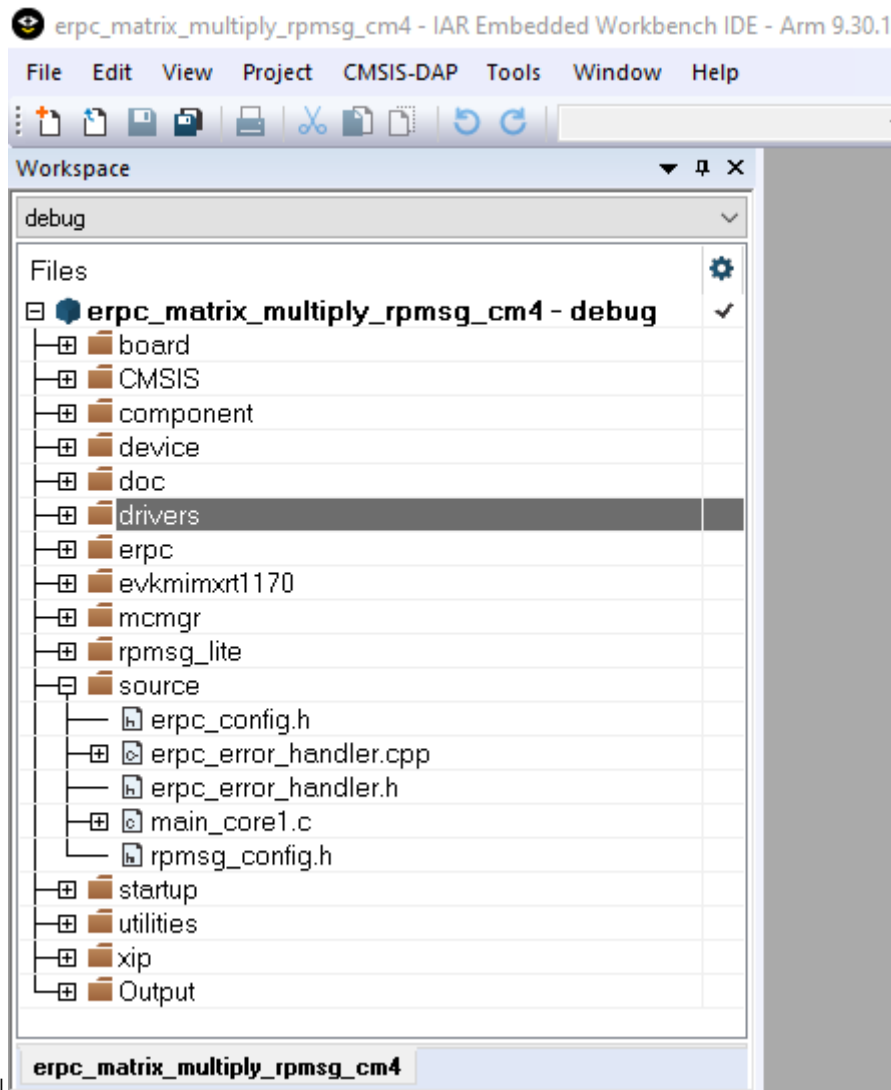
The `main_core1.c` file contains two functions:

- The **main()** function contains the code for the target board and eRPC server initialization. After the initialization, the matrix multiply service is added and the eRPC server waits for client's requests in the while loop.
- The **erpcMatrixMultiply()** function is the user implementation of the eRPC function defined in the IDL file.
- There is the possibility to write the application-specific eRPC error handler. The eRPC error handler of the matrix multiply application is implemented in the `erpc_error_handler.h` and `erpc_error_handler.cpp` files.

The eRPC-relevant code is captured in the following code snippet:

```
/* erpcMatrixMultiply function user implementation */
void erpcMatrixMultiply(const Matrix *matrix1, const Matrix *matrix2, Matrix *result_matrix)
{
    ...
}
int main()
{
    ...
    /* 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](#)

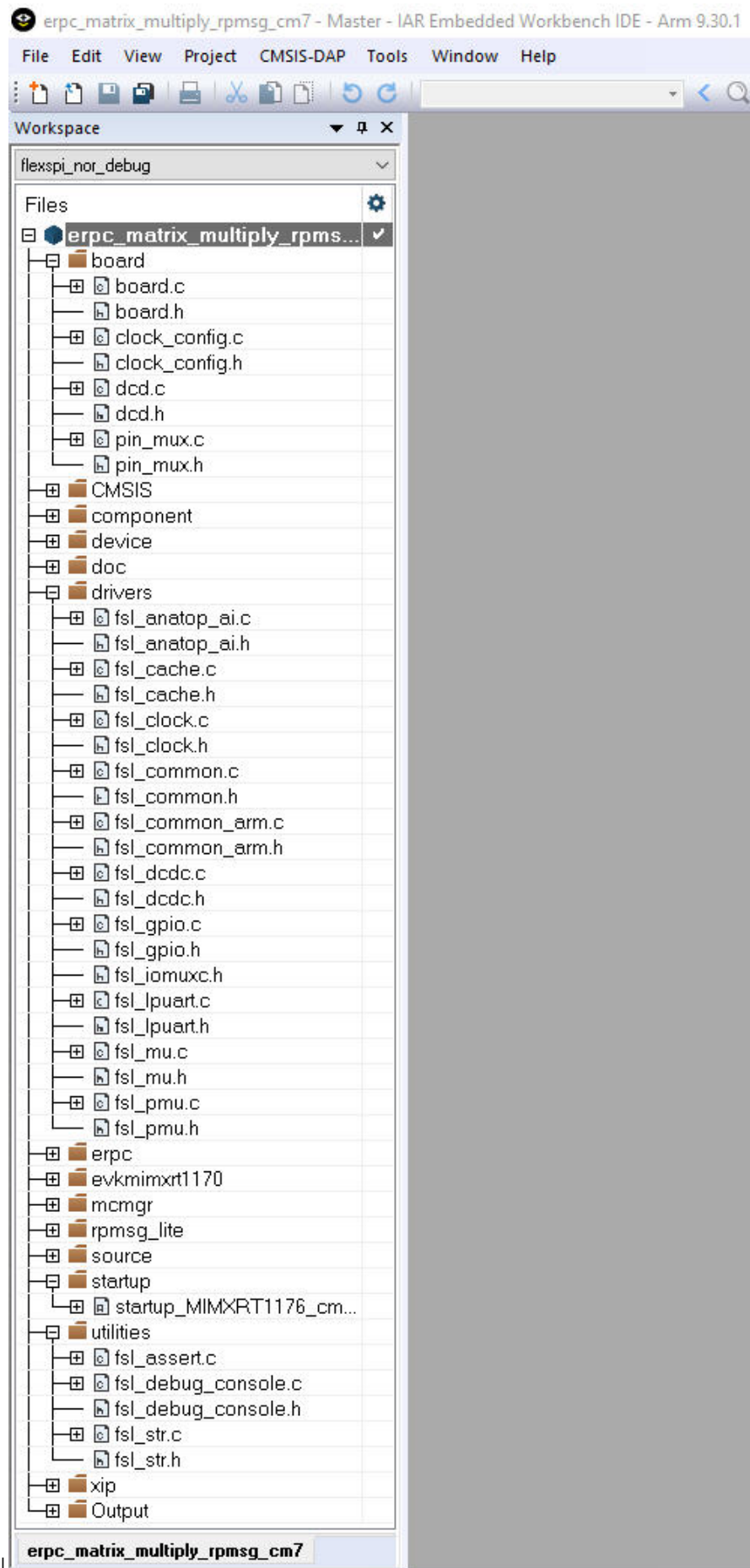
Multicore client application The “Matrix multiply” eRPC client project is located in the following folder:

`<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>/`



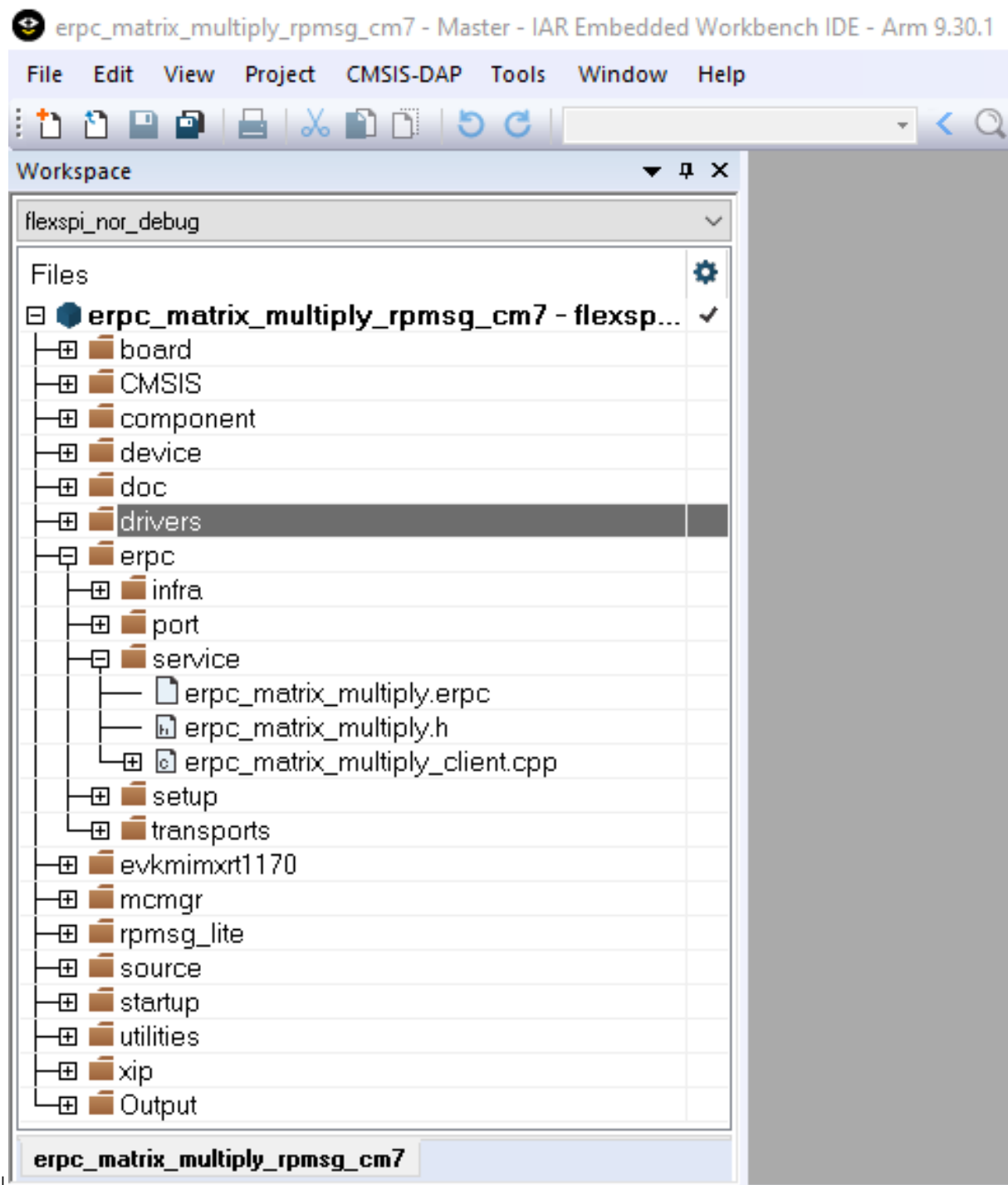
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Parent topic:Multicore client application

Client-related generated files The client-related generated files are:

- erpc__matric__multiply.h
- erpc__matrix__multiply__client.cpp

These files contain the shim code for the functions and data types declared in the IDL file. These functions also call methods for codec initialization, data serialization, performing eRPC requests, and de-serializing outputs into expected data structures (if return values are expected). These shim code files can be found in the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/` folder.



Parent topic: Multicore client application

Client infrastructure files The eRPC infrastructure files are located in the following folder:

`<MCUXpressoSDK_install_dir>/middleware/multicore/erpc/erpc_c`

The **erpc_c** folder contains files for creating eRPC client and server applications in the C/C++ language. These files are distributed into subfolders.

- The **infra** subfolder contains C++ infrastructure code used to build server and client applications.

- Two files, `erpc_client_manager.h` and `erpc_client_manager.cpp`, are used for managing the client-side application. The main purpose of the client files is to create, perform, and release eRPC requests.
- Three files (`erpc_codec.hpp`, `erpc_basic_codec.hpp`, and `erpc_basic_codec.cpp`) are used for codecs. Currently, the basic codec is the initial and only implementation of the codecs.
- `erpc_common.h` file is used for common eRPC definitions, typedefs, and enums.
- `erpc_manually_constructed.hpp` file is used for allocating static storage for the used objects.
- Message buffer files are used for storing serialized data: `erpc_message_buffer.hpp` and `erpc_message_buffer.cpp`.
- `erpc_transport.hpp` file defines the abstract interface for transport layer.

The **port** subfolder contains the eRPC porting layer to adapt to different environments.

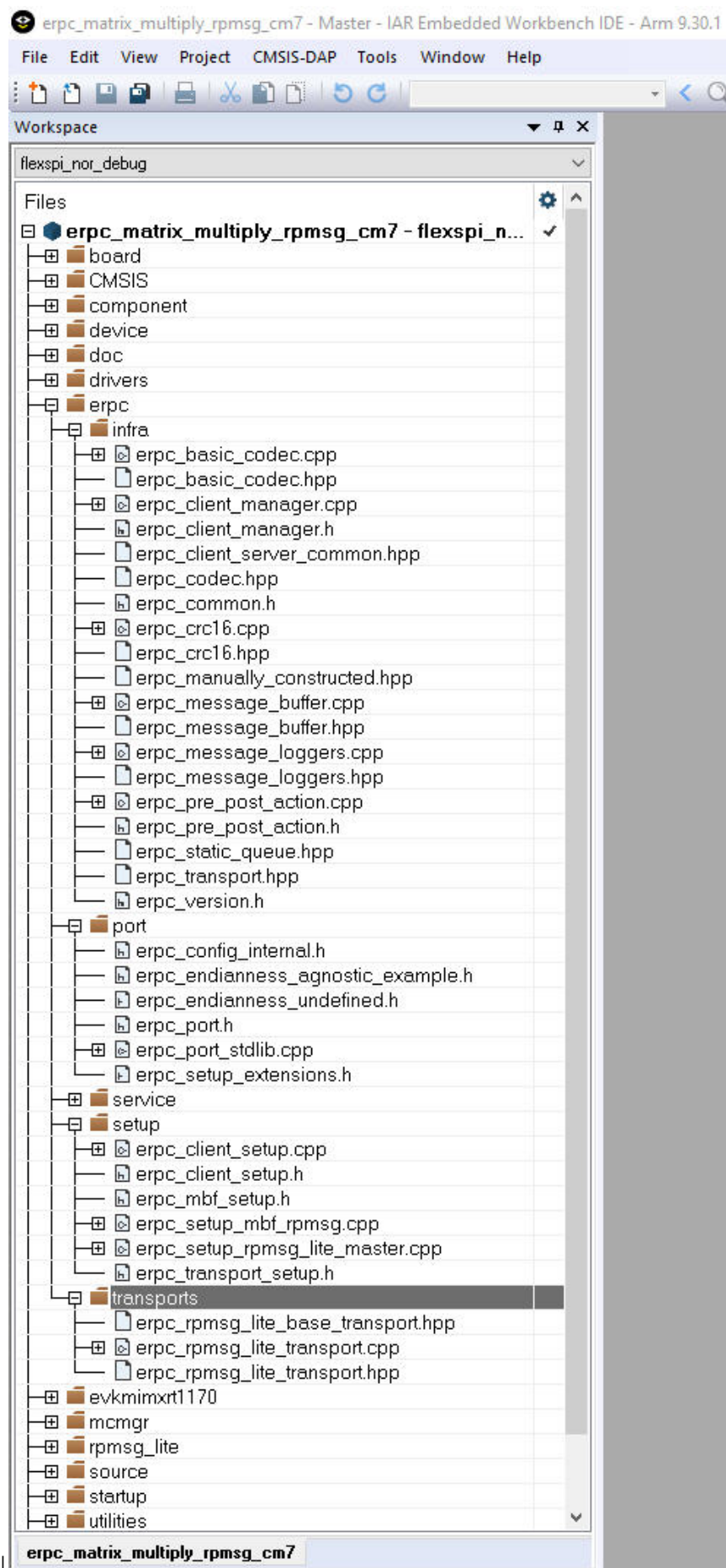
- `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
- `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
- `erpc_config_internal.h` internal eRPC configuration file.

The **setup** subfolder contains a set of plain C APIs that wrap the C++ infrastructure, providing client and server init and deinit routines that greatly simplify eRPC usage in C-based projects. No knowledge of C++ is required to use these APIs.

- `erpc_client_setup.h` and `erpc_client_setup.cpp` files needs to be added into the “Matrix multiply” example project to demonstrate the use of C-wrapped functions in this example.
- `erpc_transport_setup.h` and `erpc_setup_rpmsg_lite_master.cpp` files needs to be added into the project in order to allow C-wrapped function for transport layer setup.
- `erpc_mbf_setup.h` and `erpc_setup_mbf_rpmsg.cpp` files needs to be added into the project in order to allow message buffer factory usage.

The **transports** subfolder contains transport classes for the different methods of communication supported by eRPC. Some transports are applicable only to host PCs, while others are applicable only to embedded or multicore systems. Most transports have corresponding client and server setup functions, in the setup folder.

- RPMsg-Lite is used as the transport layer for the communication between cores, `erpc_rpmsg_lite_base_transport.hpp`, `erpc_rpmsg_lite_transport.hpp`, and `erpc_rpmsg_lite_transport.cpp` files needs to be added into the client project.



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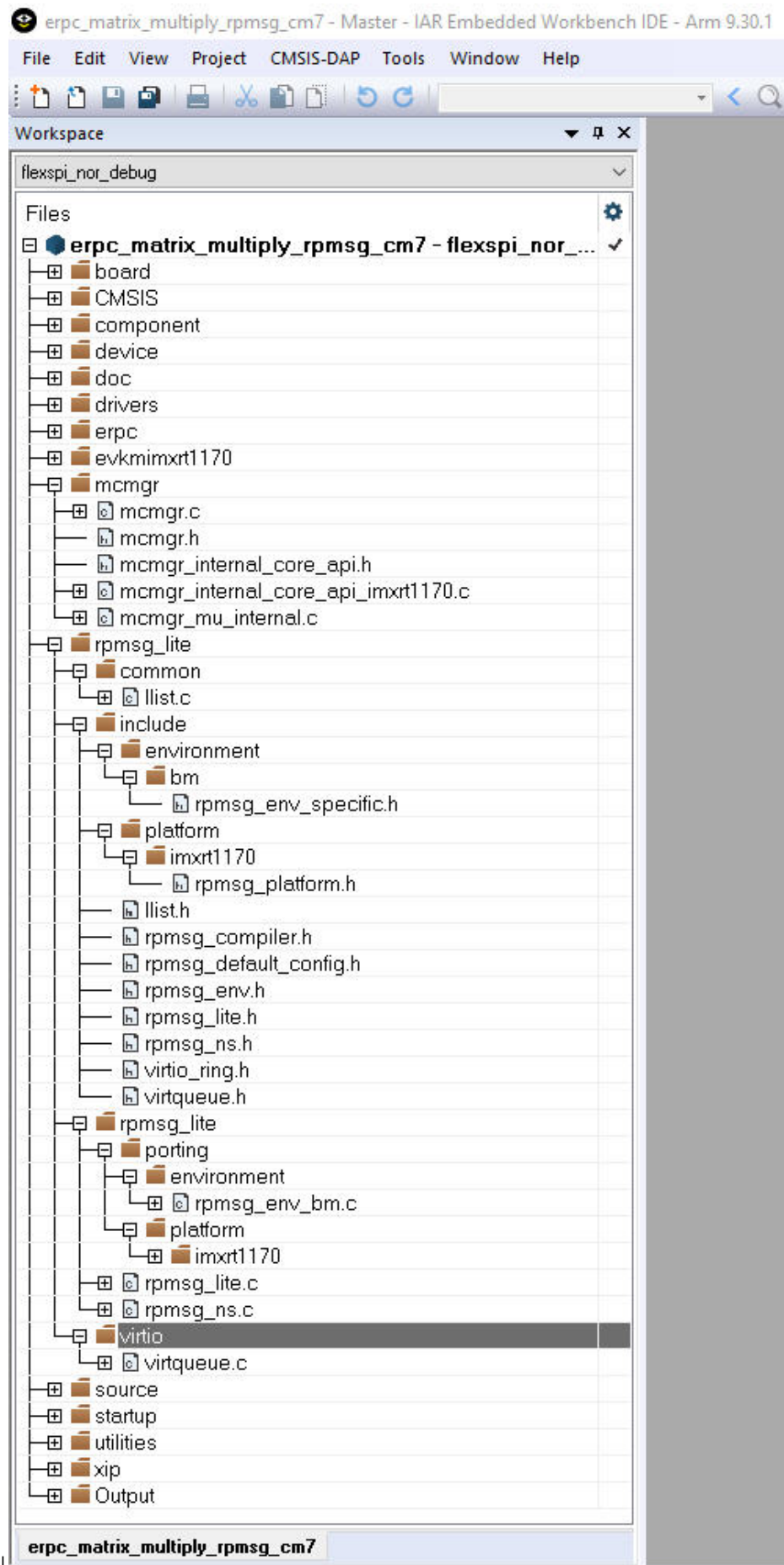
Parent topic: Multicore client application

Client 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 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.

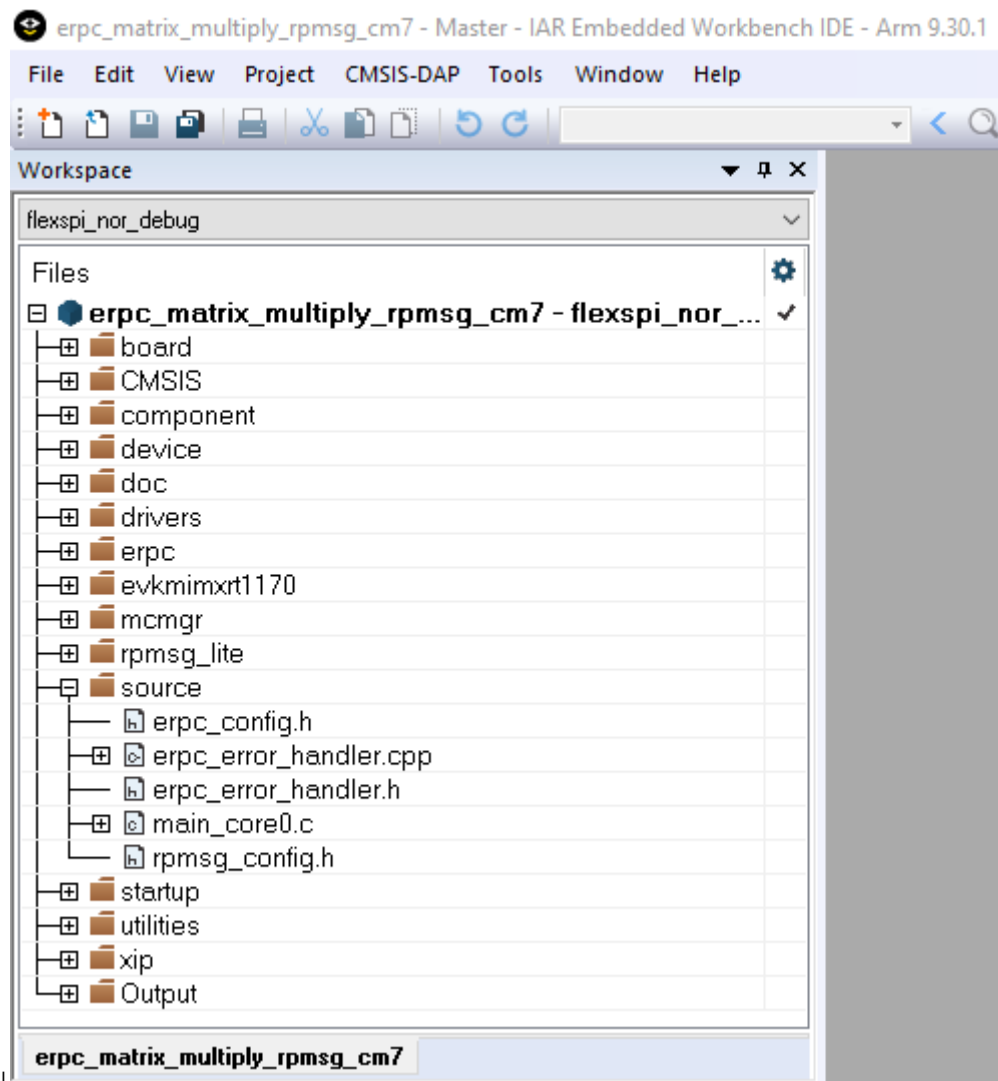
The matrix multiplication can be issued repeatedly, when pressing a software board button.

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};
...
/* RPSMsg-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 RPSMsg-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 RMPMsg-Lite). The RMPMsg-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:

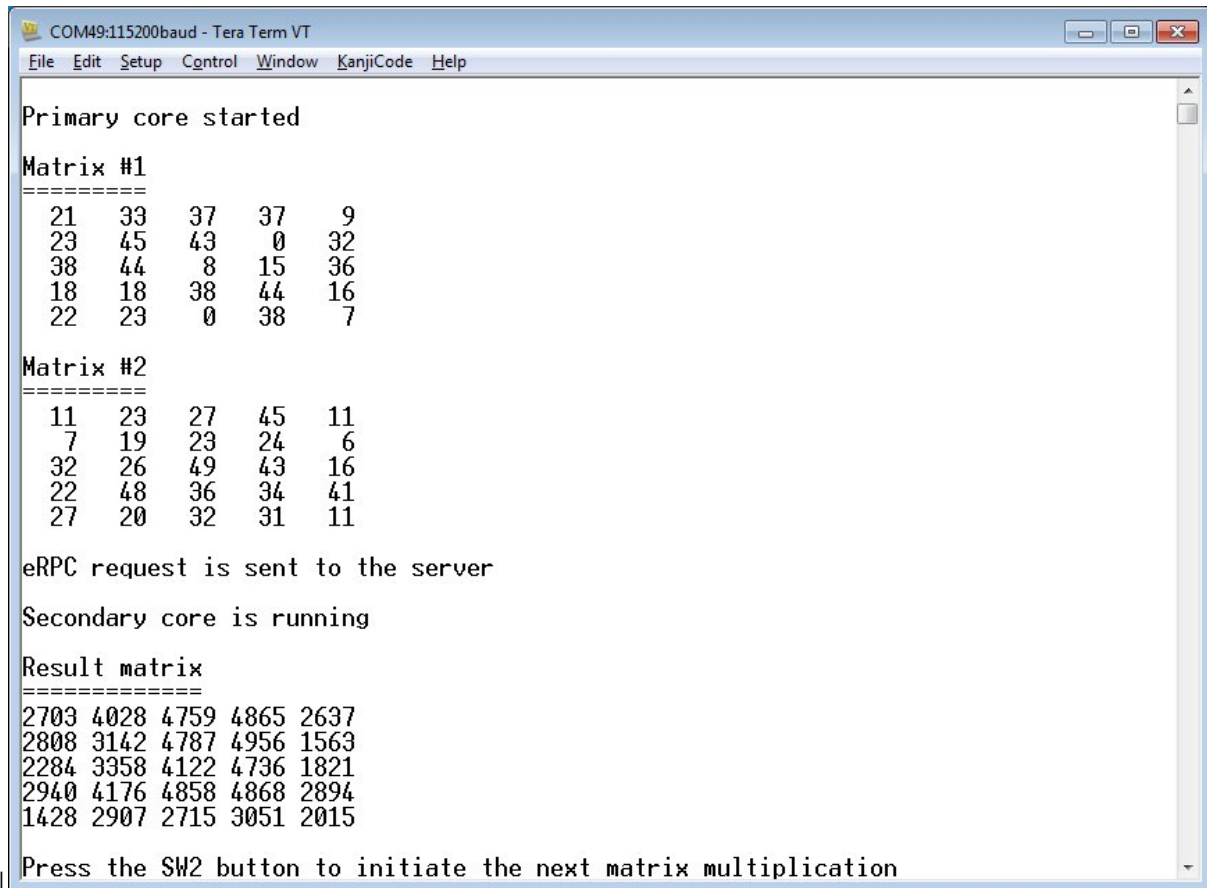
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
↳operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&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.
- RMPsg-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_x86`
 | Linux OS | `<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x64`
`<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Linux_x86`
 | | Mac OS | `<MCUXpressoSDK_install_dir>/middleware/multicore/tools/erpcgen/Mac`

The files for the “Matrix multiply” example are pre-generated and already a part of the application projects. The following section describes how they have been created.

- The easiest way to create the shim code is to copy the erpcgen application to the same folder where the IDL file (*.erpc) is located; then run the following command:

```
erpcgen <IDL_file>.erpc
```

- In the “Matrix multiply” example, the command should look like:

```
erpcgen erpc_matrix_multiply.erpc
```

Additionally, another method to create the shim code is to execute the eRPC application using input commands:

- “-?”/”—help” – Shows supported commands.
- “-o <filePath>”/”—output<filePath>” – Sets the output directory.

For example,

```
<path_to_erpcgen>/erpcgen -o <path_to_output>  
<path_to_IDL>/<IDL_file_name>.erpc
```

For the “Matrix multiply” example, when the command is executed from the default erpcgen location, it looks like:

```
erpcgen -o  
../..../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service  
../..../boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service/erpc_matrix_mu
```

In both cases, the following four files are generated into the `<MCUXpressoSDK_install_dir>/boards/evkmimxrt1170/multicore_examples/erpc_common/erpc_matrix_multiply/service` folder:

- erpc_matrix_multiply.h
- erpc_matrix_multiply_client.cpp
- erpc_matrix_multiply_server.h
- erpc_matrix_multiply_server.cpp

For multiprocessor examples, the eRPC file and pre-generated files can be found in the `<MCUXpressoSDK_install_dir>/boards/<board_name>/multiprocessor_examples/erpc_common/erpc_matrix_multiply/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.

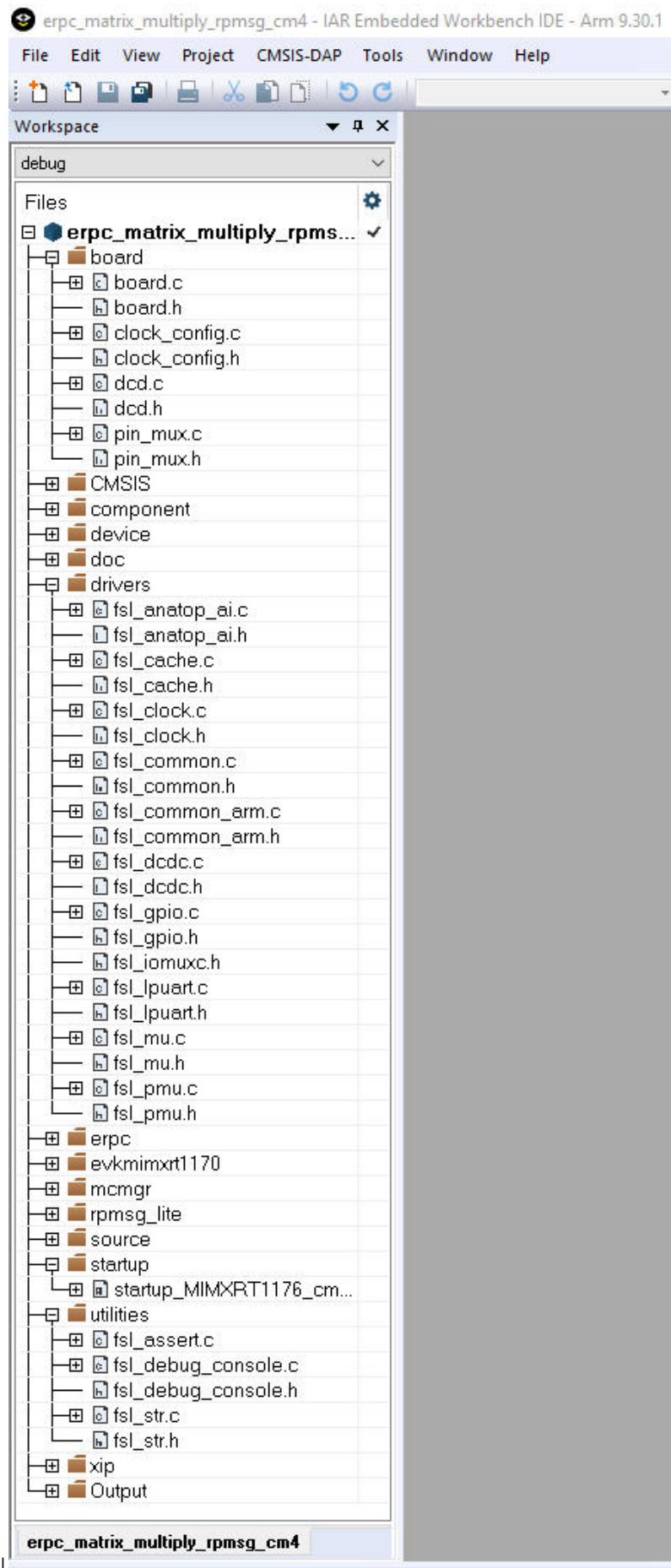
Multicore server application The “Matrix multiply” eRPC server project is located in the following folder:

`<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>/`



|

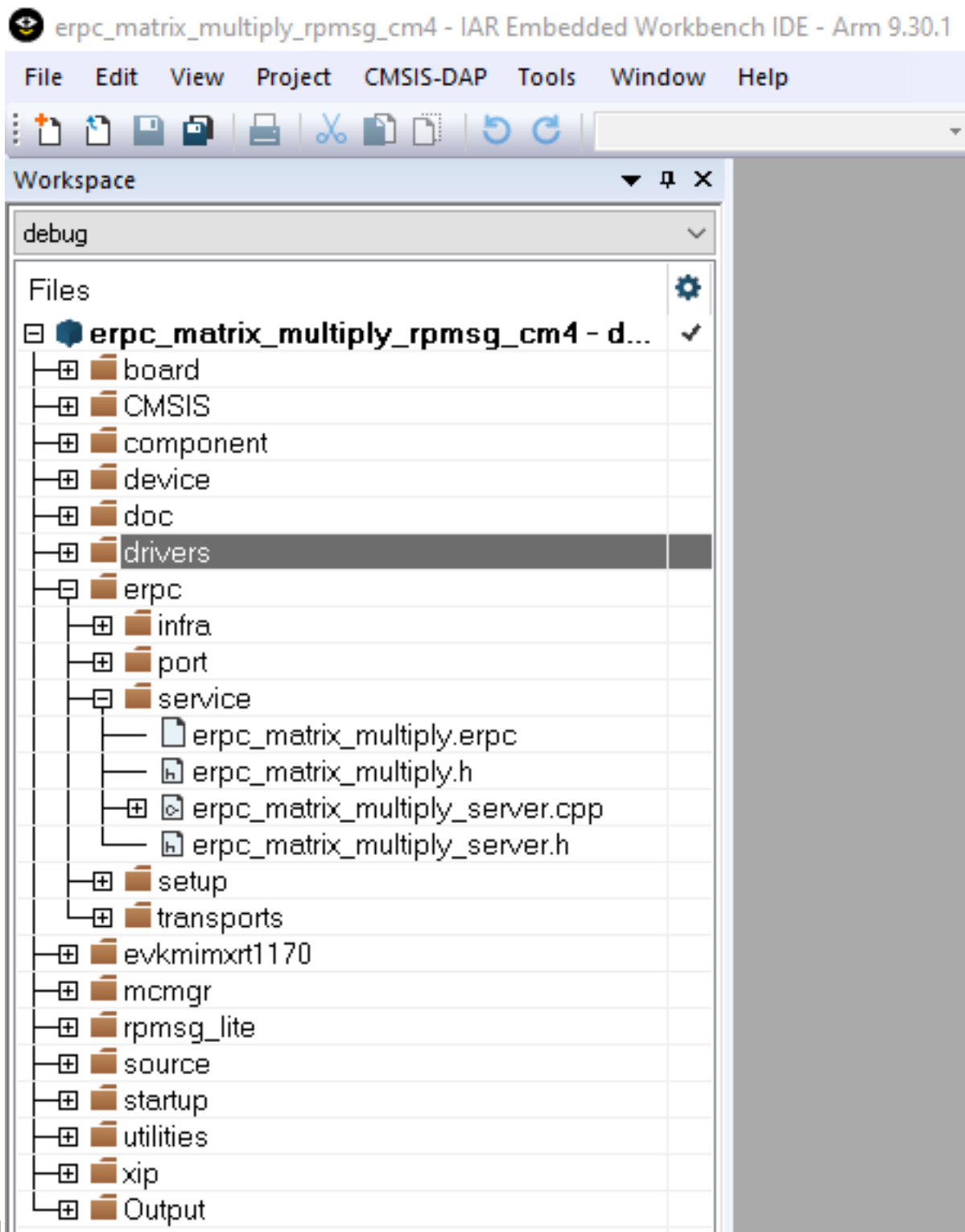
Parent topic: Multicore server application

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/



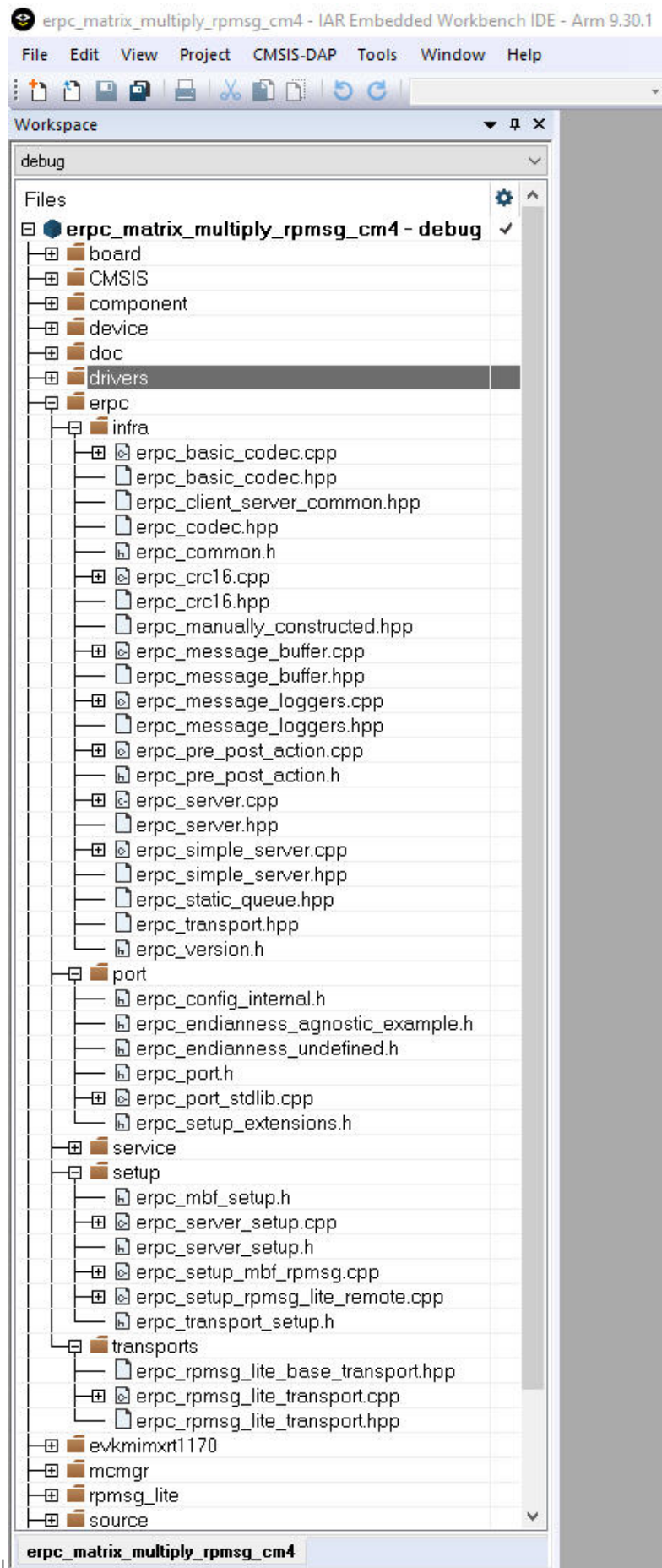
Parent topic: Multicore server application

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.



|

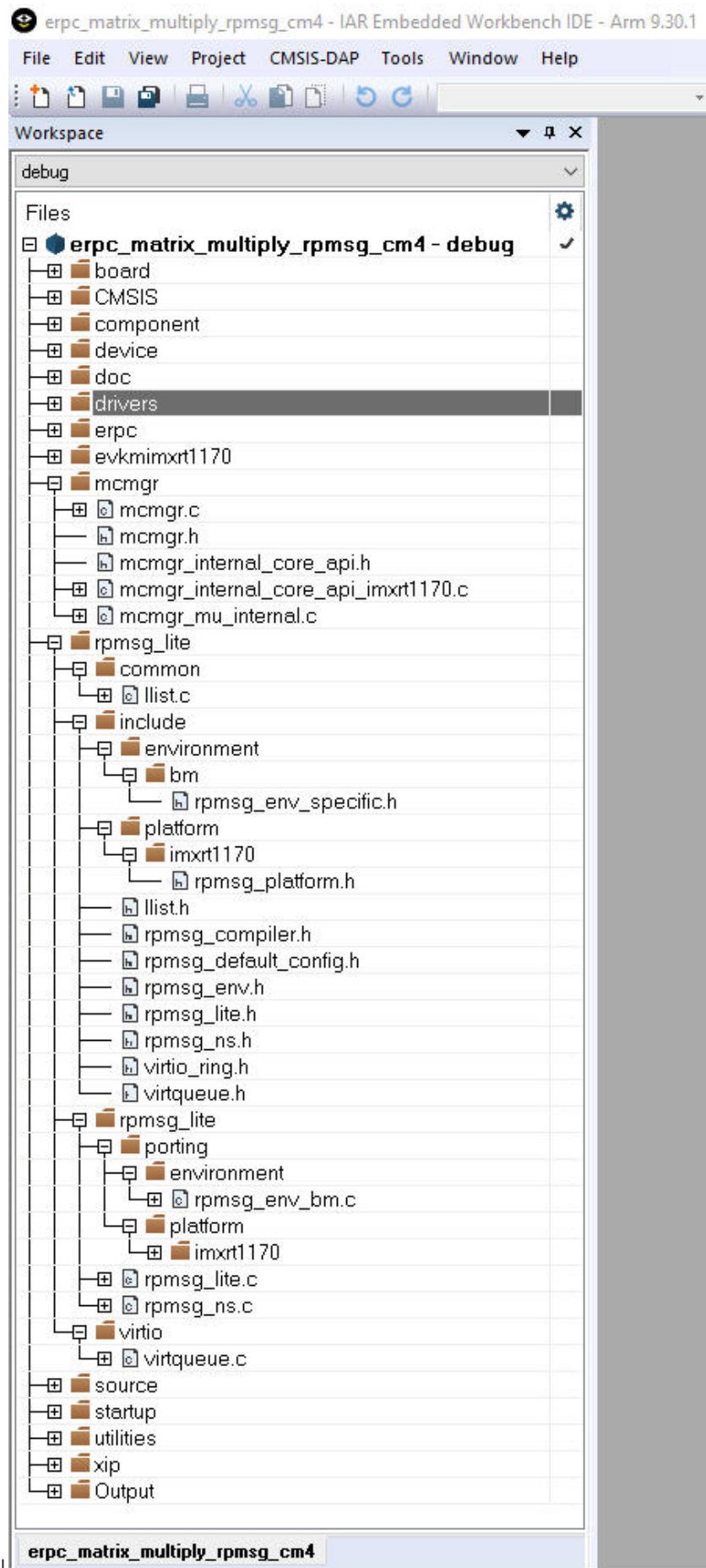
Parent topic: Multicore server application

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`

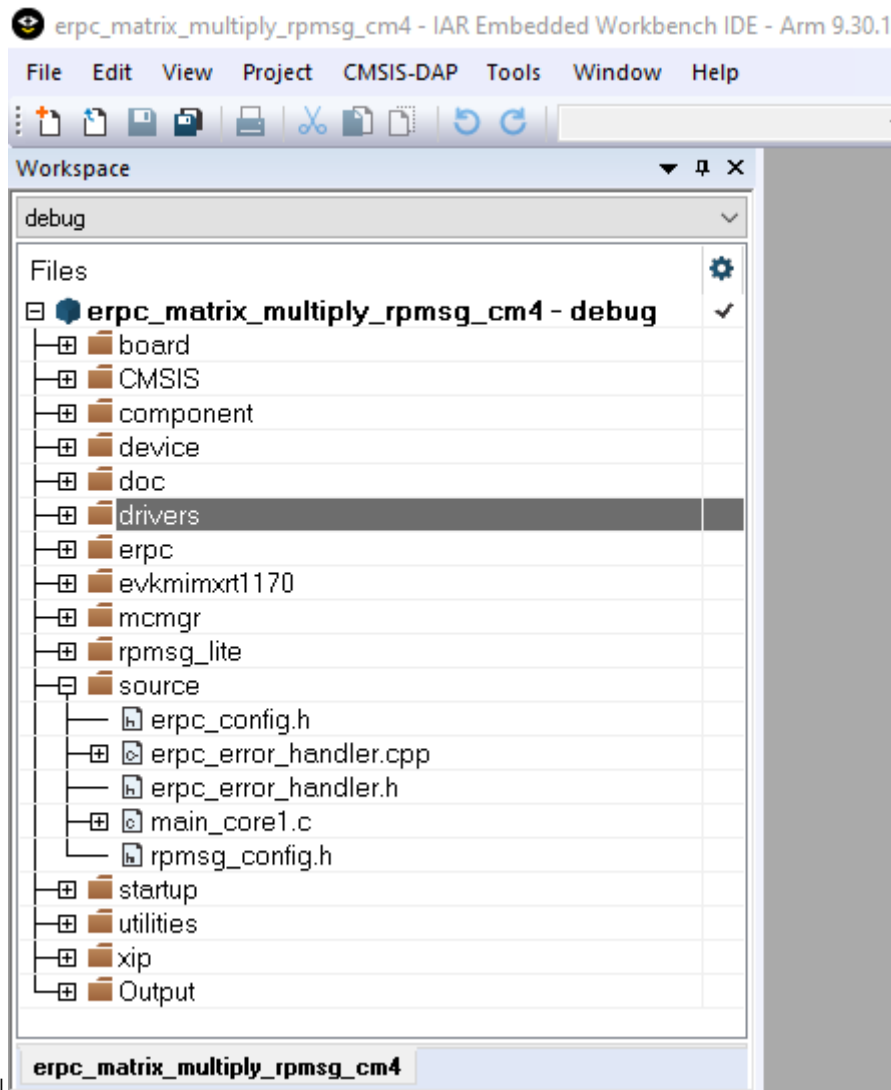
The `main_core1.c` file contains two functions:

- 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](#)

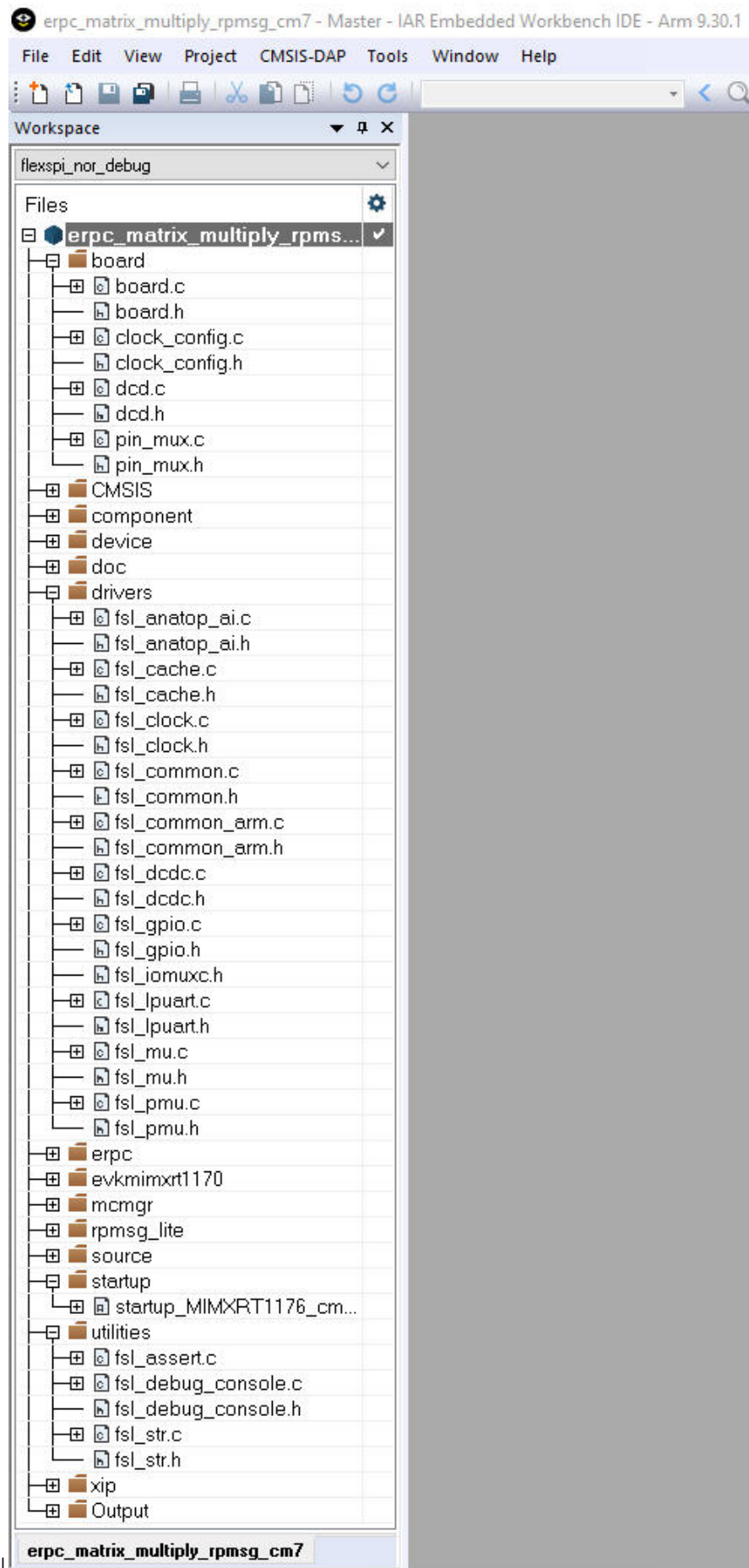
Multicore client application The “Matrix multiply” eRPC client project is located in the following folder:

`<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>/`



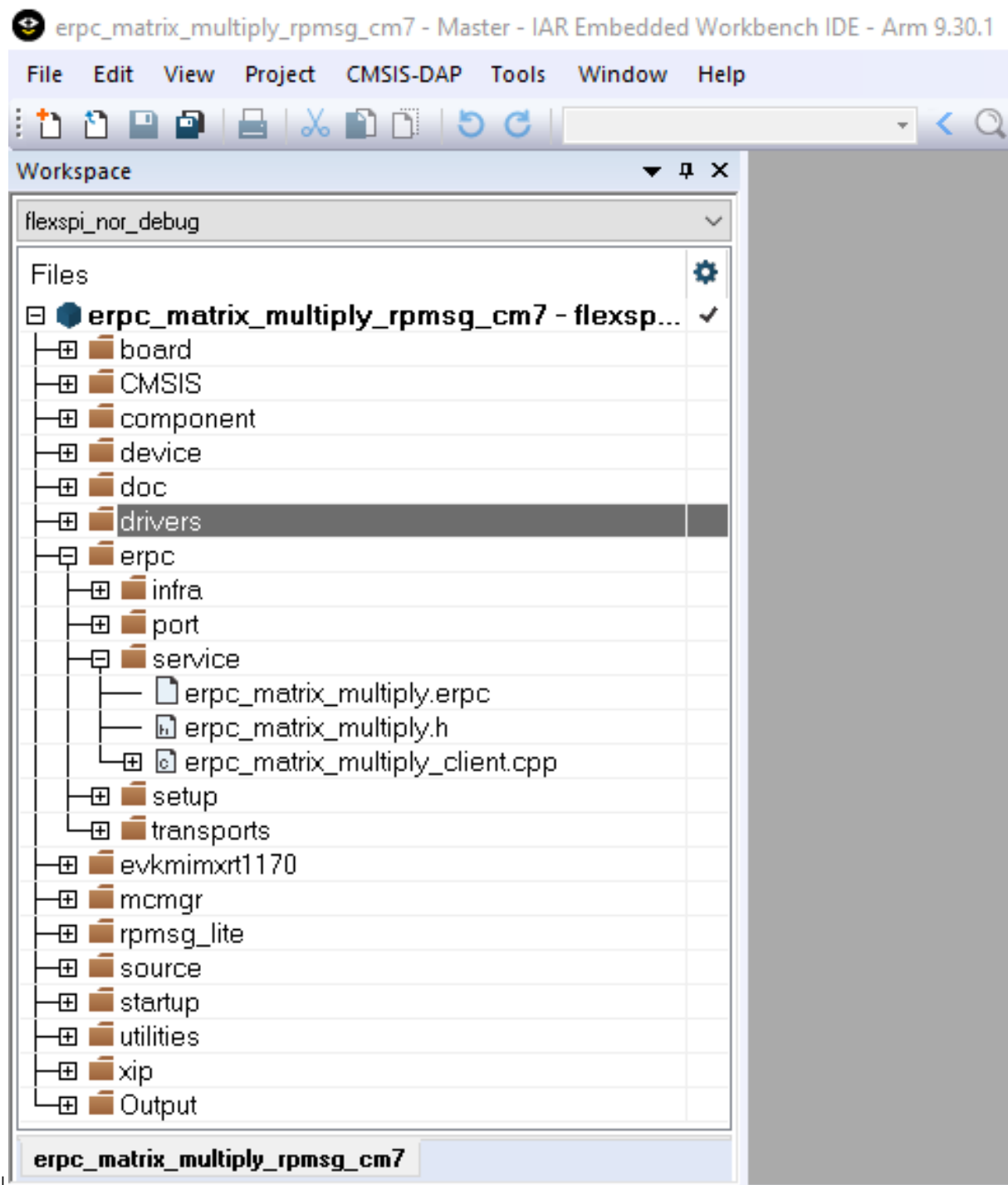
|

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.

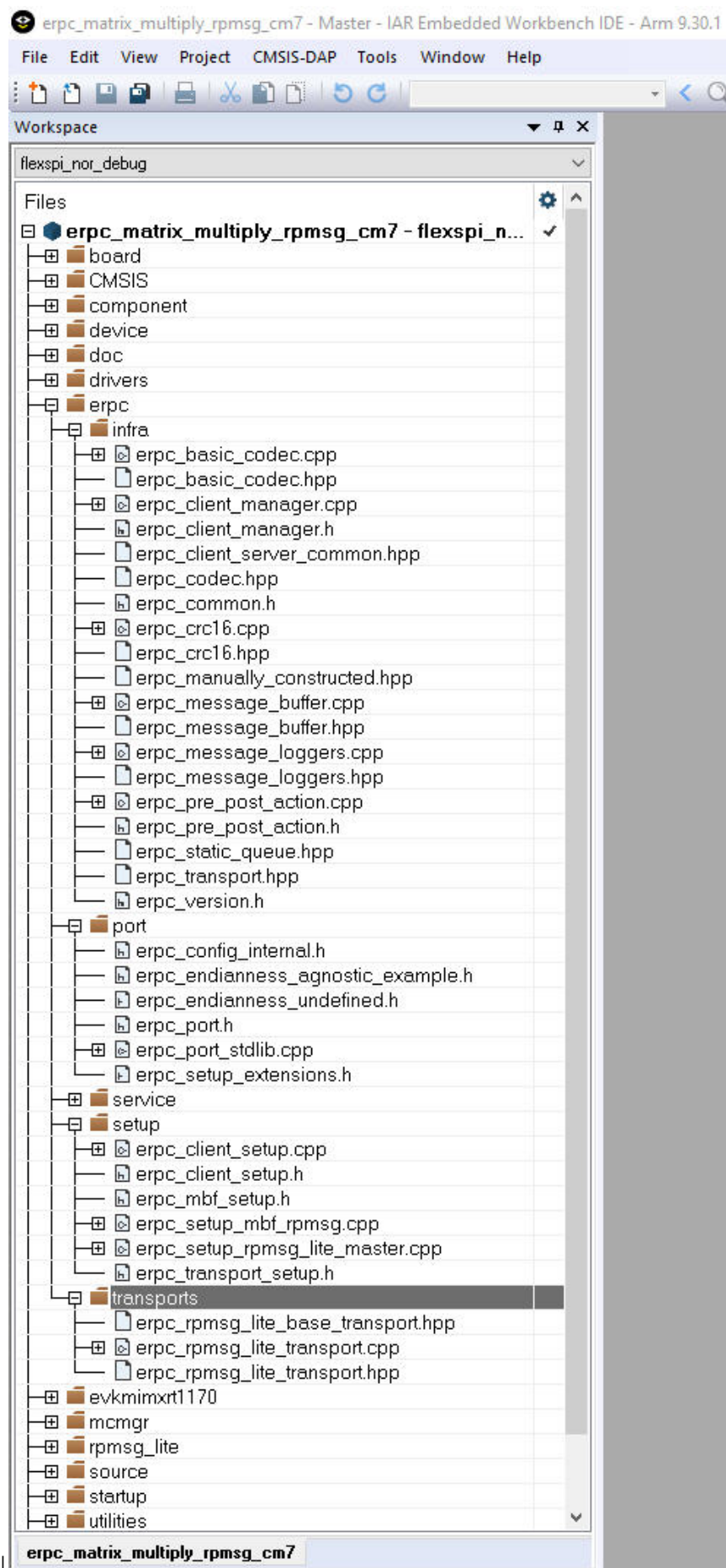
- `erpc_port.h` file contains definition of `erpc_malloc()` and `erpc_free()` functions.
- `erpc_port_stdlib.cpp` file ensures adaptation to `stdlib`.
- `erpc_config_internal.h` internal eRPC configuration file.

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.



|

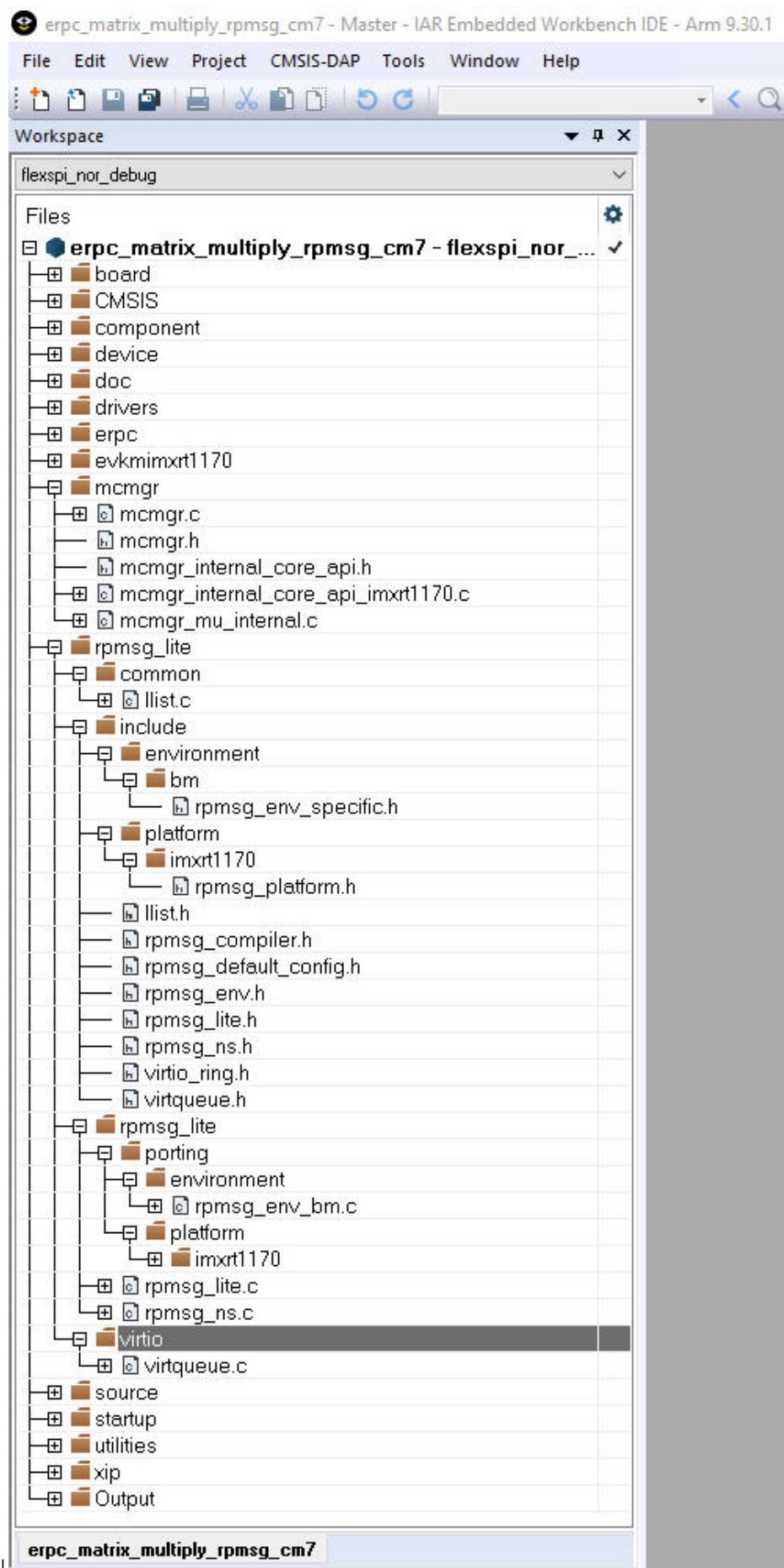
Parent topic: Multicore client application

Client multicore infrastructure files Because of the 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.

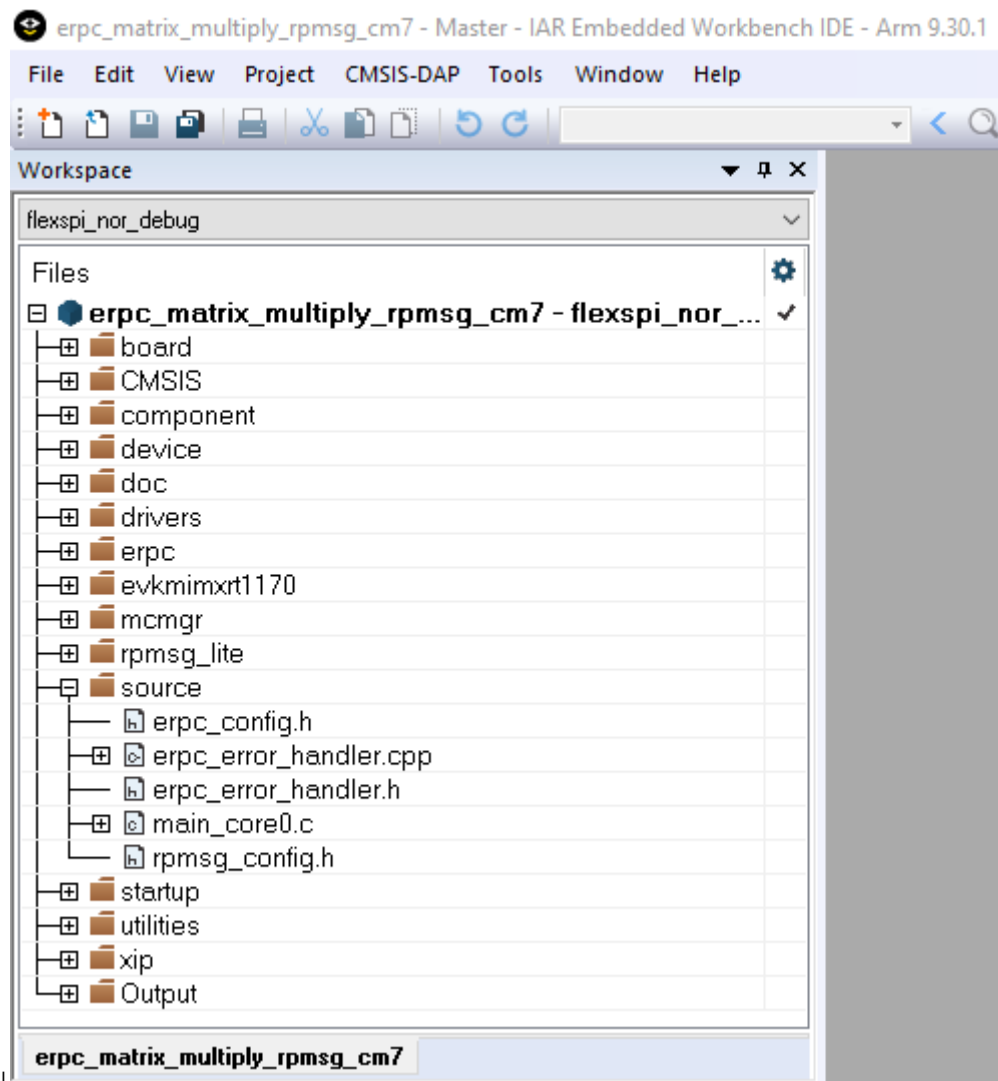
The matrix multiplication can be issued repeatedly, when pressing a software board button.

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};
...
/* RPSMsg-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 RPSMsg-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 RPMMsg-Lite). The RPMMsg-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:

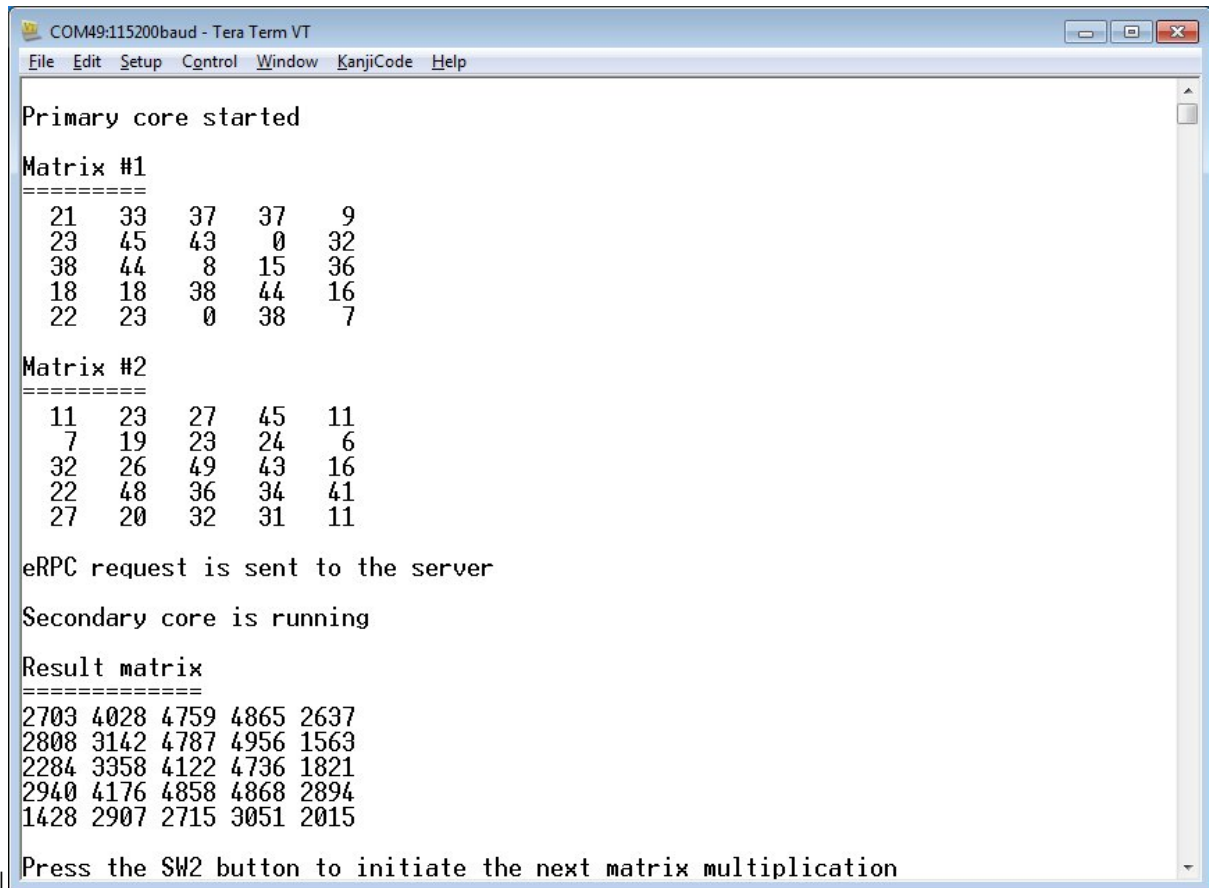
```
...
extern bool g_erpc_error_occurred;
...
/* Declare matrix arrays */
Matrix matrix1 = {0}, matrix2 = {0}, result_matrix = {0};
...
/* UART transport layer initialization, ERPC_DEMO_UART is the structure of CMSIS UART driver
↳operations */
erpc_transport_t transport;
transport = erpc_transport_cmsis_uart_init((void *)&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.

Note about the source code in the document Example code shown in this document has the following copyright and BSD-3-Clause license:

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Changelog eRPC All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

Unreleased

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 LIBUSBSIO device index being specified from the Python command line argument.

Fixed

- eRPC: Improving template usage, GitHub PR #153.
- eRPC: `run_clang_format.py` cleanup, GitHub PR #177.
- eRPC: Build TCP transport setup code into `liberpc`, GitHub PR #179.
- eRPC: Fix multiple definitions of `g_client` error, GitHub PR #180.
- eRPC: Fix `memset` past end of buffer in `erpc_setup_mbf_static.cpp`, GitHub PR #184.
- eRPC: Fix deprecated error with newer pytest version, GitHub PR #203.
- eRPC, erpcgen: Static allocation support and usage of `rpmsg` static FreeRTOSs related API, GitHub PR #168, #169.
- erpcgen: Remove redundant module imports in erpcgen, GitHub PR #196.

1.8.1

Added

- eRPC: New `i2c_slave_transport` 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 Multimedia

3.7.1 VGLite Graphics Driver

IMXRTVGLITEAPIRM

Introduction The VGLite Graphics API (Application Programming Interface) is designed to support 2D vector and 2D raster-based operations for rendering the interactive user interface that may include menus, fonts, curves, and images. The goal is to provide the maximum 2D vector/raster rendering performance, while keeping the memory footprint to the minimum.

Note: This document contains proprietary information of VeriSilicon Holdings Co., Ltd, and Vivante Corporation.

VGLite Graphics API The Vivante VGLite Graphics API is used to control the Vivante vector graphics hardware units that provide accelerated vector and raster operations.

The Vivante VGLite API is developed for use with Vivante GCNanoLiteV, GCNanoUltraV, GCNanoV, GC355, and GC555 hardware. GC355 and GC555 support the Khronos OpenVG 1.1 feature set, while GCNanoLiteV, GCNanoUltraV and GCNanoV have a feature set smaller than that required to pass Khronos OpenVG CTS.

The VGLite API driver V4 is a new design and implementation of the driver (from 2023Q1) to support the new generation 2.5D GPU (GC555), and the previous 2.5D GPU releases (GC255, GC265, GC355). The new V4 driver supports the new and improved VGLite API (version 3.0) and can generate the most CPU-efficient, customized driver build for a specific 2.5D GPU release based on the hardware feature set.

VGLite API supported features include: Porter-Duff Blending, Gradient Controls, Fast Clear, Arbitrary Rotations, Path Filling rules, Path painting, and Pattern Path Filling.

By default, VGLite API driver V4 supports one implicit global application context in a single thread. VGLite V4 driver does not support multithreaded applications, which is not suitable for embedded IoT devices.

Parent topic:[Introduction](#)

API function group The VGLite Graphics API has been designed to have independent function groups. It is permissible for a user to use only one of the function groups in the VGLite application:

- **Initialization** is used for initializing hardware and software structures
- **Blit API** is used for the raster part of rendering

- **Draw API** is used for 2D vector-based draw operations

Parent topic:[Introduction](#)

API files The VGLite source code is available as part of the NXP MCUXpresso SDK:

The VGLite graphics API functions are defined in the header file `VGLite/inc/vg_lite.h`.

All VGLite enumerations and data types are defined in `VGLite/inc/vg_lite.h`.

Parent topic:[Introduction](#)

Hardware versions The Vivante VGLite API is compatible with a range of Vivante Vector Graphics IPs including: GCNanoLiteV, GCNanoUltraV, GCNanoV, GC355, and GC555.

Note: A specific hardware version has customized feature set that may limit hardware support for some VGLite API options. The VGLite application can use the `vg_lite_query_feature` API to query specific VGLite feature availability.

Users can also check the `VGLite/VGLite/vg_lite_options.h` file which includes `CHIPID`, `REVISION`, `CID` to identify specific HW releases, and the `gcFEATURE_VG_*` macros to define the feature set for the HW release.

The `gcFEATURE_VG_*` macro values (except a few SW features) should NOT be changed. Otherwise, the VGLite driver does not function correctly on the specific HW release. Users can change the “SW Features” macro values to disable some software features, unnecessary error checks, or enable VGLite API trace for debug purposes.

.

Parent topic:[Introduction](#)

Common parameters and error values This chapter provides an overview of the common parameter types and the enumeration used for error reporting.

Common parameter types The VGLite graphics API uses a naming convention scheme wherein definitions are preceded by `vg_lite`.

Below is the list of types and structures in the driver implementation.

Nam	Type- def	Value										
vg_li	int	A signed 32-bit integer 0: FALSE; 1: TRUE.										
vg_li	char	A signed 8-bit integer										
vg_li	un- signe char	An unsigned 8-bit integer										
vg_li	short	A signed 16-bit integer										
vg_li	un- signe short	An unsigned 16-bit integer										
vg_li	int	A signed 32-bit integer										
vg_li	un- signe int	An unsigned 32-bit integer										
vg_li	un- signe long long	An unsigned 64-bit integer										
vg_li	float	A 32-bit single precision floating point number										
vg_li	dou- ble	A 64-bit double precision floating point number										
vg_li	char	A signed 8-bit integer										
vg_li	char*	A pointer to a character string										
vg_li	void*	A generic address pointer (void *). On 32-bit OS, it is a 32-bit address pointer. On 64-bit OS, it is a 64-bit address pointer.										
vg_li	void	The void type										
vg_li	vg_lit	A 32-bit color value The color value specifies the color used in various functions. The color is formed using 8-bit RGBA channels. The red channel is in the lower 8-bit of the color value, followed by the green and blue channels. The alpha channel is in the upper 8-bit of the color value.										
	<table><tr><td></td><td>31:24</td><td>23:16</td><td>15:8</td><td>7:0</td></tr><tr><td>vg_lite_color_t</td><td>A</td><td>B</td><td>G</td><td>R</td></tr></table>		31:24	23:16	15:8	7:0	vg_lite_color_t	A	B	G	R	For L8 target formats, the RGB color is converted to L8 by using the default ITU-R BT.709 conversion rules.
	31:24	23:16	15:8	7:0								
vg_lite_color_t	A	B	G	R								
VG_I	enun vg_lit	A signed 8-bit integer coordinate										
VG_I	enun vg_lit	A signed 16 bit integer coordinate										
VG_I	enun vg_lit	A signed 32-bit integer coordinate										
VG_I	enun vg_lit	A 32-bit floating point coordinate										

Parent topic: [Common parameters and error values](#)

Enumerations for error reporting This section describes enumerations used for error reporting.

`vg_lite_error_t` **enumeration** Most functions in the API include an error status via the `vg_lite_error_t` enumeration. API functions return the status of the command and will report `VG_LITE_SUCCESS` if successful with no errors. Possible error values include the values in the table below. `vg_lite_error_t` enumeration is used in many functions, including initialization, flush, blit, draw, gradient, and pattern functions.

vg_lite_error_t string values	Description
VG_LITE_GENERIC_IO	Cannot communicate with the kernel driver
VG_LITE_INVALID_ARGUMEN	An invalid argument was specified
VG_LITE_MULTI_THREAD_FA	Multi-thread/tasks fail (<i>available from June 2020</i>)
VG_LITE_NO_CONTEXT	No context specified
VG_LITE_NOT_SUPPORT	Function call is not supported. Hardware support is not available.
VG_LITE_OUT_OF_MEMORY	Out of memory (driver heap)
VG_LITE_OUT_OF_RESOURC	Out of resources (OS heap)
VG_LITE_SUCCESS	Successful with no errors
VG_LITE_TIMEOUT	Timeout
VG_LITE_ALREADY_EXISTS	Object exists (<i>available from August 2021</i>)
VG_LITE_NOT_ALIGNED	Data alignment error (<i>available from August 2021</i>)

Parent topic:Enumerations for error reporting

Parent topic:[Common parameters and error values](#)

Hardware product and feature information These query functions can be used to identify the product and its key features and to get VGLite driver information.

Enumerations for product and feature queries This section describes enumerations used for product and feature queries.

vg_lite_feature_t enumeration The following feature values may be queried for availability in compatible hardware. (*expanded March 2023 to support additional hardware for driver V4*)

Used in information function: `vg_lite_query_feature`.

vg_lite_feature_t string values	Description
gcFEATURE_BIT_VG_16PIXELS_ALIGN	Require 16 pixels aligned for the input pixel buffer
gcFEATURE_BIT_VG_24BIT	RGB888 or RGBA5658 formats support
gcFEATURE_BIT_VG_24BIT_PLANAR	24-bit planar format support
gcFEATURE_BIT_VG_AYUV_INPUT	AYUV input format support
gcFEATURE_BIT_VG_BORDER_CULLING	Border culling support
gcFEATURE_BIT_VG_COLOR_KEY	Color key support.
gcFEATURE_BIT_VG_COLOR_TRANSFORMATION	Color transform support.
gcFEATURE_BIT_VG_DEC_COMPRESS	DEC compression format output support
gcFEATURE_BIT_VG_DITHER	Dither support
gcFEATURE_BIT_VG_DOUBLE_IMAGE	Support two image source inputs
gcFEATURE_BIT_VG_FLEXA	FLEXA interface support
gcFEATURE_BIT_VG_GAMMA	Gamma support
gcFEATURE_BIT_VG_GAUSSIAN_BLUR	Gaussian blur sampling support
gcFEATURE_BIT_VG_GLOBAL_ALPHA	Global alpha support
gcFEATURE_BIT_VG_HW_PREMULTIPLY	HW supports alpha premultiply for image
gcFEATURE_BIT_VG_IM_DEC_INPUT	DEC compressed format input support
gcFEATURE_BIT_VG_IM_FASTCLEAR	Fast Clear support
gcFEATURE_BIT_VG_IM_INDEX_FORMAT	Index format support for image
gcFEATURE_BIT_VG_IM_INPUT	Blit and draw API support
gcFEATURE_BIT_VG_IM_REPEAT_REFLECT	Image repeat reflect mode support
gcFEATURE_BIT_VG_INDEX_ENDIAN	Index format endian support
gcFEATURE_BIT_VG_LINEAR_GRADIENT_EXT	Support for extended linear gradient capabilities

continues on next page

Table 1 – continued from previous page

vg_lite_feature_t string values	Description
gcFEATURE_BIT_VG_LVGL_SUPPORT	LVGL blend mode support
gcFEATURE_BIT_VG_MASK	Mask support
gcFEATURE_BIT_VG_MIRROR	Mirror support
gcFEATURE_BIT_VG_NEW_BLEND_MODE	New blend mode DARKEN/LIGHTEN support
gcFEATURE_BIT_VG_NEW_IMAGE_INDEX	New CLUT image index support
gcFEATURE_BIT_VG_PARALLEL_PATHS	New parallel path HW support
gcFEATURE_BIT_VG_PE_CLEAR	Pixel engine clear support
gcFEATURE_BIT_VG_PIXEL_MATRIX	Pixel matrix support
gcFEATURE_BIT_VG_QUALITY_8X	8x anti-aliasing path support
gcFEATURE_BIT_VG_RADIAL_GRADIENT	Radial gradient support
gcFEATURE_BIT_VG_RECTANGLE_TILED_OUT	Rectangle tiled output support
gcFEATURE_BIT_VG_RGBA2_FORMAT	RGBA2222 format support
gcFEATURE_BIT_VG_RGBA8_ETC2_EAC	ETC2/EAC compressed image format support
gcFEATURE_BIT_VG_SCISSOR	Scissor support
gcFEATURE_BIT_VG_SRC_PREMULTIPLIED	Source image alpha premultiplied
gcFEATURE_BIT_VG_STENCIL	Stencil image mode support
gcFEATURE_BIT_VG_STRIPE_MODE	Stripe mode support
gcFEATURE_BIT_VG_TESSELLATION_TILED_OUT	Tessellation tiled output support
gcFEATURE_BIT_VG_USE_DST	Read destination pixel support
gcFEATURE_BIT_VG_YUV_INPUT	YUV input format support
gcFEATURE_BIT_VG_YUV_OUTPUT	YUV format output support
gcFEATURE_BIT_VG_YUV_TILED_INPUT	YUV tiled input format support
gcFEATURE_BIT_VG_YUY2_INPUT	YUY2 input format support

Parent topic:Enumerations for product and feature queries

Parent topic:[Hardware product and feature information](#)

Structures for product and feature queries This section describes structures used for product and feature queries.

vg_lite_info_t structure This structure is used to query VGLite driver information.

Used in function: `vg_lite_get_info_t`.

vg_lite_info_t member	Type	Description
api_version	vg_lite_uint32_t	VGLite API version
header_version	vg_lite_uint32_t	VGLite header version
release_version	vg_lite_uint32_t	VGLite driver release version
reserved	vg_lite_uint32_t	Reserved for future use

Parent topic:Structures for product and feature queries

Parent topic:[Hardware product and feature information](#)

Functions for product and feature queries This section describes functions used for product and feature queries.

vg_lite_get_product_info **Description:**

This function is used to identify the VGLite-compatible product.

Syntax:

```
uint32_t vg_lite_get_product_info (  
    char      *name,  
    uint32_t   *chip_id,  
    uint32_t   *chip_rev  
);
```

Parameters:

Name	Description
name	A character array to store the name of the chip.
chip_id	Stores an ID number for the chip.
chip_rev	Stores a revision number for the chip.

Parent topic:Functions for product and feature queries

`vg_lite_get_info` **Description:**

This function is used to query the VGLite driver information.

Syntax:

```
vg_lite_error_t vg_lite_get_info (  
    vg_lite_info_t      *info  
);
```

Parameters:

Name	Description
info	Points to the VGLite driver information structure, which includes the API version, header version, and release version

Parent topic:Functions for product and feature queries

`vg_lite_get_register` **Description:**

This function can be used to read a GPU AHB register value given the AHB byte address of a register. Refer to the appropriate Vivante GPU AHB register specification documents for register descriptions. The value range of AHB accessible addresses for VGLite cores is usually 0x0 to 0x1FF and 0xA00 to 0xA7F.

Syntax:

```
vg_lite_error_t vg_lite_get_register (  
    vg_lite_uint32_t   address,  
    vg_lite_uint32_t   *result  
);
```

Parameters:

Name	Description
address	Byte Address of the register which value you want.
*result	The registers value.

Parent topic:Functions for product and feature queries

vg_lite_query_feature **Description:**

This function is used to query if a specific feature is available.

Syntax:

```
vg_lite_uint32_t vg_lite_query_feature (
    vg_lite_feature_t    feature
);
```

Parameters:

Name	Description
feature	Feature to be queried, as detailed in enum <code>vg_lite_feature_t</code>

Returns:

The feature is either not supported (0) or supported (1).

Parent topic: Functions for product and feature queries

vg_lite_get_mem_size **Description:**

This function queries whether there is any remaining allocated contiguous video memory. *(available from June 2020)*

Syntax:

```
vg_lite_error_t vg_lite_get_mem_size(
    vg_lite_uint32_t    *size
);
```

Parameters:

Name	Description
size	Pointer to the remaining allocated contiguous video memory.

Returns:

Returns `VG_LITE_SUCCESS` if the query is successful and memory is available. Returns `VG_LITE_NO_CONTEXT` if the driver is not initialized or there is no available memory.

Parent topic: Functions for product and feature queries

Parent topic: [Hardware product and feature information](#)

API control Before calling any VGLite API function, the application must initialize the VGLite implicit (global) context by calling `vg_lite_init()`, which will fill in a features table, reset the fast-clear buffer, reset the compositing target buffer and allocate the command and tessellation buffers.

The VGLite driver only supports one current context and one thread to issue commands to the Vivante Vector Graphics hardware. The VGLite driver does not support multiple concurrent contexts running simultaneously in multiple threads/processes, as the VGLite kernel driver does not support context switching. A VGLite application can only use a single context at any time to issue commands to the Vivante Vector Graphics hardware. If a VGLite application must switch contexts, `vg_lite_close()` must be called to close the current context in the current thread, then

`vg_lite_init()` can be called to initialize a new context either in the current thread or from another thread/process.

Context initialization and control functions This section provides an overview of the context initialization and control functions.

`vg_lite_init` **Description:**

This function initializes the memory and data structures needed for VGLite draw/blit functions, by allocating memory for the command buffer and a tessellation buffer of the specified size.

GC555 has a newly designed hardware tessellation module that requires less memory for the tessellation buffer than GC355 and GNanoLite-V. Specifically, the GC555 required tessellation buffer size is “buffer_height * 128 byte”. `vg_lite_init` API can simply be called with the render buffer “width” and “height” as the input parameters for GC555. This results in the best path to tessellation performance.

GC355 and GCNanoLiteV hardware tessellation module requires a tessellation buffer with size “buffer_height * buffer_width * 8 byte”. If system memory is limited, the application can define a smaller tessellation window based on the amount of memory available. GPU hardware can process the entire render buffer path tessellation in multiple passes with the tessellation window sliding across the render buffer. The multi-pass path tessellation with the smaller tessellation window has a certain performance overhead.

The minimum tessellation window that can be used is 16x16. If `tess_height` or `tess_width` is less than 0 in `vg_lite_init` API, then no path tessellation buffer is created and path drawing APIs do not work, only blit APIs can be used after `vg_lite_init`.

If this would be the first context that accesses the hardware, the hardware is turned on and initialized. If a new context must be initialized, `vg_lite_close` must be called to close the current context. Otherwise, `vg_lite_init` will return an error.

Syntax:

```
vg_lite_error_t vg_lite_init (  
    vg_lite_int32_t      tess_width,  
    vg_lite_int32_t      tess_height  
);
```

Parameters:

Name	Description
<code>tess_w</code>	Width of tessellation window. Maximum cannot be greater than render buffer width. If less than or equal to 0, then no tessellation buffer is created, in which case only blit APIs can be used afterward.
<code>tess_h</code>	Height of tessellation window. Maximum cannot be greater than render buffer height. If less than or equal to 0, then no tessellation buffer is created, in which case blit APIs can be used afterward.

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

vg_lite_close **Description:**

This function deallocates all the resources and free up all the memory that was initialized earlier by the `vg_lite_init` function. It will also turn OFF the hardware automatically if this was the only active context.

Syntax:

```
vg_lite_error_t vg_lite_close (
    void
);
```

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

vg_lite_flush **Description:**

This function explicitly submits the command buffer to the GPU without waiting for it to complete. *(From Dec 2019, return type is `vg_lite_error_t`, previously was `void`.)*

Syntax:

```
vg_lite_error_t vg_lite_flush (
    void
);
```

Returns:

Returns `VG_LITE_SUCCESS` if the flush is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

vg_lite_finish **Description:**

This function explicitly submits the command buffer to the GPU and waits for it to complete.

Syntax:

```
vg_lite_error_t vg_lite_finish (
    void
);
```

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

vg_lite_frame_delimiter **Description:**

This function sets a flag for GPU to signal the completion of current frame. A `vg_lite_finish` is called by default within this API. The enum `VG_LITE_FRAME_END_FLAG` is the only value that can be set by `flag` parameter.

Syntax:

```
vg_lite_error_t vg_lite_frame_delimiter (  
    vg_lite_frame_flag_t flag  
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Context initialization and control functions

vg_lite_set_command_buffer_size **Description:**

This function is optional. If used, call it before vg_lite_init if you want to change the command buffer size. *(available from March 2020)*

Syntax:

```
vg_lite_error_t vg_lite_set_command_buffer_size (  
    vg_lite_uint32_t      size  
);
```

Parameters:

Name	Description
size	Size of the VGLite Command buffer. Default is 64K.

Returns:

Returns VG_LITE_SUCCESS if the flush is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic:Context initialization and control functions

vg_lite_set_command_buffer **Description:**

This function sets a user-defined external memory buffer (physical, 64-byte aligned) as the VGLite command buffer. By default, the VGLite driver allocates a static command buffer internally. Thus, it is not necessary for an application to allocate and set the command buffer. This function is only used for devices where an application needs to allocate the command buffer dynamically. *(from December 2021)*

Syntax:

```
vg_lite_error_t vg_lite_set_command_buffer (  
    vg_lite_uint32_t      physical,  
    vg_lite_uint32_t      size  
);
```

Parameters:

Name	Description
physical	The physical address of a memory buffer. The address must be 64-byte aligned.
size	The size of memory buffer. The size must be 128-byte aligned.

Returns:

Returns VG_LITE_SUCCESS if the command buffer set is successful. See vg_lite_error_t enumeration for other return codes.

Parent topic:Context initialization and control functions

`vg_lite_set_tess_buffer` **Description:**

This function specifies a memory buffer from an application as the VGLite driver's tessellation buffer. By default, the VGLite driver allocates a static tessellation buffer internally. Thus, it is not necessary for an application to allocate and set the tessellation buffer. This function is only used for devices where the application needs to allocate the tessellation buffer dynamically. *(from December 2021)*

Syntax:

```
vg_lite_error_t vg_lite_set_tess_buffer (
    vg_lite_uint32_t      physical,
    vg_lite_uint32_t      size
);
```

Parameters:

Name	Description
physi- cal	The physical address of a tessellation buffer. The address must be 64-byte aligned.
size	The size of tessellation buffer. tessellation buffer size = target buffer's height * 128B.

Returns:

Returns VG_LITE_SUCCESS if the tessellation buffer set is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

`vg_lite_set_memory_pool` **Description:**

This function sets the specific memory pool from which certain type of buffers, VG_LITE_COMMAND_BUFFER, VG_LITE_TESSELLATION_BUFFER, or VG_LITE_RENDER_BUFFER, should be allocated. By default, all types of buffers are allocated from VG_LITE_MEMORY_POOL_1. This API must be called before `vg_lite_init()` for setting VG_LITE_COMMAND_BUFFER or VG_LITE_TESSELLATION_BUFFER memory pools. This API can be called anytime for VG_LITE_RENDER_BUFFER to affect the following `vg_lite_allocate()` calls.*(from December 2023)*

Syntax:

```
vg_lite_error_t vg_lite_set_memory_pool (
    vg_lite_buffer_type_t      type,
    vg_lite_memory_pool_t      pool
);
```

Parameters:

Nam	Description
type	The buffer type (VG_LITE_COMMAND_BUFFER, VG_LITE_TESSELLATION_BUFFER, or VG_LITE_RENDER_BUFFER) to be allocated from memory pool.
pool	The memory pool (VG_LITE_MEMORY_POOL_1, VG_LITE_MEMORY_POOL_2) from which the buffer type should be allocated.

Returns:

Returns VG_LITE_SUCCESS if the memory pool set is successful. See `vg_lite_error_t` enumeration for other return codes.

Parent topic:Context initialization and control functions

Parent topic:[API control](#)

Pixel buffers This chapter provides an overview of the pixel buffer alignment, cache, internal representation, enumerations, structures, and functions.

Pixel buffer alignment The VGLite hardware requires the pixel buffer start address and stride to be properly byte-aligned to work correctly. The start address and stride alignment requirement for a pixel buffer depends on the specific pixel format, and `gcFEATURE_VG_16PIXELS_ALIGNED` value (0/1) in `vg_lite_options.h` file.

Parent topic:[Pixel buffers](#)

Pixel cache The Vivante Imaging Engine (IM) includes two fully associative caches. Each cache has 8 lines. Each line has 64 bytes. In this case, one cache line can hold either a 4x4-pixel tile or a 16x1-pixel row.

Parent topic:[Pixel buffers](#)

Internal representation For non-32-bit color formats, each pixel is extended to 32 bits as follows:

If the source and destination formats have the same color format, but differ in the number of bits per color channel, the source channel is multiplied by $(2d-1)/(2s-1)$ and is rounded to the nearest integer, where:

- **d** is the number of bits in the destination channel
- **s** is the number of bits in the source channel

Example: a b11111 5-bit source channel gets converted to an 8-bit destination b11111000.

The YUV formats are internally converted to RGB. The pixel selection is unified for all formats by using the LSB of the coordinate.

Parent topic:[Pixel buffers](#)

Pixel buffer enumerations This section provides an overview of the pixel buffer enumerations.

vg_lite_buffer_format_t enumeration This enumeration specifies the color format to use for a buffer. This applies to both image and Render Target. Formats include supported swizzles for RGB. For YUV swizzles, use the related values and parameters in `vg_lite_swizzle_t`.

The application shall use the `vg_lite_query_feature` API to determine support for some hardware-specific formats. For example, related `vg_lite_feature_t` enum values include `gcFEATURE_BIT_VG_RGBA2_FORMAT` and `gcFEATURE_BIT_VG_IM_INDEX_FORMAT`.

(Alignment columns refined March and Sept 2023)

Used in structure: `vg_lite_buffer_t`.

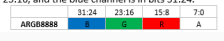
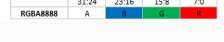
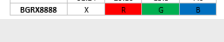
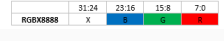
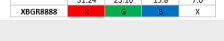
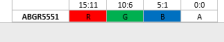
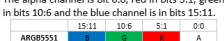
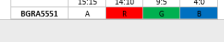
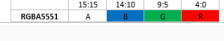
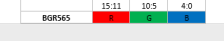
See also `vg_lite_blit`, `vg_lite_clear`, `vg_lite_draw`.

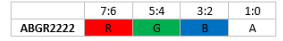
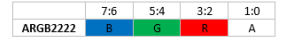
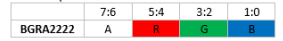
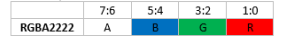
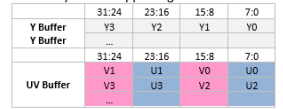
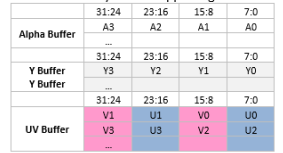
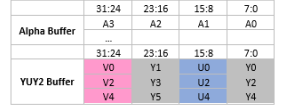
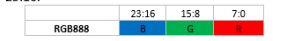
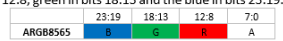
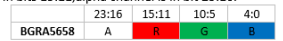
Attention: OpenVG VGImageFormat Note: The bits for each color channel are stored within a machine word from MSB to LSB in the order indicated by the pixel format name. This is the opposite of the original VG_LITE_* formats that are ordered from LSB to MSB. The formats with the same organization are listed in the same row as their VG_Lite counterparts.

Attention: Original VGLite API Image Format Note: The bits for each color channel are stored within a machine word from LSB to MSB in the order indicated by the pixel format name. This is the opposite of the OPENVG VG_* formats that are ordered from MSB to LSB.

The following codes, as also used in OpenVG 1.1 Specification Table 11, are used for format description:

- A - Alpha channel
- B - Blue color channel
- G - Green color channel
- R - Red color channel
- X - Uninterpreted padding byte or bit
- L - Grayscale
- BW - 1-bit black and white
- l - Linear color space
- s - Non-linear (sRGB) color space
- PRE - Alpha values are premultiplied

vg_lite_buffer_format_t String Value	Description	Supported as source	Supported as destination	Start address/alignment: bytes	Stride
VG_LITE_ABGR8888 VG_sRGBA_8888 VG_sRGBA_8888_PRE VG_IRGBA_8888 VG_IRGBA_8888_PRE	32-bit ABGR format with 8 bits per color channel. Alpha is in bits 7:0, blue in bits 15:8, green in bits 23:16, and the red channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_ARGB8888 VG_sBGRA_8888 VG_sBGRA_8888_PRE VG_IBGRA_8888 VG_IBGRA_8888_PRE	32-bit ARGB format with 8 bits per color channel. Alpha is in bits 7:0, red in bits 15:8, green in bits 23:16, and the blue channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_BGRA8888 VG_sARGB_8888 VG_sARGB_8888_PRE VG_IARGB_8888 VG_IARGB_8888_PRE	32-bit BGRA format with 8 bits per color channel. Blue in bits 7:0, green in bits 15:8, red is in bits 23:16, and the alpha channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_RGBA8888 VG_sABGR_8888 VG_sABGR_8888_PRE VG_IABGR_8888 VG_IABGR_8888_PRE	32-bit RGBA format with 8 bits per color channel. Red is in bits 7:0, green in bits 15:8, blue in bits 23:16, and the alpha channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_BGRX8888 VG_sXRGB_8888 VG_IXRGB_8888	32-bit BGRX format with 8 bits per color channel. Blue in bits 7:0, green in bits 15:8, red is in bits 23:16, and the X channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_RGBX8888 VG_sXBGR_8888 VG_IXBGR_8888	32-bit RGBX format with 8 bits per color channel. Red is in bits 7:0, green in bits 15:8, blue in bits 23:16, and the X channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_XBGR8888 RGBX VG_sRGBX_8888 VG_IRGBX_8888	32-bit XBGR format with 8 bits per color channel. The X channel is in bits 7:0, blue in bits 15:8, green in bits 23:16, and the red channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_XRGB8888 VG_sBGRX_8888 VG_IBGRX_8888	32-bit XRGB format with 8 bits per color channel. The X channel is in bits 7:0, red in bits 15:8, green in bits 23:16, and the blue channel is in bits 31:24. 	Yes	Yes	Start	4B / Stride 64B
VG_LITE_ABGR1555 VG_sRGBA_5551	16-bit ABGR format with 5 bits per color channel and one bit alpha. The alpha channel is in bit 0:0, blue in bits 5:1, green in bits 10:6 and the red channel is in bits 15:11. 	Yes	Yes	Start	4B / Stride 32B
VG_LITE_ARGB1555 VG_sBGRA_5551	16-bit ARGB format with 5 bits per color channel and one bit alpha. The alpha channel is bit 0:0, red in bits 5:1, green in bits 10:6 and the blue channel is in bits 15:11. 	Yes	Yes	Start	4B / Stride 32B
VG_LITE_BGRA5551 VG_sARGB_1555	16-bit BGRA format with 5 bits per color channel and one bit alpha. Blue is in bit 4:0, green in bits 9:5, red in bits 14:0 and the alpha channel is bit 15:15. 	Yes	Yes	Start	4B / Stride 32B
VG_LITE_RGBA5551 VG_sABGR_1555	16-bit RGBA format with 5 bits per color channel and one bit alpha. Red is in bit 4:0, green in bits 9:5, blue in bits 14:0 and the alpha channel is bit 15:15. 	Yes	Yes	Start	4B / Stride 32B
948 VG_LITE_BGR565 VG_sRGB_565	16-bit BGR format with 5 and 6 bits per color channel. Blue is in bits 4:0, green in bits 10:5 and the red channel is in bits 15:11. 	Yes	Yes	Start	4B / Stride 32B

Hardware-dependent formats for vg_lite_buffer_format_t	Description	Supported as source	Supported as destination	Alignment (bytes)
VG_LITE_ABGR2222	8-bit BGRA format with 2 bits per color channel. Alpha is in bits 1:0, blue in bits 3:2, green in bits 5:4 and the red channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_ARGB2222	8-bit BGRA format with 2 bits per color channel. Alpha is in bits 1:0, red in bits 3:2, green in bits 5:4 and the blue channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_BGRA2222	8-bit BGRA format with 2 bits per color channel. Blue is in bits 1:0, green in bits 3:2, red in bits 5:4 and the alpha channel is in bits 7:6. 	Yes	Yes	Start 4B / Stride 16B
VG_LITE_RGBA2222	8-bit RGBA format with 2 bits per color channel. Red is in bits 1:0, green in bits 3:2, blue in bits 5:4 and the alpha channel is in bits 7:6. 	Yes	No	8B
VG_LITE_INDEX_1	1-bit index format	Yes	No	8B
VG_LITE_INDEX_2	2-bit index format	Yes	No	both 8B
VG_LITE_INDEX_4	4-bit index format	Yes	No	both 8B
VG_LITE_INDEX_8	8-bit index format	Yes	No	both 16B
VG_LITE_NV12_TILED	Supertiled (8x8 pixels), planar YUV format, 96-bit for 4 pixels. Y plane is 32 bits for 4 pixels and is organized in 64 pixel super tiles (8x8 Y); UV plane is 64 bits for 4 pixels. Pixels are organized in super tiles are (4x4 UV pairs), available for Source IMAGE only on the supporting hardware. 	Yes	No	Y: both 16 Bytes UV: both 8 Bytes
VG_LITE_ANV12_TILED	Pixel organization as NV12_TILED but with an Alpha Buffer is also supertiled, available for Source IMAGE only on the supporting hardware. 	Yes	No	A, Y: both 16 Bytes UV: both 8 Bytes
VG_LITE_AYUY2_TILEI	Supertiled (8x8) and packed YUV format a with separate tiled Alpha Buffer. Y0 is in bits 7:0 and V is in bits 31:23, available for Source IMAGE only on the supporting hardware. 	Yes	No	both 32B
VG_LITE_RGB888	24-bit RGB format with 8 bits per color channel. Red is in bits 7:0, green in bits 15:8, blue in bits 23:16. 	Yes	Yes	Start 4B / Stride 32B
VG_LITE_BGR888	24-bit RGB format with 8 bits per color channel. Blue is in bits 7:0, green in bits 15:8, red in bits 23:16. 		Yes	Yes
VG_LITE_ARGB8565	24-bit RGBA format with 4 and 5 bits per color channel. The alpha channel is in bit 7:0, red in bits 12:8, green in bits 18:13 and the blue in bits 23:19. 		Yes	Yes
VG_LITE_BGRA5658	24-bit RGBA format with 4 and 5 bits per color channel. Blue is in bits 4:0, green in bits 10:5, red in bits 15:11, alpha channel is in bit 23:16. 	Yes	Yes	Start 4B / Stride 32B

3.7. Multimedia

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Parent topic:Pixel buffer enumerations

Image buffer alignment requirement The image (or source) buffer alignment requirement depends on the specific pixel format, and some `gcFEATURE_*_ALIGNED` defines in the `vg_lite_options.h` file.

Image format	Bits per pixel	Source tile mode	Start address alignment requirement in bytes	Stride
VG_LITE_INDEX1	1	linear	8B	2B
VG_LITE_INDEX1	1	tile	8B	1B
VG_LITE_INDEX2	2	linear	8B	4B
VG_LITE_INDEX2	2	tile	8B	1B
VG_LITE_INDEX4	4	linear	8B	8B
VG_LITE_INDEX4	4	tile	8B	2B
VG_LITE_INDEX8	8	linear	16B	16B
VG_LITE_INDEX8	8	tile	16B	4B
VG_LITE_A4	4	linear	8B	8B
VG_LITE_A4	4	tile	8B	2B
VG_LITE_A8	8	linear	16B	16B
VG_LITE_A8	8	tile	16B	4B
VG_LITE_L8	8	linear	16B	16B
VG_LITE_L8	8	tile	16B	4B
VG_LITE_ARGB2222	8	linear	16B	16B
VG_LITE_ARGB2222	8	tile	16B	4B
VG_LITE_RGB565	16	linear	32B	32B
VG_LITE_RGB565	16	tile	32B	8B
VG_LITE_ARGB1555	16	linear	32B	32B
VG_LITE_ARGB1555	16	tile	32B	8B
VG_LITE_ARGB4444	16	linear	32B	32B
VG_LITE_ARGB4444	16	tile	32B	8B
VG_LITE_ARGB8888	32	linear	64B	64B
VG_LITE_ARGB8888	32	tile	64B	16B
VG_LITE_XRGB8888	32	linear	64B	64B
VG_LITE_XRGB8888	32	tile	64B	16B
VG_LITE_ARGB8565	24	linear	64B	48B
VG_LITE_ARGB8565	24	tile	64B	12B
VG_LITE_RGB888	24	linear	64B	48B
VG_LITE_RGB888	24	tile	64B	12B
VG_LITE_YUY2/YUYV	16	linear	32B	32B
VG_LITE_YUY2/YUYV	16	tile	32B	8B
VG_LITE_NV12	12	linear	Y: 32B UV: 32B	Y: 32B UV: 32B
VG_LITE_YV12	12	linear	Y: 32B U: 16B V: 16B	Y: 32B U: 16B V: 16B
VG_LITE_NV16	16	linear	Y: 32B UV: 32B	Y: 32B UV: 32B
VG_LITE_YV16	16	linear	Y: 32B U: 16B V: 16B	Y: 32B U: 16B V: 16B
VG_LITE_YV24	24	linear	Y: 32B U: 32B V: 32B	Y: 32B U: 32B V: 32B
VG_LITE_ETC2	8	tile	16B	4B

Note:

1. The values in the table reflect the alignment requirements of the data in memory. The stride of ARGB8888 / ARGB8565 is seen as 4Byte per pixel when configuring the hardware.
2. For tile mode, the stride is still the byte size of a row of pixels in the buffer instead of 4 rows.
3. When DECNano function is enabled for the buffer, the total buffer size need align to 64Byte*compression rate for ARGB8888 or XRGB8888 format, align to 48Byte*compress rate for RGB888 format.

Additional Alignment Requirement

1. Buffer starting address must be 16 pixel-byte-size aligned, that is 8 bit-per-pixel format buffer must be 16 bytes aligned; 16 bit-per-pixel format buffer must be 32 bytes aligned; 24 and 32 bit-per-pixel format buffer must be 64 bytes aligned.
2. For linear mode buffer, the buffer stride must be 16 pixel-byte-size aligned.
3. For tile mode buffer, buffer width and height must be 4 pixel aligned so buffer width and height end at tile boundary.

Parent topic:Pixel buffer enumerations

Destination buffer alignment requirement The destination (or render target) buffer alignment requirement depends on the specific pixel format, and some `gcFEATURE_*_ALIGNED` defines in the `vg_lite_options.h` file.

Target format	Bits per pixel	Target tile mode	VG tile mode	Start address alignment requirement
VG_LITE_A8	8	linear	linear	4B
VG_LITE_A8	8	linear	tile	64B
VG_LITE_A8	8	tile	linear	64B
VG_LITE_A8	8	tile	tile	64B
VG_LITE_L8	8	linear	linear	4B
VG_LITE_L8	8	linear	tile	64B
VG_LITE_L8	8	tile	linear	64B
VG_LITE_L8	8	tile	tile	64B
VG_LITE_ARGB2222	8	linear	linear	4B
VG_LITE_ARGB2222	8	linear	tile	64B
VG_LITE_ARGB2222	8	tile	linear	64B
VG_LITE_ARGB2222	8	tile	tile	64B
VG_LITE_RGB565	16	linear	linear	4B
VG_LITE_RGB565	16	linear	tile	64B
VG_LITE_RGB565	16	tile	linear	64B
VG_LITE_RGB565	16	tile	tile	64B
VG_LITE_ARGB1555	16	linear	linear	4B
VG_LITE_ARGB1555	16	linear	tile	64B
VG_LITE_ARGB1555	16	tile	linear	64B
VG_LITE_ARGB1555	16	tile	tile	64B
VG_LITE_ARGB4444	16	linear	linear	4B
VG_LITE_ARGB4444	16	linear	tile	64B
VG_LITE_ARGB4444	16	tile	linear	64B
VG_LITE_ARGB4444	16	tile	tile	64B
VG_LITE_ARGB8888	32	linear	linear	4B
VG_LITE_ARGB8888	32	linear	tile	64B
VG_LITE_ARGB8888	32	tile	linear	64B
VG_LITE_ARGB8888	32	tile	tile	64B
VG_LITE_XRGB8888	32	linear	linear	4B
VG_LITE_XRGB8888	32	linear	tile	64B
VG_LITE_XRGB8888	32	tile	linear	64B
VG_LITE_XRGB8888	32	tile	tile	64B
VG_LITE_ARGB8565	24	linear	linear	64B
VG_LITE_ARGB8565	24	linear	tile	64B
VG_LITE_ARGB8565	24	tile	linear	64B
VG_LITE_ARGB8565	24	tile	tile	64B
VG_LITE_RGB888	24	linear	linear	64B
VG_LITE_RGB888	24	linear	tile	64B
VG_LITE_RGB888	24	tile	linear	64B
VG_LITE_RGB888	24	tile	tile	64B

Note:

1. The values in the table reflect the alignment requirements of pixel data in memory. The stride of ARGB8888/ARGB8565 is seen as 4 Bytes per pixel when configuring the hardware.
2. For tile mode, the buffer stride is still the byte size of a row of pixels instead of 4 rows of pixels.
3. For PE clear function, the clear size must align to 48 Bytes for the RGB888 or ARGB8565 format.
4. For PE clear function with DECNano enabled, the clear size must align to 48 Bytes for RGB888, align to 64 Bytes for ARGB8888 or XRGB8888.
5. If the DECNano function is enabled for the buffer, the target buffer start address needs to align to 64 Bytes.
6. If the DECNano function is enabled for the buffer, the total buffer size needs to align to a 64-byte compression rate for ARGB8888 or XRGB8888 format and align to a 48 Byte*compression rate for RGB888 format.

Additional Alignment Requirement

1. Buffer starting address must be at least 4-byte aligned. Buffer stride must be at least one pixel size aligned.
2. Buffer starting address must be 64-byte aligned for 24 bit-per-pixel format, or tile mode, or DECNano enabled.
3. Buffer height must be 4-pixel aligned for tile mode buffer.
4. For tile mode buffer, the buffer stride must be 16-byte aligned for non-24bit-per-pixel formats. So, 8 bits-per-pixel format buffer width must be 16-pixel aligned; 16 bits-per-pixel format buffer width must be 8-pixel aligned; 32 bit-per-pixel format buffer width must be 4 pixel aligned.
5. For tile mode buffer, the buffer stride must be 12-byte aligned for 24 bits-per-pixel formats, that is, the buffer width must be 4-pixel aligned.
6. For PE clear function, the clear size must align to 48 Bytes for 24-bits-per-pixel formats.
7. For PE clear function with DECNano enabled, the clear size must align to 48 Bytes for 24 bits-per-pixel formats and align to 64 Bytes for 32 bits-per-pixel formats.
8. If source buffer tile mode is different from destination buffer tile mode, buffer starting address must be 64 Byte aligned, buffer stride must be 64 Byte aligned for non-24 bits-per-pixel formats, buffer stride must be 48-Byte aligned for 24 bits-per-pixel formats.

VGLite hardware requires the raster image width to be a multiple of 16 pixels for linear gradient and radial gradient operations. This requirement applies to all image formats. Therefore, the user must pad an arbitrary image width to a multiple of 16 pixels for VGLite linear gradient and radial gradient APIs.

Parent topic:Pixel buffer enumerations

`vg_lite_buffer_layout_t` **enumeration** Specifies the buffer data layout in memory.

Used in structure: `vg_lite_buffer`.

vg_lite_buffer_layout_t String Value	Description
VG_LITE_LINEAR	Linear (scanline) layout.
VG_LITE_TILED	Data is organized in 4x4 pixel tiles. Note: for this layout, the buffer start address and stride must be 64-byte aligned

Parent topic:Pixel buffer enumerations

`vg_lite_compress_mode_t` **enumeration** Specifies the DECNano comprssion mode. (*from March 2023*)

Used in structure: `vg_lite_buffer_t`.

vg_lite_compress_mode_t value	string	Description
VG_LITE_DEC_DISABLE		Disable compression.
VG_LITE_DEC_NON_SAMPLE		compression ratio is 1.6 for ARGB8888, 2.0 for XRGB8888
VG_LITE_DEC_HSAMPLE		compression ratio is 2.0 for ARGB8888, 2.6 for XRGB8888
VG_LITE_DEC_HV_SAMPLE		compression ratio is 2.6 for ARGB8888, 4.0 for XRGB8888

Parent topic:Pixel buffer enumerations

`vg_lite_gamma_conversion_t` **enumeration** Specifies the gamma conversion mode (*from Sept 2022*)

Used in function: `vg_lite_set_gamma`.

vg_lite_gamma_conversion_t string value	Description
VG_LITE_GAMMA_NO_CONVERSION	Leave the color as it is.
VG_LITE_GAMMA_LINEAR	Convert from sRGB to linear.
VG_LITE_GAMMA_NON_LINEAR	Convert from linear to sRGB space.

Parent topic:Pixel buffer enumerations

`vg_lite_index_endian_t` **enumeration** Specifies the endian order parsing mode for index formats (*from March 2023*).

Used in structure: `vg_lite_buffer_t`.

vg_lite_index_endi string value	Description
VG_LITE_INDEX	Parse the index pixel from low to high, when using index1, the parsing order is bit0~bit7. when using index2, the parsing order is bit0:1,bit2:3,bit4:5.bit6:7. when using index4, the parsing order is bit0:3,bit4:7.
VG_LITE_INDEX	Parse the index pixel from low to high, when using index1, the parsing order is bit7~bit0. when using index2, the parsing order is bit7:6,bit5:4,bit3:2.bit1:0. when using index4, the parsing order is bit4:7,bit0:3.

Parent topic:Pixel buffer enumerations

`vg_lite_image_mode_t` **enumeration** Specifies how an image is rendered onto a buffer (*prior to Sept 2022 name was `vg_lite_buffer_image_mode_t`*).

Used in structure: `vg_lite_buffer_t`.

vg_lite_image_mode_t string value	Description
VG_LITE_ZERO	
VG_LITE_NORMAL_IMAGE_MODE	Image drawn with blending mode
VG_LITE_MULTIPLY_IMAGE_MODE	Image is multiplied with paint color
VG_LITE_STENCIL_MODE	
VG_LITE_NONE_IMAGE_MODE	Image input is ignored.
VG_LITE_RECOLOR_MODE	

Parent topic:Pixel buffer enumerations

`vg_lite_map_flag_t` **enumeration** Specifies whether mapping is for user memory or the DMA buffer (*from March 2023*).

Used in function: `vg_lite_map`.

vg_lite_map_flag_t string value	Description
VG_LITE_MAP_USER_MEMORY	Mapping is for user memory.
VG_LITE_MAP_DMABUF	Mapping is for the DMA buffer.

Parent topic:Pixel buffer enumerations

`vg_lite_paint_type_t` **enumeration** Specifies paint type (*from May 2023*).

Used in structure: `vg_lite_buffer_t`.

vg_lite_paint_type_t string value	Description
VG_LITE_PAINT_ZERO	
VG_LITE_PAINT_COLOR	Color
VG_LITE_PAINT_LINEAR_GRADIENT	Linear Gradient
VG_LITE_PAINT_RADIAL_GRADIENT	Radial Gradient
VG_LITE_PAINT_PATTERN	Pattern

Parent topic:Pixel buffer enumerations

`vg_lite_transparency_t` **enumeration** Specifies the transparency mode for a buffer (*prior to Sept 2022 name was `vg_lite_buffer_transparency_mode_t`*).

Used in structure: `vg_lite_buffer`.

vg_lite_transp string value	Description
VG_LITE_OP	Opaque image: all image pixels are copied to the VG PE for rasterization
VG_LITE_TP	Transparent image: only the non-transparent image pixels are copied to the VG PE. Note: This mode is only valid when IMAGE_MODE (vg_lite_image_mode_t) is either VG_LITE_NORMAL_IMAGE_MODE or VG_LITE_MULTIPLY_IMAGE_MODE.

Parent topic:Pixel buffer enumerations

`vg_lite_swizzle_t` **enumeration** This enumeration specifies the swizzle for the UV components of YUV data.

Used in structure: `vg_lite_yuvinfo`.

vg_lite_swizzle_t string value	Description
VG_LITE_SWIZZLE_UV	U in lower bits, V in upper bits
VG_LITE_SWIZZLE_VU	V in lower bits, U in upper bits

Parent topic:Pixel buffer enumerations

`vg_lite_yuv2rgb_t` **enumeration** This enumeration specifies the standard for conversion of YUV data to RGB data.

Used in structure: `vg_lite_yuvinfo`.

vg_lite_yuv2rgb_t string value	Description
VG_LITE_YUV601	YUV Converting with ITC.BT-601 standard
VG_LITE_YUV709	YUV Converting with ITC.BT-709 standard

Parent topic:Pixel buffer enumerations

Parent topic:[Pixel buffers](#)

Pixel buffer structures This section provides an overview on the pixel buffer structures.

`vg_lite_buffer_t` **structure** This structure defines the buffer layout for a VGLite image or memory data.

Used in structures: `vg_lite_linear_gradient_t`, `vg_lite_radial_gradient_t`.

Used in init functions: `vg_lite_allocate`, `vg_lite_free`, `vg_lite_upload_buffer`, `vg_lite_map`, `vg_lite_unmap`.

Used in blit functions: `vg_lite_blit`, `vg_lite_blit_rect`, `vg_lite_clear`, `vg_lite_create_masklayer`, `vg_lite_fill_masklayer`, `vg_lite_blend_masklayer`, `vg_lite_set_masklayer`, `vg_lite_render_masklayer`, `vg_lite_destroy_masklayer`

Used in draw functions: `vg_lite_draw`, `vg_lite_draw_pattern`, `vg_lite_draw_grad`, `vg_lite_draw_radial_grad`

vg_lite_buffer_t member	Type	Description
width	vg_lite_int32_t	Width of buffer in pixels
height	vg_lite_int32_t	Height of buffer in pixels
stride	vg_lite_int32_t	Stride in bytes
tiled	vg_lite_buffer_layout_t	Linear or tiled format for buffer enum
format	vg_lite_buffer_format_t	color format enum
handle	vg_lite_pointer_t	memory handle
memory	vg_lite_pointer_t	pointer to the start address of the memory
address	vg_lite_uint32_t	GPU address
yuv	vg_lite_yuvinfo_t	YUV format info struct
image_mode	vg_lite_image_mode_t	Blit image mode enum
transparency_mode	vg_lite_transparency_mode_t	Image transparency mode enum
fc_buffer[3]	vg_lite_fc_buffer_t	Three (3) fast clear buffers, reserved YUV format <i>(from March 2023)</i>
compress_mode	vg_lite_compress_mode_t	Compression mode <i>(from March 2023)</i>
index_endian	vg_lite_index_endian_t	Big/Little Endian setting for index formats <i>(from March 2023)</i>
paintType	vg_lite_paint_type_t	Paint type enum <i>(from May 2023)</i>
fc_enable	vg_lite_int8_t	Enable Image fast clear <i>(moved from Aug 2023)</i>
scissor_layer	vg_lite_int8_t	Get paintcolor from different paint types <i>(from Aug 2023)</i>
premultiplied	vg_lite_int8_t	The RGB pixel values are alpha-premultiplied <i>(from Aug 2023)</i>

Parent topic:Pixel buffer structures

vg_lite_fc_buffer_t structure This structure defines the organization of a fast clear buffer. *(from March 2023)*

Used in structure: `vg_lite_buffer_t`.

vg_lite_fc_buffer_t members	Type	Description
width	vg_lite_int32_t	Width of buffer in pixels
height	vg_lite_int32_t	Height of buffer in pixels
stride	vg_lite_int32_t	Stride in bytes
handle	vg_lite_pointer_t	memory handle as allocated by the VGLite kernel
memory	vg_lite_pointer_t	logical pointer to the start address of the memory for the CPU
address	vg_lite_uint32_t	address to the buffer's memory for the GPU hardware
color	vg_lite_uint32_t	The fast clear color value

Parent topic:Pixel buffer structures

vg_lite_yuvinfo_t structure This structure defines the organization of VGLite YUV data.

Used in structure: `vg_lite_buffer_t`.

vg_lite_yuvinfo_t member	Type	Description
swizzle	<code>vg_lite_swizzle_t</code>	UV swizzle enum
yuv2rgb	<code>vg_lite_yuv2rgb_t</code>	YUV conversion standard enum
'uv_planar	<code>vg_lite_uint32_t</code>	UV (U) planar address for GPU, generated by driver
v_planar	<code>vg_lite_uint32_t</code>	V planar address for GPU, generated by driver
'alpha_planar	<code>vg_lite_uint32_t</code>	Alpha planar address for GPU, generated by driver
'uv_stride	<code>vg_lite_uint32_t</code>	UV (U) stride in bytes
'v_stride	<code>vg_lite_uint32_t</code>	V planar stride in bytes
alpha_stride	<code>vg_lite_uint32_t</code>	Alpha stride in bytes
'uv_height	<code>vg_lite_uint32_t</code>	UV (U) height in pixels
'v_height	<code>vg_lite_uint32_t</code>	V stride in bytes
uv_memory	<code>vg_lite_pointer</code>	Logical pointer to the UV (U) planar memory
'v_memory	<code>vg_lite_pointer</code>	Logical pointer to the V planar memory
uv_handle	<code>vg_lite_pointer</code>	Memory handle of the UV (U) planar, generated by the driver
v_handle	<code>vg_lite_pointer</code>	Memory handle of the V planar, generated by the driver

Parent topic: Pixel buffer structures

Parent topic: [Pixel buffers](#)

Pixel buffer functions This section provides an overview of the pixel buffer functions.

`vg_lite_allocate` **function** **Description:**

This function is used to allocate a buffer before it is used in either blit or draw functions.

To allow the hardware to access some memory, such as a source image or target buffer, you must first allocate the memory. The supplied `vg_lite_buffer_t` structure must be initialized with the size (width and height) and format of the requested buffer. If the stride is set to zero, then this function fills it in. The only input parameter to this function is the pointer to the buffer structure. If the structure has all the information needed, then appropriate memory is allocated for the buffer.

This function calls the kernel to allocate the memory. The kernel fills in the memory handle, logical address, and hardware addresses in the `vg_lite_buffer_t` structure.

Alignment note:

Vivante GPUs have an alignment requirement of 64 bytes. However, to meet the alignment requirements of the Vivante display controller, the VGLite driver sets the render target buffer alignment to 128 bytes. For source image buffer alignment requirements, see the alignment notes available in Table 1.

The `vg_lite_buffer_format_t` value descriptions:

Syntax:

```
vg_lite_error_t vg_lite_allocate (
    vg_lite_buffer_t    *buffer
);
```

Parameters:

Name	Description
buffer	Pointer to the buffer that holds the size and format of the buffer being allocated. Either the memory or address field must be set to a non-zero value to map either a logical or physical address into hardware accessible memory.

Returns:

- VG_LITE_SUCCESS if the contiguous buffer was allocated successfully.
- VG_LITE_OUT_OF_RESOURCES if there is insufficient memory in the host OS heap for the buffer.
- VG_LITE_OUT_OF_MEMORY if allocation of a contiguous buffer failed.

Parent topic:Pixel buffer functions**vg_lite_free function Description:**

This function is used to deallocate the buffer that was previously allocated. It frees up the memory for that buffer.

Syntax:

```
vg_lite_error_t vg_lite_free (  
    vg_lite_buffer_t    *buffer  
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_allocate() function.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Pixel buffer functions**vg_lite_upload_buffer function Description:**

The function uploads the pixel data to a GPU memory buffer object. The format of the data (pixel) to be uploaded must match the format defined for the buffer object. The input data memory buffer should contain enough data to be uploaded to the GPU buffer pointed by the input parameter buffer.

Note: Vivante Vector Graphics IP only uses data[0] and stride[0] as it does not support planar YUV formats..

Syntax:

```
vg_lite_error_t vg_lite_upload_buffer (  
    vg_lite_buffer_t    *buffer,  
    vg_lite_uint8_t      *data[3],  
    vg_lite_uint32_t      stride[3]  
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the <code>vg_lite_allocate()</code> function
data[3]	Pointer to pixel data. For the YUV format, there may be up to 3 pointers.
stride[3]	Stride for the pixel data

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_map function Description:

This function is used to map the memory appropriately for a particular buffer. For some operating systems, it is used to get proper translation to the physical or logical address of the buffer needed by the GPU.

To use a frame buffer directly as a target buffer:

- Wrap a `vg_lite_buffer_t` structure around the buffer
- Call the kernel to map the supplied logical or physical address into hardware accessible memory

For example, if you know the logical address of the frame buffer, set the `memory` field of the `vg_lite_buffer_t` structure with that address and call this function. If you know the physical address, set the `memory` field to `NULL` and program the `address` field with the physical address.

Syntax:

```
vg_lite_error_t vg_lite_map (
    vg_lite_buffer_t      *buffer,
    vg_lite_map_flag_t    flag,
    int32_t               fd
);
```

Parameters:

Name	Description
*buffer	Pointer to a buffer structure that was filled in by calling the <code>vg_lite_allocate()</code> function
flag	Enumerate the <code>vg_lite_map_flag_t</code> value that specifies whether the mapping is for user memory or DMA buffer. <i>(from March 2023)</i>
fd	File descriptor for <code>dma_buf</code> if the flag is <code>VG_LITE_MAP_DMABUF</code> . Otherwise, this parameter is ignored. <i>(from March 2023)</i>

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_unmap function Description:

This function unmaps the buffer and frees any memory resources allocated by a previous call to the `vg_lite_map()` function.

Syntax:

```
vg_lite_error_t vg_lite_unmap (  
    vg_lite_buffer_t      *buffer  
);
```

Parameters:

Name	Description
buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_map() function

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_flush_mapped_buffer function Description:

This function flushes the CPU cache for the mapped buffer to make sure the buffer contents are written to GPU memory.

Syntax:

```
vg_lite_error_t vg_lite_flush_mapped_buffer (  
    vg_lite_buffer_t      *buffer  
);
```

Parameters:

Name	Description
*buffer	Pointer to a buffer structure that was filled in by calling the vg_lite_map() function

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_set_CLUT function Description:

This function sets the Color Lookup Table (CLUT) in the context state for index color image. Once the CLUT is set (Not NULL), the image pixel color for index format image rendering is obtained from the Color Lookup Table (CLUT) according to the pixel's color index value.

Note: Available only for IP with Indexed color support..

Syntax:

```
vg_lite_error_t vg_lite_set_CLUT (  
    vg_lite_uint32_t      count,  
    vg_lite_uint32_t      *colors  
);
```

Parameters:

Name	Description
count	This is the count of the colors in the color look-up table: - For INDEX_1, there can be up to 2 colors in the table - For INDEX_2, there can be up to 4 colors in the table - For INDEX_4, there can be up to 16 colors in the table - For INDEX_8, there can be up to 256 colors in the table
*colors	The Color Lookup Table (CLUT) pointed by “colors” will be stored in the context and programmed to the command buffer when needed. The CLUT will not take effect until the command buffer is submitted to HW. The color is in ARGB format with A located in the upper bits. Note: The VGLite driver does not validate the CLUT contents from the application.

Returns:

VG_LITE_SUCCESS as no checking is done.

Parent topic:Pixel buffer functions

vg_lite_enable_dither function Description:

This function is used to enable the dither function. Dither is turned off by default. The application can use the VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_DITHER`) to determine HW support for dither.

Syntax:

```
vg_lite_error_t vg_lite_enable_dither (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_disable_dither function Description:

This function is used to disable the dither function. Dither is turned off by default.

Syntax:

```
vg_lite_error_t vg_lite_disable_dither (
);
```

Parameters: None

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Pixel buffer functions

vg_lite_set_gamma function Description:

This function sets a gamma value.

Application can use the VGLite API `vg_lite_query_feature(gcFEATURE_BIT_VG_GAMMA)` to determine HW support for gamma.

Syntax:

```
vg_lite_error_t vg_lite_set_gamma (
    vg_lite_gamma_conversion_t gamma_value
);
```

Parameters:

Name	Description
<code>gamma_value</code>	Sets a gamma value. See enum <code>vg_lite_gamma_conversion_t</code> .

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Pixel buffer functions

Parent topic: [Pixel buffers](#)

Matrices This part of the API provides matrix controls.

Note: All the transformations in the driver/API are actually the final plane/surface coordinate system. There is no transformation of different coordinate systems with VGLite.

Matrix control float parameter type

Name	Typedef	Value
<code>vg_lite_float_t</code>	<code>float</code>	A single-precision floating-point number
<code>vg_lite_pixel_matrix_t [20]</code>	<code>vg_lite_float_t</code>	Pixel transform matrix <code>m[20]</code>, which transforms each pixel as follows: $\begin{bmatrix} a' \\ r' \\ g' \\ b' \\ 1 \end{bmatrix} = \begin{bmatrix} m0 & m1 & m2 & m3 & m4 \\ m5 & m6 & m7 & m8 & m9 \\ m10 & m11 & m12 & m13 & m14 \\ m15 & m16 & m17 & m18 & m19 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ r \\ g \\ b \\ 1 \end{bmatrix}$

Parent topic: [Matrices](#)

Matrix control structures This section provides an overview of the graphic transformation matrix control structures.

`vg_lite_matrix_t` structure This structure defines a 3x3 floating point matrix.

Used in structures: `vg_lite_linear_gradient_t`, `vg_lite_radial_gradient_t`.

Used in blit functions: `vg_lite_blit`, `vg_lite_blit_rect`.

Used in draw functions: `vg_lite_draw`, `vg_lite_draw_gradient`, `vg_lite_draw_radial_gradient`, `vg_lite_draw_pattern`, `vg_lite_identity`, `vg_lite_scale`, `vg_lite_translate`.

vg_lite_matrix_t member	Type	Description
m[3][3]	vg_lite_float_t	3x3 matrix, in [row] [column] order

Parent topic:Matrix control structures

vg_lite_pixel_channel_enable_t structure This structure provides enable/disable flags for hardware pixel channels A,R,G,B.

Used in function: `vg_lite_set_pixel_matrix_t`.

vg_lite_pixel_channel_enable_t members	Type	Description
enable_a	vg_lite_uint8_t	Enable A channel
enable_b	vg_lite_uint8_t	Enable B channel
enable_g	vg_lite_uint8_t	Enable G channel
enable_r	vg_lite_uint8_t	Enable R channel

Parent topic:Matrix control structures

Parent topic:[Matrices](#)

Matrix control functions This section provides an overview of the matrix control functions.

vg_lite_identity function Description:

This function loads an identity matrix into a matrix variable.

Syntax:

```
vg_lite_error_t vg_lite_identity (
    vg_lite_matrix_t *matrix,
);
```

Parameters:

Name	Description
*matrix	Pointer to the <code>vg_lite_matrix_t</code> structure that will be loaded with an identity matrix.

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Matrix control functions

vg_lite_set_pixel_matrix function Description:

This function sets up a pixel transform matrix `m[20]` which transforms each pixel as follows:

$$\begin{bmatrix} a' \\ r' \\ g' \\ b' \\ 1 \end{bmatrix} = \begin{bmatrix} m0 & m1 & m2 & m3 & m4 \\ m5 & m6 & m7 & m8 & m9 \\ m10 & m11 & m12 & m13 & m14 \\ m15 & m16 & m17 & m18 & m19 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} a \\ r \\ g \\ b \\ 1 \end{bmatrix}$$

The pixel transform for the A, R, G, B channels can be enabled/disabled individually with the channel parameter.

Applications can use VGLite API `vg_lite_query_feature(gcFEATURE_BIT_VG_PIXEL_MATRIX)` to determine HW support for gaussian blur.

Syntax:

```
vg_lite_error_t vg_lite_set_pixel_matrix (
    vg_lite_pixel_matrix_t      matrix,
    vg_lite_pixel_channel_enable_t *channel
);
```

Parameters:

Name	Description
*matrix	Specifies the <code>vg_lite_pixel_matrix_t</code> pixel transform matrix that will be loaded.
*channel	Pointer to the <code>vg_lite_pixel_channel_enable_t</code> structure used to enable/disable individual channels.

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Matrix control functions

`vg_lite_rotate` function Description:

This function rotates a matrix a specified number of degrees.

Syntax:

```
vg_lite_error_t vg_lite_rotate (
    vg_lite_float_t      degrees,
    vg_lite_matrix_t      *matrix
);
```

Parameters:

Name	Description
degrees	Number of degrees to rotate the matrix. Positive numbers rotate clockwise. The coordinates for the transformation are given in the surface coordinate system (top-to-bottom orientation). Rotations with positive angles are in the clockwise direction.
*matrix	Pointer to the <code>vg_lite_matrix_t</code> structure that has to be rotated

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Matrix control functions

`vg_lite_scale` **function** **Description:**

This function scales a matrix in both horizontal and vertical directions.

Syntax:

```
vg_lite_error_t vg_lite_scale (
    vg_lite_float_t      scale_x,
    vg_lite_float_t      scale_y,
    vg_lite_matrix_t     *matrix
);
```

Parameters:

Name	Description
<code>scale_x</code>	Horizontal scale
<code>scale_y</code>	Vertical scale
<code>matrix</code>	Pointer to the <code>vg_lite_matrix_t</code> structure that will be scaled.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Matrix control functions

`vg_lite_translate` **function** **Description:**

This function translates a matrix to a new location.

Syntax:

```
vg_lite_error_t vg_lite_translate (
    vg_lite_float_t      x,
    vg_lite_float_t      y,
    vg_lite_matrix_t     *matrix
);
```

Parameters:

Name	Description
<code>x</code>	X location of the transformation.
<code>y</code>	Y location of the transformation.
<code>matrix</code>	Pointer to the <code>vg_lite_matrix_t</code> structure that will be translated.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Matrix control functions

Parent topic:[Matrices](#)

Blits for compositing and blending This part of the API performs the hardware accelerated blit operations.

Compositing rules describes how two areas are combined to form a single area. Blending rules describes how combining the colors of the overlapping areas are combined. VGLite supports two blending operations and a subset of the Porter-Duff operations [PD84]. The Porter-Duff operators assume that the pixels have the alpha associated (premultiplied), it means that the pixels are premultiplied prior to the blending operation. GC555, GC355, and some GCNanoUltraV hardware support alpha premultiply for RGB image, but GCNanoLiteV does not.

The source image is copied to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction.

- The blit function can be used with or without the blend mode.
- The blit function can be used with or without specifying any color value.
- The blit function can be used for color conversion with an identity matrix and appropriate formats specified for the source and the destination buffers. In this case, do not specify blend mode and color value.

Blit enumerations This section gives details on blit enumerations.

vg_lite_blend_t enumeration This enumeration defines the blending modes supported by some VGLite API functions. S and D represent source and destination non-premultiplied RGB color channels. Sa and Da represent the source and destination alpha channels. SP and DP represent source and destination alpha-premultiplied RGB color channels ($SP = S * Sa$, $DP = D * Da$).

Note: VG_LITE_BLEND_*_LVGL modes are supported on all VG cores. On VG cores that do not support gcFEATURE_BIT_VG_LVGL_SUPPORT, the LVGL blend modes are supported by a combination of software and hardware operations. OPENVG_BLEND_* modes can only be supported on GC355 and GC555 cores.

Used in blit functions: vg_lite_blit, vg_lite_blit2, vg_lite_blit_rect.

Used in draw functions: vg_lite_draw, vg_lite_draw_grad, vg_lite_draw_radial_grad, vg_lite_draw_pattern.

vg_lite_blend_t String Values	Description
VG_LITE_BLEND_NONE	S, no blending Non-premultiplied
VG_LITE_BLEND_SRC_OVER	S + D * (1 - Sa) Non-premultiplied
VG_LITE_BLEND_DST_OVER	S * (1 - Da) + D Non-premultiplied
VG_LITE_BLEND_SRC_IN	S * Da Non-premultiplied
VG_LITE_BLEND_DST_IN	D * Sa Non-premultiplied
VG_LITE_BLEND_MULTIPLY	S * (1 - Da) + D * (1 - Sa) + S * D Non-premultiplied
VG_LITE_BLEND_SCREEN	S + D - S * D Non-premultiplied
VG_LITE_BLEND_DARKEN	min(SRC_OVER, DST_OVER) Non-premultiplied
VG_LITE_BLEND_LIGHTEN	max(SRC_OVER, DST_OVER) Non-premultiplied
VG_LITE_BLEND_ADDITIVE	S + D Non-premultiplied
VG_LITE_BLEND_SUBTRACT	D * (1 - Sa) Non-premultiplied
VG_LITE_BLEND_NORMAL_LVGL	S * Sa + D * (1 - Sa) Non-premultiplied (from March 2023)
VG_LITE_BLEND_ADDITIVE_LVGL	(S + D) * Sa + D * (1 - Sa) Non-premultiplied (from March 2023)
VG_LITE_BLEND_SUBTRACT_LVGL	(S - D) * Sa + D * (1 - Sa) Non-premultiplied (from March 2023)
VG_LITE_BLEND_MULTIPLY_LVGL	(S * D) * Sa + D * (1 - Sa) Non-premultiplied (from March 2023)
OpenVG Porter-Duff Blend String Values	<i>(from Aug 2023)</i>
OPENVG_BLEND_NONE	SP, no blending Premultiplied
OPENVG_BLEND_SRC_OVER	(SP + DP * (1 - Sa)) / (Sa + Da * (1 - Sa)) Premultiplied
OPENVG_BLEND_DST_OVER	(SP * (1 - Da) + DP) / (Sa * (1 - Da) + Da) Premultiplied
OPENVG_BLEND_SRC_IN	(SP * Da) / (Sa * Da) Premultiplied
OPENVG_BLEND_DST_IN	(DP * Sa) / (Sa * Da) Premultiplied
OPENVG_BLEND_MULTIPLY	(SP*DP + SP*(1 - Da) + DP*(1 - Sa)) / (Sa + Da*(1 - Sa)) Premultiplied
OPENVG_BLEND_SCREEN	(SP + DP - (SP*DP)) / (Sa + Da*(1 - Sa)) Premultiplied
OPENVG_BLEND_DARKEN	min(SRC_OVER, DST_OVER) Premultiplied
OPENVG_BLEND_LIGHTEN	max(SRC_OVER, DST_OVER) Premultiplied
OPENVG_BLEND_ADDITIVE	(SP + DP) / (Sa + Da) Premultiplied

Parent topic:Blit enumerations

vg_lite_color_t **parameter** The common parameter vg_lite_color_t is described in Table 1.

Parent topic:Blit enumerations

vg_lite_color_transform_t **structure** Specifies the pixel color_transform values for scale and bias.

Used in functions: vg_lite_set_color_transform.

vg_lite_color_transform_t members	Type	Description
a_scale	vg_lite_float_t	Scale value for alpha.
a_bias	vg_lite_float_t	Bias value for alpha.
r_scale	vg_lite_float_t	Scale value for red.
r_bias	vg_lite_float_t	Bias value for red.
g_scale	vg_lite_float_t	Scale value for green.
g_bias	vg_lite_float_t	Bias value for green.
b_scale	vg_lite_float_t	Scale value for blue.
b_bias	vg_lite_float_t	Bias value for blue.

Parent topic:Blit enumerations

`vg_lite_filter_t` **enumeration** Specifies the sample-filtering mode in VGLite blit and draw APIs.

Used in blit functions: `vg_lite_blit`, `vg_lite_blit_rect`.

Used in draw functions: `vg_lite_draw_radial_gradient`, `vg_lite_draw_pattern`.

<code>vg_lite_filter_t</code> string values	Description
<code>VG_LITE_FILTER_POINT</code>	Fetch only the nearest image pixel
<code>VG_LITE_FILTER_LINEAR</code>	Use linear interpolation along a horizontal line
<code>VG_LITE_FILTER_BOX</code>	Use a 2x2 box around the image pixel and perform an interpolation
<code>VG_LITE_FILTER_GAUSSIAN</code>	Perform 3x3 gaussian blur with the convolution for image pixel. (from March 2023)

Parent topic:Blit enumerations

`vg_lite_color_transform_t` **structure** Specifies the pixel color_transform values for scale and bias.

Used in functions: `vg_lite_set_color_transform`.

<code>vg_lite_color_transform_t</code> members	Type	Description
<code>a_scale</code>	<code>vg_lite_float_t</code>	Scale value for alpha.
<code>a_bias</code>	<code>vg_lite_float_t</code>	Bias value for alpha.
<code>r_scale</code>	<code>vg_lite_float_t</code>	Scale value for red.
<code>r_bias</code>	<code>vg_lite_float_t</code>	Bias value for red.
<code>g_scale</code>	<code>vg_lite_float_t</code>	Scale value for green.
<code>g_bias</code>	<code>vg_lite_float_t</code>	Bias value for green.
<code>b_scale</code>	<code>vg_lite_float_t</code>	Scale value for blue.
<code>b_bias</code>	<code>vg_lite_float_t</code>	Bias value for blue.

Parent topic:Blit enumerations

`vg_lite_mask_operation_t` **enumeration** Specifies the mask operation mode in VGLite blit APIs.

Used in functions: `vg_lite_blend_masklayer`, `vg_lite_render_masklayer`.

vg_lite_mask_o string values	Description
VG_LITE_CL	This operation sets all mask values in the region of interest to 0, ignoring the new mask layer.
VG_LITE_FILL	This operation sets all mask values in the region of interest to 1, ignoring the new mask layer.
VG_LITE_SELECT	This operation copies values in the region of interest from the new mask layer, overwriting the previous mask values.
VG_LITE_UNION	This operation replaces the previous mask in the region of interest by its union with the new mask layer. The resulting values are always greater than or equal to their previous value.
VG_LITE_INTERSECTION	This operation replaces the previous mask in the region of interest by its intersection with the new mask layer. The resulting mask values are always less than or equal to their previous value.
VG_LITE_SUBTRACT	This operation subtracts the new mask from the previous mask and replaces the previous mask in the region of interest by the resulting mask. The resulting values are always less than or equal to their previous value.

Parent topic:Blit enumerations

`vg_lite_orientation_t` **enumeration** Specifies the mirror orientation in VGLite blit APIs.

Used in functions: `vg_lite_set_mirror`.

vg_lite_orientation_t string values	Description
VG_LITE_ORIENTATION_TOP_BOTTOM	Target output orientation is from top to bottom (default).
VG_LITE_ORIENTATION_BOTTOM_TOP	Target output orientation is from bottom to top.

Parent topic:Blit enumerations

`vg_lite_param_type_t` **enumeration** Specifies the parameter type in VGLite blit APIs.

Used in functions: `vg_lite_get_parameter`.

vg_lite_param_type_t string value	Description
VG_LITE_GPU_IDLE_STATE	The count must be 1 for GPU idle state TRUE or FALSE.
VG_LITE_SCISSOR_RECT	The count must be 4n for x, y, right, bottom.

Parent topic:Blit enumerations

Parent topic:[Blits for compositing and blending](#)

Blit structures This section provides details about blit structures.

`vg_lite_buffer_t` **structure** Defined under the “Pixel buffer structures” section (see `vg_lite_buffer_t` structure).

Parent topic:Blit structures

vg_lite_color_key_t structure A “color key” have two sections, where each section contains R,G,B channels, which are noted as `high_rgb` and `low_rgb` respectively. *(from April 2022)*

When the `enable` value is true, the color key specified is effective and the alpha value is used to replace the alpha channel of the destination pixel when its RGB channels are in range [`low_rgb`, `high_rgb`]. After the color key is used in the current frame, if the color key is not needed for the next frame, it should be disabled before the next frame.

Used in structure: `vg_lite_color_key4_t`

vg_lite_color_key_t members	Type	Description
<code>enable</code>	<code>vg_lite_uint8</code>	When set (true), this color key is enabled
<code>low_r</code>	<code>vg_lite_uint8</code>	The R channel of <code>low_rgb</code>
<code>low_g</code>	<code>vg_lite_uint8</code>	The G channel of <code>low_rgb</code>
<code>low_b</code>	<code>vg_lite_uint8</code>	The B channel of <code>low_rgb</code>
<code>alpha</code>	<code>vg_lite_uint8</code>	The alpha value to replace the destination pixel alpha channel value with
<code>high_r</code>	<code>vg_lite_uint8</code>	The R channel of <code>high_rgb</code>
<code>high_g</code>	<code>vg_lite_uint8</code>	The G channel of <code>high_rgb</code>
<code>high_b</code>	<code>vg_lite_uint8</code>	The B channel of <code>high_rgb</code>

Parent topic:Blit structures

vg_lite_color_key4_t structure The priority order is: `color_key_0` > `color_key_1` > `color_key_2` > `color_key_3`. *(from April 2022)*

Used in blit function: `vg_lite_set_color_key`

vg_lite_color_key4_t members	Type	Description
<code>color_key_0</code>		<code>high_rgb_0</code> , <code>low_rgb_0</code> , <code>alpha_0</code> , <code>enable_0</code>
<code>color_key_1</code>		<code>high_rgb_1</code> , <code>low_rgb_1</code> , <code>alpha_1</code> , <code>enable_1</code>
<code>color_key_2</code>		<code>high_rgb_2</code> , <code>low_rgb_2</code> , <code>alpha_2</code> , <code>enable_2</code>
<code>color_key_3</code>		<code>high_rgb_3</code> , <code>low_rgb_3</code> , <code>alpha_3</code> , <code>enable_3</code>

Parent topic:Blit structures

vg_lite_matrix_t structure Defined under the “Matrix control structures” section (see `vg_lite_matrix_t` structure).

Parent topic:Blit structures

vg_lite_path_t structure Defined under the “Vector path structures” section (see `vg_lite_path_t` structure).

Parent topic:Blit structures

vg_lite_rectangle_t structure This structure defines a rectangle by using coordinates.

Used in blit function: `vg_lite_clear`.

vg_lite_rectangle_t member	Type	Description
x	vg_lite_int32_t	X origin of rectangle, left coordinate in pixels
y	vg_lite_int32_t	Y origin of rectangle, top coordinate in pixels
width	vg_lite_int32_t	X Width of rectangle in pixels
height	vg_lite_int32_t	Y Height of rectangle in pixels

Parent topic:Blit structures

vg_lite_point_t structure This structure defines a 2D point (*from March 2021*).

Used in structure: vg_lite_point4_t.

vg_lite_point_t member	Type	Description
X	vg_lite_int32_t	X value of coordinate
Y	vg_lite_int32_t	Y value of coordinate

Parent topic:Blit structures

vg_lite_point4_t structure This structure defines four 2D points that form a polygon. The points are defined by structure vg_lite_point_t. (*from March 2021*)

vg_lite_point4_t member	Type	Description
vg_lite_point_t[4]	vg_lite_int32_t each	a set of four points

Parent topic:Blit structures

vg_lite_float_point_t structure This structure defines a 2D float point (*from March 2024*).

Used in structure: vg_lite_float_point4_t.

vg_lite_float_point_t members	Type	Description
x	vg_lite_float_t	X value of coordinate
y	vg_lite_float_t	Y value of coordinate

Parent topic:Blit structures

vg_lite_float_point4_t structure This structure defines four 2D float points that form a polygon. The points are defined by structure vg_lite_float_point_t. (*from March 2024*)

Used in blit function: vg_lite_get_transform_matrix.

vg_lite_float_point4_t members	Type	Description
vg_lite_float_point[4]	vg_lite_float_t each	a set of four points

Parent topic:Blit structures

Parent topic:[Blits for compositing and blending](#)

Blit functions This section provides an overview on blit functions.

vg_lite_blit function Description:

This is the blit function. The blit operation is performed using a source and a destination buffer. The source and destination buffer structures are defined using the `vg_lite_buffer_t` structure. Blit copies a source image to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction. Note that `vg_lite_buffer_t` does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Note:

- The blit function can be used with or without the blend function (`vg_lite_blend_t`)
- The blit function can be used with or without specifying a foreground color value (`vg_lite_color_t`)
- The blit function can be used for color conversion with an identity matrix and appropriate formats specified for the source and the destination buffers. In this case, do not specify blend mode and color value.

Syntax:

```
vg_lite_error_t vg_lite_blit (  
    vg_lite_buffer_t      *target,  
    vg_lite_buffer_t      *source,  
    vg_lite_matrix_t      *matrix,  
    vg_lite_blend_t        blend,  
    vg_lite_color_t        color,  
    vg_lite_filter_t       filter  
);
```

Parameters:

Narr	Description
*target	Points to the <code>vg_lite_buffer_t</code> structure, which defines the destination buffer. See Image Source Alignment Requirement for valid destination color formats for the blit functions.
*source	Points to the <code>vg_lite_buffer_t</code> structure for the source buffer. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid source formats for the blit function.
*matrix	Points to a <code>vg_lite_matrix_t</code> structure that defines the transformation matrix of source pixels into the target. If the matrix is NULL, then an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blend	Specifies one of the enum <code>vg_lite_blend_t</code> values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0). Note: If the <code>matrix</code> parameter is specified with rotation or perspective, and the <code>blend</code> parameter is specified as <code>VG_LITE_BLEND_NONE</code> , <code>VG_LITE_BLEND_SRC_IN</code> , or <code>VG_LITE_BLEND_DST_IN</code> ; then, the VGLite driver overwrites the application setting for the blit operation as follows: - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is supported, then Transparency mode is always set to <code>TRANSPARENT</code>. - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is not supported, then Blend mode is always set to <code>VG_LITE_BLEND_SRC_OVER</code>. It happens due to some limitations in the VGLite hardware.
color	If non-zero, this color value is used as a mix color. The mixed color gets multiplied with each source pixel before blending happens. If you don't need a mix color, set the color parameter to 0. Note: this parameter has no effect if the source <code>vg_lite_buffer_t</code> structure member <code>image_mode</code> is set to <code>VG_LITE_ZERO</code> or <code>VG_LITE_NORMAL_IMAGE_MODE</code> .
filter	Specifies the filter type. All formats available in the <code>vg_lite_filter_t</code> enum are valid formats for this function. A value of zero (0) indicates <code>VG_LITE_FILTER_POINT</code> .

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Blit functions**vg_lite_blit2 function Description:**

This is the blit function for use with two sources. The blit2 operation is performed using two source buffers and one destination buffer. The source and destination buffer structures are defined using the `vg_lite_buffer_t` structure. Source0 and Source1 are first blended according to the blend mode with a specific transformation matrix for each image. Source1 is used as the source while Source0 is used as the dest and is directly output to the render target buffer.

The specified matrices can include translation, rotation, scaling, and perspective correction. Note that `vg_lite_buffer_t` does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Application can use VGLite API `vg_lite_query_feature(gcFEATURE_BIT_VG_DOUBLE_IMAGE)` to determine HW support for double image.

Note:

- The `vg_lite_blit` function can be used for color conversion for Source0 or Source1 before merging sources with `vg_lite_blit2`.

Syntax:

```
vg_lite_error_t vg_lite_blit2 (
    vg_lite_buffer_t      *target,
```

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```

    vg_lite_buffer_t    *source0,
    vg_lite_buffer_t    *source1,
    vg_lite_matrix_t    *matrix0,
    vg_lite_matrix_t    *matrix1,
    vg_lite_blend_t     blend,
    vg_lite_filter_t     filter
);

```

Parameters:

Name	Description
*target	Points to the <code>vg_lite_buffer_t</code> structure, which defines the destination buffer. See Alignment notes for valid destination color formats for the blit functions
*source0	Points to the <code>vg_lite_buffer_t</code> structure for the source0 and source1 buffers. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid source formats for the blit functions.
*source1	Points to the <code>vg_lite_buffer_t</code> structure for the source0 and source1 buffers. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid source formats for the blit functions.
*matrix0	Points to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix0 for the source0 pixels and matrix1 for the source1 pixels. If matrix0 and matrix1 are both NULL, the identity matrix is assumed, meaning the blending result of Source0 and Source1 is copied directly on the target at location(0,0).
*matrix1	Points to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix0 for the source0 pixels and matrix1 for the source1 pixels. If matrix0 and matrix1 are both NULL, the identity matrix is assumed, meaning the blending result of Source0 and Source1 is copied directly on the target at location(0,0).
blend	Specifies one of the enum <code>vg_lite_blend_t</code> values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0). Note: If the “matrix” parameter is specified with rotation or perspective, and the “blend” parameter is specified as <code>VG_LITE_BLEND_NONE</code> , <code>VG_LITE_BLEND_SRC_IN</code> , or <code>VG_LITE_BLEND_DST_IN</code> , the VGLite driver overwrites the application’s setting for the BLIT operation as follows: - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is supported, the transparency mode will always be set to <code>TRANSPARENT</code> . - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is not supported, the blend mode will always be set to <code>VG_LITE_BLEND_SRC_OVER</code> . This is due to some limitations in the VGLite hardware.
filter	Specifies the filter type. All formats available in the <code>vg_lite_filter_t</code> enum are valid formats for this function. A value of zero (0) indicates <code>VG_LITE_FILTER_POINT</code> .

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Blit functions**vg_lite_blit_rect function Description:**

This is the blit rectangle function. The blit operation is performed using a source and a destination buffer. The source and destination buffer structures are defined using the `vg_lite_buffer_t` structure. Blit copies a source image to the destination window with a specified matrix that can include translation, rotation, scaling, and perspective correction. Note that `vg_lite_buffer_t` does not support coverage sample anti-aliasing so the destination buffer edge may not be smooth, especially with a rotation matrix. VGLite path rendering can be used to achieve high-quality coverage sample anti-aliasing (16X, 8X, 4X) rendering effect.

Note:

- The `blit_rect` function can be used with or without the blend function (`vg_lite_blend_t`).
- The `blit_rect` function can be used with or without specifying any color value (`vg_lite_color_t`).

- The `blit_rect` function can be used for color conversion with an identity matrix and appropriate formats specified for the source and destination buffers. In this case, do not specify blend mode and color value.
- The `vg_lite_blit_rect` rectangle start origin point is always (0,0) for hardware versions prior to GCNanoLiteV 1311p that do not support a non-zero rectangle origin.

Syntax:

```
vg_lite_error_t vg_lite_blit_rect (
    vg_lite_buffer_t      *target,
    vg_lite_buffer_t      *source,
    vg_lite_rectangle_t    *rect,
    vg_lite_matrix_t       *matrix,
    vg_lite_blend_t        blend,
    vg_lite_color_t        color,
    vg_lite_filter_t       filter
);
```

Parameters:

Param	Description
*target	Points to the <code>vg_lite_buffer_t</code> structure that defines the destination buffer.
*source	Points to the <code>vg_lite_buffer_t</code> structure for the source buffer. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid source formats for the <code>blit_rect</code> function.
*rect	Specifies the rectangle area of the source image to blit. <code>rect[0]/[1]/[2]/[3]</code> are x, y, width, and height of the source rectangle respectively. Note: Non-zero source origins are supported.
*matrix	Points to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of source pixels into the target. If the matrix is NULL, then an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blend	Specifies one of the enum <code>vg_lite_blend_t</code> values for hardware-supported blend modes to be applied to each image pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0). Note: If the <code>matrix</code> parameter is specified with rotation or perspective, and the <code>blend</code> parameter is specified as <code>VG_LITE_BLEND_NONE</code> , <code>VG_LITE_BLEND_SRC_IN</code> , or <code>VG_LITE_BLEND_DST_IN</code> ; then, the VGLite driver overwrites the application setting for the blit operation as follows: - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is supported, then Transparency mode is always set to <code>TRANSPARENT</code> - If <code>gcFEATURE_BIT_VG_BORDER_CULLING</code> (<code>vg_lite_feature_t</code>) is not supported, then Blend mode is always set to <code>VG_LITE_BLEND_SRC_OVER</code>. It happens due to some limitations in the VGLite hardware.
color	If non-zero, this color value is used as a mix color. The mixed color gets multiplied with each source pixel before blending happens. If you do not need a mix color, then set the color parameter to 0. Note: This parameter has no effect if the source <code>vg_lite_buffer_t</code> structure member <code>image_mode</code> is set to <code>VG_LITE_ZERO</code> or <code>VG_LITE_NORMAL_IMAGE_MODE</code> .
filter	Specifies the filter type. All formats available in the <code>vg_lite_filter_t</code> enum are valid formats for this function. A value of zero (0) indicates <code>VG_LITE_FILTER_POINT</code> .

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Blit functions

vg_lite_copy_image **function** **Description:**

This API copied a pixel rectangle with dimension (width, height) from source buffer to destination buffer. The source image pixel (sx + i, sy + j) is copied to the destination image pixel (dx + i, dy + j), for $0 \leq i < \text{width}$ and $0 \leq j < \text{height}$. Pixels whose source or destination lie outside the bounds of the respective image are ignored. Pixel format conversion is applied as needed.

No pre-multiply, transformation, blending, filtering operations are applied to the pixel copy.

Syntax:

```
vg_lite_error_t vg_lite_copy_image (  
    vg_lite_buffer_t    *target,  
    vg_lite_buffer_t    *source,  
    vg_lite_int32_t     sx,  
    vg_lite_int32_t     sy,  
    vg_lite_int32_t     dx,  
    vg_lite_int32_t     dy,  
    vg_lite_int32_t     width,  
    vg_lite_int32_t     height  
);
```

Parameters:

Nam	Description
*target	Points to the vg_lite_buffer_t structure that defines the destination buffer.
*source	Points to the vg_lite_buffer_t structure for the source buffer. All color formats available in the vg_lite_buffer_format_t enum are valid source formats for the blit function.
sx, sy	Pixel coordinates of the lower-left corner of a pixel rectangle within the source buffer.
dx, dy	Pixel coordinates of the lower-left corner of a pixel rectangle within the target buffer.
width	Width of the copied pixel rectangle.
height	Height of the copied pixel rectangle.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Blit functions

vg_lite_get_transform_matrix **function** **Description:**

This function generates a 3x3 homogenous transform matrix from 4 float point source coordinates and 4 float point target coordinates. *(from March 2021)*

Syntax:

```
vg_lite_error_t vg_lite_get_transform_matrix (  
    vg_lite_float_point4_t    src,  
    vg_lite_float_point4_t    dst,  
    vg_lite_matrix_t          *mat  
);
```

Parameters:

Name	Description
src	Pointer to the four 2D points that form a source polygon
dst	Pointer to the four 2D points that form a destination polygon
mat	Output parameter, pointer to a 3x3 homogenous matrix that transforms the source polygon to a destination polygon.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Blit functions

vg_lite_clear function Description:

This function performs the clear operation, clearing/filling the specified buffer (entire buffer or partial rectangle in a buffer) with an explicit color.

Syntax:

```
vg_lite_error_t vg_lite_clear (
    vg_lite_buffer_t      *target,
    vg_lite_rectangle_t    *rect,
    vg_lite_color_t        color
);
```

Parameters:

Name	Description
*target	Pointer to the <code>vg_lite_buffer_t</code> structure for the destination buffer. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid destination formats for the clear function.
*rect	Pointer to the <code>vg_lite_rectangle_t</code> structure that specifies the area to be filled. If the rectangle is NULL, the entire target buffer is filled with the specified color.
color	Clear color, as specified in the <code>vg_lite_color_t</code> enum that is the color value to use for filling the buffer. If the buffer is in L8 format, the RGBA color is converted into a luminance value.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Blit functions

vg_lite_set_color_key function Description:

This function sets a color key. Color key can be used for blit or for draw pattern operations. *(from April 2022)*

A “color key” have two sections, where each section contains R,G,B channels which are noted as `high_rgb` and `low_rgb` respectively.

When the `vg_lite_color_key_t` structure value `enable` is true, the color key specified is effective and the alpha value is used to replace the alpha channel of the destination pixel when its RGB

channels are within range [low_rgb, high_rgb]. After the color key is used in the current frame, if the color key is not needed for the next frame, it should be disabled before the next frame.

Hardware support for color key is not available for GCNanoLiteV. Application can use VGLite API `vg_lite_query_feature(gcFEATURE_BIT_VG_COLOR_KEY)` to determine HW support for color key.

Syntax:

```
vg_lite_error_t vg_lite_set_color_key (
    vg_lite_color_key4_t      colorkey
);
```

Parameters:

Parameter	Description
colorkey	Color keying parameters as defined by <code>vg_lite_color_key4_t</code> .

Here are 4 groups of color key states:

- color_key_0, high_rgb_0, low_rgb_0, alpha_0, enable_0
- color_key_1, high_rgb_1, low_rgb_1, alpha_1, enable_1
- color_key_2, high_rgb_2, low_rgb_2, alpha_2, enable_2
- color_key_3, high_rgb_3, low_rgb_3, alpha_3, enable_3

The priority order of these states is:

color_key_0 > color_key_1 > color_key_2 > color_key_3.

Returns:

VG_LITE_SUCCESS if successful. VG_LITE_NOT_SUPPORT if color key is not supported in hardware.

Parent topic: Blit functions

`vg_lite_gaussian_filter` **function** **Description:**

This function sets 3x3 gaussian blur weighted values to filter an image pixel. *(from March 2023)*

The parameters w0, w1, w2 define a 3x3 gaussian blur weight matrix as:

	w2	w1	w2	
	w1	w0	w1	
	w2	w1	w2	

The sum of the 9 kernel weights must be 1.0 to avoid convolution overflow ($w0 + 4*w1 + 4*w2 = 1.0$).

The 3x3 weight matrix applies to a 3x3 pixel block:

	pixel[i-1][j-1]	pixel[i][j-1]	pixel[i+1][j-1]	
	pixel[i-1][j]	pixel[i][j]	pixel[i+1][j]	
	pixel[i-1][j+1]	pixel[i][j+1]	pixel[i+1][j+1]	

With the following dot product equation:

```
color[i][j] = w2*pixel[i-1][j-1] + w1*pixel[i][j-1] + w2*pixel[i+1][j-1]
             + w1*pixel[i-1][j]   + w0*pixel[i][j]   + w1*pixel[i+1][j]
             + w2*pixel[i-1][j+1] + w1*pixel[i][j+1] + w2*pixel[i+1][j+1];
```

Applications can use VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_GAUSSIAN_BLUR`) to determine HW support for gaussian blur.

Syntax:

```
vg_lite_error_t vg_lite_gaussian_filter (
    vg_lite_float_t    w0
    vg_lite_float_t    w1
    vg_lite_float_t    w2
);
```

Parameters:

Parameter	Description															
w0, w1, w2	w0, w1, w2 define a 3x3 gaussian blur weighted matrix as: <table><tr><td> </td><td>w2</td><td>w1</td><td>w2</td><td> </td></tr><tr><td> </td><td>w1</td><td>w0</td><td>w1</td><td> </td></tr><tr><td> </td><td>w2</td><td>w1</td><td>w2</td><td> </td></tr></table>		w2	w1	w2			w1	w0	w1			w2	w1	w2	
	w2	w1	w2													
	w1	w0	w1													
	w2	w1	w2													

Returns:

`VG_LITE_SUCCESS` if successful. Otherwise, `VG_LITE_NOT_SUPPORT` if gaussian blur is not supported in hardware.

Parent topic: Blit functions

Parent topic: [Blits for compositing and blending](#)

Blit/Draw extended functions The following BLIT or DRAW-related functions typically require GC355 or GC555 hardware and are not available for all Vivante Vector Graphics hardware configurations.

Applications can use the VGLite API `vg_lite_query_feature` to determine HW support for the related functionality.

`vg_lite_get_parameter` function Description:

This function returns the selected VGLite / GPU states to the application.

(from Aug 2023)

Syntax:

```
vg_lite_error_t vg_lite_get_parameter (
    vg_lite_param_type_t    type,
    vg_lite_int32_t         count,
    vg_lite_pointer         params
);
```

Parameters:

Parameter	Description
type	The parameter type to be queried (VG_LITE_GPU_IDLE_STATE, VG_LITE_SCISSOR_RECT)
count	The number of returned parameters
params	The pointer to the array of returned parameters

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_enable_scissor` **function** **Description:**

This function enables scissor rectangle operation for the rectangle regions defined by `vg_lite_scissor_rects` API. *(from March 2020, modified August 2020, requires GC355 or GC555 hardware)*

Applications can use VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_SCISSOR`) to determine HW support for scissoring. Support is available with GC355 and GC555.

Syntax:

```
vg_lite_error_t vg_lite_enable_scissor (  
    void  
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_disable_scissor` **function** **Description:**

This function disables scissor operation for the rectangle regions defined by the `vg_lite_scissor_rects` API. *(from March 2020, modified August 2020, requires GC355 or GC555 hardware)*.

Syntax:

```
vg_lite_error_t vg_lite_disable_scissor (  
    void  
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_scissor_rects` **function** **Description:**

This function defines scissor rectangle regions on the hardware mask layer. But the scissor function is enable/disabled by `vg_lite_enable_scissor` and `vg_lite_disable_scissor` APIs. *(from August 2022, requires GC355 or GC555 hardware)*.

Syntax:

```
vg_lite_error_t vg_lite_scissor_rects (
    vg_lite_buffer_t      *target,
    vg_lite_uint32_t      nums,
    vg_lite_rectangle_t    rect[]
);
```

Parameters:

Parameter	Description
target	Target render buffer that has the scissor mask layer.
nums	Number of scissor rectangles.
rect[]	The scissor rectangle array.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_set_scissor function Description:

This is a legacy scissor API function that can be used to set a single scissor rectangle for the render target. This scissor API is supported by a different hardware mechanism other than the mask layer and it has better performance than the mask layer scissor function.

This API is not enabled/disabled by `vg_lite_enable_scissor` and `vg_lite_disable_scissor` APIs. Instead, the `vg_lite_set_scissor` API calls with a valid scissor rectangle input (x, y, right, bottom) enables the scissor function by default. The `vg_lite_set_scissor` API call with input parameter (-1, -1, -1, -1) disables the scissor function. *(requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_scissor (
    vg_lite_int32_t      x,
    vg_lite_int32_t      y,
    vg_lite_int32_t      right,
    vg_lite_int32_t      bottom
);
```

Parameters:

Parameter	Description
x	X Origin of rectangle, left coordinate in pixels
Y	Y Origin of rectangle, top coordinate in pixels
right	X rightmost pixel of the rectangle
bottom	Y bottom pixel of the rectangle

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_disable_color_transform function Description:

This function is used to disable color transformation. By default, the color transform is turned off. *(from Sept 2022, only for GC355 and GC555 hardware)*

Applications can use the VGLite API `vg_lite_query_feature(gcFEATURE_BIT_VG_COLOR_TRANSFORMATION)` to determine HW support for color transformation. Support is available with GC355 and GC555.

Syntax:

```
vg_lite_error_t vg_lite_disable_color_transform (  
);
```

Parameters: None

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_enable_color_transform function Description:

This function is used to enable color transformation. By default, the color transform is turned off. *(from Sept 2022, only for GC355 and GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_enable_color_transform (  
);
```

Parameters: None

Returns:

Returns `VG_LITE_SUCCESS` if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_set_color_transform function Description:

This function is used to set pixel scale and bias values for color transformation for each pixel channel. *(from August 2022, only for GC355 and GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_color_transform (  
    vg_lite_color_transform_t *values  
);
```

Parameters:

Parameter	Description
*values	Pointer to the color transformation values to set. See enum <code>vg_lite_color_transform_t</code> .

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_enable_masklayer` **function** **Description:**

This function controls the availability of mask functionality. The mask is turned off by default. *(from August - Sept mber 2022, requires GC555 hardware)*

Applications can use VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_MASK`) to determine HW support for mask. The blit and draw mask functions below require GC555 hardware support. These functions were introduced in August 2022 and the syntax or name was further refined in September 2022.

Syntax:

```
vg_lite_error_t vg_lite_enable_masklayer (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_disable_masklayer` **function** **Description:**

This function controls the availability of mask functionality. The mask is turned off by default. *(from August -September 2022, requires GC555 hardware, prior to Sept 2022 name was `vg_lite_disable_mask_layer`)*

Syntax:

```
vg_lite_error_t vg_lite_disable_masklayer (
    void
);
```

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_create_masklayer` **function** **Description:**

This function creates a mask layer with the specified width and height. The mask format defaults to A8 and the default mask value is 255. *(from August 2022-September, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_create_masklayer (
    vg_lite_buffer_t      *masklayer,
    vg_lite_uint32_t      width,
    vg_lite_uint32_t      height
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be created.
width	Mask layer width (in pixels).
height	Mask layer height (in pixels).

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_blend_masklayer` **function** **Description:**

This function blends the specified area of the source mask layer with the destination mask layer according to an `vg_lite_mask_operation_t` enumeration value, to create a blended destination mask layer. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_blend_masklayer (  
    vg_lite_buffer_t      *dst_masklayer,  
    vg_lite_buffer_t      *src_masklayer,  
    vg_lite_mask_operation operation,  
    vg_lite_rectangle_t    *rect,  
);
```

Parameters:

Parameter	Description
*dst_masklayer	Points to the address of the buffer of the destination mask layer.
*src_masklayer	Points to the address of the buffer of the source mask layer.
operation	Blending mode to be applied to each image pixel, as defined by the enum <code>vg_lite_mask_operation_t</code> .
*rect	The rectangle area (x, y, width, height) of the blend operation.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

`vg_lite_set_masklayer` **function** **Description:**

This function sets the given mask layer to the hardware. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_set_masklayer (  
    vg_lite_buffer_t *masklayer  
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be set.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_render_masklayer function Description:

This function draws the mask layer according to the specified path, color, and matrix information. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_render_masklayer (
    vg_lite_buffer_t      *masklayer,
    vg_lite_mask_operation operation,
    vg_lite_path_t        *path,
    vg_lite_fill_t        fill_rule,
    vg_lite_color_t       color,
    vg_lite_matrix_t      *matrix
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the destination mask layer.
operation	Blending mode to be applied to each image pixel, as defined by the enum <code>vg_lite_mask_operation_t</code> .
*path	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw. Refer to Vector path opcodes for plotting paths in this document for opcode detail.
fill_rule	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path.
color	Specifies the color <code>vg_lite_color_t</code> RGBA value to be applied to each pixel drawn by the path.
*matrix	Points to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed, meaning the source is copied directly on the target at 0,0 location. which is usually a bad idea since the path can be anything.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_destroy_masklayer function Description:

This function is used to free a mask layer. *(from August-September 2022, requires GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_destroy_masklayer (  
    vg_lite_buffer_t      masklayer  
);
```

Parameters:

Parameter	Description
*masklayer	Points to the address of the buffer of the mask layer to be destroyed.

Returns:

Returns VG_LITE_SUCCESS if the function is successful. See vg_lite_error_t enum for other return codes.

Parent topic:Blit/Draw extended functions

vg_lite_set_mirror function Description:

This function is used to control mirror functionality. By default, the mirror is turned off and the default output orientation is from top to bottom. *(from August 2022, only for GC555 hardware)*

Application can use VGLite API [vg_lite_query_feature](vg_lite_query_feature_function.md) (gcFEATURE_BIT_VG_MIRROR) to determine HW support for mirror. Mirror functions require GC555 hardware.

Syntax:

```
vg_lite_error_t vg_lite_set_mirror (  
    vg_lite_orientation_t  orientation  
);
```

Parameters:

Parameter	Description
orientation	The orientation mode as defined by the enum <i>vg_lite_orientation_t</i> .

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if not supported.

Parent topic:Blit/Draw extended functions

vg_lite_source_global_alpha function Description:

This function sets the image/source global alpha and return a status error code. *(from June 2021, requires GCNanoUltraV or GC555 hardware)*

Application can use VGLite API vg_lite_query_feature (gcFEATURE_BIT_VG_GLOBAL_ALPHA) to determine HW support for global alpha. The global alpha BLIT-related functions require GC-NanoUltraV or GC555 hardware.

Syntax:

```
vg_lite_error_t vg_lite_source_global_alpha (
    vg_lite_global_alpha_t    alpha_mode,
    vg_lite_uint8_t           alpha_value
);
```

Parameters:

Parameter	Description
alpha_mode	Global alpha mode value. See enum <code>vg_lite_global_alpha_t</code> .
alpha_value	The image/source global alpha value to set.

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if global alpha is not supported.

Parent topic:Blit/Draw extended functions

vg_lite_dest_global_alpha function Description:

This function sets the destination global alpha and returns a status error code. *(from June 2021, requires GCNanoUltraV or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_dest_global_alpha (
    vg_lite_global_alpha_t    alpha_mode,
    vg_lite_uint8_t           alpha_value
);
```

Parameters:

Parameter	Description
alpha_mode	Global alpha mode value. See enum <code>vg_lite_global_alpha_t</code> .
alpha_value	The destination global alpha value to set.

Returns:

VG_LITE_SUCCESS or VG_LITE_NOT_SUPPORT if global alpha is not supported.

Parent topic:Blit/Draw extended functions

Parent topic:[Blits for compositing and blending](#)

Vector path control This chapter provides an overview of the vector path enumerations, structures, functions, and opcodes for plotting paths.

Vector path enumerations This section provides an overview of vector path enumerations.

vg_lite_format_t enumeration Values for `vg_lite_format_t` enum are defined in Table 1.

If <code>vg_lite_format_t</code>	Path data alignment in the array should be:
VG_LITE_S8	8 bit
VG_LITE_S16	2 bytes
VG_LITE_S32	4 bytes

Parent topic:Vector path enumerations

`vg_lite_quality_t` **enumeration** Specifies the level of hardware assisted anti-aliasing.

Used in structure: `vg_lite_path_t`.

Used in function: `vg_lite_init_path`, `vg_lite_init_arc_path`.

<code>vg_lite_quality_t</code>	Description
<code>VG_LITE_QUALITY_HIGH</code>	High quality: 16x coverage sample anti-aliasing
<code>VG_LITE_QUALITY_UPPER</code>	Upper quality: 8x coverage sample anti-aliasing. Use <code>vg_lite_query_feature</code> to determine availability of 8x CSAA (feature enum value <code>gcFEATURE_BIT_VG_QUALITY_8X</code> .(deprecated from June 2020, available with supported hardware from August 2022).
<code>VG_LITE_QUALITY_MEDIUM</code>	Medium quality: 4x coverage sample anti-aliasing
<code>VG_LITE_QUALITY_LOW</code>	Low quality: No anti-aliasing

Parent topic:Vector path enumerations

Parent topic:[Vector path control](#)

Vector path structures This section provides an overview of vector path structures.

`vg_lite_hw_memory` **structure** This structure gets the memory allocation information recorded by the kernel.

Used in structure: `vg_lite_path_t`.

<code>vg_lite_hw_memory</code> member	Type	Description
<code>handle</code>	<code>vg_lite_handle_t</code>	GPU memory object handle
<code>memory</code>	<code>vg_lite_address_t</code>	Logical memory address
<code>address</code>	<code>vg_lite_address_t</code>	GPU memory address
<code>bytes</code>	<code>vg_lite_uint32_t</code>	Size of memory
<code>property</code>	<code>vg_lite_uint32_t</code>	Bit 0 is used for path upload: - 0: Disable path data uploading (always embedded into command buffer) - 1: Enable auto path data uploading

Parent topic:Vector path structures

`vg_lite_path_t` **structure** This structure describes VGLite path data.

Path data is made of op codes and coordinates. The format for op codes is always `VG_LITE_S8`. For more details on opcodes, see [Vector path opcodes for plotting paths](#).

Used in init functions: `vg_lite_init_path`, `vg_lite_init_arc_path`, `vg_lite_upload_path`, `vg_lite_clear_path`, `vg_lite_append_path`.

Used in draw functions: `vg_lite_draw`, `vg_lite_draw_grad`, `vg_lite_draw_radial_grad`, `vg_lite_draw_pattern`.

vg_lite_path_t members	Type	Description
bounding_box[4]	vg_lite_float_t	bounding box for path [0] left [1] top [2] right [3] bottom
quality	vg_lite_quality_t	enum for quality hint for the path, anti-aliasing level
format	vg_lite_format_t	enum for coordinate format
uploaded	vg_lite_hw_mem_t	struct with path data that has been uploaded into GPU addressable memory
path_length	vg_lite_uint32_t	number of bytes in the path
path	vg_lite_pointer_t	pointer to path data
path_changed	vg_lite_int8_t	0: not changed; 1: changed.
pdata_internal	vg_lite_int8_t	0: path data memory is allocated by application; 1: path data memory is allocated by driver.
path_type	vg_lite_path_type_t	The draw path type as specified in enum <code>vg_lite_path_type_t</code> . <i>(added for stroke control, from March 2022)</i>
*stroke	vg_lite_stroke_t	As defined by structure <code>vg_lite_stroke_t</code> <i>(added for stroke control, from March 2022)</i>
stroke_path	vg_lite_pointer_t	Pointer to the physical description of the stroke path. <i>(added for stroke control, from March 2022)</i>
stroke_size	vg_lite_uint32_t	Number of bytes in the stroke path data. <i>(added for stroke control, from March 2022)</i>
stroke_color	vg_lite_color_t	The stroke path fill color. <i>(from Sept 2022)</i>
add_end	vg_lite_int8_t	Flag that add_end_path in driver <i>(from March 2023)</i>

Special notes for path objects:

- Endianness has no impact, as it is aligned against the boundaries
- Multiple contiguous opcodes should be packed by the size of the specified data format. For example, by 2 bytes for VG_LITE_S16 or by 4 bytes for VG_LITE_S32.

For example, because opcodes are 8-bit (1-byte), 16-bit (2-byte), or 32-bit (4-byte) data types:

```
...
<opcode1_that_needs_data>
<align_to_data_size>
<data_for_opcode1>
<opcode2_that_doesnt_need_data>
<align_to_data_size>
<opcode3_that_needs_data>
<align_to_data_size>
<data_for_opcode3>
...
```

- Path data in the array should always be 1-, 2-, or 4-byte aligned, depending on the format:

For example, for 32-bit (4-byte) data types:

```
...
<opcode1_that_needs_data>
<pad to 4 bytes>
<4 byte data_for_opcode1>
<opcode2_that_doesnt_need_data>
<pad to 4 bytes>
<opcode3_that_needs_data>
<pad to 4 bytes>
<4 byte data_for_opcode3>
...
```

Parent topic: Vector path structures

Parent topic: [Vector path control](#)

Vector path functions When using a small tessellation window and depending on a path's size, a path might be uploaded to the hardware multiple times because the hardware scanline convert path with the provided tessellation window size, so VGLite path rendering performance might go down. That is why it is preferable to set the tessellation buffer size to the most common path size, for example if you only render 24-pt fonts, you can set the tessellation buffer to be 24x24.

All the RGBA color formats available in the `vg_lite_buffer_format_t` are supported as the destination buffer for the draw function.

`vg_lite_get_path_length` **function** **Description:**

This function calculates the path command buffer length (in bytes).

The application is responsible for allocating a buffer according to the buffer length calculated with this function. Then, the buffer is used by the path as a command buffer. The VGLite driver does not allocate the path command buffer.

Syntax:

```
vg_lite_uint32_t vg_lite_get_path_length (  
    vg_lite_uint8_t      *opcode,  
    vg_lite_uint32_t      count,  
    vg_lite_format_t      format  
);
```

Parameters:

Parameter	Description
*opcode	Pointer to the opcode array to use to construct the path. (<i>*opcode from March 2023</i>)
count	The opcode count
format	The coordinate data format. All formats available in the <code>vg_lite_format_t</code> enum are valid formats for this function.

Returns:

Returns the command buffer length in bytes.

Parent topic: Vector path functions

`vg_lite_append_path` **function** **Description:**

This function assembles the command buffer for the path. The command buffer is allocated by the application and assigned to the path. This function makes the final GPU command buffer for the path based on the input opcodes (cmd) and coordinates (data). The application is responsible for allocating a buffer large enough for the path*. (from Jan 2022, returns a `vg_lite_error_t` status code)*

Syntax:

```
vg_lite_error_t vg_lite_append_path (  
    vg_lite_path_t      *path  
    vg_lite_uint8_t      *opcode,  
    vg_lite_pointer      data,  
    vg_lite_uint32_t      seg_count
```

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);

Parameters:

Parameter	Description
*path	Pointer to the <code>vg_lite_path_t</code> structure with the path definition.
*opcode	Pointer to the opcode array to use to construct the path. (<i>*opcode from March 2023</i>)
data	Pointer to the coordinate data array to use to construct the path
seg_count	The opcode count

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Vector path functions

vg_lite_init_path function Description:

This function initializes a path definition with specified values. (*From Dec 2019 returns `vg_lite_error_t`, previous was void.*)

Syntax:

```
vg_lite_error_t vg_lite_init_path (
    vg_lite_path_t      *path,
    vg_lite_format_t    format,
    vg_lite_quality_t    quality,
    vg_lite_uint32_t     length,
    vg_lite_pointer      *data,
    vg_lite_float_t      min_x,
    vg_lite_float_t      min_y,
    vg_lite_float_t      max_x,
    vg_lite_float_t      max_y
);
```

Parameters:

Parameter	Description
*path	Pointer to the <code>vg_lite_path_t</code> structure for the path object to be initialized with the member values specified.
format	The coordinate data format. All formats available in the <code>vg_lite_format_t</code> enum are valid formats for this function.
quality	The quality for the path object. All formats available in the <code>vg_lite_quality_t</code> enum are valid formats for this function.
length	The length of the path data (in bytes)
*data	Pointer to path data
min_x min_y max_x max_y	Minimum and maximum x and y values specifying the bounding box of the path

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Vector path functions

vg_lite_init_arc_path function Description:

This function initializes an arc path definition with specified values. *(from February 2021)*

Syntax:

```
vg_lite_error_t vg_lite_init_arc_path (
    vg_lite_path_t      *path,
    vg_lite_format_t     format,
    vg_lite_quality_t    quality,
    vg_lite_uint32_t     length,
    vg_lite_pointer      *data,
    vg_lite_float_t      min_x,
    vg_lite_float_t      min_y,
    vg_lite_float_t      max_x,
    vg_lite_float_t      max_y
);
```

Parameters:

Parameter	Function
*path	Pointer to the vg_lite_path_t structure for the path object to be initialized with the member values specified.
format	The coordinate data format. The vg_lite_format_t enum value should be FP32.
quality	The quality for the path object. All formats available in the vg_lite_quality_t enum are valid formats for this function.
length	The length of the path data (in bytes).
*data	Pointer to path data.
min_x min_y max_x max_y	Minimum and maximum x and y values specifying the bounding box of the path.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic:Vector path functions

vg_lite_upload_path function Description:

This function is used to upload a path to GPU memory.

In normal cases, the VGLite driver will copy any path data into a command buffer structure during runtime. This does take some time if there are many paths to be rendered. Also, in an embedded system the path data won't change - so it makes sense to upload the path data into GPU memory in such a form that the GPU can directly access it. This function will signal the driver to allocate a buffer that will contain the path data and the required command buffer header and footer data for the GPU to access the data directly. Call vg_lite_clear_path to free this buffer after the path is used.

Syntax:

```
vg_lite_error_t vg_lite_upload_path (
    vg_lite_path_t      *path
);
```

Parameters:

Parameter	Description
*path	Pointer to a vg_lite_path_t structure that contains the path to be uploaded.

Returns:

VG_LITE_OUT_OF_MEMORY if not enough GPU memory is available for buffer allocation.

Parent topic:Vector path functions

vg_lite_clear_path function Description:

This function will clear and reset path member values. If the path has been uploaded, it frees the GPU memory allocated when uploading the path. *(From Dec 2019 returns vg_lite_error_t, previous was void.)*

.

Syntax:

```
vg_lite_error_t vg_lite_clear_path (
    vg_lite_path_t      *path
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t path definition to be cleared.

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic:Vector path functions

Parent topic:[Vector path control](#)

Vector path opcodes for plotting paths The following opcodes are path drawing commands available for vector path data.

A path operation is submitted to the GPU as [Opcode | Coordinates]. The operation code is stored as a VG_LITE_S8 while the coordinates are specified via vg_lite_format_t.

Op-code	Arguments	Description
0x00	None	VLC_OP_END . Finish tessellation. Close any open path.
0x01	None	VLC_OP_CLOSE . For VGLite driver internal use only. Application should not use this OP directly.
0x02	(x, y)	VLC_OP_MOVE . Move to the given vertex. Close any open path. $start_x = x$ $start_y = y$
0x03	(Δx , Δy)	VLC_OP_MOVE_REL . Move to the given relative point. Close any open path. $start_x = start_x + \Delta x$ $start_y = start_y + \Delta y$
0x04	(x, y)	VLC_OP_LINE . Draw a line to the given point. $Line(start_x, start_y, x, y)$ $start_x = x$ $start_y = y$
0x05	(Δx , Δy)	VLC_OP_LINE_REL . Draw a line to the given relative point. $x = start_x + \Delta x$ $y = start_y + \Delta y$ $Line(start_x, start_y, x, y)$ $start_x = x$ $start_y = y$
0x06	(cx, cy) (x, y)	VLC_OP_QUAD . Draw a quadratic Bezier curve to the given end point using the specified control point. $Quad(start_x, start_y, cx, cy, x, y)$ $start_x = x$ $start_y = y$
0x07	(Δcx , Δcy) (Δx , Δy)	VLC_OP_QUAD_REL . Draw a quadratic Bezier curve to the given relative end point using the specified relative control point. $cx = start_x + \Delta cx$ $cy = start_y + \Delta cy$ $x = start_x + \Delta x$ $y = start_y + \Delta y$ $Quad(start_x, start_y, cx, cy, x, y)$ $start_x = x$ $start_y = y$
994		VLC_OP_CUBIC . Draw a cubic Bezier curve to the given end point using the specified control points. $Cubic(start_x, start_y, cx_1, cy_1, cx_2, cy_2, x, y)$ $start_x = x$ $start_y = y$

Parent topic: [Vector path control](#)

Vector-based draw operations This part of the API performs the hardware accelerated draw operations.

Draw and gradient enumerations This section provides an overview of draw and gradient enumerations.

vg_lite_blend_t enumeration This enumeration is defined under the “Blit enumerations” section (see [vg_lite_blend_t](#) enumeration).

Parent topic: Draw and gradient enumerations

vg_lite_color_t parameter The common parameter [vg_lite_color_t](#) is described in Common parameter types.

Parent topic: Draw and gradient enumerations

vg_lite_fill_t enumeration This enumeration is used to specify the fill rule to use. For drawing any path, the hardware supports both non-zero and odd-even fill rules.

To determine whether any point is contained inside an object, imagine drawing a line from that point out to infinity in any direction such that the line does not cross any vertex of the path. For each edge that is crossed by the line, add 1 to the counter if the edge is crossed from left to right, as seen by an observer walking across the line towards infinity, and subtract 1 if the edge crossed from right to left. In this way, each region of the plane will receive an integer value.

The non-zero fill rule says that a point is inside the shape if the resulting sum is not equal to zero. The even/odd rule says that a point is inside the shape if the resulting sum is odd, regardless of sign.

Used in function: [vg_lite_render_masklayer](#).

Used in draw functions: [vg_lite_draw](#), [vg_lite_draw_grad](#), [vg_lite_draw_radial_grad](#), [vg_lite_draw_pattern](#).

vg_lite_fill_t values	string	Description
VG_LITE_FILL_NON_ZERO		Non-zero fill rule. A pixel is drawn if it crosses at least one path pixel.
VG_LITE_FILL_ODD_EVEN		Even-odd fill rule. A pixel is drawn if it crosses an odd number of path pixels.

Parent topic: Draw and gradient enumerations

vg_lite_filter_t enumeration This enum is defined under the “Blit enumerations” section (see [vg_lite_filter_t](#) enumeration).

Parent topic: Draw and gradient enumerations

`vg_lite_gradient_spreadmode_t` **enumeration** `vg_lite_gradient_spreadmode_t` enum is defined to match OpenVG enum `VGColorRampSpreadMode` (from March 2023, replaces `vg_lite_radial_gradient_spreadmode*`, requires GC355/GC555 hardware)*

The application may only define stops with offsets between 0 and 1. Spread modes define how the given set of stops are repeated or extended in order to define interpolated color values for arbitrary input values outside the [0,1] range.

Used in structure: `vg_lite_radial_gradient_t`.

<code>vg_lite_gradient_spreadmode_t</code> String Values	Description
<code>VG_LITE_GRADIENT_SPREADMODE_REPEAT</code>	The current fill color is used for all stop values less than 0 or greater than 1 respectively.
<code>VG_LITE_GRADIENT_SPREADMODE_CLAMP</code>	Colors defined at 0 and 1 are used for all stop values less than 0 or greater than 1 respectively.
<code>VG_LITE_GRADIENT_SPREADMODE_WRAP</code>	Color values defined between 0 and 1 are repeated indefinitely in both directions.
<code>VG_LITE_GRADIENT_SPREADMODE_REFLECT</code>	Color values defined between 0 and 1 are repeated indefinitely in both directions but with alternate copies of the range reversed.

Parent topic:Draw and gradient enumerations

`vg_lite_pattern_mode_t` **enumeration** Defines how the region outside the image pattern is filled for the path.

Used in function: `vg_lite_draw_gradient`, `vg_lite_draw_pattern`.

<code>vg_lite_pattern_mode_t</code> string values	Description
<code>VG_LITE_PATTERN_MODE_REPEAT</code>	Pixels outside the bounds of the source image should be taken as the color.
<code>VG_LITE_PATTERN_MODE_CLAMP</code>	Pixels outside the bounds of the source image should be taken as having the same color as the closest edge pixel. The color of the pattern border is expanded to fill the region outside the pattern.
<code>VG_LITE_PATTERN_MODE_WRAP</code>	Pixels outside the bounds of the source image should be repeated indefinitely in all directions. (from March 2023)
<code>VG_LITE_PATTERN_MODE_REFLECT</code>	Pixels outside the bounds of the source image should be reflected indefinitely in all directions. (from March 2023)

Parent topic:Draw and gradient enumerations

`vg_lite_radial_gradient_spreadmode_t` **enumeration** (Deprecated March 2023) use `vg_lite_gradient_spreadmode_t`. Defines the radial gradient padding mode. (from Nov 2020, requires GC355 hardware)

Used in structure: `vg_lite_radial_gradient_t`.

vg_lite_radial_gradient_stop String Values	Description
VG_LITE_RADIAL_GRADIENT_STOP_0	The current fill color is used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_RADIAL_GRADIENT_STOP_1	Colors defined at 0 and 1 are used for all stop values less than 0 or greater than 1 respectively.
VG_LITE_RADIAL_GRADIENT_STOP_REPEAT	Color values defined between 0 and 1 are repeated indefinitely in both directions.
VG_LITE_RADIAL_GRADIENT_STOP_REVERSE	Color values defined between 0 and 1 are repeated indefinitely in both directions but with alternate copies of the range reversed.

Parent topic: Draw and gradient enumerations

Parent topic: [Vector-based draw operations](#)

Draw and gradient structures This section provides an overview of the draw and gradient structures.

vg_lite_buffer_t structure This structure is defined under the “Pixel buffer structures” section (see [vg_lite_buffer_t](#) structure).

Parent topic: Draw and gradient structures

vg_lite_color_ramp_t structure This structure defines the stops for the radial gradient. The five parameters provide the offset and color for the stop. Each stop is defined by a set of floating point values which specify the offset and the sRGBA color and alpha values. Color channel values are in the form of a non-premultiplied (R, G, B, alpha) quad. All parameters are in the range of [0,1]. The red, green, blue, alpha value of [0, 1] is mapped to an 8-bit pixel value [0, 255]. *(from November 2020, requires GC355 hardware)*

The define for the max number of radial gradient stops is `#define MAX_COLOR_RAMP_STOPS 256`.

Used in radial gradient structure: [vg_lite_radial_gradient_t](#).

vg_lite_color_ramp_t members	mem-	Type	Description
stop		vg_lite_float_t	Offset value for the color stop
red		vg_lite_float_t	Red color channel value for the color stop
green		vg_lite_float_t	Green color channel value for the color stop
blue		vg_lite_float_t	Blue color channel value for the color stop
alpha		vg_lite_float_t	Alpha color channel value for the color stop

Parent topic: Draw and gradient structures

vg_lite_linear_gradient_t structure This structure defines the organization of a linear gradient in VGLite data. The linear gradient is applied to filling a path. It generates a 256x1 image according to the specified settings.

Used in init and draw functions: [vg_lite_init_grad](#), [vg_lite_set_grad](#), [vg_lite_update_grad](#), [vg_lite_get_grad_matrix](#), [vg_lite_clear_grad](#), [vg_lite_draw_grad](#).

vg_lite_linear_gradient_t constants	con-	Type	Description
VLC_MAX_GRADIENT_STOP		vg_lite_int32_t	Constant. Maximum number of gradient colors = 16.
vg_lite_linear_gradient_t members			
colors		vg_lite_uint32_t	Color array for the gradient
[VLC_MAX_GRADIENT_STOP]			
count		vg_lite_uint32_t	Number of colors
stops		vg_lite_uint32_t	Number of color stops, from 0 to 255
[VLC_MAX_GRADIENT_STOP]			
matrix		vg_lite_matrix_t	Struct for the matrix to transform the gradient color ramp
image		vg_lite_buffer_t	Image object struct to represent the color ramp

Parent topic: Draw and gradient structures

vg_lite_ext_linear_gradient structure This structure defines the organization of the extended parameters possible for a linear gradient (*from April 2022*).

Used in functions: `vg_lite_draw_linear_grad`.

vg_lite_ext_linear_gradient members	Type	Description
count	vg_lite_uint32_t	Count of colors, up to 256.
matrix	vg_lite_matrix_t	The matrix to transform the gradient.
image	vg_lite_buffer_t	The image for rendering as gradient pattern.
linear_grad	vg_lite_linear_grad_t	Linear gradient parameters. Includes center point, focal point and radius.
ramp_length	vg_lite_uint32_t	Color ramp length for gradient paints provided to the driver.
color_ramp[VLC_MAX_COLORS]	vg_lite_color_ramp_t	Color ramp parameter for gradient paints provided to the driver.
converted_length	vg_lite_uint32_t	Converted internal color ramp length.
converted_ramp[VLC_MAX_COLORS]	vg_lite_color_ramp_t	Converted internal color ramp.
pre-multiplied	vg_lite_uint8_t	If this value is set to 1, the color value of <code>color_ramp</code> will be multiplied by the alpha value of <code>color_ramp</code> .
spread_mode	vg_lite_radial_grad_t	The spread mode that is applied to the pixels out of the image after transformed.

Parent topic: Draw and gradient structures

vg_lite_linear_gradient_parameter structure This structure defines a radial direction for a linear gradient. (*from April 2022*)

Line0 connects point (X0, Y0) to point (X1, Y1) and represents the radial direction of the linear gradient.

Line1 is a line perpendicular to line0 which passes through point (X0, Y0).

Line2 is a line perpendicular to line0 which passes through point (X1, Y1)

The linear gradient paint is applied at the intersection of the path fill area and the plane starting from line 1 and ending at line 2.

Used in structure: `vg_lite_ext_linear_gradient`.

Used in functions: `vg_lite_set_linear_grad`.

vg_lite_linear_gradient_parameter_t members	Type	Description
X0	<code>vg_lite_float</code>	X origin of linear gradient radial direction.
Y0	<code>vg_lite_float</code>	Y origin of linear gradient radial direction.
X1	<code>vg_lite_float</code>	X end point of linear gradient radial direction.
Y1	<code>vg_lite_float</code>	Y end point of linear gradient radial direction.

Parent topic: Draw and gradient structures

`vg_lite_matrix_t` **structure** This structure is defined under the “Matrix control structures” section (see `vg_lite_matrix_t` structure).

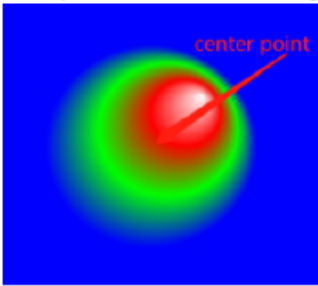
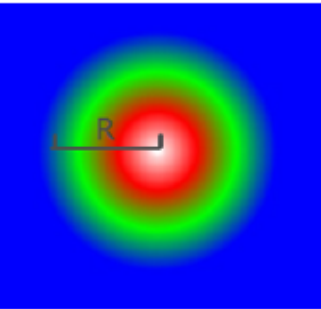
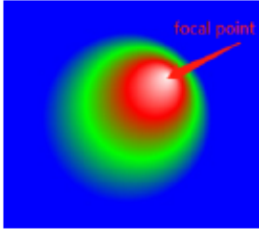
Parent topic: Draw and gradient structures

`vg_lite_path_t` **structure** This structure is defined under the “Vector path structures” section (see `vg_lite_path_t` structure).

Parent topic: Draw and gradient structures

`vg_lite_radial_gradient_parameter_t` **structure** This structure defines the gradient radius and the X and Y coordinates for the center and focal points of the gradient (*from November 2020, requires GC355 or GC555 hardware*).

Used in radial gradient structure: `vg_lite_radial_gradient_t`.

vg_lite_radial_gradient_parameter_t member	Type	Description
		Coordinates x and y of the gradient color center point. Center point refers to the center of the gradient color.
		
cx	vg_lite_float_t	
cy	vg_lite_float_t	
		Radius of the gradient
		
r	vg_lite_float_t	
		Coordinates x and y of the gradient color focal point. Focal point refers to the center of the gradient color.
		
fx	vg_lite_float_t	
fy	vg_lite_float_t	

Parent topic:Draw and gradient structures

vg_lite_radial_gradient_t structure This structure defines the application of the radial gradient to fill a path. *(from November 2020, requires GC355 or GC555 hardware).*

Used in radial gradient functions: vg_lite_draw_grad, vg_lite_set_radial_grad, vg_lite_update_radial_grad, vg_lite_get_radial_grad, vg_lite_clear_radial_grad.

vg_lite_radial_gradient_t member	Type	Description
count	vg_lite_uint32_t	Count of colors, up to 256
matrix	vg_lite_matrix_t	Structure that specifies the transform matrix for the gradient
image	vg_lite_buffer_t	Structure that specifies the image for rendering as a gradient pattern
radial_grad	vg_lite_radial_grad_t	Structure that specifies the location of the gradient's center point (cx, cy), focal point(fx, fy) and radius(r)
ramp_length	vg_lite_uint32_t	Color ramp parameters for gradient paints provided to the driver
color_ramp[VLC_MAX_COLORS]	vg_lite_color_ramp_t	Structure that specifies the color ramp
converted_length	vg_lite_uint32_t	Converted internal color ramp.
converted_ramp[VLC_MAX_COLORS]	vg_lite_color_ramp_t	Structure that specifies the internal color ramp
pre_multiplied	vg_lite_uint32_t	If this value is set to 1, the color value of color_ramp will be multiplied by the alpha value of color_ramp.
spread_mode	vg_lite_radial_grad_t	Enum that specifies the tiling mode, which is applied to the pixels out of the image after transformation

Parent topic: Draw and gradient structures

Parent topic: [Vector-based draw operations](#)

Draw functions This section provides an overview of the draw functions.

vg_lite_draw function Description:

This function performs a hardware accelerated 2D vector draw operation.

The size of the tessellation buffer can be specified at initialization and it is aligned with the minimum hardware alignment requirements of the kernel. Specifying a smaller size for tessellation buffer allocates less memory but reduces performance. Because the hardware walks the target with the provided tessellation window size, a path may be sent to the hardware multiple times. It is a good practice to set the tessellation buffer size to the most common path size. For example, if all you do is render up to 24-point fonts, you can set the tessellation buffer to 24x24.

Note:

- All the color formats available in the `vg_lite_buffer_format_t` enum are supported as the destination buffer for the draw function
- The hardware does not support strokes; they must be converted to paths before you use them in the draw API

Syntax:

```
vg_lite_error_t vg_lite_draw (
    vg_lite_buffer_t      *target,
    vg_lite_path_t        *path,
    vg_lite_fill_t        fill_rule,
    vg_lite_matrix_t      *matrix,
    vg_lite_blend_t        blend,
    vg_lite_color_t        color
);
```

Parameters:

Parameter	Description
<code>*target</code>	Pointer to the <code>vg_lite_buffer_t</code> structure for the destination buffer. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid destination formats for the draw function.
<code>*path</code>	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw. See opcode details in Vector path opcodes for plotting paths.
<code>fill_rule</code>	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path
<code>*matrix</code>	Pointer to a <code>vg_lite_matrix_t</code> structure that defines the <i>affine</i> transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed. Note: Non-affine transformations are not supported by <code>vg_lite_draw</code> ; therefore, a perspective transformation matrix might have unexpected effects on path rendering.
<code>blend</code>	Select one of the hardware-supported blend modes in the <code>vg_lite_blend_t</code> enum to be applied to each drawn pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0).
<code>color</code>	The color applied to each pixel drawn by the path.

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Draw functions

vg_lite_draw_grad function **Description:**

This function is used to fill a path with a linear gradient according to the specified fill rules. The specified path is transformed according to the selected matrix and is filled with the specified color gradient.

Syntax:

```
vg_lite_error_t vg_lite_draw_grad (  
    vg_lite_buffer_t      *target,  
    vg_lite_path_t        *path,  
    vg_lite_fill_t        fill_rule,  
    vg_lite_matrix_t      *matrix,  
    vg_lite_linear_gradient_t *grad,  
    vg_lite_blend_t        blend  
);
```

Parameters:

Parameter	Description
*target	Pointer to the <code>vg_lite_buffer_t</code> structure containing data describing the target path.
*path	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw and fill with the linear gradient. See opcode details in Vector path opcodes for plotting paths.
fill_rule	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path
*matrix	Pointer to the <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, this option is not preferable.
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure that contains the values to be used to fill the path.
blend	Specifies the blend mode in the <code>vg_lite_blend_t</code> enum to be applied to each drawn pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0).

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Draw functions

vg_lite_draw_radial_grad function Description:

This function is used to fill a path with a radial gradient according to the specified fill rules. The specified path is transformed according to the selected matrix and is filled with the radial color gradient. The application can use VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_RADIAL_GRADIENT`) to determine HW support for radial gradient.

Syntax:

```
vg_lite_error_t vg_lite_draw_radial_grad (
    vg_lite_buffer_t      *target,
    vg_lite_path_t        *path,
    vg_lite_fill_t         fill_rule,
    vg_lite_matrix_t      *path_matrix,
    vg_lite_radial_gradient_t *grad,
    vg_lite_color_t        paint_color,
    vg_lite_blend_t        blend,
    vg_lite_filter_t       filter
);
```

Parameters:

Parameter	Description
*target	Pointer to the <code>vg_lite_buffer_t</code> structure containing data describing the target path.
*path	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw for and fill with the radial gradient. See opcode details in Vector path opcodes for plotting paths.
fill_rule	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path
*path_matrix	Pointer to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, this option is not preferable.
*gradient	Pointer to the <code>vg_lite_radial_gradient_t</code> structure that contains the values to be used to fill the path. Note: <code>grad->image.image_mode</code> does not support <code>VG_LITE_MULTIPLY_IMAGE_MODE</code> .
paint_color	Specifies the paint color <code>vg_lite_color_t</code> RGBA value to be applied by <code>VG_LITE_RADIAL_GRADIENT_SPREAD_FILL</code> set by the function <code>vg_lite_set_radial_grad</code> . When pixels are out of the image after transformation, <code>paint_color</code> is applied to them. For details, see <code>vg_lite_radial_gradient_spreadmode_t</code> .
blend	Specifies the blend mode in the <code>vg_lite_blend_t</code> enum to be applied to each drawn pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0).
filter	Specifies the filter mode <code>vg_lite_filter_t</code> enum value to be applied to each drawn pixel. If no filtering is required, set this value to <code>VG_LITE_BLEND_POINT</code> (0).

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Draw functions

vg_lite_draw_pattern function Description:

This function fills a path with an image pattern. The path is transformed according to the specified matrix and is filled with the transformed image pattern.

Syntax:

```
vg_lite_error_t vg_lite_draw_pattern (
    vg_lite_buffer_t      *target,
    vg_lite_path_t        *path,
    vg_lite_fill_t        fill_rule,
    vg_lite_matrix_t      *path_matrix,
    vg_lite_buffer_t      *pattern_image,
    vg_lite_matrix_t      *pattern_matrix,
    vg_lite_blend_t        blend,
    vg_lite_pattern_mode_t pattern_mode,
    vg_lite_color_t        pattern_color,
    vg_lite_color_t        color,
    vg_lite_filter_t       filter
);
```

Parameters:

Parameter	Description
*target	Pointer to the <code>vg_lite_buffer_t</code> structure for the destination buffer. All color formats available in the <code>vg_lite_buffer_format_t</code> enum are valid destination formats for this draw function.
*path	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw. See opcode details in Vector path opcodes for plotting paths
fill_rule	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path.
*src_matrix	Pointer to the <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the source pixels into the target. If the matrix is NULL, an identity matrix is assumed, meaning the source is copied directly onto the target at 0,0 location.
*dst_matrix	Pointer to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed.
*src_image	Pointer to the <code>vg_lite_buffer_t</code> structure that describes the source of the image pattern
dst_matrix	Pointer to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the source pixels into the target. If the matrix is NULL, an identity matrix is assumed, which means that the source is copied directly at 0,0 location on the target.
blend_mode	Specifies one of the <code>vg_lite_blend_t</code> enum values for hardware-supported blend modes to be applied to each drawn pixel in the image. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0).
pattern_fill_rule	Specifies the <code>vg_lite_pattern_mode_t</code> value that defines how the region outside the image pattern is to be filled.
pattern_color	Specifies a 32bpp ARGB color (<code>vg_lite_color_t</code>) to be applied to the fill outside the image pattern area when the <code>pattern_mode</code> value is <code>VG_LITE_PATTERN_COLOR</code> . <i>(from Dec 2019, type now <code>vg_lite_color_t</code>, previously was <code>uint32_t</code>)</i>
color	Specifies a 32bpp ARGB color (<code>vg_lite_color_t</code>) to be applied as a mix color. If non-zero, the mix color value gets multiplied with each source pixel before blending happens. If a mix color is not needed, set the color parameter to 0 <i>(from May 2023)</i> . Note: This parameter has no effect if the pattern image <code>vg_lite_buffer_t</code> structure member <code>image_mode</code> is set to <code>VG_LITE_ZERO</code> or <code>VG_LITE_NORMAL_IMAGE_MODE</code> .
filter	Specifies the filter type. All formats available in the <code>vg_lite_filter_t</code> enum are valid formats for this function. A value of zero (0) indicates <code>VG_LITE_FILTER_POINT</code> .

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Draw functions

Parent topic: [Vector-based draw operations](#)

Linear gradient initialization and control functions This part of the API performs linear gradient operations.

A color gradient (color progression, color ramp) is a smooth transition between a set of colors (color stops) that is done along a line (linear, or axial color gradient) or radially, along concentric circles (radial color gradient). The color transition is done by linear interpolation between two consecutive color stops.

Note: VGLite supports linear color gradients for GCNanoLiteV and GCNanoUltraV. Both linear and radial gradients are supported with GC355 and GC555.

`vg_lite_init_grad` **function** **Description:**

This function initializes the internal buffer for the linear gradient object with default settings for rendering.

Syntax:

```
vg_lite_error_t vg_lite_init_grad (  
    vg_lite_linear_gradient_t *grad  
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure, which defines the gradient to be initialized. Default values are used.

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient initialization and control functions

`vg_lite_clear_grad` **function** **Description:**

This function is used to clear the values of a linear gradient object and free up the memory of the image buffer.

Syntax:

```
vg_lite_error_t vg_lite_clear_grad (  
    vg_lite_linear_gradient_t *grad  
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure that is to be cleared

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient initialization and control functions

`vg_lite_set_grad` **function** **Description:**

This function is used to set values for the members of the `vg_lite_linear_gradient_t` structure.

Note: The `vg_lite_set_grad` API adopts the following rules to set the default gradient colors if the input parameters are incomplete or invalid:

- If no valid stops have been specified (for example, due to an empty input array, out-of-range or out-of-order stops), a stop at 0 with (R, G, B, A) color (0.0, 0.0, 0.0, 1.0) (opaque black) and a stop at 1 with color (1.0, 1.0, 1.0, 1.0) (opaque white) are implicitly defined
- If at least one valid stop has been specified, but none has been defined with an offset of 0, then an implicit stop is added with an offset of 0 and the same color as the first user-defined stop

- If at least one valid stop has been specified, but none has been defined with an offset of 1, then an implicit stop is added with an offset of 1 and the same color as the last user-defined stop

Syntax:

```
vg_lite_error_t vg_lite_set_grad (
    vg_lite_linear_gradient_t *grad,
    uint32_t count,
    uint32_t *colors,
    uint32_t *stops
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure to be set
count	The number of colors in the linear gradient. The maximum color stop count is defined by <code>VLC_MAX_GRAD</code> which is 16.
*colors	Specifies the color array for the gradient stops. The color is in ARGB8888 format with alpha in the upper byte.
*stops	Pointer to the gradient stop offset

Returns:

Always returns `VG_LITE_SUCCESS`.

Parent topic:Linear gradient initialization and control functions

vg_lite_get_grad_matrix function Description:

This function is used to get a pointer to the transformation matrix of the gradient object. It allows an application to manipulate the matrix to facilitate correct rendering of the gradient path.

Syntax:

```
vg_lite_error_t vg_lite_get_grad_matrix (
    vg_lite_linear_gradient_t *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure, which contains the matrix to be retrieved

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient initialization and control functions

vg_lite_update_grad function Description:

This function is used to update or generate values for an image object that is going to be rendered. The `vg_lite_linear_gradient_t` object has an image buffer, which is used to render the gradient pattern. The image buffer is created or updated with the corresponding gradient parameters.

Syntax:

```
vg_lite_error_t vg_lite_update_grad (
    vg_lite_linear_gradient_t *grad
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_t</code> structure, which contains the update values to be used for the object to be rendered

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient initialization and control functions

Parent topic:[Vector-based draw operations](#)

Linear gradient extended functions The following functions are available only with IP that includes hardware support for extended linear gradient capabilities, such as GC355 and GC555. These functions are not available with GCNanoLiteV, GCNanoUltraV, or GCNanoV. Applications can use VGLite API `vg_lite_query_feature` (`gcFEATURE_BIT_VG_LINEAR_GRADIENT_EXT`) to determine HW support for linear gradient.

vg_lite_set_linear_grad function Description:

This function is used to set the values that define the linear gradient. *(from April 2022)*

Syntax:

```
vg_lite_error_t vg_lite_set_linear_grad (
    vg_lite_ext_linear_gradient_t *grad,
    vg_lite_uint32_t count,
    vg_lite_color_ramp_t *color_ramp,
    vg_lite_linear_gradient_parameter_t grad_param,
    vg_lite_radial_gradient_spreadmode_t spread_mode,
    vg_lite_uint8_t pre_mult
);
```

Parameters:

Parameter	Description
<code>*gradient</code>	Pointer to the <code>vg_lite_ext_linear_gradient_t</code> structure that is to be set.
<code>count</code>	Count of the colors in the gradient. The maximum color stop count is defined by <code>MAX_COLOR_RAMP_STOPS</code> , which is set to 256.
<code>*color</code>	It is the array of stops for the linear gradient. The number of parameters for each stop is 5, and gives the offset and color of the stop. Each stop is defined by a floating-point <i>offset</i> value and four floating-point values containing the sRGBA color and alpha value associated with each stop, in the form of a non-premultiplied (R, G, B, alpha) quad. The range of all parameters is [0,1].
<code>gradient</code>	Gradient parameters as specified in the structure <code>vg_lite_linear_gradient_parameter_t</code> .
<code>spreadmode</code>	The fill mode is applied to the pixels out of the paint after transformation. Uses the same spread mode enumeration types as radial gradient. For details, see <code>vg_lite_radial_gradient_spreadmode_t</code> enum.
<code>premultiplied</code>	This parameter controls whether color and alpha values are interpolated in premultiplied or non-premultiplied form.

Returns:

Returns `VG_LITE_INVALID_ARGUMENTS` to indicate the parameters are wrong.

Parent topic:Linear gradient extended functions

vg_lite_get_linear_grad_matrix function Description:

This function returns a pointer to an extended linear gradient object's matrix.(from March 2023).

Syntax:

```
vg_lite_matrix_t* vg_lite_get_linear_grad_matrix (
    vg_lite_ext_linear_gradient_t *gradient,
);
```

Parameters:

Parameter	Description
<code>*gradient</code>	Pointer to the <code>vg_lite_ext_linear_gradient_t</code> structure.

Returns:

Returns a pointer to `vg_lite_matrix_t` for the specified extended linear gradient.

Parent topic:Linear gradient extended functions

vg_lite_draw_linear_grad function Description:

This function returns a pointer to an extended linear gradient object's matrix.(from March 2023).

Syntax:

```
vg_lite_error_t vg_lite_draw_linear_grad (
    vg_lite_buffer_t *target,
    vg_lite_path_t *path,
    vg_lite_fill_t fill_rule,
```

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```

    vg_lite_matrix_t      *path_matrix,
    vg_lite_ext_linear_gradient_t *grad,
    vg_lite_color_t       paint_color,
    vg_lite_blend_t       blend,
    vg_lite_filter_t       filter
);

```

Parameters:

Parameter	Description
*target	Pointer to the <code>vg_lite_buffer_t</code> structure containing data describing the target path.
*path	Pointer to the <code>vg_lite_path_t</code> structure containing path data that describes the path to draw for the linear gradient. Refer to Vector path opcodes for plotting paths in this document for opcode detail.
fill_r	Specifies the <code>vg_lite_fill_t</code> enum value for the fill rule for the path.
*path	Pointer to a <code>vg_lite_matrix_t</code> structure that defines the 3x3 transformation matrix of the path. If the matrix is NULL, an identity matrix is assumed; however, this option is not preferable.
*grad	Pointer to the <code>vg_lite_ext_linear_gradient_t</code> structure that contains the values to be used to fill the path. Note: <code>grad->image.image_mode</code> does not support <code>VG_LITE_MULTIPLY_IMAGE_MODE</code> .
paint	Specifies the paint color <code>vg_lite_color_t</code> RGBA value to be applied by <code>VG_LITE_RADIAL_GRADIENT_SPREAD_FILL</code> , set by function <code>vg_lite_set_linear_grad</code> . When pixels are out of the image after transformation, this <code>paint_color</code> is applied to them. For details, see enum <code>vg_lite_radial_gradient_spreadmode_t</code> .
blend	Specifies blend mode in the <code>vg_lite_blend_t</code> enum to be applied to each drawn pixel. If no blending is required, set this value to <code>VG_LITE_BLEND_NONE</code> (0).
filter	Specified the filter mode <code>vg_lite_filter_t</code> enum value to be applied to each drawn pixel. If no filtering is required, set this value to <code>VG_LITE_BLEND_POINT</code> (0).

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic: Linear gradient extended functions

vg_lite_update_linear_grad function Description:

This function is used to update or generate the corresponding image object to render (*from April 2022*).

The `vg_lite_ext_linear_gradient_t` object has an image buffer that is used to render the linear gradient paint. The image buffer is created/updated according to the specified grad parameters.

Syntax:

```

vg_lite_error_t vg_lite_update_linear_grad (
    vg_lite_ext_linear_gradient_t *grad,
);

```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_ext_t</code> structure that is to be updated or created.

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient extended functions

vg_lite_clear_linear_grad function Description:

This function is used to clear the linear gradient object. This resets the grad members and free the image buffer's memory (*from April 2022*).

Syntax:

```
vg_lite_error_t vg_lite_clear_linear_grad (
    vg_lite_ext_linear_gradient_t *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the <code>vg_lite_linear_gradient_ext_t</code> structure that is to be cleared.

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Linear gradient extended functions

Parent topic:[Vector-based draw operations](#)

Radial gradient functions initialization and control functions The following functions are available only with IP that supports radial gradients, such as GC355 and GC555. These functions are not available with GCNanoLiteV, or GCNanoUltraV or GCNanoV.

Note: There is no init function required for radial gradients. Buffer initialization is done through the `vg_lite_update_radial_grad` function. (*from Nov 2020, requires GC355 or GC555 hardware*)

vg_lite_set_radial_grad function Description:

This function is used to set the values for the radial linear gradient definition. (*from November 2020, requires GC355 or GC555 hardware*)

Syntax:

```
vg_lite_error_t vg_lite_set_radial_grad (
    vg_lite_radial_gradient_t *grad,
    vg_lite_uint32_t count,
    vg_lite_color_ramp_t *color_ramp,
    vg_lite_radial_gradient_parameter_t grad_param,
    vg_lite_radial_gradient_spreadmode_t spread_mode,
    vg_lite_uint8_t pre_mult
);
```

Parameters:

Parameter	Description
*gradient	Pointer to the <code>vg_lite_radial_gradient_t</code> structure for the radial gradient that has to be set
count	The number of color stops in the gradient. The maximum color stop count is defined by <code>MAX_COLOR_RAMP_STOPS</code> , which is currently 256.
*color	Pointer to the <code>vg_lite_color_ramp_t</code> structure that defines the stops for the radial gradient. The five parameters provide the offset and color for each stop. Each stop is defined by a set of floating point values that specify the offset and the sRGBA color and alpha values. Color channel values are in the form of a non-premultiplied (R, G, B, alpha) quad. All parameters are in the range of [0,1]. The red, green, blue, alpha value of [0, 1] is mapped to an 8-bit pixel value [0, 255].
gradient	The radial gradient parameters are supplied as a vector of 5 floats. Parameters (cx, cy) specify the center point, parameters (fx, fy) specify the focal point, and r specifies the radius. See structure <code>vg_lite_radial_gradient_parameter_t</code> .
spread	The tiling mode that is applied to pixels out of the paint after transformation. See enum <code>vg_lite_radial_gradient_spreadmode_t</code> .
premultiplied	Controls whether color and alpha values are interpolated in premultiplied or non-premultiplied form. If this value is set to 1, the color value of <code>vgColorRamp</code> is multiplied by the alpha value of <code>vgColorRamp</code> .

Returns:

Returns `VG_LITE_INVALID_ARGUMENTS` to indicate that the parameters are wrong.

Parent topic:Radial gradient functions initialization and control functions

vg_lite_update_radial_grad function Description:

This function is used to update or generate values for an image object that is going to be rendered. The `vg_lite_radial_gradient_t` object has an image buffer that is used to render the gradient pattern. The image buffer will be created or updated with the corresponding gradient parameters. *(from November 2020, requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_update_radial_grad (
    vg_lite_radial_gradient_t *gradient,
);
```

Parameters:

Parameter	Description
*gradient	Pointer to the <code>vg_lite_radial_gradient_t</code> structure, which contains the updated values to be used for the object to be rendered

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Radial gradient functions initialization and control functions

vg_lite_get_radial_grad_matrix function Description:

This function is used to get a pointer to the radial gradient object's transformation matrix. This allows an application to manipulate the matrix to facilitate correct rendering of the gradient path*. (from Nov 2020, requires GC355 or GC555 hardware).*

Syntax:

```
vg_lite_error_t vg_lite_get_radial_grad_matrix (
    vg_lite_radial_gradient_t *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure, which contains the matrix to be retrieved

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic:Radial gradient functions initialization and control functions

vg_lite_clear_rad_grad function Description:

This function is used to clear the values of a radial gradient object and free the image buffer's memory*. (from Nov 2020, requires GC355 or GC555 hardware)*

Syntax:

```
vg_lite_error_t vg_lite_clear_radial_grad (
    vg_lite_radial_gradient_t *grad,
);
```

Parameters:

Parameter	Description
*grad	Pointer to the vg_lite_radial_gradient_t structure which is to be cleared

Returns:

Returns VG_LITE_SUCCESS if successful. See vg_lite_error_t enum for other return codes.

Parent topic:Radial gradient functions initialization and control functions

Parent topic:[Vector-based draw operations](#)

Stroke operations This part of the API performs stroke operations. *(from March 2022)*

Stroke enumerations This section gives details on stroke enumerations.

`vg_lite_cap_style_t` **enumeration** Defines the style of cap at the end of a stroke (*from March 2022*).

Used in structure: `vg_lite_stroke_t`.

Used in function: `vg_lite_set_stroke`.

<code>vg_lite_cap</code> values	Description
<code>VG_LITE_</code>	The <i>butt</i> end cap style terminates each segment with a line perpendicular to the tangent at each endpoint.
<code>VG_LITE_</code>	The <i>round</i> end cap style appends a semicircle with a diameter equal to the line width centered around each endpoint.
<code>VG_LITE_</code>	The <i>square</i> end cap style appends a rectangle with two sides of length equal to the line width perpendicular to the tangent, and two sides of length equal to half the line width parallel to the tangent, at each endpoint.

Parent topic:Stroke enumerations

`vg_lite_path_type_t` **enumeration** Defines the type of draw path (*from March 2022*).

Used in structure: `vg_lite_path_t`, `vg_lite_stroke_t`.

Used in function: `vg_lite_set_path_type`.

<code>vg_lite_path_type_t</code> string values	Description
<code>VG_LITE_DRAW_FILL_PATH</code>	Draw path is fill.
<code>VG_LITE_DRAW_STROKE_PATH</code>	Draw path is stroke.
<code>VG_LITE_DRAW_FILL_STROKE_PATH</code>	Draw path is both fill and stroke.

Parent topic:Stroke enumerations

`vg_lite_join_style_t` **enumeration** Defines the type of styles available for line joints. (*from March 2022*)

Used in structure: `vg_lite_stroke_t`.

Used in function: `vg_lite_set_stroke`.

<code>vg_lite_joi</code> string values	Description
<code>VG_LITE_</code>	The <i>miter</i> join style appends a trapezoid with one vertex at the intersection point of the two original lines, two adjacent vertices at the outer endpoints of the two “thickened” lines and a fourth vertex at the extrapolated intersection point of the outer perimeters of the two “thickened” lines.
<code>VG_LITE_</code>	The <i>round</i> join style appends a wedge-shaped portion of a circle, centered at the intersection point of the two original lines, having a radius equal to half the line width.
<code>VG_LITE_</code>	The <i>bevel</i> type join style appends a triangle with two vertices at the outer endpoints of the two “thickened” lines and a third vertex at the intersection point of the two original lines.

Parent topic:Stroke enumerations

Parent topic:[Stroke operations](#)

Stroke structures This section gives details on stroke structures.

vg_lite_path_t structure Defined under Vector Path Structures - `vg_lite_path_t` structure.

(additional members added for stroke from March 2022)

Parent topic:Stroke structures

vg_lite_path_list_t structure The structure `vg_lite_path_list_ptr` points to the `vg_lite_path_list` structure that provides divided path data according to MOVE/MOVE_REL. *(from Aug 2023)*

Used (`vg_lite_path_list_ptr`) in structures: `vg_lite_stroke_t`.

vg_lite_path_list_t members	Type	Description
path_points	vg_lite_path_point_ptr	
path_end	vg_lite_path_point_ptr	
point_count	vg_lite_uint32_t	
next	vg_lite_path_list_ptr	
closed	vg_lite_uint8_t	

Parent topic:Stroke structures

vg_lite_path_point_t structure The structure `vg_lite_path_point_ptr` points to the `vg_lite_path_point` structure which provides path detail *(from March 2022)*

Used (`vg_lite_path_point_ptr`) in structures: `vg_lite_path_point_t`, `vg_lite_stroke_conversion`, `vg_lite_sub_path_t`.

vg_lite_path_point_t mem-bers	Type	Description
x	vg_lite_float_t	X coordinate
y	vg_lite_float_t	Y coordinate
flatten_flag	vg_lite_uint8_t	Flatten flag for flattened path
curve_type	vg_lite_uint8_t	Curve type for the stroke path
tangentX	vg_lite_float_t	X tangent (Note: #define centerX tangent)
tangentY	vg_lite_float_t	Y tangent (Note: #define centerX tangent)
length	vg_lite_float_t	Line length
prev	vg_lite_path_point_ptr	Pointer to the previous point node

Parent topic:Stroke structures

vg_lite_stroke_t structure The structure provides stroke parameters and pointers to temp storage for a stroke sub path. Refer to the function `vg_lite_set_stroke` parameter descriptions for additional description for some members. *(from March 2022)*

Used in structure: `vg_lite_path_t`.

vg_lite_stroke_t members	Type	Description
cap_style	vg_lite_cap_style_t	Stroke cap style
join_style	vg_lite_join_style_t	Stroke joint style
line_width	vg_lite_float_t	Stroke line width
miter_limit	vg_lite_float_t	Stroke miter limit
*dash_pattern	vg_lite_float_t	Pointer to stroke dash pattern
pattern_count	vg_lite_uint32_t	Number of dash pattern repetitions
dash_phase	vg_lite_float_t	Stroke dash phrase
dash_length	vg_lite_float_t	Stroke dash initial length
dash_index	vg_lite_uint32_t	Stroke dash initial index
half_width	vg_lite_float_t	Half line width
pattern_length	vg_lite_float_t	Total length of stroke dash patterns.
miter_square	vg_lite_float_t	For fast checking
path_points	vg_lite_path_point_ptr	Temp storage for stroke sub path
path_end	vg_lite_path_point_ptr	Temp storage for stroke sub path
point_count	uint32_t	Temp storage for stroke sub path
left_point	vg_lite_path_point_ptr	Temp storage for stroke sub path
right_pont	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_points	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_end	vg_lite_path_point_ptr	Temp storage for stroke sub path
stroke_count	vg_lite_uint32_t	Temp storage for stroke sub path
path_list_divide	vg_lite_path_list_ptr	Divide stroke path according to move or move_rel for
cur_list	vg_lite_path_list_ptr	Pointer to current divided path data. <i>(from Aug 2023)</i>
add_end	vg_lite_uint8_t	Flag that adds end_path in driver <i>(from Aug 2023)</i>
dash_reset	vg_lite_uint8_t	<i>(from Aug 2023)</i>
stroke_paths	vg_lite_sub_path_ptr	
last_stroke	vg_lite_sub_path_ptr	
swing_handling	vg_lite_uint32_t	
swing_deltax	vg_lite_float_t	
swing_deltay	vg_lite_float_t	
swing_start	vg_lite_path_point_ptr	
swing_stroke	vg_lite_path_point_ptr	
swing_length	vg_lite_float_t	
swing_centlen	vg_lite_float_t	
swing_count	vg_lite_uint32_t	
need_swing	vg_lite_uint8_t	
swing_ccw	vg_lite_uint8_t	
stroke_length	vg_lite_float_t	
stroke_size	vg_lite_uint32_t	
fattened	vg_lite_uint8_t	The stroke line is a fat line.
closed	vg_lite_uint8_t	

Parent topic:Stroke structures

`vg_lite_sub_path_t` **structure** The structure `vg_lite_sub_path_ptr` points to the `vg_lite_sub_path` structure that provides sub path detail and a pointer to the next sub path. *(from March 2022)*

Used in structure: `vg_lite_stroke_conversion`.

vg_lite_path_point_t members	Type	Description
next	vg_lite_sub_path_ptr	Pointer to the next sub path
point_count	vg_lite_uint32_t	Number of points in the sub path
point_list	vg_lite_path_point_pt	Pointer to the point list.
end_point	vg_lite_path_point_pt	Pointer to the last point.
closed	vg_lite_uint8_t	Indicates whether or not the path is closed.
length	vg_lite_float_t	Length of the sub path.

Parent topic:Stroke structures

Parent topic:[Stroke operations](#)

Stroke functions All return `vg_lite_error_t` status.

`vg_lite_set_path_type` **function** **Description:**

This function sets the path type*. (from March 2022)*

Syntax:

```
vg_lite_error_t vg_lite_set_path_type (
    vg_lite_path_t      *path,
    vg_lite_path_type_t path_type
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t structure that describes the vector path.
path_type	Pointer to a <code>vg_lite_path_type_t</code> structure that describes the path type.

Returns:

Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Stroke functions

`vg_lite_set_stroke` **function** **Description:**

This function uses input parameters to set stroke attributes (*from March 2022*).

Syntax:

```
vg_lite_error_t vg_lite_set_stroke (
    vg_lite_path_t      *path,
    vg_lite_cap_style_t cap_style,
    vg_lite_join_style_t join_style,
    vg_lite_float_t     line_width,
    vg_lite_float_t     miter_limit,
    vg_lite_float_t     *dash_pattern,
    vg_lite_uint32_t     pattern_count,
    vg_lite_float_t     dash_phase,
    vg_lite_color_t     color
);
```

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);

Parameters:

Parameter	Description
*path	Pointer to the <code>vg_lite_path_t</code> structure that describes the path.
cap_	The end cap style is defined by the <code>vg_lite_cap_style_t</code> enum.
join_	The line join style defined by the <code>vg_lite_join_style_t</code> enum.
line_	The line width of the stroke path. A line width less than or equal to 0 prevents stroking from taking place.
miter_	When stroking using the Miter stroke <code>vg_lite_join_style_t</code> , the miter length (that is, the length between the intersection points of the inner and outer perimeters of the two “fatten” lines) is compared to the product of the user-set miter limit and the line width. If the miter length exceeds this product, the Miter join is not drawn and a Bevel join is substituted. Note: Miter limit values less than 1 are silently clamped to 1.
*dash	Pointer to a dash pattern that consists of a sequence of lengths of alternating “on” and “off” dash segments. The first value of the dash array defines the length, in user coordinates, of the first “on” dash segment. The second value defines the length of the following “off” segment. Each subsequent pair of values defines one “on” and one “off” segment. Note: If the dash pattern has an odd number of elements, the final element is ignored.
pattern	The count of dash on/off segments.
dash	Defines the starting point in the dash pattern that is associated with the start of the first segment of the path. For example, if the dash pattern is [10 20 30 40] and the dash phase is 35, the path is stroked with an “on” segment of length 25 (skipping the first “on” segment of length 10, the following “off” segment of length 20, and the first 5 units of the next “on” segment), followed by an “off” segment of length 40. The pattern is then repeated from the beginning, with an “on” segment of length 10, an “off” segment of length 20, an “on” segment of length 30.
color	The stroke color.

Returns:Returns `VG_LITE_SUCCESS` if successful. See `vg_lite_error_t` enum for other return codes.**Parent topic:**Stroke functions**vg_lite_update_stroke function Description:**

This function uses the path and stroke attributes as specified with the function `vg_lite_set_stroke` to update the stroke path’s parameters and generate stroke path data . *(from March 2022)*

Syntax:

```
vg_lite_error_t vg_lite_update_stroke (
    vg_lite_path_t      *path,
);
```

Parameters:

Parameter	Description
*path	Pointer to the vg_lite_path_t structure that describes the path.

Returns:

Returns VG_LITE_SUCCESS if successful. See `vg_lite_error_t` enum for other return codes.

Parent topic:Stroke functions

Parent topic:[Stroke operations](#)

Deprecated and renamed APIs The following functions are deprecated and are either obsolete or replaced by a more efficient implementation. Their use is discouraged and will produce unpredictable behaviors.

The names of some functions, enums and structures were modified during code refinements in 2022Q3. If the parameters did not change, the deprecated syntax detail is not provided below. Changes to enums and structs are not mentioned here, instead refer to the item itself.

Deprecated or renamed API	Recommended replacement API	Source file	Date deprecated
<code>vg_lite_perspective</code>	n/a	<code>vg_lite.h</code>	August 2022
<code>vg_lite_set_dither</code>	<code>vg_lite_enable_dither</code> <code>vg_lite_disable_dither</code>	<code>vg_lite.h</code>	August 2022
<code>vg_lite_append_path</code>	<code>vg_lite_path_append</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_path_calc_length</code>	<code>vg_lite_get_path_length</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_set_image_global_alpha</code>	<code>vg_lite_set_source_global_alpha</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_dest_global_alpha</code>	<code>vg_lite_set_dest_global_alpha</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_mem_avail</code>	<code>vg_lite_get_mem_size</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_enable_premultiply</code>	n/a	<code>vg_lite.h</code>	Dec 2022
<code>vg_lite_disable_premultiply</code>	n/a	<code>vg_lite.h</code>	Dec 2022
<code>vg_lite_set_premultiply</code>	n/a	<code>vg_lite.h</code>	Aug 2023
<code>vg_lite_radial_gradient_spreadmode_t</code> enum	<code>vg_lite_gradient_spreadmode_t</code> enum	<code>vg_lite.h</code>	March 2023
API Name Refinement <i>(no change to parameters)</i>			
<code>vg_lite_buffer_upload</code>	<code>vg_lite_upload_buffer_</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_*mask*</code>	<i>most <code>vg_lite_*mask_layer</code></i>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite*_grad</code>	<code>vg_lite*_gradient</code> <i>(parameters unchanged)</i>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite*_radial_grad*</code>	<code>vg_lite*_rad_grad*</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_buffer_image_mode_t</code>	<code>vg_lite_image_mode_t</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_transparency_mode_t</code>	<code>vg_lite_transparency_t</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_set_update_stroke</code>	<code>vg_lite_update_stroke</code>	<code>vg_lite.h</code>	Sept 2022
<code>vg_lite_set_draw_path_type</code>	<code>vg_lite_set_path_type</code>	<code>vg_lite.h</code>	Sept 2022

Deprecated vg_lite syntax Syntax for deprecated functions is provided below for reference.

Note: This list does not include items renamed during code refinement of Sept 2022.

`vg_lite_perspective` **(deprecated) Syntax:**

```
void vg_lite_perspective (
    vg_lite_float_t    px,
    vg_lite_float_t    py,
    vg_lite_matrix_t    *matrix
);
```

Parent topic:Deprecated vg_lite syntax

vg_lite_set_dither (*deprecated*) **Syntax:**

```
vg_lite_error_t vg_lite_set_dither (
    int          enable
);
```

Parent topic:Deprecated vg_lite syntax

vg_lite_enable_premultiply (*deprecated*) **Syntax:**

```
vg_lite_error_t vg_lite_enable_premultiply (
    void
);
```

Parent topic:Deprecated vg_lite syntax

vg_lite_disable_premultiply (*deprecated*) **Syntax:**

```
vg_lite_error_t vg_lite_disable_premultiply (
    void
);
```

Parent topic:Deprecated vg_lite syntax

vg_lite_set_premultiply (*deprecated*) **Syntax:**

```
vg_lite_error_t vg_lite_set_premultiply (
    vg_lite_uint8_t    src_premult,
    vg_lite_uint8_t    dst_premult,
);
```

Parent topic:Deprecated vg_lite syntax

Parent topic:[Deprecated and renamed APIs](#)

VGLite API version 2.0 to 3.0 migration guide The VGLite API version 3.0 is not fully compatible with VGLite API version 2.0. VGLite API version 3.0 includes some new API functions for the new features in the latest VG GPU like GC555. Some VGLite API version 2.0 function interfaces are changed in API version 3.0. So, the existing VGLite API version 2.0 applications must be modified to compile and run properly with the VGLite API version 3.0 driver. This chapter provides guidance for migrating VGLite API version 2.0 applications to VGLite API version 3.0.

VGLite API name changes in API version 3.0 Some original VGLite API names are changed in API version 3.0 for API naming consistency. In the VGLite API version 3.0 header file `vg_lite.h`, a set of API name macros are defined for the equivalent API names between API version 3.0 and API version 2.0, so it is not necessary to modify the VGLite API function names in API version 2.0 applications for the application to compile and run with the API version 3.0 driver.

The list of equivalent VGLite API functions between API version 3.0 and API version 2.0 is shown below. These API functions' parameters are the same between API version 3.0 and API version 2.0.

```
/* API name defines for backward compatibility to VGLite 2.0 APIs */
#define vg_lite_buffer_upload          vg_lite_upload_buffer
#define vg_lite_path_append            vg_lite_append_path
#define vg_lite_path_calc_length       vg_lite_get_path_length
#define vg_lite_set_ts_buffer          vg_lite_set_tess_buffer
#define vg_lite_set_draw_path_type     vg_lite_set_path_type
#define vg_lite_create_mask_layer       vg_lite_create_masklayer
#define vg_lite_fill_mask_layer         vg_lite_fill_masklayer
#define vg_lite_blend_mask_layer        vg_lite_blend_masklayer
#define vg_lite_generate_mask_layer_by_path vg_lite_render_masklayer
#define vg_lite_set_mask_layer          vg_lite_set_masklayer
#define vg_lite_destroy_mask_layer      vg_lite_destroy_masklayer
#define vg_lite_enable_mask             vg_lite_enable_masklayer
#define vg_lite_enable_color_transformation vg_lite_enable_color_transform
#define vg_lite_set_color_transformation vg_lite_set_color_transform
#define vg_lite_set_image_global_alpha  vg_lite_source_global_alpha
#define vg_lite_set_dest_global_alpha   vg_lite_dest_global_alpha
#define vg_lite_clear_rad_grad          vg_lite_clear_radial_grad
#define vg_lite_update_rad_grad         vg_lite_update_radial_grad
#define vg_lite_get_rad_grad_matrix     vg_lite_get_radial_grad_matrix
#define vg_lite_set_rad_grad            vg_lite_set_radial_grad
#define vg_lite_draw_linear_gradient    vg_lite_draw_linear_grad
#define vg_lite_draw_radial_gradient    vg_lite_draw_radial_grad
#define vg_lite_draw_gradient           vg_lite_draw_grad
#define vg_lite_mem_avail               vg_lite_get_mem_size
#define vg_lite_set_update_stroke       vg_lite_update_stroke
```

The list of equivalent VGLite API structures and enumerations is shown below:

```
#define vg_lite_buffer_image_mode_t    vg_lite_image_mode_t
#define vg_lite_draw_path_type_t       vg_lite_path_type_t
#define vg_lite_linear_gradient_ext_t  vg_lite_ext_linear_gradient_t
#define vg_lite_buffer_transparency_mode_t vg_lite_transparency_t
```

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

vg_lite_set_scissor API interface change The VGLite API `vg_lite_set_scissor()` function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the `vg_lite_set_scissor()` function is defined as:

```
/* Set and enable a scissor rectangle for render target. */
vg_lite_error_t vg_lite_set_scissor(vg_lite_int32_t x, vg_lite_int32_t y,
    vg_lite_int32_t right, vg_lite_int32_t bottom);
```

In VGLite API version 2.0, the `vg_lite_set_scissor()` function is defined as:

```
vg_lite_error_t vg_lite_set_scissor(int32_t x, int32_t y, int32_t width, int32_t height);
```

So, the `vg_lite_set_scissor()` API parameters “width” and “height” in the VGLite API version 2.0 application must be changed to “right” x-coordinate value and “bottom” y-coordinate value.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

vg_lite_map API interface change The VGLite API `vg_lite_map()` function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the `vg_lite_map()` function is defined as:

```
/* Map a buffer into hardware accessible address space. */
vg_lite_error_t vg_lite_map(vg_lite_buffer_t *buffer, vg_lite_map_flag_t flag, int32_t fd);
```

In VGLite API version 2.0, the `vg_lite_map()` function is defined as:

```
vg_lite_error_t vg_lite_map(vg_lite_buffer_t *buffer);
```

So, `vg_lite_map()` in VGLite API version 3.0 API requires two extra parameters “flag” and “fd”, which can simply be set as `vg_lite_map (buffer, 0, 0)` in applications.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

vg_lite_enable_scissor / vg_lite_disable_scissor API The VGLite API `vg_lite_enable_scissor()` and `vg_lite_disable_scissor()` functions are valid only for `vg_lite_scissor_rects()` API. They have no effect for `vg_lite_set_scissor()` in VGLite API version 3.0.

Although the behavior of `vg_lite_enable_scissor()` and `vg_lite_disable_scissor()` is changed in VGLite API version 3.0, there is no need to change these functions in VGLite API version 2.0 applications to work with the VGLite API version 3.0 driver.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

vg_lite_draw_pattern API interface change The VGLite API `vg_lite_draw_pattern()` function name is not changed in API version 3.0, but the API parameters are defined differently in API version 3.0.

In VGLite API version 3.0, the `vg_lite_draw_pattern()` function is defined as:

```
/* Draw a path that is filled by a transformed image pattern. */
vg_lite_error_t vg_lite_draw_pattern(vg_lite_buffer_t *target,
    vg_lite_path_t *path,
    vg_lite_fill_t fill_rule,
    vg_lite_matrix_t *path_matrix,
    vg_lite_buffer_t *pattern_image,
    vg_lite_matrix_t *pattern_matrix,
    vg_lite_blend_t blend,
    vg_lite_pattern_mode_t pattern_mode,
    vg_lite_color_t pattern_color,
    vg_lite_color_t color,
    vg_lite_filter_t filter);
```

Compared to the VGLite API version 2.0 `vg_lite_draw_pattern()` function, “color” is a new additional parameter. It specifies a 32bpp ARGB color (`vg_lite_color_t`) to be applied as a mix color. If nonzero, the mix color value gets multiplied with each source pixel before blending happens. If a mix color is not needed, set the color parameter to 0.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

[New] vg_lite_copy_image in VGLite API version 3.0 The new API `vg_lite_copy_image()` is added in VGLite API version 3.0 to support the OpenVG `vgCopyImage` API, which performs a pixel rectangle copy without pixel transformation, blending, filtering operations.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

vg_lite_set_dither API is deprecated in API version 3.0 The original API version 2.0 function `vg_lite_set_dither(int enable)` API is removed from API version 3.0, it is replaced with two new APIs for dither enable/disable:

```
/* Enable dither function. Dither is OFF by default. */
vg_lite_error_t vg_lite_enable_dither();
/* Disable dither function. Dither is OFF by default. */
vg_lite_error_t vg_lite_disable_dither();
```

Therefore, the `vg_lite_set_dither(enable)` function in the VGLite API version 2.0 application must be replaced with `vg_lite_enable_dither()` or `vg_lite_disable_dither()` to work with the VGLite API version 3.0 driver.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

Deprecated VGLite API version 2.0 functions The VGLite API `vg_lite_perspective()`, `vg_lite_enable_premultiply()`, `vg_lite_disable_premultiply()` functions are removed from API version 3.0. These API functions must be deleted from a VGLite API version 2.0 application to work with the VGLite API version 3.0 driver.

In VGLite API version 3.0, the color premultiply setting is defined by the `vg_lite_blend_t` enumeration to replace the original `vg_lite_enable_premultiply()` and `vg_lite_disable_premultiply()` APIs.

- `VG_LITE_BLEND_*` enumeration values in `vg_lite_blend_t` define non-premultiplied blending modes.
- `OPEVG_BLEND_*` enumeration values in `vg_lite_blend_t` define premultiplied Porter-Duff blending modes.

So, the VGLite API version 3.0 application can set different blending modes to get the desired premultiplied/non-premultiplied blending result.

Parent topic: [VGLite API version 2.0 to 3.0 migration guide](#)

Revision history

Doc- u- men ID	Re- lease date	Description
IMX Rev. 1.2 2025	17 Jan- uary	The document is updated to correspond to the API version 3.0
IMX Rev. 1.1 2022	22 Sept ber	- Paragraph 4.1.1 Updated <i>Table 3</i> - <i>vg_lite_feature_t</i> enumeration. - Paragraph 6.6 Added documentation for new API <i>vg_lite_set_dither</i> - Paragraph 8.2 Blit structures- Added documentation for new data structure <i>vg_lite_color_key_t</i> ; added documentation for new data structure <i>vg_lite_color_key4_t</i> - Paragraph 8.3.1, <i>vg_lite_blit</i> function- added note related to HW limitation on RT500 platform - Paragraph 8.3.2, <i>vg_lite_blit_rect</i> function -added note related to HW limitation on RT500 platforms - Paragraph 8.3.3, <i>vg_lite_get_transform_matrix</i> function- adjusted function description, adjusted function parameters description - Paragraph 8.3, blit functions- added documentation for new API <i>vg_lite_set_color_key</i> - Paragraph 8.4.1, <i>vg_lite_enable_premultiply</i> function- added note about limited support on specific platforms - Paragraph 8.4.2, <i>vg_lite_disable_premultiply</i> function- added note about limited support on specific platforms - Paragraph 10.1.3, <i>vg_lite_fill_t</i> enumeration- added note about crossing points buffer limitation - Paragraph 10.2, draw and gradient structures- added documentation for new data structure <i>vg_lite_gradient_parameter_t</i> - <i>done</i> - added documentation for new data structure <i>vg_lite_gradient_ext_t</i> - Paragraph 10.3, draw functions- added documentation for new API <i>vg_lite_draw_linear_gradient</i> - Paragraph 10, vector-Based Draw Operations - added new paragraph 10.5 <i>Extended linear gradient initialization and control functions</i> ; added documentation for new API <i>vg_lite_set_linear_gradient</i> ; added documentation for new API <i>vg_lite_get_linear_grad_matrix</i> ; added documentation for new API <i>vg_lite_update_linear_grad</i> ; Added documentation for new API <i>vg_lite_clear_linear_grad</i> - Paragraph 10.5, Radial gradient functions - adjusted paragraph title - Added new Chapter <i>Stroke Operations</i> - Chapter <i>Platform-Specific Features</i> -updated <i>Table 41</i> - Platform-specific VGLite features
IMX Rev. 1 2022	27 Jan- uary	Introduction Added i.MX RT1160 to the list of NXP devices that support VGLite graphics API <i>vg_lite_error_t</i> enumeration Updated <i>Table 1</i> <i>vg_lite_feature_t</i> enumeration Updated <i>Table 1</i> API control
IMX Rev. 0 2021	22 Febr ary	Initial release

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3.7.2 Xtensa Audio Framework (XAF)

Xtensa Audio Framework (XAF) Examples

Overview The Xtensa Audio Framework (XAF) is designed to accelerate the development of audio processing applications for the HiFi family of DSP cores. The multicore version of XAF described in these examples is designed to work with subsystems having single or multiple DSPs, enabling sophisticated audio processing capabilities in embedded systems.

Each demo showcases a dual-core architecture:

- cm33/ - The ARM application for the Cortex-M33 core, which provides the user interface and system control
- dsp/ - The DSP application that performs audio processing using the XAF middleware library

When an application is started, a shell interface is displayed on the terminal that executes from the ARM core. Users can control the application through shell commands, which are relayed via RPMsg-Lite IPC to the DSP core where they are processed and responses are returned. This architecture demonstrates efficient partitioning of workloads - with user interface and control tasks handled by the ARM core while computationally intensive audio processing is offloaded to the specialized DSP core.

For more information about XAF and detailed documentation on the API and available components, please refer to the Cadence XAF documentation ([/middleware/cadence/multicore-xaf/xa_af_hostless/doc](/middleware/cadence/multicore-xaf/xa_af_hostless/doc)).

Availability Note Important: These XAF examples are not included in the standard MCUXpresso SDK repository. They are available as part of the MCUXpresso SDK Builder package on the NXP website. To access these examples, please visit [MCUXpresso SDK Builder](#) and create a customized SDK package that includes the XAF examples for your target platform.

Included Examples

XAF Playback Example The `dsp_xaf_playback` application demonstrates audio file decoding and playback capabilities using the DSP core and Xtensa Audio Framework, supporting various audio codecs while handling operations through a shell interface on the ARM core that communicates with DSP processing.

XAF Record Example The `dsp_xaf_record` example captures audio from digital microphones (DMIC), processes it on the DSP core using voice enhancement algorithms, performs voice recognition (VIT), and outputs the detected wake words and voice commands to the console, enabling hands-free voice control applications.

XAF USB Example The XAF USB example demonstrates DSP-powered USB audio processing in two configurations: USB speaker and USB microphone. The application uses shell commands to switch between modes, with the ARM core handling USB communication while the DSP processes audio.

XAF Playback Example

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- [Hardware Requirements](#)
- [Hardware Modifications](#)
- [Preparation](#)
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- [Running the Demo](#)
- [Known Issues](#)

Overview The `dsp_xaf_playback` application demonstrates audio processing using the DSP core, the Xtensa Audio Framework (XAF) middleware library, and selected Xtensa audio codecs.

As shown in the table below, the application is supported on several development boards and each development board may have certain limitations, some development boards may also require hardware modifications or allow the use of an audio expansion board. Therefore, please check the supported features and [Hardware modifications](#) or [Example configuration](#) sections before running the demo.

Limitations:

- **MP3 encoder, G.711, G.722, BSAC, DAB+, DAB/MP2, DRM:** Provided only as linked libraries but are not enabled in the example.

Functionality The application includes the following main components:

1. **ARM Core (CM33)** - Handles user interface, SD card operations, and communicates with the DSP core
2. **DSP Core** - Processes audio data using the Xtensa Audio Framework (XAF)

The typical audio processing pipeline includes:

- File source component (reads from SD card)
- Decoder component (decodes compressed audio)
- Renderer component (outputs to audio hardware)

When the file playback command is issued, the ARM core reads the file from SD card and sends data to the DSP, which processes it and outputs to the audio hardware.

Hardware Requirements

- Development board (one of the following):
 - EVK-MIMXRT595 board
 - EVK-MIMXRT685 board

- MIMXRT685-AUD-EVK board
- MIMXRT700-EVK board
- Micro USB cable
- JTAG/SWD debugger
- Headphones with 3.5 mm stereo jack
- Personal Computer
- SD card with audio files (for file playback feature)

Hardware Modifications Some development boards need some hardware modifications to run the application.

- *EVK-MIMXRT595:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 <--> JP8-2

Note: The I3C Pin configuration in pin_mux.c is verified for default 1.8V, for 3.3V, need to manually configure slew rate to slow mode for I3C-SCL/SDA.

- *EVK-MIMXRT685:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 <--> JP8-2

- *MIMXRT685-AUD-EVK:*

- Set the hardware jumpers (Tower system/base module) to default settings.
- Set hardware jumpers JP2 2<-->3, JP44 1<-->2 and JP45 1<-->2.

- *MIMXRT700-EVK:*

Set the hardware jumpers to default settings.

Preparation

1. Connect headphones to Audio HP / Line-Out connector (J4).
 - EVK-MIMXRT595 - J4
 - EVK-MIMXRT685 - J4
 - MIMXRT685-AUD-EVK - J4, J50, J51, J52
 - MIMXRT700-EVK - J29
2. Connect a micro USB cable between the PC host and the debug USB port on the development board.
 - EVK-MIMXRT595 - J40
 - EVK-MIMXRT685 - J5
 - MIMXRT685-AUD-EVK - J5
 - MIMXRT700-EVK - J54
3. Open a serial terminal with the following settings:
 - 115200 baud rate
 - 8 data bits
 - No parity

- One stop bit
 - No flow control
4. Download the program for CM33 core to the target board.
 5. Launch the debugger in your IDE to begin running the demo.
 6. If building release configuration, start the xt-ocd daemon and download the program for DSP core to the target board. If building debug configuration, launch the Xtensa IDE or xt-gdb debugger to begin running the demo.

Notes:

- DSP image can only be debugged using J-Link debugger. See the document ‘Getting Started with Xplorer’ for your particular board for more information.

Example Configuration The example can be configured by user. Before configuration, please check the [table](#) to see if the feature is supported on the development board.

- **MIMXRT700-EVK Decoder Configuration:**

RT700 has limited RAM on Cortex-M33 core 1 which limits the available decoders. Only SBC decoder is enabled by default. In order to enable a different decoder/encoder, it is necessary to define the appropriate define on project level. Use one of the following define from the list of the supported decoders on the HiFi1 core:

- XA_AAC_DECODER
- XA_MP3_DECODER
- XA_SBC_DECODER
- XA_VORBIS_DECODER
- XA_OPUS_DECODER

Running the Demo The ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application. The DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Application for Cortex-M33 can be built by the other toolchains listed in MCUXpresso SDK Release Notes.

The release configurations of the demo will combine both applications into one ARM image. With this, the ARM core will load and start the DSP application on startup. Pre-compiled DSP binary images are provided under dsp/binary/ directory. If you make changes to the DSP application in release configuration, rebuild ARM application after building the DSP application. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol DSP_IMAGE_COPY_TO_RAM, found in IDE project settings, is defined to the value 1 when building release configuration.

The debug configurations will build two separate applications that need to be loaded independently. DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Required tool versions can be found in MCUXpresso SDK Release Notes for the board. Application for cm33 can be built by the other toolchains listed there. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol DSP_IMAGE_COPY_TO_RAM, found in IDE project settings, is defined to the value 0 when building debug configuration. The ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application.

In order to debug both the Cortex-M33 and DSP side of the application, please follow the instructions:

1. It is necessary to run the Cortex-M33 side first and stop the application before the DSP_Start function

2. Run the xt-ocd daemon with proper settings
3. Download and debug the DSP application

In order to get TRACE debug output from the XAF it is necessary to define XF_TRACE 1 in the project settings. It is possible to save the TRACE output into RAM using DUMP_TRACE_TO_BUF 1 define on project level. Please see the initialization of the TRACE function in the xaf_main_dsp.c file. For more details see XAF documentation.

When the demo runs successfully, the terminal will display the following output (example from MIMXRT700-EVK):

```
*****
DSP audio framework demo start
*****

[CM33_Main] Configure codec

[DSP_Main] Cadence Xtensa Audio Framework
[DSP_Main] Library Name   : Audio Framework (Hostless)
[DSP_Main] Library Version : 3.5
[DSP_Main] API Version    : 3.2

[DSP_Main] start
[DSP_Main] established RPMsg link
[CM33_Main] DSP image copied to DSP TCM
[CM33_Main][APP_SDCARD_Task] start
[CM33_Main][APP_DSP_IPC_Task] start
[CM33_Main][APP_Shell_Task] start

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```

Type help to see the command list. Similar description will be displayed on serial console (*If multi-channel playback mode is enabled, the description is slightly different. Available encoders/decoders may differ - refer to the [table](#).*):

```
"help": List all the registered commands

"exit": Exit program

"version": Query DSP for component versions

"file": Perform audio file decode and playback from SD card
USAGE: file [list|stop|<audio_file>]
list       List audio files on SD card available for playback
<audio_file> Select file from SD card and start playback

"decoder": Perform decode on DSP and play to speaker.
USAGE: decoder [aac|mp3|opus|sbc|vorbis_ogg|vorbis_raw]
aac:       Decode aac data
mp3:       Decode mp3 data
opus:      Decode opus data
sbc:       Decode sbc data
vorbis_ogg: Decode OGG VORBIS data
vorbis_raw: Decode raw VORBIS data

"encoder": Encode PCM data on DSP and compare with reference data.
USAGE: encoder [opus|sbc]
opus:      Encode pcm data using opus encoder
sbc:       Encode pcm data using sbc encoder

"src" Perform sample rate conversion on DSP
```

(continues on next page)

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"gain": Perform PCM gain adjustment on DSP

Xtensa IDE log when command is playing a file (mp3/aac/vorbis/...):

```
File playback start, initial buffer size: 16384
[DSP Codec] Audio Device Ready
[DSP Codec] Decoder component started
[DSP Codec] Setting decode playback format:
Decoder    : mp3_dec
Sample rate: 16000
Bit Width  : 16
Channels   : 2
[DSP Codec] Renderer component started
[DSP Codec] Connected XA_DECODER -> XA_RENDERER
[DSP_ProcessThread] start
[DSP_BufferThread] start
```

Xtensa IDE log when decoder command starts playback successfully:

```
[DSP_Main] Input buffer addr: 0x20020000, buffer size: 94276
[DSP Codec] Audio Device Ready
[DSP Codec] Decoder created
[DSP Codec] Decoder component started
[DSP Codec] Renderer component created
[DSP Codec] Connected XA_DECODER -> XA_RENDERER
[DSP_ProcessThread] start
[DSP_ProcessThread] Execution complete - exiting
[DSP_ProcessThread] exiting
[DSP Codec] Audio device closed

[CM33 CMD] [APP_DSP_IPC_Task] response from DSP, cmd: 0, error: 0
[CM33 CMD] Decode complete
```

MIMXRT685-AUD-EVK Multi-channel Support: The MIMXRT685-AUD-EVK board supports multi-channel audio. When selecting audio files for playback, you can specify the number of channels:

```
***
file [list|stop]<audio_file> [<nchannel>]]
<nchannel>    Select the number of channels (2 or 8 can be selected).
NOTE: Selected audio file must meet the following parameters:
      - Sample rate: 96 kHz
      - Width:       32 bit
***
```

Xtensa IDE log when command is playing a PCM file:

```
***
[DSP_FILE_REN] Audio Device Ready
[DSP_FILE_REN] post-proc/pcm_gain component started
[DSP_FILE_REN] post-proc/client_proxy component started
[DSP_FILE_REN] Connected post-proc/pcm_gain -> post-proc/client_proxy
[DSP_FILE_REN] renderer component started
[DSP_FILE_REN] Connected post-proc/client_proxy -> renderer
[DSP_BufferThread] start
[DSP_ProcessThread] start
[DSP_CleanupThread] start3
***
```

Known Issues

1. The “file stop” command doesn’t stop the playback for some small files (with low sample rate).
2. MIMXRT700-EVK: Has limited RAM on Cortex-M33 core 1 which limits the available decoders.

XAF Record Example

Table of Content

- [Overview](#)
- [Functionality](#)
- [Hardware Requirements](#)
- [Hardware Modifications](#)
- [Preparation](#)
- [Example Configuration](#)
- [Running the Demo](#)
- [Known Issues](#)

Overview The `dsp_xaf_record` application demonstrates audio processing using the DSP core, the Xtensa Audio Framework (XAF) middleware library, with a focus on audio recording, processing and voice recognition (VIT - Voice Intelligent Technology, Voice seeker).

As shown in the table below, the application is supported on several development boards and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and [Hardware modifications](#) or [Example configuration](#) sections before running the demo.

Functionality The application includes the following main components:

1. **ARM Core (CM33)** - Handles user interface and communicates with the DSP core
2. **DSP Core** - Processes audio data using the Xtensa Audio Framework (XAF)

The typical audio processing pipeline includes:

- Audio source component - DMIC audio
- VIT and Voice seeker component (perform voice recognition)
- Renderer component (playback on codec)

The application demonstrates recording from digital microphones (DMIC), processing the audio with voice enhancement algorithms, performing voice recognition, and prints back in console detected WakeWord and list of commands.

Hardware Requirements

- Development board (one of the following):
 - EVK-MIMXRT595 board
 - EVK-MIMXRT685 board

- MIMXRT685-AUD-EVK board (optionally with 8CH-DMIC expansion board - rev B required)
 - MIMXRT700-EVK board
- Micro USB cable
- JTAG/SWD debugger
- Headphones with 3.5 mm stereo jack
- Personal Computer

Hardware Modifications Some development boards need some hardware modifications to run the application.

- *EVK-MIMXRT595:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 <--> JP8-2

Note: The I3C Pin configuration in pin_mux.c is verified for default 1.8V, for 3.3V, need to manually configure slew rate to slow mode for I3C-SCL/SDA.

- *EVK-MIMXRT685:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 <--> JP8-2

- *MIMXRT685-AUD-EVK*

1. Set the hardware jumpers (Tower system/base module) to default settings.
2. Set hardware jumpers JP2 2<-->3, JP44 1<-->2 and JP45 1<-->2.

For 8CH-DMIC expansion board (optional):

1. Connect the 8CH-DMIC expansion board to the MIMXRT685-AUD-EVK board to the DMIC connector (J31). For safety reasons, the expansion board must be connected when the power supply is disconnected.
2. Set the hardware jumpers on the 8-DMIC expansion board to 2MIC, 3MICA, 3MICC config (Short: J6, J9, J10).
3. Set the hardware jumpers JP44 2<-->3 and JP45 2<-->3 on the MIMXRT685-AUD-EVK board for on-board DMIC bypass.

- *MIMXRT700-EVK:*

Set the hardware jumpers to default settings.

Preparation

1. Connect headphones to Audio HP / Line-Out connector.
 - EVK-MIMXRT595 - J4
 - EVK-MIMXRT685 - J4
 - MIMXRT685-AUD-EVK - J4, J50 for third channel when using 3 microphones
 - MIMXRT700-EVK - J29
2. Connect a micro USB cable between the PC host and the debug USB port on the development board.
 - EVK-MIMXRT595 - J40
 - EVK-MIMXRT685 - J5

- MIMXRT685-AUD-EVK - J5
 - MIMXRT700-EVK - J54
3. Open a serial terminal with the following settings:
 - 115200 baud rate
 - 8 data bits
 - No parity
 - One stop bit
 - No flow control
 4. Download the program for CM33 core to the target board.
 5. Launch the debugger in your IDE to begin running the demo.
 6. If building release configuration, start the xt-ocd daemon and download the program for DSP core to the target board. If building debug configuration, launch the Xtensa IDE or xt-gdb debugger to begin running the demo.

Notes:

- DSP image can only be debugged using J-Link debugger. See the document ‘Getting Started with Xplorer’ for your particular board for more information.

Example Configuration The example can be configured by user. Before configuration, please check the [table](#) to see if the feature is supported on the development board.

- **MIMXRT685-AUD-EVK 8CH-DMIC expansion board settings:**

Select how many microphones should be used

- Set the BOARD_DMIC_NUM preprocessor macro to 1,2, 3 (default) or 4 in the project for the CM33 core.
- When the 8CH-DMIC expansion board is used, the DMIC_BOARD_CONNECTED macro must be set to 1 (default) in the project for the DSP core.
- Important: When you set the value to 2, 3 or 4 you have to connect the 8CH-DMIC expansion board and set the DMIC_BOARD_CONNECTED macro to 1. Don’t forget set the hardware jumpers JP44 2-3 and JP45 2-3.

Running the Demo The ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application. The DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Application for Cortex-M33 can be built by the other toolchains listed in MCUXpresso SDK Release Notes.

The release configurations of the demo will combine both applications into one ARM image. With this, the ARM core will load and start the DSP application on startup. Pre-compiled DSP binary images are provided under dsp/binary/ directory. If you make changes to the DSP application in release configuration, rebuild ARM application after building the DSP application. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol DSP_IMAGE_COPY_TO_RAM, found in IDE project settings, is defined to the value 1 when building release configuration.

The debug configurations will build two separate applications that need to be loaded independently. DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Required tool versions can be found in MCUXpresso SDK Release Notes for the board. Application for cm33 can be built by the other toolchains listed there. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol DSP_IMAGE_COPY_TO_RAM, found in IDE project settings, is defined to the value 0 when building debug configuration. The

ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application.

In order to debug both the Cortex-M33 and DSP side of the application, please follow the instructions:

1. It is necessary to run the Cortex-M33 side first and stop the application before the DSP_Start function
2. Run the xt-ocd daemon with proper settings
3. Download and debug the DSP application

In order to get TRACE debug output from the XAF it is necessary to define XF_TRACE 1 in the project settings. It is possible to save the TRACE output into RAM using DUMP_TRACE_TO_BUF 1 define on project level. Please see the initialization of the TRACE function in the xaf_main_dsp.c file. For more details see XAF documentation.

Running on CM33 When the demo runs successfully, the CM33 terminal will display the following output (example from MIMXRT700-EVK):

```
*****
DSP audio framework demo start
*****

[CM33 Main] Configure codec

[DSP_Main] Cadence Xtensa Audio Framework
[DSP_Main] Library Name   : Audio Framework (Hostless)
[DSP_Main] Library Version : 3.5
[DSP_Main] API Version    : 3.2

[DSP_Main] start
[DSP_Main] established RPMsg link
[CM33 Main] DSP image copied to DSP TCM
[CM33 Main][APP_DSP_IPC_Task] start
[CM33 Main][APP_Shell_Task] start

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>>
```

Type help to see the command list. Similar description will be displayed on serial console (example from MIMXRT700-EVK):

```
"help": List all the registered commands

"exit": Exit program

"version": Query DSP for component versions

"record_dmic": Record DMIC audio , perform voice recognition (VIT) and playback on codec
USAGE: record_dmic [language]
For voice recognition say supported WakeWord and in 3s frame supported command.
If selected model contains strings, then WakeWord and list of commands will be printed in console.
NOTE: this command does not return to the shell
```

After running the "record_dmic en" command, similar output will be printed

```
[CM33 CMD] Setting VIT language to en
[DSP_Main] Number of channels 1, sampling rate 16000, PCM width 32
[CM33 CMD] [APP_DSP_IPC_Task] response from DSP, cmd: 13, error: 0
```

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```

[DSP Record] Audio Device Ready
[CM33 CMD] DSP DMIC Recording started
[CM33 CMD] To see VIT functionality say wakeword and command
[DSP VIT] VIT Model info
[DSP VIT] VIT Model Release = 0x40a00
[DSP VIT] Language supported : English
[DSP VIT] Number of WakeWords supported : 2
[DSP VIT] Number of Commands supported : 12
[DSP VIT] VIT_Model integrating WakeWord and Voice Commands strings : YES
[DSP VIT] WakeWords supported :
[DSP VIT] 'HEY NXP'
[DSP VIT] 'HEY TV'
[DSP VIT] Voice commands supported :
[DSP VIT] 'MUTE'
[DSP VIT] 'NEXT'
[DSP VIT] 'SKIP'
[DSP VIT] 'PAIR DEVICE'
[DSP VIT] 'PAUSE'
[DSP VIT] 'STOP'
[DSP VIT] 'POWER OFF'
[DSP VIT] 'POWER ON'
[DSP VIT] 'PLAY MUSIC'
[DSP VIT] 'PLAY GAME'
[DSP VIT] 'WATCH CARTOON'
[DSP VIT] 'WATCH MOVIE'
[DSP Record] connected CAPTURER -> GAIN_0
[DSP Record] connected XA_GAIN_0 -> XA_VIT_PRE_PROC_0
[DSP Record] connected XA_VIT_PRE_PROC_0 -> XA_RENDERER_0
[DSP VIT] - WakeWord detected 1 HEY NXP
[DSP VIT] - Voice Command detected 6 STOP

```

Xtensa IDE log of successful start of command:

```

Number of channels 2, sampling rate 16000, PCM width 16
Audio Device Ready
connected CAPTURER -> GAIN_0
connected CAPTURER -> XA_VIT_PRE_PROC_0
connected XA_VIT_PRE_PROC_0 -> XA_RENDERER_0

```

Running on DSP Debug configuration: When the demo runs successfully, the terminal will display the following:

```

Cadence Xtensa Audio Framework
Library Name   : Audio Framework (Hostless)
Library Version : 3.2
API Version    : 3.0

[DSP_Main] start
[DSP_Main] established RPMsg link
Number of channels 2, sampling rate 16000, PCM width 16

Audio Device Ready
VoiceSeekerLight lib initialized!
===== VoiceSeekerLight Configuration =====
version = 0.6.0
num mics = 2
max num mics = 4
mic0 = (35, 0, 0)
mic1 = (-35, 0, 0)
mic2 = (0, -35, 0)

```

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```

num_spks = 0
max num spks = 2
samplerate = 16000
framesize_in = 32
framesize_out = 480
create_aec = 0
create_doa = 0
buffer_length_sec = 1.5
aec_filter_length_ms = 0
===== VoiceSeekerLight Memory Allocation =====
VoiceSeekerLib allocated 80592 persistent bytes
VoiceSeekerLib allocated 3840 scratch bytes
===== VoiceSeekerLight Memory Usage
↪=====
=====
Total          = 72400 bytes

connected CAPTURER -> GAIN_0
connected XA_GAIN_0 -> XA_VOICE_SEEKER_0
connected XA_VOICE_SEEKER_0 -> XA_VIT_PRE_PROC_0
connected XA_VIT_PRE_PROC_0 -> XA_RENDERER_0

```

Known Issues There are limited features in release SRAM target because of memory limitations. To enable/disable components, set appropriate preprocessor define in project settings to 0/1 (e.g. XA_VIT_PRE_PROC etc.). Debug and flash targets have full functionality enabled.

XAF USB Example

Table of Content

- [Overview](#)
- [Functionality](#)
- [Hardware Requirements](#)
- [Hardware Modifications](#)
- [Preparation](#)
- [Running the Demo](#)
- [Known Issues](#)

Overview The dsp_xaf_usb_demo application demonstrates audio processing using the DSP core, the Xtensa Audio Framework (XAF) middleware library.

As shown in the table below, the application is supported on several development boards and each development board may have certain limitations, some development boards may also require hardware modifications or allow to use of an audio expansion board. Therefore, please check the supported features and [Hardware modifications](#) section before running the demo.

Functionality The application includes the following main components:

1. **ARM Core (CM33)** - Handles user interface, and communicates with the DSP core
2. **DSP Core** - Processes audio data using the Xtensa Audio Framework (XAF)

The XAF USB example demonstrates DSP-powered USB audio processing in two configurations: USB speaker and USB microphone. The application uses shell commands to switch between modes, with the ARM core handling USB communication while the DSP processes audio.

- USB Speaker Mode (USB2.0 → Line out): Receives audio from a USB host, processes it on the DSP, and outputs through the headphone jack, making the device function as a USB speaker for your computer.
- USB Microphone Mode (DMIC → USB2.0): Captures audio from the onboard digital microphones, processes it on the DSP, and streams it to a USB host as a standard audio input device.

Hardware Requirements

- Development board (one of the following):
 - EVK-MIMXRT595 board
 - EVK-MIMXRT685 board
 - MIMXRT685-AUD-EVK board
 - MIMXRT700-EVK board
- 2x Micro USB cable
- JTAG/SWD debugger
- Headphones with 3.5 mm stereo jack
- Personal Computer

Hardware Modifications Some development boards need some hardware modifications to run the application.

- *EVK-MIMXRT595:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 ↔ JP8-2

Note: The I3C Pin configuration in pin_mux.c is verified for default 1.8V, for 3.3V, need to manually configure slew rate to slow mode for I3C-SCL/SDA.

- *EVK-MIMXRT685:*

To enable the example audio using WM8904 codec, connect pins as follows:

- JP7-1 ↔ JP8-2

- *MIMXRT685-AUD-EVK*

- Set the hardware jumpers (Tower system/base module) to default settings.
- Set hardware jumpers JP2 2↔3, JP44 1↔2 and JP45 1↔2.

- *MIMXRT700-EVK:*

Set the hardware jumpers to default settings.

Preparation

1. Connect headphones to Audio HP / Line-Out connector.
 - EVK-MIMXRT595 - J4
 - EVK-MIMXRT685 - J4
 - MIMXRT685-AUD-EVK - J4

- MIMXRT700-EVK - J29
2. Connect the first micro USB cable between the PC host and the debug USB port on the development board.
 - EVK-MIMXRT595 - J40
 - EVK-MIMXRT685 - J5
 - MIMXRT685-AUD-EVK - J5
 - MIMXRT700-EVK - J54
 3. Connect the second micro USB cable between the PC host and the USB port on the development board.
 - EVK-MIMXRT595 - J38
 - EVK-MIMXRT685 - J7
 - MIMXRT685-AUD-EVK - J7
 - MIMXRT700-EVK - J40
 4. Open a serial terminal with the following settings:
 - 115200 baud rate
 - 8 data bits
 - No parity
 - One stop bit
 - No flow control
 5. Download the program for CM33 core to the target board.
 6. Launch the debugger in your IDE to begin running the demo.
 7. If building release configuration, start the xt-ocd daemon and download the program for DSP core to the target board. If building debug configuration, launch the Xtensa IDE or xt-gdb debugger to begin running the demo.

Notes:

- DSP image can only be debugged using J-Link debugger. See the document ‘Getting Started with Xplorer’ for your particular board for more information.

Running the Demo The ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application. The DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Application for Cortex-M33 can be built by the other toolchains listed in MCUXpresso SDK Release Notes.

The release configurations of the demo will combine both applications into one ARM image. With this, the ARM core will load and start the DSP application on startup. Pre-compiled DSP binary images are provided under dsp/binary/ directory. If you make changes to the DSP application in release configuration, rebuild ARM application after building the DSP application. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol `DSP_IMAGE_COPY_TO_RAM`, found in IDE project settings, is defined to the value 1 when building release configuration.

The debug configurations will build two separate applications that need to be loaded independently. DSP application can be built by the following tools: Xtensa Xplorer or Xtensa C Compiler. Required tool versions can be found in MCUXpresso SDK Release Notes for the board. Application for cm33 can be built by the other toolchains listed there. If you plan to use MCUXpresso IDE for cm33 you will have to make sure that the preprocessor symbol `DSP_IMAGE_COPY_TO_RAM`, found in IDE project settings, is defined to the value 0 when building debug configuration. The

ARM application will power and clock the DSP, so it must be loaded prior to loading the DSP application.

In order to debug both the Cortex-M33 and DSP side of the application, please follow the instructions:

1. It is necessary to run the Cortex-M33 side first and stop the application before the DSP_Start function
2. Run the xt-ocd daemon with proper settings
3. Download and debug the DSP application

In order to get TRACE debug output from the XAF it is necessary to define XF_TRACE 1 in the project settings. It is possible to save the TRACE output into RAM using DUMP_TRACE_TO_BUF 1 define on project level. Please see the initialization of the TRACE function in the xaf_main_dsp.c file. For more details see XAF documentation.

Running on CM33 When the demo runs successfully, the CM33 terminal will display the following output (example from MIMXRT700-EVK):

```
*****
DSP audio framework demo start
*****

[CM33 Main] Configure codec

[DSP_Main] Cadence Xtensa Audio Framework
[DSP_Main] Library Name   : Audio Framework (Hostless)
[DSP_Main] Library Version : 3.5
[DSP_Main] API Version    : 3.2

[DSP_Main] start
[DSP_Main] established RPMsg link
[CM33 Main] DSP image copied to DSP TCM
[CM33 Main][APP_DSP_IPC_Task] start
[CM33 Main][APP_Shell_Task] start

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>>
```

Type help to see the command list. Similar description will be displayed on serial console (example from MIMXRT700-EVK):

```
"help": List all the registered commands

"exit": Exit program

"version": Query DSP for component versions

"usb_speaker": Perform usb speaker device and playback on DSP
  USAGE: usb_speaker [start|stop]
  start      Start usb speaker device and playback on DSP
  stop       Stop usb speaker device and playback on DSP

"usb_mic": Record DMIC audio and playback on usb microphone audio device
  USAGE: usb_mic [start|stop]
  start      Start record and playback on usb microphone audio device
  stop       Stop record and playback on usb microphone audio device
```

When usb_speaker command starts playback successfully, the terminal will display following output:

```
[APP_DSP_IPC_Task] response from DSP, cmd: 21, error: 0
DSP USB playback start
>>
```

Xtensa IDE log when command is playing a file:

```
USB speaker start, initial buffer size: 960
[DSP_USB_SPEAKER] Audio Device Ready
[DSP_USB_SPEAKER] post-proc/pcm_gain component started
[DSP_USB_SPEAKER] post-proc/client_proxy component started
[DSP_USB_SPEAKER] Connected post-proc/pcm_gain -> post-proc/client_proxy
[DSP_USB_SPEAKER] renderer component started
[DSP_USB_SPEAKER] Connected post-proc/client_proxy -> renderer
[DSP_ProcessThread] start
[DSP_BufferThread] start
[DSP_CleanupThread] start
```

The USB device on your host will be enumerated as XAF USB DEMO.

Xtensa IDE will not show any additional log entry.

Running the demo DSP Debug configuration: When the demo runs successfully, the terminal will display the following:

```
Cadence Xtensa Audio Framework
Library Name   : Audio Framework (Hostless)
Library Version : 2.6p1
API Version    : 2.0

[DSP_Main] start
[DSP_Main] established RPMMsg link
```

Known Issues

- When starting the “usb_speaker” after the “usb_mic” command, the sound output may be distorted. Please power cycle the board.

3.8 Wireless

3.8.1 NXP Wireless Framework and Stacks

Wi-Fi, Bluetooth, 802.15.4

Application notes

- [Link AN12918-Wi-Fi-Tx-Power-Table-and-Channel-Scan-Management-for-i.MX-RT-SDK.pdf](#)
- [Link TN00066-WFA-Derivative-Certification-Process.pdf](#)

User manuals

- [Link UM11441-Getting-Started-with-NXP-based-Wireless-Modules-and-i.MX-RT-Platforms.pdf](#)
- [UM11442-NXP-Wi-Fi-and-Bluetooth-Demo-Applications-for-i.MX-RT-Platforms.pdf](#)
- [Link UM11443-NXP-Wi-Fi-and-Bluetooth-Debug-Feature-Configuration-Guide-for-i.MX-RT-Platforms.pdf](#)

- [Link](#) [UM11567-WFA-Certification-Guide-for-NXP-based-Wireless-Modules-on-i.MX-RT-Platform-Running-RTOS.pdf](#)

Release notes

Wireless SoC features and release notes for FreeRTOS

About this document This document provides information about the supported features, release versions, fixed and/or known issues, performance of the Wi-Fi, Bluetooth/802.15.4 radios, including the coexistence.

The SDK release version 25.06.00 has been tested for the wireless SoCs listed in Supported products.

Supported products

- 88W8987
- IW416
- IW611¹
- IW612²
- AW611³
- RW610
- RW612

Parent topic: [About this document](#)

Features

Wi-Fi radio

Client mode

Features	Sub features
802.11n - High throughput	2.4 GHz band operation supported channel bandwidth: 20 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

¹ The support of IW611 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

² The support of IW612 is enabled in i.MX RT1170 EVKB and i.MX RT1060 EVKC.

³ AW611 module support is available only in i.MX RT1180 EVKA

Table 5 – continued from p

Features	Sub features
802.11n - High throughput	Aggregated MAC service data unit (AMSDU) 4k TX and RX su
802.11n - High throughput	TX MCS rate adaptation (BGN)
802.11n - High throughput	RX low density parity check (LDPC) 1x1 20 MHz and 40 MHz
802.11n - High throughput	HT Beamformee (explicit)
802.11ac - Very high throughput	2.4 GHz band supported channel bandwidth: 20MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11ac - Very high throughput	5 GHz band supported channel bandwidth: 80 MHz
802.11ac - Very high throughput	Data rates up to 86.7 Mbps (MCS0 to MCS 8)
802.11ac - Very high throughput	Data rates up to 433.3 Mbps (MCS 0 to MCS 9) - 1x1
802.11ac - Very high throughput	MU-MIMO Beamformee (Explicit and Implicit)
802.11ac - Very high throughput	RTS/CTS with BW signaling
802.11ac - Very high throughput	Operation mode notification
802.11ac - Very high throughput	Backward compatibility with non-VHT devices
802.11ac - Very high throughput	TX VHT MCS rate adaptation
802.11ac - Very high throughput	Low density parity check (LDPC)
802.11ax - High efficiency	2.4 GHz band supported channel bandwidth: 20MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidth: 20 MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidth: 40 MHz
802.11ax - High efficiency	5 GHz band supported channel bandwidths: 80 MHz
802.11ax - High efficiency	OFDMA (UL/DL, 106 RU)
802.11ax - High efficiency	OFDMA (UL/DL, 484 RU)
802.11ax - High efficiency	1024 QAM
802.11ax - High efficiency	Target wake time (TWT)
802.11ax - High efficiency	256 QAM modulation – MCS8 and MCS9
802.11ax - High efficiency	1024 QAM modulation – MCS10 and MCS11, 2.4 GHz
802.11ax - High efficiency	1024 QAM modulation – MCS10 and MCS11, 5 GHz
802.11ax - High efficiency	DCM
802.11ax - High efficiency	DCM
802.11ax - High efficiency	ER (extended range)
802.11ax - High efficiency	SU Beamforming
802.11ax - High efficiency	OMI (operating mode indication)
802.11a/b/g features	802.11b/g data rates up to 54 Mbit/s
802.11a/b/g features	802.11a data rates up to 54 Mbit/s
802.11a/b/g features	TX rate adaptation (BG)
802.11a/b/g features	Fragmentation/defragmentation
802.11a/b/g features	ERP protection, slot time, preamble
802.11d	802.11d - Regulatory domain/operating class/country info
802.11e QoS	EDCA [enhanced distributed channel access] / WMM (wirele
802.11i security	OpenSource WPA Supplicant Support
802.11i security	WPA2-PSK AES WPA Supplicant
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) WPA
802.11i security	WPA2+WPA3 PSK Mixed Mode (WPA3 Transition Mode) W
802.11i security	Wi-Fi Enhanced Open - OWE (Opportunistic Wireless Encry
802.11i security	802.1x EAP Authentication Methods WPA Supplicant
802.11i security	WPA2-Enterprise Mixed Mode WPA Supplicant
802.11i security	WPA3-Enterprise (Suite-B) National Security Algorithm (CS
802.11i security	802.11w - PMF (Protected Management Frames) WPA Supp
802.11i security	Embedded Supplicant Support
802.11i security	WPA2-PSK AES Embedded Supplicant
802.11i security	WPA+WPA2 PSK Mixed Mode Embedded Supplicant
802.11i security	WPA3-SAE (Simultaneous Authentication of Equals) Embe
802.11i security	802.11w - PMF (Protected Management Frames) Embedde
802.11i security	Wi-Fi Roaming
802.11i security	WPA3 Enterprise

Table 5 – continued from p

Features	Sub features
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 - using
802.11w - PMF (protected management frames)	SA query request/response
802.11w - PMF (protected management frames)	PMF support using embedded supplicant
DPP functionality	Wi-Fi easy connect ^[^3]
General features	Embedded supplicant
General features	Host sleep packet filtering
General features	Host-based supplicant
General features	Embedded MLME
General features	EDMAC - EU adaptivity support (ETSI certification)
General features	External coexistence
General features	IPv6 NS offload
General features	FIPS
General features	TKIP ^[^1]
General features	RF test mode
General features	802.11k
General features	802.11v
General features	DFS radar detection in peripheral mode (follow AP) ^[^5]
General features	Embedded roaming based on RSSI threshold beacon loss
General features	ARP offload
General features	Cloud keep alive
General features	UNII-4 channel support
General features	ClockSync using TSF
General features	Auto reconnect
General features	CSI (channel state information)
General features	Independent reset (in-band) ^[^3]
General features	Independent reset (out-band) ^[^3]
General features	Wi-Fi agile multiband
General features	Network co-processor (NCP) mode
General features	802.11mc - WLS (Wi-Fi location service)
General features	802.11az

Parent topic:Wi-Fi radio

^[^1] As per Wi-Fi specification, connecting in TKIP security in non 802.11n mode is allowed.

^[^2] Support available in host-base supplicant.

^[^3] Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature.

^[^4] Read more about NCP feature in [References](#). ^[^5] To enable the feature, CONFIG_ECSA = 1 must be defined in wifi_config.h (does not apply to RW610 and RW612).

AP mode

Features	Sub features
802.11n - High throughput	2.4 GHz band operation supported channel bandwidth: 20 M

Table 6 – continued from previ

Features	Sub features
802.11n - High throughput	2.4 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11n - High throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11n - High throughput	Short/long guard interval (400 ns/800 ns)
802.11n - High throughput	Data rates up to 72 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	Data rates up to 150 Mbit/s (MCS 0 to MCS 7)
802.11n - High throughput	1 spatial stream (1x1)
802.11n - High throughput	HT protection mechanisms
802.11n - High throughput	Aggregated MAC protocol data unit (AMPDU) Rx support
802.11n - High throughput	Aggregated MAC service data unit (AMSDU) -4k RX support
802.11n - High throughput	Max client support (up to 8 devices)
802.11n - High throughput	TX MCS rate adaptation (BGN)
802.11n - High throughput	RX low density parity check (LDPC)
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 20 MHz
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 40 MHz
802.11ac – Very high throughput	5 GHz band supported channel bandwidth: 80MHz
802.11ac – Very high throughput	Short/long guard interval (400ns/800ns)
802.11ac – Very high throughput	Data rates up to 86.7 Mbps (MCS0 to MCS 8)
802.11ac – Very high throughput	Data rates up to 433.3 Mbps (MCS 0 to MCS 9)
802.11ac – Very high throughput	Single user- Aggregated MAC protocol data unit (SU-AMPDU)
802.11ac – Very high throughput	RTS/CTS with BW signaling
802.11ac – Very high throughput	Backward compatibility with non-VHT devices
802.11ac – Very high throughput	TX VHT MCS rate adaptation
802.11ac – Very high throughput	MU-MIMO Beamformee (explicit and implicit)
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)

Table 6 – continued from previous page

Features	Sub features
General features	External coexistence (software interface)
General features	Independent reset (in-band) ^[^1]
General features	Network co-processor (NCP) mode ^[^2]
General features	Vendor specific IE (custom IE)
General features	Hidden SSID (broadcast SSID disabled)
General features	MAC address filter
General features	Multiple external STA support

Parent topic:Wi-Fi radio

^[^1] Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory. ^[^2] Read more about NCP feature in [References](#).

AP-STA mode

Features	Sub features	88W89	IW41	IW611/IV	RW610/R	IW61	AW611
Simultaneous AP-STA operation (same channel)	AP-STA functionality	Y	Y	Y	Y	Y	Y
SAD	Software antenna diversity ^[^1]	Y	Y	Y	Y	Y	Y

Parent topic:Wi-Fi radio

^[^1] Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature.

Parent topic:[Features](#)**Wi-Fi Generic features**

Features	Sub features	88W89	IW41	IW611/IW	RW610/RW	IW61	AW611
Generic	Firmware download (parallel) ^[^1]	Y	Y	Y	N	N	Y
Generic	Secure boot	N	N	Y	Y	Y	Y
Generic	Kconfig memory optimizer	Y	Y	Y	Y	Y	Y
Generic	Firmware Compression ^[^2]	N	Y	N	N	N	N
Generic	u-AP intra-BSS	Y	N	Y	Y	Y	Y
Generic	Net Monitor Mode	N	N	N	Y	Y	N
Generic	Net Monitor Mode with packet transmission	N	N	N	Y	Y	N
Generic	In-Channel Net Monitor mode	N	N	N	N	N	N

Parent topic:Wi-Fi radio

^[^1] Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature. ^[^2] The feature is used to compress the Wi-Fi Bluetooth firmware and optimize the flashing of the host

Wi-Fi direct/P2P

Features	Sub fea- tures	88W8987	IW416 ^[1]	IW611/IW61	RW610/RW61	IW610 ^[1]	AW611 ^[3]
P2P basic func- tionality ^[1]	P2P Auto GO	Y	Y	Y	Y	Y	Y
P2P basic func- tionality ^[1]	P2P GO	Y	Y	Y	Y	Y	Y
P2P basic func- tionality ^[1]	P2P GC	Y	Y	Y	Y	Y	Y

Parent topic:Wi-Fi radio

^[1] Feature not enabled by default in the SDK. Refer to [Feature enable and memory impact](#) for the macro to enable the feature and the impact on the memory when enabling the feature. ^[2] This is an experimental software release for this feature for IW416. ^[3] Contact your support representative to use this feature for.

Bluetooth radio

Bluetooth classic

Feature		Sub feature	88W8	IW4'	IW611/	RW610/	IW6'	AW611
General features	fea-	Bluetooth Class 1.5 and Class 2 support	Y	Y	Y	N	N	Y
General features	fea-	Scatternet support	Y	Y	Y	N	N	Y
General features	fea-	Maximum of seven simultaneous ACL connections – Central links	Y	Y	Y	N	N	Y
General features	fea-	Automatic packet type selection	Y	Y	Y	N	N	Y
General features	fea-	Bluetooth - 2.1 to 5.0 specification support	Y	Y	Y	N	N	Y
General features	fea-	Low power sniff	Y	Y	Y	N	N	Y
General features	fea-	Deep sleep using out-of-band	Y	Y	N	N	N	N
General features	fea-	Wake on Bluetooth (SoC to host)	Y	Y	Y	N	N	Y
General features	fea-	Independent reset (in-band) ^[^1]	Y	Y	Y	Y	N	Y
General features	fea-	Independent reset (out-band) ^[^1]	Y	Y	N	N	N	N
General features	fea-	Firmware download (parallel) ^[^1]	Y	Y	N	N	N	N
General features	fea-	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	sup-	A2DP source/sink	Y	Y	Y	N	N	Y
Bluetooth profiles supported	sup-	AVRCP target/controller	Y	Y	Y	N	N	Y
Bluetooth profiles supported	sup-	HFP Dev/AG	Y	Y	Y	N	N	Y
Bluetooth profiles supported	sup-	OPP server/client	Y	Y	Y	N	N	Y
Bluetooth profiles supported	sup-	SPP server/client	Y	Y	Y	N	N	Y
Bluetooth profiles supported	sup-	HID target/device	Y	Y	Y	N	N	Y
Bluetooth audio features	au-	PCM NBS central/peripheral	Y	Y	Y	N	N	Y
Bluetooth audio features	au-	PCM WBS central/peripheral	Y	Y	Y	N	N	Y

Parent topic:Bluetooth radio

[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

Bluetooth LE

Features	Sub features
Generic features	Maximum 16 Bluetooth LE connections (central role)
Generic features	Deep sleep using out-of-band
Generic features	Wake on Bluetooth LE (SoC to Host)
Generic features	RF Test mode
Bluetooth profile support	Bluetooth LE GATT
Bluetooth profile support	Bluetooth LE HID over GATT
Bluetooth profile support	Bluetooth LE GAP
Bluetooth LE 4.0 support	Low Energy physical layer
Bluetooth LE 4.0 support	Low Energy link layer
Bluetooth LE 4.0 support	Enhancements to HCI for Low Energy
Bluetooth LE 4.0 support	Low energy direct test mode
Bluetooth 4.1 support	Low duty cycle directed advertising
Bluetooth 4.1 support	Bluetooth LE dual mode topology
Bluetooth 4.1 support	Bluetooth LE privacy v1.1
Bluetooth 4.1 support	Bluetooth LE link layer topology
Bluetooth 4.2 support	Bluetooth LE secure connection
Bluetooth 4.2 support	Bluetooth LE link layer privacy v1.2
Bluetooth 4.2 support	Bluetooth LE data length extension
Bluetooth 4.2 support	Link layer extended scanner filter policies
Bluetooth 5.0 support	Bluetooth LE 2 Mbps support
Bluetooth 5.0 support	High duty cycle directed advertising
Bluetooth 5.0 support	Low Energy advertising extension
Bluetooth 5.0 support	Low Energy long range
Bluetooth 5.0 support	Low Energy periodic advertisement
Bluetooth 5.2 support	Low Energy power control
Bluetooth LE audio support[^1] [^2]	Isochronous channel
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS source
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS sink
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIG Validation
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio Phy: 1M/2M/ coded
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio framed mode
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio unframed mode
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio sequential packing
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio: Mono and Stereo
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS encrypted audio
Bluetooth LE audio support[^1] [^2]	Broadcast LE Audio BIS unencrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS source
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS sink
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIG validation
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS synchronization
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio Phy: 1M/2M/ coded
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio framed mode
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio unframed mode
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio sequential packing
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio: mono and stereo
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS encrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio CIS unencrypted audio
Bluetooth LE audio support[^1] [^2]	Unicast LE Audio TX/RX and bidirectional traffic

Table 7 – continued from prev

Features	Sub features
Bluetooth LE audio support ^[^1] ^[^2]	ISO interval for LE Audio: 7.5ms 10ms 20ms 30ms
Bluetooth LE audio support ^[^1] ^[^2]	Sampling frequency for LE Audio: 8kHz 16kHz 24kHz, 32kHz
Bluetooth LE audio support ^[^1] ^[^2]	LE Audio Auracast use cases: Auracast streaming 2 BISes
Bluetooth LE audio support ^[^1] ^[^2]	LE Audio Unicast use cases: Unicast streaming 2 CISes
Bluetooth LE audio support ^[^1] ^[^2]	LE Audio Unicast Use cases: Unicast streaming 4 CISes
Bluetooth LE audio support ^[^1] ^[^2]	A2DP + Auracast/Unicast Bridge use cases – CIS/BIS
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth coexistence
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	STA + Bluetooth + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth LE coexistence
BCA TDM Coexistence mode (shared antenna)	AP + Bluetooth + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	STA + Bluetooth + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth LE coexistence
BCA TDM coexistence mode (separate antenna)	AP + Bluetooth + Bluetooth LE coexistence

Note: Details of the tested Bluetooth LE Audio use cases:

- Number of streams:
 - 1-CIG | upto 4-CIS with 1 LE ACL (for 4-CIS: execute only mono UCs, SDU Int: 10ms)
 - 1-CIG | upto 4-CIS with 4 separate LE ACL (for 4-CIS: SDU Size= Max 100 Oct, PHY=2M, RTN=1, SDU Int: 10ms only) (execute only mono UCs for 4-CIS)
 - 1-BIG | upto 4-BIS (for 4-BIS: execute only mono UCs, SDU Int: 10ms only)
- PHY: 2M and 1M
- Audio mode: mono (for 1 to 4 streams) and stereo (for 1 stream)
- Packing: sequential and interleaved
- Bit rate: maximum 96kbps
 - For 1-CIG with upto 3-CIS: maximum bit rate 96kbps
 - For 1-CIG with 4-CIS: maximum bit rate 80kbps
 - For 1-BIG with 4-BIS: maximum bit rate 80kbps
 - For 2-CIG cases: maximum bit rate 80kbps
- Mode: unframed mode
- 48_5 and 48_6 mono and stereo configurations are not supported.

Details of the tested Bluetooth coexistence (Bluetooth + Bluetooth LE Audio) use cases:

- Bluetooth + Bluetooth LE Audio
- A2DP + Bluetooth LE Audio bridging support
- A2DP sink link (central) -> LEA 2-CIS (SDU Int: 10ms only | A2DP only with SBC Codec | PHY: 2M)

Parent topic:Bluetooth radio

^[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

^[^2] LE audio feature is supported for standalone scenarios only and not for BR/EDR and Wi-Fi coexistence scenarios such as LE audio + BR/EDR link or LE audio + Wi-Fi link. From the

perspective of NXP Edgefast Bluetooth host stack, LE audio feature can be disabled by the CONFIG_BT_AUDIO macro without impact on any other features. LE audio feature can be tested by the user, using their own supported host stack.

Parent topic: [Features](#)

802.15.4 radio

Features	Sub features	IW612	IW610	RW612
General 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 ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	STA + Bluetooth	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Mobile AP + Bluetooth	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth LE + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + Bluetooth LE + Wi-Fi	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth LE ^[^2]	Y	Y	Y
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Bluetooth + Bluetooth LE	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	OpenThread + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + OpenThread + Wi-Fi	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth LE + OpenThread + Wi-Fi	Y	Y	Y
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Bluetooth + Bluetooth LE + OpenThread + Wi-Fi	Y	N	N
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	Single antenna configuration	Y	Y	Y
BCA_TDM separate antenna ^[^1] (lower and higher isolation) 1x1 Wi-Fi, (Bluetooth and 802.15.4 shared)	External Coexistence PTA	N	Y	Y

Parent topic:Coexistence

^[^1] Experimental feature intended for evaluation/early development only and not production. Incomplete mandatory certification.

^[^2] The narrow-band radio can be configured to support Bluetooth LE, 802.15.4, and to time-slice between Bluetooth LE and 802.15.4.

Parent topic:[Features](#)**Feature enable and memory impact**

Features	Macros to enable the feature	Memory impact
CSI	CONFIG_CSI	Flash - 60K, RAM - 4K
DPP	CONFIG_WPA_SUPP_DPP	Flash - 240K, RAM - 12K
Independent reset	CONFIG_WIFI_IND_DNLDCONFIG_WIFI_IND_RESET	Minimal
Parallel firmware download Wi-Fi	CONFIG_WIFI_IND_DNLD	Minimal
Parallel firmware download Bluetooth	CONFIG_BT_IND_DNLD	Minimal
WPA3 enterprise	CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME	Flash - 165K, RAM - 18K
WPA2 enterprise	CONFIG_WPA_SUPP_CRYPTO_ENTERPRISE [Macros specific to EAP-methods included] CONFIG_EAP_TLS CONFIG_EAP_PEAP CONFIG_EAP_TTLS CONFIG_EAP_FAST CONFIG_EAP_SIM CONFIG_EAP_AKA CONFIG_EAP_AKA_PRIME	Flash - 165K, RAM - 18K
Host sleep	CONFIG_HOST_SLEEP	Minimal
WMM	CONFIG_WMM ^[^1]	Flash - 10K, RAM - 57K
802.11mc	CONFIG_11MC CONFIG_CSI CONFIG_WLS_CSI_PROC ^[^2] CONFIG_11AZ	Flash: 52.78KB, RAM : 121.1KB
802.11az	CONFIG_11MC CONFIG_CSI ^[2] CONFIG_WLS_CSI_PROC ^[^2] CONFIG_11AZ	Flash: 52.78KB, RAM : 121.1KB
Non-blocking firmware download mechanism	CONFIG_FW_DNLD_ASYNC	—
Antenna diversity	CONFIG_WLAN_CALDATA_2ANT_DIVERSITY	-
P2P	CONFIG_WPA_SUPP_P2P	-

Note:

- For Wi-Fi, the macros are set with the value “0” by default in the file `wifi_config_default.h` located in `<SDK_PATH>/middleware/wifi_nxp/incl/` directory.

To enable the features, set the value of the macros to “1*” in the file `wifi_config.h` located in `*<SDK_Wi-Fi_Example_PATH>/directory***.***`

- Bluetooth

To enable the features, set the value of the macros to “1” in the file `app_bluetooth_config.h` located in `<SDK_Bluetooth_Example_PATH>/` directory.

Kconfig memory optimizer The MCUXpresso SDK provides options to reduce the host memory usage with build-time configuration parameters referred to as Kconfig memory optimizer. The configuration parameters are used to reduce the use of the flash memory and SRAM.

This section explains how to enable the host memory saving configurations within the Wi-Fi drivers of NXP wireless devices.

Memory impact of i.MX RT1060 EVKC + IW416 module (Murata 1XK):

- Maximum Flash usage: 889 KB
- Maximum SRAM usage: 418.77 KB

To reduce the use of the flash and SRAM, change the settings of the Kconfig macros listed in table in the file `wifi_config.h` located in `<path-to-SDK_Wi-Fi_Example>` directory.

Kconfig macros	Feature disabled
CON- FIG_WIFI_SL]	CONFIG_ROAMING CONFIG_11R
CON- FIG_WIFI_SL]	CONFIG_CLOUD_KEEP_ALIVE CONFIG_WIFI_EU_CRYPTO CON- FIG_TX_AMPDU_PROT_MODE CONFIG_WNM_PS CONFIG_TURBO_MODE CONFIG_AUTO_RECONNECT CONFIG_DRIVER_OWE CONFIG_OWE CONFIG_WIFI_FORCE_RTS CONFIG_WIFI_FRAG_THRESHOLD CON- FIG_COMBO_SCAN CONFIG_SCAN_CHANNEL_GAP
CON- FIG_WIFI_SL]	CONFIG_UAP_STA_MAC_ADDR_FILTER CONFIG_WIFI_MAX_CLIENTS_CNT
CON- FIG_FREERTC	If the macro is enabled, the heap memory usage is reduced by 10 KB (from 70 KB to 60 KB).
CON- FIG_LWIP_LC	Curtails LWIP stack parameters, reduces data throughput, disables data net-stats
Non- blocking firmware download mechanism	CONFIG_FW_DNLD_ASYNC

Parent topic: [Feature enable and memory impact](#)

[^1] The macro is not used for IW416.

[^2] Prerequisite macros for 802.11mc and 802.11az features

88W8987 release notes

Package information

- SDK version: 25.06.00

Parent topic: [88W8987 release notes](#)

Version information

- Wireless SoC: 88W8987
- Wi-Fi and Bluetooth/Bluetooth LE firmware version: 16.92.21.p151.7
 - 16 - Major revision
 - 91 - Feature pack
 - 21 - Release version
 - p151.7 - Patch number

Parent topic:[88W8987 release notes](#)

Host platform

- All i.MX RT platforms running FreeRTOS.
- Host interfaces
 - Wi-Fi over SDIO (SDIO 2.0 support, SDIO clock frequency: 50 MHz)
 - Bluetooth/Bluetooth LE over UART
- Test tools
 - iPerf (version 2.1.9)

Parent topic:[88W8987 release notes](#)

Wi-Fi and Bluetooth certification The Wi-Fi and Bluetooth certification is obtained with the following combinations.

WFA certifications

- STA | 802.11n
- STA | 802.11ac
- STA | PMF
- STA | FFD
- STA | SVD
- STA | WPA3 SAE (R3)
- STA | QTT

Refer to 6.

Note: This release supports STAUT only certifications.

Parent topic:Wi-Fi and Bluetooth certification

Bluetooth controller certification QDID: refer to 4.

Parent topic:Wi-Fi and Bluetooth certification

Parent topic:[88W8987 release notes](#)

Wi-Fi throughput

Throughput test setup

- Environment: Shield Room - Over the Air
- External Access Point: ASUS AX88U
- DUT: W8987 Murata (Module: **1ZM M.2**) with EVK-MIMXRT1060 EVKC platform
- DUT Power Source: External power supply
- External Client: Apple MacBook Air
- Channel: 6 | 36
- Wi-Fi application: wifi_wpa_supPLICant
- Compiler used to build application: armgcc
- Compiler Version: gcc-arm-none-eabi-13.2
- iPerf commands used in test:

TCP TX

```
iperf -c <remote_ip> -t 60
```

TCP RX

```
iperf -s
```

UDP TX

```
iperf -c <remote_ip> -t 60 -u -B <local_ip> -b 120
```

Note: The default rate is 100 Mbps.

UDP RX

```
iperf -s -u -B <local_ip>
```

Note: Read more about the throughput test setup and topology in 2.

Parent topic: Wi-Fi throughput

STA throughput External APs: ASUS AX88U

STA mode throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	46	51	60	60
WPA2-AES	45	42	60	54
WPA3-SAE	46	41	60	54

STA mode throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	62	83	121	124
WPA2-AES	61	82	120	126
WPA3-SAE	60	82	120	126

STA mode throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	52	60	64
WPA2-AES	43	52	61	64
WPA3-SAE	43	52	60	65

STA mode throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	64	87	126	125
WPA2-AES	63	85	125	120
WPA3-SAE	63	80	125	123

STA mode throughput - AC Mode | 5 GHz Band | 20 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	48	60	73	78
WPA2-AES	47	60	73	77
WPA3-SAE	47	60	73	77

STA mode throughput - AC Mode | 5 GHz Band | 40 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	68	96	161	157
WPA2-AES	69	92	160	155
WPA3-SAE	70	94	160	155

STA mode throughput - AC Mode | 5 GHz Band | 80 MHz (VHT)

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	78	99	125	203
WPA2-AES	78	98	126	197
WPA3-SAE	82	98	125	197

Parent topic:Wi-Fi throughput

Mobile AP throughput External client: Apple Macbook Air

Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	43	51	56	62
WPA2-AES	42	50	54	61
WPA3-SAE	40	50	65	62

Mobile AP Mode Throughput - BGN Mode | 2.4 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	66	81	107	121
WPA2-AES	65	80	107	120
WPA3-SAE	65	80	108	120

Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	44	52	60	61
WPA2-AES	44	51	60	61
WPA3-SAE	44	51	60	61

Mobile AP Mode Throughput - AN Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	70	89	126	103
WPA2-AES	70	87	124	102
WPA3-SAE	70	88	125	103

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 20 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	49	60	73	76
WPA2-AES	48	59	73	76
WPA3-SAE	48	60	73	76

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 40 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	77	106	161	102
WPA2-AES	77	104	160	102
WPA3-SAE	77	104	160	111

Mobile AP Mode Throughput - AC Mode | 5 GHz Band | 80 MHz

Protocol	TCP (Mbit/s)	TCP (Mbit/s)	UDP (Mbit/s)	UDP (Mbit/s)
Direction	TX	RX	TX	RX
OpenSecurity	93	114	125	206
WPA2-AES	92	111	125	191
WPA3-SAE	92	111	125	173

Parent topic: Wi-Fi throughput

Parent topic: [88W8987 release notes](#)

EU conformance tests

- EU Adaptivity test - EN 300 328 v2.1.1 (for 2.4 GHz)
- EU Adaptivity test - EN 301 893 v2.1.1 (for 5 GHz)

Parent topic:[88W8987 release notes](#)**Bug fixes and/or feature enhancements****Firmware version: From 16.91.21.p64.1 to 16.91.21.p82**

Compo- po- 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- 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- 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**

Compo- nent	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}

Com- ponent	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}

Com- 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

Parent topic:[IW416 release notes](#)

Known issues

Compo- nent	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_suplicant
- 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_suplicant* 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- 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- 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 - 4,3,2,1While 4-CIS streaming, audio glitches observed on all CIS SINK with Samsung Galaxy budsWhile 4-CIS streaming, disconnection with connection timeout observed on first CIS SINK with Samsung Galaxy budsOnly two streams (CIS/BIS) with one channel is supported.

Parent topic:[AW611 release notes](#)

Abbreviations

Abbreviation	Definition
A2DP	Advanced audio distribution profile
AMPDU	Aggregated MAC protocol data unit
AMSDU	Aggregated MAC service data unit
AP	Access point
BW	Bandwidth
CCMP	Counter mode CBC-MAC protocol
CSI	Channel state information
CTS	Clear To Send
DL	Down link
EDCA	Enhanced distributed channel access
ER	Extended range
ERP	Extended rate physical
GATT	Generic attribute profile
HFP	Hands free profile
HID	Human interface device
HT	High throughput
LDPC	Low density parity check
MCS	Modulation and coding scheme
MLME	Mac layer management entity
OMI	Operating mode indication
PMF	Protected management frames
RTS	Request to send

continues on next page

Table 8 – continued from previous page

Abbreviation	Definition
SAE	Simultaneous authentication of equals
STA	Station
TWT	Target wake time
UL	Up link
VHT	Very high throughput
WEP	Wired equivalent private
WFD	Wi-Fi direct
WMM	Wireless multi-media
WPA	Wi-Fi protected access
WPS	Wi-Fi protected setup
WSC	Wi-Fi Simple Configuration

References

1. Application note - AN13681 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
2. User manual – UM11442 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for i.MX RT Platforms (available in the SDK package)
3. User manual – UM11799 - NXP Wi-Fi and Bluetooth Demo Applications User Guide for RW61x (available in the SDK package)
4. Certification – Bluetooth controller - QDID ([link](#))
5. User manual - UM12133 - NXP NCP Application Guide for RW612 with MCU Host
6. Technical note - TN00066 – Wi-Fi Alliance (WFA) Derivative Certification Process (available in the SDK package)
7. Web page – Thread certified products ([link](#))
8. Web page – Connectivity standard alliance (csa) – NXP RW612 Tri-Radio Wireless MCU Development Platform ([link](#))
9. Web page – Connectivity standard alliance (csa) – NXP RW610 Wireless MCU Development Platform ([link](#))

Chapter 4

RTOS

4.1 FreeRTOS

4.1.1 FreeRTOS kernel

Open source RTOS kernel for small devices.

FreeRTOS kernel for MCUXpresso SDK Readme

FreeRTOS kernel for MCUXpresso SDK

Overview The purpose of this document is to describes the [FreeRTOS kernel repo](#) integration into the [NXP MCUXpresso Software Development Kit: mcuxsdk](#). MCUXpresso SDK provides a comprehensive development solutions designed to optimize, ease, and help accelerate embedded system development of applications based on MCUs from NXP. This project involves the FreeRTOS kernel repo fork with:

- cmake and Kconfig support to allow the configuration and build in MCUXpresso SDK ecosystem
- FreeRTOS OS additions, such as [FreeRTOS driver wrappers](#), RTOS ready FatFs file system, and the implementation of FreeRTOS tickless mode

The history of changes in FreeRTOS kernel repo for MCUXpresso SDK are summarized in [CHANGELOG_mcuxsdk.md](#) file.

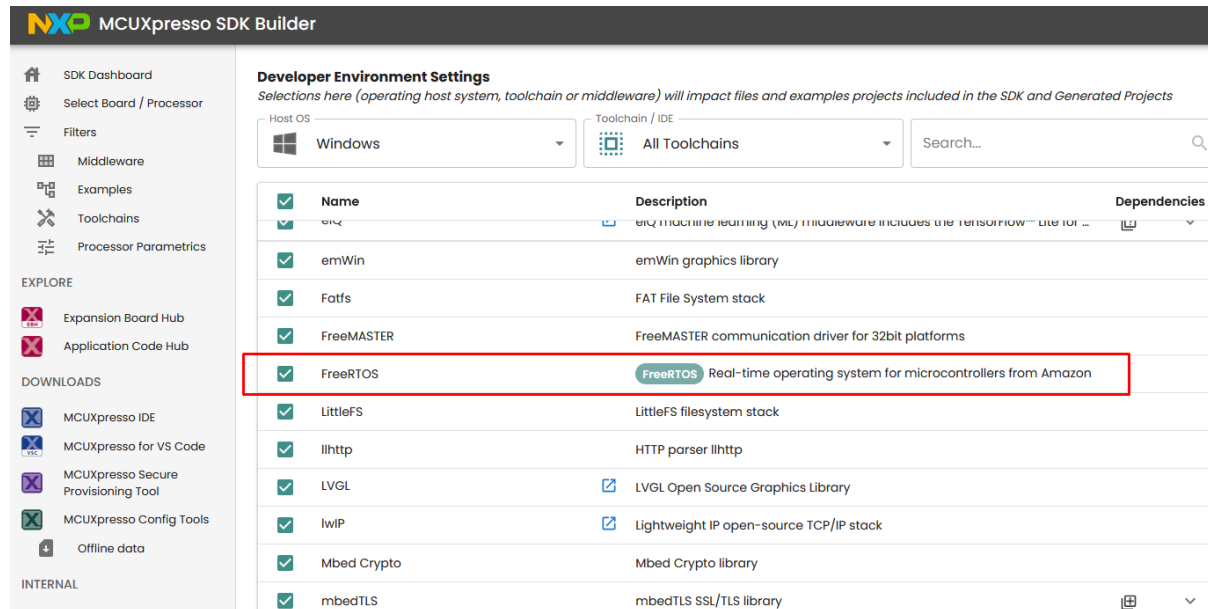
The MCUXpresso SDK framework also contains a set of FreeRTOS examples which show basic FreeRTOS OS features. This makes it easy to start a new FreeRTOS project or begin experimenting with FreeRTOS OS. Selected drivers and middleware are RTOS ready with related FreeRTOS adaptation layer.

FreeRTOS example applications The FreeRTOS examples are written to demonstrate basic FreeRTOS features and the interaction between peripheral drivers and the RTOS.

List of examples The list of freertos_examples, their description and availability for individual supported MCUXpresso SDK development boards can be obtained here: https://mcuxpresso.nxp.com/mcuxsdk/latest/html/examples/freertos_examples/index.html

Location of examples The FreeRTOS examples are located in [mcuxsdk-examples](#) repository, see the `freertos_examples` folder.

Once using MCUXpresso SDK zip packages created via the [MCUXpresso SDK Builder](#) the FreeRTOS kernel library and associated `freertos_examples` are added into final zip package once FreeRTOS components is selected on the Developer Environment Settings page:



The FreeRTOS examples in MCUXpresso SDK zip packages are located in `<MCUXpressoSDK_install_dir>/boards/<board_name>/freertos_examples/` subfolders.

Building a FreeRTOS example application For information how to use the cmake and Kconfig based build and configuration system and how to build `freertos_examples` visit: [MCUXpresso SDK documentation for Build And Configuration MCUXpresso SDK Getting Start Guide](#)

Tip: To list all FreeRTOS example projects and targets that can be built via the west build command, use this west `list_project` command in `mcuxsdk` workspace:

```
west list_project -p examples/freertos_examples
```

FreeRTOS aware debugger plugin NXP provides FreeRTOS task aware debugger for GDB. The plugin is compatible with Eclipse-based (MCUXpressoIDE) and is available after the installation.

Task List (FreeRTOS)							
TCB#	Task Name	Task Handle	Task State	Priority	Stack Usage	Event Object	Runtime
1	task_one	0x1fffecc8	Blocked	1 (1)	0 B / 880 B	MyCountingSemaphore (Rx)	0x0 (0.0%)
2	task_two	0x1ffff130	Blocked	2 (2)	0 B / 888 B	MyCountingSemaphore (Rx)	0x1 (0.1%)
3	IDLE	0x1ffff330	Running	0 (0)	0 B / 296 B		0x3e5 (99.6%)
4	Tmr Svc	0x1ffff6b8	Blocked	17 (17)	28 B / 672 B	TmrQ (Rx)	0x3 (0.3%)

FreeRTOS kernel for MCUXpresso SDK ChangeLog

Changelog FreeRTOS kernel for MCUXpresso SDK All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#), and this project adheres to [Semantic Versioning](#).

[Unreleased]**Added**

- Kconfig added CONFIG_FREERTOS_USE_CUSTOM_CONFIG_FRAGMENT config to optionally include custom FreeRTOSConfig fragment include file FreeRTOSConfig_frag.h. File must be provided by application.
- Added missing Kconfig option for configUSE_PICOLIBC_TLS.
- Add correct header files to build when configUSE_NEWLIB_REENTRANT and configUSE_PICOLIBC_TLS is selected in config.

[11.1.0_rev0]

- update amazon freertos version

[11.0.1_rev0]

- update amazon freertos version

[10.5.1_rev0]

- update amazon freertos version

[10.4.3_rev1]

- Apply CM33 security fix from 10.4.3-LTS-Patch-2. See rtos\freertos\freertos_kernel\History.txt
- Apply CM33 security fix from 10.4.3-LTS-Patch-1. See rtos\freertos\freertos_kernel\History.txt

[10.4.3_rev0]

- update amazon freertos version.

[10.4.3_rev0]

- update amazon freertos version.

[9.0.0_rev3]

- New features:
 - Tickless idle mode support for Cortex-A7. Add fsl_tickless_epit.c and fsl_tickless_generic.h in portable/IAR/ARM_CA9 folder.
 - Enabled float context saving in IAR for Cortex-A7. Added configUSE_TASK_FPU_SUPPORT macros. Modified port.c and portmacro.h in portable/IAR/ARM_CA9 folder.
- Other changes:
 - Transformed ARM_CM core specific tickless low power support into generic form under freertos/Source/portable/low_power_tickless/.

[9.0.0_rev2]

- New features:
 - Enabled MCUXpresso thread aware debugging. Add `freertos_tasks_c_additions.h` and `configINCLUDE_FREERTOS_TASK_C_ADDITIONS_H` and `configFREERTOS_MEMORY_SCHEME` macros.

[9.0.0_rev1]

- New features:
 - Enabled `-flto` optimization in GCC by adding `attribute((used))` for `vTaskSwitchContext`.
 - Enabled KDS Task Aware Debugger. Apply FreeRTOS patch to enable `configRECORD_STACK_HIGH_ADDRESS` macro. Modified files are `task.c` and `FreeRTOS.h`.

[9.0.0_rev0]

- New features:
 - Example `freertos_sem_static`.
 - Static allocation support RTOS driver wrappers.
- Other changes:
 - Tickless idle rework. Support for different timers is in separated files (`fsl_tickless_systick.c`, `fsl_tickless_lptmr.c`).
 - Removed configuration option `configSYSTICK_USE_LOW_POWER_TIMER`. Low power timer is now selected by linking of appropriate file `fsl_tickless_lptmr.c`.
 - Removed `configOVERRIDE_DEFAULT_TICK_CONFIGURATION` in RVDS port. Use of `attribute((weak))` is the preferred solution. Not same as `_weak`!

[8.2.3]

- New features:
 - Tickless idle mode support.
 - Added template application for Kinetis Expert (KEx) tool (`template_application`).
- Other changes:
 - Folder structure reduction. Keep only Kinetis related parts.

FreeRTOS kernel Readme

MCUXpresso SDK: FreeRTOS kernel This repository is a fork of FreeRTOS kernel (<https://github.com/FreeRTOS/FreeRTOS-Kernel>)(11.1.0). Modifications have been made to adapt to NXP MCUXpresso SDK. `CMakeLists.txt` and `Kconfig` added to enable FreeRTOS kernel repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository `mcuxsdk-manifests`(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

For more information about the FreeRTOS kernel repo adoption see [README_mcuxsdk.md: FreeRTOS kernel for MCUXpresso SDK Readme](#) document.



Getting started This repository contains FreeRTOS kernel source/header files and kernel ports only. This repository is referenced as a submodule in [FreeRTOS/FreeRTOS](#) repository, which contains pre-configured demo application projects under [FreeRTOS/Demo](#) directory.

The easiest way to use FreeRTOS is to start with one of the pre-configured demo application projects. That way you will have the correct FreeRTOS source files included, and the correct include paths configured. Once a demo application is building and executing you can remove the demo application files, and start to add in your own application source files. See the [FreeRTOS Kernel Quick Start Guide](#) for detailed instructions and other useful links.

Additionally, for FreeRTOS kernel feature information refer to the [Developer Documentation](#), and [API Reference](#).

Also for contributing and creating a Pull Request please refer to *the instructions here*.

Getting help If you have any questions or need assistance troubleshooting your FreeRTOS project, we have an active community that can help on the [FreeRTOS Community Support Forum](#).

To consume FreeRTOS-Kernel

Consume with CMake If using CMake, it is recommended to use this repository using FetchContent. Add the following into your project's main or a subdirectory's CMakeLists.txt:

- Define the source and version/tag you want to use:

```
FetchContent_Declare( freertos_kernel
  GIT_REPOSITORY https://github.com/FreeRTOS/FreeRTOS-Kernel.git
  GIT_TAG        main #Note: Best practice to use specific git-hash or tagged version
)
```

In case you prefer to add it as a git submodule, do:

```
git submodule add https://github.com/FreeRTOS/FreeRTOS-Kernel.git <path of the submodule>
git submodule update --init
```

- Add a freertos_config library (typically an INTERFACE library) The following assumes the directory structure:

– include/FreeRTOSConfig.h

```
add_library(freertos_config INTERFACE)

target_include_directories(freertos_config SYSTEM
INTERFACE
  include
)

target_compile_definitions(freertos_config
INTERFACE
  projCOVERAGE_TEST=0
)
```

In case you installed FreeRTOS-Kernel as a submodule, you will have to add it as a subdirectory:

```
add_subdirectory(${FREERTOS_PATH})
```

- Configure the FreeRTOS-Kernel and make it available
 - this particular example supports a native and cross-compiled build option.

```
set( FREERTOS_HEAP "4" CACHE STRING "" FORCE)
# Select the native compile PORT
set( FREERTOS_PORT "GCC_POSIX" CACHE STRING "" FORCE)
# Select the cross-compile PORT
if (CMAKE_CROSSCOMPILING)
  set(FREERTOS_PORT "GCC_ARM_CA9" CACHE STRING "" FORCE)
endif()

FetchContent_MakeAvailable(freertos_kernel)
```

- In case of cross compilation, you should also add the following to `freertos_config`:

```
target_compile_definitions(freertos_config INTERFACE ${definitions})
target_compile_options(freertos_config INTERFACE ${options})
```

Consuming stand-alone - Cloning this repository

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/FreeRTOS-Kernel.git
```

Using SSH:

```
git clone git@github.com:FreeRTOS/FreeRTOS-Kernel.git
```

Repository structure

- The root of this repository contains the three files that are common to every port - `list.c`, `queue.c` and `tasks.c`. The kernel is contained within these three files. `croutine.c` implements the optional co-routine functionality - which is normally only used on very memory limited systems.
- The `./portable` directory contains the files that are specific to a particular microcontroller and/or compiler. See the readme file in the `./portable` directory for more information.
- The `./include` directory contains the real time kernel header files.
- The `./template_configuration` directory contains a sample `FreeRTOSConfig.h` to help jumpstart a new project. See the *FreeRTOSConfig.h* file for instructions.

Code Formatting FreeRTOS files are formatted using the “`uncrustify`” tool. The configuration file used by `uncrustify` can be found in the [FreeRTOS/CI-CD-GitHub-Actions's uncrustify.cfg](#) file.

Line Endings File checked into the FreeRTOS-Kernel repository use unix-style LF line endings for the best compatibility with git.

For optimal compatibility with Microsoft Windows tools, it is best to enable the git `autocrlf` feature. You can enable this setting for the current repository using the following command:

```
git config core.autocrlf true
```

Git History Optimizations Some commits in this repository perform large refactors which touch many lines and lead to unwanted behavior when using the `git blame` command. You can configure git to ignore the list of large refactor commits in this repository with the following command:

```
git config blame.ignoreRevsFile .git-blame-ignore-revs
```

Spelling and Formatting We recommend using [Visual Studio Code](#), commonly referred to as VSCode, when working on the FreeRTOS-Kernel. The FreeRTOS-Kernel also uses [cSpell](#) as part of its spelling check. The config file for which can be found at [cspell.config.yaml](#). There is additionally a [cSpell plugin for VSCode](#) that can be used as well. `.cSpellWords.txt` contains words that are not traditionally found in an English dictionary. It is used by the spellchecker to verify the various jargon, variable names, and other odd words used in the FreeRTOS code base are correct. If your pull request fails to pass the spelling and you believe this is a mistake, then add the word to `.cSpellWords.txt`. When adding a word please then sort the list, which can be done by running the bash command: `sort -u .cSpellWords.txt -o .cSpellWords.txt`. Note that only the FreeRTOS-Kernel Source Files, *include*, *portable/MemMang*, and *portable/Common* files are checked for proper spelling, and formatting at this time.

4.1.2 FreeRTOS drivers

This is set of NXP provided FreeRTOS reentrant bus drivers.

4.1.3 backoffalgorithm

Algorithm for calculating exponential backoff with jitter for network retry attempts.

Readme

MCUXpresso SDK: backoffAlgorithm Library This repository is a fork of backoffAlgorithm library (<https://github.com/FreeRTOS/backoffalgorithm>)(1.3.0). Modifications have been made to adapt to NXP MCUXpresso SDK. `CMakeLists.txt` and `Kconfig` added to enable backoffAlgorithm repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository `mcuxsdk-manifests`(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

backoffAlgorithm Library This repository contains the backoffAlgorithm library, a utility library to calculate backoff period using an exponential backoff with jitter algorithm for retrying network operations (like failed network connection with server). This library uses the “Full Jitter” strategy for the exponential backoff with jitter algorithm. More information about the algorithm can be seen in the [Exponential Backoff and Jitter](#) AWS blog.

The backoffAlgorithm library is distributed under the *MIT Open Source License*.

Exponential backoff with jitter is typically used when retrying a failed network connection or operation request with the server. An exponential backoff with jitter helps to mitigate failed network operations with servers, that are caused due to network congestion or high request load on the server, by spreading out retry requests across multiple devices attempting network operations. Besides, in an environment with poor connectivity, a client can get disconnected at any time. A backoff strategy helps the client to conserve battery by not repeatedly attempting reconnections when they are unlikely to succeed.

See memory requirements for this library [here](#).

backoffAlgorithm v1.3.0 source code is part of the FreeRTOS 202210.00 LTS release.

backoffAlgorithm v1.0.0 source code is part of the FreeRTOS 202012.00 LTS release.

Reference example The example below shows how to use the backoffAlgorithm library on a POSIX platform to retry a DNS resolution query for amazon.com.

```
#include "backoff_algorithm.h"
#include <stdlib.h>
#include <string.h>
#include <netdb.h>
#include <unistd.h>
#include <time.h>

/* The maximum number of retries for the example code. */
#define RETRY_MAX_ATTEMPTS      ( 5U )

/* The maximum back-off delay (in milliseconds) for between retries in the example. */
#define RETRY_MAX_BACKOFF_DELAY_MS ( 5000U )

/* The base back-off delay (in milliseconds) for retry configuration in the example. */
#define RETRY_BACKOFF_BASE_MS    ( 500U )

int main()
{
    /* Variables used in this example. */
    BackoffAlgorithmStatus_t retryStatus = BackoffAlgorithmSuccess;
    BackoffAlgorithmContext_t retryParams;
    char serverAddress[] = "amazon.com";
    uint16_t nextRetryBackoff = 0;

    int32_t dnsStatus = -1;
    struct addrinfo hints;
    struct addrinfo ** pListHead = NULL;
    struct timespec tp;

    /* Add hints to retrieve only TCP sockets in getaddrinfo. */
    ( void ) memset( &hints, 0, sizeof( hints ) );

    /* Address family of either IPv4 or IPv6. */
    hints.ai_family = AF_UNSPEC;
    /* TCP Socket. */
    hints.ai_socktype = ( int32_t ) SOCK_STREAM;
    hints.ai_protocol = IPPROTO_TCP;

    /* Initialize reconnect attempts and interval. */
    BackoffAlgorithm_InitializeParams( &retryParams,
                                      RETRY_BACKOFF_BASE_MS,
                                      RETRY_MAX_BACKOFF_DELAY_MS,
                                      RETRY_MAX_ATTEMPTS );

    /* Seed the pseudo random number generator used in this example (with call to
     * rand() function provided by ISO C standard library) for use in backoff period
     * calculation when retrying failed DNS resolution. */

    /* Get current time to seed pseudo random number generator. */
    ( void ) clock_gettime( CLOCK_REALTIME, &tp );
    /* Seed pseudo random number generator with seconds. */
    srand( tp.tv_sec );

    do
    {
        /* Perform a DNS lookup on the given host name. */
        dnsStatus = getaddrinfo( serverAddress, NULL, &hints, pListHead );
    }
```

(continues on next page)

(continued from previous page)

```

/* Retry if DNS resolution query failed. */
if( dnsStatus != 0 )
{
    /* Generate a random number and get back-off value (in milliseconds) for the next retry.
    * Note: It is recommended to use a random number generator that is seeded with
    * device-specific entropy source so that backoff calculation across devices is different
    * and possibility of network collision between devices attempting retries can be avoided.
    *
    * For the simplicity of this code example, the pseudo random number generator, rand()
    * function is used. */
    retryStatus = BackoffAlgorithm_GetNextBackoff( &retryParams, rand(), &nextRetryBackoff );

    /* Wait for the calculated backoff period before the next retry attempt of querying DNS.
    * As usleep() takes nanoseconds as the parameter, we multiply the backoff period by 1000. */
    ( void ) usleep( nextRetryBackoff * 1000U );
}
} while( ( dnsStatus != 0 ) && ( retryStatus != BackoffAlgorithmRetriesExhausted ) );

return dnsStatus;
}

```

Building the library A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses a header file introduced in ISO C99, *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdint.readme*, which can be renamed to *stdint.h* to build the backoffAlgorithm library.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/backoff_algorithm.c -o example
./example
```

gcc can also produce an output file to be linked:

```
gcc -I source/include -c source/backoff_algorithm.c
```

Building unit tests

Checkout Unity Submodule By default, the submodules in this repository are configured with `update=none` in *.gitmodules*, to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/Unity
```

Platform Prerequisites

- For running unit tests
 - C89 or later compiler like *gcc*
 - CMake 3.13.0 or later
- For running the coverage target, *gcov* is additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described [above](#).)
2. Create build directory: `mkdir build && cd build`
3. Run `cmake` while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

Contributing See *CONTRIBUTING.md* for information on contributing.

4.1.4 corehttp

C language HTTP client library designed for embedded platforms.

MCUXpresso SDK: coreHTTP Client Library

This repository is a fork of coreHTTP Client library (<https://github.com/FreeRTOS/corehttp>)(3.0.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreHTTP Client repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

coreHTTP Client Library

This repository contains a C language HTTP client library designed for embedded platforms. It has no dependencies on any additional libraries other than the standard C library, [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
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of coreHTTP may differ across repositories.

Generating Documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

4.1.5 corejson

JSON parser.

Readme

MCUXpresso SDK: coreJSON Library This repository is a fork of coreJSON library (<https://github.com/FreeRTOS/corejson>)(3.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreJSON repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

coreJSON Library This repository contains the coreJSON library, a parser that strictly enforces the ECMA-404 JSON standard and is suitable for low memory footprint embedded devices. The coreJSON library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

coreJSON v3.2.0 source code is part of the FreeRTOS 202210.00 LTS release.

coreJSON v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.

Reference example

```

#include <stdio.h>
#include "core_json.h"

int main()
{
    // Variables used in this example.
    JSONStatus_t result;
    char buffer[] = "{\"foo\":\"abc\", \"bar\":{\"foo\":\"xyz\"}}";
    size_t bufferLength = sizeof( buffer ) - 1;
    char queryKey[] = "bar.foo";
    size_t queryKeyLength = sizeof( queryKey ) - 1;
    char * value;
    size_t valueLength;

    // Calling JSON_Validate() is not necessary if the document is guaranteed to be valid.
    result = JSON_Validate( buffer, bufferLength );

    if( result == JSONSuccess )
    {
        result = JSON_Search( buffer, bufferLength, queryKey, queryKeyLength,
                             &value, &valueLength );
    }

    if( result == JSONSuccess )
    {
        // The pointer "value" will point to a location in the "buffer".
        char save = value[ valueLength ];
        // After saving the character, set it to a null byte for printing.
        value[ valueLength ] = '\0';
        // "Found: bar.foo -> xyz" will be printed.
        printf( "Found: %s -> %s\n", queryKey, value );
        // Restore the original character.
        value[ valueLength ] = save;
    }

    return 0;
}

```

A search may descend through nested objects when the queryKey contains matching key strings joined by a separator, .. In the example above, bar has the value { "foo": "xyz" }. Therefore, a search for query key bar.foo would output xyz.

Building coreJSON A compiler that supports **C90 or later** such as *gcc* is required to build the library.

Additionally, the library uses 2 header files introduced in ISO C99, *stdbool.h* and *stdint.h*. For compilers that do not provide this header file, the *source/include* directory contains *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h* respectively.

For instance, if the example above is copied to a file named *example.c*, *gcc* can be used like so:

```
gcc -I source/include example.c source/core_json.c -o example
./example
```

gcc can also produce an output file to be linked:

```
gcc -I source/include -c source/core_json.c
```

Documentation

Existing documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of the coreJSON library may differ across repositories.

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Building unit tests

Checkout Unity Submodule By default, the submodules in this repository are configured with `update=none` in `.gitmodules`, to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of Unity is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/Unity
```

Platform Prerequisites

- For running unit tests
 - C90 compiler like gcc
 - CMake 3.13.0 or later
 - Ruby 2.0.0 or later is additionally required for the Unity test framework (that we use).
- For running the coverage target, gcov is additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **Unity** submodule is cloned as described [above](#).)
2. Create build directory: `mkdir build && cd build`
3. Run `cmake` while inside build directory: `cmake -S ../test`
4. Run this command to build the library and unit tests: `make all`
5. The generated test executables will be present in `build/bin/tests` folder.
6. Run `ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Contributing See *CONTRIBUTING.md* for information on contributing.

4.1.6 coremqtt

MQTT publish/subscribe messaging library.

MCUXpresso SDK: coreMQTT Library

This repository is a fork of coreMQTT library (<https://github.com/FreeRTOS/coremqtt>)(2.1.1). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

coreMQTT Client Library

This repository contains the coreMQTT library that has been optimized for a low memory footprint. The coreMQTT library is compliant with the [MQTT 3.1.1](#) standard. It has no dependencies on any additional libraries other than the standard C library, a customer-implemented network transport interface, and *optionally* a user-implemented platform time function. This library is distributed under the *MIT Open Source License*.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

coreMQTT v2.1.1 source code is part of the FreeRTOS 20210.01 LTS release.

MQTT Config File The MQTT client library exposes build configuration macros that are required for building the library. A list of all the configurations and their default values are defined in *core_mqtt_config_defaults.h*. To provide custom values for the configuration macros, a custom config file named *core_mqtt_config.h* can be provided by the application to the library.

By default, a *core_mqtt_config.h* custom config is required to build the library. To disable this requirement and build the library with default configuration values, provide `MQTT_DO_NOT_USE_CUSTOM_CONFIG` as a compile time preprocessor macro.

Thus, the MQTT library can be built by either:

- Defining a *core_mqtt_config.h* file in the application, and adding it to the include directories list of the library
- OR**
- Defining the `MQTT_DO_NOT_USE_CUSTOM_CONFIG` preprocessor macro for the library build.

Sending metrics to AWS IoT When establishing a connection with AWS IoT, users can optionally report the Operating System, Hardware Platform and MQTT client version information of their device to AWS. This information can help AWS IoT provide faster issue resolution and technical support. If users want to report this information, they can send a specially formatted string (see below) in the username field of the MQTT CONNECT packet.

Format

The format of the username string with metrics is:

```
<Actual_Username>?SDK=<OS_Name>&Version=<OS_Version>&Platform=<Hardware_Platform>&MQTTLib=<MQTT_Library_name>@<MQTT_Library_version>
```

Where

- <Actual_Username> is the actual username used for authentication, if username and password are used for authentication. When username and password based authentication is not used, this is an empty value.
- <OS_Name> is the Operating System the application is running on (e.g. FreeRTOS)
- <OS_Version> is the version number of the Operating System (e.g. V10.4.3)
- <Hardware_Platform> is the Hardware Platform the application is running on (e.g. WinSim)
- <MQTT_Library_name> is the MQTT Client library being used (e.g. coreMQTT)
- <MQTT_Library_version> is the version of the MQTT Client library being used (e.g. 1.0.2)

Example

- Actual_Username = "iotuser", OS_Name = FreeRTOS, OS_Version = V10.4.3, Hardware_Platform_Name = WinSim, MQTT_Library_Name = coremqtt, MQTT_Library_version = 2.1.1. If username is not used, then "iotuser" can be removed.

```
/* Username string:
 * iotuser?SDK=FreeRTOS&Version=v10.4.3&Platform=WinSim&MQTTLib=coremqtt@2.1.1
 */

#define OS_NAME           "FreeRTOS"
#define OS_VERSION        "V10.4.3"
#define HARDWARE_PLATFORM_NAME  "WinSim"
#define MQTT_LIB          "coremqtt@2.1.1"

#define USERNAME_STRING   "iotuser?SDK=" OS_NAME "&Version=" OS_VERSION "&Platform=" HARDWARE_PLATFORM_NAME "&MQTTLib=" MQTT_LIB
#define USERNAME_STRING_LENGTH  ( ( uint16_t ) ( sizeof( USERNAME_STRING ) - 1 ) )

MQTTConnectInfo_t connectInfo;
connectInfo.userName = USERNAME_STRING;
connectInfo.userNameLength = USERNAME_STRING_LENGTH;
mqttStatus = MQTT_Connect( pMqttContext, &connectInfo, NULL, CONNACK_RECV_TIMEOUT_MS,
↳ pSessionPresent );
```

Upgrading to v2.0.0 and above With coreMQTT versions >=v2.0.0, there are breaking changes. Please refer to the *coreMQTT version >=v2.0.0 Migration Guide*.

Building the Library The *mqttFilePaths.cmake* file contains the information of all source files and the header include path required to build the MQTT library.

Additionally, the MQTT library requires two header files that are not part of the ISO C90 standard library, *stdbool.h* and *stdint.h*. For compilers that do not provide these header files, the

source/include directory contains the files *stdbool.readme* and *stdint.readme*, which can be renamed to *stdbool.h* and *stdint.h*, respectively, to provide the type definitions required by MQTT.

As mentioned in the previous section, either a custom config file (i.e. *core_mqtt_config.h*) OR *MQTT_DO_NOT_USE_CUSTOM_CONFIG* macro needs to be provided to build the MQTT library.

For a CMake example of building the MQTT library with the *mqttFilePaths.cmake* file, refer to the *coverity_analysis* library target in *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule By default, the submodules in this repository are configured with *update=none* in *.gitmodules* to avoid increasing clone time and disk space usage of other repositories (like [amazon-freertos](#) that submodules this repository).

To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

Platform Prerequisites

- Docker

or the following:

- For running unit tests
 - **C90 compiler** like gcc
 - **CMake 3.13.0 or later**
 - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build Unit Tests

1. If using docker, launch the container:
 1. `docker build -t coremqtt .`
 2. `docker run -it -v "$PWD":/workspaces/coreMQTT -w /workspaces/coreMQTT coremqtt`
2. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#))
3. Run the *cmake* command: `cmake -S test -B build`
4. Run this command to build the library and unit tests: `make -C build all`
5. The generated test executables will be present in *build/bin/tests* folder.
6. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The *test/cbmc/proofs* directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples Please refer to the demos of the MQTT client library in the following locations for reference examples on POSIX and FreeRTOS platforms:

Platform	Location	Transport Interface Implementation
POSIX	AWS IoT Device SDK for Embedded C	POSIX sockets for TCP/IP and OpenSSL for TLS stack
FreeRTOS	FreeRTOS/FreeRTOS	FreeRTOS+TCP for TCP/IP and mbedTLS for TLS stack
FreeRTOS	FreeRTOS AWS Reference Integrations	Based on Secure Sockets Abstraction

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C
FreeRTOS.org

Note that the latest included version of coreMQTT may differ across repositories.

Generating Documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Contributing See *CONTRIBUTING.md* for information on contributing.

4.1.7 coremqtt-agent

The coreMQTT Agent library is a high level API that adds thread safety to the coreMQTT library.

Readme

MCUXpresso SDK: coreMQTT Agent Library This repository is a fork of coreMQTT Agent library (<https://github.com/FreeRTOS/coremqtt-agent>)(1.2.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable coreMQTT Agent repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

coreMQTT Agent Library The coreMQTT Agent library is a high level API that adds thread safety to the [coreMQTT](#) library. The library provides thread safe equivalents to the coreMQTT's APIs, greatly simplifying its use in multi-threaded environments. The coreMQTT Agent library manages the MQTT connection by serializing the access to the coreMQTT library and reducing implementation overhead (e.g., removing the need for the application to repeatedly call to MQTT_ProcessLoop). This allows your multi-threaded applications to share the same MQTT connection, and enables you to design an embedded application without having to worry about coreMQTT thread safety.

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#), and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

Cloning this repository This repo uses [Git Submodules](#) to bring in dependent components.

To clone using HTTPS:

```
git clone https://github.com/FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

Using SSH:

```
git clone git@github.com:FreeRTOS/coreMQTT-Agent.git --recurse-submodules
```

If you have downloaded the repo without using the `--recurse-submodules` argument, you need to run:

```
git submodule update --init --recursive
```

coreMQTT Agent Library Configurations The MQTT Agent library uses the same `core_mqtt_config.h` configuration file as coreMQTT, with the addition of configuration constants listed at the top of `core_mqtt_agent.h` and `core_mqtt_agent_command_functions.h`. Documentation for these configurations can be found [here](#).

To provide values for these configuration values, they must be either:

- Defined in `core_mqtt_config.h` used by coreMQTT **OR**
- Passed as compile time preprocessor macros

Porting the coreMQTT Agent Library In order to use the MQTT Agent library on a platform, you need to supply thread safe functions for the agent's *messaging interface*.

Messaging Interface Each of the following functions must be thread safe.

Function Pointer	Description
MQTTAgentMessageSend_t	A function that sends commands (as MQTTAgentCommand_t * pointers) to be received by MQTTAgent_CommandLoop. This can be implemented by pushing to a thread safe queue.
MQTTAgentMessageRecv_t	A function used by MQTTAgent_CommandLoop to receive MQTTAgentCommand_t * pointers that were sent by API functions. This can be implemented by receiving from a thread safe queue.
MQTTAgentCommandGet_t	A function that returns a pointer to an allocated MQTTAgentCommand_t structure, which is used to hold information and arguments for a command to be executed in MQTTAgent_CommandLoop(). If using dynamic memory, this can be implemented using malloc().
MQTTAgentCommandRelease_t	A function called to indicate that a command structure that had been allocated with the MQTTAgentCommandGet_t function pointer will no longer be used by the agent, so it may be freed or marked as not in use. If using dynamic memory, this can be implemented with free().

Reference implementations for the interface functions can be found in the [reference examples](#) below.

Additional Considerations

Static Memory If only static allocation is used, then the MQTTAgentCommandGet_t and MQTTAgentCommandRelease_t could instead be implemented with a pool of MQTTAgentCommand_t structures, with a queue or semaphore used to control access and provide thread safety. The below [reference examples](#) use static memory with a command pool.

Subscription Management The MQTT Agent does not track subscriptions for MQTT topics. The receipt of any incoming PUBLISH packet will result in the invocation of a single MQTTAgentIncomingPublishCallback_t callback, which is passed to MQTTAgent_Init() for initialization. If it is desired for different handlers to be invoked for different incoming topics, then the publish callback will have to manage subscriptions and fan out messages. A platform independent subscription manager example is implemented in the [reference examples](#) below.

Building the Library You can build the MQTT Agent source files that are in the *source* directory, and add *source/include* to your compiler's include path. Additionally, the MQTT Agent library requires the coreMQTT library, whose files follow the same *source/* and *source/include* pattern as the agent library; its build instructions can be found [here](#).

If using CMake, the *mqttAgentFilePaths.cmake* file contains the above information of the source files and the header include path from this repository. The same information is found for coreMQTT from *mqttFilePaths.cmake* in the *coreMQTT submodule*.

For a CMake example of building the MQTT Agent library with the *mqttAgentFilePaths.cmake* file, refer to the *coverity_analysis* library target in *test/CMakeLists.txt* file.

Building Unit Tests

Checkout CMock Submodule To build unit tests, the submodule dependency of CMock is required. Use the following command to clone the submodule:

```
git submodule update --checkout --init --recursive test/unit-test/CMock
```

Unit Test Platform Prerequisites

- For running unit tests
 - **C90 compiler** like gcc
 - **CMake 3.13.0 or later**
 - **Ruby 2.0.0 or later** is additionally required for the CMock test framework (that we use).
- For running the coverage target, **gcov** and **lcov** are additionally required.

Steps to build Unit Tests

1. Go to the root directory of this repository. (Make sure that the **CMock** submodule is cloned as described [above](#))
2. Run the *cmake* command: `cmake -S test -B build`
3. Run this command to build the library and unit tests: `make -C build all`
4. The generated test executables will be present in `build/bin/tests` folder.
5. Run `cd build && ctest` to execute all tests and view the test run summary.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples Please refer to the demos of the MQTT Agent library in the following locations for reference examples on FreeRTOS platforms:

Location
coreMQTT Agent Demos
FreeRTOS/FreeRTOS

Documentation The MQTT Agent API documentation can be found [here](#).

Generating documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages yourself, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Getting help You can use your Github login to get support from both the FreeRTOS community and directly from the primary FreeRTOS developers on our [active support forum](#). You can find a list of [frequently asked questions](#) [here](#).

Contributing See *CONTRIBUTING.md* for information on contributing.

License This library is licensed under the MIT License. See the *LICENSE* file.

4.1.8 corepkcs11

PKCS #11 key management library.

Readme

MCUXpresso SDK: corePKCS11 Library This repository is a fork of PKCS #11 key management library (<https://github.com/FreeRTOS/corePKCS11/tree/v3.5.0>)(v3.5.0). Modifications have been made to adapt to NXP MCUXpresso SDK. CMakeLists.txt and Kconfig added to enable corepkcs11 repo sources build in MCUXpresso SDK. It is part of the MCUXpresso SDK overall delivery which is composed of several sub-repositories/projects. Navigate to the top/parent repository mcuxsdk-manifests(<https://github.com/nxp-mcuxpresso/mcuxsdk-manifests>) for the complete delivery of MCUXpresso SDK.

corePKCS11 Library PKCS #11 is a standardized and widely used API for manipulating common cryptographic objects. It is important because the functions it specifies allow application software to use, create, modify, and delete cryptographic objects, without ever exposing those objects to the application's memory. For example, FreeRTOS AWS reference integrations use a small subset of the PKCS #11 API to, among other things, access the secret (private) key necessary to create a network connection that is authenticated and secured by the [Transport Layer Security \(TLS\)](#) protocol – without the application ever ‘seeing’ the key.

The Cryptoki or PKCS #11 standard defines a platform-independent API to manage and use cryptographic tokens. The name, “PKCS #11”, is used interchangeably to refer to the API itself and the standard which defines it.

This repository contains a software based mock implementation of the PKCS #11 interface (API) that uses the cryptographic functionality provided by Mbed TLS. Using a software mock enables rapid development and flexibility, but it is expected that the mock be replaced by an implementation specific to your chosen secure key storage in production devices.

Only a subset of the PKCS #11 standard is implemented, with a focus on operations involving asymmetric keys, random number generation, and hashing.

The targeted use cases include certificate and key management for TLS authentication and code-sign signature verification, on small embedded devices.

corePKCS11 is implemented on PKCS #11 v2.4.0, the full PKCS #11 standard can be found on the [oasis website](#).

This library has gone through code quality checks including verification that no function has a [GNU Complexity](#) score over 8, and checks against deviations from mandatory rules in the [MISRA coding standard](#). Deviations from the MISRA C:2012 guidelines are documented under *MISRA Deviations*. This library has also undergone both static code analysis from [Coverity static analysis](#) and validation of memory safety through the [CBMC automated reasoning tool](#).

See memory requirements for this library [here](#).

corePKCS11 v3.5.0 source code is part of the FreeRTOS 202210.00 LTS release.

corePKCS11 v3.0.0 source code is part of the FreeRTOS 202012.00 LTS release.

Purpose Generally vendors for secure cryptoprocessors such as Trusted Platform Module (TPM), Hardware Security Module (HSM), Secure Element, or any other type of secure hardware enclave, distribute a PKCS #11 implementation with the hardware. The purpose of the corePKCS11 software only mock library is therefore to provide a non hardware specific PKCS #11 implementation that allows for rapid prototyping and development before switching to a cryptoprocessor specific PKCS #11 implementation in production devices.

Since the PKCS #11 interface is defined as part of the PKCS #11 [specification](#) replacing this library with another implementation should require little porting effort, as the interface will not change. The system tests distributed in this repository can be leveraged to verify the behavior of a different implementation is similar to corePKCS11.

corePKCS11 Configuration The corePKCS11 library exposes preprocessor macros which must be defined prior to building the library. A list of all the configurations and their default values are defined in the doxygen documentation for this library.

Build Prerequisites

Library Usage For building the library the following are required:

- **A C99 compiler**
- **mbedcrypto** library from [mbedtls](#) version 2.x or 3.x.
- **pkcs11 API header(s)** available from [OASIS](#) or [OpenSC](#)

Optionally, variables from the pkcsFilePaths.cmake file may be referenced if your project uses cmake.

Integration and Unit Tests In order to run the integration and unit test suites the following are dependencies are necessary:

- **C Compiler**
- **CMake 3.13.0 or later**
- **Ruby 2.0.0 or later** required by CMock.
- **Python 3** required for configuring mbedtls.
- **git** required for fetching dependencies.
- **GNU Make** or **Ninja**

The *mbedtls*, *CMock*, and *Unity* libraries are downloaded and built automatically using the cmake FetchContent feature.

Coverage Measurement and Instrumentation The following software is required to run the coverage target:

- Linux, MacOS, or another POSIX-like environment.
- A recent version of **GCC** or **Clang** with support for gcov-like coverage instrumentation.
- **gcov** binary corresponding to your chosen compiler
- **lcov** from the [Linux Test Project](#)
- **perl** needed to run the lcov utility.

Coverage builds are validated on recent versions of Ubuntu Linux.

Running the Integration and Unit Tests

1. Navigate to the root directory of this repository in your shell.
2. Run **cmake** to construct a build tree: `cmake -S test -B build`
 - You may specify your preferred build tool by appending `-G'Unix Makefiles'` or `-GNinja` to the command above.
 - You may append `-DUNIT_TESTS=0` or `-DSYSTEM_TESTS=0` to disable Unit Tests or Integration Tests respectively.
3. Build the test binaries: `cmake --build ./build --target all`
4. Run `ctest --test-dir ./build` or `cmake --build ./build --target test` to run the tests without capturing coverage.
5. Run `cmake --build ./build --target coverage` to run the tests and capture coverage data.

CBMC To learn more about CBMC and proofs specifically, review the training material [here](#).

The `test/cbmc/proofs` directory contains CBMC proofs.

In order to run these proofs you will need to install CBMC and other tools by following the instructions [here](#).

Reference examples The FreeRTOS-Labs repository contains demos using the PKCS #11 library [here](#) using FreeRTOS on the Windows simulator platform. These can be used as reference examples for the library API.

Porting Guide Documentation for porting corePKCS11 to a new platform can be found on the AWS [docs](#) web page.

corePKCS11 is not meant to be ported to projects that have a TPM, HSM, or other hardware for offloading crypto-processing. This library is specifically meant to be used for development and prototyping.

Related Example Implementations These projects implement the PKCS #11 interface on real hardware and have similar behavior to corePKCS11. It is preferred to use these, over corePKCS11, as they allow for offloading Cryptography to separate hardware.

- ARM's [Platform Security Architecture](#).
- Microchip's [cryptoauthlib](#).
- Infineon's [Optiga Trust X](#).

Documentation

Existing Documentation For pre-generated documentation, please see the documentation linked in the locations below:

Location
AWS IoT Device SDK for Embedded C FreeRTOS.org

Note that the latest included version of corePKCS11 may differ across repositories.

Generating Documentation The Doxygen references were created using Doxygen version 1.9.2. To generate the Doxygen pages, please run the following command from the root of this repository:

```
doxygen docs/doxygen/config.doxyfile
```

Security See *CONTRIBUTING* for more information.

License This library is licensed under the MIT-0 License. See the LICENSE file.

4.1.9 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

Readme

MCUXpresso SDK: FreeRTOS-Plus-TCP Library This repository is a fork of FreeRTOS-Plus-TCP library (<https://github.com/FreeRTOS/freertos-plus-tcp>)(4.0.0). 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](#).