



MCUXpresso SDK Documentation

Release 26.03.00-pvw2



NXP
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This documentation contains information specific to the lpcxpresso54s018m board.

Chapter 1

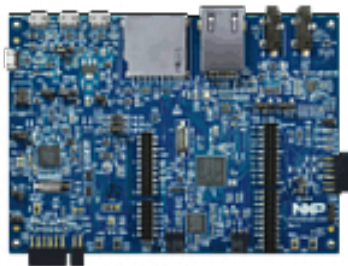
LPCXpresso54S018M

1.1 Overview

The LPCXpresso54S018M board provides a powerful and flexible platform for easy evaluation of the LPC54600 family of microcontrollers. This board is an LPCXpresso V3 style, the latest generation of the original and highly successful LPCXpresso board family. These boards provide Arduino UNO compatible shield connectors with additional expansion ports around the Arduino footprint and also a PMod/host interface port. These boards feature an on-board LPC-Link2 debug probe based on the LPC4322 MCU for a performance debug experience over high speed USB, with easy firmware update options to support CMSIS-DSP or a special version of J-link OBD from SEGGER. The board can also be used with an external debug probe such as those from SEGGER and P&E.

The LPC54S00 series is fully supported by NXP's MCUXpresso suite of free software and tools, which include an Eclipse-based IDE, configuration tools and extensive SDK drivers/examples available at <https://mcuxpresso.nxp.com>. MCUXpresso SDK includes project files for use with IDEs from lead partners Keil and IAR, and these IDEs are also fully supported by the MCUXpresso pin, clock and peripheral configuration tools.

The LPCXpresso54S018M board includes an extensive set of connectors and on-board peripherals to enable full evaluation of the target MCU and development of highly functional prototypes. The on-board peripherals are complemented by a set of drivers and examples in the MCUXpresso SDK.



MCU device and part on board is shown below:

- Device: LPC54S018M
- PartNumber: LPC54S018J4MET180

1.2 Getting Started with MCUXpresso SDK Package

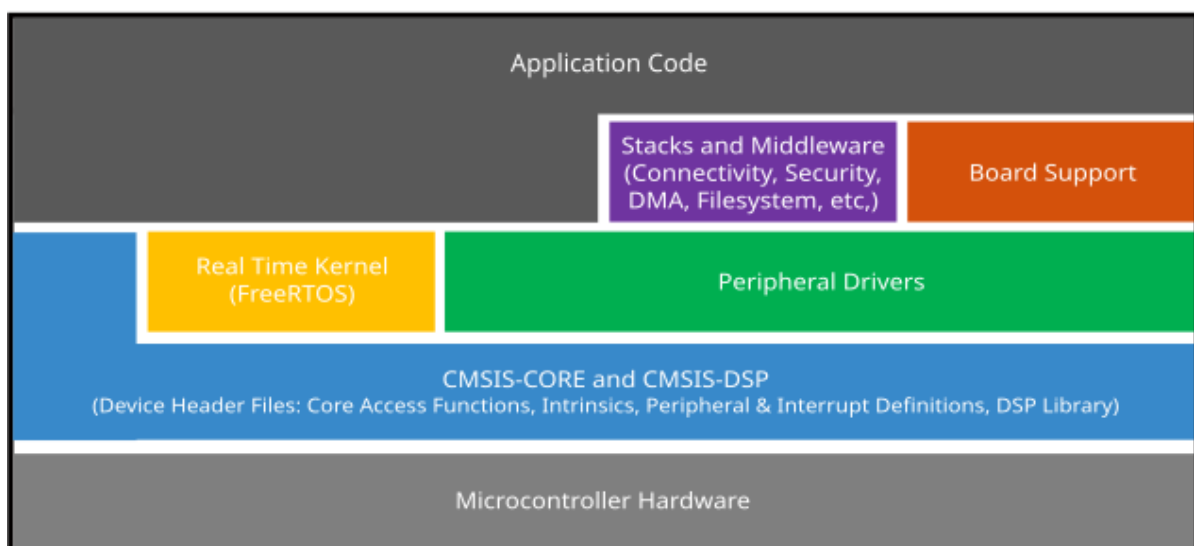
1.2.1 Getting Started with Package

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 LPCXpresso540XX* (document MCUXSDKLPC540XXRN). After opening SDK_2.6.0_LPCXpresso54018\docs, consult the *MCUXpresso SDK Release Notes_LPC540XX*.

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 sub-folders to classify the type of examples it contain. These include (but are not limited to):

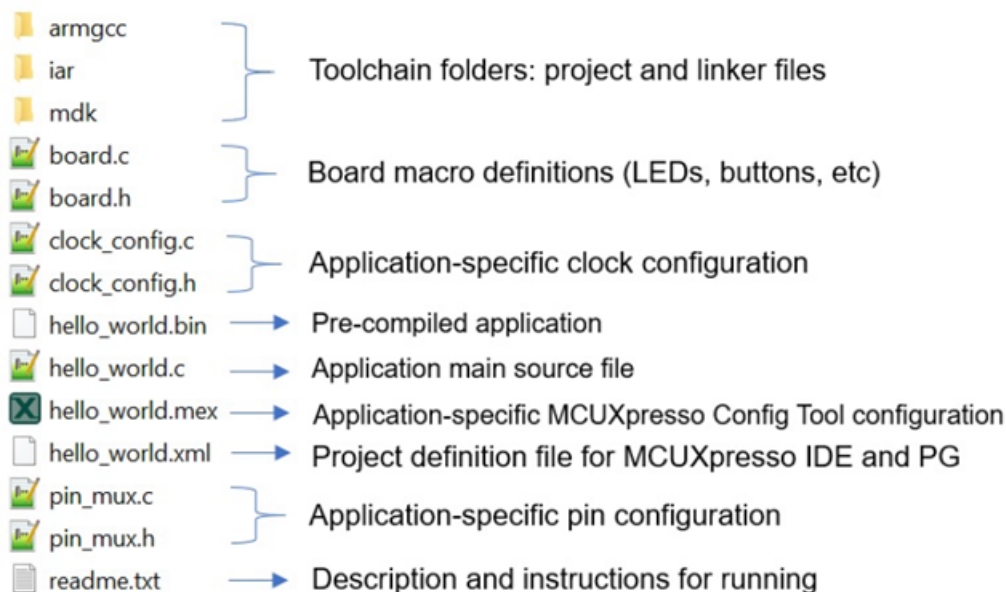
- **demo_apps**: Full-featured applications that highlight key functionality and use cases of the target MCU. These applications typically use multiple MCU peripherals and may leverage stacks and middleware.
- **driver_examples**: Simple applications that show how to use the MCUXpresso SDK's peripheral drivers for a single use case. These applications typically only use a single peripheral but there are cases where multiple peripherals are used (for example, SPI conversion using DMA).

- `rtos_examples`: Basic FreeRTOS™ OS examples that show the use of various RTOS objects (semaphores, queues, and so on) and interfaces with the MCUXpresso SDK's RTOS drivers

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, a variety of source files are referenced. The MCUXpresso SDK devices folder is the central component to all example applications. It means the examples reference the same source files and, if one of these files is modified, it could potentially impact the behavior of other examples.

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

- `devices/<device_name>`: The device's CMSIS header file, MCUXpresso SDK feature file and a few other files
- `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

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.

What is the plain load image? The plain load image is linked to SRAMX. When building, it needs to be programmed to the external onboard flash. After reset, the bootloader starts to run. Then, it checks the image type (which is set in the image header, which resides in the startup code). If the type is plain load image, the bootloader copies the image to SRAMX, then jumps to SRAMX to run.

Parent topic: Locating example application source files

What is the XIP image? When an XIP (Execute-in-Place) image is used, the MCU executes instructions and uses data directly from external (quad) SPI flash. When building, it needs to be programmed to the external onboard flash. After reset, the bootloader starts to run. Then, it checks the image type (which is set in the image header, which resides in the startup code). If the type is XIP image, the device executes in the external flash.

Parent topic: Locating example application source files

What is the SRAM target image? The SRAM target image is linked to the SRAM address when building. When debugging, the SRAM target, the IDE just loads the image into SRAM to run.

Parent topic: Locating example application source files

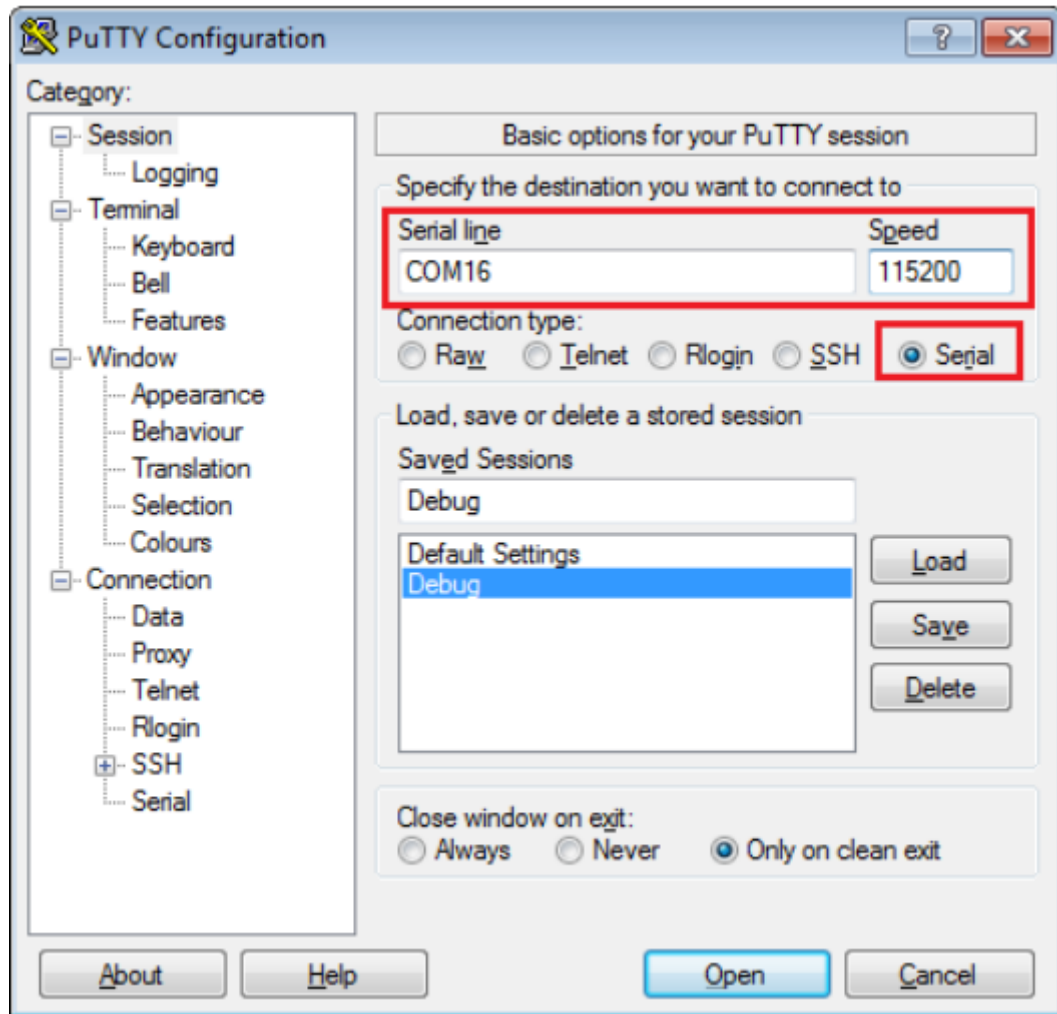
Parent topic: *MCUXpresso SDK board support package folders*

Run a demo application using IAR

This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK. The `hello_world` demo application targeted for the LPCXpresso54018 hardware platform is used as an example, although these steps can be applied to any example application in the MCUXpresso SDK.

Before downloading and running the application, perform these steps:

1. Download and install LPCScript or the Windows® operating systems driver for LPCXpresso boards from www.nxp.com/lpcutilities. This installs the required drivers for the board.
2. Connect the development platform to your PC via USB cable between the Link2 USB connector (named Link for some boards) and the PC USB connector. If you are connecting for the first time, allow about 30 seconds for the devices to enumerate.
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 Appendix A). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in board.h file)
 2. No parity
 3. 8 data bits
 4. 1 stop bit



Build an non-XIP (plain load) 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
```

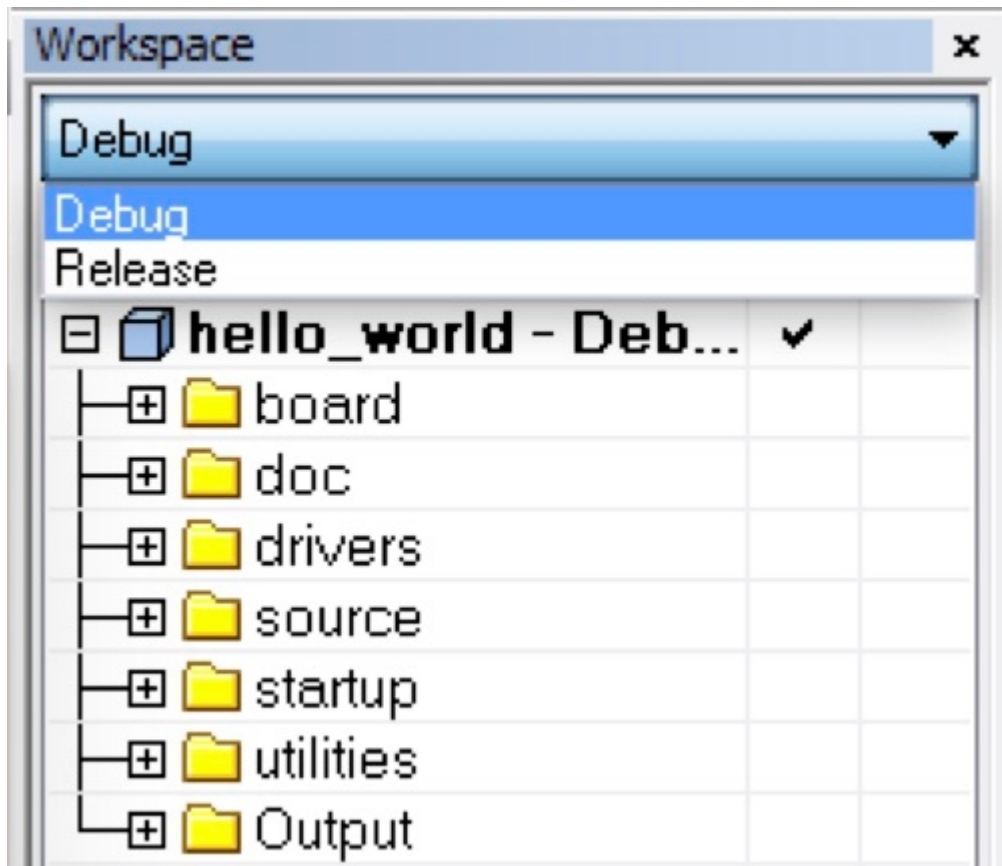
Using the LPCXpresso54018 hardware platform as an example, the hello_world workspace is located in:

```
<install_dir>/boards/lpcxpresso54018/demo_apps/hello_world/iar/hello_world.eww
```

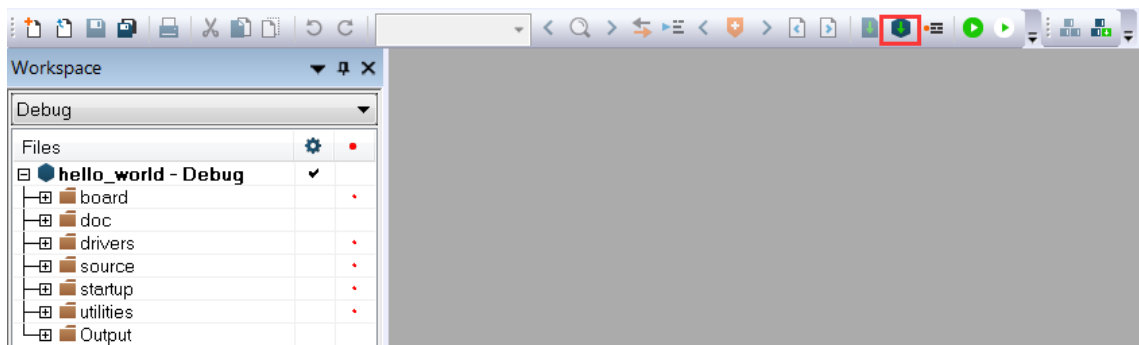
Other example applications may have additional folders in their path.

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](#)

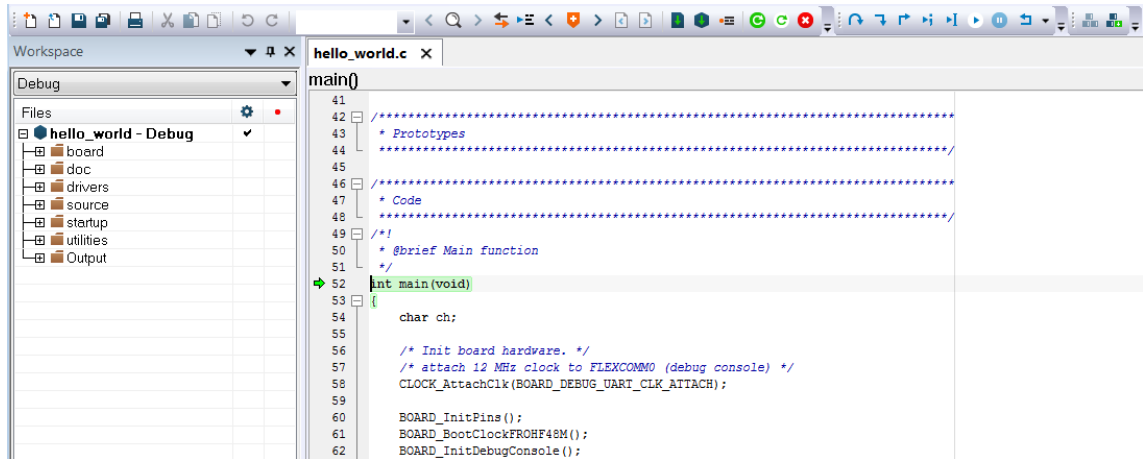
Run a non-XIP (plain load) example application using CMSIS DAP

1. In IAR, click the “Download and Debug” button to download the application to the target.



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

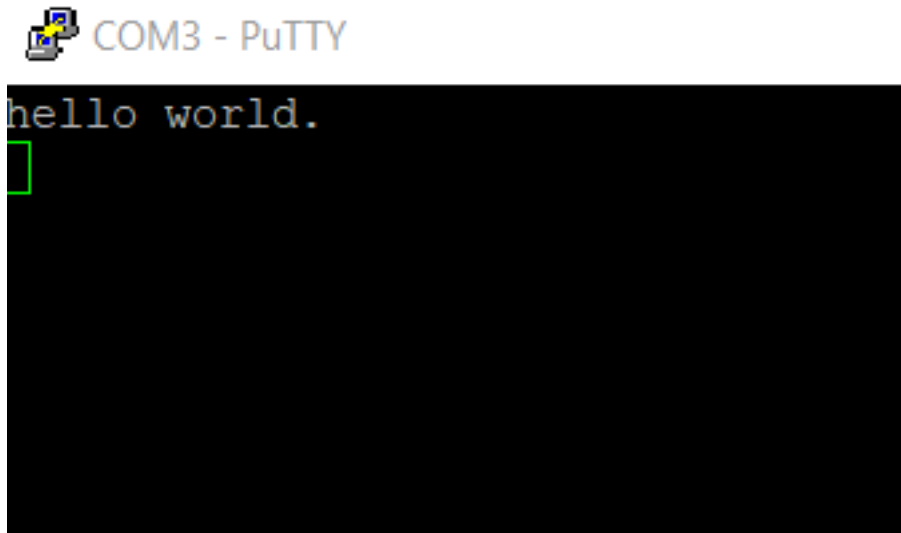
Note: The application is programmed to the external on board flash, then jumped to SRAM to run



3. Run the code by clicking the “Go” button to start the application.



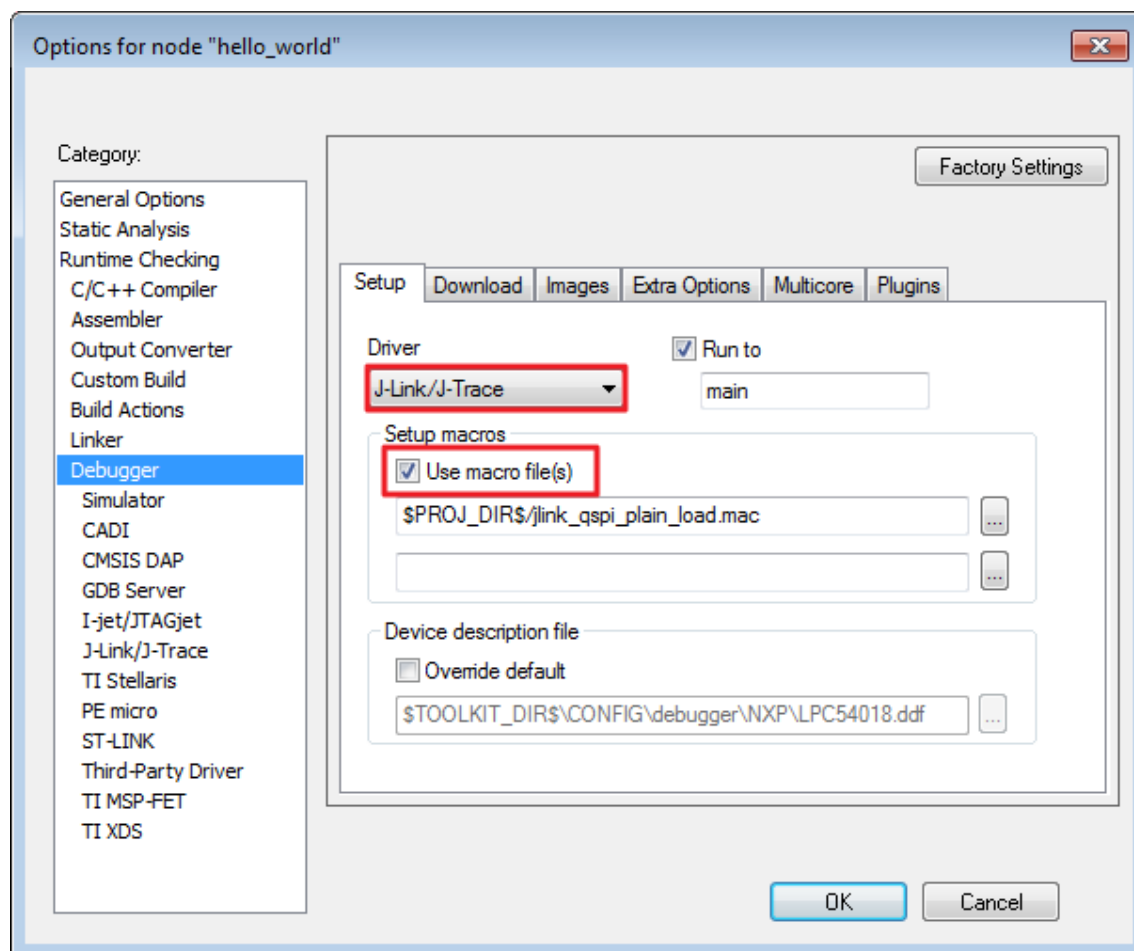
4. The hello_world application is now running and a banner is displayed on the terminal. If this does not occur, check your terminal settings and connections.



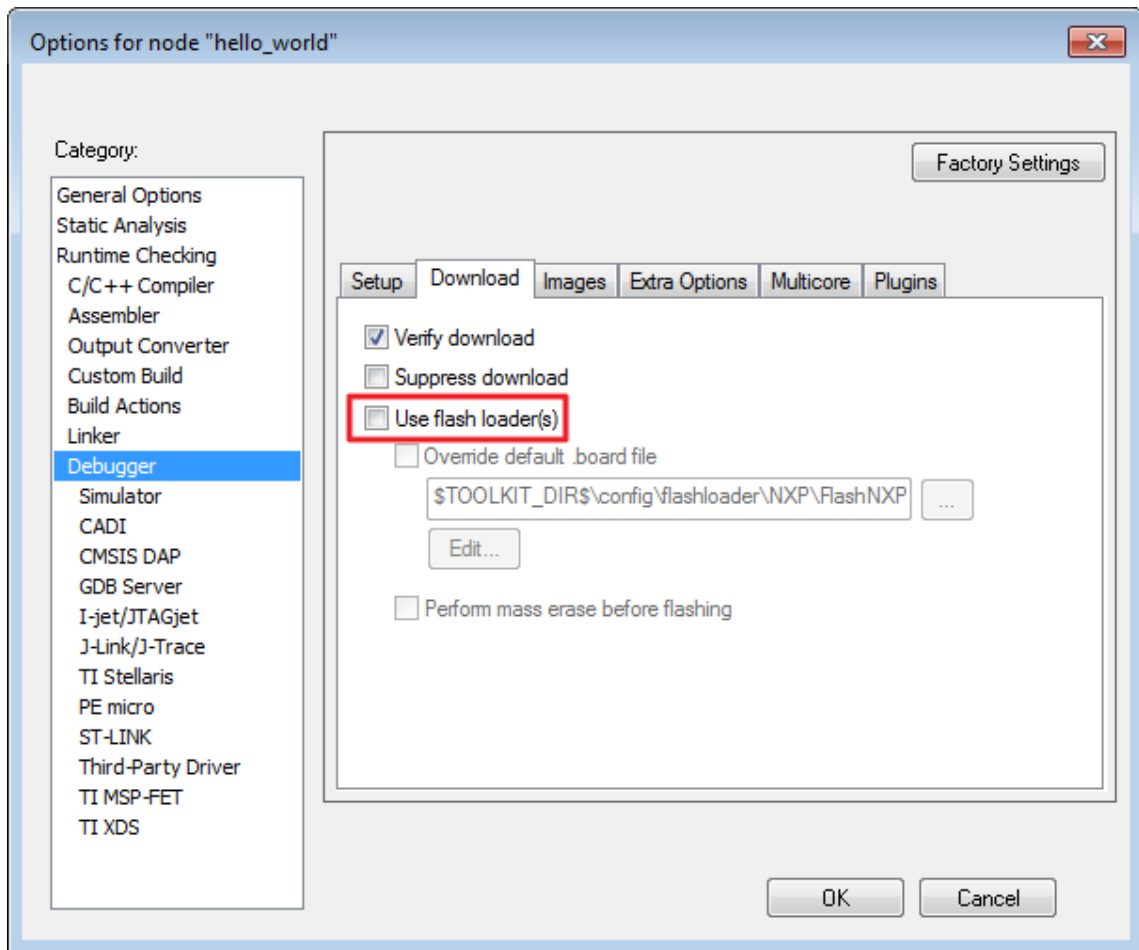
Parent topic: [Run a demo application using IAR](#)

Run a non-XIP (plain load) example application using J-Link/J-Trace This section describes how to configure EWARM if using a J-link/J-Trace debug probe, or a probe which has been programmed with J-link firmware.

1. Select “J-Link/J-Trace” and “Use macro file(s)”.



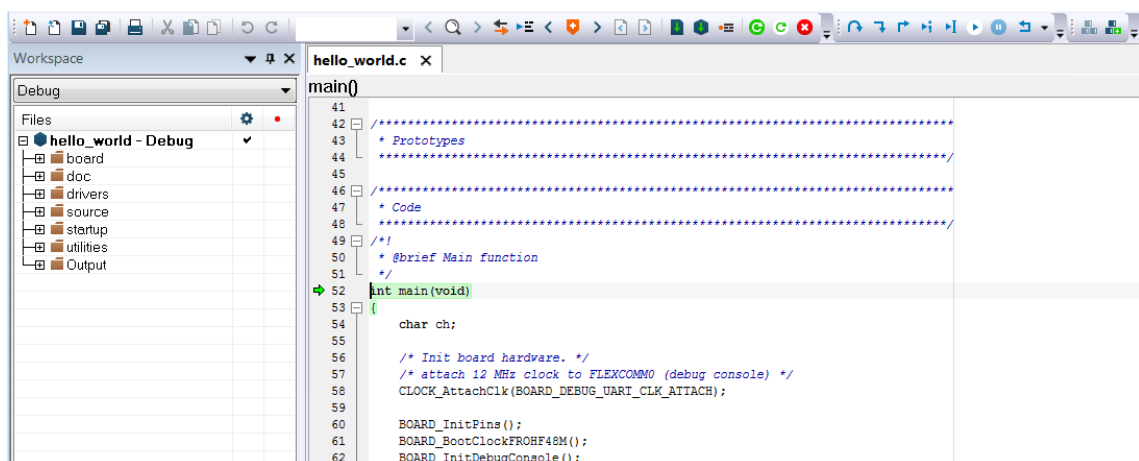
2. Unselect "Use flash loader(s)" to use SEGGER J-Link flashloaders. Then, click the "OK" button.



3. In IAR, click the “Download and Debug” button to download the application to the target.



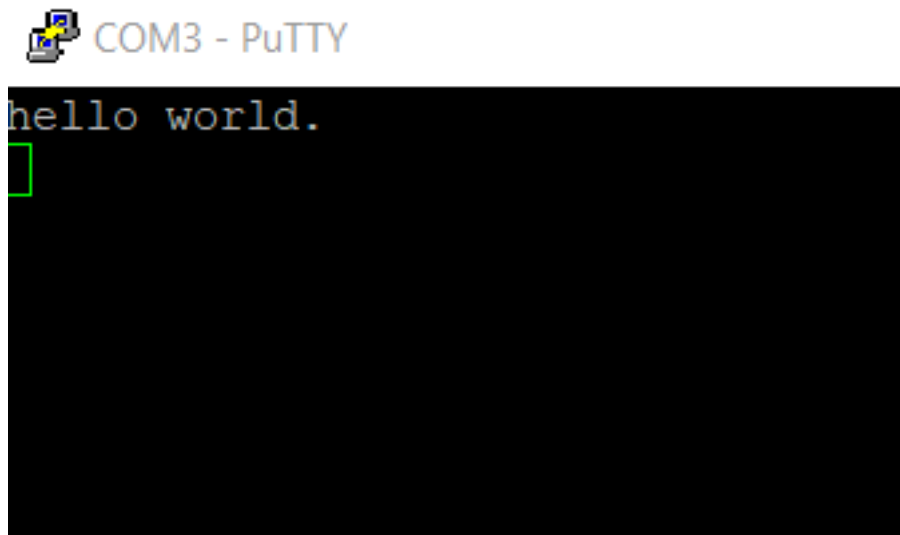
4. The application is then downloaded to the target and automatically runs to the main() function.



5. Run the code by clicking the “Go” button to start the application.



6. 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 application using IAR](#)

Build an XIP example application The following steps guide you through opening the `hello_world_qspi_xip` example application. These steps may change slightly for other example applications, as some of these applications may have additional layers of folders in their paths.

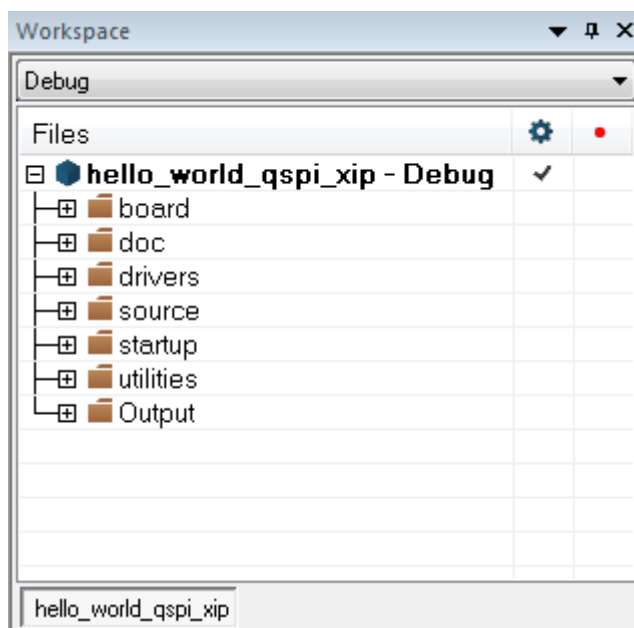
1. If not already done, open the desired demo application workspace. Most example application workspace files can be located using the following path:

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

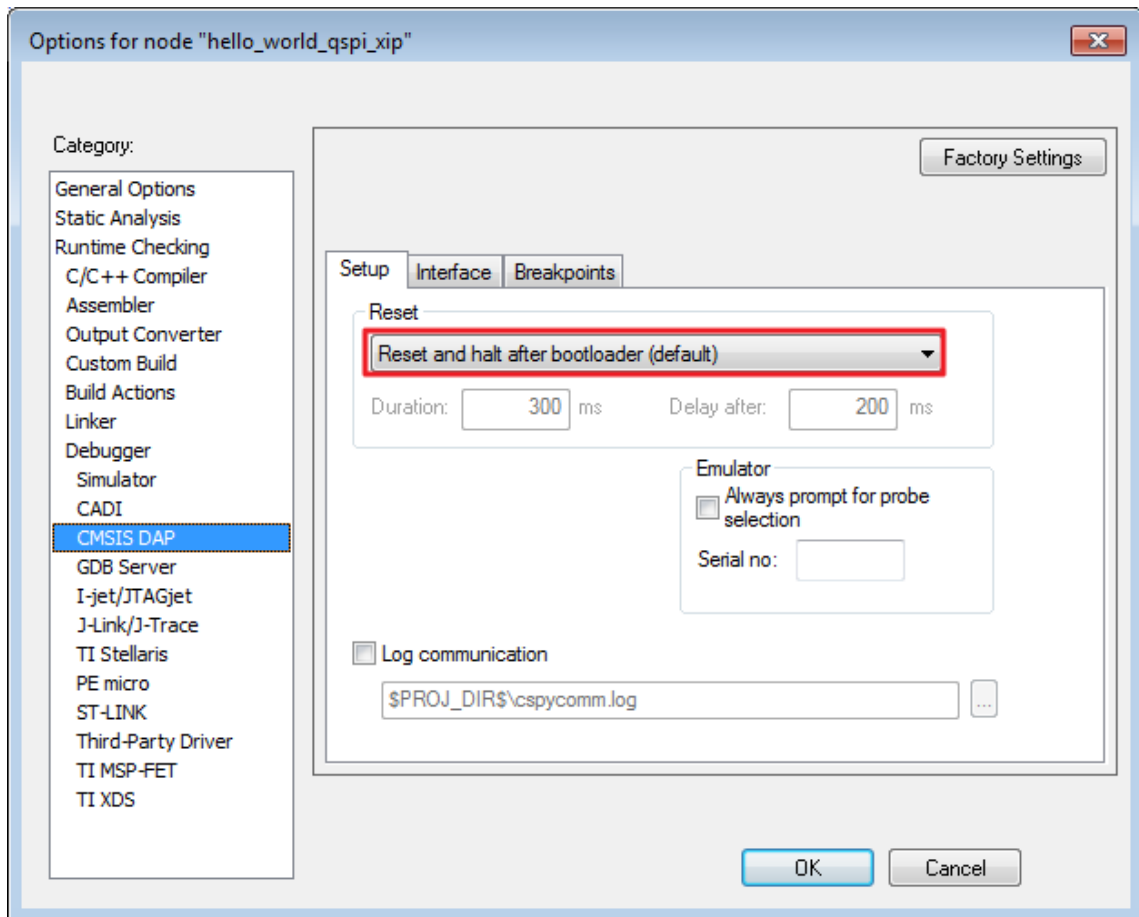
Using the LPCXpresso54018 hardware platform as an example, the `hello_world` workspace is located in

`<install_dir>/boards/lpcxpresso54018/demo_apps/hello_world/iar/hello_world_qspi_xip.eww`

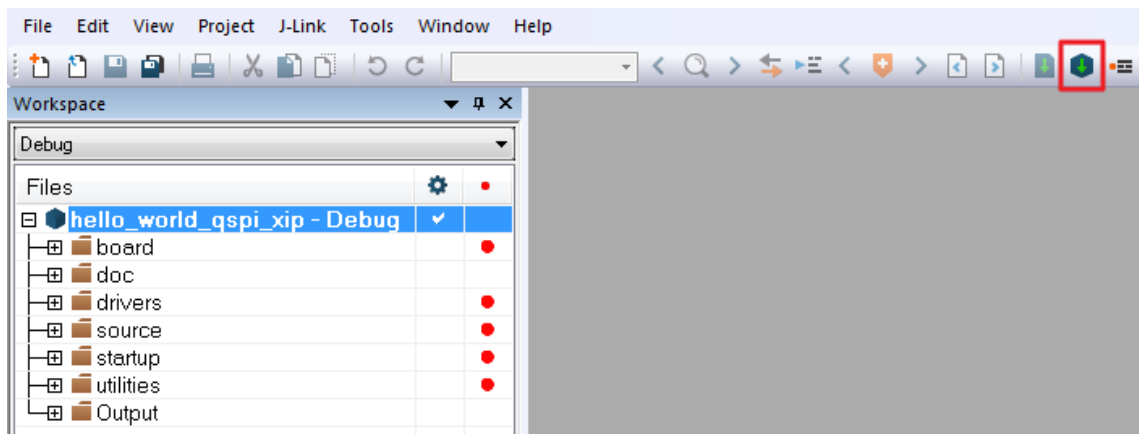
2. Select the desired build target from the drop-down. For this example, select the “`hello_world_qspi_xip - Debug`” target.



3. Select “Reset and halt after bootloader”, highlighted in red below.



4. To build the demo application, click the “Make” button, highlighted in red below.



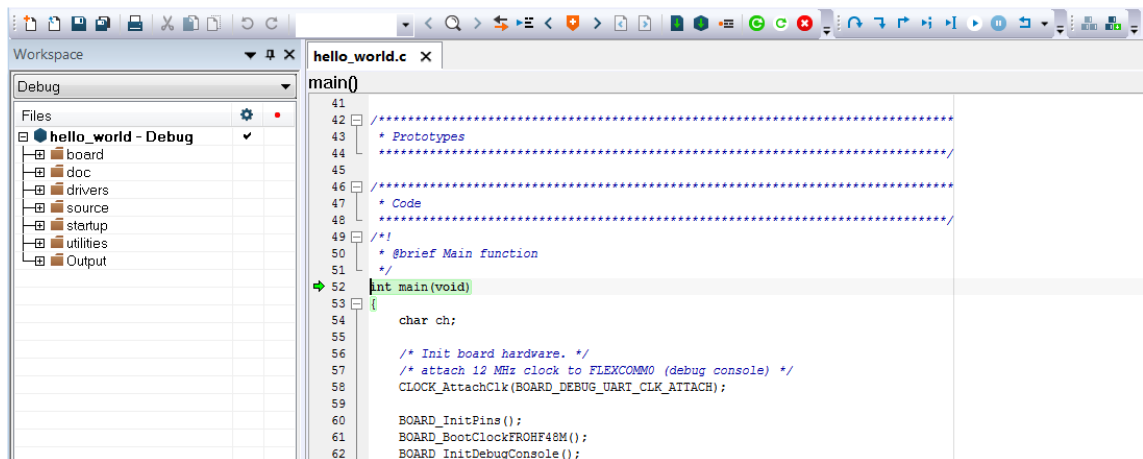
Parent topic: [Run a demo application using IAR](#)

Run an XIP example application

1. In IAR, click the “Download and Debug” button to download the application to the target.



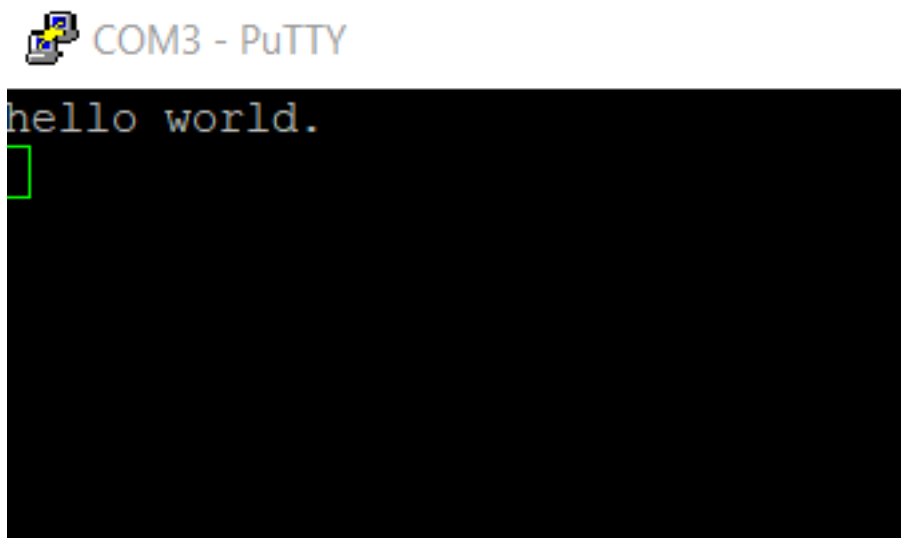
2. The application is then downloaded to the target and automatically runs to the main() function.



3. Run the code by clicking the “Go” button to start the application.



4. The hello_world_qspi_xip 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 application using IAR](#)

Run a demo using Keil® MDK/μVision

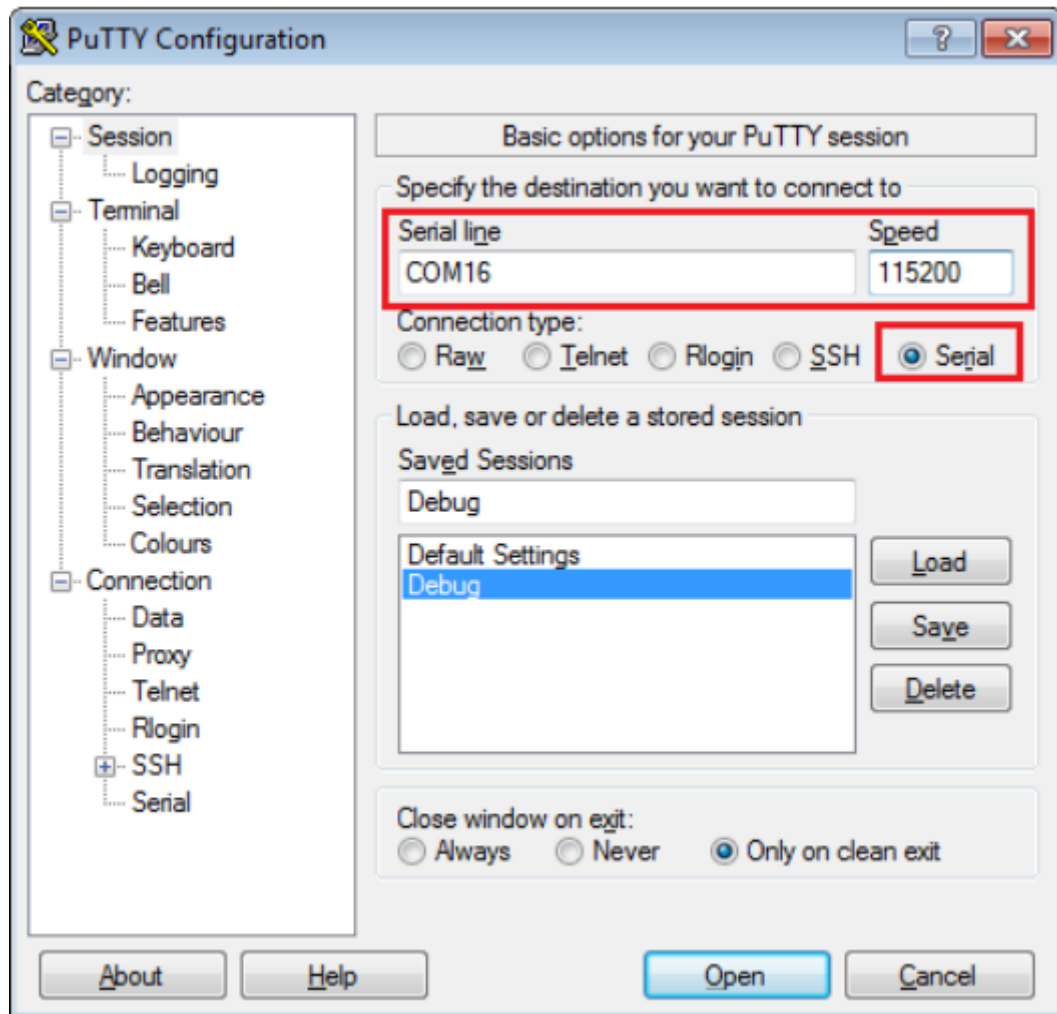
This section describes the steps required to build, run, and debug example applications provided in the MCUXpresso SDK.

The hello_world demo application targeted for the LPCXpresso54018 hardware platform is used as an example, although these steps can be applied to any demo or example application in the MCUXpresso SDK.

Before downloading and running the application, perform these steps:

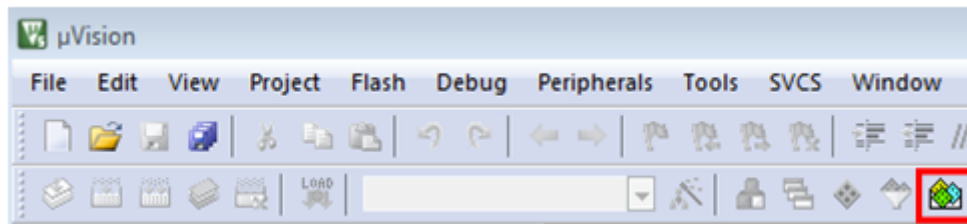
1. Download and install LPCScript or the Windows® operating systems driver for LPCXpresso boards from www.nxp.com/lpcutilities. This installs the required drivers for the board.
2. Connect the development platform to your PC via USB cable between the Link2 USB connector (named Link for some boards) and the PC USB connector. If you are connecting for the first time, allow about 30 seconds for the devices to enumerate.

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 Appendix A). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in board.h file)
 2. No parity
 3. 8 data bits
 4. 1 stop bit



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 µVision IDE.

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

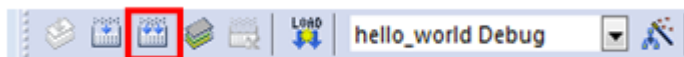
Build a non-XIP (plain load) example application

- Open the desired example application workspace in: `<install_dir>/boards/<board_name>/<example_type>/<application_name>/mdk`

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

`<install_dir>/boards/lpcxpresso54018/demo_apps/hello_world/mdk/hello_world.uvmpw`

- To build the demo project, select the “Rebuild” button, highlighted in red.



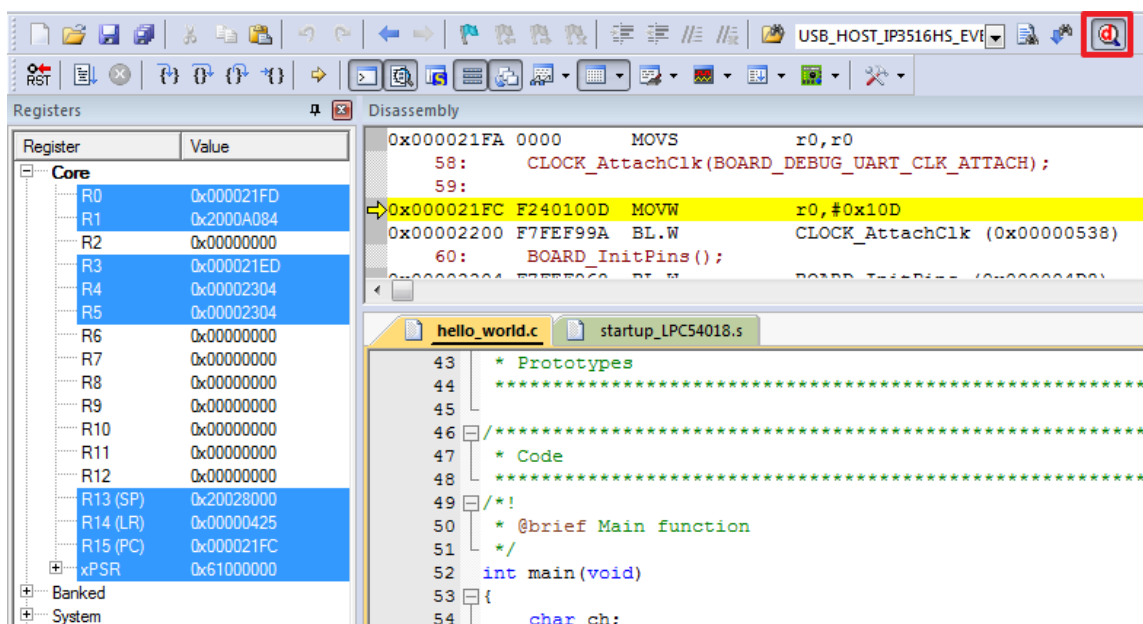
- The build completes without errors.

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

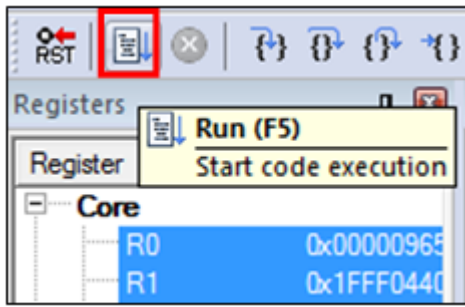
Run a non-XIP (plain load) example application

1. To debug the application, click the “Start/Stop Debug Session” button, highlighted in red.

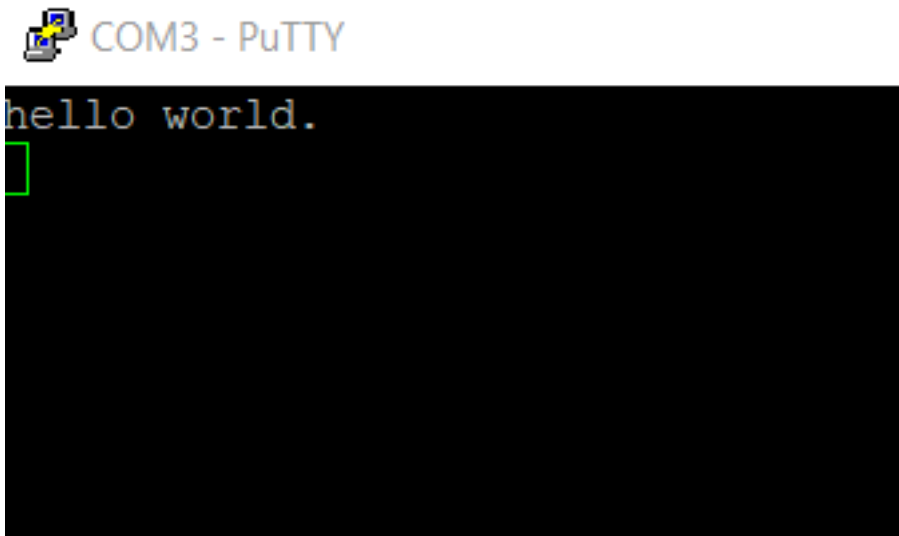
Note: The application is only downloaded into the SRAM when debugging. If you need to program the image to external flash, see [Section 4.4, “How to program the non-XIP \(plain load\) example application to external flash”](#).



2. Run the code by clicking the “Run” button to start the application.



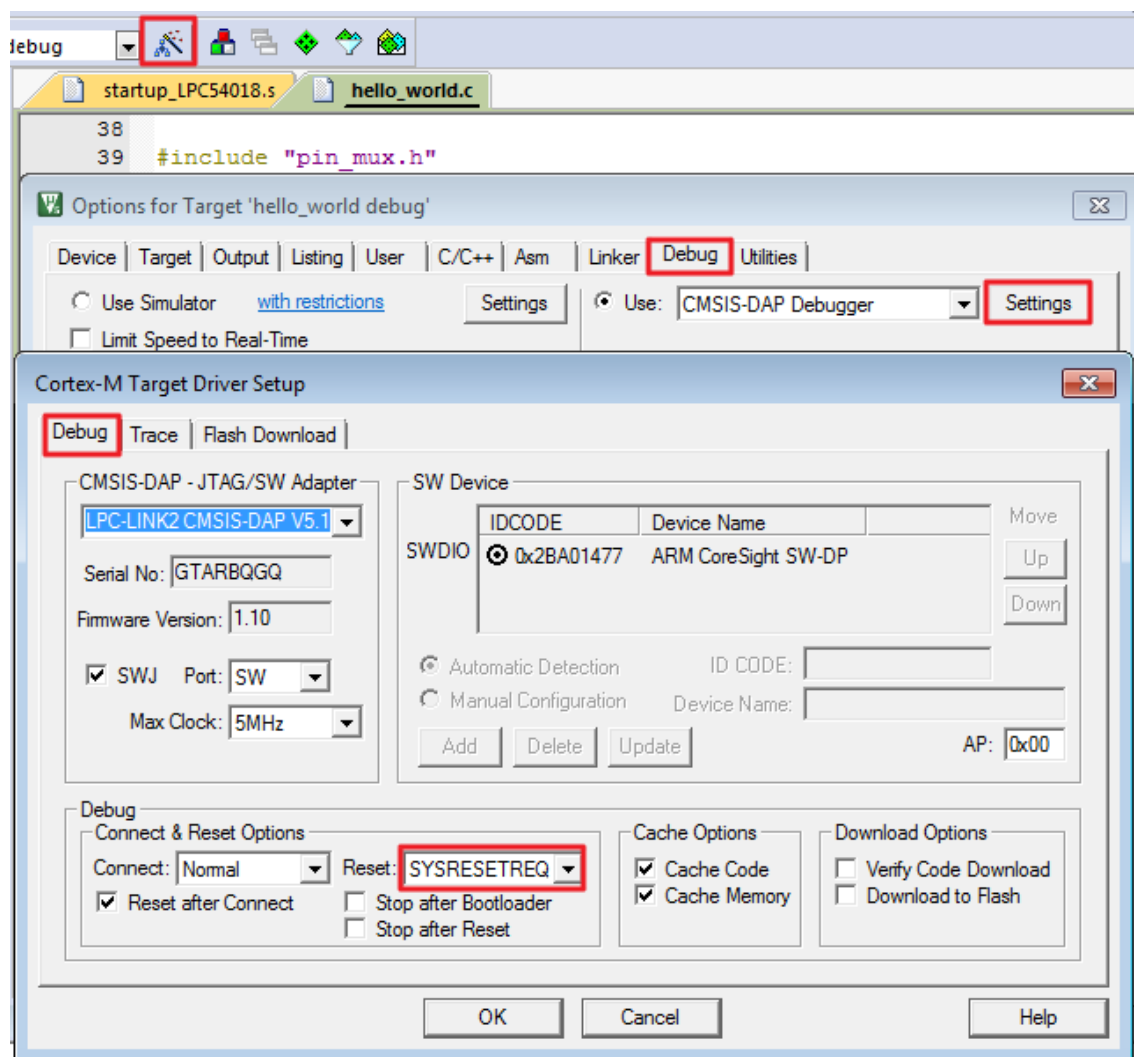
The hello_world application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.



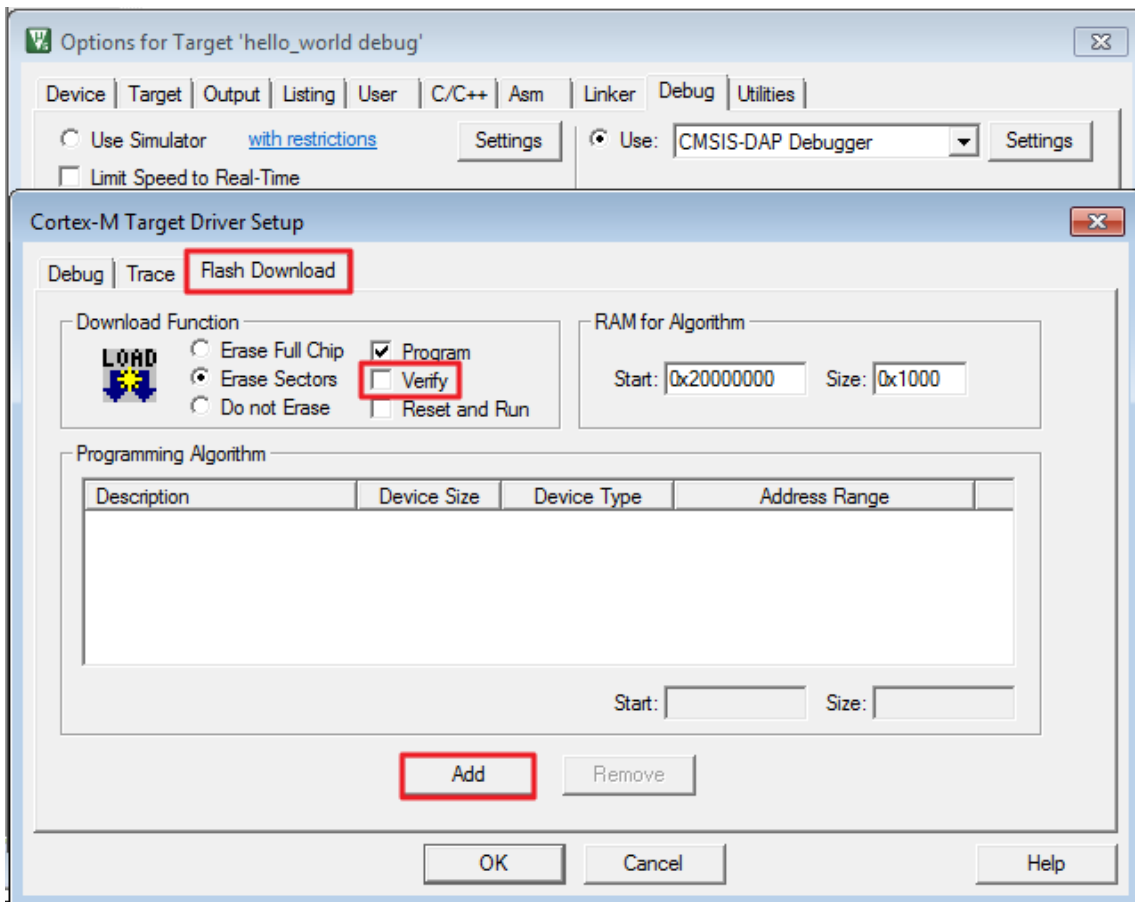
Parent topic: [Run a demo using Keil® MDK/μVision](#)

How to program the non-XIP (plain load) example application to external flash

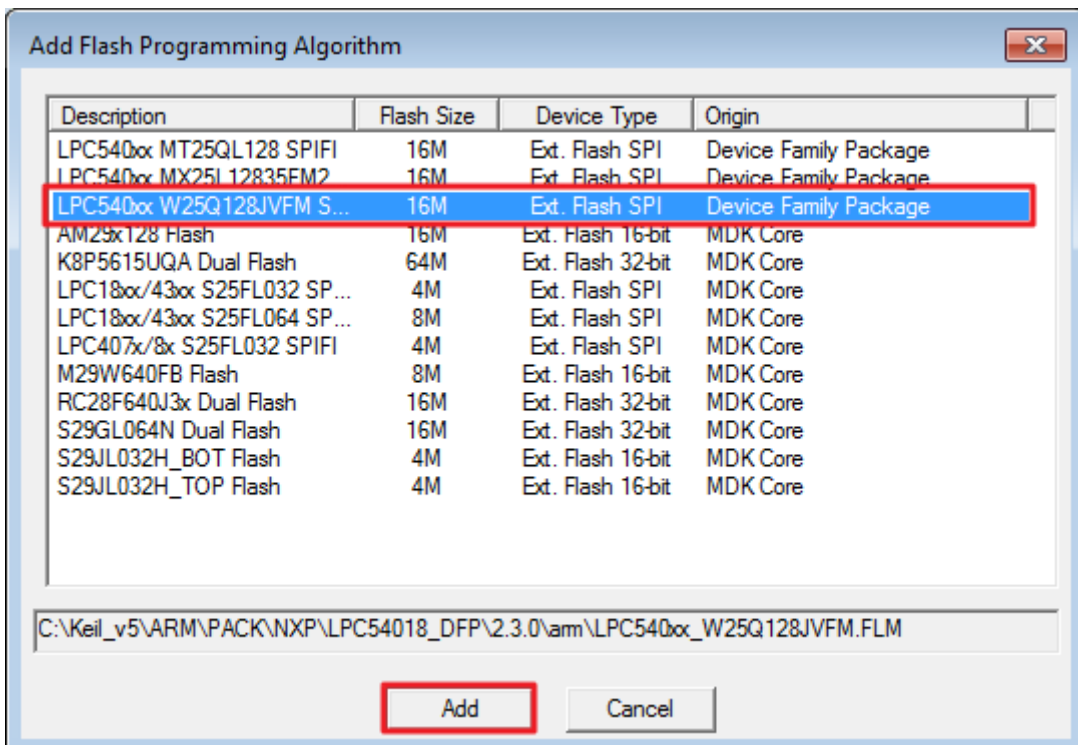
1. Click the configure target option button and select the “SYSRESETREQ” reset option.



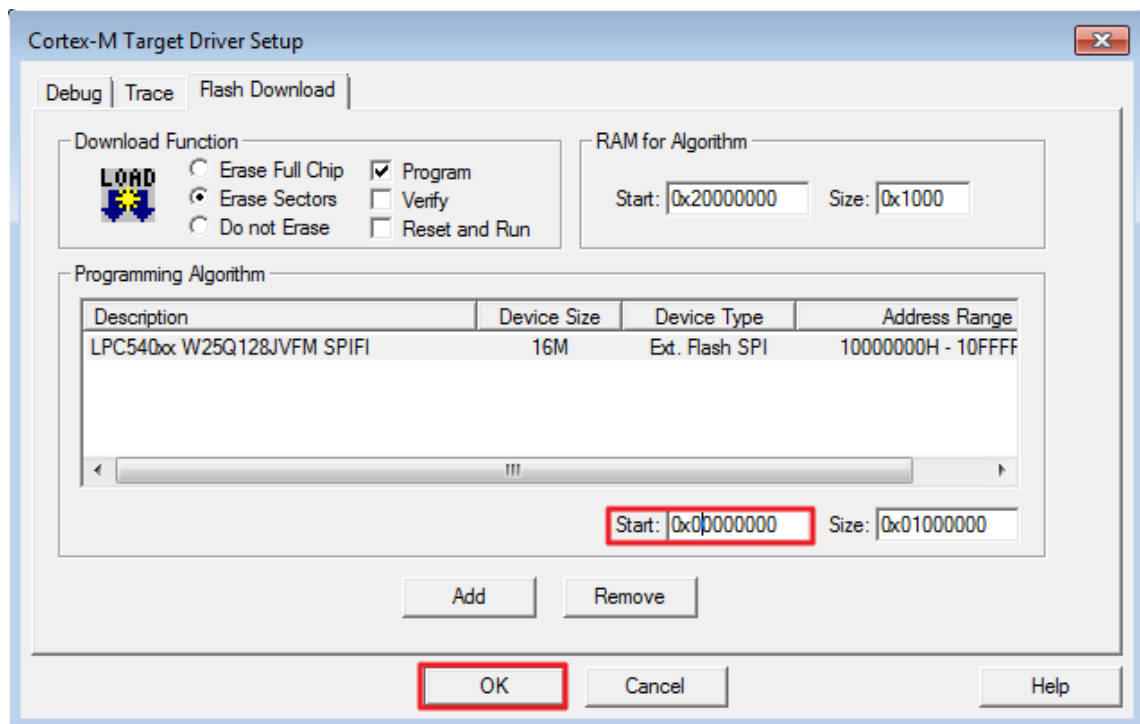
2. Select the “Flash Download” option and click the “Add” button.



3. Select the “LPC540xx W25Q128JVM SPIF” option. For the LPCXpresso54018 board, select “LPC540xx MX25L12835FM2I” for the LPC54018-IoT-Module. Then, click the “Add” button.

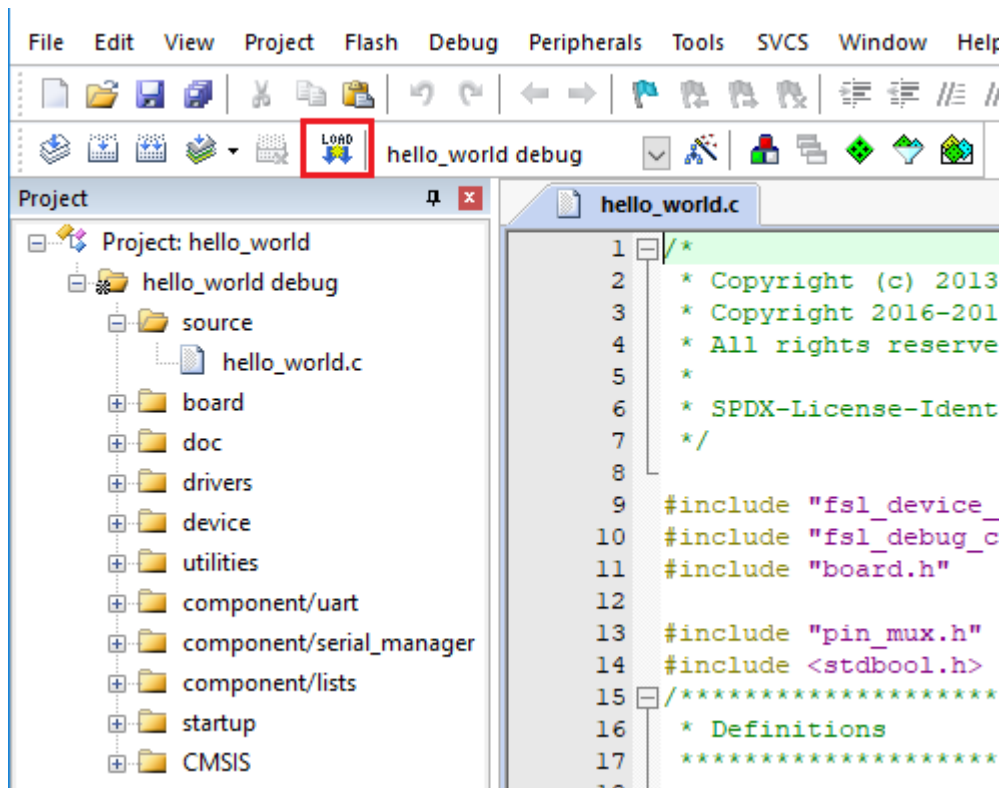


4. Set 0x00000000 as the start address and click the “OK” button.



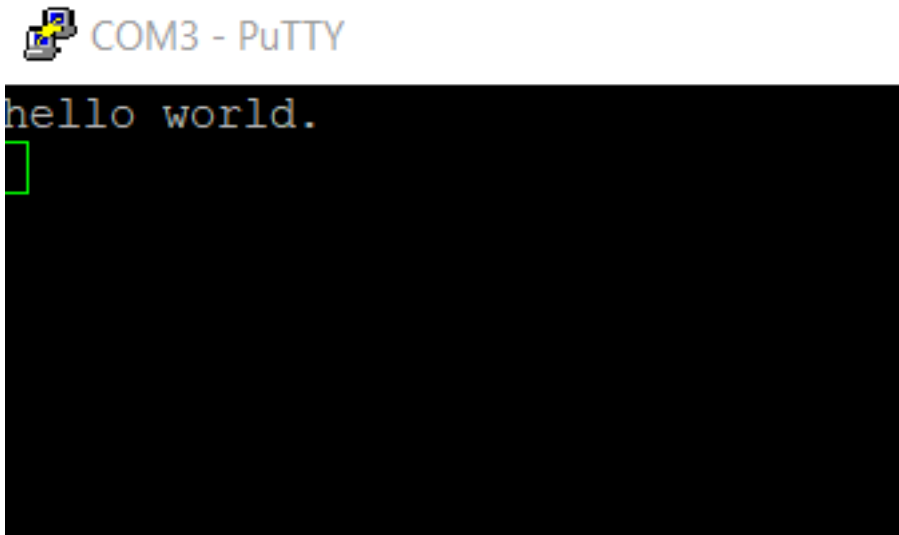
- Click the “LOAD” button.

Note: If ‘LOAD’ fails, press the SW4 button on the board, then repower the board or reset the board (get into ISP mode). Keep pressing SW4 when clicking the ‘LOAD’ button again to program the application into the external flash.



- Press the reset button on the board to run the example.

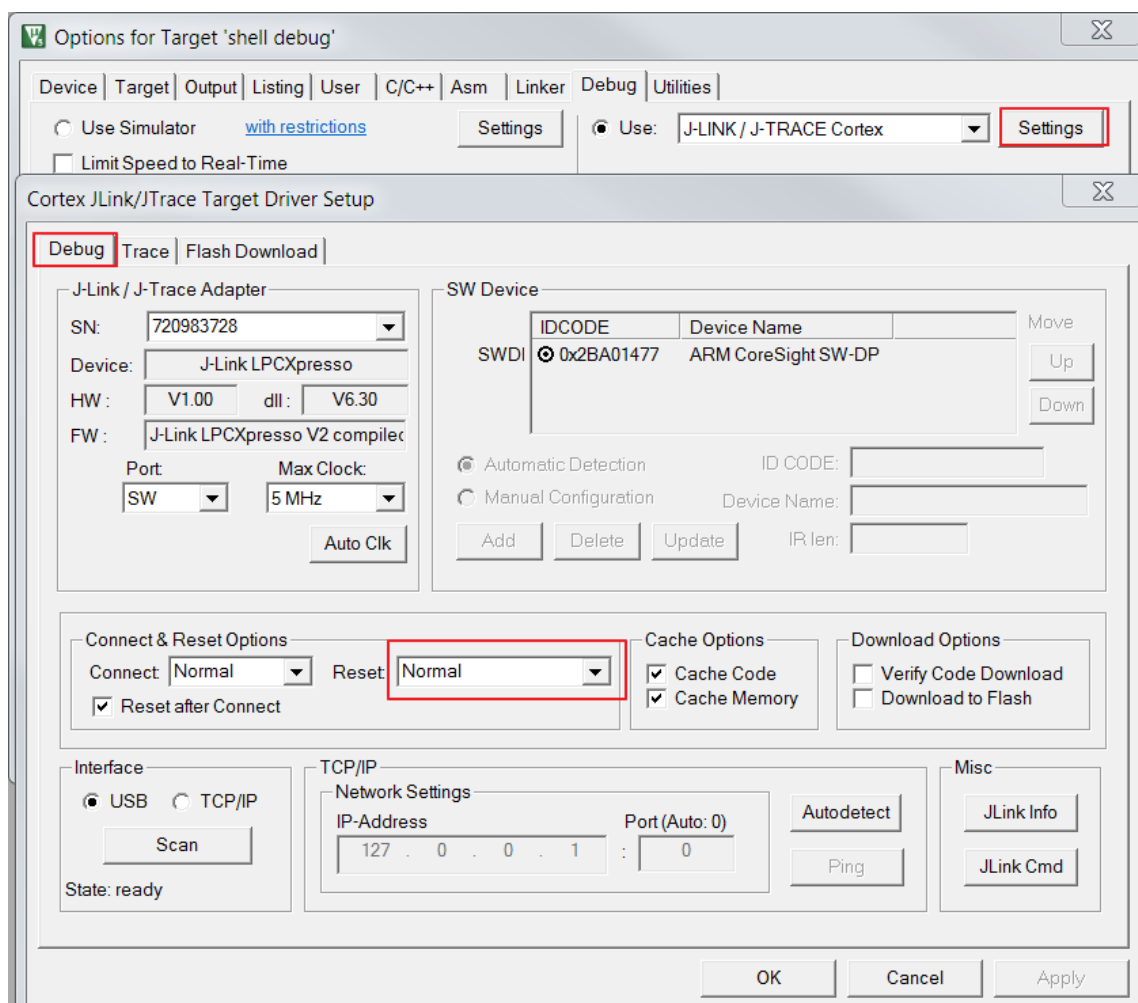
The hello_world application is now running and a banner is displayed on the terminal. If this is not true, check your terminal settings and connections.



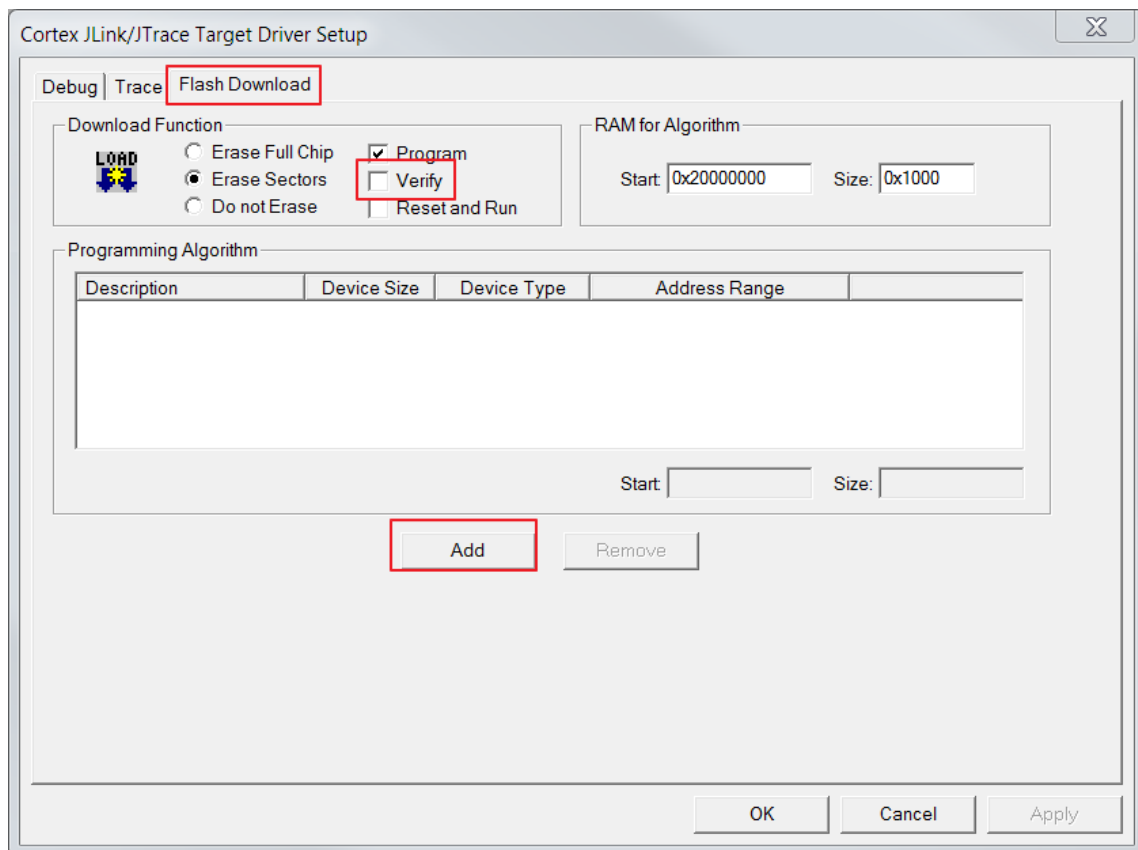
Parent topic: [Run a demo using Keil® MDK/μVision](#)

How to program the non-XIP (plain load) example application to external flash using J-Link

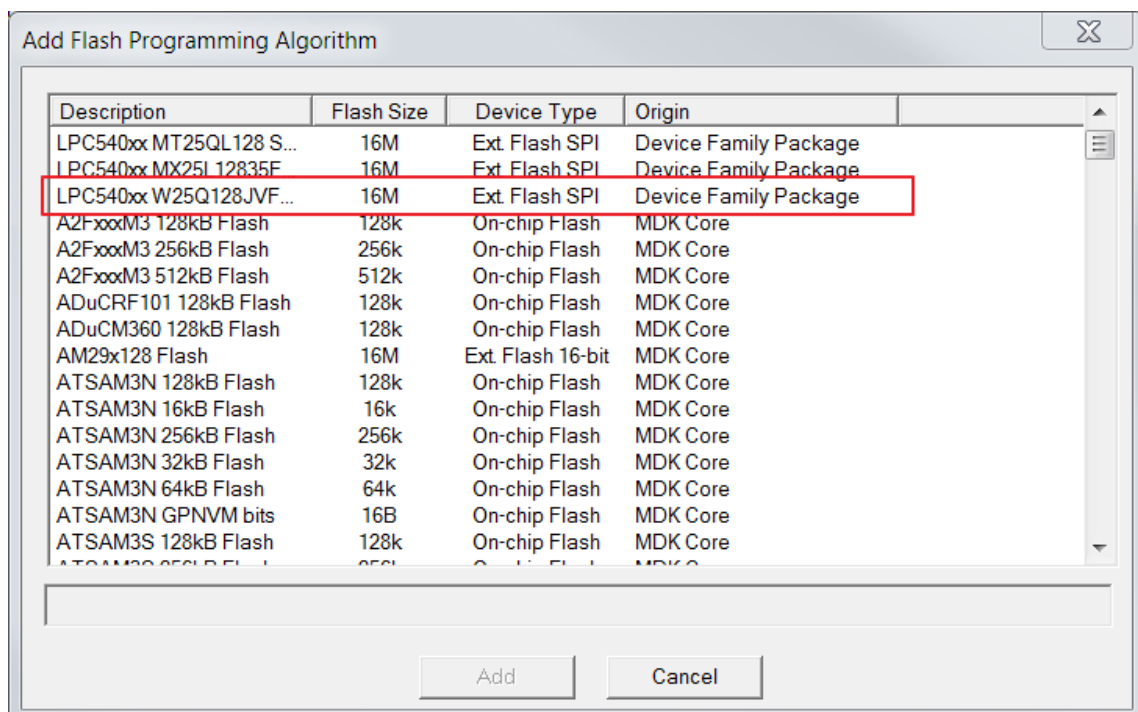
1. Click the configure target option button and select the “Normal” reset option.



2. Select the “Flash Download” option and click the “Add” button.

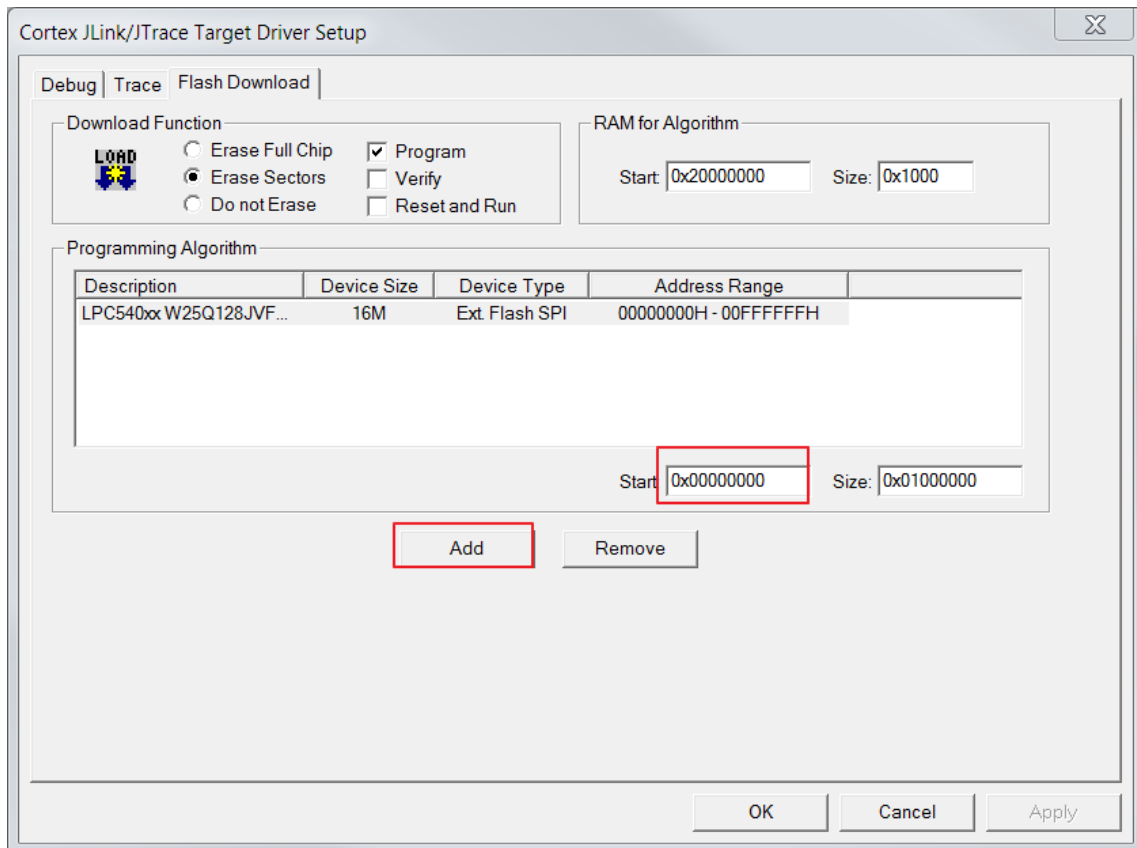


3. Select the “LPC540xx W25Q128JVM SPIF” for the LPCXpresso54018 board , select “LPC540xx MX25L12835FM2I” for the LPC54018-IoT-Module option, and click the “Add” button.



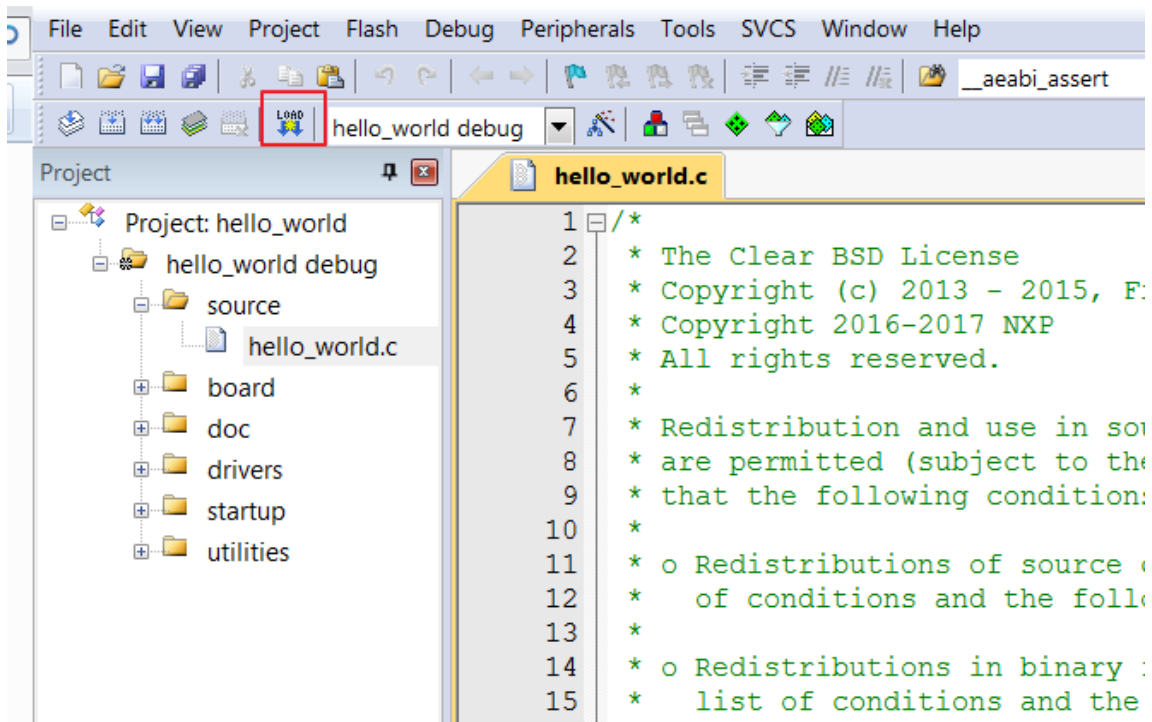
Note: Select “LPC540xx MX25L12835FM2I” for the LPC54018-IoT-Module.

4. Set 0x00000000 as the start address and click the “OK” button.



5. Click the “LOAD” button.

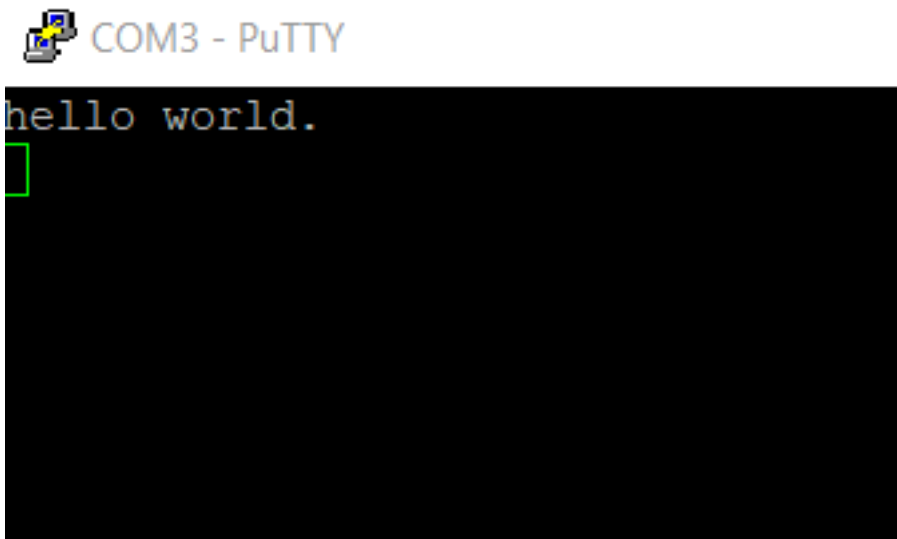
Note: If ‘LOAD’ fails, press the SW4 button on the board, then repower the board or reset the board (get into ISP mode). Keep pressing SW4 when clicking the ‘LOAD’ button again to program the application into the external flash.



6. Press the reset button on the board to run the example.

The hello_world application is now running 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 Keil® MDK/μVision](#)

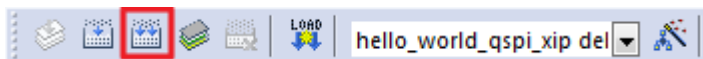
Build an XIP example application

1. Open the desired example application workspace in: `<install_dir>/boards/<board_name>/<example_type>/<application_name>/mdk`

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

`<install_dir>/boards/lpcxpresso54018/demo_apps/hello_world_qspi_xip/mdk/hello_world_qspi_xip.uvmpw`

2. To build the demo project, select the “Rebuild” button, highlighted in red.



3. The build completes without errors

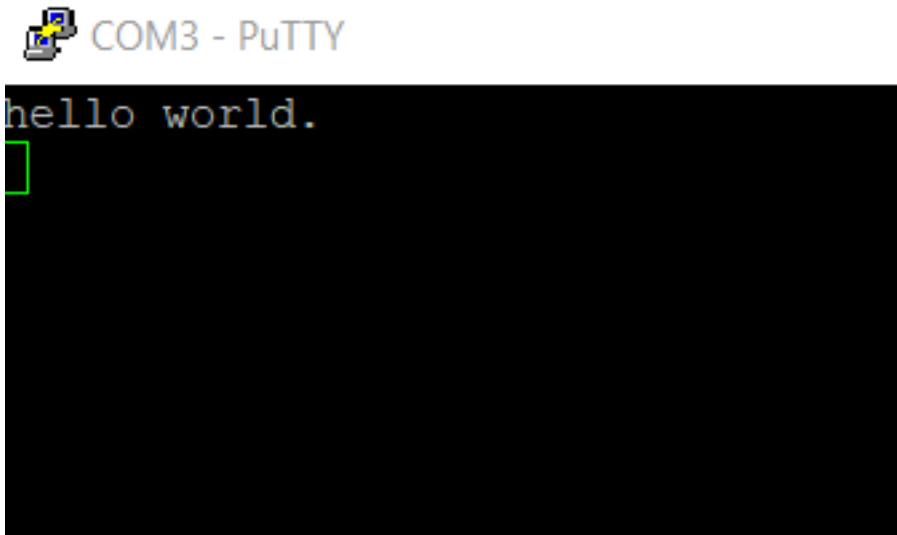
Parent topic: [Run a demo using Keil® MDK/μVision](#)

Run an XIP example application

1. Click the “LOAD” button, highlighted in red.

2. Press the reset button on the board to run the example.

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 Keil® MDK/μVision](#)

Run a demo using ARMGCC / VSCODE

This section describes the steps to run an example application from the SDK archive using the ARMGCC / VSCODE toolchain.

Refer to the [running a demo using MCUXpresso VSC](#) section for detailed instructions on setting up and configuring your project in Visual Studio Code.

Refer to the [CLI](#) section for detailed instructions on building and running your project from the command line.

Run a demo using MCUXpresso IDE

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

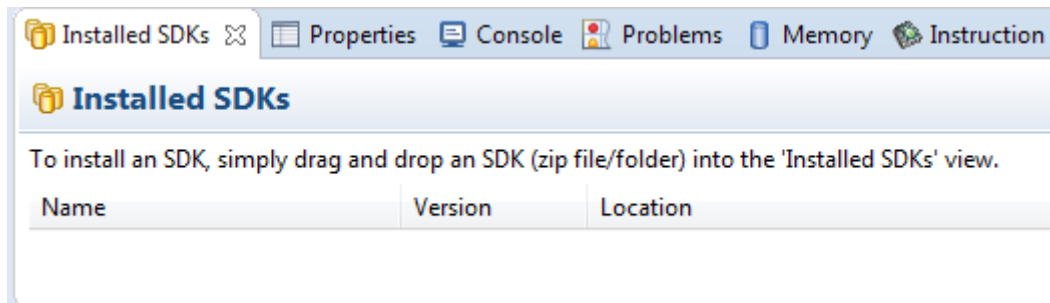
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The `hello_world` demo application targeted for the LPCXpresso54018 hardware platform is used as an example, though these steps can be applied to any example application in the MCUXpresso SDK.

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

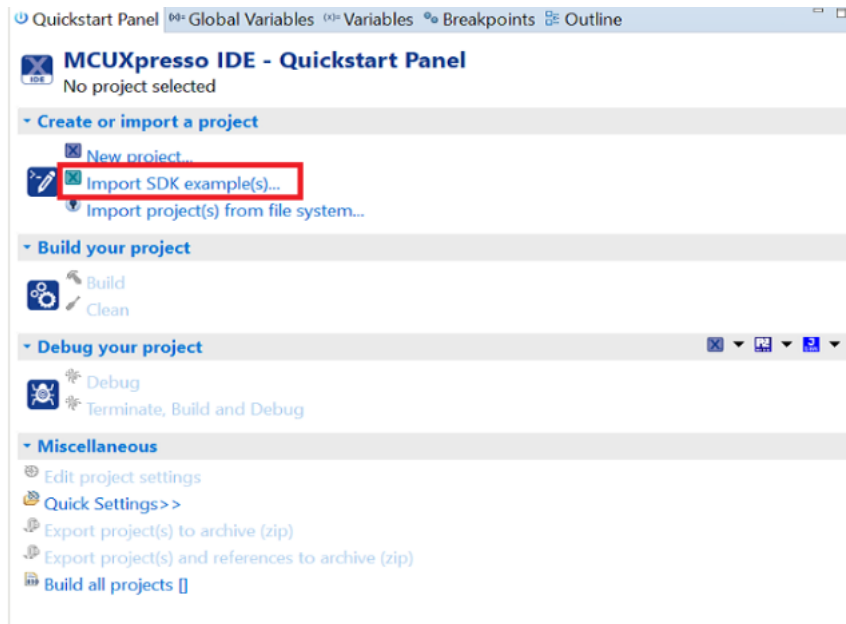
Parent topic: [Run a demo using MCUXpresso IDE](#)

Build a non-XIP (plain load) example application To build an example application, follow these steps.

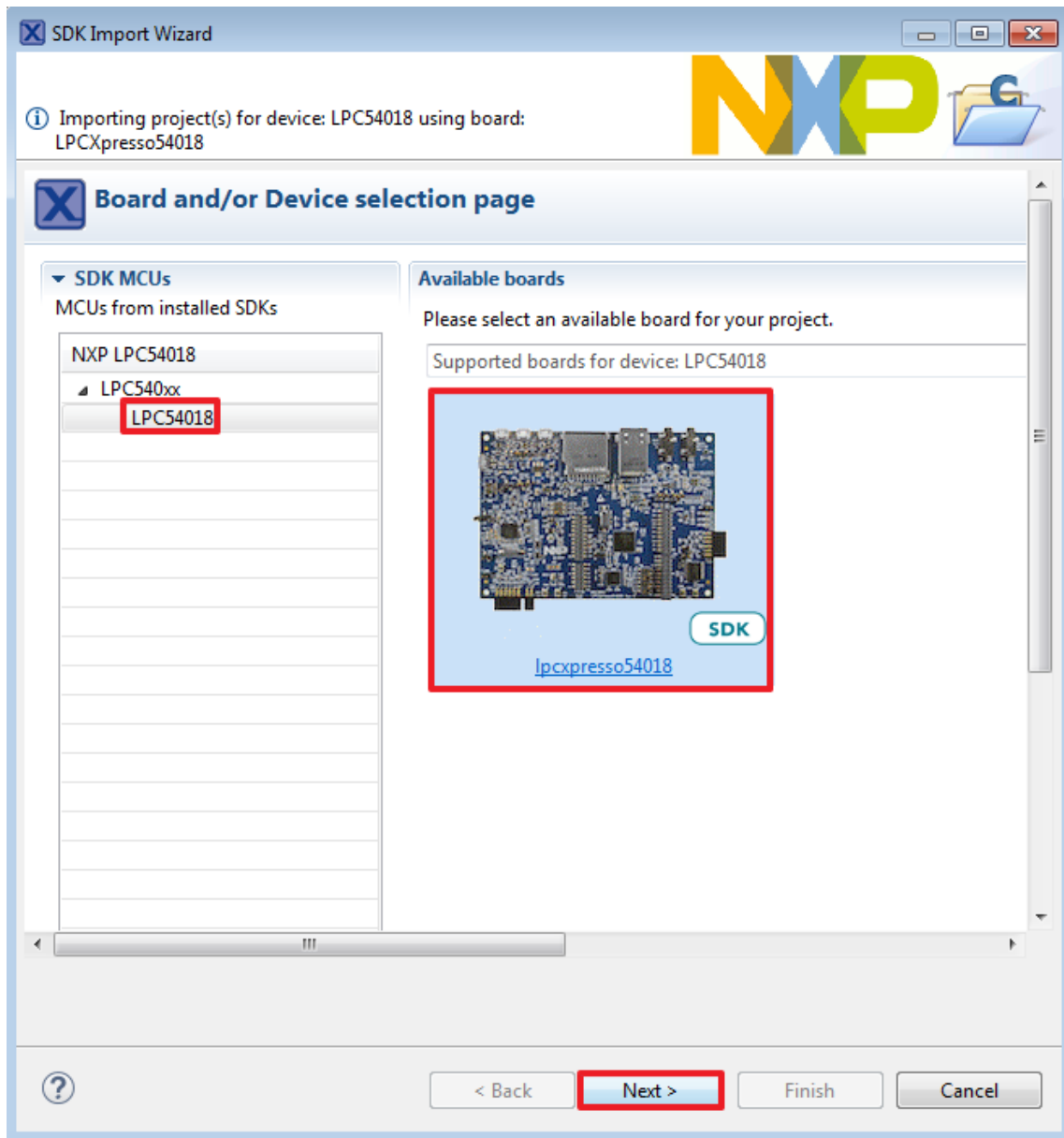
1. Drag and drop the SDK zip file into the “Installed SDKs” view to install an SDK. In the window that appears, click the “OK” button and wait until the import has finished.



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



3. In the window that appears, expand the “LPC540xx” folder and select “LPC54018”. Then, select “lpcxpresso54018” and click the “Next” button.



- Expand the “demo_apps” folder and select “hello_world”. Then, click the “Next” button.

- Ensure the option “Redlib: Use floating point version of printf” is selected if the cases print floating point numbers on the terminal (for demo applications such as adc_basic, adc_burst, adc_dma, and adc_interrupt). Otherwise, there is no need to select it. Click the “Finish” button.

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

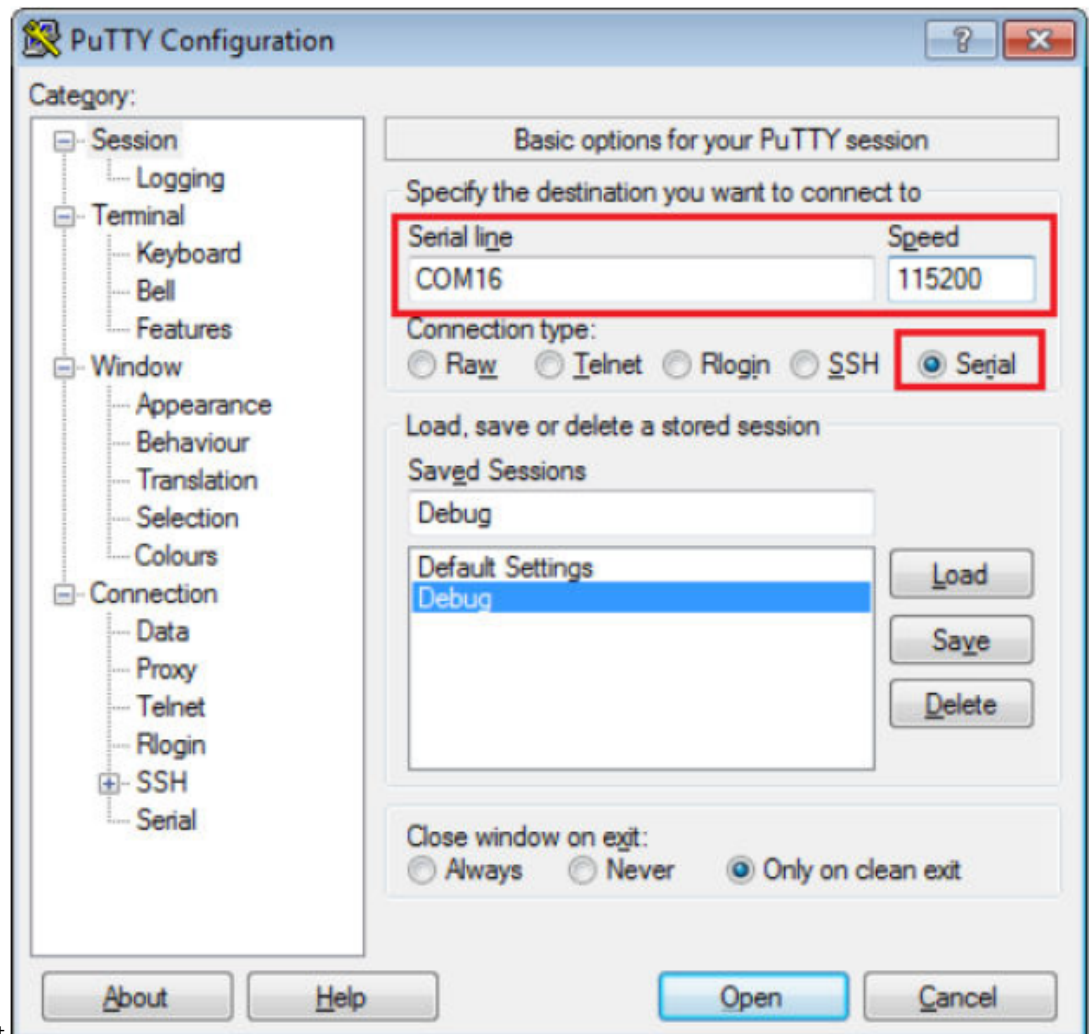
Run a non-XIP (plain load) example application For more information on debug probe support in the MCUXpresso IDE v10.1.1, visit community.nxp.com.

To download and run the application, perform these steps:

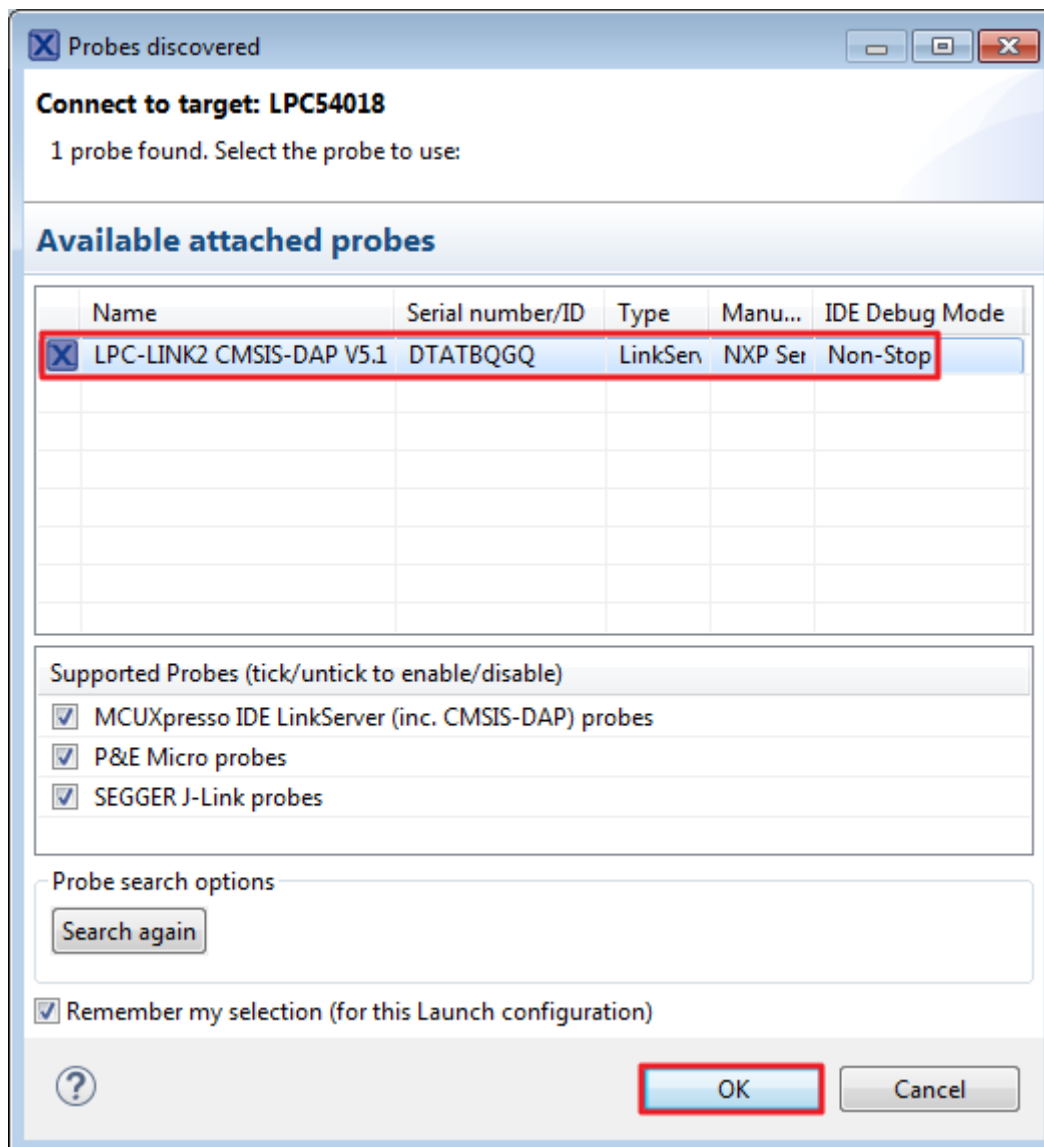
- Reference the table in Appendix B to determine the debug interface that comes loaded on your specific hardware platform. For LPCXpresso boards, install the DFU jumper for the

debug probe, then connect the debug probe USB connector.

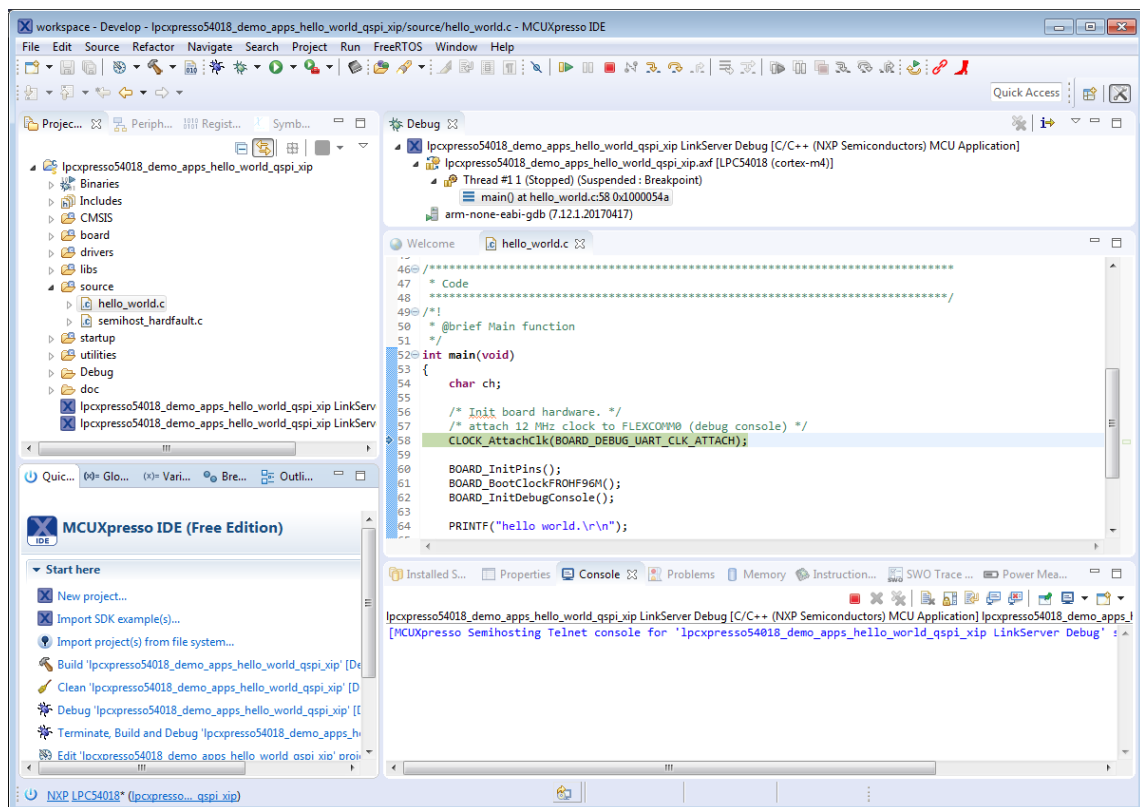
2. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug serial port number (to determine the COM port number, see Appendix A). Configure the terminal with these settings:
 1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE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



4. 1 stop bit
3. On the *Quickstart Panel*, click on “Debug ‘lpcxpresso54018_demo_apps_hello_world’ [Debug]”.
 ![(./images/debug_hello_world_case_lpc540xx.png “Debug “hello_world” case”)]
4. 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 the “OK” button. (For any future debug sessions, the stored probe selection is automatically used, unless the probe cannot be found.)



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

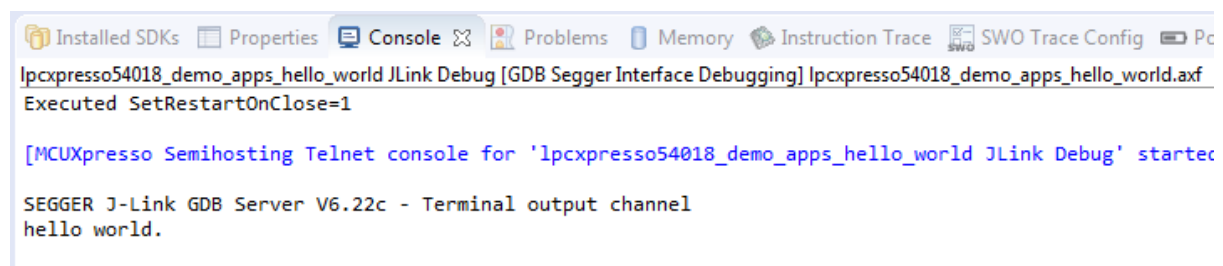


Note: The application is only downloaded into the SRAM when debugging. If you need to program the image to external flash, see Section 6.4, “How to program the non-XIP (plain load) example bin file to external flash”.

6. Start the application by clicking the “Resume” button.



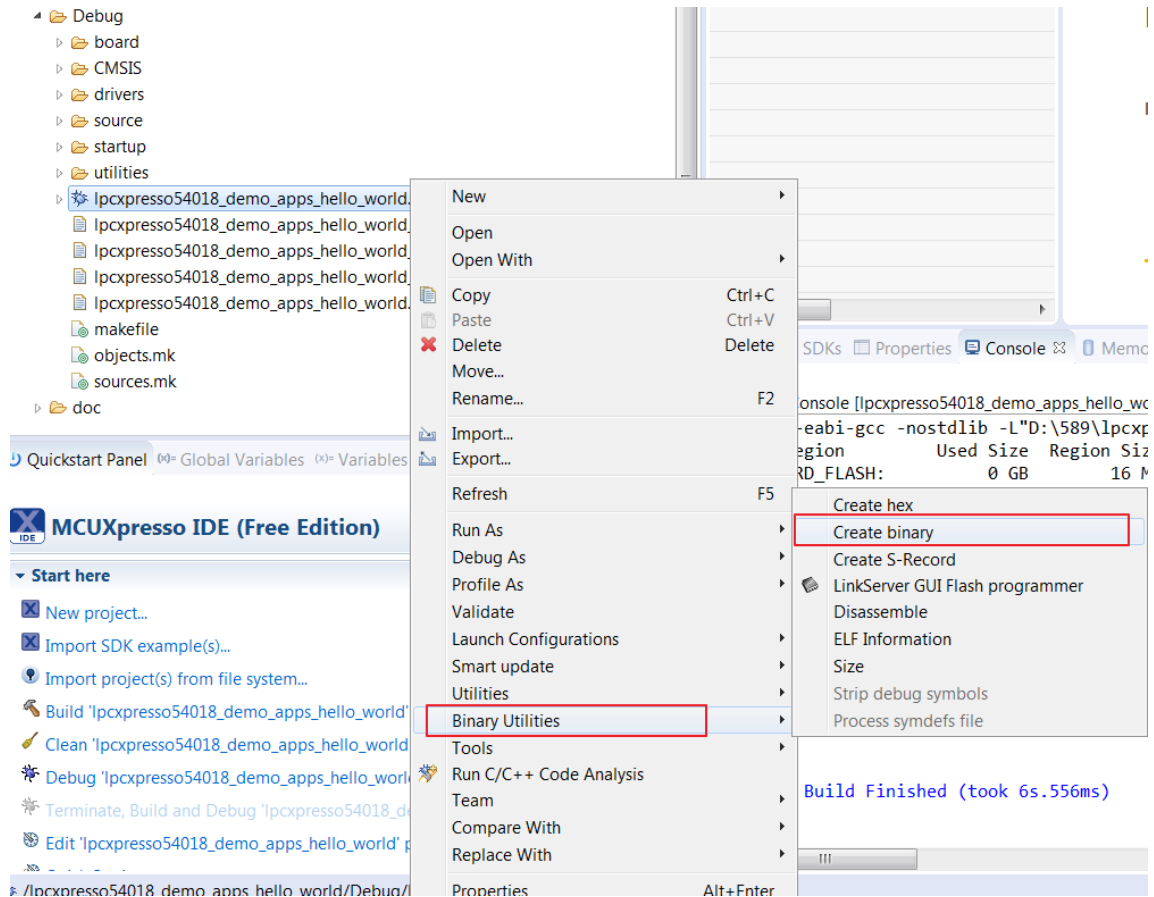
The hello_world application is now running and a banner is displayed on the console.



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

How to program the non-XIP (plain load) example bin file to external flash To build an example application, follow these steps.

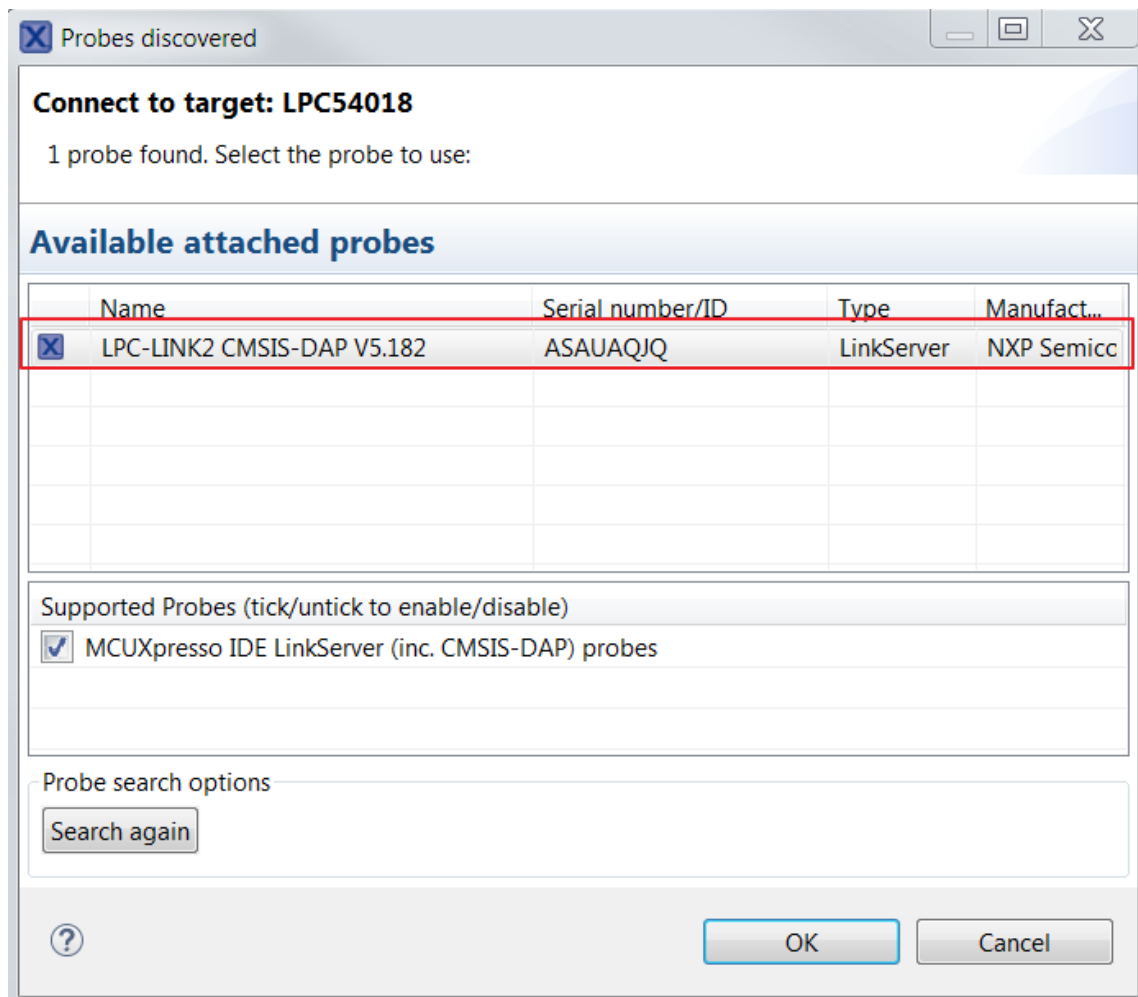
1. Create a bin file for non-XIP (plain load) demo from *.axf file.



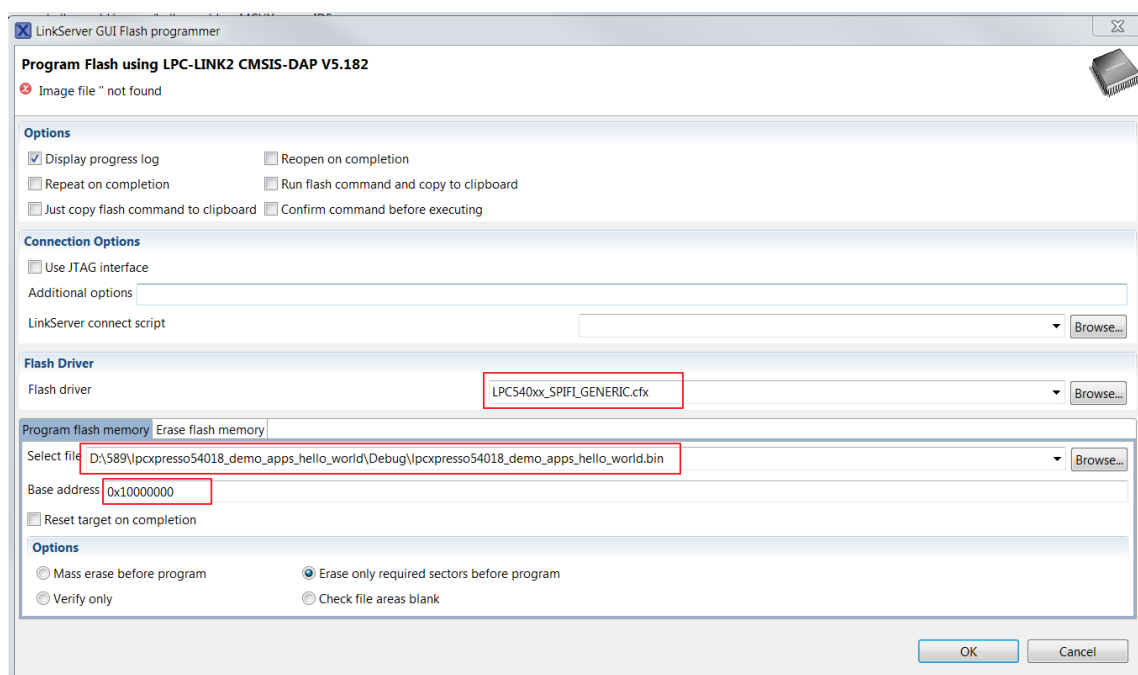
2. Click the “LinkServer GUI Flash Programmer” button.



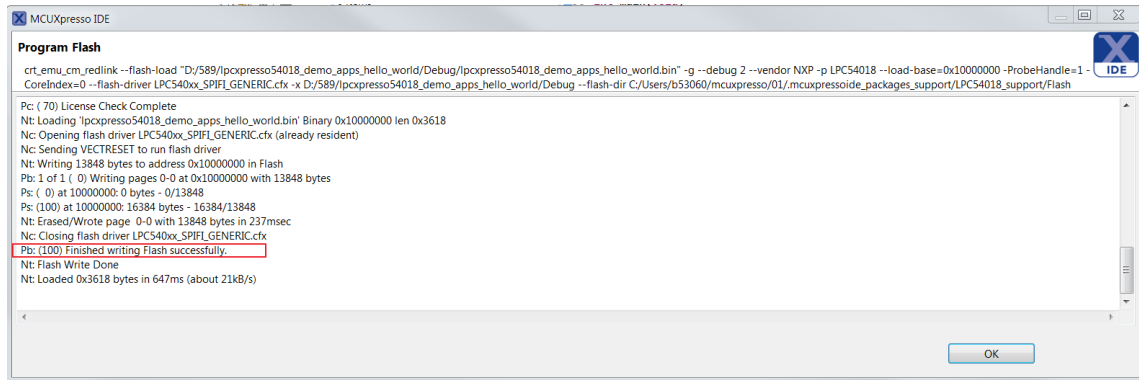
3. Select LPC-LINK2 CMSIS-DAP.



4. Select the flash driver, bin file, and external flash program address, then click the “OK” button to program the bin file to external flash.



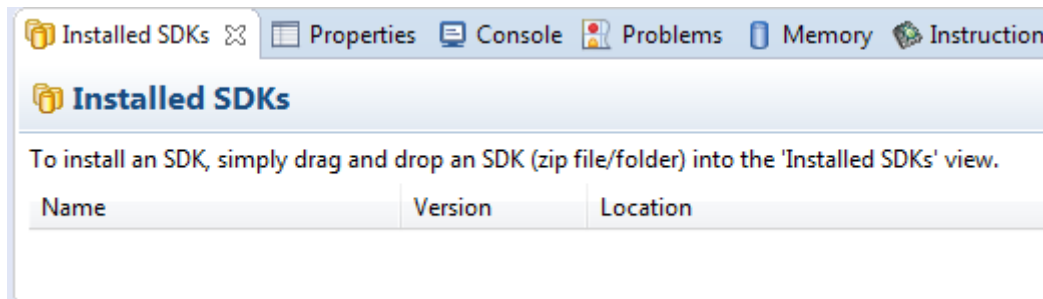
5. After programming, press the reset button on the board to run the example.



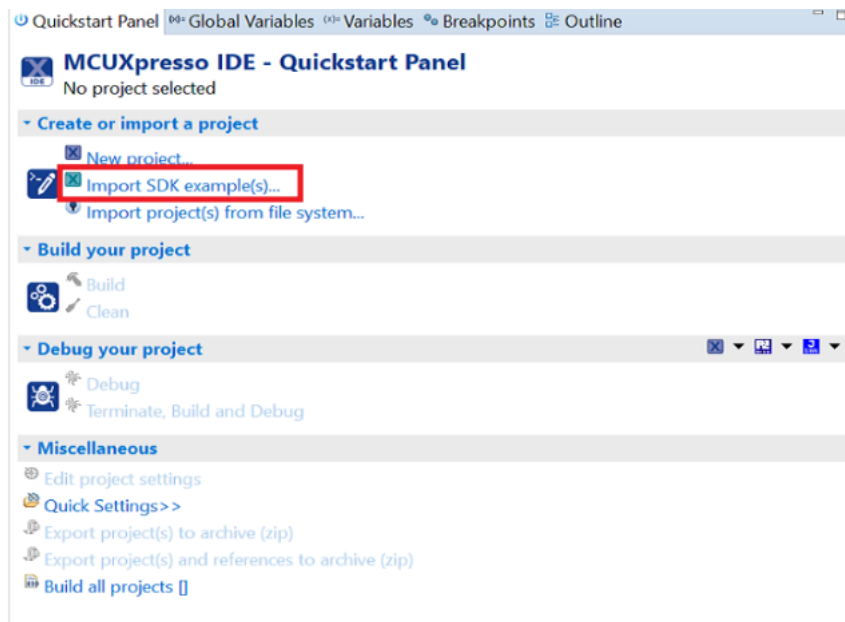
Parent topic: [Run a demo using MCUXpresso IDE](#)

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

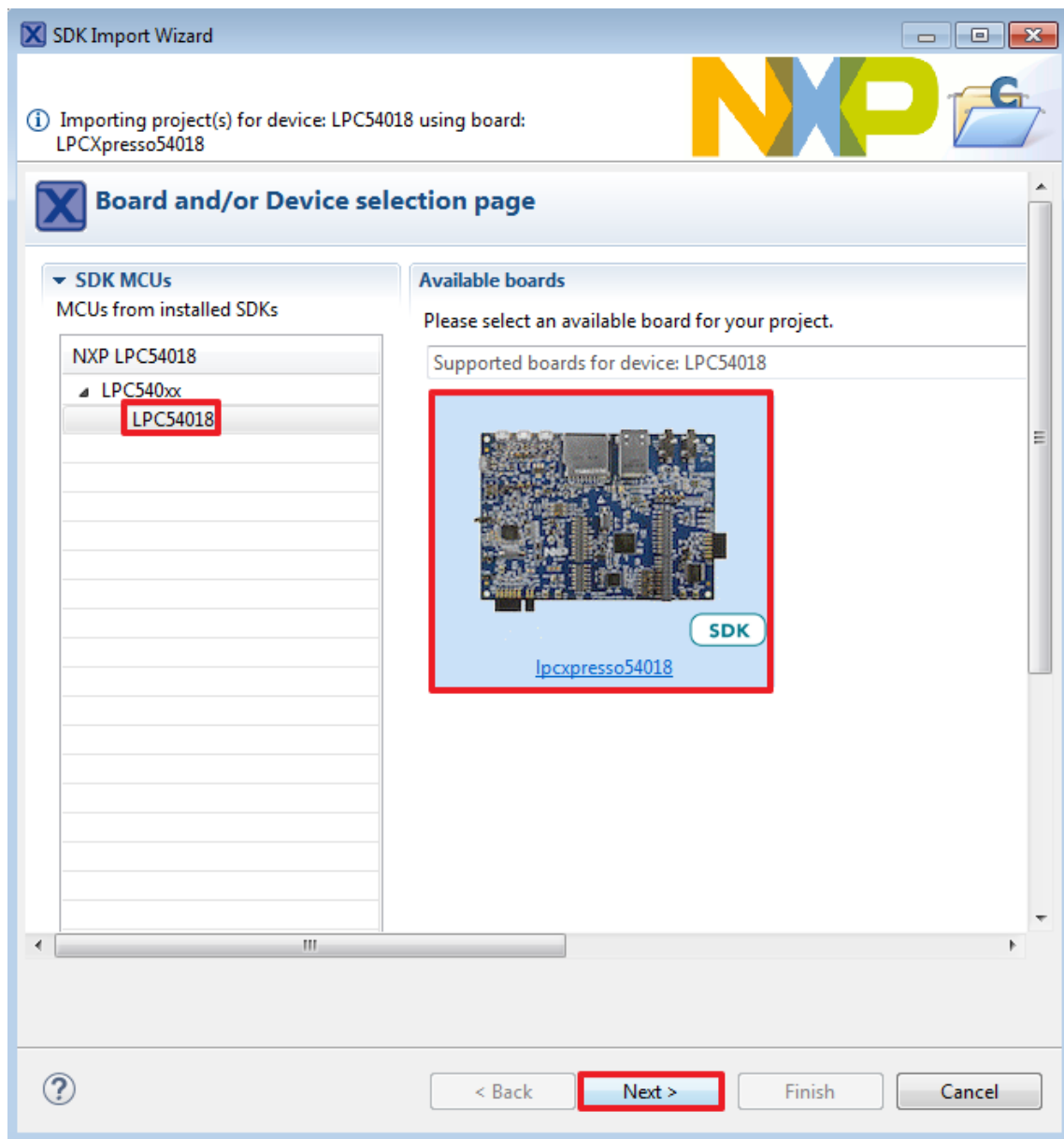
1. Drag and drop the SDK zip file into the “Installed SDKs” view to install an SDK. In the window that appears, click the “OK” button and wait until the import has finished.



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

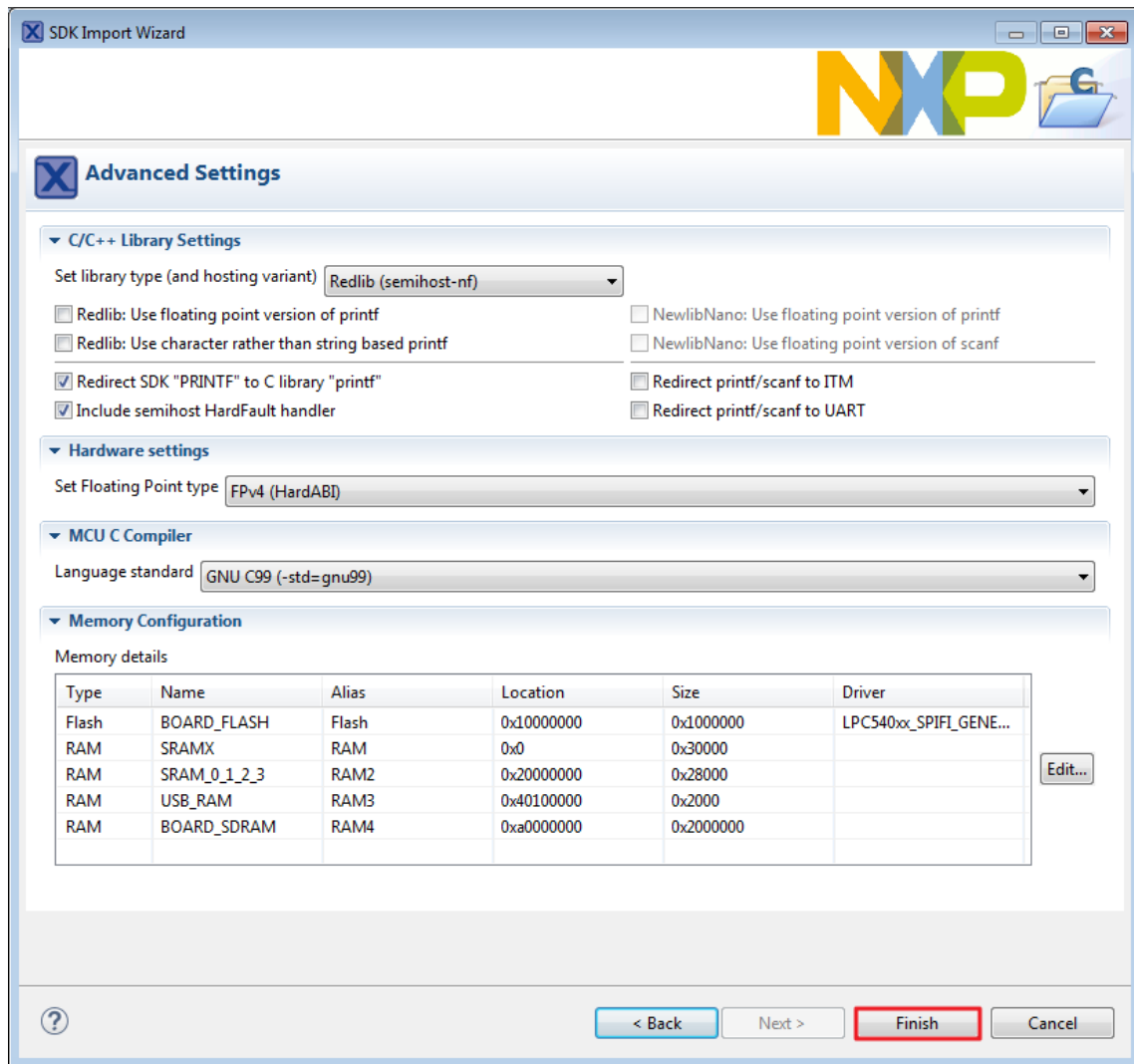


3. In the window that appears, expand the “LPC540xx folder and select “LPC54018”. Then, select “lpcpresso54018” and click the “Next” button.



4. Expand the “demo_apps” folder and select “hello_world_qspi_xip”. Then, click the “Next” button.

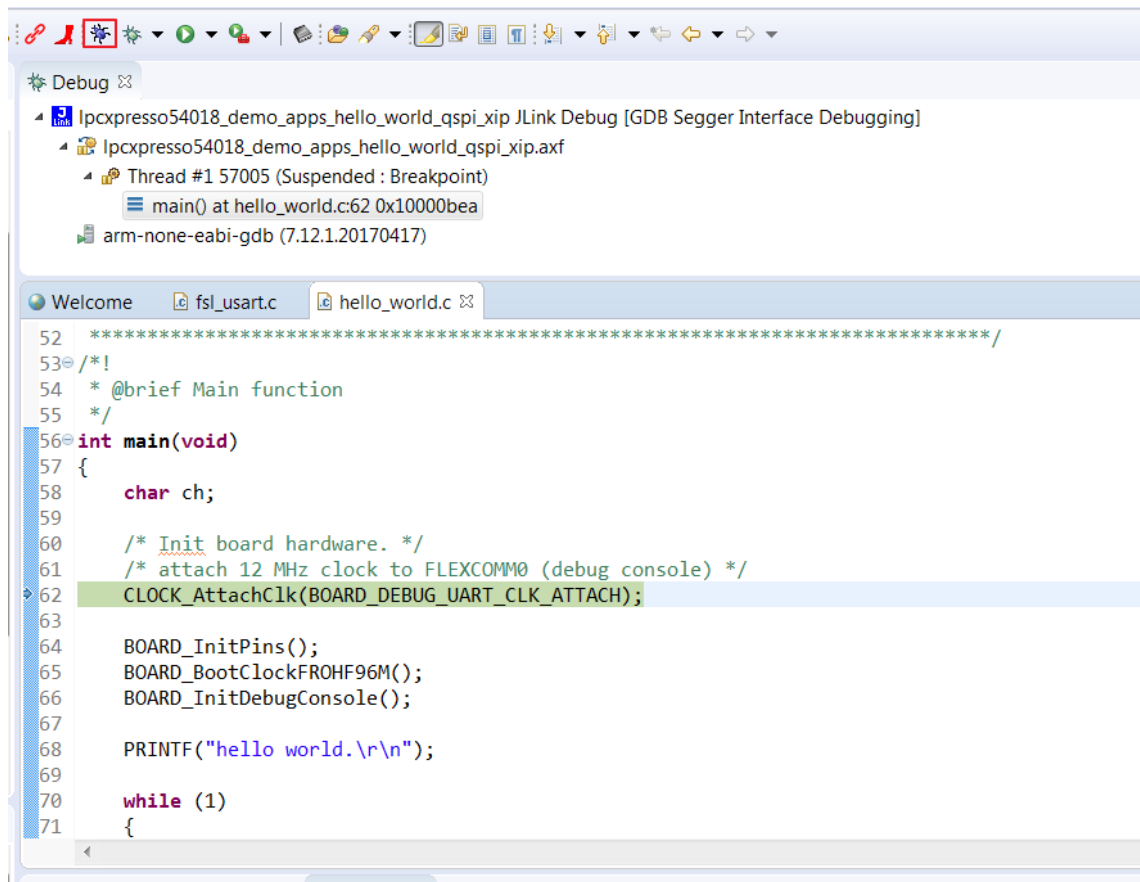
5. Ensure the option “Redlib: Use floating point version of printf” is selected if the cases print floating point numbers on the terminal (for demo applications such as adc_basic, adc_burst, adc_dma, and adc_interrupt). Otherwise, there is no need to select it. Click the “Finish” button.



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

Run an XIP example application

1. Click the “Debug” button on the tool bar to run the XIP example.

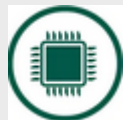


Parent topic: [Run a demo using MCUXpresso IDE](#)

MCUXpresso Config Tools

MCUXpresso Config Tools can help configure the processor and generate initialization code for the on chip peripherals. The tools are able to modify any existing example project, or create a new configuration for the selected board or processor. The generated code is designed to be used with MCUXpresso SDK version 2.x.

Table 1 describes the tools included in the MCUXpresso Config Tools.

Config Tool	Description	Image
Pins tool	For configuration of pin routing and pin electrical properties.	

| **Clock tool** | For system clock configuration | 

| **Peripherals tools** | For configuration of other peripherals | 

| **TEE tool** | Configures access policies for memory area and peripherals helping to protect and



isolate sensitive parts of the application. |

| **Device Configuration tool** | Configures Device Configuration Data (DCD) contained in the program image that the Boot ROM code interprets to setup various on-chip peripherals prior the



program launch. |

|

MCUXpresso Config Tools can be accessed in the following products:

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

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

MCUXpresso IDE New Project Wizard

MCUXpresso IDE features a new project wizard. The wizard provides functionality for the user to create new projects from the installed SDKs (and from pre-installed part support). It offers user the flexibility to select and change multiple builds. The wizard also includes a library and provides source code options. The source code is organized as software components, categorized as drivers, utilities, and middleware.

To use the wizard, start the MCUXpresso IDE. This is located in the **QuickStart Panel** at the bottom left of the MCUXpresso IDE window. Select **New project**, as shown in *Figure 1*.

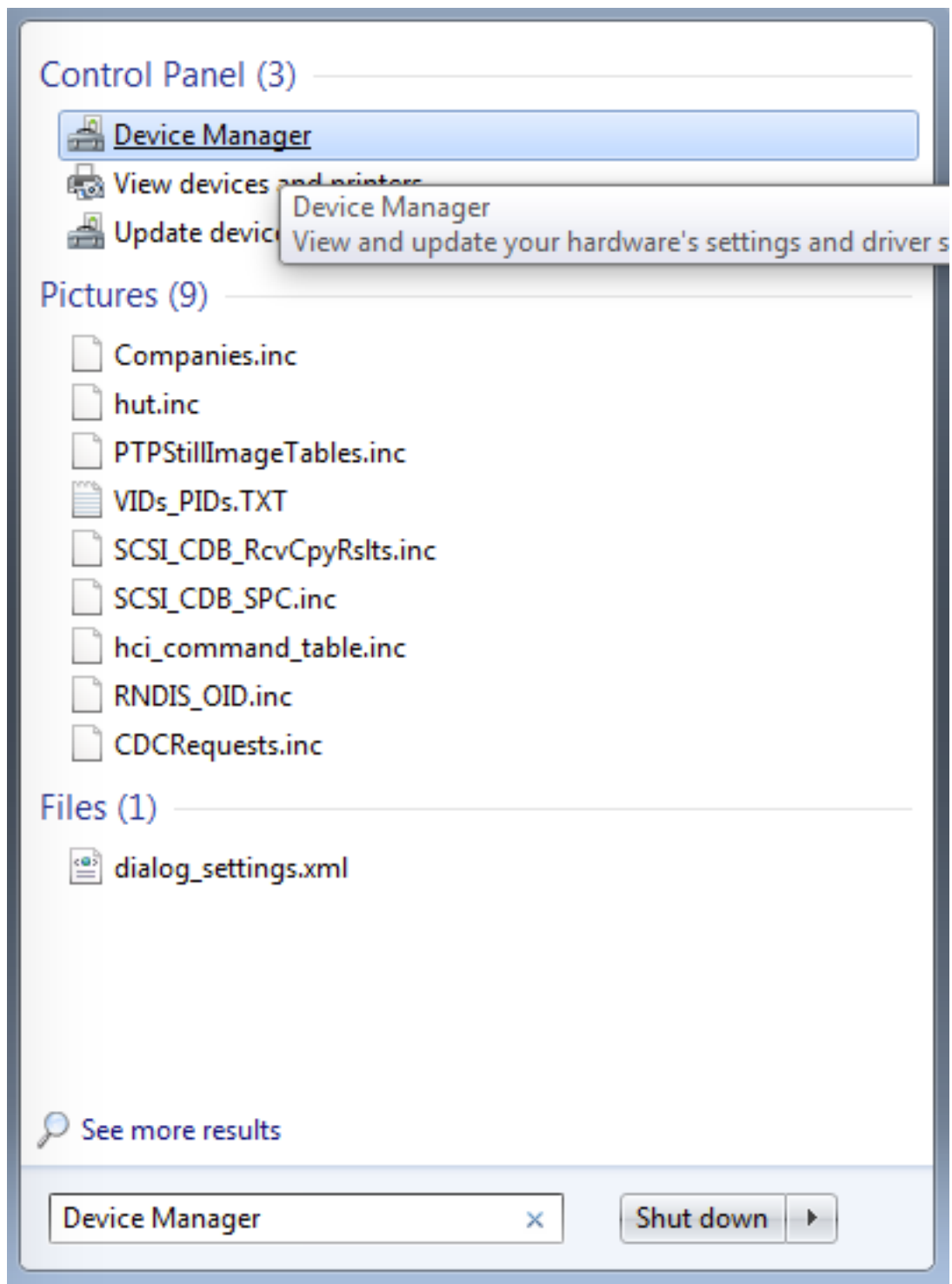


For more details and usage of new project wizard, see the *MCUXpresso_IDE_User_Guide.pdf* in the MCUXpresso IDE installation folder.

How to determine COM port

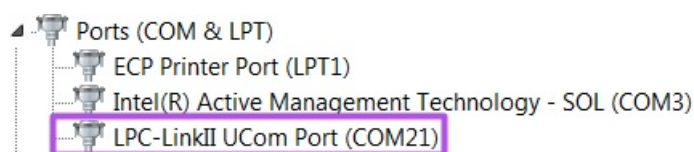
This section describes the steps necessary to determine the debug COM port number of your NXP hardware development platform. All NXP boards ship with a factory programmed, on-board debug interface, whether it's based on OpenSDA or the legacy P&E Micro OSJTAG interface. To determine what your specific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

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



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

1. LPC-Link2



Default debug interfaces

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

Note: The *OpenSDA details* column in *Table 1* is not applicable to LPC.

Hardware platform	Default interface	OpenSDA details
EVK-MC56F83000	P&E Micro OSJTAG	N/A
EVK-MIMXRT595	CMSIS-DAP	N/A
EVK-MIMXRT685	CMSIS-DAP	N/A
FRDM-K22F	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.1
FRDM-K28F	DAPLink	OpenSDA v2.1
FRDM-K32L2A4S	CMSIS-DAP	OpenSDA v2.1
FRDM-K32L2B	CMSIS-DAP	OpenSDA v2.1
FRDM-K32W042	CMSIS-DAP	N/A
FRDM-K64F	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.0
FRDM-K66F	J-Link OpenSDA	OpenSDA v2.1
FRDM-K82F	CMSIS-DAP	OpenSDA v2.1
FRDM-KE15Z	DAPLink	OpenSDA v2.1
FRDM-KE16Z	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.2
FRDM-KL02Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL03Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL25Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL26Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL27Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL28Z	P&E Micro OpenSDA	OpenSDA v2.1
FRDM-KL43Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL46Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KL81Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KL82Z	CMSIS-DAP	OpenSDA v2.0
FRDM-KV10Z	CMSIS-DAP	OpenSDA v2.1
FRDM-KV11Z	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KV31F	P&E Micro OpenSDA	OpenSDA v1.0
FRDM-KW24	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.1
FRDM-KW36	DAPLink	OpenSDA v2.2
FRDM-KW41Z	CMSIS-DAP/DAPLink	OpenSDA v2.1 or greater
Hexiwear	CMSIS-DAP/mbd/DAPLink	OpenSDA v2.0
HVP-KE18F	DAPLink	OpenSDA v2.2
HVP-KV46F150M	P&E Micro OpenSDA	OpenSDA v1
HVP-KV11Z75M	CMSIS-DAP	OpenSDA v2.1
HVP-KV58F	CMSIS-DAP	OpenSDA v2.1
HVP-KV31F120M	P&E Micro OpenSDA	OpenSDA v1
JN5189DK6	CMSIS-DAP	N/A
LPC54018 IoT Module	N/A	N/A
LPCXpresso54018	CMSIS-DAP	N/A
LPCXpresso54102	CMSIS-DAP	N/A
LPCXpresso54114	CMSIS-DAP	N/A
LPCXpresso51U68	CMSIS-DAP	N/A
LPCXpresso54608	CMSIS-DAP	N/A
LPCXpresso54618	CMSIS-DAP	N/A
LPCXpresso54628	CMSIS-DAP	N/A
LPCXpresso54S018M	CMSIS-DAP	N/A
LPCXpresso55s16	CMSIS-DAP	N/A
LPCXpresso55s28	CMSIS-DAP	N/A

continues on next page

Table 1 – continued from previous page

Hardware platform	Default interface	OpenSDA details
LPCXpresso55s69	CMSIS-DAP	N/A
MAPS-KS22	J-Link OpenSDA	OpenSDA v2.0
MIMXRT1170-EVK	CMSIS-DAP	N/A
TWR-K21D50M	P&E Micro OSJTAG	N/AOpenSDA v2.0
TWR-K21F120M	P&E Micro OSJTAG	N/A
TWR-K22F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K24F120M	CMSIS-DAP/mbd	OpenSDA v2.1
TWR-K60D100M	P&E Micro OSJTAG	N/A
TWR-K64D120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K64F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K65D180M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-K80F150M	CMSIS-DAP	OpenSDA v2.1
TWR-K81F150M	CMSIS-DAP	OpenSDA v2.1
TWR-KE18F	DAPLink	OpenSDA v2.1
TWR-KL28Z72M	P&E Micro OpenSDA	OpenSDA v2.1
TWR-KL43Z48M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KL81Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KL82Z72M	CMSIS-DAP	OpenSDA v2.0
TWR-KM34Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KM35Z75M	DAPLink	OpenSDA v2.2
TWR-KV10Z32	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV11Z75M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV31F120M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV46F150M	P&E Micro OpenSDA	OpenSDA v1.0
TWR-KV58F220M	CMSIS-DAP	OpenSDA v2.1
TWR-KW24D512	P&E Micro OpenSDA	OpenSDA v1.0
USB-KW24D512	N/A External probe	N/A
USB-KW41Z	CMSIS-DAP\DAPLink	OpenSDA v2.1 or greater

Updating debugger firmware

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

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

NXP provides the LPCScript utility, which is the recommended tool for programming the latest versions of CMSIS-DAP and J-Link firmware onto LPC-Link2 or LPCXpresso boards. The utility can be downloaded from www.nxp.com/lpcutilities.

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

1. Install the LPCScript utility.

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

Parent topic: [Updating debugger firmware](#)

How to update SPIFI clock Frequency

The SPIFI clock frequency is defined in the header, offset 0x1C. *Table 1* lists the SPIFI serial clock frequencies that are supported. So SPIFI clock frequency can be set to 24 MHz, 32 MHz, 48 MHz, and 96 MHz.

Note: If header sets SPIFI clock frequency to zero, the serial clock defaults to 24 MHz. And this setting affects both SPI boot or SPIFI boot clock. For SPIFI, the clock and other configuration settings are retained after boot unless modified by the application program.

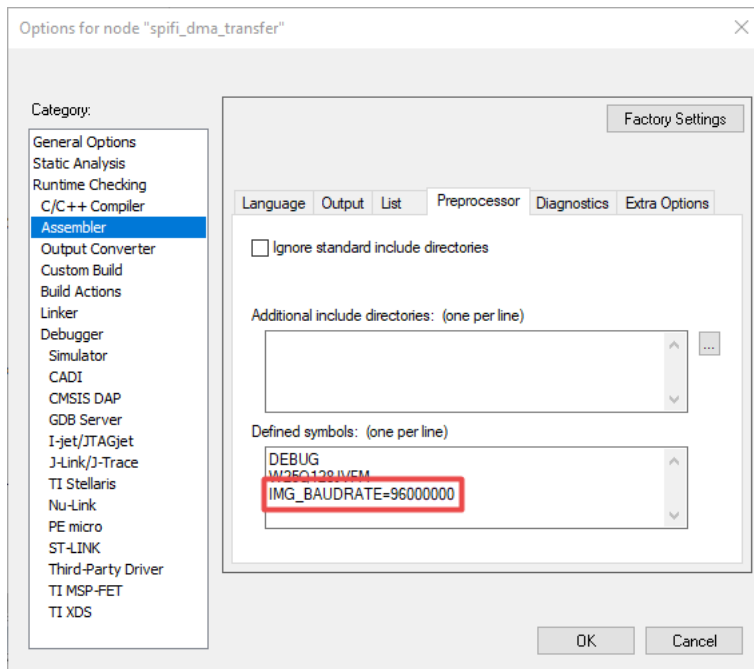
Header SPI/SPIFI clock frequency value	SPI/SPIFI clock speed
< 24000000 (SPI only)	12000000 (SPI only)
< 32000000	24000000
< 48000000	32000000
< 96000000	48000000
>= 96000000	96000000

The default SPIFI clock frequency is 24 MHz and the corresponding settings is IMG_BAUDRATE=0. To change SPIFI clock frequency, just need to add the setting of IMG_BAUDRATE=X (X=24000000, 32000000, 48000000 or 96000000) in IDEs. The macro of IMG_BAUDRATE is also defined in the startup_LPC54xx.s (.c,.cpp) file.

The following section takes 96 MHz as an example to introduce how to change SPIFI clock frequency in each IDE.

Updating SPIFI clock frequency in IAR

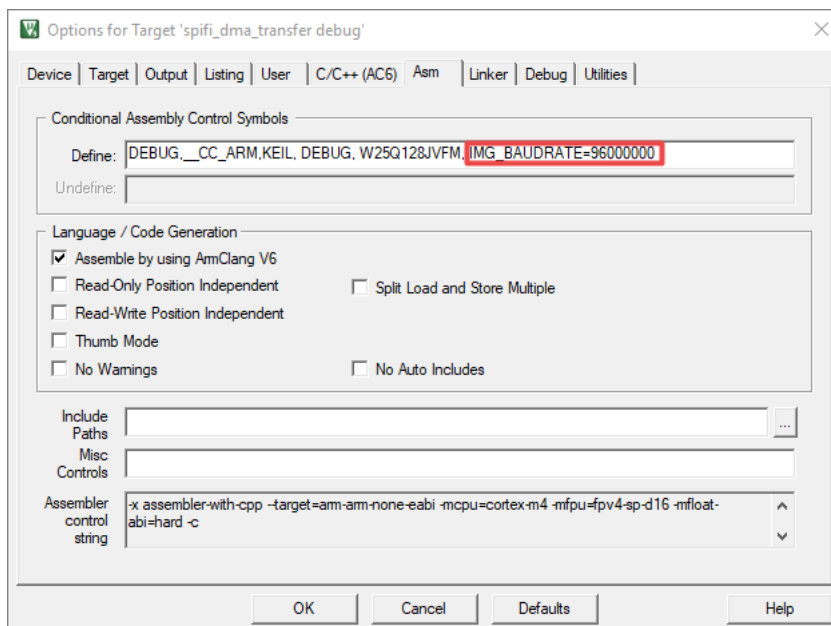
- In IAR, right click **Project** and choose **Options**. Then, click **Assembler** and **Preprocessor**.
- Add **IMG_BAUDRATE=96000000** in **Defined symbols: (one per line)**, as shown in Figure 1.



Parent topic: [How to update SPIFI clock Frequency](#)

Updating SPIFI clock frequency in Keil® MDK/μVision

- In Keil, right click **Project** and choose **Options**. Then, click **Asm**.
- Add **IMG_BAUDRATE=96000000** in **Define**, as shown in Figure 1.



Parent topic: [How to update SPIFI clock Frequency](#)

Updating SPIFI clock frequency in Arm® GCC

- In Armgcc, open the CMakeLists.txt file.
- Add two line settings.

```
SET(CMAKE_ASM_FLAGS_DEBUG "${CMAKE_ASM_FLAGS_DEBUG}-DIMG_  
↪BAUDRATE=96000000")
```

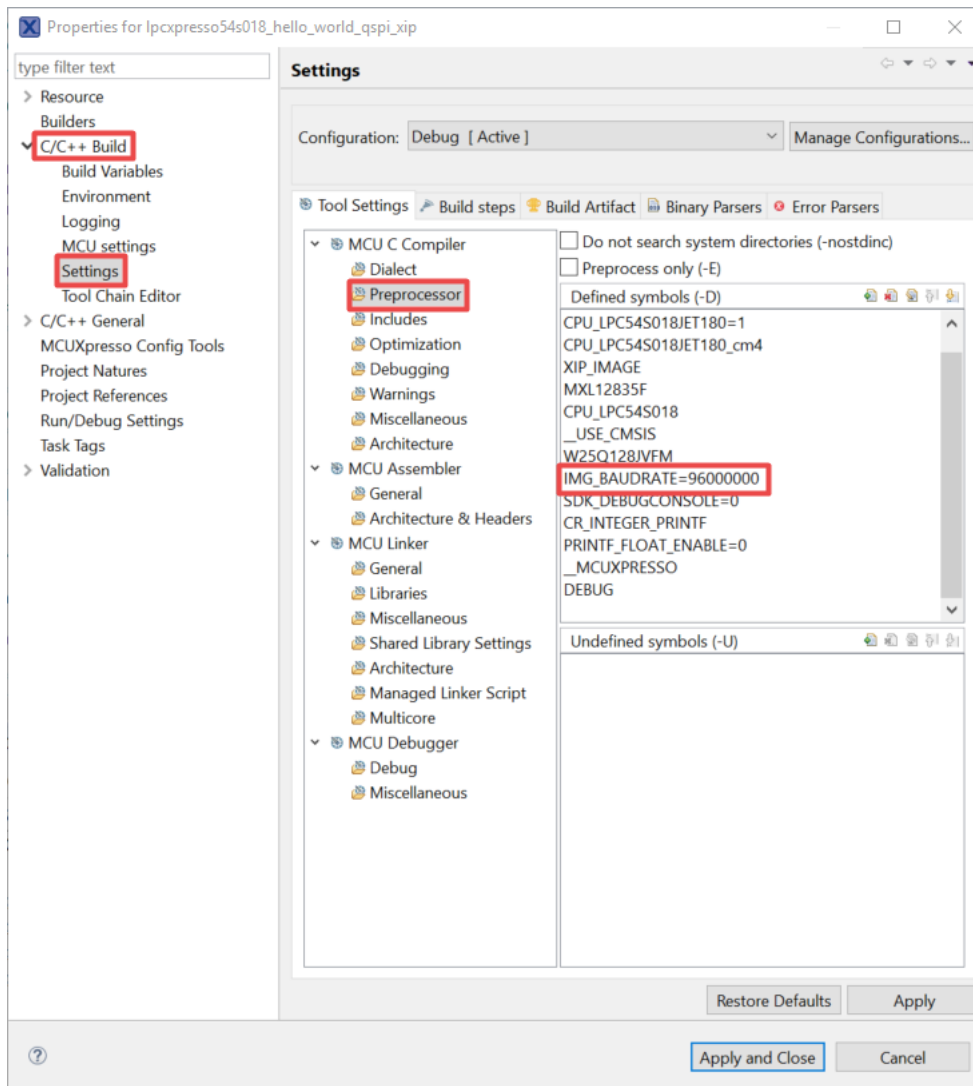
```
SET(CMAKE_ASM_FLAGS_RELEASE "${CMAKE_ASM_FLAGS_RELEASE}-DIMG_  
↪BAUDRATE=96000000")
```

```
31 SET(CMAKE_ASM_FLAGS_DEBUG "${CMAKE_ASM_FLAGS_DEBUG} -D__STARTUP_CLEAR_BSS")  
32  
33 SET(CMAKE_ASM_FLAGS_DEBUG "${CMAKE_ASM_FLAGS_DEBUG} -DIMG_BAUDRATE=96000000")  
34  
35 .....  
36  
37 SET(CMAKE_ASM_FLAGS_RELEASE "${CMAKE_ASM_FLAGS_RELEASE} -DIMG_BAUDRATE=96000000")  
38  
39 SET(CMAKE_ASM_FLAGS_RELEASE "${CMAKE_ASM_FLAGS_RELEASE} -mcpu=cortex-m4")
```

Parent topic:[How to update SPIFI clock Frequency](#)

Updating SPIFI clock frequency in MCUXpresso IDE

- In MCUXpresso IDE, right click project and choose Properties.
- Click **C/C++ Build** and choose **Settings**. Click **Preprocessor** in **Tool Settings**.
- Add **IMG_BAUDRATE=96000000** in **Defined symbols(-D)**, as shown in Figure 1.



Parent topic: [How to update SPIFI clock Frequency](#)

1.3 Getting Started with MCUXpresso SDK GitHub

1.3.1 Getting Started with MCUXpresso SDK Repository

Welcome to the **GitHub Repository SDK Guide**. This documentation provides instructions for setting up and working with the MCUXpresso SDK distributed in a **multi-repository model**. The SDK is distributed across multiple GitHub repositories and managed using the **Zephyr West** tool, enabling modular development and streamlined workflows.

Overview

The GitHub Repository SDK approach offers:

- **Modular Structure:** Multiple repositories for flexibility and scalability.
- **Zephyr West Integration:** Simplified repository management and synchronization.
- **Cross-Platform Support:** Designed for MCUXpresso SDK development environments.

Benefits of the Multi-Repository Approach

- **Scalability:** Easily add or update components without impacting the entire SDK.
- **Collaboration:** Enables distributed development across teams and repositories.
- **Version Control:** Independent versioning for components ensures better stability.
- **Automation:** Zephyr West simplifies dependency handling and repository synchronization.

Setup and Configuration

Follow these steps to prepare your development environment:

Development Tools Installation This guide explains how to install the essential tools for development with the MCUXpresso SDK.

Quick Start: Automated Installation (Recommended) The **MCUXpresso Installer** is the fastest way to get started. It automatically installs all the basic tools you need.

1. **Download the MCUXpresso Installer** from: [Dependency-Installation](#)
2. **Run the installer** and select “**MCUXpresso SDK Developer**” from the menu
3. **Click Install** and let it handle everything automatically

Manual Installation If you prefer to install tools manually or need specific versions, follow these steps:

Essential Tools

Git - Version Control **What it does:** Manages code versions and downloads SDK repositories from GitHub.

Installation:

- Visit git-scm.com
- Download for your operating system
- Run installer with default settings
- **Important:** Make sure “Add Git to PATH” is selected during installation

Setup:

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

Python - Scripting Environment **What it does:** Runs build scripts and SDK tools.

Installation:

- Install Python **3.10 or newer** from python.org
- **Important:** Check “Add Python to PATH” during installation

West - SDK Management Tool **What it does:** Manages SDK repositories and provides build commands. The west tool is developed by the Zephyr project for managing multiple repositories.

Installation:

```
pip install -U west
```

Minimum version: 1.2.0 or newer

Build System Tools

CMake - Build Configuration **What it does:** Configures how your projects are built.

Recommended version: 3.30.0 or newer

Installation:

- **Windows:** Download .msi installer from cmake.org/download
- **Linux:** Use package manager or download from cmake.org
- **macOS:** Use Homebrew (`brew install cmake`) or download from cmake.org

Ninja - Fast Build System **What it does:** Compiles your code quickly.

Minimum version: 1.12.1 or newer

Installation:

- **Windows:** Usually included, or download from ninja-build.org
- **Linux:** `sudo apt install ninja-build` or download binary
- **macOS:** `brew install ninja` or download binary

Ruby - IDE Project Generation (Optional) **What it does:** Generates project files for IDEs like IAR and Keil.

When needed: Only if you want to use traditional IDEs instead of VS Code.

Installation: Follow the Ruby environment setup guide

Compiler Toolchains Choose and install the compiler toolchain you want to use:

Toolchain	Best For	Download Link	Environment Variable
ARM GCC (Recommended)	Most users, free	ARM Toolchain GNU	ARMGCC_DIR
IAR EWARM	Professional development	IAR Systems	IAR_DIR
Keil MDK	ARM ecosystem	ARM Developer	MDK_DIR
ARM Compiler	Advanced optimization	ARM Developer	ARMCLANG_DIR

Setting Up Environment Variables After toolchain installation, set an environment variable so the build system locates it:

Windows:

```
# Example for ARM GCC installed in C:\armgcc
setx ARMGCC_DIR "C:\armgcc"
```

Linux/macOS:

```
# Add to ~/.bashrc or ~/.zshrc
export ARMGCC_DIR="/usr" # or your installation path
```

Verify Your Installation After installation, verify everything works by opening a terminal/command prompt and running these commands:

```
# Check each tool - you should see version numbers
git --version
python --version
west --version
cmake --version
ninja --version
arm-none-eabi-gcc --version # (if using ARM GCC)
```

Troubleshooting Installation Issues “Command not found” errors:

- The tool isn’t in your system PATH
- **Solution:** Add the installation directory to your PATH environment variable

Python/pip issues:

- Try using python3 and pip3 instead of python and pip
- On Windows, run the Command Prompt as an Administrator

Slow downloads:

- Add timeout option: `pip install -U west --default-timeout=1000`
- Use alternative mirror: `pip install -U west -i https://pypi.tuna.tsinghua.edu.cn/simple`

GitHub Repository Setup This guide explains how to initialize your MCUXpresso SDK workspace from GitHub repositories using the west tool. The GitHub Repository SDK uses multiple repositories hosted on GitHub to provide modular, flexible development.

Prerequisites Verify the requirements:

System Requirements:

- Python 3.8 or later
- Git 2.25 or later
- CMake 3.20 or later
- Build tools for your target platform

Verification Commands:

```
python --version  # Should show 3.8+
git --version     # Should show 2.25+
cmake --version   # Should show 3.20+
west --version    # Should show west tool installation
```

Workspace Initialization The GitHub Repository SDK uses the Zephyr west tool to manage multiple repositories containing different SDK components.

Step 1: Initialize Workspace Create and initialize your SDK workspace from GitHub:

Get the latest SDK from main branch:

```
west init -m https://github.com/nxp-mcuxpresso/mcuxsdk-manifests.git mcuxpresso-sdk
```

Get SDK at specific revision:

```
west init -m https://github.com/nxp-mcuxpresso/mcuxsdk-manifests.git mcuxpresso-sdk --mr {revision}
```

Note: Replace {revision} with the desired release tag, such as v25.09.00

Step 2: Choose Your Repository Update Strategy Navigate to the SDK workspace:

```
cd mcuxpresso-sdk
```

The west tool manages multiple GitHub repositories containing different SDK components. You have two options for downloading:

Option A: Download All Repositories (Complete SDK) Download all SDK repositories for comprehensive development:

```
west update
```

This command downloads all the repositories defined in the manifest from GitHub. Initial download takes several minutes and requires ~7 GB of disk space.

Best for:

- Exploring the complete SDK
- Multi-board development projects
- Comprehensive middleware evaluation

Option B: Targeted Repository Download (Recommended) Download only repositories needed for your specific board or device to save time and disk space:

```
# For specific board development
west update_board --set board your_board_name

# For specific device family development
west update_board --set device your_device_name

# List available repositories before downloading
west update_board --set board your_board_name --list-repo
```

Best for:

- Single board development

- Faster setup and reduced disk usage
- Focused development workflows

Examples:

```
# Update only repositories for FRDM-MCXW23 board
west update_board --set board frdmmcxw23

# Update only repositories for MCXW23 device family
west update_board --set device mcxw23
```

Step 3: Verify Installation Confirm successful setup:

```
# Verify workspace structure
ls -la
# Should show: manifests/ and mcuxsdk/ directories

# Test build system
west list_project -p examples/demo_apps/hello_world
# Should display available build configurations
```

Advanced Repository Management The west extension command `update_board` provides advanced repository management capabilities for optimized workspace setup with GitHub repositories.

Board-Specific Setup Update only repositories required for a specific board:

```
# Update only repositories for specific board, e.g., frdmmcxw23
west update_board --set board frdmmcxw23

# List available repositories for the board before updating
west update_board --set board frdmmcxw23 --list-repo
```

Device-Specific Setup Update only repositories required for a specific device family:

```
# Update only repositories for specific device, e.g., MCXW235
west update_board --set device mcxw23

# List available repositories for the device family
west update_board --set device mcxw23 --list-repo
```

Custom Configuration For advanced users who want to create custom repository combinations:

```
# Use custom configuration file
west update_board --set custom path/to/custom-config.yml

# Generate custom configuration template
cp manifests/boards/custom.yml.template my-custom-config.yml
```

Benefits of Targeted Setup Reduced Download Size

- Download only components needed for your target board or device
- Significantly faster initial setup for focused development

- Typical reduction from 7 GB to 2GB

Optimized Workspace

- Cleaner workspace with relevant components only
- Reduced disk space usage
- Faster repository operations

Flexible Development

- Switch between different board configurations easily
- Maintain separate workspaces for different projects
- Include optional components as needed

Repository Information Before setting up your workspace, you can explore what repositories are available:

```
# Display repository information in console
west update_board --set board frdm-mcxw23 --list-repo

# Export repository information to YAML file for reference
west update_board --set board frdm-mcxw23 --list-repo -o board-repos.yml
```

This command lists all the available repositories with descriptions and outlines the included components in the workspace.

Package Generation (Optional) The `update_board` command can also generate ZIP packages for offline distribution:

```
# Generate board-specific SDK package
west update_board --set board frdm-mcxw23 -o frdm-mcxw23-sdk.zip
```

Note: Package generation is primarily intended for creating custom SDK distributions. For regular development, use the workspace update commands without the `-o` option.

Workspace Management

Updating Your Workspace Keep your SDK current with latest updates from GitHub:

For Complete SDK Workspace:

```
# Update manifest repository
cd manifests
git pull

# Update all component repositories
cd ..
west update
```

For Targeted Workspace:

```
# Update manifest repository
cd manifests
git pull

# Update board-specific repositories
cd ..
west update_board --set board your_board_name
```

Workspace Status Check workspace synchronization status:

```
# Show status of all repositories
west status
```

```
# Show detailed information about repositories
west list
```

Troubleshooting Network Issues:

- Use `west update --keep-descendants` for partial failures
- Configure Git credentials for private repositories
- Check firewall settings for Git protocol access

Permission Issues:

- Ensure write permissions in workspace directory
- Run commands without `sudo`/administrator privileges
- Verify Git SSH key configuration for authenticated access

Disk Space:

- Full SDK workspace requires approximately 7-8 GB
- Targeted workspace typically requires 1-2 GB
- Use board-specific setup to reduce workspace size

Repository Management Issues:

- Verify board/device names match available configurations
- Check that custom YAML files follow the correct template format
- Use `--list-repo` to verify available repositories before setup

Next Steps With your workspace initialized:

1. Review [Workspace Structure](#) to understand the layout
2. Build your first project with [First Build Guide](#)
3. Explore [Development Workflows MCUXpresso VSCode](#) or [Development Workflows Command Line](#) for the details on project setup and execution

For advanced repository management, see the [west tool documentation](#).

Explore SDK Structure and Content

Learn about the organization of the SDK and its components:

SDK Architecture Overview The MCUXpresso SDK uses a modular architecture where software components are distributed across multiple repositories hosted on GitHub and managed through the west tool. This approach provides flexibility, maintainability, and enables selective component inclusion.

Repository Organization Based on the manifest structure, the SDK consists of four main repository categories:

Manifest Repository The manifest repo (mcuxsdk-manifests) contains the west.yml manifest file that tracks all other repositories in the SDK.

Base Repositories Recorded in submanifests/base.yml and loaded in the root west.yml manifest file. These are the foundational repositories that build the SDK:

- **Devices:** MCU-specific support packages
- **Examples:** Demonstration applications and code samples
- **Boards:** Board support packages

Middleware Repositories Recorded in the submanifests/middleware subdirectory, categorized according to functionality:

- **Connectivity:** Networking stacks, USB, and communication protocols
- **Security:** Cryptographic libraries and secure boot components
- **Wireless:** Bluetooth, IEEE 802.15.4, and other wireless protocols
- **Graphics:** Display drivers and UI frameworks
- **Audio:** Audio processing and voice recognition libraries
- **Machine Learning:** AI inference engines and neural network libraries
- **Safety:** IEC60730B safety libraries
- **Motor Control:** Motor control and real-time control libraries

Internal Repositories Recorded in submanifests/internal.yml and grouped into the “bifrost” group. These are only visible to NXP internal developers and hosted on NXP internal git servers.

Repository Hosting Public repositories are hosted on GitHub under these organizations:

- [nxp-mcuxpresso](#)
- [NXP](#)
- [nxp-zephyr](#)

Internal repositories are hosted on NXP's private Git infrastructure.

Benefits of This Architecture **Selective Integration:** Projects include only required components, reducing memory footprint and build complexity.

Independent Versioning: Each component maintains its own release cycle and version control.

Community Collaboration: Public repositories accept community contributions through standard Git workflows.

Scalable Maintenance: Component owners can update their repositories without affecting the entire SDK.

Workspace Management The west tool manages repository synchronization, version tracking, and workspace updates. All repositories are checked out under the mcuxsdk/ directory with their designated paths defined in the manifest files.

Workspace Structure After you initialize your SDK workspace, it creates a specific directory structure that organizes all SDK components. This structure is identical for both GitHub Repository SDK and Repository-Layout SDK Package.

Top-Level Organization

```
your-sdk-workspace/
  manifests/      # West manifest repository
  mcuxsdk/        # Main SDK content
```

The `mcuxsdk/` directory serves as your primary working directory and contains all the SDK components.

SDK Component Layout Based on the actual SDK structure, the main directories include:

Directory	Contents	Purpose
<code>arch/</code>	Architecture-specific files	ARM CMSIS, build configurations
<code>cmake/</code>	Build system modules	CMake configuration and build rules
<code>compo</code>	Software components	Reusable software libraries and utilities
<code>device/</code>	Device support packages	MCU-specific headers, startup code, linker scripts
<code>drivers/</code>	Peripheral drivers	Hardware abstraction layer for MCU peripherals
<code>examp</code>	Sample applications	Demonstration code and reference implementations
<code>middle</code>	Optional software stacks	Networking, graphics, security, and other libraries
<code>rtos/</code>	Operating system support	FreeRTOS integration
<code>scripts</code>	Build and utility scripts	West extensions and development tools
<code>svd</code>	Svd files for devices, this is optional because of large size. Customers run <code>west manifest config group.filter +optional</code> and <code>west update mcux-soc-svd</code> to get this folder.	

Example Organization Examples follow a two-tier structure separating common code from board-specific implementations:

Common Example Files

```
examples/demo_apps/hello_world/
  CMakeLists.txt      # Build configuration
  example.yml          # Example metadata
  hello_world.c        # Application source code
  Kconfig              # Configuration options
  readme.md            # General documentation
```

Board-Specific Files

```
examples/_boards/your_board/demo_apps/hello_world/
  app.h           # Board specific application header
  example_board_readme.md # Board specific documentation
  hardware_init.c # Board specific hardware initialization
  pin_mux.c       # Pin multiplexing configuration
  pin_mux.h       # Pin multiplexing header definitions
  hello_world.bin  # Pre-built binary for quick testing
  hello_world.mex  # MCUXpresso Config Tools project file
  prj.conf        # Board specific Kconfig configuration
  reconfig.cmake  # Board specific cmake configuration overrides
```

Device Support Structure Device support is organized hierarchically by MCU family:

```
devices/
  MCX/           # MCU portfolio
    MCXW/        # MCU family
      MCXW235/   # Specific device
        MCXW235.h # Device register definitions
      drivers/    # Device-specific drivers
      gcc/        # GNU toolchain files
      iar/        # IAR toolchain files
      mcuxpresso/ # MCUXpresso IDE files
      startup_MCXW235.c # Startup and vector table
      system_MCXW235.c # System initialization
```

Middleware Organization Middleware components are categorized by functionality and maintained in separate repositories. Based on the manifest files, common middleware categories include:

- **Connectivity:** USB, TCP/IP, industrial protocols
- **Security:** Cryptographic libraries, secure boot
- **Wireless:** Bluetooth, IEEE 802.15.4, Wi-Fi
- **Graphics:** Display drivers, UI frameworks
- **Audio:** Processing libraries, voice recognition
- **Machine Learning:** Inference engines, neural networks
- **Safety:** IEC60730B safety libraries
- **Motor Control:** Motor control and real-time control libraries

Documentation Structure SDK documentation is distributed across multiple locations:

- docs/ - Core SDK documentation and build infrastructure
- Component repositories - API documentation and integration guides
- Board directories - Hardware-specific setup instructions

For complete documentation, refer to the [online documentation](#).

Understanding Example Structure Each example has **two README files**:

1. General README: `examples/demo_apps/hello_world/readme.md`

- What the example does
- General functionality description
- Common usage information

2. Board-Specific README: `examples/_boards/{board_name}/demo_apps/hello_world/example_board_readme.md`

- Board-specific setup instructions
- Hardware connections required
- Board-specific behavior notes

Tip: Always check both readme files - start with the general one, then read the board-specific one for detailed setup.

Development Workflows

Get started with building and running projects:

Building Your First Project This guide explains how to build and run your first SDK example project using the west build system. This applies to both GitHub Repository SDK and Repository-Layout SDK Package.

Prerequisites

- GitHub Repository SDK workspace initialized OR Repository-Layout SDK Package extracted
- Development board connected via USB
- Build tools installed per [Installation Guide](#)

Understanding Board Support Use the west extension to discover available examples for your board:

```
west list _project -p examples/demo_apps/hello_world
```

This shows all supported build configurations. You can filter by toolchain:

```
west list _project -p examples/demo_apps/hello_world -t armgcc
```

Basic Build Process

Simple Build Build the hello_world example with default settings:

```
west build -b your_board examples/demo_apps/hello_world
```

The default toolchain is armgcc, and the build system will select the first debug target as default if no config is specified.

Specifying Configuration

```
# Release build
west build -b your_board examples/demo_apps/hello_world --config release

# Debug build (default)
west build -b your_board examples/demo_apps/hello_world --config debug
```

Alternative Toolchains

```
# IAR toolchain
west build -b your_board examples/demo_apps/hello_world --toolchain iar

# Other toolchains as supported by the example
```

Multicore Applications

 For multicore devices, specify the core ID:

```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world --toolchain iar -Dcore_id=cm7 --config ↵
↵ flexspi_nor_debug
```

For multicore projects using sysbuild:

```
west build -b evkbmimxrt1170 --sysbuild ./examples/multicore_examples/hello_world/primary -Dcore_ ↵
↵ id=cm7 --config flexspi_nor_debug --toolchain=armgcc -p always
```

Flash an Application

 Flash the built application to your board:

```
west flash -r linkserver
```

Debug

 Start a debug session:

```
west debug -r linkserver
```

Common Build Options

Clean Build

 Force a complete rebuild:

```
west build -b your_board examples/demo_apps/hello_world -p always
```

Dry Run

 See the commands that get executed without running them:

```
west build -b your_board examples/demo_apps/hello_world --dry-run
```

Device Variants

 For boards supporting multiple device variants:

```
west build -b your_board examples/demo_apps/hello_world --device DEVICE_PART_NUMBER --config ↵
↵ release
```

Project Configuration

CMake Configuration Only Run configuration without building:

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

Interactive Configuration Launch the configuration GUI:

```
west build -t guiconfig
```

Troubleshooting

Build Failures Use pristine builds to resolve dependency issues:

```
west build -b your_board examples/demo_apps/hello_world -p always
```

Getting Help View the help information for west build:

```
west build -h
```

Check Supported Configurations To see available configuration options and board targets for an example, refer to the below command:

```
west list_project -p examples/demo_apps/hello_world
```

Next Steps

- Explore other examples in the SDK
- Learn about [Command Line Development](#) for advanced options
- Try [VS Code Development](#) for integrated development
- Refer [Workspace Structure](#) to understand the SDK layout

MCUXpresso for VS Code Development This guide covers using MCUXpresso for VS Code extension to build, debug, and develop SDK applications with an integrated development environment.

Prerequisites

- SDK workspace initialized (GitHub Repository SDK or Repository-Layout SDK Package)
- Development tools installed per [Installation Guide](#)
- Visual Studio Code installed
- MCUXpresso for VS Code extension installed

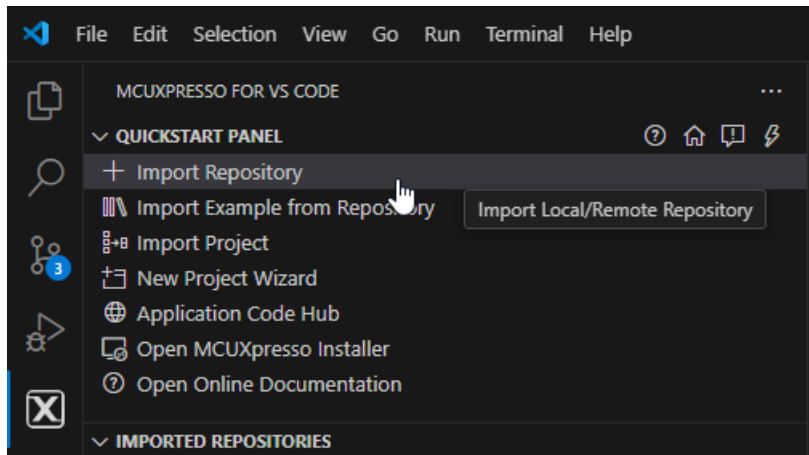
Extension Installation

Install MCUXpresso for VS Code The MCUXpresso for VS Code extension provides integrated development capabilities for MCUXpresso SDK projects. Refer to the [MCUXpresso for VS Code Wiki](#) for detailed installation and setup instructions.

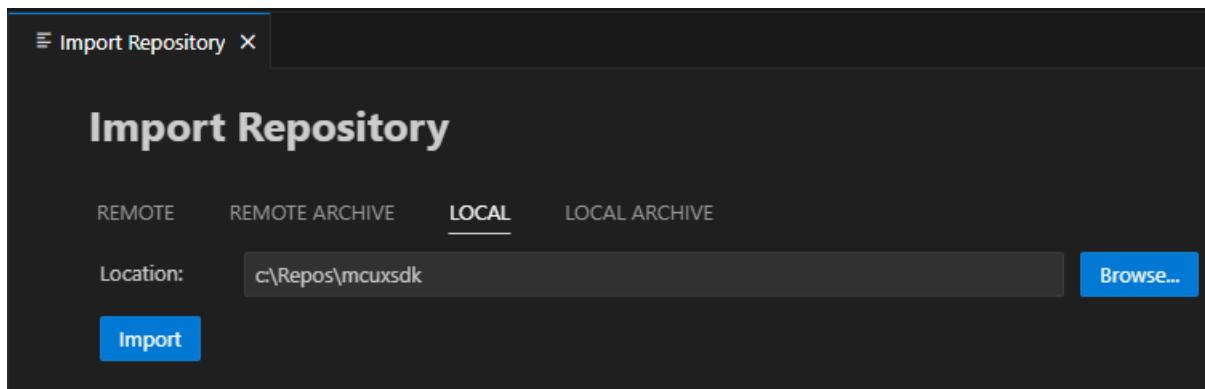
SDK Import and Setup

Import Methods The SDK can be imported in several ways. The MCUXpresso for VS Code extension supports both GitHub Repository SDK and Repository-Layout SDK Package distributions.

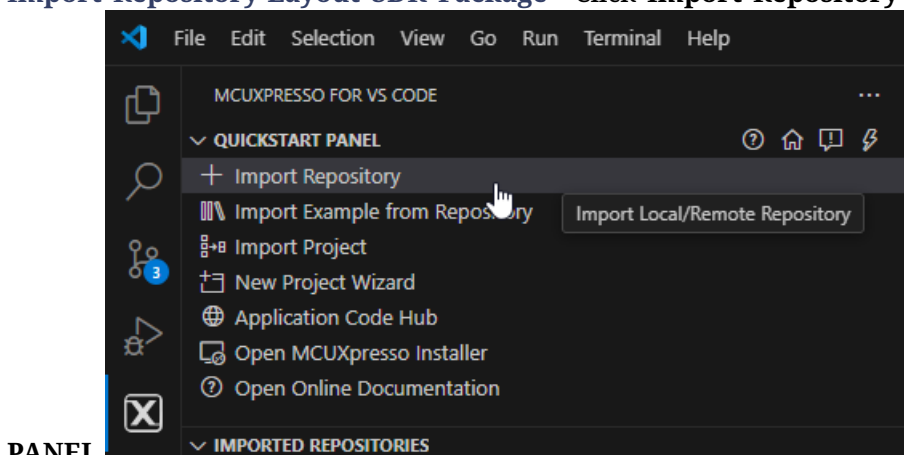
Import GitHub Repository SDK Click **Import Repository** from the **QUICKSTART PANEL**



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 according to [setting up the repo](#). Select your location and click **Import**.

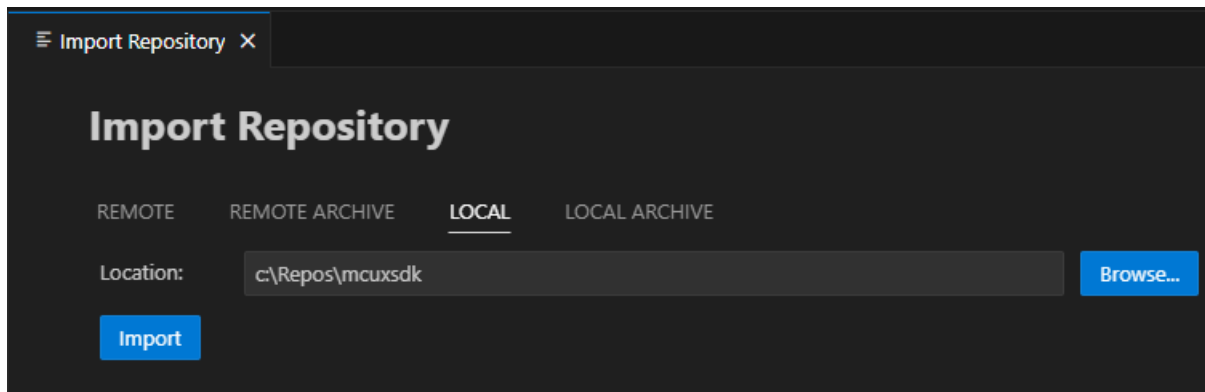


Import Repository-Layout SDK Package Click **Import Repository** from the **QUICKSTART**

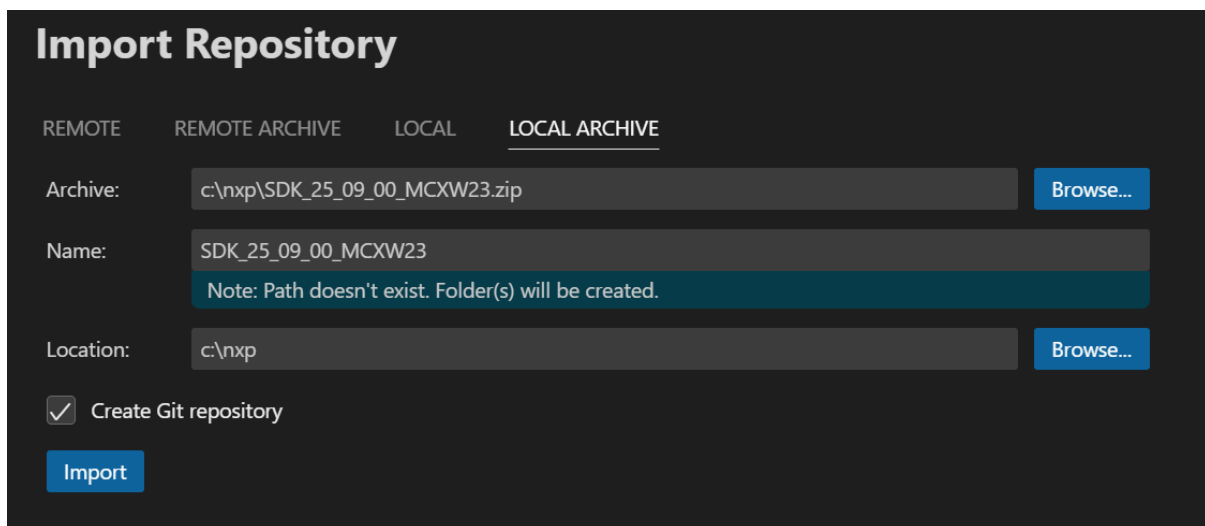


PANEL

Select **Local** if you've already unzipped the Repository-Layout SDK Package. Select your location and click **Import**.



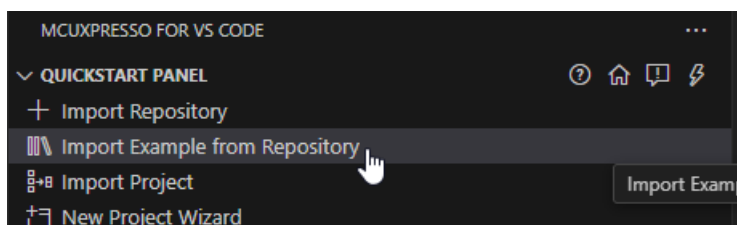
Else if the SDK is ZIP archive, select **Local Archive**, browse to the downloaded SDK ZIP file, fill the link of expect location, then click **Import**.



Building Example Applications

Import Example Project

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



2. Configure project settings:
 - **MCUXpresso SDK:** Select your imported SDK
 - **Arm GNU Toolchain:** Choose toolchain
 - **Board:** Select your target development board
 - **Template:** Choose example category

- **Application:** Select specific example (e.g., hello_world)
- **App type:** Choose between Repository applications or Freestanding applications

3. Click **Import**

Import Example from Repository

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

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

Board: FRDM-MCXC444 | v

 FRDM-MCXC444

Template: demo_apps/hello_world | v

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

App type: Freestanding application | v

Name: frdmxc444_hello_world

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

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

☐ Open readme file after project is imported

Import

Application Types **Repository Applications:**

- Located inside the MCUXpresso SDK
- Integrated with SDK workspace

Freestanding Applications:

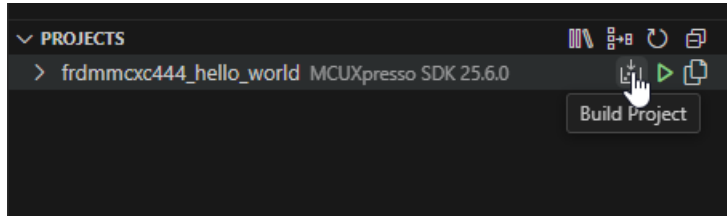
- Imported to user-defined location
- Independent of SDK location

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

Building Projects

Build Process

1. Navigate to **PROJECTS** view
2. Find your project
3. Click the **Build Project** icon

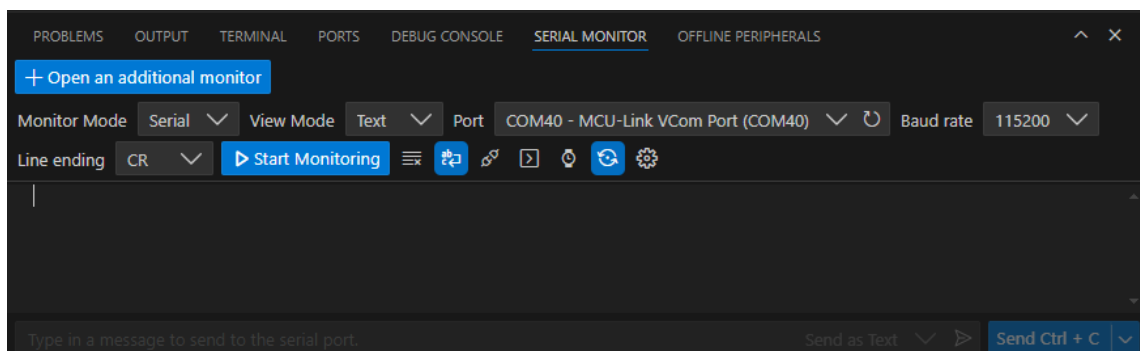


The integrated terminal will display build output at the bottom of the VS Code window.

Running and Debugging

Serial Monitor Setup

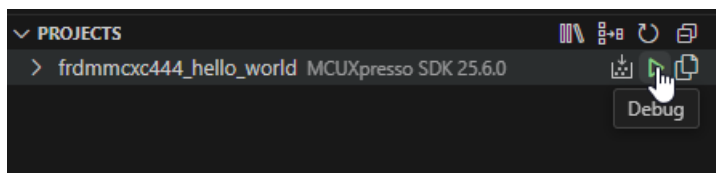
1. Open **Serial Monitor** from VS Code's integrated terminal



2. Configure serial settings:
 - **VCom Port:** Select port for your device
 - **Baud Rate:** Set to 115200

Debug Session

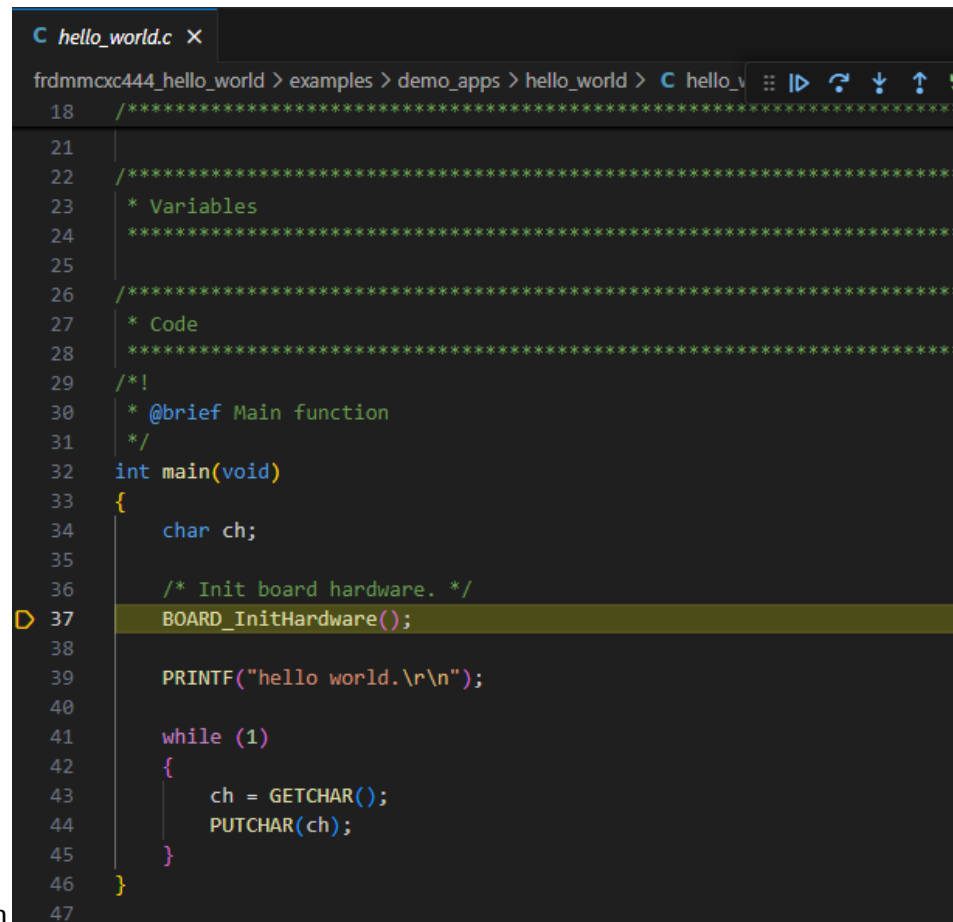
1. Navigate to **PROJECTS** view
2. Click the play button to initiate a debug session



The debug session will begin with debug controls initially at the top of the interface.

Debug Controls Use the debug controls to manage execution:

- **Continue:** Resume code execution
- **Step controls:** Navigate through code



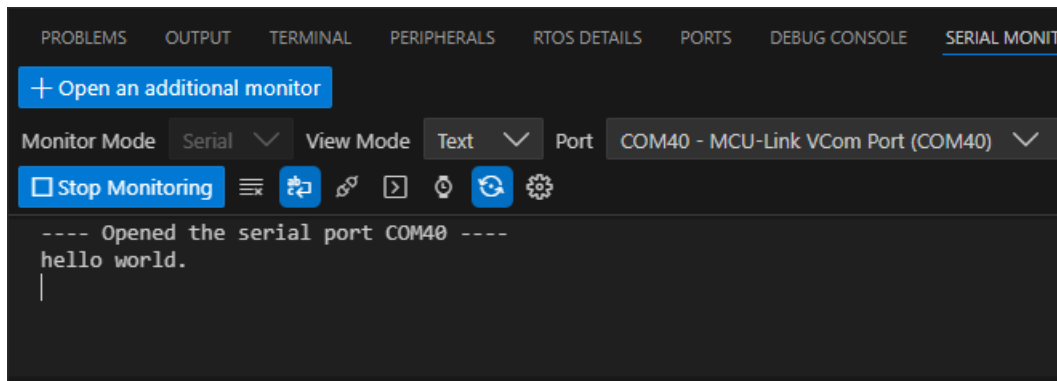
```

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

```

- **Stop:** Terminate debug session

Monitor Output Observe application output in the **Serial Monitor** to verify correct operation.



Debug Probe Support For comprehensive information on debug probe support and configuration, refer to the [MCUXpresso for VS Code Wiki DebugK](#) section.

Project Configuration

Workspace Management The extension integrates with the MCUXpresso SDK workspace structure, providing access to:

- Example applications
- Board configurations

- Middleware components
- Build system integration

Multi-Project Support The PROJECTS view allows management of multiple imported projects within the same workspace.

Troubleshooting

Import Issues SDK not detected:

- Verify SDK workspace is properly initialized
- Ensure all required repositories are updated
- Check SDK manifest files are present

Project import failures:

- Confirm board support exists for selected example
- Verify toolchain installation
- Check example compatibility with selected board

Build Problems Build failures:

- Check integrated terminal for error messages
- Verify all dependencies are installed
- Ensure toolchain is properly configured

Debug Issues Debug session fails:

- Verify board connection via USB
- Check debug probe drivers are installed
- Confirm build completed successfully

Serial monitor problems:

- Verify correct VCom port selection
- Check baud rate configuration (115200)
- Ensure board drivers are installed

Integration with Command Line MCUXpresso for VS Code integrates with the underlying west build system, allowing seamless integration with command line workflows described in [Command Line Development](#).

Advanced Features

Project Types The extension supports both repository-based and freestanding project types, providing flexibility in project organization and SDK integration.

Build System Integration The extension leverages the MCUXpresso SDK build system, providing access to all build configurations and options available through command line tools.

Next Steps

- Explore additional examples in the SDK
- Review [Command Line Development](#) for advanced build options
- Refer [MCUXpresso for VS Code Wiki](#) for detailed documentation
- Learn about [SDK Architecture](#) for better understanding of the development environment

Command Line Development This guide covers developing with the MCUXpresso SDK using command line tools and the west build system. This workflow applies to both GitHub Repository SDK and Repository-Layout SDK Package distributions.

Prerequisites

- GitHub Repository SDK workspace initialized OR Repository-Layout SDK Package extracted
- Development tools installed per [Installation Guide](#)
- Target board connected via USB

Understanding Board Support Use the west extension to discover available examples for your board:

```
west list _project -p examples/demo_apps/hello_world
```

This shows all supported build configurations. You can filter by toolchain:

```
west list _project -p examples/demo_apps/hello_world -t armgcc
```

Basic Build Commands

Standard Build Process Build with default settings (armgcc toolchain, first debug config):

```
west build -b your_board examples/demo_apps/hello_world
```

Specifying Build Configuration

```
# Release build
west build -b your_board examples/demo_apps/hello_world --config release

# Debug build with specific toolchain
west build -b your_board examples/demo_apps/hello_world --toolchain iar --config debug
```

Multicore Applications For multicore devices, specify the core ID:

```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world --toolchain iar -Dcore_id=cm7 --config ↵
↵ flexspi_nor_debug
```

For multicore projects using sysbuild:

```
west build -b evkbmimxrt1170 --sysbuild ./examples/multicore_examples/hello_world/primary -Dcore_
↪id=cm7 --config flexspi_nor_debug --toolchain=armgcc -p always
```

Shield Support For boards with shields:

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

Advanced Build Options

Clean Builds Force a complete rebuild:

```
west build -b your_board examples/demo_apps/hello_world -p always
```

Dry Run See what commands would be executed:

```
west build -b your_board examples/demo_apps/hello_world --dry-run
```

Device Variants For boards supporting multiple device variants:

```
west build -b your_board examples/demo_apps/hello_world --device MK22F12810 --config release
```

Project Configuration

CMake Configuration Only Run configuration without building:

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

Interactive Configuration Launch the configuration GUI:

```
west build -t guiconfig
```

Flashing and Debugging

Flash Application Flash the built application to your board:

```
west flash -r linkserver
```

Debug Session Start a debugging session:

```
west debug -r linkserver
```

IDE Project Generation Generate IDE project files for traditional IDEs:

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

IDE project files are generated in `mcuxsdk/build/<toolchain>` folder.

Note: Ruby installation is required for IDE project generation. See [Installation Guide](#) for setup instructions.

Troubleshooting

Build Failures Use pristine builds to resolve dependency issues:

```
west build -b your_board examples/demo_apps/hello_world -p always
```

Toolchain Issues Verify environment variables are set correctly:

```
# Check ARM GCC
echo $ARMGCC_DIR
arm-none-eabi-gcc --version

# Check IAR (if using)
echo $IAR_DIR
```

Getting Help Display help information:

```
west build -h
west flash -h
west debug -h
```

Check Supported Configurations If unsure about supported options for an example:

```
west list_project -p examples/demo_apps/hello_world
```

Best Practices

Project Organization

- Keep custom projects outside the SDK tree
- Use version control for your application code
- Document any SDK modifications

Build Efficiency

- Use `-p always` for clean builds when troubleshooting
- Leverage `--dry-run` to understand build processes
- Use specific configs and toolchains to reduce build time

Development Workflow

1. Start with existing examples closest to your requirements
2. Copy and modify rather than building from scratch
3. Test with `hello_world` before moving to complex examples
4. Use configuration tools for pin muxing and clock setup

Next Steps

- Explore [VS Code Development](#) for integrated development experience
- Review [Workspace Structure](#) to understand SDK organization
- Refer build system documentation for advanced configurations

Using MCUXpresso Config Tools MCUXpresso Config tools provide a user-friendly way to configure hardware initialization of your projects. This guide explains the basic workflow with the MCUXpresso SDK west build system and the Config Tools.

Prerequisites

- GitHub Repository SDK workspace initialized OR Repository-Layout SDK Package extracted
- MCUXpresso Config Tools standalone installed (version 25.09 or above)
- MCUXpresso SDK Project that can be successfully built

Board Files MCUXpresso Config Tools generate source files for the board. These files include `pin_mux.c/h` and `clock_config.c/h`. The files contain initialization code functions that reflect the hardware configuration in the Config Tools. Within the SDK codebase, these files are specific for the board and either shared by multiple example projects or specific for one example. Open or import the configuration from the SDK project in the Config Tools and customize the settings to match the custom board or specific project use case and regenerate the code. See *User Guide for MCUXpresso Config Tools (Desktop)* (document [GSMCUXCTUG](#)) for details.

Note: When opening the configuration for SDK example projects, the board files may be shared across multiple examples. To ensure a separate copy of the board configuration files exists, create a freestanding project with copied board files.

Visual Studio Code To open the configuration in Visual Studio Code, use the context menu for the project to access Config Tools. See [MCUXpresso Extension Documentation](#) for details. Otherwise, use the manual workflow described in detail in the following section.

Manual Workflow Use the following steps:

1. Before using Config Tools, run the west command to get the project information for Config Tools from the SDK project files, for example:

```
west cfg_project_info -b lpcxpresso55s69 ...mcuxsdk/examples/demo_apps/hello_world/ -Dcore_
↪ id=cm33_core0
```

This results in the creation of the project information json file that is searched by the config tools when the configuration is created. The parameters of the command should match the build parameters that will be used for the project.

2. Launch the MCUXpresso Config Tools and in the **Start development** wizard, select **Create a new configuration based on the existing IDE/Toolchain project**. Select the created “cfg_tools” subfolder as a project folder (for example: ...mcuxsdk/examples/demo_apps/hello_world/cfg_tools/).

Updating the SDK West project **Note:** Updating project is supported with Config Tools V25.12 or newer only.

Changes in the Config tools generated source code modules may require adjustments to the toolchain project to ensure a successful build. These changes may mean, for example, adding the newly generated files, adding include paths, required drivers, or other SDK components. This section describes how to manually resolve the changes needed in the project within the toolchain projects based on the SDK project managed by the West tool.

After the configuration in the Config Tools is finished, write updated files to the disk using the ‘Update Code’ command. The written files include a json file with the required changes for the toolchain project.

To resolve the changes in the project in the terminal, launch the west command that updates the project. For example:

```
west cfg_resolve -b lpcxpresso55s69 ...mcuxsdk/examples/demo_apps/hello_world/ -Dcore_id=cm33_core0
```

This command updates the appropriate cmake and kconfig files to address the changes. After this, the application can be built.

Note: The `cfg_resolve` command supports additional arguments. Launch the `west cfg_resolve -h` command to get the list and description.

1.4 Release Notes

1.4.1 MCUXpresso SDK Release Notes

Overview

The MCUXpresso SDK is a comprehensive software enablement package designed to simplify and accelerate application development with Arm Cortex-M-based devices from NXP, including its general purpose, crossover and Bluetooth-enabled MCUs. MCUXpresso SW and Tools for DSC further extends the SDK support to current 32-bit Digital Signal Controllers. The MCUXpresso SDK includes production-grade software with integrated RTOS (optional), integrated enabling software technologies (stacks and middleware), reference software, and more.

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

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

MCUXpresso SDK

As part of the MCUXpresso software and tools, MCUXpresso SDK is the evolution of Kinetis SDK, includes support for LPC, DSC, PN76, and i.MX System-on-Chip (SoC). The same drivers, APIs, and

middleware are still available with support for Kinetis, LPC, DSC, and i.MX silicon. The MCUXpresso SDK adds support for the MCUXpresso IDE, an Eclipse-based toolchain that works with all MCUXpresso SDKs. Easily import your SDK into the new toolchain to access to all of the available components, examples, and demos for your target silicon. In addition to the MCUXpresso IDE, support for the MCUXpresso Config Tools allows easy cloning of existing SDK examples and demos, allowing users to leverage the existing software examples provided by the SDK for their own projects.

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

Development tools

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

- MCUXpresso IDE, Rev. 25.06.xx
- IAR Embedded Workbench for Arm, version is 9.70.2
- Keil MDK, version is 5.42a
- MCUXpresso for VS Code v25.12
- GCC Arm Embedded Toolchain 14.2.x

Supported development systems

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

Development boards	MCU devices		
LPCXpresso54S018M	LPC54018J2MET180, LPC54S018J4MET180	LPC54018J4MET180,	LPC54S018J2MET180,

MCUXpresso SDK release package

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

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

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

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

RTOS

FreeRTOS Real-time operating system for microcontrollers from Amazon

Middleware

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

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

coreHTTP coreHTTP

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

TinyCBOR Concise Binary Object Representation (CBOR) Library

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

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

mbedTLS mbedtls SSL/TLS library v2.x

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

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

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

LVGL LVGL Open Source Graphics Library

llhttp HTTP parser llhttp

LittleFS LittleFS filesystem stack

FreeMASTER FreeMASTER communication driver for 32-bit platforms.

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

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.

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

Release contents

Provides an overview of the MCUXpresso SDK release package contents and locations.

Deliverable	Location
Boards	INSTALL_DIR/boards
Demo Applications	INSTALL_DIR/boards/<board_name>/demo_apps
Driver Examples	INSTALL_DIR/boards/<board_name>/driver_examples
eIQ examples	INSTALL_DIR/boards/<board_name>/eiq_examples
Board Project Template for MCUXpresso IDE NPW	INSTALL_DIR/boards/<board_name>/project_template
Driver, SoC header files, extension header files and feature header files, utilities	INSTALL_DIR/devices/<device_name>
CMSIS drivers	INSTALL_DIR/devices/<device_name>/cmsis_drivers
Peripheral drivers	INSTALL_DIR/devices/<device_name>/drivers
Toolchain linker files and startup code	INSTALL_DIR/devices/<device_name>/<toolchain_name>
Utilities such as debug console	INSTALL_DIR/devices/<device_name>/utilities
Device Project Template for MCUXpresso IDE NPW	INSTALL_DIR/devices/<device_name>/project_template
CMSIS Arm Cortex-M header files, DSP library source	INSTALL_DIR/CMSIS
Components and board device drivers	INSTALL_DIR/components
RTOS	INSTALL_DIR/rtos
Release Notes, Getting Started Document and other documents	INSTALL_DIR/docs
Tools such as shared cmake files	INSTALL_DIR/tools
Middleware	INSTALL_DIR/middleware

Known issues

This section lists the known issues, limitations, and/or workarounds.

Cannot add SDK components into FreeRTOS projects

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

USB high-speed interrupt endpoint issue

If the user wants to use a high-speed interrupt endpoint, the maximum packet size should be 512 bytes.

littlefs_shell does not produce output

littlefs_shell example compiled by armgcc does not produce debug console output on LPCXpresso54S018M board. Root cause is unknown.

The aws_shadow_enet doesn't work

The example ends with message: xEventGroupSetBitsFromISR failed, increase configTIMER_QUEUE_LENGTH or configTIMER_TASK_PRIORITY.

Affected toolchains: mcux, mdk **Affected platforms:** lpcxpresso54628, lpcxpresso54s018m

The aws_shadow_wifi_serial doesn't work

The example has problem with TLS connection.

Affected toolchains: mcux **Affected platforms:** lpcxpresso54s018m

1.5 ChangeLog

1.5.1 MCUXpresso SDK Changelog

Board Support Files

board

[25.06.00]

- Initial version

clock_config

[25.06.00]

- Initial version

pin_mux

[25.06.00]

- Initial version
-

LPC_ADC

[2.6.0]

- New Features
 - Added new feature macro to distinguish whether the GPADC_CTRL0_GPADC_TSAMP control bit is on the device.
 - Added new variable extendSampleTimeNumber to indicate the ADC extend sample time.
- Bugfix
 - Fixed the bug that incorrectly sets the PASS_ENABLE bit based on the sample time setting.

[2.5.3]

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

[2.5.2]

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

[2.5.1]

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

[2.5.0]

- Improvements
 - Add missing parameter tag of ADC_DoOffsetCalibration().
- Bug Fixes
 - Removed a duplicated API with typo in name: ADC_EnableShresholdCompareInterrupt().

[2.4.1]

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

[2.4.0]

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

[2.3.2]

- Improvements
 - Added delay after enabling using the ADC `GPADC_CTRL0 LDO_POWER_EN` bit for JN5189/QN9090.
- New Features
 - Added support for platforms which have only one ADC sequence control/result register.

[2.3.1]

- Bug Fixes
 - Avoided writing ADC STARTUP register in `ADC_Init()`.
 - Fixed Coverity zero divider error in `ADC_DoSelfCalibration()`.

[2.3.0]

- Improvements
 - Updated “`ADC_Init()`” “`ADC_GetChannelConversionResult()`” API and “`adc_resolution_t`” structure to match QN9090.
 - Added “`ADC_EnableTemperatureSensor`” API.

[2.2.1]

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

[2.2.0]

- Improvements
 - Updated “`ADC_DoSelfCalibration`” API and “`adc_config_t`” structure to match LPC845.

[2.1.0]

- Improvements
 - Renamed “`ADC_EnableShresholdCompareInterrupt`” to “`ADC_EnableThresholdCompareInterrupt`”.

[2.0.0]

- Initial version.
-

AES

[2.0.3]

- Edit aes_one_block() function to be interrupt safe.

[2.0.2]

- Fix MISRA-2012 issues.

[2.0.1]

- Improvements
 - GCM constant time tag comparison.

[2.0.0]

- Initial version.
-

CLOCK

[2.3.3]

- Improvements
 - Added lost comments for some enumerations.

[2.3.2]

- Bug Fixes
 - Fixed violation of MISRA C-2012 rule 5.7.

[2.3.1]

- Bug Fixes
 - Fixed MISRA C-2012 rule 10.1, rule 10.4, rule 10.8, rule 15.5 and so on.
 - Fixed IAR warning Pa082 for the clock driver.

[2.3.0]

- New feature:
 - Moved SDK_DelayAtLeastUs function from clock driver to common driver.

[2.2.0]

- New Feature:
 - add new APIs including `CLOCK_GetEmcClkFreq` and `CLOCK_GetMCanClkFreq` due to removing some variables in enum `clock_name_t`

[2.1.0]

- Bug Fix:
 - Fix flexcomm0-9 clock calculation.
 - Correct the return frequency of `CLOCK_GetFrgClkFreq`.
 - Fix the bug in function `CLOCK_GetPllConfig()` to refine the cache feature.
 - Update the code to suppress the incorrect configuration in `CLOCK_GetUsbPllOutFromSetup()`.
 - Fix C++ build errors in `CLOCK_GetClockAttachId()` and `CLOCK_AttachClk()`.
- New feature
 - Adding new API `CLOCK_DelayAtLeastUs()` implemented by DWT to allow users set delay in unit of microsecond.

[2.0.4]

- Bug Fix:
 - Fix attach incorrect `attach_id`.

[2.0.3]

- New Feature:
 - add get actual clock attach id api to allow users to obtain the actual clock source in target register.
- Bug Fix:
 - The attach clock and get actual clock attach id apis should check combination of two clock source.
- Optimization:
 - Make the judgement statments more clear.
 - Strengthen the compatibility of clock attach id.
 - Remove some unmeaningful definitions and add some useful ones to enhance readability.

[2.0.2]

- Change `CLOCK_SetupFROClocking` from a macro to a function for different FRO setting address per different ROM version.

[2.0.1]

- some minor fixes.

[2.0.0]

- initial version.
-

COMMON

[2.6.3]

- New Features
 - Added bit mask inversion macros to avoid type promotion.
 - Added register operation macros.
- Improvements
 - Make function `MSDK__EnableCpuCycleCounter` compatible with CMSIS-5 and CMSIS-6.
- Bug Fixes
 - Fixed build issue of CMSIS PACK BSP example caused by CMSIS 6.1 issue.

[2.6.2]

- Bug Fixes
 - Fixed violations of MISRA C-2012 rule for implicit conversions in boolean contexts

[2.6.1]

- Improvements
 - Support Cortex M23.

[2.6.0]

- Bug Fixes
 - Fix CERT-C violations.

[2.5.0]

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

[2.4.3]

- Improvements
 - Enable irq's that mount under `irqsteer` interrupt extender.

[2.4.2]

- Improvements
 - Add the macros to convert peripheral address to secure address or non-secure address.

[2.4.1]

- Improvements
 - Improve for the macro redefinition error when integrated with zephyr.

[2.4.0]

- New Features
 - Added EnableIRQWithPriority, IRQ_SetPriority, and IRQ_ClearPendingIRQ for ARM.
 - Added MSDK_EnableCpuCycleCounter, MSDK_GetCpuCycleCount for ARM.

[2.3.3]

- New Features
 - Added NETC into status group.

[2.3.2]

- Improvements
 - Make driver aarch64 compatible

[2.3.1]

- Bug Fixes
 - Fixed MAKE_VERSION overflow on 16-bit platforms.

[2.3.0]

- Improvements
 - Split the driver to common part and CPU architecture related part.

[2.2.10]

- Bug Fixes
 - Fixed the ATOMIC macros build error in cpp files.

[2.2.9]

- Bug Fixes
 - Fixed MISRA C-2012 issue, 5.6, 5.8, 8.4, 8.5, 8.6, 10.1, 10.4, 17.7, 21.3.
 - Fixed SDK_Malloc issue that not allocate memory with required size.

[2.2.8]

- Improvements
 - Included stddef.h header file for MDK tool chain.
- New Features:
 - Added atomic modification macros.

[2.2.7]

- Other Change
 - Added MECC status group definition.

[2.2.6]

- Other Change
 - Added more status group definition.
- Bug Fixes
 - Undef __VECTOR_TABLE to avoid duplicate definition in cmsis_clang.h

[2.2.5]

- Bug Fixes
 - Fixed MISRA C-2012 rule-15.5.

[2.2.4]

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

[2.2.3]

- New Features
 - Provided better accuracy of SDK_DelayAtLeastUs with DWT, use macro SDK_DELAY_USE_DWT to enable this feature.
 - Modified the Cortex-M7 delay count divisor based on latest tests on RT series boards, this setting lets result be closer to actual delay time.

[2.2.2]

- New Features
 - Added include RTE_Components.h for CMSIS pack RTE.

[2.2.1]

- Bug Fixes
 - Fixed violation of MISRA C-2012 Rule 3.1, 10.1, 10.3, 10.4, 11.6, 11.9.

[2.2.0]

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

[2.1.4]

- New Features
 - Added OTFAD into status group.

[2.1.3]

- Bug Fixes
 - MISRA C-2012 issue fixed.
 - * Fixed the rule: rule-10.3.

[2.1.2]

- Improvements
 - Add `SUPPRESS_FALL_THROUGH_WARNING()` macro for the usage of suppressing fallthrough warning.

[2.1.1]

- Bug Fixes
 - Deleted and optimized repeated macro.

[2.1.0]

- New Features
 - Added IRQ operation for XCC toolchain.
 - Added group IDs for newly supported drivers.

[2.0.2]

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

[2.0.1]

- Improvements
 - Removed the implementation of `LPC8XX Enable/DisableDeepSleepIRQ()` function.
 - Added new feature macro switch “`FSL_FEATURE_HAS_NO_NONCACHEABLE_SECTION`” for specific SoCs which have no noncacheable sections, that helps avoid an unnecessary complex in link file and the startup file.
 - Updated the `align(x)` to **attribute**(aligned(x)) to support MDK v6 armclang compiler.

[2.0.0]

- Initial version.
-

CRC

[2.1.1]

- Fix MISRA issue.

[2.1.0]

- Add CRC_WriteSeed function.

[2.0.2]

- Fix MISRA issue.

[2.0.1]

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

[2.0.0]

- Initial version.
-

CTIMER

[2.3.4]

- Bug Fixes
 - Fixed ERRATA ERR053024 CTIMER will enter interrupt twice when function clock much slower than bus clock.

[2.3.3]

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

[2.3.2]

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

[2.3.1]

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

[2.3.0]

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

[2.2.2]

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

[2.2.1]

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

[2.2.0]

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

[2.1.0]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

LPC_DMA

[2.5.4]

- Bug Fixes
 - Fixed coverity issues with CERT INT30-C, CERT INT31-C compliance.

[2.5.3]

- Improvements
 - Add assert in DMA_SetChannelXferConfig to prevent XFERCOUNT value overflow.

[2.5.2]

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

[2.5.1]

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

[2.5.0]

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

[2.4.4]

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

[2.4.3]

- Improvements
 - Added features FSL_FEATURE_DMA_DESCRIPTOR_ALIGN_SIZEn/FSL_FEATURE_DMA0_DESCRIPTOR_ALIGN_SIZEn to support the descriptor align size not constant in the two instances.

[2.4.2]

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

[2.4.1]

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

[2.4.0]

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

[2.3.0]

- Bug Fixes
 - Removed DMA_HandleIRQ prototype definition from header file.
 - Added DMA_IRQHandle prototype definition in header file.

[2.2.5]

- Improvements
 - Added new API DMA_SetupChannelDescriptor to support configuring wrap descriptor.
 - Added wrap support in function DMA_SubmitChannelTransfer.

[2.2.4]

- Bug Fixes
 - Fixed the issue that macro DMA_CHANNEL_CFER used wrong parameter to calculate DSTINC.

[2.2.3]

- Bug Fixes
 - Improved DMA driver Deinit function for correct logic order.
- Improvements
 - Added API DMA_SubmitChannelTransferParameter to support creating head descriptor directly.
 - Added API DMA_SubmitChannelDescriptor to support ping pong transfer.
 - Added macro DMA_ALLOCATE_HEAD_DESCRIPTOR/DMA_ALLOCATE_LINK_DESCRIPTOR to simplify DMA descriptor allocation.

[2.2.2]

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

[2.2.1]

- Bug Fixes
 - Fixed Coverity issue.

[2.2.0]

- Improvements
 - Changed API DMA_SetupDMADescriptor to non-static.
 - Marked APIs below as deprecated.
 - * DMA_PrepareTransfer.
 - * DMA_Submit transfer.
 - Added new APIs as below:
 - * DMA_SetChannelConfig.
 - * DMA_PrepareChannelTransfer.
 - * DMA_InstallDescriptorMemory.
 - * DMA_SubmitChannelTransfer.
 - * DMA_SetChannelConfigValid.
 - * DMA_DoChannelSoftwareTrigger.
 - * DMA_LoadChannelTransferConfig.

[2.0.1]

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

[2.0.0]

- Initial version.
-

DMIC

[2.3.3]

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

[2.3.2]

- New Features
 - Supported 4 channels in driver.

[2.3.1]

- Bug Fixes
 - Fixed the issue that DMIC_EnableChannelDma and DMIC_EnableChannelFifo did not clean relevant bits.

[2.3.0]

- Improvements
 - Added new apis DMIC_ResetChannelDecimator/DMIC_EnableChannelGlobalSync/DMIC_DisableChannelGlobalSync

[2.2.1]

- Bug Fixes
 - Fixed violations of the MISRA C-2012 rules 14.4, 17.7, 10.4, 10.3, 10.8, 14.3.

[2.2.0]

- Bug Fixes
 - Corrected the usage of feature FSL_FEATURE_DMIC_IO_HAS_NO_BYPASS.

[2.1.1]

- Improvements
 - Added feature FSL_FEATURE_DMIC_HAS_NO_IOCFG for IOCFG register.

[2.1.0]

- New Features
 - Added API DMIC_EnableChannelInterrupt/DMIC_EnableChannelDma to replace API DMIC_SetOperationMode.
 - Added API DMIC_SetIOCFG and marked DMIC_ConfigIO as deprecated.
 - Added API DMIC_EnableChannelSignExtend to support sign extend feature.

[2.0.5]

- Improvements
 - Changed some parameters' value of DMIC_FifoChannel API, such as enable, resetn, and trig_level. This is not possible for the current code logic, so it improves the DMIC_FifoChannel logic and fixes incorrect math logic.

[2.0.4]

- Bug Fixes
 - Fixed the issue that DMIC DMA driver(ver2.0.3) did not support calling DMIC_TransferReceiveDMA in DMA callback as it did before version 2.0.3. But calling DMIC_TransferReceiveDMA in callback is not recommended.

[2.0.3]

- New Features
- Supported linked transfer in DMIC DMA driver.
- Added new API DMIC_EnableChannelFifo/DMIC_DoFifoReset/DMIC_InstallDMADescriptor.

[2.0.2]

- New Features
 - Supported more channels in driver.

[2.0.1]

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

[2.0.0]

- Initial version.
-

DMIC_DMA

[2.4.2]

- Bug Fixes
 - Fixed coverity High Impact finding

[2.4.1]

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

[2.4.0]

- Bug Fixes
 - Fixed the issue that DMIC_TransferAbortReceiveDMA can not disable dmic and dma request issue.

[2.3.1]

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

[2.3.0]

- Refer DMIC driver change log 2.0.1 to 2.3.0
-

EMC

[2.0.4]

- Bug Fixes
 - Fixed violations of the MISRA C-2012 rules 10.1, 10.3, 10.4, 10.8, 11.9, 14.2, 14.3, 14.4.

[2.0.3]

- Improvements
 - Used SDK_DelayAtLeastUs instead of for loop during the dynamic memory initialization.

[2.0.3]

- Improvements
 - Replaced deprecated enumerator CLOCK_GetFreq(kCLOCK_EMC) with CLOCK_GetEmcClkFreq().

[2.0.2]

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

[2.0.1]

- Improvements
 - Added const for two BASE values.

[2.0.0]

- Initial version.
-

LPC_ENET

[2.3.5]

- Bug Fixes
 - Fixed ENET_GetMacAddr address byte order not matching ENET_SetMacAddr.

[2.3.4]

- Bug Fixes
 - Fixed the issue that free wrong buffer address when one frame stores in multiple buffers and memory pool is not enough to allocate these buffers to receive one complete frame.
 - Fixed the issue that ENET_DropFrame checks the buffer descriptor flag after it has been re-initialized.
 - Fixed the ENET_GetRxFrame FCS calculation issue.

- Fixed the issue that there's no valid error type in the return structure when Rx error bit is set.

[2.3.3]

- Bug Fixes
 - Fixed the issue that ENET_SetSMI uses wrong clock source to calculate the divisor.

[2.3.2]

- New features
 - Added hardware checksum acceleration support.
- Bug Fixes
 - Fixed the issue that enable/disable interrupt APIs miss part of configuration.

[2.3.1]

- Improvements
 - update ENET_SetSYSControl to support mcx family.

[2.3.0]

- Improvements
 - Added MDIO access wrapper APIs for ease of use.

[2.2.0]

- Bug Fixes
 - Corrected the timestamp retrieving code in ReadFrame.
- New Features
 - Supported zero copy Rx with new APIs.
- Improvements
 - Removed 4 bytes CRC data in ReadFrame function, not give them to user.
 - Deleted previous timestamp rings which store Tx/Rx timestamp temporarily for further retrieving. Now get Rx timestamp directly with receiving frame API, and get Tx timestamp in Tx over interrupt handler callback.
 - Added channel parameter for the SendFrame function, let user to decide which kind of frame can be sent from specified channel.
 - Supported scattered Tx buffers and more Tx configurations in SendFrame which aren't integrated.
 - Adjusted the callback location in Tx reclaim function. When use multiple BDs for Tx, only last BD transmit over interrupt event calls the callback. It simplifies the usage of Tx reclaiming.
 - Added interrupt configuration in config parameter for ENET_Init() to simplify the interrupt enable.
 - Changed the Tx/Rx descriptor name to common name rather than previous read format name which make user confused when driver uses it as write-back format.

[2.1.5]

- Bug Fixes
 - Fixed violations of the MISRA C-2012 rules 3.1,5.8,8.4,8.6,10.1,10.3,10.4,10.6,10.8,11.6,11.9,12.2,14.4,15.6

[2.1.4]

- Bug Fixes
 - Fixed the MDC clock divider setting issue occurring when core clock range exceeds 150M.

[2.1.3]

- In ENET_StartRxTx, updated to enable TX and RX at the same time to avoid issue where ENET module could not work under 10 M.
- Changed to use CLOCK_GetCoreSysClkFreq() instead of SystemCoreClock to get accurate core clock.

[2.1.2]

- Bug Fixes
 - Fixed ENET receive issue where it sometimes lost some unicast packets. The issue is caused by the program timing issue for writing MAC_ADDR_LOW and MAC_ADDR_HIGH.

[2.1.1]

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

[2.1.0]

- New Features
 - Added two APIs to set the ENET to ACCPET or reject the multicast frames.

[2.0.0]

- Initial version.
-

FLEXCOMM**[2.0.2]**

- Bug Fixes
 - Fixed typos in FLEXCOMM15_DriverIRQHandler().
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.
- Improvements

- Added instance calculation in FLEXCOMM16_DriverIRQHandler() to align with Flexcomm 14 and 15.

[2.0.1]

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

[2.0.0]

- Initial version.
-

FMEAS

[2.1.2]

- Improvements
 - Replace macros with inline functions for clock count retrieval.
- Bug Fixes
 - Fixed violations of the CERT INT30-C INT31-C.

[2.1.1]

- Bug Fixes
 - MISRA C-2012 issues fixed: rule 10.4, rule 10.8.

[2.1.0]

- Updated “FMEAS_GetFrequency”, “FMEAS_StartMeasure”, “FMEAS_IsMeasureComplete” API and add definition to match ASYNC_SYSCON.

[2.0.0]

- Initial version ported from LPCOpen.
-

GINT

[2.1.1]

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

[2.1.0]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

GPIO**[2.1.7]**

- Improvements
 - Enhanced GPIO_PinInit to enable clock internally.

[2.1.6]

- Bug Fixes
 - Clear bit before set it within GPIO_SetPinInterruptConfig() API.

[2.1.5]

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

[2.1.4]

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

[2.1.3]

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

[2.1.2]

- Improvements
 - Removed deprecated APIs.

[2.1.1]

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

[2.1.0]

- New Features
 - Added GPIO initialize API.

[2.0.0]

- Initial version.
-

I2C

[2.3.4]

- Bug Fixes
 - Added internal reset of master function after arbitration lost in `I2C_MasterTransferHandleIRQ()`, otherwise the `STAT[MSTARBLOSS]` is not set in next transfer.

[2.3.3]

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

[2.3.2]

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

[2.3.1]

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

[2.3.0]

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

[2.2.0]

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

[2.1.0]

- Bug Fixes
 - Fixed bug that during master transfer, when master is nacked during slave probing or sending subaddress, the return status should be `kStatus_I2C_Addr_Nak` rather than `kStatus_I2C_Nak`.
- Bug Fixes
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.4, 13.5.
- New Features
 - Added macro `I2C_MASTER_TRANSMIT_IGNORE_LAST_NACK`, so that user can configure whether to ignore the last byte being nacked by slave during master transfer.

[2.0.8]

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

[2.0.7]

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

[2.0.6]

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

[2.0.5]

- Bug Fixes
 - Fixed wrong assignment for datasize in I2C_InitTransferStateMachineDMA.
 - Fixed wrong working flow in I2C_RunTransferStateMachineDMA to ensure master can work in no start flag and no stop flag mode.
 - Fixed wrong working flow in I2C_RunTransferStateMachine and added kReceive-DataBeginState in _i2c_transfer_states to ensure master can work in no start flag and no stop flag mode.
 - Fixed wrong handle state in I2C_MasterTransferDMAHandleIRQ. After all the data has been transferred or nak is returned, handle state should be changed to idle.
- Improvements
 - Rounded up the calculated divider value in I2C_MasterSetBaudRate.

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

I2S**[2.3.2]**

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

[2.3.1]

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

[2.3.0]

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

[2.2.2]

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

[2.2.1]

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

[2.2.0]

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

[2.1.0]

- Improvements
 - Added a feature for the FLEXCOMM which supports I2S and has interconnection with DMIC.
 - Used a feature to control PDMDATA instead of I2S_CFG1_PDMDATA.
 - Added member bytesPerFrame in i2s_dma_handle_t, used for DMA transfer width configure, instead of using sizeof(uint32_t) hardcode.
 - Used the macro provided by DMA driver to define the I2S DMA descriptor.
- Bug Fixes
 - Fixed the issue that I2S DMA driver always generated duplicate callback.

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

I2S_DMA

[2.3.3]

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

[2.3.2]

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

[2.3.1]

- Refer I2S driver change log 2.0.1 to 2.3.1
-

IAP

[2.0.7]

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

[2.0.6]

- Bug Fixes
 - Fixed IAP_ReinvokeISP wrong parameter setting.

[2.0.5]

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

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

INPUTMUX

[2.0.10]

- Bug Fixes
 - Fixed CERT-C violations.

[2.0.9]

- Improvements
 - Use INPUTMUX_CLOCKS to initialize the inputmux module clock to adapt to multiple inputmux instances.
 - Modify the API base type from INPUTMUX_Type to void.

[2.0.8]

- Improvements
 - Updated a feature macro usage for function INPUTMUX_EnableSignal.

[2.0.7]

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

[2.0.6]

- Bug Fixes
 - Fixed the documentation wrong in API INPUTMUX_AttachSignal.

[2.0.5]

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

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

- Support channel mux setting in INPUTMUX_EnableSignal().

[2.0.0]

- Initial version.
-

IOCON

[2.2.1]

- Improvements
 - Added macros IOCON_INV_DI and IOCON_OPENDRAIN_DI

[2.2.0]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

[2.0.0]

- Initial version.
-

LPC_LCDC

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

MCAN**[2.4.2]**

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

[2.4.1]

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

[2.4.0]

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

[2.3.2]

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

[2.3.1]

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

[2.3.0]

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

[2.2.0]

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

[2.1.8]

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

[2.1.7]

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

[2.1.6]

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

[2.1.5]

- Bug Fixes
 - Fix MISRA C-2012 issue.

[2.1.4]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

MRT

[2.0.5]

- Bug Fixes
 - Fixed CERT INT31-C violations.

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

OTP

[2.0.1]

- Bug Fixes
 - Fixed MISRA-C 2012 violations.

[2.0.0]

- Initial version.
-

PINT**[2.3.0]**

- Improvements
 - Add API PINT_EnableInterruptByIndex and PINT_DisableInterruptByIndex to provide more granular interrupt control.

[2.2.0]

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

[2.1.13]

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

[2.1.12]

- Bug Fixes
 - Fixed coverity issue.

[2.1.11]

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

[2.1.10]

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

[2.1.9]

- Bug Fixes
 - Fixed MISRA-2012 rule 8.4.

[2.1.8]

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

[2.1.7]

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

[2.1.6]

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

[2.1.5]

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

[2.1.4]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

- Added PINT_EnableCallbackByIndex/PINT_DisableCallbackByIndex APIs to enable/disable callback by index.

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

POWER**[2.1.0]**

- New features
 - Added BOD control APIs.

[2.0.0]

- initial version.
-

PUF**[2.2.0]**

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

[2.1.6]

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

[2.1.5]

- Use common SDK delay in puf_wait_usec().

[2.1.4]

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

[2.1.3]

- Fix MISRA C-2012 issue.

[2.1.2]

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

[2.1.1]

- Fix ARMGCC build warning .

[2.1.0]

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

[2.0.3]

- Fix MISRA C-2012 issue.

[2.0.2]

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

[2.0.1]

- Bug Fixes:
 - Fixed puf_wait_usec function optimization issue.

[2.0.0]

- Initial version.
-

RESET

[2.4.0]

- Improvements
 - Add RESET_ReleasePeripheralReset API.

[2.0.1]

- Update component full_name to “Reset Driver”.

[2.0.0]

- initial version.
-

RIT**[2.1.2]**

- Bug Fixes
 - Fixed CERT INT31-C violations.

[2.1.1]

- Bug Fixes
 - Fixed violations of the MISRA C-2012 rules 10.3, 11.9, 17.7.

[2.1.0]

- Bug Fixes
 - Fixed issue for wrong implementation of clearing counter API in RIT driver.

[2.0.2]

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

[2.0.1]

- Bug Fixes
 - Fixed incorrect comments of some APIs.

[2.0.0]

- Initial version.
-

RNG**[2.1.0]**

- Renamed function RNG_GetRandomData() to RNG_GetRandomDataWord(). Added function RNG_GetRandomData() which discarding next 32 words after reading RNG register which results into better entropy, as is recommended in UM.
- API is aligned with other RNG driver, having similar functionality as other RNG/TRNG drivers.

[2.0.0]

- Initial version.
-

RTC

[2.2.0]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

- * RTC_DisableInterrupts
- * RTC_GetEnabledInterrupts

[2.0.0]

- Initial version.
-

SCTIMER

[2.5.2]

- Bug Fixes
 - Fixed CERT INT31-C violation issues.

[2.5.1]

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

[2.5.0]

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

[2.4.9]

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

[2.4.8]

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

[2.4.7]

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

[2.4.6]

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

[2.4.5]

- Bug Fixes
 - Fix SCT_EV_STATE_STATEMSKn macro build error.

[2.4.4]

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

[2.4.3]

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

[2.4.2]

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

[2.4.1]

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

[2.4.0]

[2.3.0]

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

- * SCTIMER_GetEventInState

[2.2.0]

- Improvements
 - Updated for 16-bit register access.

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

SDIF

[2.1.0]

- Improvements
 - Removed redundant member endianMode in sdif_config_t.
 - Added error status check in function SDIF_WaitCommandDone.
 - Fixed the read fifo data incomplete issue in interrupt non-dma mode.

[2.0.15]

- Bug Fixes
 - Cleared the interrupt status before enable the interrupt to avoid interrupt generate unexpectedly.
 - Fixed the SDIF_ReadDataPortBlocking blocking at wrong condition issue.
- Improvements
 - Enabled the functionality of timeout parameter in SDIF_SendCommand.
 - Added the error recovery while sending sync clock command timeout.

[2.0.14]

- Improvements
 - Used different status code for command and data interrupt callback.
- Bug Fixes
 - Fixed the DMA descriptor attribute field unreset when configuring the current transfer DMA descriptor issue which may cause the transfer terminate unexpected.

[2.0.13]

- Improvements
 - Disabled redundant interrupt per different transfer request.
 - Disabled interrupt and reset command/data pointer in handle when transfer completes.
- Bug Fixes
 - Fixed the PA082 build warning.
 - Fixed violations of the MISRA C-2012 rules 14.4, 17.7, 10.4, 10.3, 10.8, 14.3, 10.1, 16.4, 15.7, 12.2, 11.3, 11.9.

[2.0.12]

- Bug Fixes
 - Fixed the issue that SDIF_ConfigClockDelay didn't reset the delay field before write.
 - Removed useless fifo reset code in transfer function.
 - Fixed the divider overflow issue in function SDIF_SetCardClock.

[2.0.11]

- Improvements
 - Added API SDIF_GetEnabledInterruptStatus/SDIF_GetEnabledDMAInterruptStatus and used in SDIF_TransferHandleIRQ.
 - Removed useless members interruptFlags/dmaInterruptFlags in the sdif_handle_t.
 - Improved SDIF_SendCommand with return success directly when timeout is 0.
 - Added timeout error check when sending update clock command in SDIF_SetCardClock.
 - Removed START_CMD status polling for normal command sending in SDIF_TransferBlocking/SDIF_TransferNonBlocking.
 - Disabled timeout parameter in function SDIF_SendCommand.
- Bug Fixes
 - Added delay cycle for the default speed mode(400 K and 25 M) to fix the timing issue when different AHB clocks are configured.

[2.0.10]

- Bug Fixes
 - Fixed the issue that API SDIF_EnableCardClock could not clear the clock enable bit.

[2.0.9]

- Bug Fixes
 - Fixed MDK 66-D warning.

[2.0.8]

- New Features
 - Added control macro to enable/disable the RESET and CLOCK code in current driver.
 - Disabled useless interrupt while DMA is used.
 - Updated SDIF driver for one instance support two cards.

[2.0.7]

- Bug Fixes
 - Enlarged the timeout value to avoid a command conflict issue.

[2.0.6]

- Bug Fixes
 - Removed `assert(srcClock_Hz <= FSL_FEATURE_SDIF_MAX_SOURCE_CLOCK)`.
 - Used hardware reset instead of software reset during initialization.

[2.0.5]

- New Features
 - Added non-word aligned data address and DMA descriptor address transfer support. Once one of the above addresses is not aligned, switch to host transfer mode.
- Bug Fixes
 - Fixed the issue that DMA suspended during initialization.
 - Removed useless `memset` function call.

[2.0.4]

- Improvements
 - Added `cardInserted/cardRemoved` callback function.
 - Added host base address/user data parameter for all call back functions.

[2.0.3]

- Improvements
 - Improved Clock Delay macro to allow the user to redefine and remove useless delay for clock below 25 MHz.

[2.0.2]

- Bug Fixes
 - Fixed the issue that the status flag could not be cleared entirely after transfer complete.

[2.0.1]

- New Features
 - Improved interrupt transfer callback.
- Bug Fixes
 - Added assert to limit the SDIF source clock below 52 MHz.

[2.0.0]

- Initial version.
-

SHA

[2.3.2]

- Add -O2 optimization for GCC to sha_process_message_data_master(), because without it the function hangs under some conditions.

[2.3.1]

- Modified sha_process_message_data_master() to ensure that MEMCTRL will be written within 64 cycles of writing last word to INDATA as is mentioned in errata, even with different optimization levels.

[2.3.0]

- Modified SHA_Update to use blocking version of AHB Master mode when its available on chip. Added SHA_UpdateNonBlocking() function which uses nonblocking AHB Master mode.
- Fixed incorrect calculation of SHA when calling SHA_Update multiple times when is CPU used to load data.
- Added Reset into SHA_ClkInit and SHA_ClkDeinit function.

[2.2.2]

- Modified SHA_Finish function. While using pseudo DMA with maximum optimization, compiler optimize out condition. Which caused block in this function and did not check flag, which has been set in interrupt.

[2.2.1]

- MISRA C-2012 issue fix.

[2.2.0]

- Support MEMADDR pseudo DMA for loading input data in SHA_Update function (LPCXpresso54018 and LPCXpresso54628).

[2.1.1]

- MISRA C-2012 issue fixed: rule 10.3, 10.4, 11.9, 14.4, 16.4 and 17.7.

[2.1.0]

- Updated “sha_ldm_stm_16_words” “sha_one_block” API to match QN9090. QN9090 has no ALIAS register.
- Added “SHA_ClkInit” “SHA_ClkInit”

[2.0.0]

- Initial version.
-

SPI

[2.3.2]

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

[2.3.1]

- Improvements
 - Changed SPI_DUMMYDATA to 0x00.

[2.3.0]

- Update version.

[2.2.2]

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

[2.2.1]

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

[2.2.0]

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

[2.1.1]

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

[2.1.0]

- Bug Fixes
 - Fixed Coverity issue of incrementing null pointer in SPI_TransferHandleIRQInternal.
 - Eliminated IAR Pa082 warnings.
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.
- New Features

- Modified the definition of SPI_SSELPOL_MASK to support the socs that have only 3 SSEL pins.

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

SPI_DMA

[2.2.3]

- Bug Fixes
 - Fixed the bug SPI_MasterTransferGetCountDMA and SPI_SlaveTransferGetCountDMA returns wrong count.

[2.2.2]

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

[2.2.1]

- Bug Fixes
 - Fixed MISRA 2012 11.6 issue..

[2.2.0]

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

SPI Flash Interface

[2.0.3]

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

[2.0.2]

- Bug Fixes
 - Fixed the command function set issue. After the command being set, there will be no wait for the CMD flag, as it may have been cleared by CS deassert.

[2.0.1]

- New Features
 - Added an API to read/write 1/2 Bytes data from/to SPIFI. This interface is useful for flash command, which only needs 1/2 Bytes data. The previous driver needed users to make sure of the minimum length being 4, which might cause issues in some flash commands.

[2.0.0]

- Initial version.
-

USART

[2.9.0]

- New Features
 - Added support for RS-485 (configuration of OESEL, OEPOL, OETA in CFG register).
 - Added handling when a start is detected on the receiver input in USART_TransferHandleIRQ().

[2.8.5]

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

[2.8.4]

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

[2.8.3]

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

[2.8.2]

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

[2.8.1]

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

[2.8.0]

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

[2.7.0]

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

[2.6.0]

- Improvements
 - Used separate data for TX and RX in `usart_transfer_t`.
- Bug Fixes
 - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling `USART_TransferReceiveNonBlocking`, the received data count returned by `USART_TransferGetReceiveCount` is wrong.
- New Features
 - Added missing API `USART_TransferGetSendCountDMA` get send count using DMA.

[2.5.0]

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

[2.4.0]

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

[2.3.1]

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

[2.3.0]

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

- Modified USART_TransferReceiveNonBlocking and USART_TransferHandleIRQ to use 9-bit mode in multi-slave system.

[2.2.0]

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

[2.1.1]

- Improvements
 - Added check for transmitter idle in USART_TransferHandleIRQ and USART_TransferSendDMACallback to ensure all the data would be sent out to bus.
 - Modified USART_ReadBlocking so that if more than one receiver errors occur, all status flags will be cleared and the most severe error status will be returned.
- Bug Fixes
 - Eliminated IAR Pa082 warnings.
 - Fixed MISRA issues.
 - * Fixed rules 10.1, 10.3, 10.4, 10.7, 10.8, 11.3, 11.6, 11.8, 11.9, 13.5.

[2.1.0]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

USART_DMA

[2.6.0]

- Refer USART driver change log 2.0.1 to 2.6.0
-

UTICK

[2.0.5]

- Improvements
 - Improved for SOC RW610.

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.
-

WWDT**[2.1.10]**

- Bug Fixes
 - Chek WWDT_RSTS instead of FSL_FEATURE_WWDT_HAS_NO_RESET to determine whether the peripheral can be reset.

[2.1.9]

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

[2.1.8]

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

[2.1.7]

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

[2.1.5]

- Bug Fixes
 - deprecated a unusable API in WWWDWT driver.
 - * WWDT_Disable

[2.1.4]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

[2.0.0]

- Initial version.
-

1.6 Driver API Reference Manual

This section provides a link to the Driver API RM, detailing available drivers and their usage to help you integrate hardware efficiently.

[LPC54S018M](#)

1.7 Middleware Documentation

Find links to detailed middleware documentation for key components. While not all onboard middleware is covered, this serves as a useful reference for configuration and development.

1.7.1 FreeMASTER

[freemaster](#)

1.7.2 AWS IoT

[aws_iot](#)

1.7.3 FreeRTOS

FreeRTOS

1.7.4 lwIP

lwIP

1.7.5 File systemFatfs

FatFs

Chapter 2

LPC54S018M

2.1 AES: AES encryption decryption driver

status_t AES_SetKey(AES_Type *base, const uint8_t *key, size_t keySize)

Sets AES key.

Sets AES key.

Parameters

- *base* – AES peripheral base address
- *key* – Input key to use for encryption or decryption
- *keySize* – Size of the input key, in bytes. Must be 16, 24, or 32.

Returns

Status from Set Key operation

status_t AES_EncryptEcb(AES_Type *base, const uint8_t *plaintext, uint8_t *ciphertext, size_t size)

Encrypts AES using the ECB block mode.

Encrypts AES using the ECB block mode.

Parameters

- *base* – AES peripheral base address
- *plaintext* – Input plain text to encrypt
- *ciphertext* – **[out]** Output cipher text
- *size* – Size of input and output data in bytes. Must be multiple of 16 bytes.

Returns

Status from encrypt operation

status_t AES_DecryptEcb(AES_Type *base, const uint8_t *ciphertext, uint8_t *plaintext, size_t size)

Decrypts AES using the ECB block mode.

Decrypts AES using the ECB block mode.

Parameters

- *base* – AES peripheral base address
- *ciphertext* – Input ciphertext to decrypt
- *plaintext* – **[out]** Output plain text

- size – Size of input and output data in bytes. Must be multiple of 16 bytes.

Returns

Status from decrypt operation

```
status_t AES_EncryptCbc(AES_Type *base, const uint8_t *plaintext, uint8_t *ciphertext, size_t  
size, const uint8_t iv[16])
```

Encrypts AES using CBC block mode.

Parameters

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

Returns

Status from encrypt operation

```
status_t AES_DecryptCbc(AES_Type *base, const uint8_t *ciphertext, uint8_t *plaintext, size_t  
size, const uint8_t iv[16])
```

Decrypts AES using CBC block mode.

Parameters

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

Returns

Status from decrypt operation

```
status_t AES_EncryptCfb(AES_Type *base, const uint8_t *plaintext, uint8_t *ciphertext, size_t  
size, const uint8_t iv[16])
```

Encrypts AES using CFB block mode.

Parameters

- base – AES peripheral base address
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input Initial vector to be used as the first input block.

Returns

Status from encrypt operation

```
status_t AES_DecryptCfb(AES_Type *base, const uint8_t *ciphertext, uint8_t *plaintext, size_t  
size, const uint8_t iv[16])
```

Decrypts AES using CFB block mode.

Parameters

- base – AES peripheral base address
- ciphertext – Input cipher text to decrypt

- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes. Must be multiple of 16 bytes.
- iv – Input Initial vector to be used as the first input block.

Returns

Status from decrypt operation

```
status_t AES_EncryptOfb(AES_Type *base, const uint8_t *plaintext, uint8_t *ciphertext, size_t size, const uint8_t iv[16])
```

Encrypts AES using OFB block mode.

Parameters

- base – AES peripheral base address
- plaintext – Input plain text to encrypt
- ciphertext – **[out]** Output cipher text
- size – Size of input and output data in bytes.
- iv – Input Initial vector to be used as the first input block.

Returns

Status from encrypt operation

```
status_t AES_DecryptOfb(AES_Type *base, const uint8_t *ciphertext, uint8_t *plaintext, size_t size, const uint8_t iv[16])
```

Decrypts AES using OFB block mode.

Parameters

- base – AES peripheral base address
- ciphertext – Input cipher text to decrypt
- plaintext – **[out]** Output plain text
- size – Size of input and output data in bytes.
- iv – Input Initial vector to be used as the first input block.

Returns

Status from decrypt operation

```
status_t AES_CryptCtr(AES_Type *base, const uint8_t *input, uint8_t *output, size_t size, uint8_t counter[16], uint8_t counterlast[16], size_t *szLeft)
```

Encrypts or decrypts AES using CTR block mode.

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

Parameters

- base – AES peripheral base address
- input – Input data for CTR block mode
- output – **[out]** Output data for CTR block mode
- size – Size of input and output data in bytes
- counter – **[inout]** Input counter (updates on return)
- counterlast – **[out]** Output cipher of last counter, for chained CTR calls. NULL can be passed if chained calls are not used.

- `szLeft` – **[out]** Output number of bytes in left unused in counterlast block. NULL can be passed if chained calls are not used.

Returns

Status from crypt operation

```
status_t AES_EncryptTagGcm(AES_Type *base, const uint8_t *plaintext, uint8_t *ciphertext,  
                           size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad,  
                           size_t aadSize, uint8_t *tag, size_t tagSize)
```

Encrypts AES and tags using GCM block mode.

Encrypts AES and optionally tags using GCM block mode. If plaintext is NULL, only the GHASH is calculated and output in the 'tag' field.

Parameters

- `base` – AES peripheral base address
- `plaintext` – Input plain text to encrypt
- `ciphertext` – **[out]** Output cipher text.
- `size` – Size of input and output data in bytes
- `iv` – Input initial vector
- `ivSize` – Size of the IV
- `aad` – Input additional authentication data
- `aadSize` – Input size in bytes of AAD
- `tag` – **[out]** Output hash tag. Set to NULL to skip tag processing.
- `tagSize` – Input size of the tag to generate, in bytes. Must be 4,8,12,13,14,15 or 16.

Returns

Status from encrypt operation

```
status_t AES_DecryptTagGcm(AES_Type *base, const uint8_t *ciphertext, uint8_t *plaintext,  
                           size_t size, const uint8_t *iv, size_t ivSize, const uint8_t *aad,  
                           size_t aadSize, const uint8_t *tag, size_t tagSize)
```

Decrypts AES and authenticates using GCM block mode.

Decrypts AES and optionally authenticates using GCM block mode. If ciphertext is NULL, only the GHASH is calculated and compared with the received GHASH in 'tag' field.

Parameters

- `base` – AES peripheral base address
- `ciphertext` – Input cipher text to decrypt
- `plaintext` – **[out]** Output plain text.
- `size` – Size of input and output data in bytes
- `iv` – Input initial vector
- `ivSize` – Size of the IV
- `aad` – Input additional authentication data
- `aadSize` – Input size in bytes of AAD
- `tag` – Input hash tag to compare. Set to NULL to skip tag processing.
- `tagSize` – Input size of the tag, in bytes. Must be 4, 8, 12, 13, 14, 15, or 16.

Returns

Status from decrypt operation

AES_BLOCK_SIZE

AES block size in bytes

AES_IV_SIZE

AES Input Vector size in bytes

FSL_AES_DRIVER_VERSION

Defines LPC AES driver version 2.0.3.

Change log:

- Version 2.0.3
 - Edit aes_one_block() function to be interrupt safe.
- Version 2.0.2
 - Fix MISRA-2012 issues
- Version 2.0.1
 - GCM constant time tag comparison
- Version 2.0.0
 - initial version

2.2 Clock Driver

enum _clock_ip_name

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

Values:

enumerator kCLOCK_IpInvalid

Invalid Ip Name.

enumerator kCLOCK_Rom

Clock gate name: Rom.

enumerator kCLOCK_Sram1

Clock gate name: Sram1.

enumerator kCLOCK_Sram2

Clock gate name: Sram2.

enumerator kCLOCK_Sram3

Clock gate name: Sram3.

enumerator kCLOCK_Spifi

Clock gate name: Spifi.

enumerator kCLOCK_InputMux

Clock gate name: InputMux.

enumerator kCLOCK_Iocon

Clock gate name: Iocon.

enumerator kCLOCK_Gpio0

Clock gate name: Gpio0.

enumerator kCLOCK_Gpio1

Clock gate name: Gpio1.

enumerator kCLOCK_Gpio2
Clock gate name: Gpio2.

enumerator kCLOCK_Gpio3
Clock gate name: Gpio3.

enumerator kCLOCK_Pint
Clock gate name: Pint.

enumerator kCLOCK_Gint
Clock gate name: Gint.

enumerator kCLOCK_Dma
Clock gate name: Dma.

enumerator kCLOCK_Crc
Clock gate name: Crc.

enumerator kCLOCK_Wwdt
Clock gate name: Wwdt.

enumerator kCLOCK_Rtc
Clock gate name: Rtc.

enumerator kCLOCK_Adc0
Clock gate name: Adc0.

enumerator kCLOCK_Mrt
Clock gate name: Mrt.

enumerator kCLOCK_Rit
Clock gate name: Rit.

enumerator kCLOCK_Sct0
Clock gate name: Sct0.

enumerator kCLOCK_Mcan0
Clock gate name: Mcan0.

enumerator kCLOCK_Mcan1
Clock gate name: Mcan1.

enumerator kCLOCK_Utick
Clock gate name: Utick.

enumerator kCLOCK_FlexComm0
Clock gate name: FlexComm0.

enumerator kCLOCK_FlexComm1
Clock gate name: FlexComm1.

enumerator kCLOCK_FlexComm2
Clock gate name: FlexComm2.

enumerator kCLOCK_FlexComm3
Clock gate name: FlexComm3.

enumerator kCLOCK_FlexComm4
Clock gate name: FlexComm4.

enumerator kCLOCK_FlexComm5
Clock gate name: FlexComm5.

enumerator kCLOCK_FlexComm6
Clock gate name: FlexComm6.

enumerator kCLOCK_FlexComm7
Clock gate name: FlexComm7.

enumerator kCLOCK_MinUart0
Clock gate name: MinUart0.

enumerator kCLOCK_MinUart1
Clock gate name: MinUart1.

enumerator kCLOCK_MinUart2
Clock gate name: MinUart2.

enumerator kCLOCK_MinUart3
Clock gate name: MinUart3.

enumerator kCLOCK_MinUart4
Clock gate name: MinUart4.

enumerator kCLOCK_MinUart5
Clock gate name: MinUart5.

enumerator kCLOCK_MinUart6
Clock gate name: MinUart6.

enumerator kCLOCK_MinUart7
Clock gate name: MinUart7.

enumerator kCLOCK_LSpi0
Clock gate name: LSpi0.

enumerator kCLOCK_LSpi1
Clock gate name: LSpi1.

enumerator kCLOCK_LSpi2
Clock gate name: LSpi2.

enumerator kCLOCK_LSpi3
Clock gate name: LSpi3.

enumerator kCLOCK_LSpi4
Clock gate name: LSpi4.

enumerator kCLOCK_LSpi5
Clock gate name: LSpi5.

enumerator kCLOCK_LSpi6
Clock gate name: LSpi6.

enumerator kCLOCK_LSpi7
Clock gate name: LSpi7.

enumerator kCLOCK_BI2c0
Clock gate name: BI2c0.

enumerator kCLOCK_BI2c1
Clock gate name: BI2c1.

enumerator kCLOCK_BI2c2
Clock gate name: BI2c2.

enumerator kCLOCK_BI2c3
Clock gate name: BI2c3.

enumerator kCLOCK_BI2c4
Clock gate name: BI2c4.

enumerator kCLOCK_BI2c5
Clock gate name: BI2c5.

enumerator kCLOCK_BI2c6
Clock gate name: BI2c6.

enumerator kCLOCK_BI2c7
Clock gate name: BI2c7.

enumerator kCLOCK_FlexI2s0
Clock gate name: FlexI2s0.

enumerator kCLOCK_FlexI2s1
Clock gate name: FlexI2s1.

enumerator kCLOCK_FlexI2s2
Clock gate name: FlexI2s2.

enumerator kCLOCK_FlexI2s3
Clock gate name: FlexI2s3.

enumerator kCLOCK_FlexI2s4
Clock gate name: FlexI2s4.

enumerator kCLOCK_FlexI2s5
Clock gate name: FlexI2s5.

enumerator kCLOCK_FlexI2s6
Clock gate name: FlexI2s6.

enumerator kCLOCK_FlexI2s7
Clock gate name: FlexI2s7.

enumerator kCLOCK_DMic
Clock gate name: DMic.

enumerator kCLOCK_Ct32b2
Clock gate name: Ct32b2.

enumerator kCLOCK_Usbd0
Clock gate name: Usbd0.

enumerator kCLOCK_Ct32b0
Clock gate name: Ct32b0.

enumerator kCLOCK_Ct32b1
Clock gate name: Ct32b1.

enumerator kCLOCK_BodyBias0
Clock gate name: BodyBias0.

enumerator kCLOCK_EzhArchB0
Clock gate name: EzhArchB0.

enumerator kCLOCK_Lcd
Clock gate name: Lcd.

enumerator kCLOCK_Sdio
Clock gate name: Sdio.

enumerator kCLOCK_Usbh1
Clock gate name: Usbh1.

enumerator kCLOCK_Usbd1
Clock gate name: Usbd1.

enumerator kCLOCK_UsbRam1
Clock gate name: UsbRam1.

enumerator kCLOCK_Emc
Clock gate name: Emc.

enumerator kCLOCK_Eth
Clock gate name: Eth.

enumerator kCLOCK_Gpio4
Clock gate name: Gpio4.

enumerator kCLOCK_Gpio5
Clock gate name: Gpio5.

enumerator kCLOCK_Aes
Clock gate name: Aes.

enumerator kCLOCK_Otp
Clock gate name: Otp.

enumerator kCLOCK_Rng
Clock gate name: Rng.

enumerator kCLOCK_FlexComm8
Clock gate name: FlexComm8.

enumerator kCLOCK_FlexComm9
Clock gate name: FlexComm9.

enumerator kCLOCK_MinUart8
Clock gate name: MinUart8.

enumerator kCLOCK_MinUart9
Clock gate name: MinUart9.

enumerator kCLOCK_LSpi8
Clock gate name: LSpi8.

enumerator kCLOCK_LSpi9
Clock gate name: LSpi9.

enumerator kCLOCK_BI2c8
Clock gate name: BI2c8.

enumerator kCLOCK_BI2c9
Clock gate name: BI2c9.

enumerator kCLOCK_FlexI2s8
Clock gate name: FlexI2s8.

enumerator kCLOCK_FlexI2s9
Clock gate name: FlexI2s9.

enumerator kCLOCK_Usbhm0r0

Clock gate name: Usbhm0r0.

enumerator kCLOCK_Usbhsl0

Clock gate name: Usbhsl0.

enumerator kCLOCK_Sha0

Clock gate name: Sha0.

enumerator kCLOCK_SmartCard0

Clock gate name: SmartCard0.

enumerator kCLOCK_SmartCard1

Clock gate name: SmartCard1.

enumerator kCLOCK_FlexComm10

Clock gate name: FlexComm10.

enumerator kCLOCK_Puf

Clock gate name: Puf.

enumerator kCLOCK_Ct32b3

Clock gate name: Ct32b3.

enumerator kCLOCK_Ct32b4

Clock gate name: Ct32b4.

enum _clock_name

Clock name used to get clock frequency.

Values:

enumerator kCLOCK_CoreSysClk

Core/system clock (aka MAIN_CLK)

enumerator kCLOCK_BusClk

Bus clock (AHB clock)

enumerator kCLOCK_ClockOut

CLOCKOUT

enumerator kCLOCK_FroHf

FRO48/96

enumerator kCLOCK_UsbPll

USB1 PLL

enumerator kCLOCK_Mclk

MCLK

enumerator kCLOCK_Fro12M

FRO12M

enumerator kCLOCK_ExtClk

External Clock

enumerator kCLOCK_PllOut

PLL Output

enumerator kCLOCK_UsbClk

USB input

enumerator kCLOCK_WdtOsc

Watchdog Oscillator

enumerator kCLOCK_Frg

Frg Clock

enumerator kCLOCK_AsyncApbClk

Async APB clock

enum _async_clock_src

Clock source selections for the asynchronous APB clock.

Values:

enumerator kCLOCK_AsyncMainClk

Main System clock

enumerator kCLOCK_AsyncFro12Mhz

12MHz FRO

enumerator kCLOCK_AsyncAudioPllClk

Async Audio PLL clock.

enumerator kCLOCK_AsyncI2cClkFe6

Async I2C clock.

enum _clock_attach_id

The enumerator of clock attach Id.

Values:

enumerator kSYSTICK_DIV_CLK_to_SYSTICKCLK

Attach SYSTICK_DIV_CLK to SYSTICKCLK.

enumerator kWDT_OSC_to_SYSTICKCLK

Attach WDT_OSC to SYSTICKCLK.

enumerator kOSC32K_to_SYSTICKCLK

Attach OSC32K to SYSTICKCLK.

enumerator kFRO12M_to_SYSTICKCLK

Attach FRO12M to SYSTICKCLK.

enumerator kNONE_to_SYSTICKCLK

Attach NONE to SYSTICKCLK.

enumerator kFRO12M_to_MAIN_CLK

Attach FRO12M to MAIN_CLK.

enumerator kEXT_CLK_to_MAIN_CLK

Attach EXT_CLK to MAIN_CLK.

enumerator kWDT_OSC_to_MAIN_CLK

Attach WDT_OSC to MAIN_CLK.

enumerator kFRO_HF_to_MAIN_CLK

Attach FRO_HF to MAIN_CLK.

enumerator kSYS_PLL_to_MAIN_CLK

Attach SYS_PLL to MAIN_CLK.

enumerator kOSC32K_to_MAIN_CLK

Attach OSC32K to MAIN_CLK.

enumerator kMAIN_CLK_to_CLKOUT
Attach MAIN_CLK to CLKOUT.

enumerator kEXT_CLK_to_CLKOUT
Attach EXT_CLK to CLKOUT.

enumerator kWDT_OSC_to_CLKOUT
Attach WDT_OSC to CLKOUT.

enumerator kFRO_HF_to_CLKOUT
Attach FRO_HF to CLKOUT.

enumerator kSYS_PLL_to_CLKOUT
Attach SYS_PLL to CLKOUT.

enumerator kUSB_PLL_to_CLKOUT
Attach USB_PLL to CLKOUT.

enumerator kAUDIO_PLL_to_CLKOUT
Attach AUDIO_PLL to CLKOUT.

enumerator kOSC32K_OSC_to_CLKOUT
Attach OSC32K_OSC to CLKOUT.

enumerator kFRO12M_to_SYS_PLL
Attach FRO12M to SYS_PLL.

enumerator kEXT_CLK_to_SYS_PLL
Attach EXT_CLK to SYS_PLL.

enumerator kWDT_OSC_to_SYS_PLL
Attach WDT_OSC to SYS_PLL.

enumerator kOSC32K_to_SYS_PLL
Attach OSC32K to SYS_PLL.

enumerator kNONE_to_SYS_PLL
Attach NONE to SYS_PLL.

enumerator kFRO12M_to_AUDIO_PLL
Attach FRO12M to AUDIO_PLL.

enumerator kEXT_CLK_to_AUDIO_PLL
Attach EXT_CLK to AUDIO_PLL.

enumerator kNONE_to_AUDIO_PLL
Attach NONE to AUDIO_PLL.

enumerator kMAIN_CLK_to_SPIFI_CLK
Attach MAIN_CLK to SPIFI_CLK.

enumerator kSYS_PLL_to_SPIFI_CLK
Attach SYS_PLL to SPIFI_CLK.

enumerator kUSB_PLL_to_SPIFI_CLK
Attach USB_PLL to SPIFI_CLK.

enumerator kFRO_HF_to_SPIFI_CLK
Attach FRO_HF to SPIFI_CLK.

enumerator kAUDIO_PLL_to_SPIFI_CLK
Attach AUDIO_PLL to SPIFI_CLK.

enumerator kNONE_to_SPIFI_CLK
Attach NONE to SPIFI_CLK.

enumerator kFRO_HF_to_ADC_CLK
Attach FRO_HF to ADC_CLK.

enumerator kSYS_PLL_to_ADC_CLK
Attach SYS_PLL to ADC_CLK.

enumerator kUSB_PLL_to_ADC_CLK
Attach USB_PLL to ADC_CLK.

enumerator kAUDIO_PLL_to_ADC_CLK
Attach AUDIO_PLL to ADC_CLK.

enumerator kNONE_to_ADC_CLK
Attach NONE to ADC_CLK.

enumerator kFRO_HF_to_USB0_CLK
Attach FRO_HF to USB0_CLK.

enumerator kSYS_PLL_to_USB0_CLK
Attach SYS_PLL to USB0_CLK.

enumerator kUSB_PLL_to_USB0_CLK
Attach USB_PLL to USB0_CLK.

enumerator kNONE_to_USB0_CLK
Attach NONE to USB0_CLK.

enumerator kFRO_HF_to_USB1_CLK
Attach FRO_HF to USB1_CLK.

enumerator kSYS_PLL_to_USB1_CLK
Attach SYS_PLL to USB1_CLK.

enumerator kUSB_PLL_to_USB1_CLK
Attach USB_PLL to USB1_CLK.

enumerator kNONE_to_USB1_CLK
Attach NONE to USB1_CLK.

enumerator kFRO12M_to_FLEXCOMM0
Attach FRO12M to FLEXCOMM0.

enumerator kFRO_HF_to_FLEXCOMM0
Attach FRO_HF to FLEXCOMM0.

enumerator kAUDIO_PLL_to_FLEXCOMM0
Attach AUDIO_PLL to FLEXCOMM0.

enumerator kMCLK_to_FLEXCOMM0
Attach MCLK to FLEXCOMM0.

enumerator kFRG_to_FLEXCOMM0
Attach FRG to FLEXCOMM0.

enumerator kNONE_to_FLEXCOMM0
Attach NONE to FLEXCOMM0.

enumerator kFRO12M_to_FLEXCOMM1
Attach FRO12M to FLEXCOMM1.

enumerator kFRO_HF_to_FLEXCOMM1
Attach FRO_HF to FLEXCOMM1.

enumerator kAUDIO_PLL_to_FLEXCOMM1
Attach AUDIO_PLL to FLEXCOMM1.

enumerator kMCLK_to_FLEXCOMM1
Attach MCLK to FLEXCOMM1.

enumerator kFRG_to_FLEXCOMM1
Attach FRG to FLEXCOMM1.

enumerator kNONE_to_FLEXCOMM1
Attach NONE to FLEXCOMM1.

enumerator kFRO12M_to_FLEXCOMM2
Attach FRO12M to FLEXCOMM2.

enumerator kFRO_HF_to_FLEXCOMM2
Attach FRO_HF to FLEXCOMM2.

enumerator kAUDIO_PLL_to_FLEXCOMM2
Attach AUDIO_PLL to FLEXCOMM2.

enumerator kMCLK_to_FLEXCOMM2
Attach MCLK to FLEXCOMM2.

enumerator kFRG_to_FLEXCOMM2
Attach FRG to FLEXCOMM2.

enumerator kNONE_to_FLEXCOMM2
Attach NONE to FLEXCOMM2.

enumerator kFRO12M_to_FLEXCOMM3
Attach FRO12M to FLEXCOMM3.

enumerator kFRO_HF_to_FLEXCOMM3
Attach FRO_HF to FLEXCOMM3.

enumerator kAUDIO_PLL_to_FLEXCOMM3
Attach AUDIO_PLL to FLEXCOMM3.

enumerator kMCLK_to_FLEXCOMM3
Attach MCLK to FLEXCOMM3.

enumerator kFRG_to_FLEXCOMM3
Attach FRG to FLEXCOMM3.

enumerator kNONE_to_FLEXCOMM3
Attach NONE to FLEXCOMM3.

enumerator kFRO12M_to_FLEXCOMM4
Attach FRO12M to FLEXCOMM4.

enumerator kFRO_HF_to_FLEXCOMM4
Attach FRO_HF to FLEXCOMM4.

enumerator kAUDIO_PLL_to_FLEXCOMM4
Attach AUDIO_PLL to FLEXCOMM4.

enumerator kMCLK_to_FLEXCOMM4
Attach MCLK to FLEXCOMM4.

enumerator kFRG_to_FLEXCOMM4
Attach FRG to FLEXCOMM4.

enumerator kNONE_to_FLEXCOMM4
Attach NONE to FLEXCOMM4.

enumerator kFRO12M_to_FLEXCOMM5
Attach FRO12M to FLEXCOMM5.

enumerator kFRO_HF_to_FLEXCOMM5
Attach FRO_HF to FLEXCOMM5.

enumerator kAUDIO_PLL_to_FLEXCOMM5
Attach AUDIO_PLL to FLEXCOMM5.

enumerator kMCLK_to_FLEXCOMM5
Attach MCLK to FLEXCOMM5.

enumerator kFRG_to_FLEXCOMM5
Attach FRG to FLEXCOMM5.

enumerator kNONE_to_FLEXCOMM5
Attach NONE to FLEXCOMM5.

enumerator kFRO12M_to_FLEXCOMM6
Attach FRO12M to FLEXCOMM6.

enumerator kFRO_HF_to_FLEXCOMM6
Attach FRO_HF to FLEXCOMM6.

enumerator kAUDIO_PLL_to_FLEXCOMM6
Attach AUDIO_PLL to FLEXCOMM6.

enumerator kMCLK_to_FLEXCOMM6
Attach MCLK to FLEXCOMM6.

enumerator kFRG_to_FLEXCOMM6
Attach FRG to FLEXCOMM6.

enumerator kNONE_to_FLEXCOMM6
Attach NONE to FLEXCOMM6.

enumerator kFRO12M_to_FLEXCOMM7
Attach FRO12M to FLEXCOMM7.

enumerator kFRO_HF_to_FLEXCOMM7
Attach FRO_HF to FLEXCOMM7.

enumerator kAUDIO_PLL_to_FLEXCOMM7
Attach AUDIO_PLL to FLEXCOMM7.

enumerator kMCLK_to_FLEXCOMM7
Attach MCLK to FLEXCOMM7.

enumerator kFRG_to_FLEXCOMM7
Attach FRG to FLEXCOMM7.

enumerator kNONE_to_FLEXCOMM7
Attach NONE to FLEXCOMM7.

enumerator kFRO12M_to_FLEXCOMM8
Attach FRO12M to FLEXCOMM8.

enumerator kFRO_HF_to_FLEXCOMM8
Attach FRO_HF to FLEXCOMM8.

enumerator kAUDIO_PLL_to_FLEXCOMM8
Attach AUDIO_PLL to FLEXCOMM8.

enumerator kMCLK_to_FLEXCOMM8
Attach MCLK to FLEXCOMM8.

enumerator kFRG_to_FLEXCOMM8
Attach FRG to FLEXCOMM8.

enumerator kNONE_to_FLEXCOMM8
Attach NONE to FLEXCOMM8.

enumerator kFRO12M_to_FLEXCOMM9
Attach FRO12M to FLEXCOMM9.

enumerator kFRO_HF_to_FLEXCOMM9
Attach FRO_HF to FLEXCOMM9.

enumerator kAUDIO_PLL_to_FLEXCOMM9
Attach AUDIO_PLL to FLEXCOMM9.

enumerator kMCLK_to_FLEXCOMM9
Attach MCLK to FLEXCOMM9.

enumerator kFRG_to_FLEXCOMM9
Attach FRG to FLEXCOMM9.

enumerator kNONE_to_FLEXCOMM9
Attach NONE to FLEXCOMM9.

enumerator kMAIN_CLK_to_FLEXCOMM10
Attach MAIN_CLK to FLEXCOMM10.

enumerator kSYS_PLL_to_FLEXCOMM10
Attach SYS_PLL to FLEXCOMM10.

enumerator kUSB_PLL_to_FLEXCOMM10
Attach USB_PLL to FLEXCOMM10.

enumerator kFRO_HF_to_FLEXCOMM10
Attach FRO_HF to FLEXCOMM10.

enumerator kAUDIO_PLL_to_FLEXCOMM10
Attach AUDIO_PLL to FLEXCOMM10.

enumerator kNONE_to_FLEXCOMM10
Attach NONE to FLEXCOMM10.

enumerator kFRO_HF_to_MCLK
Attach FRO_HF to MCLK.

enumerator kAUDIO_PLL_to_MCLK
Attach AUDIO_PLL to MCLK.

enumerator kNONE_to_MCLK
Attach NONE to MCLK.

enumerator kMAIN_CLK_to_FRG
Attach MAIN_CLK to FRG.

enumerator kSYS_PLL_to_FRG

Attach SYS_PLL to FRG.

enumerator kFRO12M_to_FRG

Attach FRO12M to FRG.

enumerator kFRO_HF_to_FRG

Attach FRO_HF to FRG.

enumerator kNONE_to_FRG

Attach NONE to FRG.

enumerator kFRO12M_to_DMIC

Attach FRO12M to DMIC.

enumerator kFRO_HF_DIV_to_DMIC

Attach FRO_HF_DIV to DMIC.

enumerator kAUDIO_PLL_to_DMIC

Attach AUDIO_PLL to DMIC.

enumerator kMCLK_to_DMIC

Attach MCLK to DMIC.

enumerator kMAIN_CLK_to_DMIC

Attach MAIN_CLK to DMIC.

enumerator kWDT_OSC_to_DMIC

Attach WDT_OSC to DMIC.

enumerator kNONE_to_DMIC

Attach NONE to DMIC.

enumerator kMAIN_CLK_to_SCT_CLK

Attach MAIN_CLK to SCT_CLK.

enumerator kSYS_PLL_to_SCT_CLK

Attach SYS_PLL to SCT_CLK.

enumerator kFRO_HF_to_SCT_CLK

Attach FRO_HF to SCT_CLK.

enumerator kAUDIO_PLL_to_SCT_CLK

Attach AUDIO_PLL to SCT_CLK.

enumerator kNONE_to_SCT_CLK

Attach NONE to SCT_CLK.

enumerator kMAIN_CLK_to_LCD_CLK

Attach MAIN_CLK to LCD_CLK.

enumerator kLCDCLKIN_to_LCD_CLK

Attach LCDCLKIN to LCD_CLK.

enumerator kFRO_HF_to_LCD_CLK

Attach FRO_HF to LCD_CLK.

enumerator kNONE_to_LCD_CLK

Attach NONE to LCD_CLK.

enumerator kMAIN_CLK_to_SDIO_CLK

Attach MAIN_CLK to SDIO_CLK.

enumerator kSYS_PLL_to_SDIO_CLK
Attach SYS_PLL to SDIO_CLK.

enumerator kUSB_PLL_to_SDIO_CLK
Attach USB_PLL to SDIO_CLK.

enumerator kFRO_HF_to_SDIO_CLK
Attach FRO_HF to SDIO_CLK.

enumerator kAUDIO_PLL_to_SDIO_CLK
Attach AUDIO_PLL to SDIO_CLK.

enumerator kNONE_to_SDIO_CLK
Attach NONE to SDIO_CLK.

enumerator kMAIN_CLK_to_ASYNC_APB
Attach MAIN_CLK to ASYNC_APB.

enumerator kFRO12M_to_ASYNC_APB
Attach FRO12M to ASYNC_APB.

enumerator kAUDIO_PLL_to_ASYNC_APB
Attach AUDIO_PLL to ASYNC_APB.

enumerator kI2C_CLK_FC6_to_ASYNC_APB
Attach I2C_CLK_FC6 to ASYNC_APB.

enumerator kNONE_to_NONE
Attach NONE to NONE.

enum _clock_div_name

Clock dividers.

Values:

enumerator kCLOCK_DivSystickClk
Systick Clock Divider.

enumerator kCLOCK_DivArmTrClkDiv
Arm Tr Clk Div Divider.

enumerator kCLOCK_DivCan0Clk
Can0 Clock Divider.

enumerator kCLOCK_DivCan1Clk
Can1 Clock Divider.

enumerator kCLOCK_DivSmartCard0Clk
Smart Card0 Clock Divider.

enumerator kCLOCK_DivSmartCard1Clk
Smart Card1 Clock Divider.

enumerator kCLOCK_DivAhbClk
Ahb Clock Divider.

enumerator kCLOCK_DivClkOut
Clk Out Divider.

enumerator kCLOCK_DivFrohfClk
Frohf Clock Divider.

enumerator kCLOCK_DivSpifiClk

Spifi Clock Divider.

enumerator kCLOCK_DivAdcAsyncClk

Adc Async Clock Divider.

enumerator kCLOCK_DivUsb0Clk

Usb0 Clock Divider.

enumerator kCLOCK_DivUsb1Clk

Usb1 Clock Divider.

enumerator kCLOCK_DivFrg

Frg Divider.

enumerator kCLOCK_DivDmicClk

Dmic Clock Divider.

enumerator kCLOCK_DivMClk

I2S MCLK Clock Divider.

enumerator kCLOCK_DivLcdClk

Lcd Clock Divider.

enumerator kCLOCK_DivSctClk

Sct Clock Divider.

enumerator kCLOCK_DivEmcClk

Emc Clock Divider.

enumerator kCLOCK_DivSdioClk

Sdio clock Divider.

enum _pll_error

PLL status definitions.

Values:

enumerator kStatus_PLL_Success

PLL operation was successful

enumerator kStatus_PLL_OutputTooLow

PLL output rate request was too low

enumerator kStatus_PLL_OutputTooHigh

PLL output rate request was too high

enumerator kStatus_PLL_InputTooLow

PLL input rate is too low

enumerator kStatus_PLL_InputTooHigh

PLL input rate is too high

enumerator kStatus_PLL_OutsideIntLimit

Requested output rate isn't possible

enumerator kStatus_PLL_CCOTooLow

Requested CCO rate isn't possible

enumerator kStatus_PLL_CCOTooHigh

Requested CCO rate isn't possible

enum `_clock_usb_src`

USB clock source definition.

Values:

enumerator `kCLOCK_UsbSrcFro`

Use FRO 96 or 48 MHz.

enumerator `kCLOCK_UsbSrcSystemPll`

Use System PLL output.

enumerator `kCLOCK_UsbSrcMainClock`

Use Main clock.

enumerator `kCLOCK_UsbSrcUsbPll`

Use USB PLL clock.

enumerator `kCLOCK_UsbSrcNone`

Use None, this may be selected in order to reduce power when no output is needed.

enum `_usb_pll_psel`

USB PDEL Divider.

Values:

enumerator `pSel_Divide_1`

enumerator `pSel_Divide_2`

enumerator `pSel_Divide_4`

enumerator `pSel_Divide_8`

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 `_async_clock_src` `async_clock_src_t`

Clock source selections for the asynchronous APB clock.

typedef enum `_clock_attach_id` `clock_attach_id_t`

The enumerator of clock attach Id.

typedef enum `_clock_div_name` `clock_div_name_t`

Clock dividers.

typedef struct `_pll_config` `pll_config_t`

PLL configuration structure.

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

typedef struct `_pll_setup` `pll_setup_t`

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

typedef enum `_pll_error` `pll_error_t`

PLL status definitions.

```
typedef enum _clock_usb_src clock_usb_src_t
```

USB clock source definition.

```
typedef enum _usb_pll_psel usb_pll_psel
```

USB PDEL Divider.

```
typedef struct _usb_pll_setup usb_pll_setup_t
```

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

```
static inline void CLOCK_EnableClock(clock_ip_name_t clk)
```

```
static inline void CLOCK_DisableClock(clock_ip_name_t clk)
```

```
void CLOCK_SetupFROClocking(uint32_t froFreq)
```

Initialize the Core clock to given frequency (12, 48 or 96 MHz), this API is implemented in ROM code. Turns on FRO and uses default CCO, if freq is 12000000, then high speed output is off, else high speed output is enabled. Usage: CLOCK_SetupFROClocking(frequency), (frequency must be one of 12, 48 or 96 MHz) Note: Need to make sure ROM and OTP has power(PDRUNCFG0[17,29]= 0U) before calling this API since this API is implemented in ROM code and the FROHF TRIM value is stored in OTP.

Parameters

- froFreq – target fro frequency.

Returns

Nothing

```
void CLOCK_AttachClk(clock_attach_id_t connection)
```

Configure the clock selection muxes.

Parameters

- connection – : Clock to be configured.

Returns

Nothing

```
clock_attach_id_t CLOCK_GetClockAttachId(clock_attach_id_t attachId)
```

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

Parameters

- attachId – : Clock attach id to get.

Returns

Clock source value.

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

Setup peripheral clock dividers.

Parameters

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

Returns

Nothing

uint32_t CLOCK_GetFreq(*clock_name_t* clockName)

Return Frequency of selected clock.

Returns

Frequency of selected clock

uint32_t CLOCK_GetFro12MFreq(void)

Return Frequency of FRO 12MHz.

Returns

Frequency of FRO 12MHz

uint32_t CLOCK_GetClockOutClkFreq(void)

Return Frequency of ClockOut.

Returns

Frequency of ClockOut

uint32_t CLOCK_GetSpifiClkFreq(void)

Return Frequency of Spifi Clock.

Returns

Frequency of Spifi.

uint32_t CLOCK_GetAdcClkFreq(void)

Return Frequency of Adc Clock.

Returns

Frequency of Adc Clock.

uint32_t CLOCK_GetMCanClkFreq(uint32_t MCanSel)

brief Return Frequency of MCAN Clock param MCanSel : 0U: MCAN0; 1U: MCAN1 return
Frequency of MCAN Clock

uint32_t CLOCK_GetUsb0ClkFreq(void)

Return Frequency of Usb0 Clock.

Returns

Frequency of Usb0 Clock.

uint32_t CLOCK_GetUsb1ClkFreq(void)

Return Frequency of Usb1 Clock.

Returns

Frequency of Usb1 Clock.

uint32_t CLOCK_GetMclkClkFreq(void)

Return Frequency of MClk Clock.

Returns

Frequency of MClk Clock.

uint32_t CLOCK_GetSctClkFreq(void)

Return Frequency of SCTimer Clock.

Returns

Frequency of SCTimer Clock.

uint32_t CLOCK_GetSdioClkFreq(void)

Return Frequency of SDIO Clock.

Returns

Frequency of SDIO Clock.

uint32_t CLOCK_GetLcdClkFreq(void)

Return Frequency of LCD Clock.

Returns

Frequency of LCD Clock.

uint32_t CLOCK_GetLcdClkIn(void)

Return Frequency of LCD CLKIN Clock.

Returns

Frequency of LCD CLKIN Clock.

uint32_t CLOCK_GetExtClkFreq(void)

Return Frequency of External Clock.

Returns

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

uint32_t CLOCK_GetWdtOscFreq(void)

Return Frequency of Watchdog Oscillator.

Returns

Frequency of Watchdog Oscillator

uint32_t CLOCK_GetFroHfFreq(void)

Return Frequency of High-Freq output of FRO.

Returns

Frequency of High-Freq output of FRO

uint32_t CLOCK_GetFrgClkFreq(void)

Return Frequency of frg.

Returns

Frequency of FRG

uint32_t CLOCK_GetDmicClkFreq(void)

Return Frequency of dmic.

Returns

Frequency of DMIC

uint32_t CLOCK_SetFRGClock(uint32_t freq)

Set FRG Clk.

Returns

1: if set FRG CLK successfully. 0: if set FRG CLK fail.

uint32_t CLOCK_GetPllOutFreq(void)

Return Frequency of PLL.

Returns

Frequency of PLL

uint32_t CLOCK_GetUsbPllOutFreq(void)

Return Frequency of USB PLL.

Returns

Frequency of PLL

uint32_t CLOCK_GetAudioPllOutFreq(void)

Return Frequency of AUDIO PLL.

Returns

Frequency of PLL

uint32_t CLOCK_GetOsc32KFreq(void)

Return Frequency of 32kHz osc.

Returns

Frequency of 32kHz osc

uint32_t CLOCK_GetCoreSysClkFreq(void)

Return Frequency of Core System.

Returns

Frequency of Core System

uint32_t CLOCK_GetI2SMClkFreq(void)

Return Frequency of I2S MCLK Clock.

Returns

Frequency of I2S MCLK Clock

uint32_t CLOCK_GetFlexCommClkFreq(uint32_t id)

Return Frequency of Flexcomm functional Clock.

Returns

Frequency of Flexcomm functional Clock

uint32_t CLOCK_GetFRGInputClock(void)

return FRG Clk

Returns

Frequency of FRG CLK.

__STATIC_INLINE async_clock_src_t CLOCK_GetAsyncApbClkSrc (void)

Return Asynchronous APB Clock source.

Returns

Asynchronous APB CLock source

uint32_t CLOCK_GetAsyncApbClkFreq(void)

Return Frequency of Asynchronous APB Clock.

Returns

Frequency of Asynchronous APB Clock Clock

__STATIC_INLINE uint32_t CLOCK_GetEmcClkFreq (void)

Return EMC source.

Returns

EMC source

uint32_t CLOCK_GetAudioPLLInClockRate(void)

Return Audio PLL input clock rate.

Returns

Audio PLL input clock rate

uint32_t CLOCK_GetSystemPLLInClockRate(void)

Return System PLL input clock rate.

Returns

System PLL input clock rate

uint32_t CLOCK_GetSystemPLLOutClockRate(bool recompute)

Return System PLL output clock rate.

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

Parameters

- recompute – : Forces a PLL rate recomputation if true

Returns

System PLL output clock rate

uint32_t CLOCK_GetAudioPLLOutClockRate(bool recompute)

Return System AUDIO PLL output clock rate.

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

Parameters

- recompute – : Forces a AUDIO PLL rate recomputation if true

Returns

System AUDIO PLL output clock rate

uint32_t CLOCK_GetUsbPLLOutClockRate(bool recompute)

Return System USB PLL output clock rate.

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

Parameters

- recompute – : Forces a USB PLL rate recomputation if true

Returns

System USB PLL output clock rate

__STATIC_INLINE void CLOCK_SetBypassPLL (bool bypass)

Enables and disables PLL bypass mode.

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

Returns

System PLL output clock rate

__STATIC_INLINE bool CLOCK_IsSystemPLLLocked (void)

Check if PLL is locked or not.

Returns

true if the PLL is locked, false if not locked

__STATIC_INLINE bool CLOCK_IsUsbPLLLocked (void)

Check if USB PLL is locked or not.

Returns

true if the USB PLL is locked, false if not locked

__STATIC_INLINE bool CLOCK_IsAudioPLLLocked (void)

Check if AUDIO PLL is locked or not.

Returns

true if the AUDIO PLL is locked, false if not locked

__STATIC_INLINE void CLOCK_Enable_SysOsc (bool enable)

Enables and disables SYS OSC.

enable : true to enable SYS OSC, false to disable SYS OSC

void CLOCK_SetStoredPLLClockRate(uint32_t rate)

Store the current PLL rate.

Parameters

- rate – Current rate of the PLL

Returns

Nothing

void CLOCK_SetStoredAudioPLLClockRate(uint32_t rate)

Store the current AUDIO PLL rate.

Parameters

- rate – Current rate of the PLL

Returns

Nothing

uint32_t CLOCK_GetSystemPLLOutFromSetup(*pll_setup_t* *pSetup)

Return System PLL output clock rate from setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

System PLL output clock rate the setup structure will generate

uint32_t CLOCK_GetAudioPLLOutFromSetup(*pll_setup_t* *pSetup)

Return System AUDIO PLL output clock rate from setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

System PLL output clock rate the setup structure will generate

uint32_t CLOCK_GetAudioPLLOutFromFractSetup(*pll_setup_t* *pSetup)

Return System AUDIO PLL output clock rate from audio fractionl setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

System PLL output clock rate the setup structure will generate

uint32_t CLOCK_GetUsbPLLOutFromSetup(const *usb_pll_setup_t* *pSetup)

Return System USB PLL output clock rate from setup structure.

Parameters

- pSetup – : Pointer to a PLL setup structure

Returns

System PLL output clock rate the setup structure will generate

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

Set PLL output based on the passed PLL setup data.

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

Parameters

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

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

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

Set AUDIO PLL output based on the passed AUDIO PLL setup data.

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

Parameters

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

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

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

Set PLL output from PLL setup structure (precise frequency)

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

Parameters

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

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

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

Set AUDIO PLL output from AUDIOPLL setup structure (precise frequency)

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

Parameters

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

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

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

Set AUDIO PLL output from AUDIOPLL setup structure using the Audio Fractional divider register(precise frequency)

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

Parameters

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

Returns

PLL_ERROR_SUCCESS on success, or PLL setup error code

pll_error_t CLOCK_SetPLLFreq(const *pll_setup_t* *pSetup)

Set PLL output from PLL setup structure (precise frequency)

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

Parameters

- pSetup – : Pointer to populated PLL setup structure

Returns

kStatus_PLL_Success on success, or PLL setup error code

pll_error_t CLOCK_SetAudioPLLFreq(const *pll_setup_t* *pSetup)

Set Audio PLL output from Audio PLL setup structure (precise frequency)

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

Parameters

- pSetup – : Pointer to populated PLL setup structure

Returns

kStatus_PLL_Success on success, or Audio PLL setup error code

pll_error_t CLOCK_SetUsbPLLFreq(const *usb_pll_setup_t* *pSetup)

Set USB PLL output from USB PLL setup structure (precise frequency)

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

Parameters

- pSetup – : Pointer to populated USB PLL setup structure

Returns

kStatus_PLL_Success on success, or USB PLL setup error code

void CLOCK_SetupSystemPLLMult(uint32_t multiply_by, uint32_t input_freq)

Set PLL output based on the multiplier and input frequency.

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

Parameters

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

Returns

Nothing

static inline void CLOCK_DisableUsbDevicefs0Clock(*clock_ip_name_t* clk)

Disable USB clock.

Disable USB clock.

bool CLOCK_EnableUsbfs0DeviceClock(*clock_usb_src_t* src, uint32_t freq)

Enable USB Device FS clock.

Parameters

- src – : clock source
- freq – clock frequency Enable USB Device Full Speed clock.

bool CLOCK_EnableUsbfs0HostClock(*clock_usb_src_t* src, uint32_t freq)

Enable USB HOST FS clock.

Parameters

- src – : clock source
- freq – clock frequency Enable USB HOST Full Speed clock.

void CLOCK_SetStoredUsbPLLClockRate(uint32_t rate)

Set the current Usb PLL Rate.

bool CLOCK_EnableUsbhs0DeviceClock(*clock_usb_src_t* src, uint32_t freq)

Enable USB Device HS clock.

Parameters

- `src` – : clock source
- `freq` – clock frequency Enable USB Device High Speed clock.

`bool CLOCK_EnableUsbhs0HostClock(clock_usb_src_t src, uint32_t freq)`

Enable USB HOST HS clock.

Parameters

- `src` – : clock source
- `freq` – clock frequency Enable USB HOST High Speed clock.

`FSL_CLOCK_DRIVER_VERSION`

CLOCK driver version 2.3.3.

`FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL`

Configure whether driver controls clock.

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

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

`CLOCK_USR_CFG_PLL_CONFIG_CACHE_COUNT`

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

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

`SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY`

`ADC_CLOCKS`

Clock ip name array for ADC.

`ROM_CLOCKS`

Clock ip name array for ROM.

`SRAM_CLOCKS`

Clock ip name array for SRAM.

`FLASH_CLOCKS`

Clock ip name array for FLASH.

`FMC_CLOCKS`

Clock ip name array for FMC.

`EEPROM_CLOCKS`

Clock ip name array for EEPROM.

`SPIFI_CLOCKS`

Clock ip name array for SPIFI.

`INPUTMUX_CLOCKS`

Clock ip name array for INPUTMUX.

`IOCON_CLOCKS`

Clock ip name array for IOCON.

`GPIO_CLOCKS`

Clock ip name array for GPIO.

PINT_CLOCKS

Clock ip name array for PINT.

GINT_CLOCKS

Clock ip name array for GINT.

DMA_CLOCKS

Clock ip name array for DMA.

CRC_CLOCKS

Clock ip name array for CRC.

WWDT_CLOCKS

Clock ip name array for WWDT.

RTC_CLOCKS

Clock ip name array for RTC.

ADC0_CLOCKS

Clock ip name array for ADC0.

MRT_CLOCKS

Clock ip name array for MRT.

RIT_CLOCKS

Clock ip name array for RIT.

SCT_CLOCKS

Clock ip name array for SCT0.

MCAN_CLOCKS

Clock ip name array for MCAN.

UTICK_CLOCKS

Clock ip name array for UTICK.

FLEXCOMM_CLOCKS

Clock ip name array for FLEXCOMM.

LPUART_CLOCKS

Clock ip name array for LPUART.

BI2C_CLOCKS

Clock ip name array for BI2C.

LPSI_CLOCKS

Clock ip name array for LSPI.

FLEXI2S_CLOCKS

Clock ip name array for FLEXI2S.

DMIC_CLOCKS

Clock ip name array for DMIC.

CTIMER_CLOCKS

Clock ip name array for CT32B.

LCD_CLOCKS

Clock ip name array for LCD.

SDIO_CLOCKS

Clock ip name array for SDIO.

USBRAM_CLOCKS

Clock ip name array for USBRAM.

EMC_CLOCKS

Clock ip name array for EMC.

ETH_CLOCKS

Clock ip name array for ETH.

AES_CLOCKS

Clock ip name array for AES.

OTP_CLOCKS

Clock ip name array for OTP.

RNG_CLOCKS

Clock ip name array for RNG.

USBHMR0_CLOCKS

Clock ip name array for USBHMR0.

USBHSL0_CLOCKS

Clock ip name array for USBHSL0.

SHA0_CLOCKS

Clock ip name array for SHA0.

SMARTCARD_CLOCKS

Clock ip name array for SMARTCARD.

USBD_CLOCKS

Clock ip name array for USBD.

USBH_CLOCKS

Clock ip name array for USBH.

CLK_GATE_REG_OFFSET_SHIFT

Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

CLK_GATE_REG_OFFSET_MASK

CLK_GATE_BIT_SHIFT_SHIFT

CLK_GATE_BIT_SHIFT_MASK

CLK_GATE_DEFINE(reg_offset, bit_shift)

CLK_GATE_ABSTRACT_REG_OFFSET(x)

CLK_GATE_ABSTRACT_BITS_SHIFT(x)

AHB_CLK_CTRL0

AHB_CLK_CTRL1

AHB_CLK_CTRL2

ASYNC_CLK_CTRL0

CLK_ATTACH_ID(mux, sel, pos)

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

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

MUX_A(mux, sel)
MUX_B(mux, sel, selector)
GET_ID_ITEM(connection)
GET_ID_NEXT_ITEM(connection)
GET_ID_ITEM_MUX(connection)
GET_ID_ITEM_SEL(connection)
GET_ID_SELECTOR(connection)
CM_STICKCLKSEL
CM_MAINCLKSELA
CM_MAINCLKSELB
CM_CLKOUTCLKSELA
CM_SYSPLLCLKSEL
CM_AUDPLLCLKSEL
CM_SPIFICLKSEL
CM_ADCASYNCCLKSEL
CM_USB0CLKSEL
CM_USB1CLKSEL
CM_FXCOMCLKSEL0
CM_FXCOMCLKSEL1
CM_FXCOMCLKSEL2
CM_FXCOMCLKSEL3
CM_FXCOMCLKSEL4
CM_FXCOMCLKSEL5
CM_FXCOMCLKSEL6
CM_FXCOMCLKSEL7
CM_FXCOMCLKSEL8
CM_FXCOMCLKSEL9
CM_FXCOMCLKSEL10
CM_MCLKCLKSEL
CM_FRGCLKSEL
CM_DMICCLKSEL
CM_SCTCLKSEL
CM_LCDCLKSEL

CM_SDIOCLKSEL

CM_ASYNCAPB

PLL_CONFIGFLAG_USEINRATE

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

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

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

Flag to use InputRate in PLL configuration structure for setup

PLL_CONFIGFLAG_FORCENOFRACT

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

PLL_SETUPFLAG_POWERUP

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

Setup will power on the PLL after setup

PLL_SETUPFLAG_WAITLOCK

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

PLL_SETUPFLAG_ADGVOLT

Optimize system voltage for the new PLL rate

uint32_t desiredRate

Desired PLL rate in Hz

uint32_t inputRate

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

uint32_t flags

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

uint32_t pllctrl

PLL control register SYSPLLCTRL

uint32_t pllndec

PLL NDEC register SYSPLLNDEC

uint32_t pllpdec

PLL PDEC register SYSPLLPDEC

uint32_t pllmdec

PLL MDEC registers SYSPLLPDEC

uint32_t pllRate

Actual PLL rate

uint32_t audpllfrac

only audio PLL has this function

uint32_t flags

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

uint8_t msel

USB PLL control register msel:1U-256U

uint8_t psel

USB PLL control register psel:only support inter 1U 2U 4U 8U

uint8_t nsel

USB PLL control register nsel:only support inter 1U 2U 3U 4U

bool direct

USB PLL CCO output control

bool bypass

USB PLL input clock bypass control

bool fbssel

USB PLL integer mode and non-integer mode control

uint32_t inputRate

USB PLL input rate

struct _pll_config

#include <fsl_clock.h> PLL configuration structure.

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

struct _pll_setup

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

struct _usb_pll_setup

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

2.3 CRC: Cyclic Redundancy Check Driver

FSL_CRC_DRIVER_VERSION

CRC driver version. Version 2.1.1.

Current version: 2.1.1

Change log:

- Version 2.0.0
 - initial version
- Version 2.0.1
 - add explicit type cast when writing to WR_DATA

- Version 2.0.2
 - Fix MISRA issue
- Version 2.1.0
 - Add CRC_WriteSeed function
- Version 2.1.1
 - Fix MISRA issue

enum *_crc_polynomial*
CRC polynomials to use.

Values:

enumerator *kCRC_Polynomial_CRC_CCITT*
 $x^{16}+x^{12}+x^5+1$

enumerator *kCRC_Polynomial_CRC_16*
 $x^{16}+x^{15}+x^2+1$

enumerator *kCRC_Polynomial_CRC_32*
 $x^{32}+x^{26}+x^{23}+x^{22}+x^{16}+x^{12}+x^{11}+x^{10}+x^8+x^7+x^5+x^4+x^2+x+1$

typedef enum *_crc_polynomial* *crc_polynomial_t*
CRC polynomials to use.

typedef struct *_crc_config* *crc_config_t*
CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

void *CRC_Init*(*CRC_Type* *base, const *crc_config_t* *config)
Enables and configures the CRC peripheral module.

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

Parameters

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

static inline void *CRC_Deinit*(*CRC_Type* *base)
Disables the CRC peripheral module.

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

Parameters

- base – CRC peripheral address.

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

Parameters

- base – CRC peripheral address.

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

Parameters

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

`void CRC_GetDefaultConfig(crc_config_t *config)`

Loads default values to CRC protocol configuration structure.

Loads default values to CRC protocol configuration structure. The default values are:

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

Parameters

- config – CRC protocol configuration structure

`void CRC_GetConfig(CRC_Type *base, crc_config_t *config)`

Loads actual values configured in CRC peripheral to CRC protocol configuration structure.

The values, including seed, can be used to resume CRC calculation later.

Parameters

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

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

Writes data to the CRC module.

Writes input data buffer bytes to CRC data register.

Parameters

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

`static inline uint32_t CRC_Get32bitResult(CRC_Type *base)`

Reads 32-bit checksum from the CRC module.

Reads CRC data register.

Parameters

- base – CRC peripheral address.

Returns

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

`static inline uint16_t CRC_Get16bitResult(CRC_Type *base)`

Reads 16-bit checksum from the CRC module.

Reads CRC data register.

Parameters

- base – CRC peripheral address.

Returns

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

`CRC_DRIVER_USE_CRC16_CCITT_FALSE_AS_DEFAULT`

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

struct `_crc_config`

`#include <fsl_crc.h>` CRC protocol configuration.

This structure holds the configuration for the CRC protocol.

Public Members

`crc_polynomial_t` polynomial

CRC polynomial.

bool `reverseIn`

Reverse bits on input.

bool `complementIn`

Perform 1's complement on input.

bool `reverseOut`

Reverse bits on output.

bool `complementOut`

Perform 1's complement on output.

uint32_t `seed`

Starting checksum value.

2.4 CTIMER: Standard counter/timers

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

Un-gates 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 2.3.4

```
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

2.5 DMA: Direct Memory Access Controller Driver

`void DMA_Init(DMA_Type *base)`

Initializes DMA peripheral.

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

Parameters

- `base` – DMA peripheral base address.

`void DMA_Deinit(DMA_Type *base)`

Deinitializes DMA peripheral.

This function gates the DMA clock.

Parameters

- `base` – DMA peripheral base address.

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

Install DMA descriptor memory.

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

Parameters

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

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

Return whether DMA channel is processing transfer.

Parameters

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

Returns

True for active state, false otherwise.

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

Return whether DMA channel is busy.

Parameters

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

Returns

True for busy state, false otherwise.

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

Enables the interrupt source for the DMA transfer.

Parameters

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

static inline void DMA_DisableChannelInterrupts(DMA_Type *base, uint32_t channel)
Disables the interrupt source for the DMA transfer.

Parameters

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

static inline void DMA_EnableChannel(DMA_Type *base, uint32_t channel)
Enable DMA channel.

Parameters

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

static inline void DMA_DisableChannel(DMA_Type *base, uint32_t channel)
Disable DMA channel.

Parameters

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

static inline void DMA_EnableChannelPeriphRq(DMA_Type *base, uint32_t channel)
Set PERIPHREQEN of channel configuration register.

Parameters

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

static inline void DMA_DisableChannelPeriphRq(DMA_Type *base, uint32_t channel)
Get PERIPHREQEN value of channel configuration register.

Parameters

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

Returns

True for enabled PeriphRq, false for disabled.

void DMA_ConfigureChannelTrigger(DMA_Type *base, uint32_t channel, dma_channel_trigger_t *trigger)
Set trigger settings of DMA channel.

Deprecated:

Do not use this function. It has been superceded by DMA_SetChannelConfig.

Parameters

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

void DMA_SetChannelConfig(DMA_Type *base, uint32_t channel, dma_channel_trigger_t *trigger, bool isPeriph)
set channel config.

This function provide a interface to configure channel configuration registers.

Parameters

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

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

DMA channel xfer transfer configurations.

Parameters

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

Returns

The vaule of xfer config

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

Gets the remaining bytes of the current DMA descriptor transfer.

Parameters

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

Returns

The number of bytes which have not been transferred yet.

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

Set priority of channel configuration register.

Parameters

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

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

Get priority of channel configuration register.

Parameters

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

Returns

Channel priority value.


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

Set channel configuration valid.

Parameters

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

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

Do software trigger for the channel.

Parameters

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

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

Load channel transfer configurations.

Parameters

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

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

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

Deprecated:

Do not use this function. It has been superceded by DMA_SetupDescriptor.

Parameters

- desc – DMA descriptor address.
- xfercfg – Transfer configuration for DMA descriptor.
- srcAddr – Address of last item to transmit
- dstAddr – Address of last item to receive.
- nextDesc – Address of next descriptor in chain.

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

setup dma descriptor

Note: This function do not support configure wrap descriptor.

Parameters

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

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

setup dma channel descriptor

Note: This function support configure wrap descriptor.

Parameters

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

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

load channel transfer decriptor.

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

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

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

Parameters

- base – DMA base address.
- channel – DMA channel.
- descriptor – configured DMA descriptor.

```
void DMA_AbortTransfer(dma_handle_t *handle)
```

Abort running transfer by handle.

This function aborts DMA transfer specified by handle.

Parameters

- handle – DMA handle pointer.

```
void DMA_CreateHandle(dma_handle_t *handle, DMA_Type *base, uint32_t channel)
```

Creates the DMA handle.

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

Parameters

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

void DMA_SetCallback(*dma_handle_t* *handle, *dma_callback* callback, void *userData)

Installs a callback function for the DMA transfer.

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

Parameters

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

void DMA_PrepareTransfer(*dma_transfer_config_t* *config, void *srcAddr, void *dstAddr, uint32_t byteWidth, uint32_t transferBytes, *dma_transfer_type_t* type, void *nextDesc)

Prepares the DMA transfer structure.

Deprecated:

Do not use this function. It has been superceded by DMA_PrepareChannelTransfer. This function prepares the transfer configuration structure according to the user input.

Note: The data address and the data width must be consistent. For example, if the SRC is 4 bytes, so the source address must be 4 bytes aligned, or it shall result in source address error(SAE).

Parameters

- config – The user configuration structure of type *dma_transfer_t*.
- srcAddr – DMA transfer source address.
- dstAddr – DMA transfer destination address.
- byteWidth – DMA transfer destination address width(bytes).
- transferBytes – DMA transfer bytes to be transferred.
- type – DMA transfer type.
- nextDesc – Chain custom descriptor to transfer.

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

Prepare channel transfer configurations.

This function used to prepare channel transfer configurations.

Parameters

- config – Pointer to DMA channel transfer configuration structure.
- srcStartAddr – source start address.
- dstStartAddr – destination start address.

- xferCfg – xfer configuration, user can reference DMA_CHANNEL_XFER about to how to get xferCfg value.
- type – transfer type.
- trigger – DMA channel trigger configurations.
- nextDesc – address of next descriptor.

status_t DMA_SubmitTransfer(*dma_handle_t* *handle, *dma_transfer_config_t* *config)
Submits the DMA transfer request.

Deprecated:

Do not use this function. It has been superceded by DMA_SubmitChannelTransfer.

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

Parameters

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

Return values

- kStatus_DMA_Success – It means submit transfer request succeed.
- kStatus_DMA_QueueFull – It means TCD queue is full. Submit transfer request is not allowed.
- kStatus_DMA_Busy – It means the given channel is busy, need to submit request later.

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

Submit channel transfer paramter directly.

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

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

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

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

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

DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc2);
```

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```

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

```

Parameters

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

void DMA_SubmitChannelDescriptor(*dma_handle_t* *handle, *dma_descriptor_t* *descriptor)
Submit channel descriptor.

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

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

```

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

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

```

Parameters

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

status_t DMA_SubmitChannelTransfer(*dma_handle_t* *handle, *dma_channel_config_t* *config)
Submits the DMA channel transfer request.

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

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

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

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

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

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

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

DMA_SetupDescriptor(nextDesc0, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc1);
DMA_SetupDescriptor(nextDesc1, DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width,
↪ srcInc, dstInc, bytes),
srcStartAddr, dstStartAddr, nextDesc0);
DMA_CreateHandle(handle, base, channel)
DMA_PrepareChannelTransfer(config,srcStartAddr,dstStartAddr,xferCfg,type,trigger,
↪ nextDesc0);
DMA_SubmitChannelTransfer(handle, config)
DMA_StartTransfer(handle)
```

Parameters

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

Return values

- kStatus_DMA_Success – It means submit transfer request succeed.
- kStatus_DMA_QueueFull – It means TCD queue is full. Submit transfer request is not allowed.
- kStatus_DMA_Busy – It means the given channel is busy, need to submit request later.

void DMA_StartTransfer(*dma_handle_t* *handle)

DMA start transfer.

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

Parameters

- handle – DMA handle pointer.

void DMA_IRQHandle(DMA_Type *base)

DMA IRQ handler for descriptor transfer complete.

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

Parameters

- base – DMA base address.

FSL_DMA_DRIVER_VERSION

DMA driver version.

Version 2.5.4.

_dma_transfer_status DMA transfer status

Values:

enumerator kStatus_DMA_Busy

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

_dma_addr_interleave_size dma address interleave size

Values:

enumerator kDMA_AddressInterleave0xWidth

dma source/destination address no interleave

enumerator kDMA_AddressInterleave1xWidth

dma source/destination address interleave 1xwidth

enumerator kDMA_AddressInterleave2xWidth

dma source/destination address interleave 2xwidth

enumerator kDMA_AddressInterleave4xWidth

dma source/destination address interleave 3xwidth

_dma_transfer_width dma transfer width

Values:

enumerator kDMA_Transfer8BitWidth

dma channel transfer bit width is 8 bit

enumerator kDMA_Transfer16BitWidth

dma channel transfer bit width is 16 bit

enumerator kDMA_Transfer32BitWidth

dma channel transfer bit width is 32 bit

enum _dma_priority

DMA channel priority.

Values:

enumerator kDMA_ChannelPriority0
Highest channel priority - priority 0

enumerator kDMA_ChannelPriority1
Channel priority 1

enumerator kDMA_ChannelPriority2
Channel priority 2

enumerator kDMA_ChannelPriority3
Channel priority 3

enumerator kDMA_ChannelPriority4
Channel priority 4

enumerator kDMA_ChannelPriority5
Channel priority 5

enumerator kDMA_ChannelPriority6
Channel priority 6

enumerator kDMA_ChannelPriority7
Lowest channel priority - priority 7

enum _dma_int
DMA interrupt flags.

Values:

enumerator kDMA_IntA
DMA interrupt flag A

enumerator kDMA_IntB
DMA interrupt flag B

enumerator kDMA_IntError
DMA interrupt flag error

enum _dma_trigger_type
DMA trigger type.

Values:

enumerator kDMA_NoTrigger
Trigger is disabled

enumerator kDMA_LowLevelTrigger
Low level active trigger

enumerator kDMA_HighLevelTrigger
High level active trigger

enumerator kDMA_FallingEdgeTrigger
Falling edge active trigger

enumerator kDMA_RisingEdgeTrigger
Rising edge active trigger

_dma_burst_size DMA burst size

Values:

enumerator kDMA__BurstSize1

burst size 1 transfer

enumerator kDMA__BurstSize2

burst size 2 transfer

enumerator kDMA__BurstSize4

burst size 4 transfer

enumerator kDMA__BurstSize8

burst size 8 transfer

enumerator kDMA__BurstSize16

burst size 16 transfer

enumerator kDMA__BurstSize32

burst size 32 transfer

enumerator kDMA__BurstSize64

burst size 64 transfer

enumerator kDMA__BurstSize128

burst size 128 transfer

enumerator kDMA__BurstSize256

burst size 256 transfer

enumerator kDMA__BurstSize512

burst size 512 transfer

enumerator kDMA__BurstSize1024

burst size 1024 transfer

enum _dma_trigger_burst

DMA trigger burst.

Values:

enumerator kDMA__SingleTransfer

Single transfer

enumerator kDMA__LevelBurstTransfer

Burst transfer driven by level trigger

enumerator kDMA__EdgeBurstTransfer1

Perform 1 transfer by edge trigger

enumerator kDMA__EdgeBurstTransfer2

Perform 2 transfers by edge trigger

enumerator kDMA__EdgeBurstTransfer4

Perform 4 transfers by edge trigger

enumerator kDMA__EdgeBurstTransfer8

Perform 8 transfers by edge trigger

enumerator kDMA__EdgeBurstTransfer16

Perform 16 transfers by edge trigger

enumerator kDMA__EdgeBurstTransfer32

Perform 32 transfers by edge trigger

enumerator `kDMA_EdgeBurstTransfer64`
Perform 64 transfers by edge trigger

enumerator `kDMA_EdgeBurstTransfer128`
Perform 128 transfers by edge trigger

enumerator `kDMA_EdgeBurstTransfer256`
Perform 256 transfers by edge trigger

enumerator `kDMA_EdgeBurstTransfer512`
Perform 512 transfers by edge trigger

enumerator `kDMA_EdgeBurstTransfer1024`
Perform 1024 transfers by edge trigger

enum `_dma_burst_wrap`
DMA burst wrapping.

Values:

enumerator `kDMA_NoWrap`
Wrapping is disabled

enumerator `kDMA_SrcWrap`
Wrapping is enabled for source

enumerator `kDMA_DstWrap`
Wrapping is enabled for destination

enumerator `kDMA_SrcAndDstWrap`
Wrapping is enabled for source and destination

enum `_dma_transfer_type`
DMA transfer type.

Values:

enumerator `kDMA_MemoryToMemory`
Transfer from memory to memory (increment source and destination)

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

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

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

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

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

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

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

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

typedef enum *_dma_trigger_burst* dma_trigger_burst_t

DMA trigger burst.

typedef enum *_dma_burst_wrap* dma_burst_wrap_t

DMA burst wrapping.

typedef enum *_dma_transfer_type* dma_transfer_type_t

DMA transfer type.

typedef struct *_dma_channel_trigger* dma_channel_trigger_t

DMA channel trigger.

typedef struct *_dma_channel_config* dma_channel_config_t

DMA channel trigger.

typedef struct *_dma_transfer_config* dma_transfer_config_t

DMA transfer configuration.

typedef void (*dma_callback)(struct *_dma_handle* *handle, void *userData, bool transferDone, uint32_t intmode)

Define Callback function for DMA.

typedef struct *_dma_handle* dma_handle_t

DMA transfer handle structure.

DMA_MAX_TRANSFER_COUNT

DMA max transfer size.

FSL_FEATURE_DMA_NUMBER_OF_CHANNELSn(x)

DMA channel numbers.

FSL_FEATURE_DMA_MAX_CHANNELS

FSL_FEATURE_DMA_ALL_CHANNELS

FSL_FEATURE_DMA_LINK_DESCRIPTOR_ALIGN_SIZE

DMA head link descriptor table align size.

DMA_ALLOCATE_HEAD_DESCRIPTOR(name, number)

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

Parameters

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

DMA_ALLOCATE_HEAD_DESCRIPTOR_AT_NONCACHEABLE(name, number)

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

Parameters

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

DMA_ALLOCATE_LINK_DESCRIPTOR(name, number)

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

Parameters

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

DMA_ALLOCATE_LINK_DESCRIPTOR_AT_NONCACHEABLE(name, number)

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

Parameters

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

DMA_ALLOCATE_DATA_TRANSFER_BUFFER(name, width)

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

DMA_CHANNEL_GROUP(channel)

DMA_CHANNEL_INDEX(base, channel)

DMA_COMMON_REG_GET(base, channel, reg)

DMA linked descriptor address algin size.

DMA_COMMON_CONST_REG_GET(base, channel, reg)

DMA_COMMON_REG_SET(base, channel, reg, value)

DMA_DESCRIPTOR_END_ADDRESS(start, inc, bytes, width)

DMA descriptor end address calculate.

Parameters

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

DMA_CHANNEL_XFER(reload, clrTrig, intA, intB, width, srcInc, dstInc, bytes)

struct _dma_descriptor

#include <fsl_dma.h> DMA descriptor structure.

Public Members

volatile uint32_t xfercfg

Transfer configuration

void *srcEndAddr

Last source address of DMA transfer

void *dstEndAddr

Last destination address of DMA transfer

void *linkToNextDesc

Address of next DMA descriptor in chain

struct _dma_xfercfg

#include <fsl_dma.h> DMA transfer configuration.

Public Members

bool valid
Descriptor is ready to transfer

bool reload
Reload channel configuration register after current descriptor is exhausted

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

bool clrtrig
Clear trigger

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

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

uint8_t byteWidth
Byte width of data to transfer

uint8_t srcInc
Increment source address by 'srcInc' x 'byteWidth'

uint8_t dstInc
Increment destination address by 'dstInc' x 'byteWidth'

uint16_t transferCount
Number of transfers

struct _dma_channel_trigger
#include <fsl_dma.h> DMA channel trigger.

Public Members

dma_trigger_type_t type
Select hardware trigger as edge triggered or level triggered.

dma_trigger_burst_t burst
Select whether hardware triggers cause a single or burst transfer.

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

struct _dma_channel_config
#include <fsl_dma.h> DMA channel trigger.

Public Members

void *srcStartAddr
Source data address

void *dstStartAddr
Destination data address

void *nextDesc
Chain custom descriptor

```
uint32_t xferCfg
    channel transfer configurations
dma_channel_trigger_t *trigger
    DMA trigger type
bool isPeriph
    select the request type
struct __dma_transfer_config
    #include <fsl_dma.h> DMA transfer configuration.
```

Public Members

```
uint8_t *srcAddr
    Source data address
uint8_t *dstAddr
    Destination data address
uint8_t *nextDesc
    Chain custom descriptor
dma_xfercfg_t xfercfg
    Transfer options
bool isPeriph
    DMA transfer is driven by peripheral
struct __dma_handle
    #include <fsl_dma.h> DMA transfer handle structure.
```

Public Members

```
dma_callback callback
    Callback function. Invoked when transfer of descriptor with interrupt flag finishes
void *userData
    Callback function parameter
DMA_Type *base
    DMA peripheral base address
uint8_t channel
    DMA channel number
```

2.6 DMIC: Digital Microphone

2.7 DMIC DMA Driver

```
status_t DMIC_TransferCreateHandleDMA(DMIC_Type *base, dmic_dma_handle_t *handle,
                                       dmic_dma_transfer_callback_t callback, void
                                       *userData, dma_handle_t *rxDmaHandle)
```

Initializes the DMIC handle which is used in transactional functions.

Parameters

- base – DMIC peripheral base address.
- handle – Pointer to `dmic_dma_handle_t` structure.
- callback – Callback function.
- userData – User data.
- rxDmaHandle – User-requested DMA handle for RX DMA transfer.

status_t DMIC_TransferReceiveDMA(DMIC_Type *base, *dmic_dma_handle_t* *handle, *dmic_transfer_t* *xfer, uint32_t channel)

Receives data using DMA.

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

Parameters

- base – USART peripheral base address.
- handle – Pointer to `usart_dma_handle_t` structure.
- xfer – DMIC DMA transfer structure. See `dmic_transfer_t`.
- channel – DMIC start channel number.

Return values

`kStatus_Success` –

`void` DMIC_TransferAbortReceiveDMA(DMIC_Type *base, *dmic_dma_handle_t* *handle)

Aborts the received data using DMA.

This function aborts the received data using DMA.

Parameters

- base – DMIC peripheral base address
- handle – Pointer to `dmic_dma_handle_t` structure

status_t DMIC_TransferGetReceiveCountDMA(DMIC_Type *base, *dmic_dma_handle_t* *handle, uint32_t *count)

Get the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- base – DMIC peripheral base address.
- handle – DMIC 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` DMIC_InstallDMADescriptorMemory(*dmic_dma_handle_t* *handle, void *linkAddr, size_t linkNum)

Install DMA descriptor memory.

This function used to register DMA descriptor memory for linked transfer, a typical case is ping pong transfer which will request more than one DMA descriptor memory space, it should be called after `DMIC_TransferCreateHandleDMA`. User should be take care about the address of DMA descriptor pool which required align with 16BYTE at least.

Parameters

- handle – Pointer to DMA channel transfer handle.
- linkAddr – DMA link descriptor address.
- linkNum – DMA link descriptor number.

FSL_DMIC_DMA_DRIVER_VERSION

DMIC DMA driver version 2.4.2.

typedef struct *_dmic_transfer* *dmic_transfer_t*

DMIC transfer structure.

typedef struct *_dmic_dma_handle* *dmic_dma_handle_t*

typedef void (**dmic_dma_transfer_callback_t*)(DMIC_Type *base, *dmic_dma_handle_t* *handle, *status_t* status, void *userData)

DMIC transfer callback function.

struct *_dmic_transfer*

#include <fsl_dmic_dma.h> DMIC transfer structure.

Public Members

void *data

The buffer of data to be transfer.

uint8_t dataWidth

DMIC support 16bit/32bit

size_t dataSize

The byte count to be transfer.

uint8_t dataAddrInterleaveSize

destination address interleave size

struct *_dmic_transfer* *linkTransfer

use to support link transfer

struct *_dmic_dma_handle*

#include <fsl_dmic_dma.h> DMIC DMA handle.

Public Members

DMIC_Type *base

DMIC peripheral base address.

dma_handle_t *rxDmaHandle

The DMA RX channel used.

dmic_dma_transfer_callback_t callback

Callback function.

void *userData

DMIC callback function parameter.

size_t transferSize

Size of the data to receive.

volatile uint8_t state

Internal state of DMIC DMA transfer

`uint32_t` channel
DMIC channel used.

`bool` isChannelValid
DMIC channel initialization flag

`dma_descriptor_t` *desLink
descriptor pool pointer

`size_t` linkNum
number of descriptor in descriptors pool

2.8 DMIC Driver

`uint32_t` DMIC_GetInstance(DMIC_Type *base)
Get the DMIC instance from peripheral base address.

Parameters

- base – DMIC peripheral base address.

Returns

DMIC instance.

`void` DMIC_Init(DMIC_Type *base)
Turns DMIC Clock on.

Parameters

- base – : DMIC base

Returns

Nothing

`void` DMIC_DeInit(DMIC_Type *base)
Turns DMIC Clock off.

Parameters

- base – : DMIC base

Returns

Nothing

`void` DMIC_ConfigIO(DMIC_Type *base, *dmic_io_t* config)
Configure DMIC io.

Deprecated:

Do not use this function. It has been superceded by DMIC_SetIOCFG

Parameters

- base – : The base address of DMIC interface
- config – : DMIC io configuration

Returns

Nothing

static inline void DMIC_SetIOCFG(DMIC_Type *base, uint32_t sel)

Stereo PDM select.

Parameters

- base – : The base address of DMIC interface
- sel – : Reference `dmic_io_t`, can be a single or combination value of `dmic_io_t`.

Returns

Nothing

void DMIC_SetOperationMode(DMIC_Type *base, *operation_mode_t* mode)

Set DMIC operating mode.

Deprecated:

Do not use this function. It has been superceded by `DMIC_EnableChannelInterrupt`, `DMIC_EnableChannelDma`.

Parameters

- base – : The base address of DMIC interface
- mode – : DMIC mode

Returns

Nothing

void DMIC_Use2fs(DMIC_Type *base, bool use2fs)

Configure Clock scaling.

Parameters

- base – : The base address of DMIC interface
- use2fs – : clock scaling

Returns

Nothing

void DMIC_CfgChannelDc(DMIC_Type *base, *dmic_channel_t* channel, *dc_removal_t* dc_cut_level, uint32_t post_dc_gain_reduce, bool saturate16bit)

Configure DMIC channel.

Parameters

- base – : The base address of DMIC interface
- channel – : DMIC channel
- dc_cut_level – : `dc_removal_t`, Cut off Frequency
- post_dc_gain_reduce – : Fine gain adjustment in the form of a number of bits to downshift.
- saturate16bit – : If selects 16-bit saturation.

void DMIC_ConfigChannel(DMIC_Type *base, *dmic_channel_t* channel, *stereo_side_t* side, *dmic_channel_config_t* *channel_config)

Configure DMIC channel.

Parameters

- base – : The base address of DMIC interface
- channel – : DMIC channel

- side – : stereo_side_t, choice of left or right
- channel_config – : Channel configuration

Returns

Nothing

```
void DMIC__EnableChannel(DMIC_Type *base, uint32_t channelmask)
```

Enable a particular channel.

Parameters

- base – : The base address of DMIC interface
- channelmask – reference _dmic_channel_mask

Returns

Nothing

```
void DMIC__FifoChannel(DMIC_Type *base, uint32_t channel, uint32_t trig_level, uint32_t enable, uint32_t resetn)
```

Configure fifo settings for DMIC channel.

Parameters

- base – : The base address of DMIC interface
- channel – : DMIC channel
- trig_level – : FIFO trigger level
- enable – : FIFO level
- resetn – : FIFO reset

Returns

Nothing

```
static inline void DMIC__EnableChannelInterrupt(DMIC_Type *base, dmic_channel_t channel, bool enable)
```

Enable a particular channel interrupt request.

Parameters

- base – : The base address of DMIC interface
- channel – : Channel selection
- enable – : true is enable, false is disable

```
static inline void DMIC__EnableChannelDma(DMIC_Type *base, dmic_channel_t channel, bool enable)
```

Enable a particular channel dma request.

Parameters

- base – : The base address of DMIC interface
- channel – : Channel selection
- enable – : true is enable, false is disable

```
static inline void DMIC__EnableChannelFifo(DMIC_Type *base, dmic_channel_t channel, bool enable)
```

Enable a particular channel fifo.

Parameters

- base – : The base address of DMIC interface
- channel – : Channel selection

- `enable` – : true is enable, false is disable

static inline void DMIC__DoFifoReset(DMIC_Type *base, *dmic_channel_t* channel)

Channel fifo reset.

Parameters

- `base` – : The base address of DMIC interface
- `channel` – : Channel selection

static inline uint32_t DMIC__FifoGetStatus(DMIC_Type *base, uint32_t channel)

Get FIFO status.

Parameters

- `base` – : The base address of DMIC interface
- `channel` – : DMIC channel

Returns

FIFO status

static inline void DMIC__FifoClearStatus(DMIC_Type *base, uint32_t channel, uint32_t mask)

Clear FIFO status.

Parameters

- `base` – : The base address of DMIC interface
- `channel` – : DMIC channel
- `mask` – : Bits to be cleared

Returns

FIFO status

static inline uint32_t DMIC__FifoGetData(DMIC_Type *base, uint32_t channel)

Get FIFO data.

Parameters

- `base` – : The base address of DMIC interface
- `channel` – : DMIC channel

Returns

FIFO data

static inline uint32_t DMIC__FifoGetAddress(DMIC_Type *base, uint32_t channel)

Get FIFO address.

Parameters

- `base` – : The base address of DMIC interface
- `channel` – : DMIC channel

Returns

FIFO data

void DMIC__EnableIntCallback(DMIC_Type *base, *dmic_callback_t* cb)

Enable callback.

This function enables the interrupt for the selected DMIC peripheral. The callback function is not enabled until this function is called.

Parameters

- `base` – Base address of the DMIC peripheral.
- `cb` – callback Pointer to store callback function.

Return values

None. –

void DMIC_DisableIntCallback(DMIC_Type *base, *dmic_callback_t* cb)

Disable callback.

This function disables the interrupt for the selected DMIC peripheral.

Parameters

- base – Base address of the DMIC peripheral.
- cb – callback Pointer to store callback function..

Return values

None. –

static inline void DMIC_SetGainNoiseEstHwvad(DMIC_Type *base, uint32_t value)

Sets the gain value for the noise estimator.

Parameters

- base – DMIC base pointer
- value – gain value for the noise estimator.

Return values

None. –

static inline void DMIC_SetGainSignalEstHwvad(DMIC_Type *base, uint32_t value)

Sets the gain value for the signal estimator.

Parameters

- base – DMIC base pointer
- value – gain value for the signal estimator.

Return values

None. –

static inline void DMIC_SetFilterCtrlHwvad(DMIC_Type *base, uint32_t value)

Sets the hwvad filter cutoff frequency parameter.

Parameters

- base – DMIC base pointer
- value – cut off frequency value.

Return values

None. –

static inline void DMIC_SetInputGainHwvad(DMIC_Type *base, uint32_t value)

Sets the input gain of hwvad.

Parameters

- base – DMIC base pointer
- value – input gain value for hwvad.

Return values

None. –

static inline void DMIC_CtrlClrIntrHwvad(DMIC_Type *base, bool st10)

Clears hwvad internal interrupt flag.

Parameters

- base – DMIC base pointer

- st10 – bit value.

Return values

None. –

static inline void DMIC_FilterResetHwvad(DMIC_Type *base, bool rstt)

Resets hwvad filters.

Parameters

- base – DMIC base pointer
- rstt – Reset bit value.

Return values

None. –

static inline uint16_t DMIC_GetNoiseEnvlpEst(DMIC_Type *base)

Gets the value from output of the filter z7.

Parameters

- base – DMIC base pointer

Return values

output – of filter z7.

void DMIC_HwvadEnableIntCallback(DMIC_Type *base, *dmic_hwvad_callback_t* vadcb)

Enable hwvad callback.

This function enables the hwvad interrupt for the selected DMIC peripheral. The callback function is not enabled until this function is called.

Parameters

- base – Base address of the DMIC peripheral.
- vadcb – callback Pointer to store callback function.

Return values

None. –

void DMIC_HwvadDisableIntCallback(DMIC_Type *base, *dmic_hwvad_callback_t* vadcb)

Disable callback.

This function disables the hwvad interrupt for the selected DMIC peripheral.

Parameters

- base – Base address of the DMIC peripheral.
- vadcb – callback Pointer to store callback function..

Return values

None. –

FSL_DMIC_DRIVER_VERSION

DMIC driver version 2.3.3.

_dmic_status DMIC transfer status.

Values:

enumerator kStatus_DMIC_Busy

DMIC is busy

enumerator kStatus_DMIC_Idle

DMIC is idle

enumerator kStatus_DMIC_OverRunError
DMIC over run Error

enumerator kStatus_DMIC_UnderRunError
DMIC under run Error

enum __operation__mode
DMIC different operation modes.

Values:

enumerator kDMIC_OperationModeInterrupt
Interrupt mode

enumerator kDMIC_OperationModeDma
DMA mode

enum __stereo__side
DMIC left/right values.

Values:

enumerator kDMIC_Left
Left Stereo channel

enumerator kDMIC_Right
Right Stereo channel

enum pdm_div_t
DMIC Clock pre-divider values.

Values:

enumerator kDMIC_PdmDiv1
DMIC pre-divider set in divide by 1

enumerator kDMIC_PdmDiv2
DMIC pre-divider set in divide by 2

enumerator kDMIC_PdmDiv3
DMIC pre-divider set in divide by 3

enumerator kDMIC_PdmDiv4
DMIC pre-divider set in divide by 4

enumerator kDMIC_PdmDiv6
DMIC pre-divider set in divide by 6

enumerator kDMIC_PdmDiv8
DMIC pre-divider set in divide by 8

enumerator kDMIC_PdmDiv12
DMIC pre-divider set in divide by 12

enumerator kDMIC_PdmDiv16
DMIC pre-divider set in divide by 16

enumerator kDMIC_PdmDiv24
DMIC pre-divider set in divide by 24

enumerator kDMIC_PdmDiv32
DMIC pre-divider set in divide by 32

enumerator kDMIC_PdmDiv48

DMIC pre-divider set in divide by 48

enumerator kDMIC_PdmDiv64

DMIC pre-divider set in divide by 64

enumerator kDMIC_PdmDiv96

DMIC pre-divider set in divide by 96

enumerator kDMIC_PdmDiv128

DMIC pre-divider set in divide by 128

enum _compensation

Pre-emphasis Filter coefficient value for 2FS and 4FS modes.

Values:

enumerator kDMIC_CompValueZero

Compensation 0

enumerator kDMIC_CompValueNegativePoint16

Compensation -0.16

enumerator kDMIC_CompValueNegativePoint15

Compensation -0.15

enumerator kDMIC_CompValueNegativePoint13

Compensation -0.13

enum _dc_removal

DMIC DC filter control values.

Values:

enumerator kDMIC_DcNoRemove

Flat response no filter

enumerator kDMIC_DcCut155

Cut off Frequency is 155 Hz

enumerator kDMIC_DcCut78

Cut off Frequency is 78 Hz

enumerator kDMIC_DcCut39

Cut off Frequency is 39 Hz

enum _dmic_io

DMIC IO configuration.

Values:

enumerator kDMIC_PdmDual

Two separate pairs of PDM wires

enumerator kDMIC_PdmStereo

Stereo data0

enumerator kDMIC_PdmBypass

Clk Bypass clocks both channels

enumerator kDMIC_PdmBypassClk0

Clk Bypass clocks only channel0

enumerator kDMIC_PdmBypassClk1
Clk Bypass clocks only channel1

enum _dmic_channel
DMIC Channel number.

Values:

enumerator kDMIC_Channel0
DMIC channel 0

enumerator kDMIC_Channel1
DMIC channel 1

enumerator kDMIC_ChannelMAX
Maximum number of DMIC channels

_dmic_channel_mask DMIC Channel mask.

Values:

enumerator kDMIC_EnableChannel0
DMIC channel 0 mask

enumerator kDMIC_EnableChannel1
DMIC channel 1 mask

enum _dmic_phy_sample_rate
DMIC and decimator sample rates.

Values:

enumerator kDMIC_PhyFullSpeed
Decimator gets one sample per each chosen clock edge of PDM interface

enumerator kDMIC_PhyHalfSpeed
PDM clock to Microphone is halved, decimator receives each sample twice

typedef enum *_operation_mode* operation_mode_t
DMIC different operation modes.

typedef enum *_stereo_side* stereo_side_t
DMIC left/right values.

typedef enum *_compensation* compensation_t
Pre-emphasis Filter coefficient value for 2FS and 4FS modes.

typedef enum *_dc_removal* dc_removal_t
DMIC DC filter control values.

typedef enum *_dmic_io* dmic_io_t
DMIC IO configuration.

typedef enum *_dmic_channel* dmic_channel_t
DMIC Channel number.

typedef enum *_dmic_phy_sample_rate* dmic_phy_sample_rate_t
DMIC and decimator sample rates.

typedef struct *_dmic_channel_config* dmic_channel_config_t
DMIC Channel configuration structure.

```
typedef void (*dmic_callback_t)(void)
```

DMIC Callback function.

```
typedef void (*dmic_hwvad_callback_t)(void)
```

HWVAD Callback function.

```
struct __dmic_channel_config
```

#include <fsl_dmic.h> DMIC Channel configuration structure.

Public Members

pdm_div_t divhclk

DMIC Clock pre-divider values

uint32_t osr

oversampling rate(CIC decimation rate) for PCM

uint32_t gainshft

4FS PCM data gain control

compensation_t preac2coef

Pre-emphasis Filter coefficient value for 2FS

compensation_t preac4coef

Pre-emphasis Filter coefficient value for 4FS

dc_removal_t dc_cut_level

DMIC DC filter control values.

uint32_t post_dc_gain_reduce

Fine gain adjustment in the form of a number of bits to downshift

dmic_phy_sample_rate_t sample_rate

DMIC and decimator sample rates

bool saturate16bit

Selects 16-bit saturation. 0 means results roll over if out range and do not saturate. 1 means if the result overflows, it saturates at 0xFFFF for positive overflow and 0x8000 for negative overflow.

2.9 EMC: External Memory Controller Driver

```
void EMC_Init(EMC_Type *base, emc_basic_config_t *config)
```

Initializes the basic for EMC. This function ungates the EMC clock, initializes the emc system configure and enable the EMC module. This function must be called in the first step to initialize the external memory.

Parameters

- base – EMC peripheral base address.
- config – The EMC basic configuration.

```
void EMC_DynamicMemInit(EMC_Type *base, emc_dynamic_timing_config_t *timing,  
                        emc_dynamic_chip_config_t *config, uint32_t totalChips)
```

Initializes the dynamic memory controller. This function initializes the dynamic memory controller in external memory controller. This function must be called after EMC_Init and before accessing the external dynamic memory.

Parameters

- `base` – EMC peripheral base address.
- `timing` – The timing and latency for dynamica memory controller setting. It shall be used for all dynamica memory chips, threfore the worst timing value for all used chips must be given.
- `config` – The EMC dynamic memory controller chip independent configuration pointer. This configuration pointer is actually pointer to a configuration array. the array number depends on the “totalChips”.
- `totalChips` – The total dynamic memory chip numbers been used or the length of the “emc_dynamic_chip_config_t” type memory.

```
void EMC_StaticMemInit(EMC_Type *base, uint32_t *extWait_Ns, emc_static_chip_config_t  
                      *config, uint32_t totalChips)
```

Initializes the static memory controller. This function initializes the static memory controller in external memory controller. This function must be called after `EMC_Init` and before accessing the external static memory.

Parameters

- `base` – EMC peripheral base address.
- `extWait_Ns` – The extended wait timeout or the read/write transfer time. This is common for all static memory chips and set with `NULL` if not required.
- `config` – The EMC static memory controller chip independent configuration pointer. This configuration pointer is actually pointer to a configuration array. the array number depends on the “totalChips”.
- `totalChips` – The total static memory chip numbers been used or the length of the “emc_static_chip_config_t” type memory.

```
void EMC_Deinit(EMC_Type *base)
```

Deinitializes the EMC module and gates the clock. This function gates the EMC controller clock. As a result, the EMC module doesn't work after calling this function.

Parameters

- `base` – EMC peripheral base address.

```
static inline void EMC_Enable(EMC_Type *base, bool enable)
```

Enables/disables the EMC module.

Parameters

- `base` – EMC peripheral base address.
- `enable` – True enable EMC module, false disable.

```
static inline void EMC_EnableDynamicMemControl(EMC_Type *base, bool enable)
```

Enables/disables the EMC Dynaimc memory controller.

Parameters

- `base` – EMC peripheral base address.
- `enable` – True enable EMC dynamic memory controller, false disable.

```
static inline void EMC_MirrorChipAddr(EMC_Type *base, bool enable)
```

Enables/disables the EMC address mirror. Enable the address mirror the `EMC_CS1` is mirrored to both `EMC_CS0` and `EMC_DYCS0` memory areas. Disable the address mirror enables `EMC_CS0` and `EMC_DYCS0` memory to be accessed.

Parameters

- `base` – EMC peripheral base address.

- enable – True enable the address mirror, false disable the address mirror.

static inline void EMC_EnterSelfRefreshCommand(EMC_Type *base, bool enable)

Enter the self-refresh mode for dynamic memory controller. This function provided self-refresh mode enter or exit for application.

Parameters

- base – EMC peripheral base address.
- enable – True enter the self-refresh mode, false to exit self-refresh and enter the normal mode.

static inline bool EMC_IsInSelfrefreshMode(EMC_Type *base)

Get the operating mode of the EMC. This function can be used to get the operating mode of the EMC.

Parameters

- base – EMC peripheral base address.

Returns

The EMC in self-refresh mode if true, else in normal mode.

static inline void EMC_EnterLowPowerMode(EMC_Type *base, bool enable)

Enter/exit the low-power mode.

Parameters

- base – EMC peripheral base address.
- enable – True Enter the low-power mode, false exit low-power mode and return to normal mode.

FSL_EMC_DRIVER_VERSION

EMC driver version.

enum __emc_static_memwidth

Define EMC memory width for static memory device.

Values:

enumerator kEMC_8BitWidth

8 bit memory width.

enumerator kEMC_16BitWidth

16 bit memory width.

enumerator kEMC_32BitWidth

32 bit memory width.

enum __emc_static_special_config

Define EMC static configuration.

Values:

enumerator kEMC_AsynchronosPageEnable

Enable the asynchronous page mode. page length four.

enumerator kEMC_ActiveHighChipSelect

Chip select active high.

enumerator kEMC_ByteLaneStateAllLow

Reads/writes the respective value bits in BLS3:0 are low.

enumerator kEMC_ExtWaitEnable

Extended wait enable.

enumerator kEMC_BufferEnable

Buffer enable.

enum _emc_dynamic_device

EMC dynamic memory device.

Values:

enumerator kEMC_Sdram

Dynamic memory device: SDRAM.

enumerator kEMC_Lpsdram

Dynamic memory device: Low-power SDRAM.

enum _emc_dynamic_read

EMC dynamic read strategy.

Values:

enumerator kEMC_NoDelay

No delay.

enumerator kEMC_Cmddelay

Command delayed strategy, using EMCCLKDELAY.

enumerator kEMC_CmdDelayPulseOneclk

Command delayed strategy pluse one clock cycle using EMCCLKDELAY.

enumerator kEMC_CmddelayPulsetwoclk

Command delayed strategy pulse two clock cycle using EMCCLKDELAY.

enum _emc_endian_mode

EMC endian mode.

Values:

enumerator kEMC_LittleEndian

Little endian mode.

enumerator kEMC_BigEndian

Big endian mode.

enum _emc_fbclk_src

EMC Feedback clock input source select.

Values:

enumerator kEMC_IntloopbackEmcclk

Use the internal loop back from EMC_CLK output.

enumerator kEMC_EMCFbclkInput

Use the external EMC_FBCLK input.

typedef enum _emc_static_memwidth emc_static_memwidth_t

Define EMC memory width for static memory device.

typedef enum _emc_static_special_config emc_static_special_config_t

Define EMC static configuration.

typedef enum _emc_dynamic_device emc_dynamic_device_t

EMC dynamic memory device.

typedef enum _emc_dynamic_read emc_dynamic_read_t

EMC dynamic read strategy.

typedef enum *_emc_endian_mode* emc_endian_mode_t
 EMC endian mode.

typedef enum *_emc_fbclk_src* emc_fbclk_src_t
 EMC Feedback clock input source select.

typedef struct *_emc_dynamic_timing_config* emc_dynamic_timing_config_t
 EMC dynamic timing/delay configure structure.

typedef struct *_emc_dynamic_chip_config* emc_dynamic_chip_config_t
 EMC dynamic memory controller independent chip configuration structure. Please take refer to the address mapping table in the RM in EMC chapter when you set the “devAddrMap”. Choose the right Bit 14 Bit12 ~ Bit 7 group in the table according to the bus width/banks/row/column length for you device. Set devAddrMap with the value make up with the seven bits (bit14 bit12 ~ bit 7) and inset the bit 13 with 0. for example, if the bit 14 and bit12 ~ bit7 is 1000001 is choosen according to the 32bit high-performance bus width with 2 banks, 11 row lwngh, 8 column length. Set devAddrMap with 0x81.

typedef struct *_emc_static_chip_config* emc_static_chip_config_t
 EMC static memory controller independent chip configuration structure.

typedef struct *_emc_basic_config* emc_basic_config_t
 EMC module basic configuration structure.

 Defines the static memory controller configure structure and uses the EMC_Init() function to make necessary initializations.

EMC_STATIC_MEMDEV_NUM

 Define the chip numbers for dynamic and static memory devices.

EMC_DYNAMIC_MEMDEV_NUM

EMC_ADDRMAP_SHIFT

EMC_ADDRMAP_MASK

EMC_ADDRMAP(x)

EMC_HZ_ONEMHZ

EMC_MILLISECS_ONESEC

EMC_SDRAM_MODE_CL_SHIFT

EMC_SDRAM_MODE_CL_MASK

EMC_SDRAM_NOP_DELAY_US

 EDMA_SDRAM NOP command wait us.

EMC_SDRAM_PRECHARGE_DELAY_US

 EDMA_SDRAM precharge command wait us.

EMC_SDRAM_AUTO_REFRESH_DELAY_US

 EDMA_SDRAM auto refresh wait us.

struct *_emc_dynamic_timing_config*
 #include <fsl_emc.h> EMC dynamic timing/delay configure structure.

Public Members

uint32_t refreshPeriod_Nanosec

 The refresh period in unit of nanosecond.

uint32_t tRp_Ns

Precharge command period in unit of nanosecond.

uint32_t tRas_Ns

Active to precharge command period in unit of nanosecond.

uint32_t tSrex_Ns

Self-refresh exit time in unit of nanosecond.

uint32_t tApr_Ns

Last data out to active command time in unit of nanosecond.

uint32_t tDal_Ns

Data-in to active command in unit of nanosecond.

uint32_t tWr_Ns

Write recovery time in unit of nanosecond.

uint32_t tRc_Ns

Active to active command period in unit of nanosecond.

uint32_t tRfc_Ns

Auto-refresh period and auto-refresh to active command period in unit of nanosecond.

uint32_t tXsr_Ns

Exit self-refresh to active command time in unit of nanosecond.

uint32_t tRrd_Ns

Active bank A to active bank B latency in unit of nanosecond.

uint8_t tMrd_Nclk

Load mode register to active command time in unit of EMCCLK cycles.

struct _emc_dynamic_chip_config

#include <fsl_emc.h> EMC dynamic memory controller independent chip configuration structure. Please take refer to the address mapping table in the RM in EMC chapter when you set the “devAddrMap”. Choose the right Bit 14 Bit12 ~ Bit 7 group in the table according to the bus width/banks/row/column length for you device. Set devAddrMap with the value make up with the seven bits (bit14 bit12 ~ bit 7) and inset the bit 13 with 0. for example, if the bit 14 and bit12 ~ bit7 is 1000001 is choosen according to the 32bit high-performance bus width with 2 banks, 11 row lwngh, 8 column length. Set devAddrMap with 0x81.

Public Members

uint8_t chipIndex

Chip Index, range from 0 ~ EMC_DYNAMIC_MEMDEV_NUM - 1.

emc_dynamic_device_t dynamicDevice

All chips shall use the same device setting. mixed use are not supported.

uint8_t rAS_Nclk

Active to read/write delay tRCD.

uint16_t sdramModeReg

Sdram mode register setting.

uint16_t sdramExtModeReg

Used for low-power sdram device. The extended mode register.

uint8_t devAddrMap

dynamic device address mapping, choose the address mapping for your specific device.

struct __emc_static_chip_config

#include <fsl_emc.h> EMC static memory controller independent chip configuration structure.

Public Members

emc_static_memwidth_t memWidth

Memory width.

uint32_t specailConfig

Static configuration, a logical OR of “emc_static_special_config_t”.

uint32_t tWaitWriteEn_Ns

The delay from chip select to write enable in unit of nanosecond.

uint32_t tWaitOutEn_Ns

The delay from chip select to output enable in unit of nanosecond.

uint32_t tWaitReadNoPage_Ns

In No-page mode, the delay from chip select to read access in unit of nanosecond.

uint32_t tWaitReadPage_Ns

In page mode, the read after the first read wait states in unit of nanosecond.

uint32_t tWaitWrite_Ns

The delay from chip select to write access in unit of nanosecond.

uint32_t tWaitTurn_Ns

The Bus turn-around time in unit of nanosecond.

struct __emc_basic_config

#include <fsl_emc.h> EMC module basic configuration structure.

Defines the static memory controller configure structure and uses the EMC_Init() function to make necessary initializations.

Public Members

emc_endian_mode_t endian

Endian mode .

emc_fbclk_src_t fbClkSrc

The feedback clock source.

uint8_t emcClkDiv

$EMC\_CLK = AHB\_CLK / (emc\_clkDiv + 1)$.

2.10 FLEXCOMM: FLEXCOMM Driver

2.11 FLEXCOMM Driver

FSL_FLEXCOMM_DRIVER_VERSION

FlexCOMM driver version 2.0.2.

enum FLEXCOMM_PERIPH_T

FLEXCOMM peripheral modes.

Values:

enumerator FLEXCOMM_PERIPH_NONE

No peripheral

enumerator FLEXCOMM_PERIPH_USART

USART peripheral

enumerator FLEXCOMM_PERIPH_SPI

SPI Peripheral

enumerator FLEXCOMM_PERIPH_I2C

I2C Peripheral

enumerator FLEXCOMM_PERIPH_I2S_TX

I2S TX Peripheral

enumerator FLEXCOMM_PERIPH_I2S_RX

I2S RX Peripheral

typedef void (*flexcomm_irq_handler_t)(void *base, void *handle)

Typedef for interrupt handler.

IRQn_Type const kFlexcommIrqs[]

Array with IRQ number for each FLEXCOMM module.

uint32_t FLEXCOMM_GetInstance(void *base)

Returns instance number for FLEXCOMM module with given base address.

status_t FLEXCOMM_Init(void *base, FLEXCOMM_PERIPH_T periph)

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

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

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

2.12 FMEAS: Frequency Measure Driver

static inline void FMEAS_StartMeasure(FMEAS_SYSCON_Type *base)

Starts a frequency measurement cycle.

Parameters

- base – : SYSCON peripheral base address.

static inline bool FMEAS_IsMeasureComplete(FMEAS_SYSCON_Type *base)

Indicates when a frequency measurement cycle is complete.

Parameters

- base – : SYSCON peripheral base address.

Returns

true if a measurement cycle is active, otherwise false.

uint32_t FMEAS_GetFrequency(*FMEAS_SYSCON_Type* *base, uint32_t refClockRate)

Returns the computed value for a frequency measurement cycle.

Parameters

- base – : SYSCON peripheral base address.
- refClockRate – : Reference clock rate used during the frequency measurement cycle.

Returns

Frequency in Hz.

FSL_FMEAS_DRIVER_VERSION

Defines LPC Frequency Measure driver version 2.1.1.

typedef SYSCON_Type FMEAS_SYSCON_Type

FMEAS_SYSCON_FREQMECTRL_CAPVAL_MASK

FMEAS_SYSCON_FREQMECTRL_CAPVAL_SHIFT

FMEAS_SYSCON_FREQMECTRL_CAPVAL

FMEAS_SYSCON_FREQMECTRL_PROG_MASK

FMEAS_SYSCON_FREQMECTRL_PROG_SHIFT

FMEAS_SYSCON_FREQMECTRL_PROG

2.13 GINT: Group GPIO Input Interrupt Driver

FSL_GINT_DRIVER_VERSION

Driver version.

enum __gint_comb

GINT combine inputs type.

Values:

enumerator kGINT_CombineOr

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

enumerator kGINT_CombineAnd

A grouped interrupt is generated when all enabled inputs are active

enum __gint_trig

GINT trigger type.

Values:

enumerator kGINT_TrigEdge

Edge triggered based on polarity

enumerator kGINT_TrigLevel

Level triggered based on polarity

enum __gint_port

Values:

enumerator kGINT_Port0

enumerator kGINT_Port1

typedef enum *_gint_comb* gint_comb_t

GINT combine inputs type.

typedef enum *_gint_trig* gint_trig_t

GINT trigger type.

typedef enum *_gint_port* gint_port_t

typedef void (*gint_cb_t)(void)

GINT Callback function.

void GINT_Init(GINT_Type *base)

Initialize GINT peripheral.

This function initializes the GINT peripheral and enables the clock.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

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

Setup GINT peripheral control parameters.

This function sets the control parameters of GINT peripheral.

Parameters

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

Return values

None. –

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

Get GINT peripheral control parameters.

This function returns the control parameters of GINT peripheral.

Parameters

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

Return values

None. –

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

Configure GINT peripheral pins.

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

Parameters

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

Return values

None. –

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

Get GINT peripheral pin configuration.

This function returns the pin configuration of a given port.

Parameters

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

Return values

None. –

```
void GINT__EnableCallback(GINT_Type *base)
```

Enable callback.

This function enables the interrupt for the selected GINT peripheral. Although the pin(s) are monitored as soon as they are enabled, the callback function is not enabled until this function is called.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

```
void GINT__DisableCallback(GINT_Type *base)
```

Disable callback.

This function disables the interrupt for the selected GINT peripheral. Although the pins are still being monitored but the callback function is not called.

Parameters

- base – Base address of the peripheral.

Return values

None. –

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

Clear GINT status.

This function clears the GINT status bit.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

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

Get GINT status.

This function returns the GINT status.

Parameters

- base – Base address of the GINT peripheral.

Return values

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

```
void GINT__Deinit(GINT_Type *base)
```

Deinitialize GINT peripheral.

This function disables the GINT clock.

Parameters

- base – Base address of the GINT peripheral.

Return values

None. –

2.14 I2C: Inter-Integrated Circuit Driver

2.15 I2C DMA Driver

```
void I2C__MasterTransferCreateHandleDMA(I2C_Type *base, i2c_master_dma_handle_t *handle,  
                                         i2c_master_dma_transfer_callback_t callback, void  
                                         *userData, dma_handle_t *dmaHandle)
```

Init the I2C handle which is used in transactional functions.

Parameters

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

```
status_t I2C__MasterTransferDMA(I2C_Type *base, i2c_master_dma_handle_t *handle,  
                                i2c_master_transfer_t *xfer)
```

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

Parameters

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

Return values

- `kStatus_Success` – Successfully complete the data transmission.
- `kStatus_I2C_Busy` – Previous transmission still not finished.
- `kStatus_I2C_Timeout` – Transfer error, wait signal timeout.
- `kStatus_I2C_ArbitrationLost` – Transfer error, arbitration lost.
- `kStatus_I2C_Nak` – Transfer error, receive Nak during transfer.

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

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

Parameters

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

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

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

Parameters

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

`FSL_I2C_DMA_DRIVER_VERSION`

I2C DMA driver version.

`typedef struct i2c_master_dma_handle i2c_master_dma_handle_t`

I2C master dma handle typedef.

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

I2C master dma transfer callback typedef.

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

Typedef for master dma handler.

`I2C_MAX_DMA_TRANSFER_COUNT`

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

`struct i2c_master_dma_handle`

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

Public Members

`uint8_t state`

Transfer state machine current state.

`uint32_t transferCount`

Indicates progress of the transfer

`uint32_t remainingBytesDMA`

Remaining byte count to be transferred using DMA.

`uint8_t *buf`

Buffer pointer for current state.

`bool checkAddrNack`

Whether to check the nack signal is detected during addressing.

`dma_handle_t *dmaHandle`

The DMA handler used.

`i2c_master_transfer_t transfer`

Copy of the current transfer info.

`i2c_master_dma_transfer_callback_t completionCallback`

Callback function called after dma transfer finished.

`void *userData`

Callback parameter passed to callback function.

2.16 I2C Driver

`FSL_I2C_DRIVER_VERSION`

I2C driver version.

I2C status return codes.

Values:

`enumerator kStatus_I2C_Busy`

The master is already performing a transfer.

`enumerator kStatus_I2C_Idle`

The slave driver is idle.

`enumerator kStatus_I2C_Nak`

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

`enumerator kStatus_I2C_InvalidParameter`

Unable to proceed due to invalid parameter.

`enumerator kStatus_I2C_BitError`

Transferred bit was not seen on the bus.

`enumerator kStatus_I2C_ArbitrationLost`

Arbitration lost error.

`enumerator kStatus_I2C_NoTransferInProgress`

Attempt to abort a transfer when one is not in progress.

`enumerator kStatus_I2C_DmaRequestFail`

DMA request failed.

`enumerator kStatus_I2C_StartStopError`

Start and stop error.

`enumerator kStatus_I2C_UnexpectedState`

Unexpected state.

`enumerator kStatus_I2C_Timeout`

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

`enumerator kStatus_I2C_Addr_Nak`

NAK received for Address

enumerator kStatus_I2C_EventTimeout

Timeout waiting for bus event.

enumerator kStatus_I2C_SclLowTimeout

Timeout SCL signal remains low.

enum _i2c_status_flags

I2C status flags.

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

Values:

enumerator kI2C_MasterPendingFlag

The I2C module is waiting for software interaction. bit 0

enumerator kI2C_MasterArbitrationLostFlag

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

enumerator kI2C_MasterStartStopErrorFlag

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

enumerator kI2C_MasterIdleFlag

The I2C master idle status. bit 5

enumerator kI2C_MasterRxReadyFlag

The I2C master rx ready status. bit 1

enumerator kI2C_MasterTxReadyFlag

The I2C master tx ready status. bit 2

enumerator kI2C_MasterAddrNackFlag

The I2C master address nack status. bit 7

enumerator kI2C_MasterDataNackFlag

The I2C master data nack status. bit 3

enumerator kI2C_SlavePendingFlag

The I2C module is waiting for software interaction. bit 8

enumerator kI2C_SlaveNotStretching

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

enumerator kI2C_SlaveSelected

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

enumerator kI2C_SlaveDeselected

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

enumerator kI2C_SlaveAddressedFlag

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

enumerator kI2C_SlaveReceiveFlag

Slave receive data available. bit 9

enumerator kI2C_SlaveTransmitFlag

Slave data can be transmitted. bit 10

enumerator kI2C_SlaveAddress0MatchFlag

Slave address0 match. bit 20

enumerator kI2C_SlaveAddress1MatchFlag
Slave address1 match. bit 12

enumerator kI2C_SlaveAddress2MatchFlag
Slave address2 match. bit 13

enumerator kI2C_SlaveAddress3MatchFlag
Slave address3 match. bit 21

enumerator kI2C_MonitorReadyFlag
The I2C monitor ready interrupt. bit 16

enumerator kI2C_MonitorOverflowFlag
The monitor data overrun interrupt. bit 17

enumerator kI2C_MonitorActiveFlag
The monitor is active. bit 18

enumerator kI2C_MonitorIdleFlag
The monitor idle interrupt. bit 19

enumerator kI2C_EventTimeoutFlag
The bus event timeout interrupt. bit 24

enumerator kI2C_SclTimeoutFlag
The SCL timeout interrupt. bit 25

enumerator kI2C_MasterAllClearFlags

enumerator kI2C_SlaveAllClearFlags

enumerator kI2C_CommonAllClearFlags

enum _i2c_interrupt_enable
I2C interrupt enable.

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

Values:

enumerator kI2C_MasterPendingInterruptEnable
The I2C master communication pending interrupt.

enumerator kI2C_MasterArbitrationLostInterruptEnable
The I2C master arbitration lost interrupt.

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

enumerator kI2C_SlavePendingInterruptEnable
The I2C slave communication pending interrupt.

enumerator kI2C_SlaveNotStretchingInterruptEnable
The I2C slave not stretching interrupt, deep-sleep mode can be entered only when this interrupt occurs.

enumerator kI2C_SlaveDeselectedInterruptEnable
The I2C slave deselection interrupt.

enumerator kI2C_MonitorReadyInterruptEnable
The I2C monitor ready interrupt.

enumerator `kI2C_MonitorOverflowInterruptEnable`

The monitor data overrun interrupt.

enumerator `kI2C_MonitorIdleInterruptEnable`

The monitor idle interrupt.

enumerator `kI2C_EventTimeoutInterruptEnable`

The bus event timeout interrupt.

enumerator `kI2C_SclTimeoutInterruptEnable`

The SCL timeout interrupt.

enumerator `kI2C_MasterAllInterruptEnable`

enumerator `kI2C_SlaveAllInterruptEnable`

enumerator `kI2C_CommonAllInterruptEnable`

`I2C_RETRY_TIMES`

Retry times for waiting flag.

`I2C_MASTER_TRANSMIT_IGNORE_LAST_NACK`

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

`I2C_STAT_MSTCODE_IDLE`

Master Idle State Code

`I2C_STAT_MSTCODE_RXREADY`

Master Receive Ready State Code

`I2C_STAT_MSTCODE_TXREADY`

Master Transmit Ready State Code

`I2C_STAT_MSTCODE_NACKADR`

Master NACK by slave on address State Code

`I2C_STAT_MSTCODE_NACKDAT`

Master NACK by slave on data State Code

`I2C_STAT_SLVST_ADDR`

`I2C_STAT_SLVST_RX`

`I2C_STAT_SLVST_TX`

2.17 I2C Master Driver

`void I2C_MasterGetDefaultConfig(i2c_master_config_t *masterConfig)`

Provides a default configuration for the I2C master peripheral.

This function provides the following default configuration for the I2C master peripheral:

```
masterConfig->enableMaster      = true;
masterConfig->baudRate_Bps      = 100000U;
masterConfig->enableTimeout     = false;
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with `I2C_MasterInit()`.

Parameters

- masterConfig – **[out]** User provided configuration structure for default values. Refer to i2c_master_config_t.

```
void I2C_MasterInit(I2C_Type *base, const i2c_master_config_t *masterConfig, uint32_t srcClock_Hz)
```

Initializes the I2C master peripheral.

This function enables the peripheral clock and initializes the I2C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

Parameters

- base – The I2C peripheral base address.
- masterConfig – User provided peripheral configuration. Use I2C_MasterGetDefaultConfig() to get a set of defaults that you can override.
- srcClock_Hz – Frequency in Hertz of the I2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

```
void I2C_MasterDeinit(I2C_Type *base)
```

Deinitializes the I2C master peripheral.

This function disables the I2C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- base – The I2C peripheral base address.

```
uint32_t I2C_GetInstance(I2C_Type *base)
```

Returns an instance number given a base address.

If an invalid base address is passed, debug builds will assert. Release builds will just return instance number 0.

Parameters

- base – The I2C peripheral base address.

Returns

I2C instance number starting from 0.

```
static inline void I2C_MasterReset(I2C_Type *base)
```

Performs a software reset.

Restores the I2C master peripheral to reset conditions.

Parameters

- base – The I2C peripheral base address.

```
static inline void I2C_MasterEnable(I2C_Type *base, bool enable)
```

Enables or disables the I2C module as master.

Parameters

- base – The I2C peripheral base address.
- enable – Pass true to enable or false to disable the specified I2C as master.

```
uint32_t I2C_GetStatusFlags(I2C_Type *base)
```

Gets the I2C status flags.

A bit mask with the state of all I2C status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

See also:

`_i2c_status_flags`.

Parameters

- `base` – The I2C peripheral base address.

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

```
static inline void I2C_ClearStatusFlags(I2C_Type *base, uint32_t statusMask)
```

Clears the I2C status flag state.

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

See also:

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

Parameters

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

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

Clears the I2C master status flag state.

Deprecated:

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

- `kI2C_MasterArbitrationLostFlag`
- `kI2C_MasterStartStopErrorFlag`

Attempts to clear other flags has no effect.

See also:

`_i2c_status_flags`.

Parameters

- `base` – The I2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i2c_status_flags` enumerators OR'd together. You may pass the result of a previous call to `I2C_GetStatusFlags()`.

```
static inline void I2C__EnableInterrupts(I2C_Type *base, uint32_t interruptMask)
```

Enables the I2C interrupt requests.

Parameters

- base – The I2C peripheral base address.
- interruptMask – Bit mask of interrupts to enable. See `_i2c_interrupt_enable` for the set of constants that should be OR'd together to form the bit mask.

```
static inline void I2C__DisableInterrupts(I2C_Type *base, uint32_t interruptMask)
```

Disables the I2C interrupt requests.

Parameters

- base – The I2C peripheral base address.
- interruptMask – Bit mask of interrupts to disable. See `_i2c_interrupt_enable` for the set of constants that should be OR'd together to form the bit mask.

```
static inline uint32_t I2C__GetEnabledInterrupts(I2C_Type *base)
```

Returns the set of currently enabled I2C interrupt requests.

Parameters

- base – The I2C peripheral base address.

Returns

A bitmask composed of `_i2c_interrupt_enable` enumerators OR'd together to indicate the set of enabled interrupts.

```
void I2C__MasterSetBaudRate(I2C_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)
```

Sets the I2C bus frequency for master transactions.

The I2C master is automatically disabled and re-enabled as necessary to configure the baud rate. Do not call this function during a transfer, or the transfer is aborted.

Parameters

- base – The I2C peripheral base address.
- srcClock_Hz – I2C functional clock frequency in Hertz.
- baudRate_Bps – Requested bus frequency in bits per second.

```
void I2C__MasterSetTimeoutValue(I2C_Type *base, uint8_t timeout_Ms, uint32_t srcClock_Hz)
```

Sets the I2C bus timeout value.

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

Parameters

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

```
static inline bool I2C__MasterGetBusIdleState(I2C_Type *base)
```

Returns whether the bus is idle.

Requires the master mode to be enabled.

Parameters

- base – The I2C peripheral base address.

Return values

- true – Bus is busy.
- false – Bus is idle.

status_t I2C_MasterStart(I2C_Type *base, uint8_t address, *i2c_direction_t* direction)

Sends a START on the I2C bus.

This function is used to initiate a new master mode transfer by sending the START signal. The slave address is sent following the I2C START signal.

Parameters

- base – I2C peripheral base pointer
- address – 7-bit slave device address.
- direction – Master transfer directions(transmit/receive).

Return values

- kStatus_Success – Successfully send the start signal.
- kStatus_I2C_Busy – Current bus is busy.

status_t I2C_MasterStop(I2C_Type *base)

Sends a STOP signal on the I2C bus.

Return values

- kStatus_Success – Successfully send the stop signal.
- kStatus_I2C_Timeout – Send stop signal failed, timeout.

static inline *status_t* I2C_MasterRepeatedStart(I2C_Type *base, uint8_t address, *i2c_direction_t* direction)

Sends a REPEATED START on the I2C bus.

Parameters

- base – I2C peripheral base pointer
- address – 7-bit slave device address.
- direction – Master transfer directions(transmit/receive).

Return values

- kStatus_Success – Successfully send the start signal.
- kStatus_I2C_Busy – Current bus is busy but not occupied by current I2C master.

status_t I2C_MasterWriteBlocking(I2C_Type *base, const void *txBuff, size_t txSize, uint32_t flags)

Performs a polling send transfer on the I2C bus.

Sends up to *txSize* number of bytes to the previously addressed slave device. The slave may reply with a NAK to any byte in order to terminate the transfer early. If this happens, this function returns kStatus_I2C_Nak.

Parameters

- base – The I2C peripheral base address.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.
- flags – Transfer control flag to control special behavior like suppressing start or stop, for normal transfers use kI2C_TransferDefaultFlag

Return values

- `kStatus_Success` – Data was sent successfully.
- `kStatus_I2C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I2C_Nak` – The slave device sent a NAK in response to a byte.
- `kStatus_I2C_ArbitrationLost` – Arbitration lost error.

`status_t I2C_MasterReadBlocking(I2C_Type *base, void *rxBuff, size_t rxSize, uint32_t flags)`

Performs a polling receive transfer on the I2C bus.

Parameters

- `base` – The I2C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.
- `flags` – Transfer control flag to control special behavior like suppressing start or stop, for normal transfers use `kI2C_TransferDefaultFlag`

Return values

- `kStatus_Success` – Data was received successfully.
- `kStatus_I2C_Busy` – Another master is currently utilizing the bus.
- `kStatus_I2C_Nak` – The slave device sent a NAK in response to a byte.
- `kStatus_I2C_ArbitrationLost` – Arbitration lost error.

`status_t I2C_MasterTransferBlocking(I2C_Type *base, i2c_master_transfer_t *xfer)`

Performs a master polling transfer on the I2C bus.

Note: The API does not return until the transfer succeeds or fails due to arbitration lost or receiving a NAK.

Parameters

- `base` – I2C peripheral base address.
- `xfer` – Pointer to the transfer structure.

Return values

- `kStatus_Success` – Successfully complete the data transmission.
- `kStatus_I2C_Busy` – Previous transmission still not finished.
- `kStatus_I2C_Timeout` – Transfer error, wait signal timeout.
- `kStatus_I2C_ArbitrationLost` – Transfer error, arbitration lost.
- `kStatus_I2C_Nak` – Transfer error, receive NAK during transfer.
- `kStatus_I2C_Addr_Nak` – Transfer error, receive NAK during addressing.

`void I2C_MasterTransferCreateHandle(I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_callback_t callback, void *userData)`

Creates a new handle for the I2C master non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the `I2C_MasterTransferAbort()` API shall be called.

Parameters

- `base` – The I2C peripheral base address.

- `handle` – **[out]** Pointer to the I2C master driver handle.
- `callback` – User provided pointer to the asynchronous callback function.
- `userData` – User provided pointer to the application callback data.

`status_t I2C_MasterTransferNonBlocking(I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_t *xfer)`

Performs a non-blocking transaction on the I2C bus.

Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.
- `xfer` – The pointer to the transfer descriptor.

Return values

- `kStatus_Success` – The transaction was started successfully.
- `kStatus_I2C_Busy` – Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

`status_t I2C_MasterTransferGetCount(I2C_Type *base, i2c_master_handle_t *handle, size_t *count)`

Returns number of bytes transferred so far.

Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.
- `count` – **[out]** Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus_Success` –
- `kStatus_I2C_Busy` –

`status_t I2C_MasterTransferAbort(I2C_Type *base, i2c_master_handle_t *handle)`

Terminates a non-blocking I2C master transmission early.

Note: It is not safe to call this function from an IRQ handler that has a higher priority than the I2C peripheral's IRQ priority.

Parameters

- `base` – The I2C peripheral base address.
- `handle` – Pointer to the I2C master driver handle.

Return values

- `kStatus_Success` – A transaction was successfully aborted.
- `kStatus_I2C_Timeout` – Timeout during polling for flags.

`void I2C_MasterTransferHandleIRQ(I2C_Type *base, i2c_master_handle_t *handle)`

Reusable routine to handle master interrupts.

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

Parameters

- base – The I2C peripheral base address.
- handle – Pointer to the I2C master driver handle.

enum `_i2c_direction`

Direction of master and slave transfers.

Values:

enumerator `kI2C_Write`

Master transmit.

enumerator `kI2C_Read`

Master receive.

enum `_i2c_master_transfer_flags`

Transfer option flags.

Note: These enumerations are intended to be OR'd together to form a bit mask of options for the `_i2c_master_transfer::flags` field.

Values:

enumerator `kI2C_TransferDefaultFlag`

Transfer starts with a start signal, stops with a stop signal.

enumerator `kI2C_TransferNoStartFlag`

Don't send a start condition, address, and sub address

enumerator `kI2C_TransferRepeatedStartFlag`

Send a repeated start condition

enumerator `kI2C_TransferNoStopFlag`

Don't send a stop condition.

enum `_i2c_transfer_states`

States for the state machine used by transactional APIs.

Values:

enumerator `kIdleState`

enumerator `kTransmitSubaddrState`

enumerator `kTransmitDataState`

enumerator `kReceiveDataBeginState`

enumerator `kReceiveDataState`

enumerator `kReceiveLastDataState`

enumerator `kStartState`

enumerator `kStopState`

enumerator `kWaitForCompletionState`

typedef enum `_i2c_direction` `i2c_direction_t`

Direction of master and slave transfers.

```
typedef struct _i2c_master_config i2c_master_config_t
```

Structure with settings to initialize the I2C master module.

This structure holds configuration settings for the I2C peripheral. To initialize this structure to reasonable defaults, call the I2C_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

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

```
typedef struct _i2c_master_transfer i2c_master_transfer_t
```

I2C master transfer typedef.

```
typedef struct _i2c_master_handle i2c_master_handle_t
```

I2C master handle typedef.

```
typedef void (*i2c_master_transfer_callback_t)(I2C_Type *base, i2c_master_handle_t *handle,  
status_t completionStatus, void *userData)
```

Master completion callback function pointer type.

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to I2C_MasterTransferCreateHandle().

Param base

The I2C peripheral base address.

Param completionStatus

Either kStatus_Success or an error code describing how the transfer completed.

Param userData

Arbitrary pointer-sized value passed from the application.

```
struct _i2c_master_config
```

#include <fsl_i2c.h> Structure with settings to initialize the I2C master module.

This structure holds configuration settings for the I2C peripheral. To initialize this structure to reasonable defaults, call the I2C_MasterGetDefaultConfig() function and pass a pointer to your configuration structure instance.

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

Public Members

```
bool enableMaster
```

Whether to enable master mode.

```
uint32_t baudRate_Bps
```

Desired baud rate in bits per second.

```
bool enableTimeout
```

Enable internal timeout function.

```
uint8_t timeout_Ms
```

Event timeout and SCL low timeout value.

```
struct _i2c_master_transfer
```

#include <fsl_i2c.h> Non-blocking transfer descriptor structure.

This structure is used to pass transaction parameters to the I2C_MasterTransferNonBlocking() API.

Public Members

uint32_t flags

Bit mask of options for the transfer. See enumeration `_i2c_master_transfer_flags` for available options. Set to 0 or `ki2C_TransferDefaultFlag` for normal transfers.

uint8_t slaveAddress

The 7-bit slave address.

i2c_direction_t direction

Either `ki2C_Read` or `ki2C_Write`.

uint32_t subaddress

Sub address. Transferred MSB first.

size_t subaddressSize

Length of sub address to send in bytes. Maximum size is 4 bytes.

void *data

Pointer to data to transfer.

size_t dataSize

Number of bytes to transfer.

struct `_i2c_master_handle`

#include <fsl_i2c.h> Driver handle for master non-blocking APIs.

Note: The contents of this structure are private and subject to change.

Public Members

uint8_t state

Transfer state machine current state.

uint32_t transferCount

Indicates progress of the transfer

uint32_t remainingBytes

Remaining byte count in current state.

uint8_t *buf

Buffer pointer for current state.

bool checkAddrNack

Whether to check the nack signal is detected during addressing.

i2c_master_transfer_t transfer

Copy of the current transfer info.

i2c_master_transfer_callback_t completionCallback

Callback function pointer.

void *userData

Application data passed to callback.

2.18 I2C Slave Driver

`void I2C_SlaveGetDefaultConfig(i2c_slave_config_t *slaveConfig)`

Provides a default configuration for the I2C slave peripheral.

This function provides the following default configuration for the I2C slave peripheral:

```
slaveConfig->enableSlave = true;
slaveConfig->address0.disable = false;
slaveConfig->address0.address = 0u;
slaveConfig->address1.disable = true;
slaveConfig->address2.disable = true;
slaveConfig->address3.disable = true;
slaveConfig->busSpeed = kI2C_SlaveStandardMode;
```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with `I2C_SlaveInit()`. Be sure to override at least the *address0.address* member of the configuration structure with the desired slave address.

Parameters

- *slaveConfig* – **[out]** User provided configuration structure that is set to default values. Refer to *i2c_slave_config_t*.

`status_t I2C_SlaveInit(I2C_Type *base, const i2c_slave_config_t *slaveConfig, uint32_t srcClock_Hz)`

Initializes the I2C slave peripheral.

This function enables the peripheral clock and initializes the I2C slave peripheral as described by the user provided configuration.

Parameters

- *base* – The I2C peripheral base address.
- *slaveConfig* – User provided peripheral configuration. Use `I2C_SlaveGetDefaultConfig()` to get a set of defaults that you can override.
- *srcClock_Hz* – Frequency in Hertz of the I2C functional clock. Used to calculate CLKDIV value to provide enough data setup time for master when slave stretches the clock.

`void I2C_SlaveSetAddress(I2C_Type *base, i2c_slave_address_register_t addressRegister, uint8_t address, bool addressDisable)`

Configures Slave Address n register.

This function writes new value to Slave Address register.

Parameters

- *base* – The I2C peripheral base address.
- *addressRegister* – The module supports multiple address registers. The parameter determines which one shall be changed.
- *address* – The slave address to be stored to the address register for matching.
- *addressDisable* – Disable matching of the specified address register.

`void I2C_SlaveDeinit(I2C_Type *base)`

Deinitializes the I2C slave peripheral.

This function disables the I2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

- `base` – The I2C peripheral base address.

`static inline void I2C_SlaveEnable(I2C_Type *base, bool enable)`

Enables or disables the I2C module as slave.

Parameters

- `base` – The I2C peripheral base address.
- `enable` – True to enable or false to disable.

`static inline void I2C_SlaveClearStatusFlags(I2C_Type *base, uint32_t statusMask)`

Clears the I2C status flag state.

The following status register flags can be cleared:

- `slave deselected flag`

Attempts to clear other flags has no effect.

See also:

`_i2c_slave_flags`.

Parameters

- `base` – The I2C peripheral base address.
- `statusMask` – A bitmask of status flags that are to be cleared. The mask is composed of `_i2c_slave_flags` enumerators OR'd together. You may pass the result of a previous call to `I2C_SlaveGetStatusFlags()`.

`status_t I2C_SlaveWriteBlocking(I2C_Type *base, const uint8_t *txBuff, size_t txSize)`

Performs a polling send transfer on the I2C bus.

The function executes blocking address phase and blocking data phase.

Parameters

- `base` – The I2C peripheral base address.
- `txBuff` – The pointer to the data to be transferred.
- `txSize` – The length in bytes of the data to be transferred.

Returns

`kStatus_Success` Data has been sent.

Returns

`kStatus_Fail` Unexpected slave state (master data write while master read from slave is expected).

`status_t I2C_SlaveReadBlocking(I2C_Type *base, uint8_t *rxBuff, size_t rxSize)`

Performs a polling receive transfer on the I2C bus.

The function executes blocking address phase and blocking data phase.

Parameters

- `base` – The I2C peripheral base address.
- `rxBuff` – The pointer to the data to be transferred.
- `rxSize` – The length in bytes of the data to be transferred.

Returns

`kStatus_Success` Data has been received.

Returns

kStatus_Fail Unexpected slave state (master data read while master write to slave is expected).

```
void I2C_SlaveTransferCreateHandle(I2C_Type *base, i2c_slave_handle_t *handle,  
                                i2c_slave_transfer_callback_t callback, void *userData)
```

Creates a new handle for the I2C slave non-blocking APIs.

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the I2C_SlaveTransferAbort() API shall be called.

Parameters

- base – The I2C peripheral base address.
- handle – **[out]** Pointer to the I2C slave driver handle.
- callback – User provided pointer to the asynchronous callback function.
- userData – User provided pointer to the application callback data.

```
status_t I2C_SlaveTransferNonBlocking(I2C_Type *base, i2c_slave_handle_t *handle, uint32_t  
                                     eventMask)
```

Starts accepting slave transfers.

Call this API after calling I2C_SlaveInit() and I2C_SlaveTransferCreateHandle() to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to I2C_SlaveTransferCreateHandle(). The callback is always invoked from the interrupt context.

If no slave Tx transfer is busy, a master read from slave request invokes kI2C_SlaveTransmitEvent callback. If no slave Rx transfer is busy, a master write to slave request invokes kI2C_SlaveReceiveEvent callback.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of *i2c_slave_transfer_event_t* enumerators for the events you wish to receive. The *kI2C_SlaveTransmitEvent* and *kI2C_SlaveReceiveEvent* events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the *kI2C_SlaveAllEvents* constant is provided as a convenient way to enable all events.

Parameters

- base – The I2C peripheral base address.
- handle – Pointer to *i2c_slave_handle_t* structure which stores the transfer state.
- eventMask – Bit mask formed by OR'ing together *i2c_slave_transfer_event_t* enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and *kI2C_SlaveAllEvents* to enable all events.

Return values

- kStatus_Success – Slave transfers were successfully started.
- kStatus_I2C_Busy – Slave transfers have already been started on this handle.

```
status_t I2C_SlaveSetSendBuffer(I2C_Type *base, volatile i2c_slave_transfer_t *transfer, const  
                               void *txData, size_t txSize, uint32_t eventMask)
```

Starts accepting master read from slave requests.

The function can be called in response to `ki2C_SlaveTransmitEvent` callback to start a new slave Tx transfer from within the transfer callback.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of `i2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `ki2C_SlaveTransmitEvent` and `ki2C_SlaveReceiveEvent` events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the `ki2C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

Parameters

- `base` – The I2C peripheral base address.
- `transfer` – Pointer to `i2c_slave_transfer_t` structure.
- `txData` – Pointer to data to send to master.
- `txSize` – Size of `txData` in bytes.
- `eventMask` – Bit mask formed by OR'ing together `i2c_slave_transfer_event_t` enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and `ki2C_SlaveAllEvents` to enable all events.

Return values

- `kStatus_Success` – Slave transfers were successfully started.
- `kStatus_I2C_Busy` – Slave transfers have already been started on this handle.

`status_t I2C_SlaveSetReceiveBuffer(I2C_Type *base, volatile i2c_slave_transfer_t *transfer, void *rxData, size_t rxSize, uint32_t eventMask)`

Starts accepting master write to slave requests.

The function can be called in response to `ki2C_SlaveReceiveEvent` callback to start a new slave Rx transfer from within the transfer callback.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of `i2c_slave_transfer_event_t` enumerators for the events you wish to receive. The `ki2C_SlaveTransmitEvent` and `ki2C_SlaveReceiveEvent` events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the `ki2C_SlaveAllEvents` constant is provided as a convenient way to enable all events.

Parameters

- `base` – The I2C peripheral base address.
- `transfer` – Pointer to `i2c_slave_transfer_t` structure.
- `rxData` – Pointer to data to store data from master.
- `rxSize` – Size of `rxData` in bytes.
- `eventMask` – Bit mask formed by OR'ing together `i2c_slave_transfer_event_t` enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and `ki2C_SlaveAllEvents` to enable all events.

Return values

- `kStatus_Success` – Slave transfers were successfully started.
- `kStatus_I2C_Busy` – Slave transfers have already been started on this handle.

```
static inline uint32_t I2C_SlaveGetReceivedAddress(I2C_Type *base, volatile i2c_slave_transfer_t *transfer)
```

Returns the slave address sent by the I2C master.

This function should only be called from the address match event callback `kI2C_SlaveAddressMatchEvent`.

Parameters

- `base` – The I2C peripheral base address.
- `transfer` – The I2C slave transfer.

Returns

The 8-bit address matched by the I2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

```
void I2C_SlaveTransferAbort(I2C_Type *base, i2c_slave_handle_t *handle)
```

Aborts the slave non-blocking transfers.

Note: This API could be called at any time to stop slave for handling the bus events.

Parameters

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

Return values

- `kStatus_Success` –
- `kStatus_I2C_Idle` –

```
status_t I2C_SlaveTransferGetCount(I2C_Type *base, i2c_slave_handle_t *handle, size_t *count)
```

Gets the slave transfer remaining bytes during a interrupt non-blocking transfer.

Parameters

- `base` – I2C base pointer.
- `handle` – pointer to `i2c_slave_handle_t` structure.
- `count` – Number of bytes transferred so far by the non-blocking transaction.

Return values

- `kStatus_InvalidArgument` – `count` is Invalid.
- `kStatus_Success` – Successfully return the count.

```
void I2C_SlaveTransferHandleIRQ(I2C_Type *base, i2c_slave_handle_t *handle)
```

Reusable routine to handle slave interrupts.

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

Parameters

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

enum `_i2c_slave_address_register`

I2C slave address register.

Values:

enumerator `kI2C_SlaveAddressRegister0`

Slave Address 0 register.

enumerator `kI2C_SlaveAddressRegister1`

Slave Address 1 register.

enumerator `kI2C_SlaveAddressRegister2`

Slave Address 2 register.

enumerator `kI2C_SlaveAddressRegister3`

Slave Address 3 register.

enum `_i2c_slave_address_qual_mode`

I2C slave address match options.

Values:

enumerator `kI2C_QualModeMask`

The SLVQUAL0 field (`qualAddress`) is used as a logical mask for matching address0.

enumerator `kI2C_QualModeExtend`

The SLVQUAL0 (`qualAddress`) field is used to extend address 0 matching in a range of addresses.

enum `_i2c_slave_bus_speed`

I2C slave bus speed options.

Values:

enumerator `kI2C_SlaveStandardMode`

enumerator `kI2C_SlaveFastMode`

enumerator `kI2C_SlaveFastModePlus`

enumerator `kI2C_SlaveHsMode`

enum `_i2c_slave_transfer_event`

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

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to `I2C_SlaveTransferNonBlocking()` in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

Values:

enumerator `kI2C_SlaveAddressMatchEvent`

Received the slave address after a start or repeated start.

enumerator `kI2C_SlaveTransmitEvent`

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

enumerator `kI2C_SlaveReceiveEvent`

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

enumerator `kI2C_SlaveCompletionEvent`

All data in the active transfer have been consumed.

enumerator `kI2C_SlaveDeselectedEvent`

The slave function has become deselected (SLVSEL flag changing from 1 to 0).

enumerator `kI2C_SlaveAllEvents`

Bit mask of all available events.

enum `_i2c_slave_fsm`

I2C slave software finite state machine states.

Values:

enumerator `kI2C_SlaveFsmAddressMatch`

enumerator `kI2C_SlaveFsmReceive`

enumerator `kI2C_SlaveFsmTransmit`

typedef enum `_i2c_slave_address_register` `i2c_slave_address_register_t`

I2C slave address register.

typedef struct `_i2c_slave_address` `i2c_slave_address_t`

Data structure with 7-bit Slave address and Slave address disable.

typedef enum `_i2c_slave_address_qual_mode` `i2c_slave_address_qual_mode_t`

I2C slave address match options.

typedef enum `_i2c_slave_bus_speed` `i2c_slave_bus_speed_t`

I2C slave bus speed options.

typedef struct `_i2c_slave_config` `i2c_slave_config_t`

Structure with settings to initialize the I2C slave module.

This structure holds configuration settings for the I2C slave peripheral. To initialize this structure to reasonable defaults, call the `I2C_SlaveGetDefaultConfig()` function and pass a pointer to your configuration structure instance.

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

typedef enum `_i2c_slave_transfer_event` `i2c_slave_transfer_event_t`

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

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to `I2C_SlaveTransferNonBlocking()` in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

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

typedef struct `_i2c_slave_handle` `i2c_slave_handle_t`

I2C slave handle typedef.

typedef struct `_i2c_slave_transfer` `i2c_slave_transfer_t`

I2C slave transfer structure.

typedef void (*`i2c_slave_transfer_callback_t`)(`I2C_Type` *base, volatile `i2c_slave_transfer_t` *transfer, void *userData)

Slave event callback function pointer type.

This callback is used only for the slave non-blocking transfer API. To install a callback, use the `I2C_SlaveSetCallback()` function after you have created a handle.

Param base

Base address for the I2C instance on which the event occurred.

Param transfer

Pointer to transfer descriptor containing values passed to and/or from the call-back.

Param userData

Arbitrary pointer-sized value passed from the application.

```
typedef enum _i2c_slave_fsm i2c_slave_fsm_t
```

I2C slave software finite state machine states.

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

Typedef for master interrupt handler.

```
typedef void (*flexcomm_i2c_slave_irq_handler_t)(I2C_Type *base, i2c_slave_handle_t *handle)
```

Typedef for slave interrupt handler.

```
struct _i2c_slave_address
```

#include <fsl_i2c.h> Data structure with 7-bit Slave address and Slave address disable.

Public Members

uint8_t address

7-bit Slave address SLVADR.

bool addressDisable

Slave address disable SADISABLE.

```
struct _i2c_slave_config
```

#include <fsl_i2c.h> Structure with settings to initialize the I2C slave module.

This structure holds configuration settings for the I2C slave peripheral. To initialize this structure to reasonable defaults, call the I2C_SlaveGetDefaultConfig() function and pass a pointer to your configuration structure instance.

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

Public Members

i2c_slave_address_t address0

Slave's 7-bit address and disable.

i2c_slave_address_t address1

Alternate slave 7-bit address and disable.

i2c_slave_address_t address2

Alternate slave 7-bit address and disable.

i2c_slave_address_t address3

Alternate slave 7-bit address and disable.

i2c_slave_address_qual_mode_t qualMode

Qualify mode for slave address 0.

uint8_t qualAddress

Slave address qualifier for address 0.

i2c_slave_bus_speed_t busSpeed

Slave bus speed mode. If the slave function stretches SCL to allow for software response, it must provide sufficient data setup time to the master before releasing the stretched clock. This is accomplished by inserting one clock time of CLKDIV at that point. The busSpeed value is used to configure CLKDIV such that one clock time is greater than the tSU;DAT value noted in the I2C bus specification for the I2C mode that is being used. If the busSpeed mode is unknown at compile time, use the longest data setup time kI2C_SlaveStandardMode (250 ns)

bool enableSlave

Enable slave mode.

struct *_i2c_slave_transfer*

#include <fsl_i2c.h> I2C slave transfer structure.

Public Members

i2c_slave_handle_t *handle

Pointer to handle that contains this transfer.

i2c_slave_transfer_event_t event

Reason the callback is being invoked.

uint8_t receivedAddress

Matching address send by master. 7-bits plus R/nW bit0

uint32_t eventMask

Mask of enabled events.

uint8_t *rxData

Transfer buffer for receive data

const uint8_t *txData

Transfer buffer for transmit data

size_t txSize

Transfer size

size_t rxSize

Transfer size

size_t transferredCount

Number of bytes transferred during this transfer.

status_t completionStatus

Success or error code describing how the transfer completed. Only applies for kI2C_SlaveCompletionEvent.

struct *_i2c_slave_handle*

#include <fsl_i2c.h> I2C slave handle structure.

Note: The contents of this structure are private and subject to change.

Public Members

volatile *i2c_slave_transfer_t* transfer

I2C slave transfer.

volatile bool isBusy

Whether transfer is busy.

volatile *i2c_slave_fsm_t* slaveFsm

slave transfer state machine.

i2c_slave_transfer_callback_t callback

Callback function called at transfer event.

void *userData

Callback parameter passed to callback.

2.19 I2S: I2S Driver

2.20 I2S DMA Driver

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

Initializes handle for transfer of audio data.

Parameters

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

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

Begins or queue sending of the given data.

Parameters

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

Return values

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

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

Aborts transfer of data.

Parameters

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

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

Initializes handle for reception of audio data.

Parameters

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

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

Begins or queue reception of data into given buffer.

Parameters

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

Return values

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

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

Invoked from DMA interrupt handler.

Parameters

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

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

Install DMA descriptor memory for loop transfer only.

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

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

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

Parameters

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

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

Send link transfer data using DMA.

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

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

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

Parameters

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

Return values

`kStatus_Success` –

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

Receive link transfer data using DMA.

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

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

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

Parameters

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

Return values

`kStatus_Success` –

`FSL_I2S_DMA_DRIVER_VERSION`

I2S DMA driver version 2.3.3.

`typedef struct i2s_dma_handle i2s_dma_handle_t`

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

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

Callback function invoked from DMA API on completion.

Param base

I2S base pointer.

Param handle

pointer to I2S transaction.

Param completionStatus
status of the transaction.

Param userData
optional pointer to user arguments data.

```
struct _i2s_dma_handle  
#include <fsl_i2s_dma.h> i2s dma handle
```

Public Members

```
uint32_t state  
    Internal state of I2S DMA transfer  
uint8_t bytesPerFrame  
    bytes per frame  
i2s_dma_transfer_callback_t completionCallback  
    Callback function pointer  
void *userData  
    Application data passed to callback  
dma_handle_t *dmaHandle  
    DMA handle  
volatile i2s_transfer_t i2sQueue[(4U)]  
    Transfer queue storing transfer buffers  
volatile uint8_t queueUser  
    Queue index where user's next transfer will be stored  
volatile uint8_t queueDriver  
    Queue index of buffer actually used by the driver  
dma_descriptor_t *i2sLoopDMADescriptor  
    descriptor pool pointer  
size_t i2sLoopDMADescriptorNum  
    number of descriptor in descriptors pool
```

2.21 I2S Driver

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

Initializes the FLEXCOMM peripheral for I2S transmit functionality.

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

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

Parameters

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


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

Initializes the FLEXCOMM peripheral for I2S receive functionality.

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

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

Parameters

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

```
void I2S_TxGetDefaultConfig(i2s_config_t *config)
```

Sets the I2S Tx configuration structure to default values.

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

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

Default values:

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

Parameters

- config – pointer to I2S configuration structure.

```
void I2S_RxGetDefaultConfig(i2s_config_t *config)
```

Sets the I2S Rx configuration structure to default values.

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

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

Default values:

```
config->masterSlave = kI2S_MasterSlaveNormalSlave;
config->mode = kI2S_ModeI2sClassic;
```

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

Parameters

- config – pointer to I2S configuration structure.

void I2S_Deinit(I2S_Type *base)

De-initializes the I2S peripheral.

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

Parameters

- base – I2S base pointer.

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

Transmitter/Receiver bit clock rate configurations.

Parameters

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

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

Initializes handle for transfer of audio data.

Parameters

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

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

Begins or queue sending of the given data.

Parameters

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

- transfer – data buffer.

Return values

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

void I2S_TxTransferAbort(I2S_Type *base, i2s_handle_t *handle)

Aborts sending of data.

Parameters

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

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

Initializes handle for reception of audio data.

Parameters

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

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

Begins or queue reception of data into given buffer.

Parameters

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

Return values

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

void I2S_RxTransferAbort(I2S_Type *base, i2s_handle_t *handle)

Aborts receiving of data.

Parameters

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

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

Returns number of bytes transferred so far.

Parameters

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

Return values

- `kStatus__Success` –
- `kStatus__NoTransferInProgress` – there is no non-blocking transaction currently in progress.

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

Returns number of buffer underruns or overruns.

Parameters

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

Return values

- `kStatus__Success` –
- `kStatus__NoTransferInProgress` – there is no non-blocking transaction currently in progress.

`static inline void I2S_Enable(I2S_Type *base)`

Enables I2S operation.

Parameters

- `base` – I2S base pointer.

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

Enables I2S secondary channel.

Parameters

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

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

Disables I2S secondary channel.

Parameters

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

`static inline void I2S_Disable(I2S_Type *base)`

Disables I2S operation.

Parameters

- `base` – I2S base pointer.

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

Enables I2S FIFO interrupts.

Parameters

- `base` – I2S base pointer.

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

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

Disables I2S FIFO interrupts.

Parameters

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

`static inline uint32_t I2S_GetEnabledInterrupts(I2S_Type *base)`

Returns the set of currently enabled I2S FIFO interrupts.

Parameters

- `base` – I2S base pointer.

Returns

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

`status_t I2S_EmptyTxFifo(I2S_Type *base)`

Flush the valid data in TX fifo.

Parameters

- `base` – I2S base pointer.

Returns

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

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

Invoked from interrupt handler when transmit FIFO level decreases.

Parameters

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

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

Invoked from interrupt handler when receive FIFO level decreases.

Parameters

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

`FSL_I2S_DRIVER_VERSION`

I2S driver version 2.3.2.

`_i2s_status` I2S status codes.

Values:

enumerator `kStatus_I2S_BufferComplete`

Transfer from/into a single buffer has completed

enumerator `kStatus_I2S_Done`

All buffers transfers have completed

enumerator `kStatus_I2S_Busy`

Already performing a transfer and cannot queue another buffer

enum _i2s_flags

I2S flags.

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

Values:

enumerator kI2S_TxErrorFlag

TX error interrupt

enumerator kI2S_TxLevelFlag

TX level interrupt

enumerator kI2S_RxErrorFlag

RX error interrupt

enumerator kI2S_RxLevelFlag

RX level interrupt

enum _i2s_master_slave

Master / slave mode.

Values:

enumerator kI2S_MasterSlaveNormalSlave

Normal slave

enumerator kI2S_MasterSlaveWsSyncMaster

WS synchronized master

enumerator kI2S_MasterSlaveExtSckMaster

Master using existing SCK

enumerator kI2S_MasterSlaveNormalMaster

Normal master

enum _i2s_mode

I2S mode.

Values:

enumerator kI2S_ModeI2sClassic

I2S classic mode

enumerator kI2S_ModeDspWs50

DSP mode, WS having 50% duty cycle

enumerator kI2S_ModeDspWsShort

DSP mode, WS having one clock long pulse

enumerator kI2S_ModeDspWsLong

DSP mode, WS having one data slot long pulse

_i2s_secondary_channel I2S secondary channel.

Values:

enumerator kI2S_SecondaryChannel1

secondary channel 1

```
enumerator kI2S_SecondaryChannel2
    secondary channel 2
enumerator kI2S_SecondaryChannel3
    secondary channel 3
typedef enum _i2s_flags i2s_flags_t
    I2S flags.
```

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

```
typedef enum _i2s_master_slave i2s_master_slave_t
    Master / slave mode.
typedef enum _i2s_mode i2s_mode_t
    I2S mode.
typedef struct _i2s_config i2s_config_t
    I2S configuration structure.
typedef struct _i2s_transfer i2s_transfer_t
    Buffer to transfer from or receive audio data into.
typedef struct _i2s_handle i2s_handle_t
    Transactional state of the initialized transfer or receive I2S operation.
typedef void (*i2s_transfer_callback_t)(I2S_Type *base, i2s_handle_t *handle, status_t
completionStatus, void *userData)
    Callback function invoked from transactional API on completion of a single buffer transfer.

Param base
    I2S base pointer.

Param handle
    pointer to I2S transaction.

Param completionStatus
    status of the transaction.

Param userData
    optional pointer to user arguments data.
```

```
I2S_NUM_BUFFERS
    Number of buffers .
struct _i2s_config
    #include <fsl_i2s.h> I2S configuration structure.
```

Public Members

```
i2s_master_slave_t masterSlave
    Master / slave configuration
i2s_mode_t mode
    I2S mode
bool rightLow
    Right channel data in low portion of FIFO
```

`bool leftJust`
Left justify data in FIFO

`bool pdmData`
Data source is the D-Mic subsystem

`bool sckPol`
SCK polarity

`bool wsPol`
WS polarity

`uint16_t divider`
Flexcomm function clock divider (1 - 4096)

`bool oneChannel`
true mono, false stereo

`uint8_t dataLength`
Data length (4 - 32)

`uint16_t frameLength`
Frame width (4 - 512)

`uint16_t position`
Data position in the frame

`uint8_t watermark`
FIFO trigger level

`bool txEmptyZero`
Transmit zero when buffer becomes empty or last item

`bool pack48`
Packing format for 48-bit data (false - 24 bit values, true - alternating 32-bit and 16-bit values)

`struct _i2s_transfer`
#include <fsl_i2s.h> Buffer to transfer from or receive audio data into.

Public Members

`uint8_t *data`
Pointer to data buffer.

`size_t dataSize`
Buffer size in bytes.

`struct _i2s_handle`
#include <fsl_i2s.h> Members not to be accessed / modified outside of the driver.

Public Members

`volatile uint32_t state`
State of transfer

`i2s_transfer_callback_t completionCallback`
Callback function pointer

`void *userData`
Application data passed to callback

`bool oneChannel`
true mono, false stereo

`uint8_t dataLength`
Data length (4 - 32)

`bool pack48`
Packing format for 48-bit data (false - 24 bit values, true - alternating 32-bit and 16-bit values)

`uint8_t watermark`
FIFO trigger level

`bool useFifo48H`
When dataLength 17-24: true use FIFOWR48H, false use FIFOWR

`volatile i2s_transfer_t i2sQueue[(4U)]`
Transfer queue storing transfer buffers

`volatile uint8_t queueUser`
Queue index where user's next transfer will be stored

`volatile uint8_t queueDriver`
Queue index of buffer actually used by the driver

`volatile uint32_t errorCount`
Number of buffer underruns/overruns

`volatile uint32_t transferCount`
Number of bytes transferred

2.22 IAP: In Application Programming Driver

`status_t IAP_ReadPartID(uint32_t *partID)`

Read part identification number.

This function is used to read the part identification number.

Parameters

- `partID` – Address to store the part identification number.

Return values

`kStatus_IAP_Success` – Api has been executed successfully.

`status_t IAP_ReadBootCodeVersion(uint32_t *bootCodeVersion)`

Read boot code version number.

This function is used to read the boot code version number.

note Boot code version is two 32-bit words. Word 0 is the major version, word 1 is the minor version.

Parameters

- `bootCodeVersion` – Address to store the boot code version.

Return values

`kStatus_IAP_Success` – Api has been executed successfully.

```
void IAP_ReinvokeISP(uint8_t ispType, uint32_t *status)
```

Reinvoke ISP.

This function is used to invoke the boot loader in ISP mode. It maps boot vectors and configures the peripherals for ISP.

note The error response will be returned when IAP is disabled or an invalid ISP type selection appears. The call won't return unless an error occurs, so there can be no status code.

Parameters

- `ispType` – ISP type selection.
- `status` – store the possible status.

Return values

`kStatus_IAP_ReinvokeISPConfig` – reinvoke configuration error.

```
status_t IAP_ReadUniqueID(uint32_t *uniqueID)
```

Read unique identification.

This function is used to read the unique id.

Parameters

- `uniqueID` – store the uniqueID.

Return values

`kStatus_IAP_Success` – Api has been executed successfully.

FSL_IAP_DRIVER_VERSION

iap status codes.

Values:

enumerator `kStatus_IAP_Success`

Api is executed successfully

enumerator `kStatus_IAP_InvalidCommand`

Invalid command

enumerator `kStatus_IAP_SrcAddrError`

Source address is not on word boundary

enumerator `kStatus_IAP_DstAddrError`

Destination address is not on a correct boundary

enumerator `kStatus_IAP_SrcAddrNotMapped`

Source address is not mapped in the memory map

enumerator `kStatus_IAP_DstAddrNotMapped`

Destination address is not mapped in the memory map

enumerator `kStatus_IAP_CountError`

Byte count is not multiple of 4 or is not a permitted value

enumerator `kStatus_IAP_InvalidSector`

Sector/page number is invalid or end sector/page number is greater than start sector/page number

enumerator `kStatus_IAP_SectorNotblank`

One or more sectors are not blank

enumerator kStatus_IAP_NotPrepared

Command to prepare sector for write operation has not been executed

enumerator kStatus_IAP_CompareError

Destination and source memory contents do not match

enumerator kStatus_IAP_Busy

Flash programming hardware interface is busy

enumerator kStatus_IAP_ParamError

Insufficient number of parameters or invalid parameter

enumerator kStatus_IAP_AddrError

Address is not on word boundary

enumerator kStatus_IAP_AddrNotMapped

Address is not mapped in the memory map

enumerator kStatus_IAP_NoPower

Flash memory block is powered down

enumerator kStatus_IAP_NoClock

Flash memory block or controller is not clocked

enumerator kStatus_IAP_ReinvokeISPConfig

Reinvoke configuration error

enum _iap_commands

iap command codes.

Values:

enumerator kIapCmd_IAP_ReadFactorySettings

Read the factory settings

enumerator kIapCmd_IAP_PrepareSectorforWrite

Prepare Sector for write

enumerator kIapCmd_IAP_CopyRamToFlash

Copy RAM to flash

enumerator kIapCmd_IAP_EraseSector

Erase Sector

enumerator kIapCmd_IAP_BlankCheckSector

Blank check sector

enumerator kIapCmd_IAP_ReadPartId

Read part id

enumerator kIapCmd_IAP_Read_BootromVersion

Read bootrom version

enumerator kIapCmd_IAP_Compare

Compare

enumerator kIapCmd_IAP_ReinvokeISP

Reinvoke ISP

enumerator kIapCmd_IAP_ReadUid

Read Uid

enumerator kIapCmd_IAP_ErasePage

Erase Page

enumerator kIapCmd_IAP_ReadSignature

Read Signature

enumerator kIapCmd_IAP_ExtendedReadSignature

Extended Read Signature

enumerator kIapCmd_IAP_ReadEEPROMPage

Read EEPROM page

enumerator kIapCmd_IAP_WriteEEPROMPage

Write EEPROM page

enum _flash_access_time

Flash memory access time.

Values:

enumerator kFlash_IAP_OneSystemClockTime

enumerator kFlash_IAP_TwoSystemClockTime

1 system clock flash access time

enumerator kFlash_IAP_ThreeSystemClockTime

2 system clock flash access time

2.23 INPUTMUX: Input Multiplexing Driver

enum _inputmux_connection_t

INPUTMUX connections type.

Values:

enumerator kINPUTMUX_SctGpi0ToSct0

SCT INMUX.

enumerator kINPUTMUX_SctGpi1ToSct0

enumerator kINPUTMUX_SctGpi2ToSct0

enumerator kINPUTMUX_SctGpi3ToSct0

enumerator kINPUTMUX_SctGpi4ToSct0

enumerator kINPUTMUX_SctGpi5ToSct0

enumerator kINPUTMUX_SctGpi6ToSct0

enumerator kINPUTMUX_SctGpi7ToSct0

enumerator kINPUTMUX_T0Out0ToSct0

enumerator kINPUTMUX_T1Out0ToSct0

enumerator kINPUTMUX_T2Out0ToSct0

enumerator kINPUTMUX_T3Out0ToSct0

enumerator kINPUTMUX_T4Out0ToSct0

enumerator kINPUTMUX__AdcThcmpIrqToSct0
enumerator kINPUTMUX__GpioIntBmatchToSct0
enumerator kINPUTMUX__Usb0FrameToggleToSct0
enumerator kINPUTMUX__Usb1FrameToggleToSct0
enumerator kINPUTMUX__ArmTxevToSct0
enumerator kINPUTMUX__DebugHaltedToSct0
enumerator kINPUTMUX__SmartCard0TxActivreToSct0
enumerator kINPUTMUX__SmartCard0RxActivreToSct0
enumerator kINPUTMUX__SmartCard1TxActivreToSct0
enumerator kINPUTMUX__SmartCard1RxActivreToSct0
enumerator kINPUTMUX__I2s6SclkToSct0
enumerator kINPUTMUX__I2s7clkToSct0

Frequency measure.

enumerator kINPUTMUX__MainOscToFreqmeas
enumerator kINPUTMUX__Fro12MhzToFreqmeas
enumerator kINPUTMUX__Fro96MhzToFreqmeas
enumerator kINPUTMUX__WdtOscToFreqmeas
enumerator kINPUTMUX__32KhzOscToFreqmeas
enumerator kINPUTMUX__MainClkToFreqmeas
enumerator kINPUTMUX__FreqmeGpioClk_a
enumerator kINPUTMUX__FreqmeGpioClk_b

Pin Interrupt.

enumerator kINPUTMUX__GpioPort0Pin0ToPintsel
enumerator kINPUTMUX__GpioPort0Pin1ToPintsel
enumerator kINPUTMUX__GpioPort0Pin2ToPintsel
enumerator kINPUTMUX__GpioPort0Pin3ToPintsel
enumerator kINPUTMUX__GpioPort0Pin4ToPintsel
enumerator kINPUTMUX__GpioPort0Pin5ToPintsel
enumerator kINPUTMUX__GpioPort0Pin6ToPintsel
enumerator kINPUTMUX__GpioPort0Pin7ToPintsel
enumerator kINPUTMUX__GpioPort0Pin8ToPintsel
enumerator kINPUTMUX__GpioPort0Pin9ToPintsel
enumerator kINPUTMUX__GpioPort0Pin10ToPintsel
enumerator kINPUTMUX__GpioPort0Pin11ToPintsel

enumerator kINPUTMUX_GpioPort0Pin12ToPintsel
enumerator kINPUTMUX_GpioPort0Pin13ToPintsel
enumerator kINPUTMUX_GpioPort0Pin14ToPintsel
enumerator kINPUTMUX_GpioPort0Pin15ToPintsel
enumerator kINPUTMUX_GpioPort0Pin16ToPintsel
enumerator kINPUTMUX_GpioPort0Pin17ToPintsel
enumerator kINPUTMUX_GpioPort0Pin18ToPintsel
enumerator kINPUTMUX_GpioPort0Pin19ToPintsel
enumerator kINPUTMUX_GpioPort0Pin20ToPintsel
enumerator kINPUTMUX_GpioPort0Pin21ToPintsel
enumerator kINPUTMUX_GpioPort0Pin22ToPintsel
enumerator kINPUTMUX_GpioPort0Pin23ToPintsel
enumerator kINPUTMUX_GpioPort0Pin24ToPintsel
enumerator kINPUTMUX_GpioPort0Pin25ToPintsel
enumerator kINPUTMUX_GpioPort0Pin26ToPintsel
enumerator kINPUTMUX_GpioPort0Pin27ToPintsel
enumerator kINPUTMUX_GpioPort0Pin28ToPintsel
enumerator kINPUTMUX_GpioPort0Pin29ToPintsel
enumerator kINPUTMUX_GpioPort0Pin30ToPintsel
enumerator kINPUTMUX_GpioPort0Pin31ToPintsel
enumerator kINPUTMUX_GpioPort1Pin0ToPintsel
enumerator kINPUTMUX_GpioPort1Pin1ToPintsel
enumerator kINPUTMUX_GpioPort1Pin2ToPintsel
enumerator kINPUTMUX_GpioPort1Pin3ToPintsel
enumerator kINPUTMUX_GpioPort1Pin4ToPintsel
enumerator kINPUTMUX_GpioPort1Pin5ToPintsel
enumerator kINPUTMUX_GpioPort1Pin6ToPintsel
enumerator kINPUTMUX_GpioPort1Pin7ToPintsel
enumerator kINPUTMUX_GpioPort1Pin8ToPintsel
enumerator kINPUTMUX_GpioPort1Pin9ToPintsel
enumerator kINPUTMUX_GpioPort1Pin10ToPintsel
enumerator kINPUTMUX_GpioPort1Pin11ToPintsel
enumerator kINPUTMUX_GpioPort1Pin12ToPintsel

enumerator kINPUTMUX_GpioPort1Pin13ToPintsel
enumerator kINPUTMUX_GpioPort1Pin14ToPintsel
enumerator kINPUTMUX_GpioPort1Pin15ToPintsel
enumerator kINPUTMUX_GpioPort1Pin16ToPintsel
enumerator kINPUTMUX_GpioPort1Pin17ToPintsel
enumerator kINPUTMUX_GpioPort1Pin18ToPintsel
enumerator kINPUTMUX_GpioPort1Pin19ToPintsel
enumerator kINPUTMUX_GpioPort1Pin20ToPintsel
enumerator kINPUTMUX_GpioPort1Pin21ToPintsel
enumerator kINPUTMUX_GpioPort1Pin22ToPintsel
enumerator kINPUTMUX_GpioPort1Pin23ToPintsel
enumerator kINPUTMUX_GpioPort1Pin24ToPintsel
enumerator kINPUTMUX_GpioPort1Pin25ToPintsel
enumerator kINPUTMUX_GpioPort1Pin26ToPintsel
enumerator kINPUTMUX_GpioPort1Pin27ToPintsel
enumerator kINPUTMUX_GpioPort1Pin28ToPintsel
enumerator kINPUTMUX_GpioPort1Pin29ToPintsel
enumerator kINPUTMUX_GpioPort1Pin30ToPintsel
enumerator kINPUTMUX_GpioPort1Pin31ToPintsel
DMA ITRIG.

enumerator kINPUTMUX_Adc0SeqaIrqToDma
enumerator kINPUTMUX_Adc0SeqbIrqToDma
enumerator kINPUTMUX_Sct0DmaReq0ToDma
enumerator kINPUTMUX_Sct0DmaReq1ToDma
enumerator kINPUTMUX_PinInt0ToDma
enumerator kINPUTMUX_PinInt1ToDma
enumerator kINPUTMUX_PinInt2ToDma
enumerator kINPUTMUX_PinInt3ToDma
enumerator kINPUTMUX_Ctimer0M0ToDma
enumerator kINPUTMUX_Ctimer0M1ToDma
enumerator kINPUTMUX_Ctimer1M0ToDma
enumerator kINPUTMUX_Ctimer1M1ToDma
enumerator kINPUTMUX_Ctimer2M0ToDma

enumerator kINPUTMUX_Ctimer2M1ToDma
enumerator kINPUTMUX_Ctimer3M0ToDma
enumerator kINPUTMUX_Ctimer3M1ToDma
enumerator kINPUTMUX_Ctimer4M0ToDma
enumerator kINPUTMUX_Ctimer4M1ToDma
enumerator kINPUTMUX_Otrig0ToDma
enumerator kINPUTMUX_Otrig1ToDma
enumerator kINPUTMUX_Otrig2ToDma
enumerator kINPUTMUX_Otrig3ToDma
enumerator AES256_INPUT_DMA_REQ
enumerator AES256_OUTPUT_DMA_REQ
DMA OTRIG.
enumerator kINPUTMUX_DmaFlexcomm0RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm0TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm1RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm1TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm2RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm2TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm3RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm3TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm4RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm4TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm5RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm5TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm6RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm6TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm7RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm7TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaDmic0Ch0TrigoutToTriginChannels
enumerator kINPUTMUX_DmaDmic0Ch1TrigoutToTriginChannels
enumerator kINPUTMUX_DmaSpifi0TrigoutToTriginChannels
enumerator kINPUTMUX_DmaSha_TrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm8RxTrigoutToTriginChannels


```

enumerator kINPUTMUX_DmaFlexcomm8TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm9RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm9TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaSmartcard0RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaSmartcard0TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaSmartcard1RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaSmartcard1TxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm10RxTrigoutToTriginChannels
enumerator kINPUTMUX_DmaFlexcomm10TxTrigoutToTriginChannels

```

```

typedef enum inputmux_connection_t inputmux_connection_t
    INPUTMUX connections type.

```

```
SCT0_PMUX_ID
```

Periphinmux IDs.

```
PINTSEL_PMUX_ID
```

```
DMA_TRIG0_PMUX_ID
```

```
DMA_OTRIG_PMUX_ID
```

```
FREQMEAS_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, uint16_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. –

2.24 Common Driver

`FSL_COMMON_DRIVER_VERSION`

common driver version.

`DEBUG_CONSOLE_DEVICE_TYPE_NONE`

No debug console.

`DEBUG_CONSOLE_DEVICE_TYPE_UART`

Debug console based on UART.

`DEBUG_CONSOLE_DEVICE_TYPE_LPUART`

Debug console based on LPUART.

`DEBUG_CONSOLE_DEVICE_TYPE_LPSCI`

Debug console based on LPSCI.

`DEBUG_CONSOLE_DEVICE_TYPE_USBCDC`

Debug console based on USBCDC.

`DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM`

Debug console based on FLEXCOMM.

`DEBUG_CONSOLE_DEVICE_TYPE_IUART`

Debug console based on i.MX UART.

`DEBUG_CONSOLE_DEVICE_TYPE_VUSART`

Debug console based on LPC_VUSART.

`DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART`

Debug console based on LPC_USART.

`DEBUG_CONSOLE_DEVICE_TYPE_SWO`

Debug console based on SWO.

`DEBUG_CONSOLE_DEVICE_TYPE_QSCI`

Debug console based on QSCI.

`MIN(a, b)`

Computes the minimum of *a* and *b*.

`MAX(a, b)`

Computes the maximum of *a* and *b*.

`UINT16_MAX`

Max value of `uint16_t` type.

UINT32_MAX

Max value of uint32_t type.

MCUX_MASK_INVERT_8(mask)

8-bit mask inversion.

MCUX_MASK_INVERT_16(mask)

16-bit mask inversion.

MCUX_MASK_INVERT_32(mask)

32-bit mask inversion for completeness.

MCUX_REG_WRITE8(reg, value)

8-bit register write macro

MCUX_REG_WRITE16(reg, value)

16-bit register write macro

MCUX_REG_WRITE32(reg, value)

32-bit register write macro

MCUX_REG_READ8(reg)

8-bit register read macro

MCUX_REG_READ16(reg)

16-bit register read macro

MCUX_REG_READ32(reg)

32-bit register read macro

MCUX_REG_BIT_SET8(reg, mask)

8-bit register bit set macro

MCUX_REG_BIT_SET16(reg, mask)

16-bit register bit set macro

MCUX_REG_BIT_SET32(reg, mask)

32-bit register bit set macro

MCUX_REG_BIT_CLEAR8(reg, mask)

8-bit register bit clear macro

MCUX_REG_BIT_CLEAR16(reg, mask)

16-bit register bit clear macro

MCUX_REG_BIT_CLEAR32(reg, mask)

32-bit register bit clear macro

MCUX_REG_BIT_GET8(reg, mask)

8-bit register bit get macro

MCUX_REG_BIT_GET16(reg, mask)

16-bit register bit get macro

MCUX_REG_BIT_GET32(reg, mask)

32-bit register bit get macro

MCUX_REG_MODIFY8(reg, mask, value)

32-bit register read-modify-write macro

MCUX_REG_MODIFY16(reg, mask, value)

16-bit register read-modify-write macro

MCUX_REG_MODIFY32(reg, mask, value)

32-bit register read-modify-write macro

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_ALIGN(var, alignbytes)

Macro to define a variable with alignbytes alignment

SDK_SIZEALIGN(var, alignbytes)

Macro to define a variable with L1 d-cache line size alignment

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value (rounded up)

SDK_SIZEALIGN_UP(var, alignbytes)

Macro to change a value to a given size aligned value (rounded up), the wrapper of SDK_SIZEALIGN

SDK_SIZEALIGN_DOWN(var, alignbytes)

Macro to change a value to a given size aligned value (rounded down)

SDK_IS_ALIGNED(var, alignbytes)

Macro to check if a value is aligned to a given size

AT_NONCACHEABLE_SECTION(*var*)

Define a variable *var*, and place it in non-cacheable section.

AT_NONCACHEABLE_SECTION_ALIGN(*var*, *alignbytes*)

Define a variable *var*, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

AT_NONCACHEABLE_SECTION_INIT(*var*)

Define a variable *var* with initial value, and place it in non-cacheable section.

AT_NONCACHEABLE_SECTION_ALIGN_INIT(*var*, *alignbytes*)

Define a variable *var* with initial value, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

AT_CACHE_LINE_SECTION(*var*)

Define a variable *var*, which is cache line size aligned and be placed in CacheLineData section.

AT_CACHE_LINE_SECTION_INIT(*var*)

Define a variable *var* with initial value, which is cache line size aligned and be placed in CacheLineData.init section.

AT_QUICKACCESS_SECTION_CODE(*func*)

Place function in a section which can be accessed quickly by core.

AT_QUICKACCESS_SECTION_DATA(*var*)

Place data in a section which can be accessed quickly by core.

AT_QUICKACCESS_SECTION_DATA_ALIGN(*var*, *alignbytes*)

Place data in a section which can be accessed quickly by core, and the variable address is set to align with *alignbytes*.

MCUX_RAMFUNC

Function attribute to place function in RAM. For example, to place function *my_func* in ram, use like:

```
MCUX_RAMFUNC my_func
```

RAMFUNCTION_SECTION_CODE(*func*)

Place function in ram.

enum __status_groups

Status group numbers.

Values:

enumerator kStatusGroup_Generic

Group number for generic status codes.

enumerator kStatusGroup_FLASH

Group number for FLASH status codes.

enumerator kStatusGroup_LPSPI

Group number for LPSPI status codes.

enumerator kStatusGroup_FLEXIO_SPI

Group number for FLEXIO SPI status codes.

enumerator kStatusGroup_DSPI

Group number for DSPI status codes.

enumerator kStatusGroup_FLEXIO_UART
Group number for FLEXIO UART status codes.

enumerator kStatusGroup_FLEXIO_I2C
Group number for FLEXIO I2C status codes.

enumerator kStatusGroup_LPI2C
Group number for LPI2C status codes.

enumerator kStatusGroup_UART
Group number for UART status codes.

enumerator kStatusGroup_I2C
Group number for UART status codes.

enumerator kStatusGroup_LPSCI
Group number for LPSCI status codes.

enumerator kStatusGroup_LPUART
Group number for LPUART status codes.

enumerator kStatusGroup_SPI
Group number for SPI status code.

enumerator kStatusGroup_XRDC
Group number for XRDC status code.

enumerator kStatusGroup_SEMA42
Group number for SEMA42 status code.

enumerator kStatusGroup_SDHC
Group number for SDHC status code

enumerator kStatusGroup_SDMMC
Group number for SDMMC status code

enumerator kStatusGroup_SAI
Group number for SAI status code

enumerator kStatusGroup_MCG
Group number for MCG status codes.

enumerator kStatusGroup_SCG
Group number for SCG status codes.

enumerator kStatusGroup_SDSPI
Group number for SDSPI status codes.

enumerator kStatusGroup_FLEXIO_I2S
Group number for FLEXIO I2S status codes

enumerator kStatusGroup_FLEXIO_MCULCD
Group number for FLEXIO LCD status codes

enumerator kStatusGroup_FLASHIAP
Group number for FLASHIAP status codes

enumerator kStatusGroup_FLEXCOMM_I2C
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup_I2S
Group number for I2S status codes

enumerator kStatusGroup_IUART
Group number for IUART status codes

enumerator kStatusGroup_CSI
Group number for CSI status codes

enumerator kStatusGroup_MIPIDSI
Group number for MIPI DSI status codes

enumerator kStatusGroup_SDRAMC
Group number for SDRAMC status codes.

enumerator kStatusGroup_POWER
Group number for POWER status codes.

enumerator kStatusGroup_ENET
Group number for ENET status codes.

enumerator kStatusGroup_PHY
Group number for PHY status codes.

enumerator kStatusGroup_TRGMUX
Group number for TRGMUX status codes.

enumerator kStatusGroup_SMARTCARD
Group number for SMARTCARD status codes.

enumerator kStatusGroup_LMEM
Group number for LMEM status codes.

enumerator kStatusGroup_QSPI
Group number for QSPI status codes.

enumerator kStatusGroup_DMA
Group number for DMA status codes.

enumerator kStatusGroup_EDMA
Group number for EDMA status codes.

enumerator kStatusGroup_DMAMGR
Group number for DMAMGR status codes.

enumerator kStatusGroup_FLEXCAN
Group number for FlexCAN status codes.

enumerator kStatusGroup_LTC
Group number for LTC status codes.

enumerator kStatusGroup_FLEXIO_CAMERA
Group number for FLEXIO CAMERA status codes.

enumerator kStatusGroup_LPC_SPI
Group number for LPC_SPI status codes.

enumerator kStatusGroup_LPC_USART
Group number for LPC_USART status codes.

enumerator kStatusGroup_DMIC
Group number for DMIC status codes.

enumerator kStatusGroup_SDIF
Group number for SDIF status codes.

enumerator kStatusGroup_SPIFI
Group number for SPIFI status codes.

enumerator kStatusGroup_OTP
Group number for OTP status codes.

enumerator kStatusGroup_MCAN
Group number for MCAN status codes.

enumerator kStatusGroup_CAAM
Group number for CAAM status codes.

enumerator kStatusGroup_ECSPI
Group number for ECSPI status codes.

enumerator kStatusGroup_USDHC
Group number for USDHC status codes.

enumerator kStatusGroup_LPC_I2C
Group number for LPC_I2C status codes.

enumerator kStatusGroup_DCP
Group number for DCP status codes.

enumerator kStatusGroup_MSCAN
Group number for MSCAN status codes.

enumerator kStatusGroup_ESAI
Group number for ESAI status codes.

enumerator kStatusGroup_FLEXSPI
Group number for FLEXSPI status codes.

enumerator kStatusGroup_MMDC
Group number for MMDC status codes.

enumerator kStatusGroup_PDM
Group number for MIC status codes.

enumerator kStatusGroup_SDMA
Group number for SDMA status codes.

enumerator kStatusGroup_ICS
Group number for ICS status codes.

enumerator kStatusGroup_SPDIF
Group number for SPDIF status codes.

enumerator kStatusGroup_LPC_MINISPI
Group number for LPC_MINISPI status codes.

enumerator kStatusGroup_HASHCRYPT
Group number for Hashcrypt status codes

enumerator kStatusGroup_LPC_SPI_SSP
Group number for LPC_SPI_SSP status codes.

enumerator kStatusGroup_I3C
Group number for I3C status codes

enumerator kStatusGroup_LPC_I2C_1
Group number for LPC_I2C_1 status codes.

enumerator kStatusGroup_NOTIFIER
Group number for NOTIFIER status codes.

enumerator kStatusGroup_DebugConsole
Group number for debug console status codes.

enumerator kStatusGroup_SEMC
Group number for SEMC status codes.

enumerator kStatusGroup_ApplicationRangeStart
Starting number for application groups.

enumerator kStatusGroup_IAP
Group number for IAP status codes

enumerator kStatusGroup_SFA
Group number for SFA status codes

enumerator kStatusGroup_SPC
Group number for SPC status codes.

enumerator kStatusGroup_PUF
Group number for PUF status codes.

enumerator kStatusGroup_TOUCH_PANEL
Group number for touch panel status codes

enumerator kStatusGroup_VBAT
Group number for VBAT status codes

enumerator kStatusGroup_XSPI
Group number for XSPI status codes

enumerator kStatusGroup_PNGDEC
Group number for PNGDEC status codes

enumerator kStatusGroup_JPEGDEC
Group number for JPEGDEC status codes

enumerator kStatusGroup_AUDMIX
Group number for AUDMIX status codes

enumerator kStatusGroup_HAL_GPIO
Group number for HAL GPIO status codes.

enumerator kStatusGroup_HAL_UART
Group number for HAL UART status codes.

enumerator kStatusGroup_HAL_TIMER
Group number for HAL TIMER status codes.

enumerator kStatusGroup_HAL_SPI
Group number for HAL SPI status codes.

enumerator kStatusGroup_HAL_I2C
Group number for HAL I2C status codes.

enumerator kStatusGroup_HAL_FLASH
Group number for HAL FLASH status codes.

enumerator kStatusGroup_HAL_PWM
Group number for HAL PWM status codes.

enumerator `kStatusGroup_HAL_RNG`
Group number for HAL RNG status codes.

enumerator `kStatusGroup_HAL_I2S`
Group number for HAL I2S status codes.

enumerator `kStatusGroup_HAL_ADC_SENSOR`
Group number for HAL ADC SENSOR status codes.

enumerator `kStatusGroup_TIMERMANAGER`
Group number for TiMER MANAGER status codes.

enumerator `kStatusGroup_SERIALMANAGER`
Group number for SERIAL MANAGER status codes.

enumerator `kStatusGroup_LED`
Group number for LED status codes.

enumerator `kStatusGroup_BUTTON`
Group number for BUTTON status codes.

enumerator `kStatusGroup_EXTERN_EEPROM`
Group number for EXTERN EEPROM status codes.

enumerator `kStatusGroup_SHELL`
Group number for SHELL status codes.

enumerator `kStatusGroup_MEM_MANAGER`
Group number for MEM MANAGER status codes.

enumerator `kStatusGroup_LIST`
Group number for List status codes.

enumerator `kStatusGroup_OSA`
Group number for OSA status codes.

enumerator `kStatusGroup_COMMON_TASK`
Group number for Common task status codes.

enumerator `kStatusGroup_MSG`
Group number for messaging status codes.

enumerator `kStatusGroup_SDK_OCOTP`
Group number for OCOTP status codes.

enumerator `kStatusGroup_SDK_FLEXSPINOR`
Group number for FLEXSPINOR status codes.

enumerator `kStatusGroup_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.

enumerator kStatusGroup_LPC_QSPI

Group number for LPC QSPI 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()`.

`void EnableDeepSleepIRQ(IRQn_Type interrupt)`

Enable specific interrupt for wake-up from deep-sleep mode.

Enable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

Note: This function also enables the interrupt in the NVIC (`EnableIRQ()` is called internally).

Parameters

- `interrupt` – The IRQ number.

`void DisableDeepSleepIRQ(IRQn_Type interrupt)`

Disable specific interrupt for wake-up from deep-sleep mode.

Disable the interrupt for wake-up from deep sleep mode. Some interrupts are typically used in sleep mode only and will not occur during deep-sleep mode because relevant clocks are stopped. However, it is possible to enable those clocks (significantly increasing power consumption in the reduced power mode), making these wake-ups possible.

Note: This function also disables the interrupt in the NVIC (`DisableIRQ()` is called internally).

Parameters

- `interrupt` – The IRQ number.

`static inline bool __SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t newValue)`

`static inline uint32_t __SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)`

`FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ`

Macro to use the default weak IRQ handler in drivers.

`MAKE_STATUS(group, code)`

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

`MAKE_VERSION(major, minor, bugfix)`

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms (such as Cortex M) and 16-bit platforms (such as DSC).

Unused	Major Version	Minor Version	Bug Fix
31 25 24	17 16	9 8	0

`ARRAY_SIZE(x)`

Computes the number of elements in an array.

`UINT64_H(X)`

Macro to get upper 32 bits of a 64-bit value

`UINT64_L(X)`

Macro to get lower 32 bits of a 64-bit value

SUPPRESS_FALL_THROUGH_WARNING()

For switch case code block, if case section ends without “break;” statement, there will be fallthrough warning with compiler flag -Wextra or -Wimplicit-fallthrough=n when using armgcc. To suppress this warning, “SUPPRESS_FALL_THROUGH_WARNING();” need to be added at the end of each case section which misses “break;”statement.

MSDK_REG_SECURE_ADDR(x)

Convert the register address to the one used in secure mode.

MSDK_REG_NONSECURE_ADDR(x)

Convert the register address to the one used in non-secure mode.

MSDK_HAS_DWT_CYCCNT

The chip supports DWT CYCCNT or not.

MSDK_INVALID_IRQ_HANDLER

Invalid IRQ handler address.

2.25 ADC: 12-bit SAR Analog-to-Digital Converter Driver

void ADC_Init(ADC_Type *base, const *adc_config_t* *config)

Initialize the ADC module.

Parameters

- base – ADC peripheral base address.
- config – Pointer to configuration structure, see to *adc_config_t*.

void ADC_Deinit(ADC_Type *base)

Deinitialize the ADC module.

Parameters

- base – ADC peripheral base address.

void ADC_GetDefaultConfig(*adc_config_t* *config)

Gets an available pre-defined settings for initial configuration.

This function initializes the initial configuration structure with an available settings. The default values are:

```
config->clockMode = kADC_ClockSynchronousMode;
config->clockDividerNumber = 0U;
config->resolution = kADC_Resolution12bit;
config->enableBypassCalibration = false;
config->sampleTimeNumber = 0U;
config->extendSampleTimeNumber = kADC_ExtendSampleTimeNotUsed;
```

Parameters

- config – Pointer to configuration structure.

bool ADC_DoSelfCalibration(ADC_Type *base)

Do the hardware self-calibration.

Deprecated:

Do not use this function. It has been superceded by ADC_DoOffsetCalibration.

To calibrate the ADC, set the ADC clock to 500 kHz. In order to achieve the specified ADC accuracy, the A/D converter must be recalibrated, at a minimum, following every chip reset before initiating normal ADC operation.

Parameters

- `base` – ADC peripheral base address.

Return values

- `true` – Calibration succeed.
- `false` – Calibration failed.

```
bool ADC_DoOffsetCalibration(ADC_Type *base, uint32_t frequency)
```

Do the hardware offset-calibration.

To calibrate the ADC, set the ADC clock to no more then 30 MHz. In order to achieve the specified ADC accuracy, the A/D converter must be recalibrated, at a minimum, following every chip reset before initiating normal ADC operation.

Parameters

- `base` – ADC peripheral base address.
- `frequency` – The clock frequency that ADC operates at.

Return values

- `true` – Calibration succeed.
- `false` – Calibration failed.

```
static inline void ADC_EnableConvSeqA(ADC_Type *base, bool enable)
```

Enable the conversion sequence A.

In order to avoid spuriously triggering the sequence, the trigger to conversion sequence should be ready before the sequence is ready. when the sequence is disabled, the trigger would be ignored. Also, it is suggested to disable the sequence during changing the sequence's setting.

Parameters

- `base` – ADC peripheral base address.
- `enable` – Switcher to enable the feature or not.

```
void ADC_SetConvSeqAConfig(ADC_Type *base, const adc_conv_seq_config_t *config)
```

Configure the conversion sequence A.

Parameters

- `base` – ADC peripheral base address.
- `config` – Pointer to configuration structure, see to `adc_conv_seq_config_t`.

```
static inline void ADC_DoSoftwareTriggerConvSeqA(ADC_Type *base)
```

Do trigger the sequence's conversion by software.

Parameters

- `base` – ADC peripheral base address.

```
static inline void ADC_EnableConvSeqABurstMode(ADC_Type *base, bool enable)
```

Enable the burst conversion of sequence A.

Enable the burst mode would cause the conversion sequence to be cntinuously cycled through. Other triggers would be ignored while this mode is enabled. Repeated conversions could be halted by disabling this mode. And the sequence currently in process will be completed before cnversions are terminated. Note that a new sequence could begin just before the burst mode is disabled.

Parameters

- base – ADC peripheral base address.
- enable – Switcher to enable this feature.

```
static inline void ADC_SetConvSeqAHighPriority(ADC_Type *base)
```

Set the high priority for conversion sequence A.

Parameters

- base – ADC peripheral base address.

```
static inline void ADC_EnableConvSeqB(ADC_Type *base, bool enable)
```

Enable the conversion sequence B.

In order to avoid spuriously triggering the sequence, the trigger to conversion sequence should be ready before the sequence is ready. When the sequence is disabled, the trigger would be ignored. Also, it is suggested to disable the sequence during changing the sequence's setting.

Parameters

- base – ADC peripheral base address.
- enable – Switcher to enable the feature or not.

```
void ADC_SetConvSeqBConfig(ADC_Type *base, const adc_conv_seq_config_t *config)
```

Configure the conversion sequence B.

Parameters

- base – ADC peripheral base address.
- config – Pointer to configuration structure, see to *adc_conv_seq_config_t*.

```
static inline void ADC_DoSoftwareTriggerConvSeqB(ADC_Type *base)
```

Do trigger the sequence's conversion by software.

Parameters

- base – ADC peripheral base address.

```
static inline void ADC_EnableConvSeqBBurstMode(ADC_Type *base, bool enable)
```

Enable the burst conversion of sequence B.

Enable the burst mode would cause the conversion sequence to be continuously cycled through. Other triggers would be ignored while this mode is enabled. Repeated conversions could be halted by disabling this mode. And the sequence currently in process will be completed before conversions are terminated. Note that a new sequence could begin just before the burst mode is disabled.

Parameters

- base – ADC peripheral base address.
- enable – Switcher to enable this feature.

```
static inline void ADC_SetConvSeqBHighPriority(ADC_Type *base)
```

Set the high priority for conversion sequence B.

Parameters

- base – ADC peripheral base address.

```
bool ADC_GetConvSeqAGlobalConversionResult(ADC_Type *base, adc_result_info_t *info)
```

Get the global ADC conversion information of sequence A.

Parameters

- `base` – ADC peripheral base address.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

Return values

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
bool ADC_GetConvSeqBGlobalConversionResult(ADC_Type *base, adc_result_info_t *info)
```

Get the global ADC conversion information of sequence B.

Parameters

- `base` – ADC peripheral base address.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

Return values

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
bool ADC_GetChannelConversionResult(ADC_Type *base, uint32_t channel, adc_result_info_t *info)
```

Get the channel's ADC conversion completed under each conversion sequence.

Parameters

- `base` – ADC peripheral base address.
- `channel` – The indicated channel number.
- `info` – Pointer to information structure, see to `adc_result_info_t`;

Return values

- `true` – The conversion result is ready.
- `false` – The conversion result is not ready yet.

```
static inline void ADC_SetThresholdPair0(ADC_Type *base, uint32_t lowValue, uint32_t highValue)
```

Set the threshold pair 0 with low and high value.

Parameters

- `base` – ADC peripheral base address.
- `lowValue` – LOW threshold value.
- `highValue` – HIGH threshold value.

```
static inline void ADC_SetThresholdPair1(ADC_Type *base, uint32_t lowValue, uint32_t highValue)
```

Set the threshold pair 1 with low and high value.

Parameters

- `base` – ADC peripheral base address.
- `lowValue` – LOW threshold value. The available value is with 12-bit.
- `highValue` – HIGH threshold value. The available value is with 12-bit.

```
static inline void ADC_SetChannelWithThresholdPair0(ADC_Type *base, uint32_t channelMask)
```

Set given channels to apply the threshold pair 0.

Parameters

- `base` – ADC peripheral base address.

- channelMask – Indicated channels' mask.

static inline void ADC_SetChannelWithThresholdPair1(ADC_Type *base, uint32_t channelMask)

Set given channels to apply the threshold pare 1.

Parameters

- base – ADC peripheral base address.
- channelMask – Indicated channels' mask.

static inline void ADC_EnableInterrupts(ADC_Type *base, uint32_t mask)

Enable interrupts for conversion sequences.

Parameters

- base – ADC peripheral base address.
- mask – Mask of interrupt mask value for global block except each channel, see to `_adc_interrupt_enable`.

static inline void ADC_DisableInterrupts(ADC_Type *base, uint32_t mask)

Disable interrupts for conversion sequence.

Parameters

- base – ADC peripheral base address.
- mask – Mask of interrupt mask value for global block except each channel, see to `_adc_interrupt_enable`.

static inline void ADC_EnableThresholdCompareInterrupt(ADC_Type *base, uint32_t channel,
adc_threshold_interrupt_mode_t mode)

Enable the interrupt of threshold compare event for each channel.

Parameters

- base – ADC peripheral base address.
- channel – Channel number.
- mode – Interrupt mode for threshold compare event, see to `adc_threshold_interrupt_mode_t`.

static inline uint32_t ADC_GetStatusFlags(ADC_Type *base)

Get status flags of ADC module.

Parameters

- base – ADC peripheral base address.

Returns

Mask of status flags of module, see to `_adc_status_flags`.

static inline void ADC_ClearStatusFlags(ADC_Type *base, uint32_t mask)

Clear status flags of ADC module.

Parameters

- base – ADC peripheral base address.
- mask – Mask of status flags of module, see to `_adc_status_flags`.

FSL_ADC_DRIVER_VERSION

ADC driver version 2.6.0.

enum `_adc_status_flags`

Flags.

Values:

enumerator kADC_ThresholdCompareFlagOnChn0

Threshold comparison event on Channel 0.

enumerator kADC_ThresholdCompareFlagOnChn1

Threshold comparison event on Channel 1.

enumerator kADC_ThresholdCompareFlagOnChn2

Threshold comparison event on Channel 2.

enumerator kADC_ThresholdCompareFlagOnChn3

Threshold comparison event on Channel 3.

enumerator kADC_ThresholdCompareFlagOnChn4

Threshold comparison event on Channel 4.

enumerator kADC_ThresholdCompareFlagOnChn5

Threshold comparison event on Channel 5.

enumerator kADC_ThresholdCompareFlagOnChn6

Threshold comparison event on Channel 6.

enumerator kADC_ThresholdCompareFlagOnChn7

Threshold comparison event on Channel 7.

enumerator kADC_ThresholdCompareFlagOnChn8

Threshold comparison event on Channel 8.

enumerator kADC_ThresholdCompareFlagOnChn9

Threshold comparison event on Channel 9.

enumerator kADC_ThresholdCompareFlagOnChn10

Threshold comparison event on Channel 10.

enumerator kADC_ThresholdCompareFlagOnChn11

Threshold comparison event on Channel 11.

enumerator kADC_OverrunFlagForChn0

Mirror the OVERRUN status flag from the result register for ADC channel 0.

enumerator kADC_OverrunFlagForChn1

Mirror the OVERRUN status flag from the result register for ADC channel 1.

enumerator kADC_OverrunFlagForChn2

Mirror the OVERRUN status flag from the result register for ADC channel 2.

enumerator kADC_OverrunFlagForChn3

Mirror the OVERRUN status flag from the result register for ADC channel 3.

enumerator kADC_OverrunFlagForChn4

Mirror the OVERRUN status flag from the result register for ADC channel 4.

enumerator kADC_OverrunFlagForChn5

Mirror the OVERRUN status flag from the result register for ADC channel 5.

enumerator kADC_OverrunFlagForChn6

Mirror the OVERRUN status flag from the result register for ADC channel 6.

enumerator kADC_OverrunFlagForChn7

Mirror the OVERRUN status flag from the result register for ADC channel 7.

enumerator kADC_OverrunFlagForChn8

Mirror the OVERRUN status flag from the result register for ADC channel 8.

enumerator kADC_OverrunFlagForChn9

Mirror the OVERRUN status flag from the result register for ADC channel 9.

enumerator kADC_OverrunFlagForChn10

Mirror the OVERRUN status flag from the result register for ADC channel 10.

enumerator kADC_OverrunFlagForChn11

Mirror the OVERRUN status flag from the result register for ADC channel 11.

enumerator kADC_GlobalOverrunFlagForSeqA

Mirror the global OVERRUN status flag for conversion sequence A.

enumerator kADC_GlobalOverrunFlagForSeqB

Mirror the global OVERRUN status flag for conversion sequence B.

enumerator kADC_ConvSeqAInterruptFlag

Sequence A interrupt/DMA trigger.

enumerator kADC_ConvSeqBInterruptFlag

Sequence B interrupt/DMA trigger.

enumerator kADC_ThresholdCompareInterruptFlag

Threshold comparison interrupt flag.

enumerator kADC_OverrunInterruptFlag

Overrun interrupt flag.

enum _adc_interrupt_enable

Interrupts.

Note: Not all the interrupt options are listed here

Values:

enumerator kADC_ConvSeqAInterruptEnable

Enable interrupt upon completion of each individual conversion in sequence A, or entire sequence.

enumerator kADC_ConvSeqBInterruptEnable

Enable interrupt upon completion of each individual conversion in sequence B, or entire sequence.

enumerator kADC_OverrunInterruptEnable

Enable the detection of an overrun condition on any of the channel data registers will cause an overrun interrupt/DMA trigger.

enum _adc_clock_mode

Define selection of clock mode.

Values:

enumerator kADC_ClockSynchronousMode

The ADC clock would be derived from the system clock based on “clockDividerNumber”.

enumerator kADC_ClockAsynchronousMode

The ADC clock would be based on the SYSCON block’s divider.

enum _adc_resolution

Define selection of resolution.

Values:

enumerator kADC_Resolution6bit
6-bit resolution.

enumerator kADC_Resolution8bit
8-bit resolution.

enumerator kADC_Resolution10bit
10-bit resolution.

enumerator kADC_Resolution12bit
12-bit resolution.

enum _adc_voltage_range
Define range of the analog supply voltage VDDA.

Values:

enumerator kADC_HighVoltageRange

enumerator kADC_LowVoltageRange

enum _adc_trigger_polarity
Define selection of polarity of selected input trigger for conversion sequence.

Values:

enumerator kADC_TriggerPolarityNegativeEdge
A negative edge launches the conversion sequence on the trigger(s).

enumerator kADC_TriggerPolarityPositiveEdge
A positive edge launches the conversion sequence on the trigger(s).

enum _adc_priority
Define selection of conversion sequence's priority.

Values:

enumerator kADC_PriorityLow
This sequence would be preempted when another sequence is started.

enumerator kADC_PriorityHigh
This sequence would preempt other sequence even when it is started.

enum _adc_seq_interrupt_mode
Define selection of conversion sequence's interrupt.

Values:

enumerator kADC_InterruptForEachConversion
The sequence interrupt/DMA trigger will be set at the end of each individual ADC conversion inside this conversion sequence.

enumerator kADC_InterruptForEachSequence
The sequence interrupt/DMA trigger will be set when the entire set of this sequence conversions completes.

enum _adc_threshold_compare_status
Define status of threshold compare result.

Values:

enumerator kADC_ThresholdCompareInRange
LOW threshold <= conversion value <= HIGH threshold.

enumerator kADC_ThresholdCompareBelowRange
conversion value < LOW threshold.

enumerator kADC_ThresholdCompareAboveRange
conversion value > HIGH threshold.

enum _adc_threshold_crossing_status
Define status of threshold crossing detection result.

Values:

enumerator kADC_ThresholdCrossingNoDetected
No threshold Crossing detected.

enumerator kADC_ThresholdCrossingDownward
Downward Threshold Crossing detected.

enumerator kADC_ThresholdCrossingUpward
Upward Threshold Crossing Detected.

enum _adc_threshold_interrupt_mode
Define interrupt mode for threshold compare event.

Values:

enumerator kADC_ThresholdInterruptDisabled
Threshold comparison interrupt is disabled.

enumerator kADC_ThresholdInterruptOnOutside
Threshold comparison interrupt is enabled on outside threshold.

enumerator kADC_ThresholdInterruptOnCrossing
Threshold comparison interrupt is enabled on crossing threshold.

enum _adc_inforesultshift
Define the info result mode of different resolution.

Values:

enumerator kADC_Resolution12bitInfoResultShift
Info result shift of Resolution12bit.

enumerator kADC_Resolution10bitInfoResultShift
Info result shift of Resolution10bit.

enumerator kADC_Resolution8bitInfoResultShift
Info result shift of Resolution8bit.

enumerator kADC_Resolution6bitInfoResultShift
Info result shift of Resolution6bit.

enum _adc_tempsensor_common_mode
Define common modes for Temperature sensor.

Values:

enumerator kADC_HighNegativeOffsetAdded
Temperature sensor common mode: high negative offset added.

enumerator kADC_IntermediateNegativeOffsetAdded
Temperature sensor common mode: intermediate negative offset added.

enumerator kADC_NoOffsetAdded
Temperature sensor common mode: no offset added.

enumerator kADC_LowPositiveOffsetAdded

Temperature sensor common mode: low positive offset added.

enum _adc_second_control

Define source impedance modes for GPADC control.

Values:

enumerator kADC_Impedance621Ohm

Extend ADC sampling time according to source impedance 1: 0.621 kOhm.

enumerator kADC_Impedance55kOhm

Extend ADC sampling time according to source impedance 20 (default): 55 kOhm.

enumerator kADC_Impedance87kOhm

Extend ADC sampling time according to source impedance 31: 87 kOhm.

enumerator kADC_NormalFunctionalMode

TEST mode: Normal functional mode.

enumerator kADC_MultiplexeTestMode

TEST mode: Multiplexer test mode.

enumerator kADC_ADCInUnityGainMode

TEST mode: ADC in unity gain mode.

typedef enum _adc_clock_mode adc_clock_mode_t

Define selection of clock mode.

typedef enum _adc_resolution adc_resolution_t

Define selection of resolution.

typedef enum _adc_voltage_range adc_vdda_range_t

Define range of the analog supply voltage VDDA.

typedef enum _adc_trigger_polarity adc_trigger_polarity_t

Define selection of polarity of selected input trigger for conversion sequence.

typedef enum _adc_priority adc_priority_t

Define selection of conversion sequence's priority.

typedef enum _adc_seq_interrupt_mode adc_seq_interrupt_mode_t

Define selection of conversion sequence's interrupt.

typedef enum _adc_threshold_compare_status adc_threshold_compare_status_t

Define status of threshold compare result.

typedef enum _adc_threshold_crossing_status adc_threshold_crossing_status_t

Define status of threshold crossing detection result.

typedef enum _adc_threshold_interrupt_mode adc_threshold_interrupt_mode_t

Define interrupt mode for threshold compare event.

typedef enum _adc_inforeresultshift adc_inforeresult_t

Define the info result mode of different resolution.

typedef enum _adc_tempsensor_common_mode adc_tempsensor_common_mode_t

Define common modes for Temperature sensor.

typedef enum _adc_second_control adc_second_control_t

Define source impedance modes for GPADC control.

```
typedef struct _adc_config adc_config_t
```

Define structure for configuring the block.

```
typedef struct _adc_conv_seq_config adc_conv_seq_config_t
```

Define structure for configuring conversion sequence.

```
typedef struct _adc_result_info adc_result_info_t
```

Define structure of keeping conversion result information.

```
struct _adc_config
```

#include <fsl_adc.h> Define structure for configuring the block.

Public Members

adc_clock_mode_t clockMode

Select the clock mode for ADC converter.

uint32_t clockDividerNumber

This field is only available when using kADC_ClockSynchronousMode for “clockMode” field. The divider would be plused by 1 based on the value in this field. The available range is in 8 bits.

adc_resolution_t resolution

Select the conversion bits.

bool enableBypassCalibration

By default, a calibration cycle must be performed each time the chip is powered-up. Re-calibration may be warranted periodically - especially if operating conditions have changed. To enable this option would avoid the need to calibrate if offset error is not a concern in the application.

uint32_t sampleTimeNumber

By default, with value as “0U”, the sample period would be 2.5 ADC clocks. Then, to plus the “sampleTimeNumber” value here. The available value range is in 3 bits.

bool enableLowPowerMode

If disable low-power mode, ADC remains activated even when no conversions are requested. If enable low-power mode, The ADC is automatically powered-down when no conversions are taking place.

adc_vdda_range_t voltageRange

Configure the ADC for the appropriate operating range of the analog supply voltage VDDA. Failure to set the area correctly causes the ADC to return incorrect conversion results.

```
struct _adc_conv_seq_config
```

#include <fsl_adc.h> Define structure for configuring conversion sequence.

Public Members

uint32_t channelMask

Selects which one or more of the ADC channels will be sampled and converted when this sequence is launched. The masked channels would be involved in current conversion sequence, beginning with the lowest-order. The available range is in 12-bit.

uint32_t triggerMask

Selects which one or more of the available hardware trigger sources will cause this conversion sequence to be initiated. The available range is 6-bit.

adc_trigger_polarity_t triggerPolarity

Select the trigger to launch conversion sequence.

bool enableSyncBypass

To enable this feature allows the hardware trigger input to bypass synchronization flip-flop stages and therefore shorten the time between the trigger input signal and the start of a conversion.

bool enableSingleStep

When enabling this feature, a trigger will launch a single conversion on the next channel in the sequence instead of the default response of launching an entire sequence of conversions.

adc_seq_interrupt_mode_t interruptMode

Select the interrupt/DMA trigger mode.

struct *_adc_result_info*

#include <fsl_adc.h> Define structure of keeping conversion result information.

Public Members

uint32_t result

Keep the conversion data value.

adc_threshold_compare_status_t thresholdCompareStatus

Keep the threshold compare status.

adc_threshold_crossing_status_t thresholdCorssingStatus

Keep the threshold crossing status.

uint32_t channelNumber

Keep the channel number for this conversion.

bool overrunFlag

Keep the status whether the conversion is overrun or not.

2.26 ENET: Ethernet Driver

void ENET_GetDefaultConfig(*enet_config_t* *config)

Gets the ENET default configuration structure.

The purpose of this API is to get the default ENET configure structure for ENET_Init(). User may use the initialized structure unchanged in ENET_Init(), or modify some fields of the structure before calling ENET_Init(). Example:

```
enet_config_t config;
ENET_GetDefaultConfig(&config);
```

Parameters

- config – The ENET mac controller configuration structure pointer.

void ENET_Init(ENET_Type *base, const *enet_config_t* *config, uint8_t *macAddr, uint32_t refclkSrc_Hz)

Initializes the ENET module.

This function ungates the module clock and initializes it with the ENET basic configuration.

Note: As our transactional transmit API use the zero-copy transmit buffer. So there are two thing we emphasize here:

- a. Tx buffer free/requeue for application should be done in the Tx interrupt handler. Please set callback: `kENET_TxIntEvent` with Tx buffer free/requeue process APIs.
 - b. The Tx interrupt is forced to open.
-

Parameters

- `base` – ENET peripheral base address.
- `config` – ENET mac configuration structure pointer. The “`enet_config_t`” type mac configuration return from `ENET_GetDefaultConfig` can be used directly. It is also possible to verify the Mac configuration using other methods.
- `macAddr` – ENET mac address of Ethernet device. This MAC address should be provided.
- `refclkSrc_Hz` – ENET input reference clock.

`void ENET_Deinit(ENET_Type *base)`

Deinitializes the ENET module.

This function gates the module clock and disables the ENET module.

Parameters

- `base` – ENET peripheral base address.

`status_t ENET_DescriptorInit(ENET_Type *base, enet_config_t *config, enet_buffer_config_t *bufferConfig)`

Initialize for all ENET descriptors.

Note: This function finishes all Tx/Rx descriptors initialization. The descriptor initialization should be called after `ENET_Init()`.

Parameters

- `base` – ENET peripheral base address.
- `config` – The configuration for ENET.
- `bufferConfig` – All buffers configuration.

`status_t ENET_RxBufferAllocAll(ENET_Type *base, enet_handle_t *handle)`

Allocates Rx buffers for all BDs. It's used for zero copy Rx. In zero copy Rx case, Rx buffers are dynamic. This function will populate initial buffers in all BDs for receiving. Then `ENET_GetRxFrame()` is used to get Rx frame with zero copy, it will allocate new buffer to replace the buffer in BD taken by application, application should free those buffers after they're used.

Note: This function should be called after `ENET_CreateHandler()` and buffer allocating callback function should be ready.

Parameters

- `base` – ENET peripheral base address.

- `handle` – The ENET handler structure. This is the same handler pointer used in the `ENET_Init`.

`void ENET_RxBufferFreeAll(ENET_Type *base, enet_handle_t *handle)`

Frees Rx buffers in all BDs. It's used for zero copy Rx. In zero copy Rx case, Rx buffers are dynamic. This function will free left buffers in all BDs.

Parameters

- `base` – ENET peripheral base address.
- `handle` – The ENET handler structure. This is the same handler pointer used in the `ENET_Init`.

`void ENET_StartRxTx(ENET_Type *base, uint8_t txRingNum, uint8_t rxRingNum)`

Starts the ENET Tx/Rx. This function enable the Tx/Rx and starts the Tx/Rx DMA. This shall be set after ENET initialization and before starting to receive the data.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- `base` – ENET peripheral base address.
- `rxRingNum` – The number of the used Rx rings. It shall not be larger than the `ENET_RING_NUM_MAX(2)`. If the `ringNum` is set with 1, the ring 0 will be used.
- `txRingNum` – The number of the used Tx rings. It shall not be larger than the `ENET_RING_NUM_MAX(2)`. If the `ringNum` is set with 1, the ring 0 will be used.

`void ENET_SetISRHandler(ENET_Type *base, enet_isr_t ISRHandler)`

Set the second level IRQ handler.

Parameters

- `base` – ENET peripheral base address.
- `ISRHandler` – The handler to install.

`static inline void ENET_SetMII(ENET_Type *base, enet_mii_speed_t speed, enet_mii_duplex_t duplex)`

Sets the ENET MII speed and duplex.

This API is provided to dynamically change the speed and dulpex for MAC.

Parameters

- `base` – ENET peripheral base address.
- `speed` – The speed of the RMII mode.
- `duplex` – The duplex of the RMII mode.

`void ENET_SetSMI(ENET_Type *base)`

Sets the ENET SMI(serial management interface)- MII management interface.

Parameters

- `base` – ENET peripheral base address.

static inline bool ENET_IsSMIBusy(ENET_Type *base)

Checks if the SMI is busy.

Parameters

- base – ENET peripheral base address.

Returns

The status of MII Busy status.

static inline uint16_t ENET_ReadSMIData(ENET_Type *base)

Reads data from the PHY register through SMI interface.

Parameters

- base – ENET peripheral base address.

Returns

The data read from PHY

void ENET_StartSMIWrite(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

Sends the MDIO IEEE802.3 Clause 22 format write command.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register.
- data – The data written to PHY.

void ENET_StartSMIRead(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr)

Sends the MDIO IEEE802.3 Clause 22 format read command.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register.

status_t ENET_MDIOWrite(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t data)

MDIO write with IEEE802.3 Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.
- regAddr – The PHY register.
- data – The data written to PHY.

Returns

kStatus_Success MDIO access succeeds.

Returns

kStatus_Timeout MDIO access timeout.

status_t ENET_MDIORead(ENET_Type *base, uint8_t phyAddr, uint8_t regAddr, uint16_t *pData)

MDIO read with IEEE802.3 Clause 22 format.

Parameters

- base – ENET peripheral base address.
- phyAddr – The PHY address.

- regAddr – The PHY register.
- pData – The data read from PHY.

Returns

kStatus_Success MDIO access succeeds.

Returns

kStatus_Timeout MDIO access timeout.

uint32_t ENET_GetInstance(ENET_Type *base)

Get the ENET instance from peripheral base address.

Parameters

- base – ENET peripheral base address.

Returns

ENET instance.

static inline void ENET_SetMacAddr(ENET_Type *base, uint8_t *macAddr)

Sets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

void ENET_GetMacAddr(ENET_Type *base, uint8_t *macAddr)

Gets the ENET module Mac address.

Parameters

- base – ENET peripheral base address.
- macAddr – The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

static inline void ENET_AcceptAllMulticast(ENET_Type *base)

Enable ENET device to accept all multicast frames.

Parameters

- base – ENET peripheral base address.

static inline void ENET_RejectAllMulticast(ENET_Type *base)

ENET device reject to accept all multicast frames.

Parameters

- base – ENET peripheral base address.

void ENET_EnterPowerDown(ENET_Type *base, uint32_t *wakeFilter)

Set the MAC to enter into power down mode. the remote power wake up frame and magic frame can wake up the ENET from the power down mode.

Parameters

- base – ENET peripheral base address.
- wakeFilter – The wakeFilter provided to configure the wake up frame filter. Set the wakeFilter to NULL is not required. But if you have the filter requirement, please make sure the wakeFilter pointer shall be eight continuous 32-bits configuration.

static inline void ENET_ExitPowerDown(ENET_Type *base)

Set the MAC to exit power down mode. Exit from the power down mode and recover to normal work mode.

Parameters

- base – ENET peripheral base address.

void ENET_EnableInterrupts(ENET_Type *base, uint32_t mask)

Enables the ENET DMA and MAC interrupts.

This function enables the ENET interrupt according to the provided mask. The mask is a logical OR of `enet_dma_interrupt_enable_t` and `enet_mac_interrupt_enable_t`. For example, to enable the dma and mac interrupt, do the following.

```
ENET_EnableInterrupts(ENET, kENET_DmaRx | kENET_DmaTx | kENET_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to enable. This is a logical OR of both enumeration :: `enet_dma_interrupt_enable_t` and `enet_mac_interrupt_enable_t`.

void ENET_DisableInterrupts(ENET_Type *base, uint32_t mask)

Disables the ENET DMA and MAC interrupts.

This function disables the ENET interrupt according to the provided mask. The mask is a logical OR of `enet_dma_interrupt_enable_t` and `enet_mac_interrupt_enable_t`. For example, to disable the dma and mac interrupt, do the following.

```
ENET_DisableInterrupts(ENET, kENET_DmaRx | kENET_DmaTx | kENET_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupts to disables. This is a logical OR of both enumeration :: `enet_dma_interrupt_enable_t` and `enet_mac_interrupt_enable_t`.

static inline uint32_t ENET_GetDmaInterruptStatus(ENET_Type *base, uint8_t channel)

Gets the ENET DMA interrupt status flag.

Parameters

- base – ENET peripheral base address.
- channel – The DMA Channel. Shall not be larger than `ENET_RING_NUM_MAX`.

Returns

The event status of the interrupt source. This is the logical OR of members of the enumeration :: `enet_dma_interrupt_enable_t`.

static inline void ENET_ClearDmaInterruptStatus(ENET_Type *base, uint8_t channel, uint32_t mask)

Clear the ENET DMA interrupt status flag.

Parameters

- base – ENET peripheral base address.
- channel – The DMA Channel. Shall not be larger than `ENET_RING_NUM_MAX`.
- mask – The event status of the interrupt source. This is the logical OR of members of the enumeration :: `enet_dma_interrupt_enable_t`.


```
static inline uint32_t ENET_GetMacInterruptStatus(ENET_Type *base)
```

Gets the ENET MAC interrupt status flag.

Parameters

- base – ENET peripheral base address.

Returns

The event status of the interrupt source. Use the enum in `enet_mac_interrupt_enable_t` and right shift `ENET_MACINT_ENUM_OFFSET` to mask the returned value to get the exact interrupt status.

```
void ENET_ClearMacInterruptStatus(ENET_Type *base, uint32_t mask)
```

Clears the ENET mac interrupt events status flag.

This function clears enabled ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See the `enet_mac_interrupt_enable_t`. For example, to clear the TX frame interrupt and RX frame interrupt, do the following.

```
ENET_ClearMacInterruptStatus(ENET, kENET_MacPmt);
```

Parameters

- base – ENET peripheral base address.
- mask – ENET interrupt source to be cleared. This is the logical OR of members of the enumeration :: `enet_mac_interrupt_enable_t`.

```
static inline bool ENET_IsTxDescriptorDmaOwn(enet_tx_bd_struct_t *txDesc)
```

Get the Tx descriptor DMA Own flag.

Parameters

- txDesc – The given Tx descriptor.

Return values

True – the dma own Tx descriptor, false application own Tx descriptor.

```
void ENET_SetupTxDescriptor(enet_tx_bd_struct_t *txDesc, void *buffer1, uint32_t bytes1, void
                           *buffer2, uint32_t bytes2, uint32_t framelen, bool intEnable, bool
                           tsEnable, enet_desc_flag_t flag, uint8_t slotNum)
```

Setup a given Tx descriptor. This function is a low level functional API to setup or prepare a given Tx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required. Transmit buffers are ‘zero-copy’ buffers, so the buffer must remain in memory until the packet has been fully transmitted. The buffers should be free or requeued in the transmit interrupt irq handler.

Parameters

- txDesc – The given Tx descriptor.
- buffer1 – The first buffer address in the descriptor.
- bytes1 – The bytes in the first buffer.
- buffer2 – The second buffer address in the descriptor.
- bytes2 – The bytes in the second buffer.
- framelen – The length of the frame to be transmitted.
- intEnable – Interrupt enable flag.

- tsEnable – The timestamp enable.
- flag – The flag of this Tx descriptor, see “enet_desc_flag_t”.
- slotNum – The slot num used for AV mode only.

```
static inline void ENET_UpdateTxDescriptorTail(ENET_Type *base, uint8_t channel, uint32_t txDescTailAddrAlign)
```

Update the Tx descriptor tail pointer. This function is a low level functional API to update the Tx descriptor tail. This is called after you setup a new Tx descriptor to update the tail pointer to make the new descriptor accessible by DMA.

Parameters

- base – ENET peripheral base address.
- channel – The Tx DMA channel.
- txDescTailAddrAlign – The new Tx tail pointer address.

```
static inline void ENET_UpdateRxDescriptorTail(ENET_Type *base, uint8_t channel, uint32_t rxDescTailAddrAlign)
```

Update the Rx descriptor tail pointer. This function is a low level functional API to update the Rx descriptor tail. This is called after you setup a new Rx descriptor to update the tail pointer to make the new descriptor accessible by DMA and to anounce the Rx poll command for DMA.

Parameters

- base – ENET peripheral base address.
- channel – The Rx DMA channel.
- rxDescTailAddrAlign – The new Rx tail pointer address.

```
static inline uint32_t ENET_GetRxDescriptor(enet_rx_bd_struct_t *rxDesc)
```

Gets the context in the ENET Rx descriptor. This function is a low level functional API to get the status flag from a given Rx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- rxDesc – The given Rx descriptor.

Return values

The – RDES3 regions for write-back format Rx buffer descriptor.

```
void ENET_UpdateRxDescriptor(enet_rx_bd_struct_t *rxDesc, void *buffer1, void *buffer2, bool intEnable, bool doubleBuffEnable)
```

Updates the buffers and the own status for a given Rx descriptor. This function is a low level functional API to Updates the buffers and the own status for a given Rx descriptor.

Note: This must be called after all the ENET initialization. And should be called when the ENET receive/transmit is required.

Parameters

- rxDesc – The given Rx descriptor.
- buffer1 – The first buffer address in the descriptor.

- `buffer2` – The second buffer address in the descriptor.
- `intEnable` – Interrupt enable flag.
- `doubleBuffEnable` – The double buffer enable flag.

```
void ENET__CreateHandler(ENET_Type *base, enet_handle_t *handle, enet_config_t *config,  
                        enet_buffer_config_t *bufferConfig, enet_callback_t callback, void  
                        *userData)
```

Create ENET Handler.

This is a transactional API and it's provided to store all datas which are needed during the whole transactional process. This API should not be used when you use functional APIs to do data Tx/Rx. This is funtion will store many data/flag for transactional use.

Parameters

- `base` – ENET peripheral base address.
- `handle` – ENET handler.
- `config` – ENET configuration.
- `bufferConfig` – ENET buffer configuration.
- `callback` – The callback function.
- `userData` – The application data.

```
status_t ENET__GetRxFramSize(ENET_Type *base, enet_handle_t *handle, uint32_t *length,  
                             uint8_t channel)
```

Gets the size of the read frame. This function gets a received frame size from the ENET buffer descriptors.

Note: The FCS of the frame is automatically removed by MAC and the size is the length without the FCS. After calling `ENET__GetRxFramSize`, `ENET_ReadFrame()` should be called to update the receive buffers If the result is not “`kStatus_ENET_RxFrameEmpty`”.

Parameters

- `base` – ENET peripheral base address.
- `handle` – The ENET handler structure. This is the same handler pointer used in the `ENET_Init`.
- `length` – The length of the valid frame received.
- `channel` – The DMAC channel for the Rx.

Return values

- `kStatus_ENET_RxFrameEmpty` – No frame received. Should not call `ENET_ReadFrame` to read frame.
- `kStatus_ENET_RxFrameError` – Data error happens. `ENET_ReadFrame` should be called with NULL data and NULL length to update the receive buffers.
- `kStatus_Success` – Receive a frame Successfully then the `ENET_ReadFrame` should be called with the right data buffer and the captured data length input.

```
status_t ENET__ReadFrame(ENET_Type *base, enet_handle_t *handle, uint8_t *data, uint32_t  
                        length, uint8_t channel, enet_ptp_time_t *timestamp)
```

Reads a frame from the ENET device. This function reads a frame from the ENET DMA

descriptors. The ENET_GetRxFramSize should be used to get the size of the prepared data buffer. For example use Rx dma channel 0:

```
uint32_t length;
enet_handle_t g_handle;
Comment: Get the received frame size firstly.
status = ENET_GetRxFramSize(&g_handle, &length, 0);
if (length != 0)
{
    Comment: Allocate memory here with the size of "length"
    uint8_t *data = memory allocate interface;
    if (!data)
    {
        ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0);
    }
    else
    {
        status = ENET_ReadFrame(ENET, &g_handle, data, length, 0);
    }
}
else if (status == kStatus_ENET_RxFrameError)
{
    Comment: Update the received buffer when a error frame is received.
    ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0);
}
```

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler structure. This is the same handler pointer used in the ENET_Init.
- data – The data buffer provided by user to store the frame which memory size should be at least “length”.
- length – The size of the data buffer which is still the length of the received frame.
- channel – The Rx DMA channel. Shall not be larger than 2.
- timestamp – The timestamp address to store received timestamp.

Returns

The execute status, successful or failure.

status_t ENET_GetRxFramSize(*ENET_Type* *base, *enet_handle_t* *handle, *enet_rx_frame_struct_t* *rxFrame, *uint8_t* channel)

Receives one frame in specified BD ring with zero copy.

This function will use the user-defined allocate and free callback. Every time application gets one frame through this function, driver will allocate new buffers for the BDs whose buffers have been taken by application.

Note: This function will drop current frame and update related BDs as available for DMA if new buffers allocating fails. Application must provide a memory pool including at least BD number + 1 buffers(+2 if enable double buffer) to make this function work normally.

Parameters

- base – ENET peripheral base address.

- `handle` – The ENET handler pointer. This is the same handler pointer used in the `ENET_Init`.
- `rxFrame` – The received frame information structure provided by user.
- `channel` – The Rx DMA channel. Shall not be larger than 2.

Return values

- `kStatus_Success` – Succeed to get one frame and allocate new memory for Rx buffer.
- `kStatus_ENET_RxFrameEmpty` – There's no Rx frame in the BD.
- `kStatus_ENET_RxFrameError` – There's issue in this receiving. In this function, issue frame will be dropped.
- `kStatus_ENET_RxFrameDrop` – There's no new buffer memory for BD, dropped this frame.

`status_t` `ENET_SendFrame(ENET_Type *base, enet_handle_t *handle, enet_tx_frame_struct_t *txFrame, uint8_t channel)`

Transmits an ENET frame.

Note: The CRC is automatically appended to the data. Input the data to send without the CRC. This API uses input buffer for Tx, application should reclaim the buffer after Tx is over.

Parameters

- `base` – ENET peripheral base address.
- `handle` – The ENET handler pointer. This is the same handler pointer used in the `ENET_Init`.
- `txFrame` – The Tx frame structure.
- `channel` – Channel to send the frame, same with queue index.

Return values

- `kStatus_Success` – Send frame succeed.
- `kStatus_ENET_TxFrameBusy` – Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with `kStatus_ENET_TxFrameBusy`. Also need to pay attention to reclaim Tx frame after Tx is over.
- `kStatus_ENET_TxFrameOverLen` – Transmit frame length exceeds the 0x3FFF limit defined by the driver.

`void` `ENET_ReclaimTxDescriptor(ENET_Type *base, enet_handle_t *handle, uint8_t channel)`

Reclaim Tx descriptors. This function is used to update the Tx descriptor status and store the Tx timestamp when the 1588 feature is enabled. This is called by the transmit interrupt IRQ handler after the complete of a frame transmission.

Parameters

- `base` – ENET peripheral base address.
- `handle` – The ENET handler pointer. This is the same handler pointer used in the `ENET_Init`.
- `channel` – The Tx DMA channel.

```
void ENET_IRQHandler(ENET_Type *base, enet_handle_t *handle)
```

The ENET IRQ handler.

Parameters

- base – ENET peripheral base address.
- handle – The ENET handler pointer.

```
FSL_ENET_DRIVER_VERSION
```

Defines the driver version.

```
ENET_RXDESCRIP_RD_BUFF1VALID_MASK
```

Defines for read format.

Buffer1 address valid.

```
ENET_RXDESCRIP_RD_BUFF2VALID_MASK
```

Buffer2 address valid.

```
ENET_RXDESCRIP_RD_IOC_MASK
```

Interrupt enable on complete.

```
ENET_RXDESCRIP_RD_OWN_MASK
```

Own bit.

```
ENET_RXDESCRIP_WR_ERR_MASK
```

Defines for write back format.

```
ENET_RXDESCRIP_WR_PYLOAD_MASK
```

```
ENET_RXDESCRIP_WR_PTPMSGTYPE_MASK
```

```
ENET_RXDESCRIP_WR_PTPTYPE_MASK
```

```
ENET_RXDESCRIP_WR_PTPVERSION_MASK
```

```
ENET_RXDESCRIP_WR_PTPTSA_MASK
```

```
ENET_RXDESCRIP_WR_PACKETLEN_MASK
```

```
ENET_RXDESCRIP_WR_ERRSUM_MASK
```

```
ENET_RXDESCRIP_WR_TYPE_MASK
```

```
ENET_RXDESCRIP_WR_DE_MASK
```

```
ENET_RXDESCRIP_WR_RE_MASK
```

```
ENET_RXDESCRIP_WR_OE_MASK
```

```
ENET_RXDESCRIP_WR_RS0V_MASK
```

```
ENET_RXDESCRIP_WR_RS1V_MASK
```

```
ENET_RXDESCRIP_WR_RS2V_MASK
```

```
ENET_RXDESCRIP_WR_LD_MASK
```

```
ENET_RXDESCRIP_WR_FD_MASK
```

```
ENET_RXDESCRIP_WR_CTXT_MASK
```

```
ENET_RXDESCRIP_WR_OWN_MASK
```

ENET_TXDESCRIP_RD_BL1_MASK

Defines for read format.

ENET_TXDESCRIP_RD_BL2_MASK

ENET_TXDESCRIP_RD_BL1(n)

ENET_TXDESCRIP_RD_BL2(n)

ENET_TXDESCRIP_RD_TTSE_MASK

ENET_TXDESCRIP_RD_IOC_MASK

ENET_TXDESCRIP_RD_FL_MASK

ENET_TXDESCRIP_RD_FL(n)

ENET_TXDESCRIP_RD_CIC(n)

ENET_TXDESCRIP_RD_TSE_MASK

ENET_TXDESCRIP_RD_SLOT(n)

ENET_TXDESCRIP_RD_SAIC(n)

ENET_TXDESCRIP_RD_CPC(n)

ENET_TXDESCRIP_RD_LDFD(n)

ENET_TXDESCRIP_RD_LD_MASK

ENET_TXDESCRIP_RD_FD_MASK

ENET_TXDESCRIP_RD_CTXT_MASK

ENET_TXDESCRIP_RD_OWN_MASK

ENET_TXDESCRIP_WB_TTSS_MASK

Defines for write back format.

ENET_ABNORM_INT_MASK

ENET_NORM_INT_MASK

ENET_FRAME_MAX_FRAMELEN

Default maximum ethernet frame size.

ENET_FCS_LEN

Ethernet Rx frame FCS length.

ENET_ADDR_ALIGNMENT

Recommended ethernet buffer alignment.

ENET_BUFF_ALIGNMENT

Receive buffer alignment shall be 4bytes-aligned.

ENET_RING_NUM_MAX

The maximum number of Tx/Rx descriptor rings.

ENET_MTL_RXFIFOSIZE

The Rx fifo size.

ENET_MTL_TXFIFOSIZE

The Tx fifo size.

ENET_MACINT_ENUM_OFFSET

The offset for mac interrupt in enum type.

ENET_FRAME_TX_LEN_LIMITATION

The Tx frame length software limitation.

ENET_FRAME_RX_ERROR_BITS(x)

The Rx frame error bits field.

Defines the status return codes for transaction.

Values:

enumerator kStatus_ENET_InitMemoryFail

Status code 4000. Init failed since buffer memory was not enough.

enumerator kStatus_ENET_RxFrameError

Status code 4001. A frame received but data error occurred.

enumerator kStatus_ENET_RxFrameFail

Status code 4002. Failed to receive a frame.

enumerator kStatus_ENET_RxFrameEmpty

Status code 4003. No frame arrived.

enumerator kStatus_ENET_RxFrameDrop

Status code 4004. Rx frame was dropped since there's no buffer memory.

enumerator kStatus_ENET_TxFrameBusy

Status code 4005. There were no resources for Tx operation.

enumerator kStatus_ENET_TxFrameFail

Status code 4006. Transmit frame failed.

enumerator kStatus_ENET_TxFrameOverLen

Status code 4007. Failed to send an oversize frame.

enum _enet_mii_mode

Defines the MII/RMII mode for data interface between the MAC and the PHY.

Values:

enumerator kENET_MiiMode

MII mode for data interface.

enumerator kENET_RmiiMode

RMII mode for data interface.

enum _enet_mii_speed

Defines the 10/100 Mbps speed for the MII data interface.

Values:

enumerator kENET_MiiSpeed10M

Speed 10 Mbps.

enumerator kENET_MiiSpeed100M

Speed 100 Mbps.

enum _enet_mii_duplex

Defines the half or full duplex for the MII data interface.

Values:

enumerator kENET_MiiHalfDuplex

Half duplex mode.

enumerator kENET_MiiFullDuplex

Full duplex mode.

enum _enet_mii_normal_opcode

Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

Values:

enumerator kENET_MiiWriteFrame

Write frame operation for a valid MII management frame.

enumerator kENET_MiiReadFrame

Read frame operation for a valid MII management frame.

enum _enet_dma_burstlen

Define the DMA maximum transmit burst length.

Values:

enumerator kENET_BurstLen1

DMA burst length 1.

enumerator kENET_BurstLen2

DMA burst length 2.

enumerator kENET_BurstLen4

DMA burst length 4.

enumerator kENET_BurstLen8

DMA burst length 8.

enumerator kENET_BurstLen16

DMA burst length 16.

enumerator kENET_BurstLen32

DMA burst length 32.

enumerator kENET_BurstLen64

DMA burst length 64. eight times enabled.

enumerator kENET_BurstLen128

DMA burst length 128. eight times enabled.

enumerator kENET_BurstLen256

DMA burst length 256. eight times enabled.

enum _enet_desc_flag

Define the flag for the descriptor.

Values:

enumerator kENET_MiddleFlag

It's a middle descriptor of the frame.

enumerator kENET_LastFlagOnly

It's the last descriptor of the frame.

enumerator kENET_FirstFlagOnly

It's the first descriptor of the frame.

enumerator kENET_FirstLastFlag

It's the first and last descriptor of the frame.

enum __enet_systime_op

Define the system time adjust operation control.

Values:

enumerator kENET_SystimeAdd

System time add to.

enumerator kENET_SystimeSubtract

System time subtract.

enum __enet_ts_rollover_type

Define the system time rollover control.

Values:

enumerator kENET_BinaryRollover

System time binary rollover.

enumerator kENET_DigitalRollover

System time digital rollover.

enum __enet_special_config

Defines some special configuration for ENET.

These control flags are provided for special user requirements. Normally, there is no need to set these control flags for ENET initialization. But if you have some special requirements, set the flags to specialControl in the enet_config_t.

Note: “kENET_StoreAndForward” is recommended to be set when the ENET_PTP1588FEATURE_REQUIRED is defined or else the timestamp will be messed up when the overflow happens.

Values:

enumerator kENET_DescDoubleBuffer

The double buffer is used in the Tx/Rx descriptor.

enumerator kENET_StoreAndForward

The Rx/Tx store and forward enable.

enumerator kENET_PromiscuousEnable

The promiscuous enabled.

enumerator kENET_FlowControlEnable

The flow control enabled.

enumerator kENET_BroadcastRxDisable

The broadcast disabled.

enumerator kENET_MulticastAllEnable

All multicast are passed.

enumerator kENET_8023AS2KPacket

8023as support for 2K packets.

enumerator kENET_RxChecksumOffloadEnable

The Rx checksum offload enabled.

enum _enet_dma_interrupt_enable

List of DMA interrupts supported by the ENET interrupt. This enumeration uses one-hot encoding to allow a logical OR of multiple members.

Values:

enumerator kENET_DmaTx

Tx interrupt.

enumerator kENET_DmaTxStop

Tx stop interrupt.

enumerator kENET_DmaTxBuffUnavail

Tx buffer unavailable.

enumerator kENET_DmaRx

Rx interrupt.

enumerator kENET_DmaRxBuffUnavail

Rx buffer unavailable.

enumerator kENET_DmaRxStop

Rx stop.

enumerator kENET_DmaRxWatchdogTimeout

Rx watchdog timeout.

enumerator kENET_DmaEarlyTx

Early transmit.

enumerator kENET_DmaEarlyRx

Early receive.

enumerator kENET_DmaBusErr

Fatal bus error.

enum _enet_mac_interrupt_enable

List of mac interrupts supported by the ENET interrupt. This enumeration uses one-hot encoding to allow a logical OR of multiple members.

Values:

enumerator kENET_MacPmt

enumerator kENET_MacTimestamp

enum _enet_event

Defines the common interrupt event for callback use.

Values:

enumerator kENET_RxIntEvent

Receive interrupt event.

enumerator kENET_TxIntEvent

Transmit interrupt event.

enumerator kENET_WakeUpIntEvent

Wake up interrupt event.

enumerator kENET_TimeStampIntEvent

Time stamp interrupt event.

enum `_enet_dma_tx_sche`

Define the DMA transmit arbitration for multi-queue.

Values:

enumerator `kENET_FixPri`

Fixed priority. channel 0 has lower priority than channel 1.

enumerator `kENET_WeightStrPri`

Weighted(burst length) strict priority.

enumerator `kENET_WeightRoundRobin`

Weighted (weight factor) round robin.

enum `_enet_mtl_multiqueue_txsche`

Define the MTL Tx scheduling algorithm for multiple queues/rings.

Values:

enumerator `kENET_txWeightRR`

Tx weight round-robin.

enumerator `kENET_txStrPrio`

Tx strict priority.

enum `_enet_mtl_multiqueue_rxsche`

Define the MTL Rx scheduling algorithm for multiple queues/rings.

Values:

enumerator `kENET_rxStrPrio`

Tx weight round-robin, Rx strict priority.

enumerator `kENET_rxWeightStrPrio`

Tx strict priority, Rx weight strict priority.

enum `_enet_mtl_rxqueuemap`

Define the MTL Rx queue and DMA channel mapping.

Values:

enumerator `kENET_StaticDirectMap`

The received frame in Rx Qn(n = 0,1) directly map to dma channel n.

enumerator `kENET_DynamicMap`

The received frame in Rx Qn(n = 0,1) map to the dma channel m(m = 0,1) related with the same Mac.

enum `_enet_ptp_event_type`

Defines the ENET PTP message related constant.

Values:

enumerator `kENET_PtpEventMsgType`

PTP event message type.

enumerator `kENET_PtpSrcPortIdLen`

PTP message sequence id length.

enumerator `kENET_PtpEventPort`

PTP event port number.

enumerator `kENET_PtpGnrlPort`

PTP general port number.

enum *_enet_tx_offload*

Define the Tx checksum offload options.

Values:

enumerator *kENET_TxOffloadDisable*

Disable Tx checksum offload.

enumerator *kENET_TxOffloadIPHeader*

Enable IP header checksum calculation and insertion.

enumerator *kENET_TxOffloadIPHeaderPlusPayload*

Enable IP header and payload checksum calculation and insertion.

enumerator *kENET_TxOffloadAll*

Enable IP header, payload and pseudo header checksum calculation and insertion.

typedef enum *_enet_mii_mode* *enet_mii_mode_t*

Defines the MII/RMII mode for data interface between the MAC and the PHY.

typedef enum *_enet_mii_speed* *enet_mii_speed_t*

Defines the 10/100 Mbps speed for the MII data interface.

typedef enum *_enet_mii_duplex* *enet_mii_duplex_t*

Defines the half or full duplex for the MII data interface.

typedef enum *_enet_mii_normal_opcode* *enet_mii_normal_opcode_t*

Define the MII opcode for normal MDIO_CLAUSES_22 Frame.

typedef enum *_enet_dma_burstlen* *enet_dma_burstlen_t*

Define the DMA maximum transmit burst length.

typedef enum *_enet_desc_flag* *enet_desc_flag_t*

Define the flag for the descriptor.

typedef enum *_enet_systime_op* *enet_systime_op_t*

Define the system time adjust operation control.

typedef enum *_enet_ts_rollover_type* *enet_ts_rollover_type_t*

Define the system time rollover control.

typedef enum *_enet_special_config* *enet_special_config_t*

Defines some special configuration for ENET.

These control flags are provided for special user requirements. Normally, there is no need to set this control flags for ENET initialization. But if you have some special requirements, set the flags to specialControl in the *enet_config_t*.

Note: “kENET_StoreAndForward” is recommended to be set when the ENET_PTP1588FEATURE_REQUIRED is defined or else the timestamp will be mess-up when the overflow happens.

typedef enum *_enet_dma_interrupt_enable* *enet_dma_interrupt_enable_t*

List of DMA interrupts supported by the ENET interrupt. This enumeration uses one-hot encoding to allow a logical OR of multiple members.

typedef enum *_enet_mac_interrupt_enable* *enet_mac_interrupt_enable_t*

List of mac interrupts supported by the ENET interrupt. This enumeration uses one-hot encoding to allow a logical OR of multiple members.

typedef enum *_enet_event* enet_event_t

Defines the common interrupt event for callback use.

typedef enum *_enet_dma_tx_sche* enet_dma_tx_sche_t

Define the DMA transmit arbitration for multi-queue.

typedef enum *_enet_mtl_multiqueue_txsche* enet_mtl_multiqueue_txsche_t

Define the MTL Tx scheduling algorithm for multiple queues/rings.

typedef enum *_enet_mtl_multiqueue_rxsche* enet_mtl_multiqueue_rxsche_t

Define the MTL Rx scheduling algorithm for multiple queues/rings.

typedef enum *_enet_mtl_rxqueuemap* enet_mtl_rxqueuemap_t

Define the MTL Rx queue and DMA channel mapping.

typedef enum *_enet_ptp_event_type* enet_ptp_event_type_t

Defines the ENET PTP message related constant.

typedef enum *_enet_tx_offload* enet_tx_offload_t

Define the Tx checksum offload options.

typedef struct *_enet_rx_bd_struct* enet_rx_bd_struct_t

Defines the receive descriptor structure. It has the read-format and write-back format structures. They both have the same size with different region definition. So we define common name as the receive descriptor structure. When initialize the buffer descriptors, read-format region mask bits should be used. When Rx frame has been in the buffer descriptors, write-back format region store the Rx result information.

typedef struct *_enet_tx_bd_struct* enet_tx_bd_struct_t

Defines the transmit descriptor structure. It has the read-format and write-back format structure. They both have the same size with different region definition. So we define common name as the transmit descriptor structure. When initialize the buffer descriptors for Tx, read-format region mask bits should be used. When frame has been transmitted, write-back format region store the Tx result information.

typedef struct *_enet_tx_bd_config_struct* enet_tx_bd_config_struct_t

Defines the Tx BD configuration structure.

typedef struct *_enet_ptp_time* enet_ptp_time_t

Defines the ENET PTP time stamp structure.

typedef struct *enet_tx_reclaim_info* enet_tx_reclaim_info_t

Defines the Tx reclaim information structure.

typedef struct *_enet_tx_dirty_ring* enet_tx_dirty_ring_t

Defines the ENET transmit dirty addresses ring/queue structure.

typedef struct *_enet_buffer_config* enet_buffer_config_t

Defines the buffer descriptor configure structure.

Notes:

- a. The receive and transmit descriptor start address pointer and tail pointer must be word-aligned.
- b. The recommended minimum Tx/Rx ring length is 4.
- c. The Tx/Rx descriptor tail address shall be the address pointer to the address just after the end of the last descriptor. because only the descriptors between the start address and the tail address will be used by DMA.
- d. The descriptor address is the start address of all used contiguous memory. for example, the rxDescStartAddrAlign is the start address of rxRingLen contiguous descriptor memory for Rx descriptor ring 0.

- e. The “**rxBufferstartAddr*” is the first element of *rxRingLen* ($2 \times \text{rxRingLen}$ for double buffers) Rx buffers. It means the **rxBufferstartAddr* is the Rx buffer for the first descriptor the **rxBufferstartAddr + 1* is the Rx buffer for the second descriptor or the Rx buffer for the second buffer in the first descriptor. So please make sure the *rxBufferstartAddr* is the address of a *rxRingLen* or $2 \times \text{rxRingLen}$ array.

```
typedef struct enet_multiqueue_config enet_multiqueue_config_t
```

Defines the configuration when multi-queue is used.

```
typedef void (*enet_rx_alloc_callback_t)(ENET_Type *base, void *userData, uint8_t channel)
```

Defines the Rx memory buffer alloc function pointer.

```
typedef void (*enet_rx_free_callback_t)(ENET_Type *base, void *buffer, void *userData, uint8_t channel)
```

Defines the Rx memory buffer free function pointer.

```
typedef struct enet_config enet_config_t
```

Defines the basic configuration structure for the ENET device.

Note:

- a. Default the signal queue is used so the “*multiqueueCfg*” is set default with NULL. Set the pointer with a valid configuration pointer if the multiple queues are required. If multiple queue is enabled, please make sure the buffer configuration for all are prepared also.

```
typedef struct enet_handle enet_handle_t
```

```
typedef void (*enet_callback_t)(ENET_Type *base, enet_handle_t *handle, enet_event_t event, uint8_t channel, enet_tx_reclaim_info_t *txReclaimInfo, void *userData)
```

ENET callback function.

```
typedef struct enet_tx_bd_ring enet_tx_bd_ring_t
```

Defines the ENET transmit buffer descriptor ring/queue structure.

```
typedef struct enet_rx_bd_ring enet_rx_bd_ring_t
```

Defines the ENET receive buffer descriptor ring/queue structure.

```
typedef struct enet_buffer_struct enet_buffer_struct_t
```

```
typedef struct enet_rx_frame_attribute_struct enet_rx_frame_attribute_t
```

Rx frame attribute structure.

```
typedef struct enet_rx_frame_error enet_rx_frame_error_t
```

Defines the Rx frame error structure.

```
typedef struct enet_rx_frame_struct enet_rx_frame_struct_t
```

Defines the Rx frame data structure.

```
typedef struct enet_tx_config_struct enet_tx_config_struct_t
```

```
typedef struct enet_tx_frame_struct enet_tx_frame_struct_t
```

```
typedef void (*enet_isr_t)(ENET_Type *base, enet_handle_t *handle)
```

```
const clock_ip_name_t s_enetClock[]
```

Pointers to enet clocks for each instance.

```
struct enet_rx_bd_struct
```

#include <fsl_enet.h> Defines the receive descriptor structure It has the read-format and write-back format structures. They both have the same size with different region definition. So we define common name as the receive descriptor structure. When initialize the buffer descriptors, read-format region mask bits should be used. When Rx frame has been in the buffer descriptors, write-back format region store the Rx result information.

Public Members

__IO uint32_t rdes0
Receive descriptor 0

__IO uint32_t rdes1
Receive descriptor 1

__IO uint32_t rdes2
Receive descriptor 2

__IO uint32_t rdes3
Receive descriptor 3

struct _enet_tx_bd_struct

#include <fsl_enet.h> Defines the transmit descriptor structure. It has the read-format and write-back format structure. They both have the same size with different region definition. So we define a common name as the transmit descriptor structure. When initialize the buffer descriptors for Tx, read-format region mask bits should be used. When frame has been transmitted, write-back format region store the Tx result information.

Public Members

__IO uint32_t tdes0
Transmit descriptor 0

__IO uint32_t tdes1
Transmit descriptor 1

__IO uint32_t tdes2
Transmit descriptor 2

__IO uint32_t tdes3
Transmit descriptor 3

struct _enet_tx_bd_config_struct

#include <fsl_enet.h> Defines the Tx BD configuration structure.

Public Members

void *buffer1
The first buffer address in the descriptor.

uint32_t bytes1
The bytes in the first buffer.

void *buffer2
The second buffer address in the descriptor.

uint32_t bytes2
The bytes in the second buffer.

uint32_t framelen
The length of the frame to be transmitted.

bool intEnable
Interrupt enable flag.

bool tsEnable
The timestamp enable.

enet_tx_offload_t txOffloadOps

The Tx checksum offload option, only valid for Queue 0.

enet_desc_flag_t flag

The flag of this tx descriptor, see “enet_qos_desc_flag”.

uint8_t slotNum

The slot number used for AV mode only.

struct _enet_ptp_time

#include <fsl_enet.h> Defines the ENET PTP time stamp structure.

Public Members

uint64_t second

Second.

uint32_t nanosecond

Nanosecond.

struct enet_tx_reclaim_info

#include <fsl_enet.h> Defines the Tx reclaim information structure.

Public Members

void *context

User specified data, could be buffer address for free

bool isTsAvail

Flag indicates timestamp available status

enet_ptp_time_t timeStamp

Timestamp of frame

struct _enet_tx_dirty_ring

#include <fsl_enet.h> Defines the ENET transmit dirty addresses ring/queue structure.

Public Members

enet_tx_reclaim_info_t *txDirtyBase

Dirty buffer descriptor base address pointer.

uint16_t txGenIdx

Tx generate index.

uint16_t txConsumeIdx

Tx consume index.

uint16_t txRingLen

Tx ring length.

bool isFull

Tx ring is full flag, add this parameter to avoid waste one element.

struct _enet_buffer_config

#include <fsl_enet.h> Defines the buffer descriptor configure structure.

Notes:

- a. The receive and transmit descriptor start address pointer and tail pointer must be word-aligned.
- b. The recommended minimum Tx/Rx ring length is 4.
- c. The Tx/Rx descriptor tail address shall be the address pointer to the address just after the end of the last last descriptor. because only the descriptors between the start address and the tail address will be used by DMA.
- d. The decriptor address is the start address of all used contiguous memory. for example, the rxDescStartAddrAlign is the start address of rxRingLen contiguous descriptor memorise for Rx descriptor ring 0.
- e. The “*rxBufferstartAddr” is the first element of rxRingLen (2*rxRingLen for double buffers) Rx buffers. It means the *rxBufferStartAddr is the Rx buffer for the first descriptor the *rxBufferStartAddr + 1 is the Rx buffer for the second descriptor or the Rx buffer for the second buffer in the first descriptor. So please make sure the rxBufferStartAddr is the address of a rxRingLen or 2*rxRingLen array.

Public Members

uint8_t rxRingLen

The length of receive buffer descriptor ring.

uint8_t txRingLen

The length of transmit buffer descriptor ring.

enet_tx_bd_struct_t *txDescStartAddrAlign

Aligned transmit descriptor start address.

enet_tx_bd_struct_t *txDescTailAddrAlign

Aligned transmit descriptor tail address.

enet_tx_reclaim_info_t *txDirtyStartAddr

Start address of the dirty Tx frame information.

enet_rx_bd_struct_t *rxDescStartAddrAlign

Aligned receive descriptor start address.

enet_rx_bd_struct_t *rxDescTailAddrAlign

Aligned receive descriptor tail address.

uint32_t *rxBufferStartAddr

Start address of the Rx buffers.

uint32_t rxBuffSizeAlign

Aligned receive data buffer size.

struct enet_multiqueue_config

#include <fsl_enet.h> Defines the configuration when multi-queue is used.

Public Members

enet_dma_tx_sche_t dmaTxSche

Transmit arbitration.

enet_dma_burstlen_t burstLen

Burset len for the queue 1.

uint8_t txdmaChnWeight[(2U)]

Transmit channel weight.

enet_mtl_multiqueue_txsche_t mtltxSche

Transmit schedule for multi-queue.

enet_mtl_multiqueue_rxsche_t mtlrxSche

Receive schedule for multi-queue.

uint8_t rxqueuweight[(2U)]

Refer to the MTL RxQ Control register.

uint32_t txqueuweight[(2U)]

Refer to the MTL TxQ Quantum Weight register.

uint8_t rxqueuePrio[(2U)]

Receive queue priority.

uint8_t txqueuePrio[(2U)]

Refer to Transmit Queue Priority Mapping register.

enet_mtl_rxqueuemap_t mtlrxQuemap

Rx queue DMA Channel mapping.

struct *_enet_config*

#include <fsl_enet.h> Defines the basic configuration structure for the ENET device.

Note:

- a. Default the signal queue is used so the “multiqueueCfg” is set default with NULL. Set the pointer with a valid configuration pointer if the multiple queues are required. If multiple queue is enabled, please make sure the buffer configuration for all are prepared also.

Public Members

uint16_t specialControl

The logical or of *enet_special_config_t*

enet_multiqueue_config_t *multiqueueCfg

Use both Tx/Rx queue(dma channel) 0 and 1.

uint32_t interrupt

MAC interrupt source. A logical OR of *enet_dma_interrupt_enable_t* and *enet_mac_interrupt_enable_t*.

enet_mii_mode_t miiMode

MII mode.

enet_mii_speed_t miiSpeed

MII Speed.

enet_mii_duplex_t miiDuplex

MII duplex.

uint16_t pauseDuration

Used in the Tx flow control frame, only valid when *kENET_FlowControlEnable* is set.

enet_rx_alloc_callback_t rxBuffAlloc

Callback to alloc memory, must be provided for zero-copy Rx.

enet_rx_free_callback_t rxBuffFree

Callback to free memory, must be provided for zero-copy Rx.

struct *_enet_tx_bd_ring*

#include <fsl_enet.h> Defines the ENET transmit buffer descriptor ring/queue structure.

Public Members

enet_tx_bd_struct_t *txBdBase
Buffer descriptor base address pointer.

uint16_t txGenIdx
Tx generate index.

uint16_t txConsumIdx
Tx consum index.

volatile uint16_t txDescUsed
Tx descriptor used number.

uint16_t txRingLen
Tx ring length.

struct __enet_rx_bd_ring
#include <fsl_enet.h> Defines the ENET receive buffer descriptor ring/queue structure.

Public Members

enet_rx_bd_struct_t *rxBdBase
Buffer descriptor base address pointer.

uint16_t rxGenIdx
The current available receive buffer descriptor pointer.

uint16_t rxRingLen
Receive ring length.

uint32_t rxBuffSizeAlign
Receive buffer size.

struct __enet_handle
#include <fsl_enet.h> Defines the ENET handler structure.

Public Members

bool multiQueEnable
Multi-queue enable status.

bool doubleBuffEnable
The double buffer enable status.

bool rxintEnable
Rx interrupt enable status.

enet_rx_bd_ring_t rxBdRing[(2U)]
Receive buffer descriptor.

enet_tx_bd_ring_t txBdRing[(2U)]
Transmit buffer descriptor.

enet_tx_dirty_ring_t txDirtyRing[(2U)]
Transmit dirty buffers addresses.

uint32_t *rxBufferStartAddr[(2U)]
The Init-Rx buffers used for reinit corrupted BD due to write-back operation.

uint32_t txLenLimitation[(2U)]

Tx frame length limitation.

enet_callback_t callback

Callback function.

void *userData

Callback function parameter.

enet_rx_alloc_callback_t rxBuffAlloc

Callback to alloc memory, must be provided for zero-copy Rx.

enet_rx_free_callback_t rxBuffFree

Callback to free memory, must be provided for zero-copy Rx.

struct __enet_buffer_struct

#include <fsl_enet.h>

Public Members

void *buffer

The buffer stores the whole or partial frame.

uint16_t length

The byte length of this buffer.

struct __enet_rx_frame_attribute_struct

#include <fsl_enet.h> Rx frame attribute structure.

Public Members

bool isTsAvail

Rx frame timestamp is available or not.

enet_ptp_time_t timestamp

The nanosecond part timestamp of this Rx frame.

struct __enet_rx_frame_error

#include <fsl_enet.h> Defines the Rx frame error structure.

Public Members

bool statsDribbleErr

The received packet has a non-integer multiple of bytes (odd nibbles).

bool statsRxErr

Receive error.

bool statsOverflowErr

Rx FIFO overflow error.

bool statsWatchdogTimeoutErr

Receive watchdog timeout.

bool statsGaintPacketErr

Receive error.

bool statsRxFcsErr

Receive CRC error.

```
struct __enet_rx_frame_struct
#include <fsl_enet.h> Defines the Rx frame data structure.
```

Public Members

enet_buffer_struct_t *rxBuffArray
Rx frame buffer structure.

uint16_t totLen
Rx frame total length.

enet_rx_frame_attribute_t rxAttribute
Rx frame attribute structure.

enet_rx_frame_error_t rxFrameError
Rx frame error.

```
struct __enet_tx_config_struct
#include <fsl_enet.h>
```

Public Members

uint8_t intEnable
Enable interrupt every time one BD is completed.

uint8_t tsEnable
Transmit timestamp enable.

uint8_t slotNum
Slot number control bits in AV mode.

enet_tx_offload_t txOffloadOps
Tx checksum offload option.

```
struct __enet_tx_frame_struct
#include <fsl_enet.h>
```

Public Members

enet_buffer_struct_t *txBuffArray
Tx frame buffer structure.

uint32_t txBuffNum
Buffer number of this Tx frame.

enet_tx_config_struct_t txConfig
Tx extra configuration.

void *context
Driver reclaims and gives it in Tx over callback.

2.27 GPIO: General Purpose I/O

`void GPIO_PortInit(GPIO_Type *base, uint32_t port)`

Initializes the GPIO peripheral.

This function ungates the GPIO clock.

Parameters

- `base` – GPIO peripheral base pointer.
- `port` – GPIO port number.

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

Initializes a GPIO pin used by the board.

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

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

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

Parameters

- `base` – GPIO peripheral base pointer(Typically GPIO)
- `port` – GPIO port number
- `pin` – GPIO pin number
- `config` – GPIO pin configuration pointer

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

Sets the output level of the one GPIO pin to the logic 1 or 0.

Parameters

- `base` – GPIO peripheral base pointer(Typically GPIO)
- `port` – GPIO port number
- `pin` – GPIO pin number
- `output` – GPIO pin output logic level.
 - 0: corresponding pin output low-logic level.
 - 1: corresponding pin output high-logic level.

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

Reads the current input value of the GPIO PIN.

Parameters

- `base` – GPIO peripheral base pointer(Typically GPIO)
- `port` – GPIO port number
- `pin` – GPIO pin number

Return values

GPIO – port input value

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

FSL_GPIO_DRIVER_VERSION

LPC GPIO driver version.

enum _gpio_pin_direction

LPC GPIO direction definition.

Values:

enumerator kGPIO_DigitalInput

Set current pin as digital input

enumerator kGPIO_DigitalOutput

Set current pin as digital output

typedef enum _gpio_pin_direction gpio_pin_direction_t

LPC GPIO direction definition.

typedef struct _gpio_pin_config gpio_pin_config_t

The GPIO pin configuration structure.

Every pin can only be configured as either output pin or input pin at a time. If configured as a input pin, then leave the outputConfig unused.

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

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

Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

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

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

Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

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

Reverses current output logic of the multiple GPIO pins.

Parameters

- base – GPIO peripheral base pointer(Typically GPIO)
- port – GPIO port number
- mask – GPIO pin number macro

struct _gpio_pin_config

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

Every pin can only be configured as either output pin or input pin at a time. If configured as a input pin, then leave the outputConfig unused.

Public Members

gpio_pin_direction_t pinDirection

GPIO direction, input or output

uint8_t outputLogic

Set default output logic, no use in input

2.28 IOCON: I/O pin configuration

FSL_IOCON_DRIVER_VERSION

IOCON driver version.

typedef struct *iocon_group* iocon_group_t

Array of IOCON pin definitions passed to IOCON_SetPinMuxing() must be in this format.

__STATIC_INLINE void IOCON_PinMuxSet (IOCON_Type *base, uint8_t port, uint8_t pin, uint32_t modefunc)

Sets I/O Control pin mux.

Parameters

- base – : The base of IOCON peripheral on the chip
- port – : GPIO port to mux
- pin – : GPIO pin to mux
- modefunc – : OR'ed values of type IOCON_*

Returns

Nothing

__STATIC_INLINE void IOCON_SetPinMuxing (IOCON_Type *base, const iocon_group_t *pinArray, uint32_t arrayLength)

Set all I/O Control pin muxing.

Parameters

- base – : The base of IOCON peripheral on the chip
- pinArray – : Pointer to array of pin mux selections
- arrayLength – : Number of entries in pinArray

Returns

Nothing

FSL_COMPONENT_ID

IOCON_FUNC0

IOCON function and mode selection definitions.

Note: See the User Manual for specific modes and functions supported by the various pins.
Selects pin function 0

IOCON_FUNC1

Selects pin function 1

IOCON_FUNC2

Selects pin function 2

IOCON_FUNC3

Selects pin function 3

IOCON_FUNC4

Selects pin function 4

IOCON_FUNC5

Selects pin function 5

IOCON_FUNC6

Selects pin function 6

IOCON_FUNC7

Selects pin function 7

struct _iocon_group

#include <fsl_iocon.h> Array of IOCON pin definitions passed to IOCON_SetPinMuxing() must be in this format.

2.29 LCDC: LCD Controller Driver

status_t LCDC_Init(LCD_Type *base, const *lcdc_config_t* *config, uint32_t srcClock_Hz)

Initialize the LCD module.

Parameters

- base – LCD peripheral base address.
- config – Pointer to configuration structure, see to *lcdc_config_t*.
- srcClock_Hz – The LCD input clock (LCDCLK) frequency in Hz.

Return values

- kStatus_Success – LCD is initialized successfully.
- kStatus_InvalidArgument – Initialize failed because of invalid argument.

void LCDC_Deinit(LCD_Type *base)

Deinitialize the LCD module.

Parameters

- base – LCD peripheral base address.

void LCDC_GetDefaultConfig(*lcdc_config_t* *config)

Gets default pre-defined settings for initial configuration.

This function initializes the configuration structure. The default values are:

```
config->panelClock_Hz = 0U;
config->ppl = 0U;
config->hsw = 0U;
config->hfp = 0U;
config->hbp = 0U;
config->lpp = 0U;
config->vsw = 0U;
config->vfp = 0U;
config->vbp = 0U;
config->acBiasFreq = 1U;
config->polarityFlags = 0U;
config->enableLineEnd = false;
config->lineEndDelay = 0U;
```

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```

config->upperPanelAddr = 0U;
config->lowerPanelAddr = 0U;
config->bpp = kLDCDC_1BPP;
config->dataFormat = kLDCDC_LittleEndian;
config->swapRedBlue = false;
config->display = kLDCDC_DisplayTFT;

```

Parameters

- config – Pointer to configuration structure.

static inline void LDCDC_Start(LCD_Type *base)

Start to output LCD timing signal.

The LCD power up sequence should be:

- Apply power to LCD, here all output signals are held low.
- When LCD power stabilized, call LDCDC_Start to output the timing signals.
- Apply contrast voltage to LCD panel. Delay if the display requires.
- Call LDCDC_PowerUp.

Parameters

- base – LCD peripheral base address.

static inline void LDCDC_Stop(LCD_Type *base)

Stop the LCD timing signal.

The LCD power down sequence should be:

- Call LDCDC_PowerDown.
- Delay if the display requires. Disable contrast voltage to LCD panel.
- Call LDCDC_Stop to disable the timing signals.
- Disable power to LCD.

Parameters

- base – LCD peripheral base address.

static inline void LDCDC_PowerUp(LCD_Type *base)

Power up the LCD and output the pixel signal.

Parameters

- base – LCD peripheral base address.

static inline void LDCDC_PowerDown(LCD_Type *base)

Power down the LCD and disable the output pixel signal.

Parameters

- base – LCD peripheral base address.

void LDCDC_SetPanelAddr(LCD_Type *base, *ldc_panel_t* panel, uint32_t addr)

Sets panel frame base address.

Parameters

- base – LCD peripheral base address.
- panel – Which panel to set.
- addr – Frame base address, must be doubleword(64-bit) aligned.

`void LCDC_SetPalette(LCD_Type *base, const uint32_t *palette, uint8_t count_words)`
Sets palette.

Parameters

- `base` – LCD peripheral base address.
- `palette` – Pointer to the palette array.
- `count_words` – Length of the palette array to set (how many words), it should not be larger than `LCDC_PALETTE_SIZE_WORDS`.

`static inline void LCDC_SetVerticalInterruptMode(LCD_Type *base,
lcde_vertical_compare_interrupt_mode_t mode)`

Sets the vertical compare interrupt mode.

Parameters

- `base` – LCD peripheral base address.
- `mode` – The vertical compare interrupt mode.

`void LCDC_EnableInterrupts(LCD_Type *base, uint32_t mask)`
Enable LCD interrupts.

Example to enable LCD base address update interrupt and vertical compare interrupt:

```
LCDC_EnableInterrupts(LCD, kLCDC_BaseAddrUpdateInterrupt | kLCDC_  
↪ VerticalCompareInterrupt);
```

Parameters

- `base` – LCD peripheral base address.
- `mask` – Interrupts to enable, it is OR'ed value of `_ldc_interrupts`.

`void LCDC_DisableInterrupts(LCD_Type *base, uint32_t mask)`
Disable LCD interrupts.

Example to disable LCD base address update interrupt and vertical compare interrupt:

```
LCDC_DisableInterrupts(LCD, kLCDC_BaseAddrUpdateInterrupt | kLCDC_  
↪ VerticalCompareInterrupt);
```

Parameters

- `base` – LCD peripheral base address.
- `mask` – Interrupts to disable, it is OR'ed value of `_ldc_interrupts`.

`uint32_t LCDC_GetInterruptsPendingStatus(LCD_Type *base)`
Get LCD interrupt pending status.

Example:

```
uint32_t status;  
  
status = LCDC_GetInterruptsPendingStatus(LCD);  
  
if (kLCDC_BaseAddrUpdateInterrupt & status)  
{  
    LCD base address update interrupt occurred.  
}  
  
if (kLCDC_VeriticalCompareInterrupt & status)
```

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```
{
    LCD vertical compare interrupt occurred.
}
```

Parameters

- base – LCD peripheral base address.

Returns

Interrupts pending status, it is OR'ed value of `_ldc_interrupts`.

```
uint32_t LCD_C_GetEnabledInterruptsPendingStatus(LCD_Type *base)
```

Get LCD enabled interrupt pending status.

This function is similar with `LCD_C_GetInterruptsPendingStatus`, the only difference is, this function only returns the pending status of the interrupts that have been enabled using `LCD_EnableInterrupts`.

Parameters

- base – LCD peripheral base address.

Returns

Interrupts pending status, it is OR'ed value of `_ldc_interrupts`.

```
void LCD_C_ClearInterruptsStatus(LCD_Type *base, uint32_t mask)
```

Clear LCD interrupts pending status.

Example to clear LCD base address update interrupt and vertical compare interrupt pending status:

```
LCD_C_ClearInterruptsStatus(LCD, kLCD_C_BaseAddrUpdateInterrupt | kLCD_C_
↪ VerticalCompareInterrupt);
```

Parameters

- base – LCD peripheral base address.
- mask – Interrupts to disable, it is OR'ed value of `_ldc_interrupts`.

```
void LCD_C_SetCursorConfig(LCD_Type *base, const lcdc_cursor_config_t *config)
```

Set the hardware cursor configuration.

This function should be called before enabling the hardware cursor. It supports initializing multiple cursor images at a time when using 32x32 pixels cursor.

For example:

```
uint32_t cursor0Img[LCD_C_CURSOR_IMG_32X32_WORDS] = {...};
uint32_t cursor2Img[LCD_C_CURSOR_IMG_32X32_WORDS] = {...};

ldc_cursor_config_t cursorConfig;

LCD_C_CursorGetDefaultConfig(&cursorConfig);

cursorConfig.image[0] = cursor0Img;
cursorConfig.image[2] = cursor2Img;

LCD_C_SetCursorConfig(LCD, &cursorConfig);

LCD_C_ChooseCursor(LCD, 0);
LCD_C_SetCursorPosition(LCD, 0, 0);

LCD_C_EnableCursor(LCD);
```

In this example, cursor 0 and cursor 2 image data are initialized, but cursor 1 and cursor 3 image data are not initialized because image[1] and image[2] are all NULL. With this, application could initialize all cursor images it will use at the beginning and call `LCDC_SetCursorImage` directly to display the one which it needs.

Parameters

- base – LCD peripheral base address.
- config – Pointer to the hardware cursor configuration structure.

`void LCDC_CursorGetDefaultConfig(lcdc_cursor_config_t *config)`

Get the hardware cursor default configuration.

The default configuration values are:

```
config->size = kLCDC_CursorSize32;
config->syncMode = kLCDC_CursorAsync;
config->palette0.red = 0U;
config->palette0.green = 0U;
config->palette0.blue = 0U;
config->palette1.red = 255U;
config->palette1.green = 255U;
config->palette1.blue = 255U;
config->image[0] = (uint32_t *)0;
config->image[1] = (uint32_t *)0;
config->image[2] = (uint32_t *)0;
config->image[3] = (uint32_t *)0;
```

Parameters

- config – Pointer to the hardware cursor configuration structure.

`static inline void LCDC_EnableCursor(LCD_Type *base, bool enable)`

Enable or disable the cursor.

Parameters

- base – LCD peripheral base address.
- enable – True to enable, false to disable.

`static inline void LCDC_ChooseCursor(LCD_Type *base, uint8_t index)`

Choose which cursor to display.

When using 32x32 cursor, the number of cursors supports is `LCDC_CURSOR_COUNT`. When using 64x64 cursor, the LCD only supports one cursor. This function selects which cursor to display when using 32x32 cursor. When synchronization mode is `kLCDC_CursorSync`, the change effects in the next frame. When synchronization mode is `kLCDC_CursorAsync`, change effects immediately.

Note: The function `LCDC_SetCursorPosition` must be called after this function to show the new cursor.

Parameters

- base – LCD peripheral base address.
- index – Index of the cursor to display.

`void LCDC_SetCursorPosition(LCD_Type *base, int32_t positionX, int32_t positionY)`

Set the position of cursor.

When synchronization mode is `kLDCD_CursorSync`, position change effects in the next frame. When synchronization mode is `kLDCD_CursorAsync`, position change effects immediately.

Parameters

- `base` – LCD peripheral base address.
- `positionX` – X ordinate of the cursor top-left measured in pixels
- `positionY` – Y ordinate of the cursor top-left measured in pixels

```
void LDCD_SetCursorImage(LCD_Type *base, lcdc_cursor_size_t size, uint8_t index, const
                        uint32_t *image)
```

Set the cursor image.

The interrupt `kLDCD_CursorInterrupt` indicates that last cursor pixel is displayed. When the hardware cursor is enabled,

Parameters

- `base` – LCD peripheral base address.
- `size` – The cursor size.
- `index` – Index of the cursor to set when using 32x32 cursor.
- `image` – Pointer to the cursor image. When using 32x32 cursor, the image size should be `LDCD_CURSOR_IMG_32X32_WORDS`. When using 64x64 cursor, the image size should be `LDCD_CURSOR_IMG_64X64_WORDS`.

`FSL_LCDC_DRIVER_VERSION`

LDCD driver version.

`enum _lcdc_polarity_flags`

LCD signal polarity flags.

Values:

enumerator `kLDCD_InvertVsyncPolarity`

Invert the VSYNC polarity, set to active low.

enumerator `kLDCD_InvertHsyncPolarity`

Invert the HSYNC polarity, set to active low.

enumerator `kLDCD_InvertClkPolarity`

Invert the panel clock polarity, set to drive data on falling edge.

enumerator `kLDCD_InvertDePolarity`

Invert the data enable (DE) polarity, set to active low.

`enum _lcdc_bpp`

LCD bits per pixel.

Values:

enumerator `kLDCD_1BPP`

1 bpp.

enumerator `kLDCD_2BPP`

2 bpp.

enumerator `kLDCD_4BPP`

4 bpp.

enumerator `kLDCD_8BPP`

8 bpp.

enumerator kLCDC_16BPP

16 bpp.

enumerator kLCDC_24BPP

24 bpp, TFT panel only.

enumerator kLCDC_16BPP565

16 bpp, 5:6:5 mode.

enumerator kLCDC_12BPP

12 bpp, 4:4:4 mode.

enum _lcdc_display

The types of display panel.

Values:

enumerator kLCDC_DisplayTFT

Active matrix TFT panels with up to 24-bit bus interface.

enumerator kLCDC_DisplaySingleMonoSTN4Bit

Single-panel monochrome STN (4-bit bus interface).

enumerator kLCDC_DisplaySingleMonoSTN8Bit

Single-panel monochrome STN (8-bit bus interface).

enumerator kLCDC_DisplayDualMonoSTN4Bit

Dual-panel monochrome STN (4-bit bus interface).

enumerator kLCDC_DisplayDualMonoSTN8Bit

Dual-panel monochrome STN (8-bit bus interface).

enumerator kLCDC_DisplaySingleColorSTN8Bit

Single-panel color STN (8-bit bus interface).

enumerator kLCDC_DisplayDualColorSTN8Bit

Dual-panel color STN (8-bit bus interface).

enum _lcdc_data_format

LCD panel buffer data format.

Values:

enumerator kLCDC_LittleEndian

Little endian byte, little endian pixel.

enumerator kLCDC_BigEndian

Big endian byte, big endian pixel.

enumerator kLCDC_WinCeMode

little-endian byte, big-endian pixel for Windows CE mode.

enum _lcdc_vertical_compare_interrupt_mode

LCD vertical compare interrupt mode.

Values:

enumerator kLCDC_StartOfVsync

Generate vertical compare interrupt at start of VSYNC.

enumerator kLCDC_StartOfBackPorch

Generate vertical compare interrupt at start of back porch.

enumerator kLDCD_StartOfActiveVideo

Generate vertical compare interrupt at start of active video.

enumerator kLDCD_StartOfFrontPorch

Generate vertical compare interrupt at start of front porch.

enum _lcdc_interrupts

LCD interrupts.

Values:

enumerator kLDCD_CursorInterrupt

Cursor image read finished interrupt.

enumerator kLDCD_FifoUnderflowInterrupt

FIFO underflow interrupt.

enumerator kLDCD_BaseAddrUpdateInterrupt

Panel frame base address update interrupt.

enumerator kLDCD_VerticalCompareInterrupt

Vertical compare interrupt.

enumerator kLDCD_AhbErrorInterrupt

AHB master error interrupt.

enum _lcdc_panel

LCD panel frame.

Values:

enumerator kLDCD_UpperPanel

Upper panel frame.

enumerator kLDCD_LowerPanel

Lower panel frame.

enum _lcdc_cursor_size

LCD hardware cursor size.

Values:

enumerator kLDCD_CursorSize32

32x32 pixel cursor.

enumerator kLDCD_CursorSize64

64x64 pixel cursor.

enum _lcdc_cursor_sync_mode

LCD hardware cursor frame synchronization mode.

Values:

enumerator kLDCD_CursorAsync

Cursor change will be displayed immediately.

enumerator kLDCD_CursorSync

Cursor change will be displayed in next frame.

typedef enum _lcdc_bpp lcdc_bpp_t

LCD bits per pixel.

typedef enum _lcdc_display lcdc_display_t

The types of display panel.

typedef enum *_ldc_data_format* ldc_data_format_t

LCD panel buffer data format.

typedef struct *_ldc_config* ldc_config_t

LCD configuration structure.

typedef enum *_ldc_vertical_compare_interrupt_mode* ldc_vertical_compare_interrupt_mode_t

LCD vertical compare interrupt mode.

typedef enum *_ldc_panel* ldc_panel_t

LCD panel frame.

typedef enum *_ldc_cursor_size* ldc_cursor_size_t

LCD hardware cursor size.

typedef struct *_ldc_cursor_palette* ldc_cursor_palette_t

LCD hardware cursor palette.

typedef enum *_ldc_cursor_sync_mode* ldc_cursor_sync_mode_t

LCD hardware cursor frame synchronization mode.

typedef struct *_ldc_cursor_config* ldc_cursor_config_t

LCD hardware cursor configuration structure.

LCDC_CURSOR_COUNT

How many hardware cursors supports.

LCDC_CURSOR_IMG_BPP

LCD cursor image bits per pixel.

LCDC_CURSOR_IMG_32X32_WORDS

LCD 32x32 cursor image size in word(32-bit).

LCDC_CURSOR_IMG_64X64_WORDS

LCD 64x64 cursor image size in word(32-bit).

LCDC_PALETTE_SIZE_WORDS

LCD palette size in words(32-bit).

struct *_ldc_config*

#include <fsl_ldc.h> LCD configuration structure.

Public Members

uint32_t panelClock_Hz

Panel clock in Hz.

uint16_t ppl

Pixels per line, it must could be divided by 16.

uint8_t hsw

HSYNC pulse width.

uint8_t hfp

Horizontal front porch.

uint8_t hbp

Horizontal back porch.

uint16_t lpp

Lines per panal.

`uint8_t vsw`
VSYNC pulse width.

`uint8_t vfp`
Vrtical front porch.

`uint8_t vbp`
Vertical back porch.

`uint8_t acBiasFreq`
The number of line clocks between AC bias pin toggling. Only used for STN display.

`uint16_t polarityFlags`
OR'ed value of `_ldc_polarity_flags`, used to contol the signal polarity.

`bool enableLineEnd`
Enable line end or not, the line end is a positive pulse with 4 panel clock.

`uint8_t lineEndDelay`
The panel clocks between the last pixel of line and the start of line end.

`uint32_t upperPanelAddr`
LCD upper panel base address, must be double-word(64-bit) align.

`uint32_t lowerPanelAddr`
LCD lower panel base address, must be double-word(64-bit) align.

`ldc_bpp_t bpp`
LCD bits per pixel.

`ldc_data_format_t dataFormat`
Data format.

`bool swapRedBlue`
Set true to use BGR format, set false to choose RGB format.

`ldc_display_t display`
The display type.

`struct _ldc_cursor_palette`
#include <fsl_ldc.h> LCD hardware cursor palette.

Public Members

`uint8_t red`
Red color component.

`uint8_t green`
Red color component.

`uint8_t blue`
Red color component.

`struct _ldc_cursor_config`
#include <fsl_ldc.h> LCD hardware cursor configuration structure.

Public Members

`ldc_cursor_size_t size`
Cursor size.

lcdc_cursor_sync_mode_t syncMode

Cursor synchronization mode.

lcdc_cursor_palette_t palette0

Cursor palette 0.

lcdc_cursor_palette_t palette1

Cursor palette 1.

uint32_t *image[4U]

Pointer to cursor image data.

2.30 MCAN: Controller Area Network Driver

void MCAN_Init(CAN_Type *base, const *mcan_config_t* *config, uint32_t sourceClock_Hz)

Initializes an MCAN instance.

This function initializes the MCAN module with user-defined settings. This example shows how to set up the *mcan_config_t* parameters and how to call the MCAN_Init function by passing in these parameters.

```
mcan_config_t config;
config->baudRateA = 500000U;
config->baudRateD = 1000000U;
config->enableCanfdNormal = false;
config->enableCanfdSwitch = false;
config->enableLoopBackInt = false;
config->enableLoopBackExt = false;
config->enableBusMon = false;
MCAN_Init(CANFD0, &config, 8000000UL);
```

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the user-defined configuration structure.
- sourceClock_Hz – MCAN Protocol Engine clock source frequency in Hz.

void MCAN_Deinit(CAN_Type *base)

Deinitializes an MCAN instance.

This function deinitializes the MCAN module.

Parameters

- base – MCAN peripheral base address.

void MCAN_GetDefaultConfig(*mcan_config_t* *config)

Gets the default configuration structure.

This function initializes the MCAN configuration structure to default values. The default values are as follows. config->baudRateA = 500000U; config->baudRateD = 1000000U; config->enableCanfdNormal = false; config->enableCanfdSwitch = false; config->enableLoopBackInt = false; config->enableLoopBackExt = false; config->enableBusMon = false;

Parameters

- config – Pointer to the MCAN configuration structure.

static inline void MCAN_EnterInitialMode(CAN_Type *base)

MCAN enters initialization mode.

After enter initialization mode, users can write access to the protected configuration registers.

Parameters

- base – MCAN peripheral base address.

static inline void MCAN_EnterNormalMode(CAN_Type *base)

MCAN enters normal mode.

After initialization, INIT bit in CCCR register must be cleared to enter normal mode thus synchronizes to the CAN bus and ready for communication.

Parameters

- base – MCAN peripheral base address.

static inline void MCAN_SetMsgRAMBase(CAN_Type *base, uint32_t value)

Sets the MCAN Message RAM base address.

This function sets the Message RAM base address.

Parameters

- base – MCAN peripheral base address.
- value – Desired Message RAM base.

static inline uint32_t MCAN_GetMsgRAMBase(CAN_Type *base)

Gets the MCAN Message RAM base address.

This function gets the Message RAM base address.

Parameters

- base – MCAN peripheral base address.

Returns

Message RAM base address.

bool MCAN_CalculateImprovedTimingValues(uint32_t baudRate, uint32_t sourceClock_Hz, *mcan_timing_config_t* *pconfig)

Calculates the improved timing values by specific baudrates for classical CAN.

Parameters

- baudRate – The classical CAN speed in bps defined by user
- sourceClock_Hz – The Source clock data speed in bps. Zero to disable baudrate switching
- pconfig – Pointer to the MCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

bool MCAN_CalculateSpecifiedTimingValues(uint32_t sourceClock_Hz, *mcan_timing_config_t* *pconfig, const *mcan_timing_param_t* *pParamConfig)

Calculates the specified timing values for classical CAN with user-defined settings.

User can specify baudrates, sample point position, bus length, and transceiver propagation delay. This example shows how to set up the *mcan_timing_param_t* parameters and how to call the this function by passing in these parameters.

```
mcan_timing_config_t timing_config;
mcan_timing_param_t timing_param;
timing_param.busLength = 1U;
timing_param.propTxRx = 230U;
timing_param.nominalbaudRate = 500000U;
timing_param.nominalSP = 800U;
MCAN_CalculateSpecifiedTimingValues(MCAN_CLK_FREQ, &timing_config, &timing_param);
```

Note that due to integer division will sacrifice the precision, actual sample point may not equal to expected. If actual sample point is not in allowed 2% range, this function will return false. So it is better to select higher source clock when baudrate is relatively high. This will ensure more time quanta and higher precision of sample point. Parameter busLength and propTxRx are optional and intended to verify whether propagation delay is too long to corrupt sample point. User can set these parameter zero if you do not want to consider this factor.

Parameters

- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.
- config – Pointer to the MCAN timing parameters structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

`void MCAN_SetArbitrationTimingConfig(CAN_Type *base, const mcan_timing_config_t *config)`
Sets the MCAN protocol arbitration phase timing characteristic.

This function gives user settings to CAN bus timing characteristic. The function is for an experienced user. For less experienced users, call the MCAN_Init() and fill the baud rate field with a desired value. This provides the default arbitration phase timing characteristics.

Note that calling MCAN_SetArbitrationTimingConfig() overrides the baud rate set in MCAN_Init().

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the timing configuration structure.

`status_t MCAN_SetBaudRate(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t baudRate_Bps)`

Set Baud Rate of MCAN classic mode.

This function set the baud rate of MCAN base on MCAN_CalculateImprovedTimingValues() API calculated timing values.

Parameters

- base – MCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- baudRate_Bps – Baud Rate in Bps.

Returns

kStatus_Success - Set CAN baud rate (only has Nominal phase) successfully.

`bool MCAN_FDCalculateImprovedTimingValues(uint32_t baudRate, uint32_t baudRateFD, uint32_t sourceClock_Hz, mcan_timing_config_t *pconfig)`

Calculates the improved timing values by specific baudrates for CANFD.

Parameters

- baudRate – The CANFD bus control speed in bps defined by user
- baudRateFD – The CANFD bus data speed in bps defined by user
- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

```
bool MCAN_FDCalculateSpecifiedTimingValues(uint32_t sourceClock_Hz, mcan_timing_config_t
                                         *pconfig, const mcan_timing_param_t
                                         *pParamConfig)
```

Calculates the specified timing values for CANFD with user-defined settings.

User can specify baudrates, sample point position, bus length, and transceiver propagation delay. This example shows how to set up the `mcan_timing_param_t` parameters and how to call the this function by passing in these parameters.

```
mcan_timing_config_t timing_config;
mcan_timing_param_t timing_param;
timing_param.busLength = 1U;
timing_param.propTxRx = 230U;
timing_param.nominalbaudRate = 500000U;
timing_param.nominalSP = 800U;
timing_param.databaudRate = 4000000U;
timing_param.dataSP = 700U;
MCAN_FDCalculateSpecifiedTimingValues(MCAN_CLK_FREQ, &timing_config, &timing_param);
```

Note that due to integer division will sacrifice the precision, actual sample point may not equal to expected. So it is better to select higher source clock when baudrate is relatively high. Select higher nominal baudrate when source clock is relatively high because large clock predivider will lead to less time quanta in data phase. This function will set predivider in arbitration phase equal to data phase. These methods will ensure more time quanta and higher precision of sample point. Parameter busLength and propTxRx are optional and intended to verify whether propagation delay is too long to corrupt sample point. User can set these parameter zero if you do not want to consider this factor.

Parameters

- sourceClock_Hz – The Source clock data speed in bps.
- pconfig – Pointer to the MCAN timing configuration structure.
- config – Pointer to the MCAN timing parameters structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

```
status_t MCAN_SetBaudRateFD(CAN_Type *base, uint32_t sourceClock_Hz, uint32_t
                           baudRateN_Bps, uint32_t baudRateD_Bps)
```

Set Baud Rate of MCAN FD mode.

This function set the baud rate of MCAN FD base on MCAN_FDCalculateImprovedTimingValues API calculated timing values.

Parameters

- base – MCAN peripheral base address.
- sourceClock_Hz – Source Clock in Hz.
- baudRateN_Bps – Nominal Baud Rate in Bps.
- baudRateD_Bps – Data Baud Rate in Bps.

Returns

kStatus_Success - Set CAN FD baud rate (include Nominal and Data phase) successfully.

void MCAN_SetDataTimingConfig(CAN_Type *base, const *mcan_timing_config_t* *config)

Sets the MCAN protocol data phase timing characteristic.

This function gives user settings to CAN bus timing characteristic. The function is for an experienced user. For less experienced users, call the MCAN_Init() and fill the baud rate field with a desired value. This provides the default data phase timing characteristics.

Note that calling MCAN_SetArbitrationTimingConfig() overrides the baud rate set in MCAN_Init().

Parameters

- base – MCAN peripheral base address.
- config – Pointer to the timing configuration structure.

void MCAN_SetRxFifo0Config(CAN_Type *base, const *mcan_rx_fifo_config_t* *config)

Configures an MCAN receive fifo 0 buffer.

This function sets start address, element size, watermark, operation mode and datafield size of the receive fifo 0.

Parameters

- base – MCAN peripheral base address.
- config – The receive fifo 0 configuration structure.

void MCAN_SetRxFifo1Config(CAN_Type *base, const *mcan_rx_fifo_config_t* *config)

Configures an MCAN receive fifo 1 buffer.

This function sets start address, element size, watermark, operation mode and datafield size of the receive fifo 1.

Parameters

- base – MCAN peripheral base address.
- config – The receive fifo 1 configuration structure.

void MCAN_SetRxBufferConfig(CAN_Type *base, const *mcan_rx_buffer_config_t* *config)

Configures an MCAN receive buffer.

This function sets start address and datafield size of the receive buffer.

Parameters

- base – MCAN peripheral base address.
- config – The receive buffer configuration structure.

void MCAN_SetTxEventFifoConfig(CAN_Type *base, const *mcan_tx_fifo_config_t* *config)

Configures an MCAN transmit event fifo.

This function sets start address, element size, watermark of the transmit event fifo.

Parameters

- base – MCAN peripheral base address.
- config – The transmit event fifo configuration structure.

void MCAN_SetTxBufferConfig(CAN_Type *base, const *mcan_tx_buffer_config_t* *config)

Configures an MCAN transmit buffer.

This function sets start address, element size, fifo/queue mode and datafield size of the transmit buffer.

Parameters

- base – MCAN peripheral base address.
- config – The transmit buffer configuration structure.

void MCAN_SetFilterConfig(CAN_Type *base, const *mcan_frame_filter_config_t* *config)

Set filter configuration.

This function sets remote and non masking frames in global filter configuration, also the start address, list size in standard/extended ID filter configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.

status_t MCAN_SetMessageRamConfig(CAN_Type *base, const *mcan_memory_config_t* *config)

Set Message RAM related configuration.

Note: This function include Standard/extended ID filter, Rx FIFO 0/1, Rx buffer, Tx event FIFO and Tx buffer configurations

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.

Return values

- kStatus_Success – - Message RAM related configuration Successfully.
- kStatus_Fail – - Message RAM related configure fail due to wrong address parameter.

void MCAN_SetSTDFilterElement(CAN_Type *base, const *mcan_frame_filter_config_t* *config, const *mcan_std_filter_element_config_t* *filter, uint8_t idx)

Set standard message ID filter element configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.
- filter – The MCAN standard message ID filter element configuration.
- idx – The standard message ID filter element index.

void MCAN_SetEXTFilterElement(CAN_Type *base, const *mcan_frame_filter_config_t* *config, const *mcan_ext_filter_element_config_t* *filter, uint8_t idx)

Set extended message ID filter element configuration.

Parameters

- base – MCAN peripheral base address.
- config – The MCAN filter configuration.
- filter – The MCAN extended message ID filter element configuration.
- idx – The extended message ID filter element index.

```
static inline uint32_t MCAN_GetStatusFlag(CAN_Type *base, uint32_t mask)
```

Gets the MCAN module interrupt flags.

This function gets all MCAN interrupt status flags.

Parameters

- base – MCAN peripheral base address.
- mask – The ORed MCAN interrupt mask.

Returns

MCAN status flags which are ORed.

```
static inline void MCAN_ClearStatusFlag(CAN_Type *base, uint32_t mask)
```

Clears the MCAN module interrupt flags.

This function clears MCAN interrupt status flags.

Parameters

- base – MCAN peripheral base address.
- mask – The ORed MCAN interrupt mask.

```
static inline bool MCAN_GetRxBufferStatusFlag(CAN_Type *base, uint8_t idx)
```

Gets the new data flag of specific Rx Buffer.

This function gets new data flag of specific Rx Buffer.

Parameters

- base – MCAN peripheral base address.
- idx – Rx Buffer index.

Returns

Rx Buffer new data status flag.

```
static inline void MCAN_ClearRxBufferStatusFlag(CAN_Type *base, uint8_t idx)
```

Clears the new data flag of specific Rx Buffer.

This function clears new data flag of specific Rx Buffer.

Parameters

- base – MCAN peripheral base address.
- idx – Rx Buffer index.

```
static inline void MCAN_EnableInterrupts(CAN_Type *base, uint32_t line, uint32_t mask)
```

Enables MCAN interrupts according to the provided interrupt line and mask.

This function enables the MCAN interrupts according to the provided interrupt line and mask. The mask is a logical OR of enumeration members.

Parameters

- base – MCAN peripheral base address.
- line – Interrupt line number, 0 or 1.
- mask – The interrupts to enable.

```
static inline void MCAN_EnableTransmitBufferInterrupts(CAN_Type *base, uint8_t idx)
```

Enables MCAN Tx Buffer interrupts according to the provided index.

This function enables the MCAN Tx Buffer interrupts.

Parameters

- base – MCAN peripheral base address.

- idx – Tx Buffer index.

static inline void MCAN_DisableTransmitBufferInterrupts(CAN_Type *base, uint8_t idx)

Disables MCAN Tx Buffer interrupts according to the provided index.

This function disables the MCAN Tx Buffer interrupts.

Parameters

- base – MCAN peripheral base address.
- idx – Tx Buffer index.

static inline void MCAN_DisableInterrupts(CAN_Type *base, uint32_t mask)

Disables MCAN interrupts according to the provided mask.

This function disables the MCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members.

Parameters

- base – MCAN peripheral base address.
- mask – The interrupts to disable.

uint32_t MCAN_IsTransmitRequestPending(CAN_Type *base, uint8_t idx)

Gets the Tx buffer request pending status.

This function returns Tx Message Buffer transmission request pending status.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.

uint32_t MCAN_IsTransmitOccurred(CAN_Type *base, uint8_t idx)

Gets the Tx buffer transmission occurred status.

This function returns Tx Message Buffer transmission occurred status.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.

status_t MCAN_WriteTxBuffer(CAN_Type *base, uint8_t idx, const *mcan_tx_buffer_frame_t* *pTxFrame)

Writes an MCAN Message to the Transmit Buffer.

This function writes a CAN Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN Message transmit. After that the function returns immediately.

Parameters

- base – MCAN peripheral base address.
- idx – The MCAN Tx Buffer index.
- pTxFrame – Pointer to CAN message frame to be sent.

status_t MCAN_ReadRxBuffer(CAN_Type *base, uint8_t idx, *mcan_rx_buffer_frame_t* *pRxFrame)

Reads an MCAN Message from Rx Buffer.

This function reads a CAN message from the Rx Buffer in the Message RAM.

Parameters

- base – MCAN peripheral base address.

- `idx` – The MCAN Rx Buffer index.
- `pRxFrame` – Pointer to CAN message frame structure for reception.

Return values

`kStatus_Success` – Read Message from Rx Buffer successfully.

`status_t` MCAN_ReadRxFifo(CAN_Type *base, uint8_t fifoBlock, *mcan_rx_buffer_frame_t* *pRxFrame)

Reads an MCAN Message from Rx FIFO.

This function reads a CAN message from the Rx FIFO in the Message RAM.

Parameters

- `base` – MCAN peripheral base address.
- `fifoBlock` – Rx FIFO block 0 or 1.
- `pRxFrame` – Pointer to CAN message frame structure for reception.

Return values

`kStatus_Success` – Read Message from Rx FIFO successfully.

static inline void MCAN_TransmitAddRequest(CAN_Type *base, uint8_t idx)

Tx Buffer add request to send message out.

This function add sending request to corresponding Tx Buffer.

Parameters

- `base` – MCAN peripheral base address.
- `idx` – Tx Buffer index.

static inline void MCAN_TransmitCancelRequest(CAN_Type *base, uint8_t idx)

Tx Buffer cancel sending request.

This function clears Tx buffer request pending bit.

Parameters

- `base` – MCAN peripheral base address.
- `idx` – Tx Buffer index.

`status_t` MCAN_TransferSendBlocking(CAN_Type *base, uint8_t idx, *mcan_tx_buffer_frame_t* *pTxFrame)

Performs a polling send transaction on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- `base` – MCAN peripheral base pointer.
- `idx` – The MCAN buffer index.
- `pTxFrame` – Pointer to CAN message frame to be sent.

Return values

- `kStatus_Success` – Write Tx Message Buffer Successfully.
- `kStatus_Fail` – Tx Message Buffer is currently in use.

`status_t` MCAN_TransferReceiveBlocking(CAN_Type *base, uint8_t idx, *mcan_rx_buffer_frame_t* *pRxFrame)

Performs a polling receive transaction on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- base – MCAN peripheral base pointer.
- idx – The MCAN buffer index.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – Read Rx Message Buffer Successfully.
- kStatus_Fail – No new message.

status_t MCAN_TransferReceiveFifoBlocking(CAN_Type *base, uint8_t fifoBlock,
mcan_rx_buffer_frame_t *pRxFrame)

Performs a polling receive transaction from Rx FIFO on the CAN bus.

Note that a transfer handle does not need to be created before calling this API.

Parameters

- base – MCAN peripheral base pointer.
- fifoBlock – Rx FIFO block, 0 or 1.
- pRxFrame – Pointer to CAN message frame structure for reception.

Return values

- kStatus_Success – Read Message from Rx FIFO successfully.
- kStatus_Fail – No new message in Rx FIFO.

void MCAN_TransferCreateHandle(CAN_Type *base, mcan_handle_t *handle,
mcan_transfer_callback_t callback, void *userData)

Initializes the MCAN handle.

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

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

status_t MCAN_TransferSendNonBlocking(CAN_Type *base, mcan_handle_t *handle,
mcan_buffer_transfer_t *xfer)

Sends a message using IRQ.

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- xfer – MCAN Buffer transfer structure. See the mcan_buffer_transfer_t.

Return values

- kStatus_Success – Start Tx Buffer sending process successfully.
- kStatus_Fail – Write Tx Buffer failed.
- kStatus_MCAN_TxBusy – Tx Buffer is in use.

```
status_t MCAN_TransferReceiveFifoNonBlocking(CAN_Type *base, uint8_t fifoBlock,  
                                              mcan_handle_t *handle, mcan_fifo_transfer_t  
                                              *xfer)
```

Receives a message from Rx FIFO using IRQ.

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- fifoBlock – Rx FIFO block, 0 or 1.
- xfer – MCAN Rx FIFO transfer structure. See the *mcan_fifo_transfer_t*.

Return values

- *kStatus_Success* – - Start Rx FIFO receiving process successfully.
- *kStatus_MCAN_RxFifo0Busy* – - Rx FIFO 0 is currently in use.
- *kStatus_MCAN_RxFifo1Busy* – - Rx FIFO 1 is currently in use.

```
void MCAN_TransferAbortSend(CAN_Type *base, mcan_handle_t *handle, uint8_t bufferIdx)
```

Aborts the interrupt driven message send process.

This function aborts the interrupt driven message send process.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.
- bufferIdx – The MCAN Buffer index.

```
void MCAN_TransferAbortReceiveFifo(CAN_Type *base, uint8_t fifoBlock, mcan_handle_t  
                                   *handle)
```

Aborts the interrupt driven message receive from Rx FIFO process.

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

- base – MCAN peripheral base address.
- fifoBlock – MCAN Fifo block, 0 or 1.
- handle – MCAN handle pointer.

```
void MCAN_TransferHandleIRQ(CAN_Type *base, mcan_handle_t *handle)
```

MCAN IRQ handle function.

This function handles the MCAN Error, the Buffer, and the Rx FIFO IRQ request.

Parameters

- base – MCAN peripheral base address.
- handle – MCAN handle pointer.

```
FSL_MCAN_DRIVER_VERSION
```

MCAN driver version.

MCAN transfer status.

Values:

enumerator kStatus_MCAN_TxBusy
Tx Buffer is Busy.

enumerator kStatus_MCAN_TxIdle
Tx Buffer is Idle.

enumerator kStatus_MCAN_RxBusy
Rx Buffer is Busy.

enumerator kStatus_MCAN_RxIdle
Rx Buffer is Idle.

enumerator kStatus_MCAN_RxFifo0New
New message written to Rx FIFO 0.

enumerator kStatus_MCAN_RxFifo0Idle
Rx FIFO 0 is Idle.

enumerator kStatus_MCAN_RxFifo0Watermark
Rx FIFO 0 fill level reached watermark.

enumerator kStatus_MCAN_RxFifo0Full
Rx FIFO 0 full.

enumerator kStatus_MCAN_RxFifo0Lost
Rx FIFO 0 message lost.

enumerator kStatus_MCAN_RxFifo1New
New message written to Rx FIFO 1.

enumerator kStatus_MCAN_RxFifo1Idle
Rx FIFO 1 is Idle.

enumerator kStatus_MCAN_RxFifo1Watermark
Rx FIFO 1 fill level reached watermark.

enumerator kStatus_MCAN_RxFifo1Full
Rx FIFO 1 full.

enumerator kStatus_MCAN_RxFifo1Lost
Rx FIFO 1 message lost.

enumerator kStatus_MCAN_RxFifo0Busy
Rx FIFO 0 is busy.

enumerator kStatus_MCAN_RxFifo1Busy
Rx FIFO 1 is busy.

enumerator kStatus_MCAN_ErrorStatus
MCAN Module Error and Status.

enumerator kStatus_MCAN_UnHandled
UnHandled Interrupt asserted.

enum _mcan_flags
MCAN status flags.

This provides constants for the MCAN status flags for use in the MCAN functions. Note: The CPU read action clears MCAN_ErrorFlag, therefore user need to read MCAN_ErrorFlag and distinguish which error is occur using _mcan_error_flags enumerations.

Values:

enumerator kMCAN_AccesstoRsvdFlag
CAN Synchronization Status.

enumerator kMCAN_ProtocolErrDIntFlag
Tx Warning Interrupt Flag.

enumerator kMCAN_ProtocolErrAIntFlag
Rx Warning Interrupt Flag.

enumerator kMCAN_BusOffIntFlag
Tx Error Warning Status.

enumerator kMCAN_ErrorWarningIntFlag
Rx Error Warning Status.

enumerator kMCAN_ErrorPassiveIntFlag
Rx Error Warning Status.

enum _mcan_rx_fifo_flags

MCAN Rx FIFO status flags.

The MCAN Rx FIFO Status enumerations are used to determine the status of the Rx FIFO.

Values:

enumerator kMCAN_RxFifo0NewFlag
Rx FIFO 0 new message flag.

enumerator kMCAN_RxFifo0WatermarkFlag
Rx FIFO 0 watermark reached flag.

enumerator kMCAN_RxFifo0FullFlag
Rx FIFO 0 full flag.

enumerator kMCAN_RxFifo0LostFlag
Rx FIFO 0 message lost flag.

enumerator kMCAN_RxFifo1NewFlag
Rx FIFO 0 new message flag.

enumerator kMCAN_RxFifo1WatermarkFlag
Rx FIFO 0 watermark reached flag.

enumerator kMCAN_RxFifo1FullFlag
Rx FIFO 0 full flag.

enumerator kMCAN_RxFifo1LostFlag
Rx FIFO 0 message lost flag.

enum _mcan_tx_flags

MCAN Tx status flags.

The MCAN Tx Status enumerations are used to determine the status of the Tx Buffer/Event FIFO.

Values:

enumerator kMCAN_TxTransmitCompleteFlag
Transmission completed flag.

enumerator kMCAN_TxTransmitCancelFinishFlag
Transmission cancellation finished flag.

enumerator kMCAN_TxEventFifoLostFlag

Tx Event FIFO element lost.

enumerator kMCAN_TxEventFifoFullFlag

Tx Event FIFO full.

enumerator kMCAN_TxEventFifoWatermarkFlag

Tx Event FIFO fill level reached watermark.

enumerator kMCAN_TxEventFifoNewFlag

Tx Handler wrote Tx Event FIFO element flag.

enumerator kMCAN_TxEventFifoEmptyFlag

Tx FIFO empty flag.

enum _mcan_interrupt_enable

MCAN interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the MCAN Module interrupt configurations.

Values:

enumerator kMCAN_BusOffInterruptEnable

Bus Off interrupt.

enumerator kMCAN_ErrorInterruptEnable

Error interrupt.

enumerator kMCAN_WarningInterruptEnable

Rx Warning interrupt.

enum _mcan_frame_idformat

MCAN frame format.

Values:

enumerator kMCAN_FrameIDStandard

Standard frame format attribute.

enumerator kMCAN_FrameIDExtend

Extend frame format attribute.

enum _mcan_frame_type

MCAN frame type.

Values:

enumerator kMCAN_FrameTypeData

Data frame type attribute.

enumerator kMCAN_FrameTypeRemote

Remote frame type attribute.

enum _mcan_bytes_in_datafield

MCAN frame datafield size.

Values:

enumerator kMCAN_8ByteDatafield

8 byte data field.

enumerator kMCAN_12ByteDatafield

12 byte data field.

enumerator kMCAN_16ByteDatafield

16 byte data field.

enumerator kMCAN_20ByteDatafield

20 byte data field.

enumerator kMCAN_24ByteDatafield

24 byte data field.

enumerator kMCAN_32ByteDatafield

32 byte data field.

enumerator kMCAN_48ByteDatafield

48 byte data field.

enumerator kMCAN_64ByteDatafield

64 byte data field.

enum __mcan_fifo_type

MCAN Rx FIFO block number.

Values:

enumerator kMCAN_Fifo0

CAN Rx FIFO 0.

enumerator kMCAN_Fifo1

CAN Rx FIFO 1.

enum __mcan_fifo_opmode_config

MCAN FIFO Operation Mode.

Values:

enumerator kMCAN_FifoBlocking

FIFO blocking mode.

enumerator kMCAN_FifoOverwrite

FIFO overwrite mode.

enum __mcan_txmode_config

MCAN Tx FIFO/Queue Mode.

Values:

enumerator kMCAN_txFifo

Tx FIFO operation.

enumerator kMCAN_txQueue

Tx Queue operation.

enum __mcan_remote_frame_config

MCAN remote frames treatment.

Values:

enumerator kMCAN_filterFrame

Filter remote frames.

enumerator kMCAN_rejectFrame

Reject all remote frames.

enum `_mcan_nonmasking_frame_config`

MCAN non-masking frames treatment.

Values:

enumerator `kMCAN_acceptinFifo0`

Accept non-masking frames in Rx FIFO 0.

enumerator `kMCAN_acceptinFifo1`

Accept non-masking frames in Rx FIFO 1.

enumerator `kMCAN_reject0`

Reject non-masking frames.

enumerator `kMCAN_reject1`

Reject non-masking frames.

enum `_mcan_fec_config`

MCAN Filter Element Configuration.

Values:

enumerator `kMCAN_disable`

Disable filter element.

enumerator `kMCAN_storeinFifo0`

Store in Rx FIFO 0 if filter matches.

enumerator `kMCAN_storeinFifo1`

Store in Rx FIFO 1 if filter matches.

enumerator `kMCAN_reject`

Reject ID if filter matches.

enumerator `kMCAN_setprio`

Set priority if filter matches.

enumerator `kMCAN_setpriofifo0`

Set priority and store in FIFO 0 if filter matches.

enumerator `kMCAN_setpriofifo1`

Set priority and store in FIFO 1 if filter matches.

enumerator `kMCAN_storeinbuffer`

Store into Rx Buffer or as debug message.

enum `_mcan_std_filter_type`

MCAN Filter Type.

Values:

enumerator `kMCAN_range`

Range filter from SFID1 to SFID2.

enumerator `kMCAN_dual`

Dual ID filter for SFID1 or SFID2.

enumerator `kMCAN_classic`

Classic filter: SFID1 = filter; SFID2 = mask.

enumerator `kMCAN_disableORrange2`

Filter element disabled for standard filter or Range filter; XIDAM mask not applied for extended filter.

`typedef enum _mcan_frame_idformat mcan_frame_idformat_t`
MCAN frame format.

`typedef enum _mcan_frame_type mcan_frame_type_t`
MCAN frame type.

`typedef enum _mcan_bytes_in_datafield mcan_bytes_in_datafield_t`
MCAN frame datafield size.

`typedef struct _mcan_tx_buffer_frame mcan_tx_buffer_frame_t`
MCAN Tx Buffer structure.

`typedef struct _mcan_rx_buffer_frame mcan_rx_buffer_frame_t`
MCAN Rx FIFO/Buffer structure.

`typedef enum _mcan_fifo_type mcan_fifo_type_t`
MCAN Rx FIFO block number.

`typedef enum _mcan_fifo_opmode_config mcan_fifo_opmode_config_t`
MCAN FIFO Operation Mode.

`typedef enum _mcan_txmode_config mcan_txmode_config_t`
MCAN Tx FIFO/Queue Mode.

`typedef enum _mcan_remote_frame_config mcan_remote_frame_config_t`
MCAN remote frames treatment.

`typedef enum _mcan_nonmasking_frame_config mcan_nonmasking_frame_config_t`
MCAN non-masking frames treatment.

`typedef enum _mcan_fec_config mcan_fec_config_t`
MCAN Filter Element Configuration.

`typedef struct _mcan_rx_fifo_config mcan_rx_fifo_config_t`
MCAN Rx FIFO configuration.

`typedef struct _mcan_rx_buffer_config mcan_rx_buffer_config_t`
MCAN Rx Buffer configuration.

`typedef struct _mcan_tx_fifo_config mcan_tx_fifo_config_t`
MCAN Tx Event FIFO configuration.

`typedef struct _mcan_tx_buffer_config mcan_tx_buffer_config_t`
MCAN Tx Buffer configuration.

`typedef enum _mcan_std_filter_type mcan_filter_type_t`
MCAN Filter Type.

`typedef struct _mcan_std_filter_element_config mcan_std_filter_element_config_t`
MCAN Standard Message ID Filter Element.

`typedef struct _mcan_ext_filter_element_config mcan_ext_filter_element_config_t`
MCAN Extended Message ID Filter Element.

`typedef struct _mcan_frame_filter_config mcan_frame_filter_config_t`
MCAN Rx filter configuration.

`typedef struct _mcan_timing_config mcan_timing_config_t`
MCAN protocol timing characteristic configuration structure.

`typedef struct _mcan_timing_param mcan_timing_param_t`
MCAN bit timing parameter configuration structure.

```
typedef struct _mcan_memory_config mcan_memory_config_t
```

MCAN Message RAM related configuration structure.

```
typedef struct _mcan_config mcan_config_t
```

MCAN module configuration structure.

```
typedef struct _mcan_buffer_transfer mcan_buffer_transfer_t
```

MCAN Buffer transfer.

```
typedef struct _mcan_fifo_transfer mcan_fifo_transfer_t
```

MCAN Rx FIFO transfer.

```
typedef struct _mcan_handle mcan_handle_t
```

MCAN handle structure definition.

```
typedef void (*mcan_transfer_callback_t)(CAN_Type *base, mcan_handle_t *handle, status_t  
status, uint32_t result, void *userData)
```

MCAN transfer callback function.

The MCAN transfer callback returns a value from the underlying layer. If the status equals to `kStatus_MCAN_ErrorStatus`, the result parameter is the Content of MCAN status register which can be used to get the working status(or error status) of MCAN module. If the status equals to other MCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other MCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

MCAN_RETRY_TIMES

```
struct _mcan_tx_buffer_frame
```

#include <fsl_mcan.h> MCAN Tx Buffer structure.

Public Members

uint8_t size

classical CAN is 8(bytes), FD is 12/64 such.

```
struct _mcan_rx_buffer_frame
```

#include <fsl_mcan.h> MCAN Rx FIFO/Buffer structure.

Public Members

uint8_t size

classical CAN is 8(bytes), FD is 12/64 such.

```
struct _mcan_rx_fifo_config
```

#include <fsl_mcan.h> MCAN Rx FIFO configuration.

Public Members

uint32_t address

FIFO start address.

uint32_t elementSize

FIFO element number.

uint32_t watermark

FIFO watermark level.

mcan_fifo_opmode_config_t opmode

FIFO blocking/overwrite mode.

mcan_bytes_in_datafield_t datafieldSize

Data field size per frame, size>8 is for CANFD.

struct *_mcan_rx_buffer_config*

#include <fsl_mcan.h> MCAN Rx Buffer configuration.

Public Members

uint32_t address

Rx Buffer start address.

mcan_bytes_in_datafield_t datafieldSize

Data field size per frame, size>8 is for CANFD.

struct *_mcan_tx_fifo_config*

#include <fsl_mcan.h> MCAN Tx Event FIFO configuration.

Public Members

uint32_t address

Event fifo start address.

uint32_t elementSize

FIFO element number.

uint32_t watermark

FIFO watermark level.

struct *_mcan_tx_buffer_config*

#include <fsl_mcan.h> MCAN Tx Buffer configuration.

Public Members

uint32_t address

Tx Buffers Start Address.

uint32_t dedicatedSize

Number of Dedicated Transmit Buffers.

uint32_t fqSize

Transmit FIFO/Queue Size.

mcan_txmode_config_t mode

Tx FIFO/Queue Mode.

mcan_bytes_in_datafield_t datafieldSize

Data field size per frame, size>8 is for CANFD.

struct *_mcan_std_filter_element_config*

#include <fsl_mcan.h> MCAN Standard Message ID Filter Element.

Public Members

uint32_t sfid2

Standard Filter ID 2.

uint32_t ____pad0____

Reserved.

uint32_t sfid1

Standard Filter ID 1.

uint32_t sfec

Standard Filter Element Configuration.

uint32_t sft

Standard Filter Type.

struct _mcan_ext_filter_element_config

#include <fsl_mcan.h> MCAN Extended Message ID Filter Element.

Public Members

uint32_t efid1

Extended Filter ID 1.

uint32_t efec

Extended Filter Element Configuration.

uint32_t efid2

Extended Filter ID 2.

uint32_t ____pad0____

Reserved.

uint32_t eft

Extended Filter Type.

struct _mcan_frame_filter_config

#include <fsl_mcan.h> MCAN Rx filter configuration.

Public Members

uint32_t address

Filter start address.

uint32_t listSize

Filter list size.

mcan_frame_idformat_t idFormat

Frame format.

mcan_remote_frame_config_t remFrame

Remote frame treatment.

mcan_nonmasking_frame_config_t nmFrame

Non-masking frame treatment.

struct _mcan_timing_config

#include <fsl_mcan.h> MCAN protocol timing characteristic configuration structure.

Public Members

uint16_t preDivider
Nominal Clock Pre-scaler Division Factor.

uint8_t rJumpwidth
Nominal Re-sync Jump Width.

uint8_t seg1
Nominal Time Segment 1.

uint8_t seg2
Nominal Time Segment 2.

uint16_t datapreDivider
Data Clock Pre-scaler Division Factor.

uint8_t datarJumpwidth
Data Re-sync Jump Width.

uint8_t dataseg1
Data Time Segment 1.

uint8_t dataseg2
Data Time Segment 2.

struct _mcan_timing_param
#include <fsl_mcan.h> MCAN bit timing parameter configuration structure.

Public Members

uint32_t busLength
Maximum Bus length in meter.

uint32_t propTxRx
Transceiver propagation delay in nanosecond.

uint32_t nominalbaudRate
Baud rate of Arbitration phase in bps.

uint32_t nominalSP
Sample point of Arbitration phase, range in 10 ~ 990, 800 means 80%.

uint32_t databaudRate
Baud rate of Data phase in bps.

uint32_t dataSP
Sample point of Data phase, range in 0 ~ 1000, 800 means 80%.

struct _mcan_memory_config
#include <fsl_mcan.h> MCAN Message RAM related configuration structure.

Public Members

uint32_t baseAddr
Message RAM base address, should be 4k alignment.

struct _mcan_config
#include <fsl_mcan.h> MCAN module configuration structure.

Public Members

uint32_t baudRateA

Baud rate of Arbitration phase in bps.

uint32_t baudRateD

Baud rate of Data phase in bps.

bool enableCanfdNormal

Enable or Disable CANFD normal.

bool enableCanfdSwitch

Enable or Disable CANFD with baudrate switch.

bool enableLoopBackInt

Enable or Disable Internal Back.

bool enableLoopBackExt

Enable or Disable External Loop Back.

bool enableBusMon

Enable or Disable Bus Monitoring Mode.

mcan_timing_config_t timingConfig

Protocol timing .

struct *_mcan_buffer_transfer*

#include <fsl_mcan.h> MCAN Buffer transfer.

Public Members

mcan_tx_buffer_frame_t *frame

The buffer of CAN Message to be transfer.

uint8_t bufferIdx

The index of Message buffer used to transfer Message.

struct *_mcan_fifo_transfer*

#include <fsl_mcan.h> MCAN Rx FIFO transfer.

Public Members

mcan_rx_buffer_frame_t *frame

The buffer of CAN Message to be received from Rx FIFO.

struct *_mcan_handle*

#include <fsl_mcan.h> MCAN handle structure.

Public Members

mcan_transfer_callback_t callback

Callback function.

void *userData

MCAN callback function parameter.

mcan_tx_buffer_frame_t *volatile bufferFrameBuf[64]

The buffer for received data from Buffers.

mcan_rx_buffer_frame_t *volatile rxFifoFrameBuf

The buffer for received data from Rx FIFO.

volatile uint8_t bufferState[64]

Message Buffer transfer state.

volatile uint8_t rxFifoState

Rx FIFO transfer state.

struct ____unnamed11____

Public Members

uint32_t id

CAN Frame Identifier.

uint32_t rtr

CAN Frame Type(DATA or REMOTE).

uint32_t xtd

CAN Frame Type(STD or EXT).

uint32_t esi

CAN Frame Error State Indicator.

struct ____unnamed13____

Public Members

uint32_t dlc

Data Length Code 9 10 11 12 13 14 15 Number of data bytes 12 16 20 24 32 48 64

uint32_t brs

Bit Rate Switch.

uint32_t fdf

CAN FD format.

uint32_t ____pad1____

Reserved.

uint32_t efc

Event FIFO control.

uint32_t mm

Message Marker.

struct ____unnamed15____

Public Members

uint32_t id

CAN Frame Identifier.

uint32_t rtr

CAN Frame Type(DATA or REMOTE).

uint32_t xtd

CAN Frame Type(STD or EXT).

```
uint32_t esi
    CAN Frame Error State Indicator.
struct __unnamed17__
```

Public Members

```
uint32_t rxts
    Rx Timestamp.
uint32_t dlc
    Data Length Code 9 10 11 12 13 14 15 Number of data bytes 12 16 20 24 32 48 64
uint32_t brs
    Bit Rate Switch.
uint32_t fdf
    CAN FD format.
uint32_t __pad0__
    Reserved.
uint32_t fidx
    Filter Index.
uint32_t anmf
    Accepted Non-matching Frame.
```

2.31 MRT: Multi-Rate Timer

```
void MRT_Init(MRT_Type *base, const mrt_config_t *config)
    Ungates the MRT clock and configures the peripheral for basic operation.
```

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

Parameters

- *base* – Multi-Rate timer peripheral base address
- *config* – Pointer to user's MRT config structure. If MRT has MULTITASK bit field in MODCFG register, param config is useless.

```
void MRT_Deinit(MRT_Type *base)
    Gate the MRT clock.
```

Parameters

- *base* – Multi-Rate timer peripheral base address

```
static inline void MRT_GetDefaultConfig(mrt_config_t *config)
    Fill in the MRT config struct with the default settings.
```

The default values are:

```
config->enableMultiTask = false;
```

Parameters

- `config` – Pointer to user's MRT config structure.

```
static inline void MRT_SetupChannelMode(MRT_Type *base, mrt_chnl_t channel, const  
                                       mrt_timer_mode_t mode)
```

Sets up an MRT channel mode.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Channel that is being configured.
- `mode` – Timer mode to use for the channel.

```
static inline void MRT_EnableInterrupts(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Enables the MRT interrupt.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number
- `mask` – The interrupts to enable. This is a logical OR of members of the enumeration `mrt_interrupt_enable_t`

```
static inline void MRT_DisableInterrupts(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Disables the selected MRT interrupt.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number
- `mask` – The interrupts to disable. This is a logical OR of members of the enumeration `mrt_interrupt_enable_t`

```
static inline uint32_t MRT_GetEnabledInterrupts(MRT_Type *base, mrt_chnl_t channel)
```

Gets the enabled MRT interrupts.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

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

```
static inline uint32_t MRT_GetStatusFlags(MRT_Type *base, mrt_chnl_t channel)
```

Gets the MRT status flags.

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

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

```
static inline void MRT_ClearStatusFlags(MRT_Type *base, mrt_chnl_t channel, uint32_t mask)
```

Clears the MRT status flags.

Parameters

- `base` – Multi-Rate timer peripheral base address

- `channel` – Timer channel number
- `mask` – The status flags to clear. This is a logical OR of members of the enumeration `mrt_status_flags_t`

`void MRT_UpdateTimerPeriod(MRT_Type *base, mrt_chnl_t channel, uint32_t count, bool immediateLoad)`

Used to update the timer period in units of count.

The new value will be immediately loaded or will be loaded at the end of the current time interval. For one-shot interrupt mode the new value will be immediately loaded.

Note: User can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number
- `count` – Timer period in units of ticks
- `immediateLoad` – `true`: Load the new value immediately into the TIMER register; `false`: Load the new value at the end of current timer interval

`static inline uint32_t MRT_GetCurrentTimerCount(MRT_Type *base, mrt_chnl_t channel)`

Reads the current timer counting value.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: User can call the utility macros provided in `fsl_common.h` to convert ticks to usec or msec

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number

Returns

Current timer counting value in ticks

`static inline void MRT_StartTimer(MRT_Type *base, mrt_chnl_t channel, uint32_t count)`

Starts the timer counting.

After calling this function, timers load period value, counts down to 0 and depending on the timer mode it will either load the respective start value again or stop.

Note: User can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- `base` – Multi-Rate timer peripheral base address
- `channel` – Timer channel number.
- `count` – Timer period in units of ticks. Count can contain the LOAD bit, which control the force load feature.

```
static inline void MRT_StopTimer(MRT_Type *base, mrt_chnl_t channel)
```

Stops the timer counting.

This function stops the timer from counting.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.

```
static inline uint32_t MRT_GetIdleChannel(MRT_Type *base)
```

Find the available channel.

This function returns the lowest available channel number.

Parameters

- base – Multi-Rate timer peripheral base address

```
static inline void MRT_ReleaseChannel(MRT_Type *base, mrt_chnl_t channel)
```

Release the channel when the timer is using the multi-task mode.

In multi-task mode, the INUSE flags allow more control over when MRT channels are released for further use. The user can hold on to a channel acquired by calling `MRT_GetIdleChannel()` for as long as it is needed and release it by calling this function. This removes the need to ask for an available channel for every use.

Parameters

- base – Multi-Rate timer peripheral base address
- channel – Timer channel number.

```
FSL_MRT_DRIVER_VERSION
```

```
enum _mrt_chnl
```

List of MRT channels.

Values:

```
enumerator kMRT_Channel_0
```

MRT channel number 0

```
enumerator kMRT_Channel_1
```

MRT channel number 1

```
enumerator kMRT_Channel_2
```

MRT channel number 2

```
enumerator kMRT_Channel_3
```

MRT channel number 3

```
enum _mrt_timer_mode
```

List of MRT timer modes.

Values:

```
enumerator kMRT_RepeatMode
```

Repeat Interrupt mode

```
enumerator kMRT_OneShotMode
```

One-shot Interrupt mode

```
enumerator kMRT_OneShotStallMode
```

One-shot stall mode

enum `_mrt_interrupt_enable`

List of MRT interrupts.

Values:

enumerator `kMRT_TimerInterruptEnable`

Timer interrupt enable

enum `_mrt_status_flags`

List of MRT status flags.

Values:

enumerator `kMRT_TimerInterruptFlag`

Timer interrupt flag

enumerator `kMRT_TimerRunFlag`

Indicates state of the timer

typedef enum `_mrt_chnl` `mrt_chnl_t`

List of MRT channels.

typedef enum `_mrt_timer_mode` `mrt_timer_mode_t`

List of MRT timer modes.

typedef enum `_mrt_interrupt_enable` `mrt_interrupt_enable_t`

List of MRT interrupts.

typedef enum `_mrt_status_flags` `mrt_status_flags_t`

List of MRT status flags.

typedef struct `_mrt_config` `mrt_config_t`

MRT configuration structure.

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

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

struct `_mrt_config`

#include <fsl_mrt.h> MRT configuration structure.

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

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

Public Members

bool `enableMultiTask`

true: Timers run in multi-task mode; false: Timers run in hardware status mode

2.32 OTP: One-Time Programmable memory and API

FSL_OTP_DRIVER_VERSION

OTP driver version 2.0.1.

Current version: 2.0.1

Change log:

- Version 2.0.1
 - Fixed MISRA-C 2012 violations.
- Version 2.0.0
 - Initial version.

enum _otp_bank

Bank bit flags.

Values:

enumerator kOTP_Bank0

Bank 0.

enumerator kOTP_Bank1

Bank 1.

enumerator kOTP_Bank2

Bank 2.

enumerator kOTP_Bank3

Bank 3.

enum _otp_word

Bank word bit flags.

Values:

enumerator kOTP_Word0

Word 0.

enumerator kOTP_Word1

Word 1.

enumerator kOTP_Word2

Word 2.

enumerator kOTP_Word3

Word 3.

enum _otp_lock

Lock modifications of a read or write access to a bank register.

Values:

enumerator kOTP_LockDontLock

Do not lock.

enumerator kOTP_LockLock

Lock till reset.

enum _otp_status

OTP error codes.

Values:

enumerator `kStatus_OTP_WrEnableInvalid`
Write enable invalid.

enumerator `kStatus_OTP_SomeBitsAlreadyProgrammed`
Some bits already programmed.

enumerator `kStatus_OTP_AllDataOrMaskZero`
All data or mask zero.

enumerator `kStatus_OTP_WriteAccessLocked`
Write access locked.

enumerator `kStatus_OTP_ReadDataMismatch`
Read data mismatch.

enumerator `kStatus_OTP_UsbIdEnabled`
USB ID enabled.

enumerator `kStatus_OTP_EthMacEnabled`
Ethernet MAC enabled.

enumerator `kStatus_OTP_AesKeysEnabled`
AES keys enabled.

enumerator `kStatus_OTP_IllegalBank`
Illegal bank.

enumerator `kStatus_OTP_ShufflerConfigNotValid`
Shuffler config not valid.

enumerator `kStatus_OTP_ShufflerNotEnabled`
Shuffler not enabled.

enumerator `kStatus_OTP_ShufflerCanOnlyProgSingleKey`
Shuffler can only program single key.

enumerator `kStatus_OTP_IllegalProgramData`
Illegal program data.

enumerator `kStatus_OTP_ReadAccessLocked`
Read access locked.

typedef enum *_otp_bank* otp_bank_t
Bank bit flags.

typedef enum *_otp_word* otp_word_t
Bank word bit flags.

typedef enum *_otp_lock* otp_lock_t
Lock modifications of a read or write access to a bank register.

static inline *status_t* OTP_Init(void)
Initializes OTP controller.

Returns
`kStatus_Success` upon successful execution, error status otherwise.

static inline *status_t* OTP_EnableBankWriteMask(*otp_bank_t* bankMask)
Unlock one or more OTP banks for write access.

Parameters

- `bankMask` – bit flag that specifies which banks to unlock.

Returns

kStatus_Success upon successful execution, error status otherwise.

static inline *status_t* OTP__DisableBankWriteMask(*otp_bank_t* bankMask)

Lock one or more OTP banks for write access.

Parameters

- bankMask – bit flag that specifies which banks to lock.

Returns

kStatus_Success upon successful execution, error status otherwise.

static inline *status_t* OTP__EnableBankWriteLock(*uint32_t* bankIndex, *otp_word_t* regEnableMask, *otp_word_t* regDisableMask, *otp_lock_t* lockWrite)

Locks or unlocks write access to a register of an OTP bank and possibly lock un/locking of it.

Parameters

- bankIndex – OTP bank index, 0 = bank 0, 1 = bank 1 etc.
- regEnableMask – bit flag that specifies for which words to enable writing.
- regDisableMask – bit flag that specifies for which words to disable writing.
- lockWrite – specifies if access set can be modified or is locked till reset.

Returns

kStatus_Success upon successful execution, error status otherwise.

static inline *status_t* OTP__EnableBankReadLock(*uint32_t* bankIndex, *otp_word_t* regEnableMask, *otp_word_t* regDisableMask, *otp_lock_t* lockWrite)

Locks or unlocks read access to a register of an OTP bank and possibly lock un/locking of it.

Parameters

- bankIndex – OTP bank index, 0 = bank 0, 1 = bank 1 etc.
- regEnableMask – bit flag that specifies for which words to enable reading.
- regDisableMask – bit flag that specifies for which words to disable reading.
- lockWrite – specifies if access set can be modified or is locked till reset.

Returns

kStatus_Success upon successful execution, error status otherwise.

static inline *status_t* OTP__ProgramRegister(*uint32_t* bankIndex, *uint32_t* regIndex, *uint32_t* value)

Program a single register in an OTP bank.

Parameters

- bankIndex – OTP bank index, 0 = bank 0, 1 = bank 1 etc.
- regIndex – OTP register index.
- value – value to write.

Returns

kStatus_Success upon successful execution, error status otherwise.

static inline *uint32_t* OTP__GetDriverVersion(void)

Returns the version of the OTP driver in ROM.

Returns

version.

FSL_COMPONENT_ID

_OTP_ERR_BASE

_OTP_MAKE_STATUS(errorCode)

2.33 PINT: Pin Interrupt and Pattern Match Driver

FSL_PINT_DRIVER_VERSION

enum _pint_pin_enable

PINT Pin Interrupt enable type.

Values:

enumerator kPINT_PinIntEnableNone

Do not generate Pin Interrupt

enumerator kPINT_PinIntEnableRiseEdge

Generate Pin Interrupt on rising edge

enumerator kPINT_PinIntEnableFallEdge

Generate Pin Interrupt on falling edge

enumerator kPINT_PinIntEnableBothEdges

Generate Pin Interrupt on both edges

enumerator kPINT_PinIntEnableLowLevel

Generate Pin Interrupt on low level

enumerator kPINT_PinIntEnableHighLevel

Generate Pin Interrupt on high level

enum _pint_int

PINT Pin Interrupt type.

Values:

enumerator kPINT_PinInt0

Pin Interrupt 0

enum _pint_pmatch_input_src

PINT Pattern Match bit slice input source type.

Values:

enumerator kPINT_PatternMatchInp0Src

Input source 0

enumerator kPINT_PatternMatchInp1Src

Input source 1

enumerator kPINT_PatternMatchInp2Src

Input source 2

enumerator kPINT_PatternMatchInp3Src

Input source 3

enumerator kPINT_PatternMatchInp4Src

Input source 4

enumerator kPINT_PatternMatchInp5Src
Input source 5

enumerator kPINT_PatternMatchInp6Src
Input source 6

enumerator kPINT_PatternMatchInp7Src
Input source 7

enumerator kPINT_SecPatternMatchInp0Src
Input source 0

enumerator kPINT_SecPatternMatchInp1Src
Input source 1

enum _pint_pmatch_bslice
PINT Pattern Match bit slice type.

Values:

enumerator kPINT_PatternMatchBSlice0
Bit slice 0

enum _pint_pmatch_bslice_cfg
PINT Pattern Match configuration type.

Values:

enumerator kPINT_PatternMatchAlways
Always Contributes to product term match

enumerator kPINT_PatternMatchStickyRise
Sticky Rising edge

enumerator kPINT_PatternMatchStickyFall
Sticky Falling edge

enumerator kPINT_PatternMatchStickyBothEdges
Sticky Rising or Falling edge

enumerator kPINT_PatternMatchHigh
High level

enumerator kPINT_PatternMatchLow
Low level

enumerator kPINT_PatternMatchNever
Never contributes to product term match

enumerator kPINT_PatternMatchBothEdges
Either rising or falling edge

typedef enum _pint_pin_enable pint_pin_enable_t
PINT Pin Interrupt enable type.

typedef enum _pint_int pint_pin_int_t
PINT Pin Interrupt type.

typedef enum _pint_pmatch_input_src pint_pmatch_input_src_t
PINT Pattern Match bit slice input source type.

typedef enum _pint_pmatch_bslice pint_pmatch_bslice_t
PINT Pattern Match bit slice type.

```
typedef enum _pint_pmatch_bslice_cfg pint_pmatch_bslice_cfg_t
```

PINT Pattern Match configuration type.

```
typedef struct _pint_status pint_status_t
```

PINT event status.

```
typedef void (*pint_cb_t)(pint_pin_int_t pintr, pint_status_t *status)
```

PINT Callback function.

```
typedef struct _pint_pmatch_cfg pint_pmatch_cfg_t
```

```
void PINT_Init(PINT_Type *base)
```

Initialize PINT peripheral.

This function initializes the PINT peripheral and enables the clock.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

```
void PINT_SetCallback(PINT_Type *base, pint_cb_t callback)
```

Set PINT callback.

This function set the callback for PINT interrupt handler.

Parameters

- base – Base address of the PINT peripheral.
- callback – Callback.

Return values

None. –

```
void PINT_PinInterruptConfig(PINT_Type *base, pint_pin_int_t intr, pint_pin_enable_t enable)
```

Configure PINT peripheral pin interrupt.

This function configures a given pin interrupt.

Parameters

- base – Base address of the PINT peripheral.
- intr – Pin interrupt.
- enable – Selects detection logic.

Return values

None. –

```
void PINT_PinInterruptGetConfig(PINT_Type *base, pint_pin_int_t pintr, pint_pin_enable_t *enable)
```

Get PINT peripheral pin interrupt configuration.

This function returns the configuration of a given pin interrupt.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.
- enable – Pointer to store the detection logic.

Return values

None. –

```
void PINT_PinInterruptClrStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt status only when the pin was triggered by edge-sensitive.

This function clears the selected pin interrupt status.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetStatus(PINT_Type *base, pint_pin_int_t pintr)
```

Get Selected pin interrupt status.

This function returns the selected pin interrupt status.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

status – = 0 No pin interrupt request. = 1 Selected Pin interrupt request active.

```
void PINT_PinInterruptClrStatusAll(PINT_Type *base)
```

Clear all pin interrupts status only when pins were triggered by edge-sensitive.

This function clears the status of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetStatusAll(PINT_Type *base)
```

Get all pin interrupts status.

This function returns the status of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

status – Each bit position indicates the status of corresponding pin interrupt.
= 0 No pin interrupt request. = 1 Pin interrupt request active.

```
static inline void PINT_PinInterruptClrFallFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt fall flag.

This function clears the selected pin interrupt fall flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetFallFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Get selected pin interrupt fall flag.

This function returns the selected pin interrupt fall flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

flag – = 0 Falling edge has not been detected. = 1 Falling edge has been detected.

```
static inline void PINT_PinInterruptClrFallFlagAll(PINT_Type *base)
```

Clear all pin interrupt fall flags.

This function clears the fall flag for all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetFallFlagAll(PINT_Type *base)
```

Get all pin interrupt fall flags.

This function returns the fall flag of all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

flags – Each bit position indicates the falling edge detection of the corresponding pin interrupt. 0 Falling edge has not been detected. = 1 Falling edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Clear Selected pin interrupt rise flag.

This function clears the selected pin interrupt rise flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlag(PINT_Type *base, pint_pin_int_t pintr)
```

Get selected pin interrupt rise flag.

This function returns the selected pin interrupt rise flag.

Parameters

- base – Base address of the PINT peripheral.
- pintr – Pin interrupt.

Return values

flag – = 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
static inline void PINT_PinInterruptClrRiseFlagAll(PINT_Type *base)
```

Clear all pin interrupt rise flags.

This function clears the rise flag for all pin interrupts.

Parameters

- base – Base address of the PINT peripheral.

Return values

None. –

```
static inline uint32_t PINT_PinInterruptGetRiseFlagAll(PINT_Type *base)
```

Get all pin interrupt rise flags.

This function returns the rise flag of all pin interrupts.

Parameters

- *base* – Base address of the PINT peripheral.

Return values

flags – Each bit position indicates the rising edge detection of the corresponding pin interrupt. 0 Rising edge has not been detected. = 1 Rising edge has been detected.

```
void PINT_PatternMatchConfig(PINT_Type *base, pint_pmatch_bslicet bslice, pint_pmatch_cfg_t *cfg)
```

Configure PINT pattern match.

This function configures a given pattern match bit slice.

Parameters

- *base* – Base address of the PINT peripheral.
- *bslice* – Pattern match bit slice number.
- *cfg* – Pointer to bit slice configuration.

Return values

None. –

```
void PINT_PatternMatchGetConfig(PINT_Type *base, pint_pmatch_bslicet 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_bslicet 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_EnableInterruptByIndex(PINT_Type *base, *pint_pin_int_t* pintIdx)

enable interrupt in NVIC by pin index.

This function enables the interrupt in the NVIC. The difference with PINT_EnableCallbackByIndex() is that PINT_EnableCallbackByIndex() not only enables the interrupt in the NVIC but also clears pending interrupts. Use this function together with PINT_DisableInterruptByIndex() to temporarily disable/enable the pin interrupt. Use PINT_EnableCallbackByIndex() to enable the interrupt after installing the callback.

Parameters

- base – Base address of the peripheral.
- pinIdx – pin index.

Return values

None. –

`void PINT_DisableInterruptByIndex(PINT_Type *base, pint_pin_int_t pintIdx)`

disable interrupt in NVIC by pin index.

This function disables the interrupt in the NVIC. The difference with `PINT_DisableCallbackByIndex()` is that `PINT_DisableCallbackByIndex()` not only disables the interrupt in the NVIC but also clears pending interrupts. Use this function together with `PINT_EnableInterruptByIndex()` to temporarily disable/enable the pin interrupt. Use `PINT_DisableCallbackByIndex()` to disable the interrupt in a de-init function.

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>

2.34 Power Driver

enum pd_bits

Values:

enumerator kPDRUNCFG_LP_REG
enumerator kPDRUNCFG_PD_FRO_EN
enumerator kPDRUNCFG_PD_TS
enumerator kPDRUNCFG_PD_BOD_RESET
enumerator kPDRUNCFG_PD_BOD_INTR
enumerator kPDRUNCFG_PD_VD2_ANA
enumerator kPDRUNCFG_PD_ADC0
enumerator kPDRUNCFG_PD_RAM0
enumerator kPDRUNCFG_PD_RAM1
enumerator kPDRUNCFG_PD_RAM2
enumerator kPDRUNCFG_PD_RAM3
enumerator kPDRUNCFG_PD_ROM
enumerator kPDRUNCFG_PD_VDDA
enumerator kPDRUNCFG_PD_WDT_OSC
enumerator kPDRUNCFG_PD_USB0_PHY
enumerator kPDRUNCFG_PD_SYS_PLL0
enumerator kPDRUNCFG_PD_VREFP
enumerator kPDRUNCFG_PD_FLASH_BG
enumerator kPDRUNCFG_PD_VD3
enumerator kPDRUNCFG_PD_VD4
enumerator kPDRUNCFG_PD_VD5
enumerator kPDRUNCFG_PD_VD6
enumerator kPDRUNCFG_REQ_DELAY
enumerator kPDRUNCFG_FORCE_RBB
enumerator kPDRUNCFG_PD_USB1_PHY
enumerator kPDRUNCFG_PD_USB_PLL
enumerator kPDRUNCFG_PD_AUDIO_PLL
enumerator kPDRUNCFG_PD_SYS_OSC
enumerator kPDRUNCFG_PD_EEPROM
enumerator kPDRUNCFG_PD_rng

enumerator kPDRUNCFG_ForceUnsigned

enum __power_mode_config

Values:

enumerator kPmu_Sleep

enumerator kPmu_Deep_Sleep

enumerator kPmu_Deep_PowerDown

enum __power_bod_status

The enumeration of BOD status flags.

Values:

enumerator kBod_ResetStatusFlag

BOD reset has occurred.

enumerator kBod_InterruptStatusFlag

BOD interrupt has occurred

enum __power_bod_reset_level

The enumeration of BOD reset level.

Values:

enumerator kBod_ResetLevel0

Reset Level0: 1.62V.

enumerator kBod_ResetLevel1

Reset Level0: 1.68V.

enumerator kBod_ResetLevel2

Reset Level0: 2.21V.

enumerator kBod_ResetLevel3

Reset Level0: 2.85V.

enum __power_bod_interrupt_level

The enumeration of BOD interrupt level.

Values:

enumerator kBod_InterruptLevel0

Interrupt level: 1.63V.

enumerator kBod_InterruptLevel1

Interrupt level: 1.68V.

enumerator kBod_InterruptLevel2

Interrupt level: 1.95V.

enumerator kBod_InterruptLevel3

Interrupt level: 2.86V.

typedef enum *pd_bits* pd_bit_t

typedef enum *__power_mode_config* power_mode_cfg_t

typedef enum *__power_bod_status* power_bod_status_t

The enumeration of BOD status flags.

typedef enum *__power_bod_reset_level* power_bod_reset_level_t

The enumeration of BOD reset level.

typedef enum *_power_bod_interrupt_level* power_bod_interrupt_level_t

The enumeration of BOD interrupt level.

typedef struct *_power_bod_config* power_bod_config_t

The configuration of power bod, including reset level, interrupt level, and so on.

FSL_POWER_DRIVER_VERSION

power driver version 2.2.0.

MAKE_PD_BITS(reg, slot)

PDRCFG0

PDRCFG1

static inline void POWER_EnablePD(*pd_bit_t* en)

API to enable PDRUNCFG bit in the Syscon. Note that enabling the bit powers down the peripheral.

Parameters

- en – peripheral for which to enable the PDRUNCFG bit

Returns

none

static inline void POWER_DisablePD(*pd_bit_t* en)

API to disable PDRUNCFG bit in the Syscon. Note that disabling the bit powers up the peripheral.

Parameters

- en – peripheral for which to disable the PDRUNCFG bit

Returns

none

static inline void POWER_EnableDeepSleep(void)

API to enable deep sleep bit in the ARM Core.

Returns

none

static inline void POWER_DisableDeepSleep(void)

API to disable deep sleep bit in the ARM Core.

Returns

none

void POWER_OtpReload(void)

Power Library API to reload OTP. This API must be called if VD6 is power down and power back again since FROHF TRIM value is store in OTP. If not, when calling FROHF setting API in clock driver then the FROHF clock out put will be inaccurate.

Returns

none

void POWER_SetPLL(void)

Power Library API to power the PLLs.

Returns

none

void POWER_SetUsbPhy(void)

Power Library API to power the USB PHY.

Returns

none

void POWER_EnterPowerMode(*power_mode_cfg_t* mode, uint64_t exclude_from_pd)

Power Library API to enter different power modes.

Parameters

- mode – Power mode.
- exclude_from_pd – Bit mask of the PDRUNCFG0(low 32bits) and PDRUNCFG1(high 32bits) that needs to be powered on during power mode selected.

Returns

none

void POWER_EnterSleep(void)

Power Library API to enter sleep mode.

Returns

none

void POWER_EnterDeepSleep(uint64_t exclude_from_pd)

Power Library API to enter deep sleep mode.

Parameters

- exclude_from_pd – Bit mask of the PDRUNCFG0(low 32bits) and PDRUNCFG1(high 32bits) bits that needs to be powered on during deep sleep

Returns

none

void POWER_EnterDeepPowerDown(uint64_t exclude_from_pd)

Power Library API to enter deep power down mode.

Parameters

- exclude_from_pd – Bit mask of the PDRUNCFG0(low 32bits) and PDRUNCFG1(high 32bits) that needs to be powered on during deep power down mode, but this has no effect as the voltages are cut off.

Returns

none

void POWER_SetVoltageForFreq(uint32_t freq)

Power Library API to choose normal regulation and set the voltage for the desired operating frequency.

Parameters

- freq – - The desired frequency at which the part would like to operate, note that the voltage and flash wait states should be set before changing frequency

Returns

none

uint32_t POWER_GetLibVersion(void)

Power Library API to return the library version.

Returns

version number of the power library

void POWER_InitBod(const *power_bod_config_t* *bodConfig)

Initialize BOD, including enabling/disabling BOD interrupt, enabling/disabling BOD reset, setting BOD interrupt level, and reset level.

Parameters

- bodConfig – Pointer the the structure *power_bod_config_t*.

void POWER_GetDefaultBodConfig(*power_bod_config_t* *bodConfig)

Get default BOD configuration.

```
bodConfig->enableReset = true;
bodConfig->resetLevel = kBod_ResetLevel0;
bodConfig->enableInterrupt = false;
bodConfig->interruptLevel = kBod_InterruptLevel0;
```

Parameters

- bodConfig – Pointer the the structure *power_bod_config_t*.

static inline void POWER_DeinitBod(void)

De-initialize BOD.

static inline uint32_t POWER_GetBodStatusFlags(void)

Get Bod status flags.

Returns

uint32_t

static inline void POWER_ClearBodStatusFlags(uint32_t mask)

Clear Bod status flags.

Parameters

- mask – The mask of status flags to clear, should be the OR'ed value of *power_bod_status_t*.

bool enableReset

Enable/disable BOD reset function.

power_bod_reset_level_t resetLevel

BOD reset level, please refer to *power_bod_reset_level_t*.

bool enableInterrupt

Enable/disable BOD interrupt function.

power_bod_interrupt_level_t interruptLevel

BOD interrupt level, please refer to *power_bod_interrupt_level_t*.

struct __power_bod_config

#include <fsl_power.h> The configuration of power bod, including reset level, interrupt level, and so on.

2.35 PUF: Physical Unclonable Function

FSL_PUF_DRIVER_VERSION

PUF driver version. Version 2.2.0.

Current version: 2.2.0

Change log:

- 2.0.0

- Initial version.
- 2.0.1
 - Fixed puf_wait_usec function optimization issue.
- 2.0.2
 - Add PUF configuration structure and support for PUF SRAM controller. Remove magic constants.
- 2.0.3
 - Fix MISRA C-2012 issue.
- 2.1.0
 - Align driver with PUF SRAM controller registers on LPCXpresso55s16.
 - Update initialization logic .
- 2.1.1
 - Fix ARMGCC build warning .
- 2.1.2
 - Update: Add automatic big to little endian swap for user (pre-shared) keys destined to secret hardware bus (PUF key index 0).
- 2.1.3
 - Fix MISRA C-2012 issue.
- 2.1.4
 - Replace register uint32_t ticksCount with volatile uint32_t ticksCount in puf_wait_usec() to prevent optimization out delay loop.
- 2.1.5
 - Use common SDK delay in puf_wait_usec()
- 2.1.6
 - Changed wait time in PUF_Init(), when initialization fails it will try PUF_Powercycle() with shorter time. If this shorter time will also fail, initialization will be tried with worst case time as before.
- 2.2.0
- Add support for kPUF_KeySlot4.
- Add new PUF_ClearKey() function, that clears a desired PUF internal HW key register.

enum __puf_key_index_register

Values:

enumerator kPUF_KeyIndex_00

enumerator kPUF_KeyIndex_01

enumerator kPUF_KeyIndex_02

enumerator kPUF_KeyIndex_03

enumerator kPUF_KeyIndex_04

enumerator kPUF_KeyIndex_05

enumerator kPUF_KeyIndex_06

```
enumerator kPUF_KeyIndex_07
enumerator kPUF_KeyIndex_08
enumerator kPUF_KeyIndex_09
enumerator kPUF_KeyIndex_10
enumerator kPUF_KeyIndex_11
enumerator kPUF_KeyIndex_12
enumerator kPUF_KeyIndex_13
enumerator kPUF_KeyIndex_14
enumerator kPUF_KeyIndex_15

enum _puf_min_max
    Values:
    enumerator kPUF_KeySizeMin
    enumerator kPUF_KeySizeMax
    enumerator kPUF_KeyIndexMax

enum _puf_key_slot
    PUF key slot.
    Values:
    enumerator kPUF_KeySlot0
        PUF key slot 0
    enumerator kPUF_KeySlot1
        PUF key slot 1

    PUF status return codes.
    Values:
    enumerator kStatus_EnrollNotAllowed
    enumerator kStatus_StartNotAllowed

typedef enum _puf_key_index_register puf_key_index_register_t
typedef enum _puf_min_max puf_min_max_t
typedef enum _puf_key_slot puf_key_slot_t
    PUF key slot.

PUF_GET_KEY_CODE_SIZE_FOR_KEY_SIZE(x)
    Get Key Code size in bytes from key size in bytes at compile time.

PUF_MIN_KEY_CODE_SIZE

PUF_ACTIVATION_CODE_SIZE

KEystore_PUF_DISCHARGE_TIME_FIRST_TRY_MS

KEystore_PUF_DISCHARGE_TIME_MAX_MS

struct puf_config_t
    #include <fsl_puf.h>
```

2.36 Reset Driver

enum _SYSCON_RSTn

Enumeration for peripheral reset control bits.

Defines the enumeration for peripheral reset control bits in PRESETCTRL/ASYNCPRESETCTRL registers

Values:

enumerator kSPIFI_RST_SHIFT_RSTn
SPIFI reset control

enumerator kMUX_RST_SHIFT_RSTn
Input mux reset control

enumerator kIOCON_RST_SHIFT_RSTn
IOCON reset control

enumerator kGPIO0_RST_SHIFT_RSTn
GPIO0 reset control

enumerator kGPIO1_RST_SHIFT_RSTn
GPIO1 reset control

enumerator kGPIO2_RST_SHIFT_RSTn
GPIO2 reset control

enumerator kGPIO3_RST_SHIFT_RSTn
GPIO3 reset control

enumerator kPINT_RST_SHIFT_RSTn
Pin interrupt (PINT) reset control

enumerator kGINT_RST_SHIFT_RSTn
Grouped interrupt (PINT) reset control.

enumerator kDMA_RST_SHIFT_RSTn
DMA reset control

enumerator kCRC_RST_SHIFT_RSTn
CRC reset control

enumerator kWWDT_RST_SHIFT_RSTn
Watchdog timer reset control

enumerator kADC0_RST_SHIFT_RSTn
ADC0 reset control

enumerator kMRT_RST_SHIFT_RSTn
Multi-rate timer (MRT) reset control

enumerator kSCT0_RST_SHIFT_RSTn
SCTimer/PWM 0 (SCT0) reset control

enumerator kMCAN0_RST_SHIFT_RSTn
MCAN0 reset control

enumerator kMCAN1_RST_SHIFT_RSTn
MCAN1 reset control

enumerator kUTICK_RST_SHIFT_RSTn
Micro-tick timer reset control

enumerator kFC0_RST_SHIFT_RSTn
Flexcomm Interface 0 reset control

enumerator kFC1_RST_SHIFT_RSTn
Flexcomm Interface 1 reset control

enumerator kFC2_RST_SHIFT_RSTn
Flexcomm Interface 2 reset control

enumerator kFC3_RST_SHIFT_RSTn
Flexcomm Interface 3 reset control

enumerator kFC4_RST_SHIFT_RSTn
Flexcomm Interface 4 reset control

enumerator kFC5_RST_SHIFT_RSTn
Flexcomm Interface 5 reset control

enumerator kFC6_RST_SHIFT_RSTn
Flexcomm Interface 6 reset control

enumerator kFC7_RST_SHIFT_RSTn
Flexcomm Interface 7 reset control

enumerator kDMIC_RST_SHIFT_RSTn
Digital microphone interface reset control

enumerator kCT32B2_RST_SHIFT_RSTn
CT32B2 reset control

enumerator kUSB0D_RST_SHIFT_RSTn
USB0D reset control

enumerator kCT32B0_RST_SHIFT_RSTn
CT32B0 reset control

enumerator kCT32B1_RST_SHIFT_RSTn
CT32B1 reset control

enumerator kLCD_RST_SHIFT_RSTn
LCD reset control

enumerator kSDIO_RST_SHIFT_RSTn
SDIO reset control

enumerator kUSB1H_RST_SHIFT_RSTn
USB1H reset control

enumerator kUSB1D_RST_SHIFT_RSTn
USB1D reset control

enumerator kUSB1RAM_RST_SHIFT_RSTn
USB1RAM reset control

enumerator kEMC_RST_SHIFT_RSTn
EMC reset control

enumerator kETH_RST_SHIFT_RSTn
ETH reset control

enumerator kGPIO4_RST_SHIFT_RSTn
GPIO4 reset control

```

enumerator kGPIO5_RST_SHIFT_RSTn
    GPIO5 reset control
enumerator kAES_RST_SHIFT_RSTn
    AES reset control
enumerator kOTP_RST_SHIFT_RSTn
    OTP reset control
enumerator kRNG_RST_SHIFT_RSTn
    RNG reset control
enumerator kFC8_RST_SHIFT_RSTn
    Flexcomm Interface 8 reset control
enumerator kFC9_RST_SHIFT_RSTn
    Flexcomm Interface 9 reset control
enumerator kUSB0HMR_RST_SHIFT_RSTn
    USB0HMR reset control
enumerator kUSB0HSL_RST_SHIFT_RSTn
    USB0HSL reset control
enumerator kSHA_RST_SHIFT_RSTn
    SHA reset control
enumerator kSC0_RST_SHIFT_RSTn
    SC0 reset control
enumerator kSC1_RST_SHIFT_RSTn
    SC1 reset control
enumerator kFC10_RST_SHIFT_RSTn
    Flexcomm Interface 10 reset control
enumerator kPUF_RST_SHIFT_RSTn
    PUF reset control
enumerator kCT32B3_RST_SHIFT_RSTn
    CT32B3 reset control
enumerator kCT32B4_RST_SHIFT_RSTn
    CT32B4 reset control
typedef enum _SYSCON_RSTn SYSCON_RSTn_t
    Enumeration for peripheral reset control bits.
    Defines the enumeration for peripheral reset control bits in PRESETC-
    TRL/ASYNCPRESETCTRL registers
typedef SYSCON_RSTn_t reset_ip_name_t
void RESET_SetPeripheralReset(reset_ip_name_t peripheral)
    Assert reset to peripheral.
    Asserts reset signal to specified peripheral module.

```

Parameters

- *peripheral* – Assert reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

`void RESET_ClearPeripheralReset(reset_ip_name_t peripheral)`

Clear reset to peripheral.

Clears reset signal to specified peripheral module, allows it to operate.

Parameters

- `peripheral` – Clear reset to this peripheral. The enum argument contains encoding of reset register and reset bit position in the reset register.

`void RESET_PeripheralReset(reset_ip_name_t peripheral)`

Reset peripheral module.

Reset peripheral module.

Parameters

- `peripheral` – Peripheral to reset. The enum argument contains encoding of reset register and reset bit position in the reset register.

`static inline void RESET_ReleasePeripheralReset(reset_ip_name_t peripheral)`

Release peripheral module.

Release peripheral module.

Parameters

- `peripheral` – Peripheral to release. The enum argument contains encoding of reset register and reset bit position in the reset register.

`FSL_RESET_DRIVER_VERSION`

reset driver version 2.4.0

`ADC_RSTS`

Array initializers with peripheral reset bits

`AES_RSTS`

`CRC_RSTS`

`CTIMER_RSTS`

`DMA_RSTS_N`

`DMIC_RSTS`

`EMC_RSTS`

`ETH_RST`

`FLEXCOMM_RSTS`

`GINT_RSTS`

`GPIO_RSTS_N`

`INPUTMUX_RSTS`

`IOCON_RSTS`

`FLASH_RSTS`

`LCD_RSTS`

`MRT_RSTS`

`MCAN_RSTS`

OTP_RSTS
PINT_RSTS
RNG_RSTS
SDIO_RST
SCT_RSTS
SHA_RST
SPIFI_RSTS
USB0D_RST
USB0HMR_RST
USB0HSL_RST
USB1H_RST
USB1D_RST
USB1RAM_RST
UTICK_RSTS
WWDT_RSTS
USB1RAM_RSTS
USB1H_RSTS
USB1D_RSTS
USB0HSL_RSTS
USB0HMR_RSTS
USB0D_RSTS
SHA_RSTS
SDIO_RSTS
ETH_RSTS

2.37 RIT: Repetitive Interrupt Timer

void RIT_Init(RIT_Type *base, const *rit_config_t* *config)

Ungates the RIT clock, enables the RIT module, and configures the peripheral for basic operations.

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

Parameters

- base – RIT peripheral base address
- config – Pointer to the user's RIT config structure

void RIT_Deinit(RIT_Type *base)

Gates the RIT clock and disables the RIT module.

Parameters

- base – RIT peripheral base address

void RIT_GetDefaultConfig(*rit_config_t* *config)

Fills in the RIT configuration structure with the default settings.

The default values are as follows.

```
config->enableRunInDebug = false;
```

Parameters

- config – Pointer to the onfiguration structure.

static inline uint32_t RIT_GetStatusFlags(RIT_Type *base)

Gets the RIT status flags.

Parameters

- base – RIT peripheral base address

Returns

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

static inline void RIT_ClearStatusFlags(RIT_Type *base, uint32_t mask)

Clears the RIT status flags.

Parameters

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

void RIT_SetTimerCompare(RIT_Type *base, uint64_t count)

Sets the timer period in units of count.

This function sets the RI compare value. If the counter value equals to the compare value, it will generate an interrupt.

Note: Users can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- base – RIT peripheral base address
- count – Timer period in units of ticks

void RIT_SetMaskBit(RIT_Type *base, uint64_t count)

Sets the mask bit of count compare.

This function sets the RI mask value. A 1 written to any bit will force the compare to be true for the corresponding bit of the counter and compare register (causes the comparison of the register bits to be always true).

Note: Users can call the utility macros provided in `fsl_common.h` to convert to ticks

Parameters

- base – RIT peripheral base address
- count – Timer period in units of ticks

uint64_t RIT_GetCompareTimerCount(RIT_Type *base)

Reads the current value of compare register.

Note: Users can call the utility macros provided in fsl_common.h to convert ticks to usec or msec

Parameters

- base – RIT peripheral base address

Returns

Current RI compare value

uint64_t RIT_GetCounterTimerCount(RIT_Type *base)

Reads the current timer counting value of counter register.

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note: Users can call the utility macros provided in fsl_common.h to convert ticks to usec or msec

Parameters

- base – RIT peripheral base address

Returns

Current timer counting value in ticks

uint64_t RIT_GetMaskTimerCount(RIT_Type *base)

Reads the current value of mask register.

Note: Users can call the utility macros provided in fsl_common.h to convert ticks to usec or msec

Parameters

- base – RIT peripheral base address

Returns

Current RI mask value

static inline void RIT_StartTimer(RIT_Type *base)

Starts the timer counting.

After calling this function, timers load initial value(0U), count up to desired value or overflow then the counter will count up again.

Parameters

- base – RIT peripheral base address

static inline void RIT_StopTimer(RIT_Type *base)

Stops the timer counting.

This function stop timer counting. Timer reload their new value after the next time they call the RIT_StartTimer.

Parameters

- base – RIT peripheral base address

FSL_RIT_DRIVER_VERSION

Version 2.1.2

enum _rit_status_flags

List of RIT status flags.

Values:

enumerator kRIT_TimerFlag

Timer flag

typedef enum _rit_status_flags rit_status_flags_t

List of RIT status flags.

typedef struct _rit_config rit_config_t

RIT config structure.

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

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

static inline void RIT_ClearCounter(RIT_Type *base, bool enable)

Sets the Timer Counter auto clear or not.

This function set the counter auto clear or not whenever the counter value equals the masked compare value specified by the contents of COMPVAL/COMPVAL_H and MASK/MASK_H registers..

Deprecated:

Do not use this function. It has been superceded by RIT_SetCountAutoClear.

static inline void RIT_SetCountAutoClear(RIT_Type *base, bool enable)

Sets the Timer Counter auto clear or not.

This function set the counter auto clear or not whenever the counter value equals the masked compare value specified by the contents of COMPVAL/COMPVAL_H and MASK/MASK_H registers..

Parameters

- base – RIT peripheral base address
- enable – Enable/disable Counter auto clear when value equals the compare value.
 - true: Enable Counter auto clear.
 - false: Disable Counter auto clear.

struct _rit_config

#include <fsl_rit.h> RIT config structure.

This structure holds the configuration settings for the RIT peripheral. To initialize this structure to reasonable defaults, call the RIT_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 enableRunInDebug`

true: The timer is halted when the processor is halted for debugging.; false: Debug has no effect on the timer operation.

2.38 RNG: Random Number Generator

`FSL_RNG_DRIVER_VERSION`

RNG driver version 2.1.0.

Current version: 2.1.0

Change log:

- Version 2.0.0
 - Initial version.
- Version 2.1.0
 - Renamed function `RNG_GetRandomData()` to `RNG_GetRandomDataWord()`. Added function `RNG_GetRandomData()` which discarding next 32 words after reading RNG register which results into better entropy, as is recommended in UM.
 - API is aligned with other RNG driver, having similar functionality as other RNG/TRNG drivers.

`status_t RNG_GetRandomData(void *data, size_t dataSize)`

Gets random data.

This function gets random data from the RNG.

Parameters

- `data` – Pointer address used to store random data.
- `dataSize` – Size of the buffer pointed by the `data` parameter.

Returns

Status from operation

`static inline uint32_t RNG_GetRandomDataWord(void)`

Gets random data.

This function returns single 32 bit random number. For each read word next 32 words should be discarded to achieve better entropy.

Returns

random data

`FSL_COMPONENT_ID`

2.39 RTC: Real Time Clock

`void RTC_Init(RTC_Type *base)`

Un-gate the RTC clock and enable the RTC oscillator.

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

Parameters

- base – RTC peripheral base address

static inline void RTC_Deinit(RTC_Type *base)

Stop the timer and gate the RTC clock.

Parameters

- base – RTC peripheral base address

status_t RTC_SetDatetime(RTC_Type *base, const rtc_datetime_t *datetime)

Set the RTC date and time according to the given time structure.

The RTC counter must be stopped prior to calling this function as writes to the RTC seconds register will fail if the RTC counter is running.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the date and time details to set are stored

Returns

kStatus_Success: Success in setting the time and starting the RTC
kStatus_InvalidArgument: Error because the datetime format is incorrect

void RTC_GetDatetime(RTC_Type *base, rtc_datetime_t *datetime)

Get the RTC time and stores it in the given time structure.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the date and time details are stored.

status_t RTC_SetAlarm(RTC_Type *base, const rtc_datetime_t *alarmTime)

Set the RTC alarm time.

The function checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error.

Parameters

- base – RTC peripheral base address
- alarmTime – Pointer to structure where the alarm time is stored.

Returns

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

void RTC_GetAlarm(RTC_Type *base, rtc_datetime_t *datetime)

Return the RTC alarm time.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to structure where the alarm date and time details are stored.

static inline void RTC_EnableWakeupTimer(RTC_Type *base, bool enable)

Enable the RTC wake-up timer (1KHZ).

After calling this function, the RTC driver will use/un-use the RTC wake-up (1KHZ) at the same time.

Parameters

- base – RTC peripheral base address
- enable – Use/Un-use the RTC wake-up timer.
 - true: Use RTC wake-up timer at the same time.
 - false: Un-use RTC wake-up timer, RTC only use the normal seconds timer by default.

```
static inline uint32_t RTC_GetEnabledWakeupTimer(RTC_Type *base)
```

Get the enabled status of the RTC wake-up timer (1KHZ).

Parameters

- base – RTC peripheral base address

Returns

The enabled status of RTC wake-up timer (1KHZ).

```
static inline void RTC_EnableWakeUpTimerInterruptFromDPD(RTC_Type *base, bool enable)
```

Enable the wake-up timer interrupt from deep power down mode.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable wake-up timer interrupt from deep power down mode.
 - true: Enable wake-up timer interrupt from deep power down mode.
 - false: Disable wake-up timer interrupt from deep power down mode.

```
static inline void RTC_EnableAlarmTimerInterruptFromDPD(RTC_Type *base, bool enable)
```

Enable the alarm timer interrupt from deep power down mode.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable alarm timer interrupt from deep power down mode.
 - true: Enable alarm timer interrupt from deep power down mode.
 - false: Disable alarm timer interrupt from deep power down mode.

```
static inline void RTC_EnableInterrupts(RTC_Type *base, uint32_t mask)
```

Enables the selected RTC interrupts.

Deprecated:

Do not use this function. It has been superseded by `RTC_EnableAlarmTimerInterruptFromDPD` and `RTC_EnableWakeUpTimerInterruptFromDPD`

Parameters

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

```
static inline void RTC_DisableInterrupts(RTC_Type *base, uint32_t mask)
```

Disables the selected RTC interrupts.

Deprecated:

Do not use this function. It has been superceded by `RTC_EnableAlarmTimerInterruptFromDPD` and `RTC_EnableWakeUpTimerInterruptFromDPD`

Parameters

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

```
static inline uint32_t RTC_GetEnabledInterrupts(RTC_Type *base)
```

Get the enabled RTC interrupts.

Deprecated:

Do not use this function. It will be deleted in next release version.

Parameters

- `base` – RTC peripheral base address

Returns

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

```
static inline uint32_t RTC_GetStatusFlags(RTC_Type *base)
```

Get the RTC status flags.

Parameters

- `base` – RTC peripheral base address

Returns

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

```
static inline void RTC_ClearStatusFlags(RTC_Type *base, uint32_t mask)
```

Clear the RTC status flags.

Parameters

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

```
static inline void RTC_EnableTimer(RTC_Type *base, bool enable)
```

Enable the RTC timer counter.

After calling this function, the RTC inner counter increments once a second when only using the RTC seconds timer (1hz), while the RTC inner wake-up timer countdown once a millisecond when using RTC wake-up timer (1KHZ) at the same time. RTC timer contain two timers, one is the RTC normal seconds timer, the other one is the RTC wake-up timer, the RTC enable bit is the master switch for the whole RTC timer, so user can use the RTC seconds (1HZ) timer independly, but they can't use the RTC wake-up timer (1KHZ) independently.

Parameters

- `base` – RTC peripheral base address
- `enable` – Enable/Disable RTC Timer counter.
 - `true`: Enable RTC Timer counter.
 - `false`: Disable RTC Timer counter.

```
static inline void RTC_StartTimer(RTC_Type *base)
```

Starts the RTC time counter.

Deprecated:

Do not use this function. It has been superceded by RTC_EnableTimer

After calling this function, the timer counter increments once a second provided SR[TOF] or SR[TIF] are not set.

Parameters

- base – RTC peripheral base address

```
static inline void RTC_StopTimer(RTC_Type *base)
```

Stops the RTC time counter.

Deprecated:

Do not use this function. It has been superceded by RTC_EnableTimer

RTC's seconds register can be written to only when the timer is stopped.

Parameters

- base – RTC peripheral base address

```
FSL_RTC_DRIVER_VERSION
```

Version 2.2.0

```
enum _rtc_interrupt_enable
```

List of RTC interrupts.

Values:

```
enumerator kRTC_AlarmInterruptEnable
```

Alarm interrupt.

```
enumerator kRTC_WakeupInterruptEnable
```

Wake-up interrupt.

```
enum _rtc_status_flags
```

List of RTC flags.

Values:

```
enumerator kRTC_AlarmFlag
```

Alarm flag

```
enumerator kRTC_WakeupFlag
```

1kHz wake-up timer flag

```
typedef enum _rtc_interrupt_enable rtc_interrupt_enable_t
```

List of RTC interrupts.

```
typedef enum _rtc_status_flags rtc_status_flags_t
```

List of RTC flags.

```
typedef struct _rtc_datetime rtc_datetime_t
```

Structure is used to hold the date and time.

```
static inline void RTC__SetSecondsTimerMatch(RTC_Type *base, uint32_t matchValue)
```

Set the RTC seconds timer (1HZ) MATCH value.

Parameters

- base – RTC peripheral base address
- matchValue – The value to be set into the RTC MATCH register

```
static inline uint32_t RTC__GetSecondsTimerMatch(RTC_Type *base)
```

Read actual RTC seconds timer (1HZ) MATCH value.

Parameters

- base – RTC peripheral base address

Returns

The actual RTC seconds timer (1HZ) MATCH value.

```
static inline void RTC__SetSecondsTimerCount(RTC_Type *base, uint32_t countValue)
```

Set the RTC seconds timer (1HZ) COUNT value.

Parameters

- base – RTC peripheral base address
- countValue – The value to be loaded into the RTC COUNT register

```
static inline uint32_t RTC__GetSecondsTimerCount(RTC_Type *base)
```

Read the actual RTC seconds timer (1HZ) COUNT value.

Parameters

- base – RTC peripheral base address

Returns

The actual RTC seconds timer (1HZ) COUNT value.

```
static inline void RTC__SetWakeupCount(RTC_Type *base, uint16_t wakeupValue)
```

Enable the RTC wake-up timer (1KHZ) and set countdown value to the RTC WAKE register.

Parameters

- base – RTC peripheral base address
- wakeupValue – The value to be loaded into the WAKE register in RTC wake-up timer (1KHZ).

```
static inline uint16_t RTC__GetWakeupCount(RTC_Type *base)
```

Read the actual value from the WAKE register value in RTC wake-up timer (1KHZ)

Read the WAKE register twice and compare the result, if the value match, the time can be used.

Parameters

- base – RTC peripheral base address

Returns

The actual value of the WAKE register value in RTC wake-up timer (1KHZ).

```
static inline void RTC__Reset(RTC_Type *base)
```

Perform a software reset on the RTC module.

This resets all RTC registers to their reset value. The bit is cleared by software explicitly clearing it.

Parameters

- base – RTC peripheral base address

struct _rtc_datetime

#include <fsl_rtc.h> Structure is used to hold the date and time.

Public Members

uint16_t year

Range from 1970 to 2099.

uint8_t month

Range from 1 to 12.

uint8_t day

Range from 1 to 31 (depending on month).

uint8_t hour

Range from 0 to 23.

uint8_t minute

Range from 0 to 59.

uint8_t second

Range from 0 to 59.

2.40 SCTimer: SCTimer/PWM (SCT)

status_t SCTIMER_Init(SCT_Type *base, const sctimer_config_t *config)

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

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

Parameters

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

Returns

kStatus_Success indicates success; Else indicates failure.

void SCTIMER_Deinit(SCT_Type *base)

Gates the SCTimer clock.

Parameters

- base – SCTimer peripheral base address

void SCTIMER_GetDefaultConfig(sctimer_config_t *config)

Fills in the SCTimer configuration structure with the default settings.

The default values are:

```
config->enableCounterUnify = true;
config->clockMode = kSCTIMER_System_ClockMode;
config->clockSelect = kSCTIMER_Clock_On_Rise_Input_0;
config->enableBidirection_l = false;
config->enableBidirection_h = false;
config->prescale_l = 0U;
```

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```
config->prescale_h = 0U;  
config->outInitState = 0U;  
config->inputsync = 0xFU;
```

Parameters

- config – Pointer to the user configuration structure.

```
status_t SCTIMER_SetupPwm(SCT_Type *base, const sctimer_pwm_signal_param_t  
                          *pwmParams, sctimer_pwm_mode_t mode, uint32_t  
                          pwmFreq_Hz, uint32_t srcClock_Hz, uint32_t *event)
```

Configures the PWM signal parameters.

Call this function to configure the PWM signal period, mode, duty cycle, and edge. This function will create 2 events; one of the events will trigger on match with the pulse value and the other will trigger when the counter matches the PWM period. The PWM period event is also used as a limit event to reset the counter or change direction. Both events are enabled for the same state. The state number can be retrieved by calling the function `SCTIMER_GetCurrentStateNumber()`. The counter is set to operate as one 32-bit counter (unify bit is set to 1). The counter operates in bi-directional mode when generating a center-aligned PWM.

Note: When setting PWM output from multiple output pins, they all should use the same PWM mode i.e all PWM's should be either edge-aligned or center-aligned. When using this API, the PWM signal frequency of all the initialized channels must be the same. Otherwise all the initialized channels' PWM signal frequency is equal to the last call to the API's `pwmFreq_Hz`.

Parameters

- base – SCTimer peripheral base address
- pwmParams – PWM parameters to configure the output
- mode – PWM operation mode, options available in enumeration `sctimer_pwm_mode_t`
- pwmFreq_Hz – PWM signal frequency in Hz
- srcClock_Hz – SCTimer counter clock in Hz
- event – Pointer to a variable where the PWM period event number is stored

Returns

`kStatus_Success` on success `kStatus_Fail` If we have hit the limit in terms of number of events created or if an incorrect PWM duty cycle is passed in.

```
void SCTIMER_UpdatePwmDutycycle(SCT_Type *base, sctimer_out_t output, uint8_t  
                               dutyCyclePercent, uint32_t event)
```

Updates the duty cycle of an active PWM signal.

Before calling this function, the counter is set to operate as one 32-bit counter (unify bit is set to 1).

Parameters

- base – SCTimer peripheral base address
- output – The output to configure
- dutyCyclePercent – New PWM pulse width; the value should be between 1 to 100

- `event` – Event number associated with this PWM signal. This was returned to the user by the function `SCTIMER_SetupPwm()`.

`static inline void SCTIMER_EnableInterrupts(SCT_Type *base, uint32_t mask)`

Enables the selected SCTimer interrupts.

Parameters

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

`static inline void SCTIMER_DisableInterrupts(SCT_Type *base, uint32_t mask)`

Disables the selected SCTimer interrupts.

Parameters

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

`static inline uint32_t SCTIMER_GetEnabledInterrupts(SCT_Type *base)`

Gets the enabled SCTimer interrupts.

Parameters

- `base` – SCTimer peripheral base address

Returns

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

`static inline uint32_t SCTIMER_GetStatusFlags(SCT_Type *base)`

Gets the SCTimer status flags.

Parameters

- `base` – SCTimer peripheral base address

Returns

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

`static inline void SCTIMER_ClearStatusFlags(SCT_Type *base, uint32_t mask)`

Clears the SCTimer status flags.

Parameters

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

`static inline void SCTIMER_StartTimer(SCT_Type *base, uint32_t countertoStart)`

Starts the SCTimer counter.

Note: In 16-bit mode, we can enable both Counter_L and Counter_H, In 32-bit mode, we only can select Counter_U.

Parameters

- `base` – SCTimer peripheral base address
- `countertoStart` – The SCTimer counters to enable. This is a logical OR of members of the enumeration `sctimer_counter_t`.

```
static inline void SCTIMER_StopTimer(SCT_Type *base, uint32_t countertoStop)
```

Halts the SCTimer counter.

Parameters

- base – SCTimer peripheral base address
- countertoStop – The SCTimer counters to stop. This is a logical OR of members of the enumeration `sctimer_counter_t`.

```
status_t SCTIMER_CreateAndScheduleEvent(SCT_Type *base, sctimer_event_t howToMonitor,  
                                         uint32_t matchValue, uint32_t whichIO,  
                                         sctimer_counter_t whichCounter, uint32_t *event)
```

Create an event that is triggered on a match or IO and schedule in current state.

This function will configure an event using the options provided by the user. If the event type uses the counter match, then the function will set the user provided match value into a match register and put this match register number into the event control register. The event is enabled for the current state and the event number is increased by one at the end. The function returns the event number; this event number can be used to configure actions to be done when this event is triggered.

Parameters

- base – SCTimer peripheral base address
- howToMonitor – Event type; options are available in the enumeration `sctimer_interrupt_enable_t`
- matchValue – The match value that will be programmed to a match register
- whichIO – The input or output that will be involved in event triggering. This field is ignored if the event type is “match only”
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select `Counter_L` and `Counter_H`, In 32-bit mode, we can select `Counter_U`.
- event – Pointer to a variable where the new event number is stored

Returns

`kStatus_Success` on success `kStatus_Error` if we have hit the limit in terms of number of events created or if we have reached the limit in terms of number of match registers

```
void SCTIMER_ScheduleEvent(SCT_Type *base, uint32_t event)
```

Enable an event in the current state.

This function will allow the event passed in to trigger in the current state. The event must be created earlier by either calling the function `SCTIMER_SetupPwm()` or function `SCTIMER_CreateAndScheduleEvent()`.

Parameters

- base – SCTimer peripheral base address
- event – Event number to enable in the current state

```
status_t SCTIMER_IncreaseState(SCT_Type *base)
```

Increase the state by 1.

All future events created by calling the function `SCTIMER_ScheduleEvent()` will be enabled in this new state.

Parameters

- base – SCTimer peripheral base address

Returns

kStatus_Success on success kStatus_Error if we have hit the limit in terms of states used

uint32_t SCTIMER_GetCurrentState(SCT_Type *base)

Provides the current state.

User can use this to set the next state by calling the function SCTIMER_SetupNextStateAction().

Parameters

- base – SCTimer peripheral base address

Returns

The current state

static inline void SCTIMER_SetCounterState(SCT_Type *base, *sctimer_counter_t* whichCounter, uint32_t state)

Set the counter current state.

The function is to set the state variable bit field of STATE register. Writing to the STATE_L, STATE_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- state – The counter current state number (only support range from 0~31).

static inline uint16_t SCTIMER_GetCounterState(SCT_Type *base, *sctimer_counter_t* whichCounter)

Get the counter current state value.

The function is to get the state variable bit field of STATE register.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.

Returns

The the counter current state value.

status_t SCTIMER_SetupCaptureAction(SCT_Type *base, *sctimer_counter_t* whichCounter, uint32_t *captureRegister, uint32_t event)

Setup capture of the counter value on trigger of a selected event.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- captureRegister – Pointer to a variable where the capture register number will be returned. User can read the captured value from this register when the specified event is triggered.
- event – Event number that will trigger the capture

Returns

kStatus_Success on success kStatus_Error if we have hit the limit in terms of number of match/capture registers available

void SCTIMER_SetCallback(SCT_Type *base, *sctimer_event_callback_t* callback, uint32_t event)

Receive notification when the event trigger an interrupt.

If the interrupt for the event is enabled by the user, then a callback can be registered which will be invoked when the event is triggered

Parameters

- base – SCTimer peripheral base address
- event – Event number that will trigger the interrupt
- callback – Function to invoke when the event is triggered

static inline void SCTIMER_SetupStateLdMethodAction(SCT_Type *base, uint32_t event, bool fgLoad)

Change the load method of transition to the specified state.

Change the load method of transition, it will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- event – Event number that will change the method to trigger the state transition
- fgLoad – The method to load highest-numbered event occurring for that state to the STATE register.
 - true: Load the STATEV value to STATE when the event occurs to be the next state.
 - false: Add the STATEV value to STATE when the event occurs to be the next state.

static inline void SCTIMER_SetupNextStateActionwithLdMethod(SCT_Type *base, uint32_t nextState, uint32_t event, bool fgLoad)

Transition to the specified state with Load method.

This transition will be triggered by the event number that is passed in by the user, the method decide how to load the highest-numbered event occurring for that state to the STATE register.

Parameters

- base – SCTimer peripheral base address
- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition
- fgLoad – The method to load the highest-numbered event occurring for that state to the STATE register.
 - true: Load the STATEV value to STATE when the event occurs to be the next state.
 - false: Add the STATEV value to STATE when the event occurs to be the next state.

```
static inline void SCTIMER_SetupNextStateAction(SCT_Type *base, uint32_t nextState, uint32_t event)
```

Transition to the specified state.

Deprecated:

Do not use this function. It has been superceded by SCTIMER_SetupNextStateActionwithLdMethod

This transition will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- nextState – The next state SCTimer will transition to
- event – Event number that will trigger the state transition

```
static inline void SCTIMER_SetupEventActiveDirection(SCT_Type *base,
                                                    sctimer_event_active_direction_t
                                                    activeDirection, uint32_t event)
```

Setup event active direction when the counters are operating in BIDIR mode.

Parameters

- base – SCTimer peripheral base address
- activeDirection – Event generation active direction, see sctimer_event_active_direction_t.
- event – Event number that need setup the active direction.

```
static inline void SCTIMER_SetupOutputSetAction(SCT_Type *base, uint32_t whichIO, uint32_t event)
```

Set the Output.

This output will be set when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to set
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupOutputClearAction(SCT_Type *base, uint32_t whichIO,
                                                  uint32_t event)
```

Clear the Output.

This output will be cleared when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to clear
- event – Event number that will trigger the output change

```
void SCTIMER_SetupOutputToggleAction(SCT_Type *base, uint32_t whichIO, uint32_t event)
```

Toggle the output level.

This change in the output level is triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- whichIO – The output to toggle
- event – Event number that will trigger the output change

```
static inline void SCTIMER_SetupCounterLimitAction(SCT_Type *base, sctimer_counter_t
                                                    whichCounter, uint32_t event)
```

Limit the running counter.

The counter is limited when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be limited

```
static inline void SCTIMER_SetupCounterStopAction(SCT_Type *base, sctimer_counter_t
                                                    whichCounter, uint32_t event)
```

Stop the running counter.

The counter is stopped when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be stopped

```
static inline void SCTIMER_SetupCounterStartAction(SCT_Type *base, sctimer_counter_t
                                                    whichCounter, uint32_t event)
```

Re-start the stopped counter.

The counter will re-start when the event number that is passed in by the user is triggered.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to re-start

```
static inline void SCTIMER_SetupCounterHaltAction(SCT_Type *base, sctimer_counter_t
                                                    whichCounter, uint32_t event)
```

Halt the running counter.

The counter is disabled (halted) when the event number that is passed in by the user is triggered. When the counter is halted, all further events are disabled. The HALT condition can only be removed by calling the SCTIMER_StartTimer() function.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- event – Event number that will trigger the counter to be halted


```
static inline void SCTIMER_SetupDmaTriggerAction(SCT_Type *base, uint32_t dmaNumber,
                                                uint32_t event)
```

Generate a DMA request.

DMA request will be triggered by the event number that is passed in by the user.

Parameters

- base – SCTimer peripheral base address
- dmaNumber – The DMA request to generate
- event – Event number that will trigger the DMA request

```
static inline void SCTIMER_SetCOUNTValue(SCT_Type *base, sctimer_counter_t whichCounter,
                                          uint32_t value)
```

Set the value of counter.

The function is to set the value of Count register, Writing to the COUNT_L, COUNT_H, or unified register is only allowed when the corresponding counter is halted (HALT bits are set to 1 in the CTRL register).

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- value – the counter value update to the COUNT register.

```
static inline uint32_t SCTIMER_GetCOUNTValue(SCT_Type *base, sctimer_counter_t
                                              whichCounter)
```

Get the value of counter.

The function is to read the value of Count register, software can read the counter registers at any time..

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.

Returns

The value of counter selected.

```
static inline void SCTIMER_SetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Set the state mask bit field of EV_STATE register.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be set.
- state – The state value in which the event is enabled to occur.

```
static inline void SCTIMER_ClearEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Clear the state mask bit field of EV_STATE register.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be clear.
- state – The state value in which the event is disabled to occur.

```
static inline bool SCTIMER_GetEventInState(SCT_Type *base, uint32_t event, uint32_t state)
```

Get the state mask bit field of EV_STATE register.

Note: This function is to check whether the event is enabled in a specific state.

Parameters

- base – SCTimer peripheral base address
- event – The EV_STATE register be read.
- state – The state value.

Returns

The the state mask bit field of EV_STATE register.

- true: The event is enable in state.
- false: The event is disable in state.

```
static inline uint32_t SCTIMER_GetCaptureValue(SCT_Type *base, sctimer_counter_t  
whichCounter, uint8_t capChannel)
```

Get the value of capture register.

This function returns the captured value upon occurrence of the events selected by the corresponding Capture Control registers occurred.

Parameters

- base – SCTimer peripheral base address
- whichCounter – SCTimer counter to use. In 16-bit mode, we can select Counter_L and Counter_H, In 32-bit mode, we can select Counter_U.
- capChannel – SCTimer capture register of capture channel.

Returns

The SCTimer counter value at which this register was last captured.

```
void SCTIMER_EventHandleIRQ(SCT_Type *base)
```

SCTimer interrupt handler.

Parameters

- base – SCTimer peripheral base address.

```
FSL_SCTIMER_DRIVER_VERSION
```

Version

```
enum _sctimer_pwm_mode
```

SCTimer PWM operation modes.

Values:

```
enumerator kSCTIMER_EdgeAlignedPwm
```

Edge-aligned PWM

```
enumerator kSCTIMER_CenterAlignedPwm
```

Center-aligned PWM

```
enum _sctimer_counter
```

SCTimer counters type.

Values:

enumerator kSCTIMER_Counter_L
16-bit Low counter.

enumerator kSCTIMER_Counter_H
16-bit High counter.

enumerator kSCTIMER_Counter_U
32-bit Unified counter.

enum _sctimer_input

List of SCTimer input pins.

Values:

enumerator kSCTIMER_Input_0
SCTIMER input 0

enumerator kSCTIMER_Input_1
SCTIMER input 1

enumerator kSCTIMER_Input_2
SCTIMER input 2

enumerator kSCTIMER_Input_3
SCTIMER input 3

enumerator kSCTIMER_Input_4
SCTIMER input 4

enumerator kSCTIMER_Input_5
SCTIMER input 5

enumerator kSCTIMER_Input_6
SCTIMER input 6

enumerator kSCTIMER_Input_7
SCTIMER input 7

enum _sctimer_out

List of SCTimer output pins.

Values:

enumerator kSCTIMER_Out_0
SCTIMER output 0

enumerator kSCTIMER_Out_1
SCTIMER output 1

enumerator kSCTIMER_Out_2
SCTIMER output 2

enumerator kSCTIMER_Out_3
SCTIMER output 3

enumerator kSCTIMER_Out_4
SCTIMER output 4

enumerator kSCTIMER_Out_5
SCTIMER output 5

enumerator kSCTIMER_Out_6
SCTIMER output 6

enumerator kSCTIMER_Out_7

SCTIMER output 7

enumerator kSCTIMER_Out_8

SCTIMER output 8

enumerator kSCTIMER_Out_9

SCTIMER output 9

enum __sctimer_pwm_level_select

SCTimer PWM output pulse mode: high-true, low-true or no output.

Values:

enumerator kSCTIMER_LowTrue

Low true pulses

enumerator kSCTIMER_HighTrue

High true pulses

enum __sctimer_clock_mode

SCTimer clock mode options.

Values:

enumerator kSCTIMER_System_ClockMode

System Clock Mode

enumerator kSCTIMER_Sampled_ClockMode

Sampled System Clock Mode

enumerator kSCTIMER_Input_ClockMode

SCT Input Clock Mode

enumerator kSCTIMER_Asynchronous_ClockMode

Asynchronous Mode

enum __sctimer_clock_select

SCTimer clock select options.

Values:

enumerator kSCTIMER_Clock_On_Rise_Input_0

Rising edges on input 0

enumerator kSCTIMER_Clock_On_Fall_Input_0

Falling edges on input 0

enumerator kSCTIMER_Clock_On_Rise_Input_1

Rising edges on input 1

enumerator kSCTIMER_Clock_On_Fall_Input_1

Falling edges on input 1

enumerator kSCTIMER_Clock_On_Rise_Input_2

Rising edges on input 2

enumerator kSCTIMER_Clock_On_Fall_Input_2

Falling edges on input 2

enumerator kSCTIMER_Clock_On_Rise_Input_3

Rising edges on input 3

enumerator kSCTIMER_Clock_On_Fall_Input_3

Falling edges on input 3

enumerator kSCTIMER_Clock_On_Rise_Input_4

Rising edges on input 4

enumerator kSCTIMER_Clock_On_Fall_Input_4

Falling edges on input 4

enumerator kSCTIMER_Clock_On_Rise_Input_5

Rising edges on input 5

enumerator kSCTIMER_Clock_On_Fall_Input_5

Falling edges on input 5

enumerator kSCTIMER_Clock_On_Rise_Input_6

Rising edges on input 6

enumerator kSCTIMER_Clock_On_Fall_Input_6

Falling edges on input 6

enumerator kSCTIMER_Clock_On_Rise_Input_7

Rising edges on input 7

enumerator kSCTIMER_Clock_On_Fall_Input_7

Falling edges on input 7

enum _sctimer_conflict_resolution

SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

Values:

enumerator kSCTIMER_ResolveNone

No change

enumerator kSCTIMER_ResolveSet

Set output

enumerator kSCTIMER_ResolveClear

Clear output

enumerator kSCTIMER_ResolveToggle

Toggle output

enum _sctimer_event_active_direction

List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

Values:

enumerator kSCTIMER_ActiveIndependent

This event is triggered regardless of the count direction.

enumerator kSCTIMER_ActiveInCountUp

This event is triggered only during up-counting when BIDIR = 1.

enumerator kSCTIMER_ActiveInCountDown

This event is triggered only during down-counting when BIDIR = 1.

enum `_sctimer_event`

List of SCTimer event types.

Values:

enumerator `kSCTIMER_InputLowOrMatchEvent`
enumerator `kSCTIMER_InputRiseOrMatchEvent`
enumerator `kSCTIMER_InputFallOrMatchEvent`
enumerator `kSCTIMER_InputHighOrMatchEvent`
enumerator `kSCTIMER_MatchEventOnly`
enumerator `kSCTIMER_InputLowEvent`
enumerator `kSCTIMER_InputRiseEvent`
enumerator `kSCTIMER_InputFallEvent`
enumerator `kSCTIMER_InputHighEvent`
enumerator `kSCTIMER_InputLowAndMatchEvent`
enumerator `kSCTIMER_InputRiseAndMatchEvent`
enumerator `kSCTIMER_InputFallAndMatchEvent`
enumerator `kSCTIMER_InputHighAndMatchEvent`
enumerator `kSCTIMER_OutputLowOrMatchEvent`
enumerator `kSCTIMER_OutputRiseOrMatchEvent`
enumerator `kSCTIMER_OutputFallOrMatchEvent`
enumerator `kSCTIMER_OutputHighOrMatchEvent`
enumerator `kSCTIMER_OutputLowEvent`
enumerator `kSCTIMER_OutputRiseEvent`
enumerator `kSCTIMER_OutputFallEvent`
enumerator `kSCTIMER_OutputHighEvent`
enumerator `kSCTIMER_OutputLowAndMatchEvent`
enumerator `kSCTIMER_OutputRiseAndMatchEvent`
enumerator `kSCTIMER_OutputFallAndMatchEvent`
enumerator `kSCTIMER_OutputHighAndMatchEvent`

enum `_sctimer_interrupt_enable`

List of SCTimer interrupts.

Values:

enumerator `kSCTIMER_Event0InterruptEnable`
 Event 0 interrupt
enumerator `kSCTIMER_Event1InterruptEnable`
 Event 1 interrupt

enumerator kSCTIMER_Event2InterruptEnable

Event 2 interrupt

enumerator kSCTIMER_Event3InterruptEnable

Event 3 interrupt

enumerator kSCTIMER_Event4InterruptEnable

Event 4 interrupt

enumerator kSCTIMER_Event5InterruptEnable

Event 5 interrupt

enumerator kSCTIMER_Event6InterruptEnable

Event 6 interrupt

enumerator kSCTIMER_Event7InterruptEnable

Event 7 interrupt

enumerator kSCTIMER_Event8InterruptEnable

Event 8 interrupt

enumerator kSCTIMER_Event9InterruptEnable

Event 9 interrupt

enumerator kSCTIMER_Event10InterruptEnable

Event 10 interrupt

enumerator kSCTIMER_Event11InterruptEnable

Event 11 interrupt

enumerator kSCTIMER_Event12InterruptEnable

Event 12 interrupt

enum _sctimer_status_flags

List of SCTimer flags.

Values:

enumerator kSCTIMER_Event0Flag

Event 0 Flag

enumerator kSCTIMER_Event1Flag

Event 1 Flag

enumerator kSCTIMER_Event2Flag

Event 2 Flag

enumerator kSCTIMER_Event3Flag

Event 3 Flag

enumerator kSCTIMER_Event4Flag

Event 4 Flag

enumerator kSCTIMER_Event5Flag

Event 5 Flag

enumerator kSCTIMER_Event6Flag

Event 6 Flag

enumerator kSCTIMER_Event7Flag

Event 7 Flag

enumerator `kSCTIMER_Event8Flag`
Event 8 Flag

enumerator `kSCTIMER_Event9Flag`
Event 9 Flag

enumerator `kSCTIMER_Event10Flag`
Event 10 Flag

enumerator `kSCTIMER_Event11Flag`
Event 11 Flag

enumerator `kSCTIMER_Event12Flag`
Event 12 Flag

enumerator `kSCTIMER_BusErrorLFlag`
Bus error due to write when L counter was not halted

enumerator `kSCTIMER_BusErrorHFlag`
Bus error due to write when H counter was not halted

typedef enum `_sctimer_pwm_mode` `sctimer_pwm_mode_t`
SCTimer PWM operation modes.

typedef enum `_sctimer_counter` `sctimer_counter_t`
SCTimer counters type.

typedef enum `_sctimer_input` `sctimer_input_t`
List of SCTimer input pins.

typedef enum `_sctimer_out` `sctimer_out_t`
List of SCTimer output pins.

typedef enum `_sctimer_pwm_level_select` `sctimer_pwm_level_select_t`
SCTimer PWM output pulse mode: high-true, low-true or no output.

typedef struct `_sctimer_pwm_signal_param` `sctimer_pwm_signal_param_t`
Options to configure a SCTimer PWM signal.

typedef enum `_sctimer_clock_mode` `sctimer_clock_mode_t`
SCTimer clock mode options.

typedef enum `_sctimer_clock_select` `sctimer_clock_select_t`
SCTimer clock select options.

typedef enum `_sctimer_conflict_resolution` `sctimer_conflict_resolution_t`
SCTimer output conflict resolution options.

Specifies what action should be taken if multiple events dictate that a given output should be both set and cleared at the same time

typedef enum `_sctimer_event_active_direction` `sctimer_event_active_direction_t`
List of SCTimer event generation active direction when the counters are operating in BIDIR mode.

typedef enum `_sctimer_event` `sctimer_event_t`
List of SCTimer event types.

typedef void (*`sctimer_event_callback_t`)(void)
SCTimer callback typedef.

typedef enum `_sctimer_interrupt_enable` `sctimer_interrupt_enable_t`
List of SCTimer interrupts.


```
typedef enum _sctimer_status_flags sctimer_status_flags_t
```

List of SCTimer flags.

```
typedef struct _sctimer_config sctimer_config_t
```

SCTimer configuration structure.

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

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

```
SCT_EV_STATE_STATEMSK(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 enable-CounterUnify 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);`

2.41 SDIF: SD/MMC/SDIO card interface

`FSL_SDIF_DRIVER_VERSION`
Driver version 2.0.15.

`_sdif_status` SDIF status

Values:

enumerator `kStatus_SDIF_DescriptorBufferLenError`
Set DMA descriptor failed

enumerator `kStatus_SDIF_InvalidArgument`
invalid argument status

enumerator `kStatus_SDIF_SyncCmdTimeout`
sync command to CIU timeout status

enumerator `kStatus_SDIF_SendCmdFail`
send command to card fail

enumerator `kStatus_SDIF_SendCmdErrorBufferFull`
send command to card fail, due to command buffer full user need to resend this command

enumerator `kStatus_SDIF_DMATransferFailWithFBE`
DMA transfer data fail with fatal bus error , to do with this error :issue a hard reset/controller reset

enumerator `kStatus_SDIF_DMATransferDescriptorUnavailable`
DMA descriptor unavailable

enumerator `kStatus_SDIF_DataTransferFail`
transfer data fail

enumerator `kStatus_SDIF_ResponseError`
response error

enumerator kStatus_SDIF_DMAAddrNotAlign

DMA address not align

enumerator kStatus_SDIF_BusyTransferring

SDIF transfer busy status

enumerator kStatus_SDIF_DataTransferSuccess

transfer data success

enumerator kStatus_SDIF_SendCmdSuccess

transfer command success

_sdif_capability_flag Host controller capabilities flag mask

Values:

enumerator kSDIF_SupportHighSpeedFlag

Support high-speed

enumerator kSDIF_SupportDmaFlag

Support DMA

enumerator kSDIF_SupportSuspendResumeFlag

Support suspend/resume

enumerator kSDIF_SupportV330Flag

Support voltage 3.3V

enumerator kSDIF_Support4BitFlag

Support 4 bit mode

enumerator kSDIF_Support8BitFlag

Support 8 bit mode

_sdif_reset_type define the reset type

Values:

enumerator kSDIF_ResetController

reset controller,will reset: BIU/CIU interface CIU and state machine,ABORT_READ_DATA,SEND_IRQ_RESPONSE and READ_WAIT bits of control register,START_CMD bit of the command register

enumerator kSDIF_ResetFIFO

reset data FIFO

enumerator kSDIF_ResetDMAInterface

reset DMA interface

enumerator kSDIF_ResetAll

reset all

enum _sdif_bus_width

define the card bus width type

Values:

enumerator kSDIF_Bus1BitWidth

1bit bus width, 1bit mode and 4bit mode share one register bit

enumerator kSDIF_Bus4BitWidth

4bit mode mask

enumerator kSDIF_Bus8BitWidth
support 8 bit mode

_sdif_command_flags define the command flags

Values:

enumerator kSDIF_CmdResponseExpect
command request response

enumerator kSDIF_CmdResponseLengthLong
command response length long

enumerator kSDIF_CmdCheckResponseCRC
request check command response CRC

enumerator kSDIF_DataExpect
request data transfer, either read/write

enumerator kSDIF_DataWriteToCard
data transfer direction

enumerator kSDIF_DataStreamTransfer
data transfer mode :stream/block transfer command

enumerator kSDIF_DataTransferAutoStop
data transfer with auto stop at the end of

enumerator kSDIF_WaitPreTransferComplete
wait pre transfer complete before sending this cmd

enumerator kSDIF_TransferStopAbort
when host issue stop or abort cmd to stop data transfer ,this bit should set so that
cmd/data state-machines of CIU can return to idle correctly

enumerator kSDIF_SendInitialization
send initialization 80 clocks for SD card after power on

enumerator kSDIF_CmdUpdateClockRegisterOnly
send cmd update the CIU clock register only

enumerator kSDIF_CmdtoReadCEATADevice
host is perform read access to CE-ATA device

enumerator kSDIF_CmdExpectCCS
command expect command completion signal signal

enumerator kSDIF_BootModeEnable
this bit should only be set for mandatory boot mode

enumerator kSDIF_BootModeExpectAck
boot mode expect ack

enumerator kSDIF_BootModeDisable
when software set this bit along with START_CMD, CIU terminates the boot operation

enumerator kSDIF_BootModeAlternate
select boot mode ,alternate or mandatory

enumerator kSDIF_CmdVoltageSwitch
this bit set for CMD11 only

enumerator kSDIF_CmdDataUseHoldReg
cmd and data send to card through the HOLD register

_sdif_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

_sdif_response_type The command response type.

Define 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

_sdif_interrupt_mask define the interrupt mask flags

Values:

enumerator kSDIF_CardDetect
mask for card detect

enumerator kSDIF_ResponseError
command response error

enumerator kSDIF_CommandDone
command transfer over

enumerator kSDIF_DataTransferOver
data transfer over flag

enumerator kSDIF_WriteFIFORequest
write FIFO request

enumerator kSDIF_ReadFIFORequest
read FIFO request

enumerator kSDIF_ResponseCRCError
response CRC error

enumerator kSDIF_DataCRCError
data CRC error

enumerator kSDIF_ResponseTimeout
response timeout

enumerator kSDIF_DataReadTimeout
read data timeout

enumerator kSDIF_DataStarvationByHostTimeout
data starvation by host time out

enumerator kSDIF_FIFOError
indicate the FIFO under run or overrun error

enumerator kSDIF_HardwareLockError
hardware lock write error

enumerator kSDIF_DataStartBitError
start bit error

enumerator kSDIF_AutoCmdDone
indicate the auto command done

enumerator kSDIF_DataEndBitError
end bit error

enumerator kSDIF_SDIOInterrupt
interrupt from the SDIO card

enumerator kSDIF_CommandTransferStatus
command transfer status collection

enumerator kSDIF_DataTransferStatus
data transfer status collection

enumerator kSDIF_DataTransferError

enumerator kSDIF_AllInterruptStatus
all interrupt mask

_sdif_dma_status define the internal DMA status flags

Values:

enumerator kSDIF_DMATransFinishOneDescriptor
DMA transfer finished for one DMA descriptor

enumerator kSDIF_DMARecvFinishOneDescriptor
DMA receive finished for one DMA descriptor

enumerator kSDIF_DMAFatalBusError
DMA fatal bus error

enumerator kSDIF_DMADescriptorUnavailable
DMA descriptor unavailable

enumerator kSDIF_DMACardErrorSummary
card error summary

enumerator kSDIF_NormalInterruptSummary
normal interrupt summary

enumerator kSDIF_AbnormalInterruptSummary
abnormal interrupt summary

enumerator kSDIF_DMAAllStatus

_sdif_dma_descriptor_flag define the internal DMA descriptor flag

Deprecated:

Do not use this enum anymore, please use SDIF_DMA_DESCRIPTOR_XXX_FLAG instead.

Values:

enumerator kSDIF_DisableCompleteInterrupt
disable the complete interrupt flag for the ends in the buffer pointed to by this descriptor

enumerator kSDIF_DMADescriptorDataBufferEnd
indicate this descriptor contain the last data buffer of data

enumerator kSDIF_DMADescriptorDataBufferStart
indicate this descriptor contain the first data buffer of data,if first buffer size is 0,next descriptor contain the begin of the data

enumerator kSDIF_DMASecondAddrChained
indicate that the second addr in the descriptor is the next descriptor addr not the data buffer

enumerator kSDIF_DMADescriptorEnd
indicate that the descriptor list reached its final descriptor

enumerator kSDIF_DMADescriptorOwnByDMA
indicate the descriptor is own by SD/MMC DMA

enum _sdif_dma_mode
define the internal DMA mode

Values:

enumerator kSDIF_ChainDMAMode

enumerator kSDIF_DualDMAMode

```
typedef enum _sdif_bus_width sdif__bus__width__t
```

define the card bus width type

```
typedef enum _sdif_dma_mode sdif__dma__mode__t
```

define the internal DMA mode

```
typedef struct _sdif_dma_descriptor sdif__dma__descriptor__t
```

define the internal DMA descriptor

```
typedef struct _sdif_dma_config sdif__dma__config__t
```

Defines the internal DMA configure structure.

```
typedef struct _sdif_data sdif__data__t
```

Card data descriptor.

```
typedef struct _sdif_command sdif__command__t
```

Card command descriptor.

Define card command-related attribute.

```
typedef struct _sdif_transfer sdif__transfer__t
```

Transfer state.

```
typedef struct _sdif_config sdif__config__t
```

Data structure to initialize the sdif.

```
typedef struct _sdif_capability sdif__capability__t
```

SDIF capability information. Defines a structure to get the capability information of SDIF.

```
typedef struct _sdif_transfer_callback sdif__transfer__callback__t
```

sdif callback functions.

```
typedef struct _sdif_handle sdif__handle__t
```

sdif handle

Defines the structure to save the sdif state information and callback function. The detail interrupt status when send command or transfer data can be obtained from interruptFlags field by using mask defined in sdif_interrupt_flag_t;

Note: All the fields except interruptFlags and transferredWords must be allocated by the user.

```
typedef status_t (*sdif__transfer__function__t)(SDIF_Type *base, sdif_transfer_t *content)
```

sdif transfer function.

```
typedef struct _sdif_host sdif__host__t
```

sdif host descriptor

```
void SDIF__Init(SDIF_Type *base, sdif_config_t *config)
```

SDIF module initialization function.

Configures the SDIF according to the user configuration.

Parameters

- base – SDIF peripheral base address.
- config – SDIF configuration information.

```
void SDIF__Deinit(SDIF_Type *base)
```

SDIF module deinit function. user should call this function follow with IP reset.

Parameters

- base – SDIF peripheral base address.

bool SDIF_SendCardActive(SDIF_Type *base, uint32_t timeout)

SDIF send initialize 80 clocks for SD card after initial.

Parameters

- base – SDIF peripheral base address.
- timeout – timeout value

static inline void SDIF_EnableCardClock(SDIF_Type *base, bool enable)

SDIF module enable/disable card clock.

Parameters

- base – SDIF peripheral base address.
- enable – enable/disable flag

static inline void SDIF_EnableLowPowerMode(SDIF_Type *base, bool enable)

SDIF module enable/disable module disable the card clock to enter low power mode when card is idle, for SDIF cards, if interrupts must be detected, clock should not be stopped.

Parameters

- base – SDIF peripheral base address.
- enable – enable/disable flag

static inline void SDIF_EnableCardPower(SDIF_Type *base, bool enable)

enable/disable the card power. once turn power on, software should wait for regulator/switch ramp-up time before trying to initialize card.

Parameters

- base – SDIF peripheral base address.
- enable – enable/disable flag.

void SDIF_SetCardBusWidth(SDIF_Type *base, *sdif_bus_width_t* type)

set card data bus width

Parameters

- base – SDIF peripheral base address.
- type – bus width type

static inline uint32_t SDIF_DetectCardInsert(SDIF_Type *base, bool data3)

SDIF module detect card insert status function.

Parameters

- base – SDIF peripheral base address.
- data3 – indicate use data3 as card insert detect pin

Return values

1 – card is inserted 0 card is removed

uint32_t SDIF_SetCardClock(SDIF_Type *base, uint32_t srcClock_Hz, uint32_t target_HZ)

Sets the card bus clock frequency.

Parameters

- base – SDIF peripheral base address.
- srcClock_Hz – SDIF source clock frequency united in Hz.
- target_HZ – card bus clock frequency united in Hz.

Returns

The nearest frequency of busClock_Hz configured to SD bus.

`bool SDIF_Reset(SDIF_Type *base, uint32_t mask, uint32_t timeout)`

reset the different block of the interface.

Parameters

- `base` – SDIF peripheral base address.
- `mask` – indicate which block to reset.
- `timeout` – timeout value, set to wait the bit self clear

Returns

reset result.

`static inline uint32_t SDIF_GetCardWriteProtect(SDIF_Type *base)`

get the card write protect status

Parameters

- `base` – SDIF peripheral base address.

`static inline void SDIF_AssertHardwareReset(SDIF_Type *base)`

toggle state on hardware reset PIN This is used which card has a reset PIN typically.

Parameters

- `base` – SDIF peripheral base address.

`status_t SDIF_SendCommand(SDIF_Type *base, sdif_command_t *cmd, uint32_t timeout)`

send command to the card

This api include polling the status of the bit `START_COMMAND`, if 0 used as timeout value, then this function will return directly without polling the `START_CMD` status.

Parameters

- `base` – SDIF peripheral base address.
- `cmd` – configuration collection
- `timeout` – the timeout value of polling `START_CMD` auto clear status.

Returns

command excute status

`static inline void SDIF_EnableGlobalInterrupt(SDIF_Type *base, bool enable)`

SDIF enable/disable global interrupt.

Parameters

- `base` – SDIF peripheral base address.
- `enable` – enable/disable flag

`static inline void SDIF_EnableInterrupt(SDIF_Type *base, uint32_t mask)`

SDIF enable interrupt.

Parameters

- `base` – SDIF peripheral base address.
- `mask` – mask

`static inline void SDIF_DisableInterrupt(SDIF_Type *base, uint32_t mask)`

SDIF disable interrupt.

Parameters

- base – SDIF peripheral base address.
- mask – mask

static inline uint32_t SDIF__GetInterruptStatus(SDIF_Type *base)

SDIF get interrupt status.

Parameters

- base – SDIF peripheral base address.

static inline uint32_t SDIF__GetEnabledInterruptStatus(SDIF_Type *base)

SDIF get enabled interrupt status.

Parameters

- base – SDIF peripheral base address.

static inline void SDIF__ClearInterruptStatus(SDIF_Type *base, uint32_t mask)

SDIF clear interrupt status.

Parameters

- base – SDIF peripheral base address.
- mask – mask to clear

void SDIF__TransferCreateHandle(SDIF_Type *base, *sdif_handle_t* *handle,
sdif_transfer_callback_t *callback, void *userData)

Creates the SDIF handle. register call back function for interrupt and enable the interrupt.

Parameters

- base – SDIF peripheral base address.
- handle – SDIF handle pointer.
- callback – Structure pointer to contain all callback functions.
- userData – Callback function parameter.

static inline void SDIF__EnableDmaInterrupt(SDIF_Type *base, uint32_t mask)

SDIF enable DMA interrupt.

Parameters

- base – SDIF peripheral base address.
- mask – mask to set

static inline void SDIF__DisableDmaInterrupt(SDIF_Type *base, uint32_t mask)

SDIF disable DMA interrupt.

Parameters

- base – SDIF peripheral base address.
- mask – mask to clear

static inline uint32_t SDIF__GetInternalDMAStatus(SDIF_Type *base)

SDIF get internal DMA status.

Parameters

- base – SDIF peripheral base address.

Returns

the internal DMA status register

static inline uint32_t SDIF_GetEnabledDMAInterruptStatus(SDIF_Type *base)

SDIF get enabled internal DMA interrupt status.

Parameters

- base – SDIF peripheral base address.

Returns

the internal DMA status register

static inline void SDIF_ClearInternalDMAStatus(SDIF_Type *base, uint32_t mask)

SDIF clear internal DMA status.

Parameters

- base – SDIF peripheral base address.
- mask – mask to clear

status_t SDIF_InternalDMAConfig(SDIF_Type *base, sdif_dma_config_t *config, const uint32_t *data, uint32_t dataSize)

SDIF internal DMA config function.

Parameters

- base – SDIF peripheral base address.
- config – DMA configuration collection
- data – buffer pointer
- dataSize – buffer size

static inline void SDIF_EnableInternalDMA(SDIF_Type *base, bool enable)

SDIF internal DMA enable.

Parameters

- base – SDIF peripheral base address.
- enable – internal DMA enable or disable flag.

static inline void SDIF_SendReadWait(SDIF_Type *base)

SDIF send read wait to SDIF card function.

Parameters

- base – SDIF peripheral base address.

bool SDIF_AbortReadData(SDIF_Type *base, uint32_t timeout)

SDIF abort the read data when SDIF card is in suspend state Once assert this bit,data state machine will be reset which is waiting for the next blocking data,used in SDIO card suspend sequence,should call after suspend cmd send.

Parameters

- base – SDIF peripheral base address.
- timeout – timeout value to wait this bit self clear which indicate the data machine reset to idle

static inline void SDIF_EnableCEATAInterrupt(SDIF_Type *base, bool enable)

SDIF enable/disable CE-ATA card interrupt this bit should set together with the card register.

Parameters

- base – SDIF peripheral base address.
- enable – enable/disable flag

status_t SDIF__TransferNonBlocking(*SDIF_Type* *base, *sdif_handle_t* *handle, *sdif_dma_config_t* *dmaConfig, *sdif_transfer_t* *transfer)

SDIF transfer function data/cmd in a non-blocking way this API should be use in interrupt mode, when use this API user must call SDIF_TransferCreateHandle first, all status check through interrupt.

Parameters

- base – SDIF peripheral base address.
- handle – handle
- dmaConfig – config structure This parameter can be config as:
 - a. NULL In this condition, polling transfer mode is selected
 - b. available DMA config In this condition, DMA transfer mode is selected
- transfer – transfer configuration collection

status_t SDIF__TransferBlocking(*SDIF_Type* *base, *sdif_dma_config_t* *dmaConfig, *sdif_transfer_t* *transfer)

SDIF transfer function data/cmd in a blocking way.

Parameters

- base – SDIF peripheral base address.
- dmaConfig – config structure
 - a. NULL In this condition, polling transfer mode is selected
 - b. available DMA config In this condition, DMA transfer mode is selected
- transfer – transfer configuration collection

status_t SDIF__ReleaseDMADescriptor(*SDIF_Type* *base, *sdif_dma_config_t* *dmaConfig)

SDIF release the DMA descriptor to DMA engine this function should be called when DMA descriptor unavailable status occurs.

Parameters

- base – SDIF peripheral base address.
- dmaConfig – DMA config pointer

void SDIF__GetCapability(*SDIF_Type* *base, *sdif_capability_t* *capability)

SDIF return the controller capability.

Parameters

- base – SDIF peripheral base address.
- capability – capability pointer

static inline uint32_t SDIF__GetControllerStatus(*SDIF_Type* *base)

SDIF return the controller status.

Parameters

- base – SDIF peripheral base address.

static inline void SDIF__SendCCSD(*SDIF_Type* *base, *bool* withAutoStop)

SDIF send command complete signal disable to CE-ATA card.

Parameters

- base – SDIF peripheral base address.
- withAutoStop – auto stop flag

```
void SDIF_ConfigClockDelay(uint32_t target_HZ, uint32_t divider)
```

SDIF config the clock delay This function is used to config the cclk_in delay to sample and driver the data ,should meet the min setup time and hold time, and user need to config this parameter according to your board setting.

Parameters

- target_HZ – freq work mode
- divider – not used in this function anymore, use DELAY value instead of phase directly.

```
SDIF_CLOCK_RANGE_NEED_DELAY
```

SDIOCLKCTRL setting Below clock delay setting should depend on specific platform, so it can be redefined when timing mismatch issue occur. Such as: response error/CRC error and so on.

clock range value which need to add delay to avoid timing issue

```
SDIF_HIGHSPEED_SAMPLE_DELAY
```

High speed mode clk_sample fixed delay.

12 * 250ps = 3ns

```
SDIF_HIGHSPEED_DRV_DELAY
```

High speed mode clk_drv fixed delay.

31 * 250ps = 7.75ns

```
SDIF_HIGHSPEED_SAMPLE_PHASE_SHIFT
```

High speed mode clk_sample phase shift.

```
SDIF_HIGHSPEED_DRV_PHASE_SHIFT
```

High speed mode clk_drv phase shift.

```
SDIF_DEFAULT_MODE_SAMPLE_DELAY
```

default mode sample fixed delay

12 * 250ps = 3ns

```
SDIF_DEFAULT_MODE_DRV_DELAY
```

31 * 250ps = 7.75ns

```
SDIF_INTERNAL_DMA_ADDR_ALIGN
```

SDIF internal DMA descriptor address and the data buffer address align.

```
SDIF_DMA_DESCRIPTOR_DISABLE_COMPLETE_INT_FLAG
```

SDIF DMA descriptor flag.

```
SDIF_DMA_DESCRIPTOR_DATA_BUFFER_END_FLAG
```

```
SDIF_DMA_DESCRIPTOR_DATA_BUFFER_START_FLAG
```

```
SDIF_DMA_DESCRIPTOR_SECOND_ADDR_CHAIN_FLAG
```

```
SDIF_DMA_DESCRIPTOR_DESCRIPTOR_END_FLAG
```

```
SDIF_DMA_DESCRIPTOR_OWN_BY_DMA_FLAG
```

```
struct _sdif_dma_descriptor
```

#include <fsl_sdif.h> define the internal DMA descriptor

Public Members

uint32_t dmaDesAttribute
internal DMA attribute control and status

uint32_t dmaDataBufferSize
internal DMA transfer buffer size control

const uint32_t *dmaDataBufferAddr0
internal DMA buffer 0 addr ,the buffer size must be 32bit aligned

const uint32_t *dmaDataBufferAddr1
internal DMA buffer 1 addr ,the buffer size must be 32bit aligned

struct _sdif_dma_config

#include <fsl_sdif.h> Defines the internal DMA configure structure.

Public Members

bool enableFixBurstLen
fix burst len enable/disable flag,When set, the AHB will use only SINGLE, INCR4, INCR8 or INCR16 during start of normal burst transfers. When reset, the AHB will use SINGLE and INCR burst transfer operations

sdif_dma_mode_t mode
define the DMA mode

uint8_t dmaDesSkipLen
define the descriptor skip length ,the length between two descriptor this field is special for dual DMA mode

uint32_t *dmaDesBufferStartAddr
internal DMA descriptor start address

uint32_t dmaDesBufferLen
internal DMA buffer descriptor buffer len ,user need to pay attention to the dma descriptor buffer length if it is bigger enough for your transfer

struct _sdif_data

#include <fsl_sdif.h> Card data descriptor.

Public Members

bool streamTransfer
indicate this is a stream data transfer command

bool enableAutoCommand12
indicate if auto stop will send when data transfer over

bool enableIgnoreError
indicate if enable ignore error when transfer data

size_t blockSize
Block size, take care when configure this parameter

uint32_t blockCount
Block count

uint32_t *rxData
data buffer to receive

```
    const uint32_t *txData
        data buffer to transfer
struct __sdif__command
    #include <fsl_sdif.h> Card command descriptor.
    Define card command-related attribute.
```

Public Members

```
uint32_t index
    Command index
uint32_t argument
    Command argument
uint32_t response[4U]
    Response for this command
uint32_t type
    define the command type
uint32_t responseType
    Command response type
uint32_t flags
    Cmd flags
uint32_t responseErrorFlags
    response error flags, need to check the flags when receive the cmd response
struct __sdif__transfer
    #include <fsl_sdif.h> Transfer state.
```

Public Members

```
sdif_data_t *data
    Data to transfer
sdif_command_t *command
    Command to send
struct __sdif__config
    #include <fsl_sdif.h> Data structure to initialize the sdif.
```

Public Members

```
uint8_t responseTimeout
    command response timeout value
uint32_t cardDetDebounce_Clock
    define the debounce clock count which will used in card detect logic,typical value is 5-25ms
uint32_t dataTimeout
    data timeout value
struct __sdif__capability
    #include <fsl_sdif.h> SDIF capability information. Defines a structure to get the capability information of SDIF.
```


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 byte count can be transfered

uint32_t flags
Capability flags to indicate the support information

struct _sdif_transfer_callback
#include <fsl_sdif.h> sdif callback functions.

Public Members

void (*cardInserted)(SDIF_Type *base, void *userData)
card insert call back

void (*cardRemoved)(SDIF_Type *base, void *userData)
card remove call back

void (*SDIOInterrupt)(SDIF_Type *base, void *userData)
SDIO card interrupt occurs

void (*DMADesUnavailable)(SDIF_Type *base, void *userData)
DMA descriptor unavailable

void (*CommandReload)(SDIF_Type *base, void *userData)
command buffer full,need re-load

void (*TransferComplete)(SDIF_Type *base, void *handle, *status_t* status, void *userData)
Transfer complete callback

struct _sdif_handle
#include <fsl_sdif.h> sdif handle

Defines the structure to save the sdif state information and callback function. The detail interrupt status when send command or transfer data can be obtained from interruptFlags field by using mask defined in sdif_interrupt_flag_t;

Note: All the fields except interruptFlags and transferredWords must be allocated by the user.

Public Members

sdif_data_t *volatile data
Data to transfer

sdif_command_t *volatile command
Command to send

volatile uint32_t transferredWords
Words transferred by polling way
sdif_transfer_callback_t callback
Callback function
void *userData
Parameter for transfer complete callback
struct __sdif_host
#include <fsl_sdif.h> sdif host descriptor

Public Members

SDIF_Type *base
sdif peripheral base address
uint32_t sourceClock_Hz
sdif source clock frequency united in Hz
sdif_config_t config
sdif configuration
sdif_transfer_function_t transfer
sdif transfer function
sdif_capability_t capability
sdif capability information

2.42 SHA: SHA encryption decryption driver

FSL_SHA_DRIVER_VERSION

Defines LPC SHA driver version 2.3.2.

Current version: 2.3.2

Change log:

- Version 2.0.0
 - Initial version
- Version 2.1.0
 - Updated “sha_ldm_stm_16_words” “sha_one_block” API to match QN9090. QN9090 has no ALIAS register.
 - Added “SHA_ClkInit” “SHA_ClkInit”
- Version 2.1.1
 - MISRA C-2012 issue fixed: rule 10.3, 10.4, 11.9, 14.4, 16.4 and 17.7.
- Version 2.2.0
 - Support MEMADDR pseudo DMA for loading input data in SHA_Update function (LPCXpresso54018 and LPCXpresso54628).
- Version 2.2.1
 - MISRA C-2012 issue fix.

- Version 2.2.2 Modified SHA_Finish function. While using pseudo DMA with maximum optimization, compiler optimize out condition. Which caused block in this function and did not check state, which has been set in interrupt.
- Version 2.3.0 Modified SHA_Update to use blocking version of AHB Master mode when its available on chip. Added SHA_UpdateNonBlocking() function which uses nonblocking AHB Master mode. Fixed incorrect calculation of SHA when calling SHA_Update multiple times when is CPU used to load data. Added Reset into SHA_ClkInit and SHA_ClkDeinit function.
- Version 2.3.1 Modified sha_process_message_data_master() to ensure that MEMCTRL will be written within 64 cycles of writing last word to INDATA as is mentioned in errata, even with different optimization levels.
- Version 2.3.2 Add -O2 optimization for GCC to sha_process_message_data_master(), because without it the function hangs under some conditions.

enum `_sha_algo_t`

Supported cryptographic block cipher functions for HASH creation

Values:

enumerator `kSHA_Sha1`

`SHA_1`

enumerator `kSHA_Sha256`

`SHA_256`

typedef enum `_sha_algo_t` `sha_algo_t`

Supported cryptographic block cipher functions for HASH creation

typedef struct `_sha_ctx_t` `sha_ctx_t`

Storage type used to save hash context.

typedef void (`*sha_callback_t`)(`SHA_Type *base`, `sha_ctx_t *ctx`, `status_t status`, void `*userData`)

background hash callback function.

`SHA_CTX_SIZE`

SHA Context size.

struct `_sha_ctx_t`

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

2.43 Sha_algorithm_level_api

`status_t` `SHA_Init`(`SHA_Type *base`, `sha_ctx_t *ctx`, `sha_algo_t algo`)

Initialize HASH context.

This function initializes new hash context.

Parameters

- `base` – SHA peripheral base address
- `ctx` – **[out]** Output hash context
- `algo` – Underlying algorithm to use for hash computation. Either SHA-1 or SHA-256.

Returns

Status of initialization

status_t SHA_Update(*SHA_Type* *base, *sha_ctx_t* *ctx, const uint8_t *message, size_t messageSize)

Add data to current HASH.

Add data to current HASH. This can be called repeatedly with an arbitrary amount of data to be hashed.

Parameters

- base – SHA peripheral base address
- ctx – **[inout]** HASH context
- message – Input message
- messageSize – Size of input message in bytes

Returns

Status of the hash update operation

status_t SHA_Finish(*SHA_Type* *base, *sha_ctx_t* *ctx, uint8_t *output, size_t *outputSize)

Finalize hashing.

Outputs the final hash and erases the context. SHA-1 or SHA-256 padding bits are automatically added by this function.

Parameters

- base – SHA peripheral base address
- ctx – **[inout]** HASH context
- output – **[out]** Output hash data
- outputSize – **[inout]** On input, determines the size of bytes of the output array. On output, tells how many bytes have been written to output.

Returns

Status of the hash finish operation

void SHA_SetCallback(*SHA_Type* *base, *sha_ctx_t* *ctx, *sha_callback_t* callback, void *userData)

Initializes the SHA handle for background hashing.

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

Parameters

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

status_t SHA_UpdateNonBlocking(*SHA_Type* *base, *sha_ctx_t* *ctx, const uint8_t *input, size_t inputSize)

Create running hash on given data.

Configures the SHA to compute new running hash as AHB master and returns immediately. SHA AHB Master mode supports only aligned input address and can be called only once per continuous block of data. Every call to this function must be preceded with SHA_Init() and finished with _SHA_Finish(). Once callback function is invoked by SHA isr, it should set

a flag for the main application to finalize the hashing (padding) and to read out the final digest by calling SHA_Finish().

Parameters

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

Returns

Status of the hash update operation.

`void SHA_ClkInit(SHA_Type *base)`

Start SHA clock.

Start SHA clock

Parameters

- `base` – SHA peripheral base address

`void SHA_ClkDeinit(SHA_Type *base)`

Stop SHA clock.

Stop SHA clock

Parameters

- `base` – SHA peripheral base address

2.44 SPI: Serial Peripheral Interface Driver

2.45 SPI DMA Driver

`status_t SPI_MasterTransferCreateHandleDMA(SPI_Type *base, spi_dma_handle_t *handle, spi_dma_callback_t callback, void *userData, dma_handle_t *txHandle, dma_handle_t *rxHandle)`

Initialize the SPI master DMA handle.

This function initializes the SPI master DMA handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, user need only call this API once to get the initialized handle.

Parameters

- `base` – SPI peripheral base address.
- `handle` – SPI handle pointer.
- `callback` – User callback function called at the end of a transfer.
- `userData` – User data for callback.
- `txHandle` – DMA handle pointer for SPI Tx, the handle shall be static allocated by users.
- `rxHandle` – DMA handle pointer for SPI Rx, the handle shall be static allocated by users.

```
status_t SPI_MasterTransferDMA(SPI_Type *base, spi_dma_handle_t *handle, spi_transfer_t *xfer)
```

Perform a non-blocking SPI transfer using DMA.

Note: This interface returned immediately after transfer initiates, users should call SPI_GetTransferStatus to poll the transfer status to check whether SPI transfer finished.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- xfer – Pointer to dma transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_SPI_Busy – SPI is not idle, is running another transfer.

```
status_t SPI_MasterHalfDuplexTransferDMA(SPI_Type *base, spi_dma_handle_t *handle, spi_half_duplex_transfer_t *xfer)
```

Transfers a block of data using a DMA method.

This function using polling way to do the first half transimission and using DMA way to do the srcond half transimission, the transfer mechanism is half-duplex. When do the second half transimission, code will return right away. When all data is transferred, the callback function is called.

Parameters

- base – SPI base pointer
- handle – A pointer to the spi_master_dma_handle_t structure which stores the transfer state.
- xfer – A pointer to the spi_half_duplex_transfer_t structure.

Returns

status of status_t.

```
static inline status_t SPI_SlaveTransferCreateHandleDMA(SPI_Type *base, spi_dma_handle_t *handle, spi_dma_callback_t callback, void *userData, dma_handle_t *txHandle, dma_handle_t *rxHandle)
```

Initialize the SPI slave DMA handle.

This function initializes the SPI slave DMA handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, user need only call this API once to get the initialized handle.

Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – User callback function called at the end of a transfer.
- userData – User data for callback.
- txHandle – DMA handle pointer for SPI Tx, the handle shall be static allocated by users.

- rxHandle – DMA handle pointer for SPI Rx, the handle shall be static allocated by users.

```
static inline status_t SPI_SlaveTransferDMA(SPI_Type *base, spi_dma_handle_t *handle,  
                                           spi_transfer_t *xfer)
```

Perform a non-blocking SPI transfer using DMA.

Note: This interface returned immediately after transfer initiates, users should call SPI_GetTransferStatus to poll the transfer status to check whether SPI transfer finished.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- xfer – Pointer to dma transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_SPI_Busy – SPI is not idle, is running another transfer.

```
void SPI_MasterTransferAbortDMA(SPI_Type *base, spi_dma_handle_t *handle)
```

Abort a SPI transfer using DMA.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.

```
status_t SPI_MasterTransferGetCountDMA(SPI_Type *base, spi_dma_handle_t *handle, size_t  
                                       *count)
```

Gets the master DMA transfered bytes.

This function gets the master DMA transfered bytes.

Parameters

- base – SPI peripheral base address.
- handle – A pointer to the spi_dma_handle_t structure which stores the transfer state.
- count – A number of bytes transferred by the non-blocking transaction.

Returns

status of status_t.

```
static inline void SPI_SlaveTransferAbortDMA(SPI_Type *base, spi_dma_handle_t *handle)
```

Abort a SPI transfer using DMA.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.

```
static inline status_t SPI_SlaveTransferGetCountDMA(SPI_Type *base, spi_dma_handle_t  
                                                    *handle, size_t *count)
```

Gets the slave DMA transfered bytes.

This function gets the slave DMA transfered bytes.

Parameters

- `base` – SPI peripheral base address.
- `handle` – A pointer to the `spi_dma_handle_t` structure which stores the transfer state.
- `count` – A number of bytes transferred by the non-blocking transaction.

Returns

status of `status_t`.

`FSL_SPI_DMA_DRIVER_VERSION`

SPI DMA driver version.

`typedef struct _spi_dma_handle spi_dma_handle_t`

`typedef void (*spi_dma_callback_t)(SPI_Type *base, spi_dma_handle_t *handle, status_t status, void *userData)`

SPI DMA callback called at the end of transfer.

`struct _spi_dma_handle`

`#include <fsl_spi_dma.h>` SPI DMA transfer handle, users should not touch the content of the handle.

Public Members

`SPI_Type *base`

SPI base address

`volatile bool txInProgress`

Send transfer finished

`volatile bool rxInProgress`

Receive transfer finished

`uint8_t bytesPerFrame`

Bytes in a frame for SPI transfer

`uint8_t lastwordBytes`

The Bytes of lastword for master

`uint16_t txDummy`

The dummy data for TX.

`uint32_t lastword`

The last word for master TX.

`dma_handle_t *txHandle`

DMA handler for SPI send

`dma_handle_t *rxHandle`

DMA handler for SPI receive

`spi_dma_callback_t callback`

Callback for SPI DMA transfer

`void *userData`

User Data for SPI DMA callback

`uint32_t state`

Internal state of SPI DMA transfer

`size_t` transferSize
Bytes need to be transfer

`uint32_t` instance
Index of SPI instance

`const uint8_t *txNextData`
The pointer of next time tx data

`size_t` txRemainingBytes
lastwordBytes + txRemainingBytes is number of data to be send [in bytes]

`uint8_t *rxNextData`
The pointer of next time rx data

`size_t` rxRemainingBytes
Number of data to be received [in bytes]

`bool` isSlave
SPI work in slave mode.

2.46 SPI Driver

`FSL_SPI_DRIVER_VERSION`
SPI driver version.

`enum _spi_xfer_option`
SPI transfer option.
Values:

`enumerator` kSPI_FrameDelay
A delay may be inserted, defined in the DLY register.

`enumerator` kSPI_FrameAssert
SSEL will be deasserted at the end of a transfer

`enum _spi_shift_direction`
SPI data shifter direction options.
Values:

`enumerator` kSPI_MsbFirst
Data transfers start with most significant bit.

`enumerator` kSPI_LsbFirst
Data transfers start with least significant bit.

`enum _spi_clock_polarity`
SPI clock polarity configuration.
Values:

`enumerator` kSPI_ClockPolarityActiveHigh
Active-high SPI clock (idles low).

`enumerator` kSPI_ClockPolarityActiveLow
Active-low SPI clock (idles high).

enum `_spi_clock_phase`

SPI clock phase configuration.

Values:

enumerator `kSPI_ClockPhaseFirstEdge`

First edge on SCK occurs at the middle of the first cycle of a data transfer.

enumerator `kSPI_ClockPhaseSecondEdge`

First edge on SCK occurs at the start of the first cycle of a data transfer.

enum `_spi_txfifo_watermark`

txFIFO watermark values

Values:

enumerator `kSPI_TxFifo0`

SPI tx watermark is empty

enumerator `kSPI_TxFifo1`

SPI tx watermark at 1 item

enumerator `kSPI_TxFifo2`

SPI tx watermark at 2 items

enumerator `kSPI_TxFifo3`

SPI tx watermark at 3 items

enumerator `kSPI_TxFifo4`

SPI tx watermark at 4 items

enumerator `kSPI_TxFifo5`

SPI tx watermark at 5 items

enumerator `kSPI_TxFifo6`

SPI tx watermark at 6 items

enumerator `kSPI_TxFifo7`

SPI tx watermark at 7 items

enum `_spi_rxfifo_watermark`

rxFIFO watermark values

Values:

enumerator `kSPI_RxFifo1`

SPI rx watermark at 1 item

enumerator `kSPI_RxFifo2`

SPI rx watermark at 2 items

enumerator `kSPI_RxFifo3`

SPI rx watermark at 3 items

enumerator `kSPI_RxFifo4`

SPI rx watermark at 4 items

enumerator `kSPI_RxFifo5`

SPI rx watermark at 5 items

enumerator `kSPI_RxFifo6`

SPI rx watermark at 6 items

enumerator kSPI_RxFifo7
SPI rx watermark at 7 items
enumerator kSPI_RxFifo8
SPI rx watermark at 8 items

enum _spi_data_width
Transfer data width.

Values:

enumerator kSPI_Data4Bits
4 bits data width

enumerator kSPI_Data5Bits
5 bits data width

enumerator kSPI_Data6Bits
6 bits data width

enumerator kSPI_Data7Bits
7 bits data width

enumerator kSPI_Data8Bits
8 bits data width

enumerator kSPI_Data9Bits
9 bits data width

enumerator kSPI_Data10Bits
10 bits data width

enumerator kSPI_Data11Bits
11 bits data width

enumerator kSPI_Data12Bits
12 bits data width

enumerator kSPI_Data13Bits
13 bits data width

enumerator kSPI_Data14Bits
14 bits data width

enumerator kSPI_Data15Bits
15 bits data width

enumerator kSPI_Data16Bits
16 bits data width

enum _spi_ssel
Slave select.

Values:

enumerator kSPI_Ssel0
Slave select 0

enumerator kSPI_Ssel1
Slave select 1

enumerator kSPI_Ssel2
Slave select 2

enumerator kSPI_Ssel3

Slave select 3

enum _spi_spol

ssel polarity

Values:

enumerator kSPI_Spol0ActiveHigh

enumerator kSPI_Spol1ActiveHigh

enumerator kSPI_Spol3ActiveHigh

enumerator kSPI_SpolActiveAllHigh

enumerator kSPI_SpolActiveAllLow

SPI transfer status.

Values:

enumerator kStatus_SPI_Busy

SPI bus is busy

enumerator kStatus_SPI_Idle

SPI is idle

enumerator kStatus_SPI_Error

SPI error

enumerator kStatus_SPI_BaudrateNotSupport

Baudrate is not support in current clock source

enumerator kStatus_SPI_Timeout

SPI timeout polling status flags.

enum _spi_interrupt_enable

SPI interrupt sources.

Values:

enumerator kSPI_RxLvlIrq

Rx level interrupt

enumerator kSPI_TxLvlIrq

Tx level interrupt

enum _spi_statusflags

SPI status flags.

Values:

enumerator kSPI_TxEmptyFlag

txFifo is empty

enumerator kSPI_TxNotFullFlag

txFifo is not full

enumerator kSPI_RxNotEmptyFlag

rxFIFO is not empty

enumerator kSPI_RxFullFlag

rxFIFO is full

`typedef enum _spi_xfer_option spi_xfer_option_t`
SPI transfer option.

`typedef enum _spi_shift_direction spi_shift_direction_t`
SPI data shifter direction options.

`typedef enum _spi_clock_polarity spi_clock_polarity_t`
SPI clock polarity configuration.

`typedef enum _spi_clock_phase spi_clock_phase_t`
SPI clock phase configuration.

`typedef enum _spi_txfifo_watermark spi_txfifo_watermark_t`
txFIFO watermark values

`typedef enum _spi_rxfifo_watermark spi_rxfifo_watermark_t`
rxFIFO watermark values

`typedef enum _spi_data_width spi_data_width_t`
Transfer data width.

`typedef enum _spi_ssel spi_ssel_t`
Slave select.

`typedef enum _spi_spol spi_spol_t`
ssel polarity

`typedef struct _spi_delay_config spi_delay_config_t`
SPI delay time configure structure. Note: The DLY register controls several programmable delays related to SPI signalling, it stands for how many SPI clock time will be inserted. The maximum value of these delay time is 15.

`typedef struct _spi_master_config spi_master_config_t`
SPI master user configure structure.

`typedef struct _spi_slave_config spi_slave_config_t`
SPI slave user configure structure.

`typedef struct _spi_transfer spi_transfer_t`
SPI transfer structure.

`typedef struct _spi_half_duplex_transfer spi_half_duplex_transfer_t`
SPI half-duplex(master only) transfer structure.

`typedef struct _spi_config spi_config_t`
Internal configuration structure used in 'spi' and 'spi_dma' driver.

`typedef struct _spi_master_handle spi_master_handle_t`
Master handle type.

`typedef spi_master_handle_t spi_slave_handle_t`
Slave handle type.

`typedef void (*spi_master_callback_t)(SPI_Type *base, spi_master_handle_t *handle, status_t status, void *userData)`
SPI master callback for finished transmit.

`typedef void (*spi_slave_callback_t)(SPI_Type *base, spi_slave_handle_t *handle, status_t status, void *userData)`
SPI slave callback for finished transmit.

```
typedef void (*flexcomm_spi_master_irq_handler_t)(SPI_Type *base, spi_master_handle_t *handle)
```

Typedef for master interrupt handler.

```
typedef void (*flexcomm_spi_slave_irq_handler_t)(SPI_Type *base, spi_slave_handle_t *handle)
```

Typedef for slave interrupt handler.

```
volatile uint8_t s_dummyData[]
```

SPI default SSEL COUNT.

Global variable for dummy data value setting.

```
SPI_DUMMYDATA
```

SPI dummy transfer data, the data is sent while txBuff is NULL.

```
SPI_RETRY_TIMES
```

Retry times for waiting flag.

```
SPI_DATA(n)
```

```
SPI_CTRLMASK
```

```
SPI_ASSERTNUM_SSEL(n)
```

```
SPI_DEASSERTNUM_SSEL(n)
```

```
SPI_DEASSERT_ALL
```

```
SPI_FIFOWR_FLAGS_MASK
```

```
SPI_FIFOTRIG_TXLVL_GET(base)
```

```
SPI_FIFOTRIG_RXLVL_GET(base)
```

```
struct _spi_delay_config
```

#include <fsl_spi.h> SPI delay time configure structure. Note: The DLY register controls several programmable delays related to SPI signalling, it stands for how many SPI clock time will be inserted. The maxinum value of these delay time is 15.

Public Members

```
uint8_t preDelay
```

Delay between SSEL assertion and the beginning of transfer.

```
uint8_t postDelay
```

Delay between the end of transfer and SSEL deassertion.

```
uint8_t frameDelay
```

Delay between frame to frame.

```
uint8_t transferDelay
```

Delay between transfer to transfer.

```
struct _spi_master_config
```

#include <fsl_spi.h> SPI master user configure structure.

Public Members

```
bool enableLoopback
```

Enable loopback for test purpose

`bool enableMaster`
 Enable SPI at initialization time

`spi_clock_polarity_t polarity`
 Clock polarity

`spi_clock_phase_t phase`
 Clock phase

`spi_shift_direction_t direction`
 MSB or LSB

`uint32_t baudRate_Bps`
 Baud Rate for SPI in Hz

`spi_data_width_t dataWidth`
 Width of the data

`spi_ssel_t sselNum`
 Slave select number

`spi_spol_t sselPol`
 Configure active CS polarity

`uint8_t txWatermark`
 txFIFO watermark

`uint8_t rxWatermark`
 rxFIFO watermark

`spi_delay_config_t delayConfig`
 Delay configuration.

`struct __spi_slave_config`
 #include <fsl_spi.h> SPI slave user configure structure.

Public Members

`bool enableSlave`
 Enable SPI at initialization time

`spi_clock_polarity_t polarity`
 Clock polarity

`spi_clock_phase_t phase`
 Clock phase

`spi_shift_direction_t direction`
 MSB or LSB

`spi_data_width_t dataWidth`
 Width of the data

`spi_spol_t sselPol`
 Configure active CS polarity

`uint8_t txWatermark`
 txFIFO watermark

`uint8_t rxWatermark`
 rxFIFO watermark

`struct __spi_transfer`
 #include <fsl_spi.h> SPI transfer structure.

Public Members

const uint8_t *txData

Send buffer

uint8_t *rxData

Receive buffer

uint32_t configFlags

Additional option to control transfer, spi_xfer_option_t.

size_t dataSize

Transfer bytes

struct __spi_half_duplex_transfer

#include <fsl_spi.h> SPI half-duplex(master only) transfer structure.

Public Members

const uint8_t *txData

Send buffer

uint8_t *rxData

Receive buffer

size_t txDataSize

Transfer bytes for transmit

size_t rxDataSize

Transfer bytes

uint32_t configFlags

Transfer configuration flags, spi_xfer_option_t.

bool isPcsAssertInTransfer

If PCS pin keep assert between transmit and receive. true for assert and false for de-assert.

bool isTransmitFirst

True for transmit first and false for receive first.

struct __spi_config

#include <fsl_spi.h> Internal configuration structure used in 'spi' and 'spi_dma' driver.

struct __spi_master_handle

#include <fsl_spi.h> SPI transfer handle structure.

Public Members

const uint8_t *volatile txData

Transfer buffer

uint8_t *volatile rxData

Receive buffer

volatile size_t txRemainingBytes

Number of data to be transmitted [in bytes]

volatile size_t rxRemainingBytes

Number of data to be received [in bytes]

`volatile int8_t toReceiveCount`

The number of data expected to receive in data width. Since the received count and sent count should be the same to complete the transfer, if the sent count is x and the received count is y, toReceiveCount is x-y.

`size_t totalByteCount`

A number of transfer bytes

`volatile uint32_t state`

SPI internal state

`spi_master_callback_t callback`

SPI callback

`void *userData`

Callback parameter

`uint8_t dataWidth`

Width of the data [Valid values: 1 to 16]

`uint8_t sselNum`

Slave select number to be asserted when transferring data [Valid values: 0 to 3]

`uint32_t configFlags`

Additional option to control transfer

`uint8_t txWatermark`

txFIFO watermark

`uint8_t rxWatermark`

rxFIFO watermark

2.47 SPIFI: SPIFI flash interface driver

```
void SPIFI_TransferTxCreateHandleDMA(SPIFI_Type *base, spifi_dma_handle_t *handle,
                                     spifi_dma_callback_t callback, void *userData,
                                     dma_handle_t *dmaHandle)
```

Initializes the SPIFI handle for send which is used in transactional functions and set the callback.

Parameters

- base – SPIFI peripheral base address
- handle – Pointer to `spifi_dma_handle_t` structure
- callback – SPIFI callback, NULL means no callback.
- userData – User callback function data.
- dmaHandle – User requested DMA handle for DMA transfer

```
void SPIFI_TransferRxCreateHandleDMA(SPIFI_Type *base, spifi_dma_handle_t *handle,
                                     spifi_dma_callback_t callback, void *userData,
                                     dma_handle_t *dmaHandle)
```

Initializes the SPIFI handle for receive which is used in transactional functions and set the callback.

Parameters

- base – SPIFI peripheral base address
- handle – Pointer to `spifi_dma_handle_t` structure

- callback – SPIFI callback, NULL means no callback.
- userData – User callback function data.
- dmaHandle – User requested DMA handle for DMA transfer

status_t SPIFI_TransferSendDMA(SPIFI_Type *base, *spifi_dma_handle_t* *handle, *spifi_transfer_t* *xfer)

Transfers SPIFI data using an DMA non-blocking method.

This function writes data to the SPIFI transmit FIFO. This function is non-blocking.

Parameters

- base – Pointer to QuadSPI Type.
- handle – Pointer to *spifi_dma_handle_t* structure
- xfer – SPIFI transfer structure.

status_t SPIFI_TransferReceiveDMA(SPIFI_Type *base, *spifi_dma_handle_t* *handle, *spifi_transfer_t* *xfer)

Receives data using an DMA non-blocking method.

This function receive data from the SPIFI receive buffer/FIFO. This function is non-blocking.

Parameters

- base – Pointer to QuadSPI Type.
- handle – Pointer to *spifi_dma_handle_t* structure
- xfer – SPIFI transfer structure.

void SPIFI_TransferAbortSendDMA(SPIFI_Type *base, *spifi_dma_handle_t* *handle)

Aborts the sent data using DMA.

This function aborts the sent data using DMA.

Parameters

- base – SPIFI peripheral base address.
- handle – Pointer to *spifi_dma_handle_t* structure

void SPIFI_TransferAbortReceiveDMA(SPIFI_Type *base, *spifi_dma_handle_t* *handle)

Aborts the receive data using DMA.

This function abort receive data which using DMA.

Parameters

- base – SPIFI peripheral base address.
- handle – Pointer to *spifi_dma_handle_t* structure

status_t SPIFI_TransferGetSendCountDMA(SPIFI_Type *base, *spifi_dma_handle_t* *handle, *size_t* *count)

Gets the transferred counts of send.

Parameters

- base – Pointer to QuadSPI Type.
- handle – Pointer to *spifi_dma_handle_t* structure.
- 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 SPIFI_TransferGetReceiveCountDMA(SPIFI_Type *base, spifi_dma_handle_t *handle, size_t *count)`

Gets the status of the receive transfer.

Parameters

- `base` – Pointer to QuadSPI Type.
- `handle` – Pointer to `spifi_dma_handle_t` structure
- `count` – Bytes received.

Return values

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

`uint32_t SPIFI_GetInstance(SPIFI_Type *base)`

Get the SPIFI instance from peripheral base address.

Parameters

- `base` – SPIFI peripheral base address.

Returns

SPIFI instance.

`void SPIFI_Init(SPIFI_Type *base, const spifi_config_t *config)`

Initializes the SPIFI with the user configuration structure.

This function configures the SPIFI module with the user-defined configuration.

Parameters

- `base` – SPIFI peripheral base address.
- `config` – The pointer to the configuration structure.

`void SPIFI_GetDefaultConfig(spifi_config_t *config)`

Get SPIFI default configure settings.

Parameters

- `config` – SPIFI config structure pointer.

`void SPIFI_Deinit(SPIFI_Type *base)`

Deinitializes the SPIFI regions.

Parameters

- `base` – SPIFI peripheral base address.

`void SPIFI_SetCommand(SPIFI_Type *base, spifi_command_t *cmd)`

Set SPIFI flash command.

Parameters

- `base` – SPIFI peripheral base address.
- `cmd` – SPIFI command structure pointer.

`static inline void SPIFI_SetCommandAddress(SPIFI_Type *base, uint32_t addr)`

Set SPIFI command address.

Parameters

- `base` – SPIFI peripheral base address.
- `addr` – Address value for the command.

`static inline void SPIFI_SetIntermediateData(SPIFI_Type *base, uint32_t val)`

Set SPIFI intermediate data.

Before writing a command which needs specific intermediate value, users shall call this function to write it. The main use of this function for current serial flash is to select no-opcode mode and cancelling this mode. As dummy cycle do not care about the value, no need to call this function.

Parameters

- `base` – SPIFI peripheral base address.
- `val` – Intermediate data.

`static inline void SPIFI_SetCacheLimit(SPIFI_Type *base, uint32_t val)`

Set SPIFI Cache limit value.

SPIFI includes caching of previously-accessed data to improve performance. Software can write an address to this function, to prevent such caching at and above the address.

Parameters

- `base` – SPIFI peripheral base address.
- `val` – Zero-based upper limit of cacheable memory.

`static inline void SPIFI_ResetCommand(SPIFI_Type *base)`

Reset the command field of SPIFI.

This function is used to abort the current command or memory mode.

Parameters

- `base` – SPIFI peripheral base address.

`void SPIFI_SetMemoryCommand(SPIFI_Type *base, spifi_command_t *cmd)`

Set SPIFI flash AHB read command.

Call this function means SPIFI enters to memory mode, while users need to use command, a `SPIFI_ResetCommand` shall be called.

Parameters

- `base` – SPIFI peripheral base address.
- `cmd` – SPIFI command structure pointer.

`static inline void SPIFI_EnableInterrupt(SPIFI_Type *base, uint32_t mask)`

Enable SPIFI interrupt.

The interrupt is triggered only in command mode, and it means the command now is finished.

Parameters

- `base` – SPIFI peripheral base address.
- `mask` – SPIFI interrupt enable mask. It is a logic OR of members the enumeration :: `spifi_interrupt_enable_t`

`static inline void SPIFI_DisableInterrupt(SPIFI_Type *base, uint32_t mask)`

Disable SPIFI interrupt.

The interrupt is triggered only in command mode, and it means the command now is finished.

Parameters

- base – SPIFI peripheral base address.
- mask – SPIFI interrupt enable mask. It is a logic OR of members the enumeration :: spifi_interrupt_enable_t

static inline uint32_t SPIFI_GetStatusFlag(SPIFI_Type *base)

Get the status of all interrupt flags for SPIFI.

Parameters

- base – SPIFI peripheral base address.

Returns

SPIFI flag status

FSL_SPIFI_DMA_DRIVER_VERSION

SPIFI DMA driver version 2.0.3.

FSL_SPIFI_DRIVER_VERSION

SPIFI driver version 2.0.3.

Status structure of SPIFI.

Values:

enumerator kStatus_SPIFI_Idle

SPIFI is in idle state

enumerator kStatus_SPIFI_Busy

SPIFI is busy

enumerator kStatus_SPIFI_Error

Error occurred during SPIFI transfer

enum _spifi_interrupt_enable

SPIFI interrupt source.

Values:

enumerator kSPIFI_CommandFinishInterruptEnable

Interrupt while command finished

enum _spifi_spi_mode

SPIFI SPI mode select.

Values:

enumerator kSPIFI_SPISckLow

SCK low after last bit of command, keeps low while CS high

enumerator kSPIFI_SPISckHigh

SCK high after last bit of command and while CS high

enum _spifi_dual_mode

SPIFI dual mode select.

Values:

enumerator kSPIFI_QuadMode

SPIFI uses IO3:0

enumerator kSPIFI_DualMode

SPIFI uses IO1:0

enum `_spifi_data_direction`

SPIFI data direction.

Values:

enumerator `kSPIFI_DataInput`

Data input from serial flash.

enumerator `kSPIFI_DataOutput`

Data output to serial flash.

enum `_spifi_command_format`

SPIFI command opcode format.

Values:

enumerator `kSPIFI_CommandAllSerial`

All fields of command are serial.

enumerator `kSPIFI_CommandDataQuad`

Only data field is dual/quad, others are serial.

enumerator `kSPIFI_CommandOpcodeSerial`

Only opcode field is serial, others are quad/dual.

enumerator `kSPIFI_CommandAllQuad`

All fields of command are dual/quad mode.

enum `_spifi_command_type`

SPIFI command type.

Values:

enumerator `kSPIFI_CommandOpcodeOnly`

Command only have opcode, no address field

enumerator `kSPIFI_CommandOpcodeAddrOneByte`

Command have opcode and also one byte address field

enumerator `kSPIFI_CommandOpcodeAddrTwoBytes`

Command have opcode and also two bytes address field

enumerator `kSPIFI_CommandOpcodeAddrThreeBytes`

Command have opcode and also three bytes address field.

enumerator `kSPIFI_CommandOpcodeAddrFourBytes`

Command have opcode and also four bytes address field

enumerator `kSPIFI_CommandNoOpcodeAddrThreeBytes`

Command have no opcode and three bytes address field

enumerator `kSPIFI_CommandNoOpcodeAddrFourBytes`

Command have no opcode and four bytes address field

SPIFI status flags.

Values:

enumerator `kSPIFI_MemoryCommandWriteFinished`

Memory command write finished

enumerator `kSPIFI_CommandWriteFinished`

Command write finished

enumerator `kSPIFI_InterruptRequest`

CMD flag from 1 to 0, means command execute finished

typedef struct *_spifi_dma_handle* spifi_dma_handle_t

typedef void (*spifi_dma_callback_t)(SPIFI_Type *base, *spifi_dma_handle_t* *handle, *status_t* status, void *userData)

SPIFI DMA transfer callback function for finish and error.

typedef enum *_spifi_interrupt_enable* spifi_interrupt_enable_t

SPIFI interrupt source.

typedef enum *_spifi_spi_mode* spifi_spi_mode_t

SPIFI SPI mode select.

typedef enum *_spifi_dual_mode* spifi_dual_mode_t

SPIFI dual mode select.

typedef enum *_spifi_data_direction* spifi_data_direction_t

SPIFI data direction.

typedef enum *_spifi_command_format* spifi_command_format_t

SPIFI command opcode format.

typedef enum *_spifi_command_type* spifi_command_type_t

SPIFI command type.

typedef struct *_spifi_command* spifi_command_t

SPIFI command structure.

typedef struct *_spifi_config* spifi_config_t

SPIFI region configuration structure.

typedef struct *_spifi_transfer* spifi_transfer_t

Transfer structure for SPIFI.

static inline void SPIFI_EnableDMA(SPIFI_Type *base, bool enable)

Enable or disable DMA request for SPIFI.

Parameters

- base – SPIFI peripheral base address.
- enable – True means enable DMA and false means disable DMA.

static inline uint32_t SPIFI_GetDataRegisterAddress(SPIFI_Type *base)

Gets the SPIFI data register address.

This API is used to provide a transfer address for the SPIFI DMA transfer configuration.

Parameters

- base – SPIFI base pointer

Returns

data register address

static inline void SPIFI_WriteData(SPIFI_Type *base, uint32_t data)

Write a word data in address of SPIFI.

Users can write a page or at least a word data into SPIFI address.

Parameters

- base – SPIFI peripheral base address.
- data – Data need be write.

```
static inline void SPIFI_WriteDataByte(SPIFI_Type *base, uint8_t data)
```

Write a byte data in address of SPIFI.

Users can write a byte data into SPIFI address.

Parameters

- base – SPIFI peripheral base address.
- data – Data need be write.

```
void SPIFI_WriteDataHalfword(SPIFI_Type *base, uint16_t data)
```

Write a halfword data in address of SPIFI.

Users can write a halfword data into SPIFI address.

Parameters

- base – SPIFI peripheral base address.
- data – Data need be write.

```
static inline uint32_t SPIFI_ReadData(SPIFI_Type *base)
```

Read data from serial flash.

Users should notice before call this function, the data length field in command register shall larger than 4, otherwise a hardfault will happen.

Parameters

- base – SPIFI peripheral base address.

Returns

Data input from flash.

```
static inline uint8_t SPIFI_ReadDataByte(SPIFI_Type *base)
```

Read a byte data from serial flash.

Parameters

- base – SPIFI peripheral base address.

Returns

Data input from flash.

```
uint16_t SPIFI_ReadDataHalfword(SPIFI_Type *base)
```

Read a halfword data from serial flash.

Parameters

- base – SPIFI peripheral base address.

Returns

Data input from flash.

```
struct _spifi_dma_handle
```

#include <fsl_spifi_dma.h> SPIFI DMA transfer handle, users should not touch the content of the handle.

Public Members

dma_handle_t *dmaHandle

DMA handler for SPIFI send

size_t transferSize

Bytes need to transfer.

uint32_t state

Internal state for SPIFI DMA transfer

spifi_dma_callback_t callback

Callback for users while transfer finish or error occurred

void *userData

User callback parameter

struct __spifi_command

#include <fsl_spifi.h> SPIFI command structure.

Public Members

uint16_t dataLen

How many data bytes are needed in this command.

bool isPollMode

For command need to read data from serial flash

spifi_data_direction_t direction

Data direction of this command.

uint8_t intermediateBytes

How many intermediate bytes needed

spifi_command_format_t format

Command format

spifi_command_type_t type

Command type

uint8_t opcode

Command opcode value

struct __spifi_config

#include <fsl_spifi.h> SPIFI region configuration structure.

Public Members

uint16_t timeout

SPI transfer timeout, the unit is SCK cycles

uint8_t csHighTime

CS high time cycles

bool disablePrefetch

True means SPIFI will not attempt a speculative prefetch.

bool disableCachePrefech

Disable prefetch of cache line

bool isFeedbackClock

Is data sample uses feedback clock.

spifi_spi_mode_t spiMode

SPIFI spi mode select

bool isReadFullClockCycle

If enable read full clock cycle.

spifi_dual_mode_t dualMode
SPIFI dual mode, dual or quad.

struct __spifi_transfer
#include <fsl_spifi.h> Transfer structure for SPIFI.

Public Members

uint8_t *data
Pointer to data to transmit
size_t dataSize
Bytes to be transmit

2.48 SPIFI DMA Driver

2.49 SPIFI Driver

2.50 USART: Universal Synchronous/Asynchronous Receiver/Transmitter Driver

2.51 USART DMA Driver

status_t USART_TransferCreateHandleDMA(USART_Type *base, *usart_dma_handle_t* *handle,
usart_dma_transfer_callback_t callback, void
*userData, *dma_handle_t* *txDmaHandle,
dma_handle_t *rxDmaHandle)

Initializes the USART handle which is used in transactional functions.

Parameters

- base – USART peripheral base address.
- handle – Pointer to *usart_dma_handle_t* structure.
- callback – Callback function.
- userData – User data.
- txDmaHandle – User-requested DMA handle for TX DMA transfer.
- rxDmaHandle – User-requested DMA handle for RX DMA transfer.

status_t USART_TransferSendDMA(USART_Type *base, *usart_dma_handle_t* *handle,
usart_transfer_t *xfer)

Sends data using DMA.

This function sends data using DMA. This is a non-blocking function, which returns right away. When all data is sent, the send callback function is called.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- xfer – USART DMA transfer structure. See *usart_transfer_t*.

Return values

- `kStatus__Success` – if succeed, others failed.
- `kStatus__USART__TxBusy` – Previous transfer on going.
- `kStatus__InvalidArgument` – Invalid argument.

`status_t` `USART__TransferReceiveDMA(USART_Type *base, usart_dma_handle_t *handle, usart_transfer_t *xfer)`

Receives data using DMA.

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

Parameters

- `base` – USART peripheral base address.
- `handle` – Pointer to `usart_dma_handle_t` structure.
- `xfer` – USART DMA transfer structure. See `usart_transfer_t`.

Return values

- `kStatus__Success` – if succeed, others failed.
- `kStatus__USART__RxBusy` – Previous transfer on going.
- `kStatus__InvalidArgument` – Invalid argument.

`void` `USART__TransferAbortSendDMA(USART_Type *base, usart_dma_handle_t *handle)`

Aborts the sent data using DMA.

This function aborts send data using DMA.

Parameters

- `base` – USART peripheral base address
- `handle` – Pointer to `usart_dma_handle_t` structure

`void` `USART__TransferAbortReceiveDMA(USART_Type *base, usart_dma_handle_t *handle)`

Aborts the received data using DMA.

This function aborts the received data using DMA.

Parameters

- `base` – USART peripheral base address
- `handle` – Pointer to `usart_dma_handle_t` structure

`status_t` `USART__TransferGetReceiveCountDMA(USART_Type *base, usart_dma_handle_t *handle, uint32_t *count)`

Get the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.
- `count` – Receive bytes count.

Return values

- `kStatus__NoTransferInProgress` – No receive in progress.
- `kStatus__InvalidArgument` – Parameter is invalid.

- `kStatus_Success` – Get successfully through the parameter `count`;

`status_t` USART_TransferGetSendCountDMA(USART_Type *base, *usart_dma_handle_t* *handle, `uint32_t` *count)

Get the number of bytes that have been sent.

This function gets the number of bytes that have been sent.

Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.
- `count` – Sent bytes count.

Return values

- `kStatus_NoTransferInProgress` – No receive in progress.
- `kStatus_InvalidArgument` – Parameter is invalid.
- `kStatus_Success` – Get successfully through the parameter `count`;

`FSL_USART_DMA_DRIVER_VERSION`

USART dma driver version.

`typedef struct _usart_dma_handle` `usart_dma_handle_t`

`typedef void (*usart_dma_transfer_callback_t)(USART_Type *base, usart_dma_handle_t *handle, status_t status, void *userData)`

UART transfer callback function.

`struct _usart_dma_handle`

`#include <fsl_usart_dma.h>` UART DMA handle.

Public Members

`USART_Type` *base

UART peripheral base address.

usart_dma_transfer_callback_t callback

Callback function.

void *userData

UART callback function parameter.

`size_t` rxDataSizeAll

Size of the data to receive.

`size_t` txDataSizeAll

Size of the data to send out.

dma_handle_t *txDmaHandle

The DMA TX channel used.

dma_handle_t *rxDmaHandle

The DMA RX channel used.

volatile `uint8_t` txState

TX transfer state.

volatile `uint8_t` rxState

RX transfer state

2.52 USART Driver

status_t USART_Init(USART_Type *base, const usart_config_t *config, uint32_t srcClock_Hz)

Initializes a USART instance with user configuration structure and peripheral clock.

This function configures the USART module with the user-defined settings. The user can configure the configuration structure and also get the default configuration by using the USART_GetDefaultConfig() function. Example below shows how to use this API to configure USART.

```
usart_config_t usartConfig;
usartConfig.baudRate_Bps = 115200U;
usartConfig.parityMode = kUSART_ParityDisabled;
usartConfig.stopBitCount = kUSART_OneStopBit;
USART_Init(USART1, &usartConfig, 20000000U);
```

Parameters

- base – USART peripheral base address.
- config – Pointer to user-defined configuration structure.
- srcClock_Hz – USART clock source frequency in HZ.

Return values

- kStatus_USART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_InvalidArgument – USART base address is not valid
- kStatus_Success – Status USART initialize succeed

void USART_Deinit(USART_Type *base)

Deinitializes a USART instance.

This function waits for TX complete, disables TX and RX, and disables the USART clock.

Parameters

- base – USART peripheral base address.

void USART_GetDefaultConfig(usart_config_t *config)

Gets the default configuration structure.

This function initializes the USART configuration structure to a default value. The default values are: usartConfig->baudRate_Bps = 115200U; usartConfig->parityMode = kUSART_ParityDisabled; usartConfig->stopBitCount = kUSART_OneStopBit; usartConfig->bitCountPerChar = kUSART_8BitsPerChar; usartConfig->loopback = false; usartConfig->enableTx = false; usartConfig->enableRx = false;

Parameters

- config – Pointer to configuration structure.

status_t USART_SetBaudRate(USART_Type *base, uint32_t baudrate_Bps, uint32_t srcClock_Hz)

Sets the USART instance baud rate.

This function configures the USART module baud rate. This function is used to update the USART module baud rate after the USART module is initialized by the USART_Init.

```
USART_SetBaudRate(USART1, 115200U, 20000000U);
```

Parameters

- base – USART peripheral base address.

- baudrate_Bps – USART baudrate to be set.
- srcClock_Hz – USART clock source frequency in HZ.

Return values

- kStatus_USART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – Set baudrate succeed.
- kStatus_InvalidArgument – One or more arguments are invalid.

status_t USART_Enable32kMode(USART_Type *base, uint32_t baudRate_Bps, bool enableMode32k, uint32_t srcClock_Hz)

Enable 32 kHz mode which USART uses clock from the RTC oscillator as the clock source.

Please note that in order to use a 32 kHz clock to operate USART properly, the RTC oscillator and its 32 kHz output must be manually enabled by user, by calling RTC_Init and setting SYSCON_RTCOSCTRL_EN bit to 1. And in 32kHz clocking mode the USART can only work at 9600 baudrate or at the baudrate that 9600 can evenly divide, eg: 4800, 3200.

Parameters

- base – USART peripheral base address.
- baudRate_Bps – USART baudrate to be set..
- enableMode32k – true is 32k mode, false is normal mode.
- srcClock_Hz – USART clock source frequency in HZ.

Return values

- kStatus_USART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – Set baudrate succeed.
- kStatus_InvalidArgument – One or more arguments are invalid.

void USART_Enable9bitMode(USART_Type *base, bool enable)

Enable 9-bit data mode for USART.

This function set the 9-bit mode for USART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – USART peripheral base address.
- enable – true to enable, false to disable.

static inline void USART_SetMatchAddress(USART_Type *base, uint8_t address)

Set the USART slave address.

This function configures the address for USART module that works as slave in 9-bit data mode. When the address detection is enabled, the frame it receives with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note: Any USART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

- base – USART peripheral base address.
- address – USART slave address.

static inline void USART__EnableMatchAddress(USART_Type *base, bool match)

Enable the USART match address feature.

Parameters

- base – USART peripheral base address.
- match – true to enable match address, false to disable.

static inline uint32_t USART__GetStatusFlags(USART_Type *base)

Get USART status flags.

This function get all USART status flags, the flags are returned as the logical OR value of the enumerators `_usart_flags`. To check a specific status, compare the return value with enumerators in `_usart_flags`. For example, to check whether the TX is empty:

```
if (kUSART_TxFifoNotFullFlag & USART__GetStatusFlags(USART1))
{
    ...
}
```

Parameters

- base – USART peripheral base address.

Returns

USART status flags which are ORed by the enumerators in the `_usart_flags`.

static inline void USART__ClearStatusFlags(USART_Type *base, uint32_t mask)

Clear USART status flags.

This function clear supported USART status flags. The mask is a logical OR of enumeration members. See `kUSART_AllClearFlags`. For example:

```
USART__ClearStatusFlags(USART1, kUSART_TxError | kUSART_RxError)
```

Parameters

- base – USART peripheral base address.
- mask – status flags to be cleared.

static inline void USART__EnableInterrupts(USART_Type *base, uint32_t mask)

Enables USART interrupts according to the provided mask.

This function enables the USART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See `_usart_interrupt_enable`. For example, to enable TX empty interrupt and RX full interrupt:

```
USART__EnableInterrupts(USART1, kUSART_TxLevelInterruptEnable | kUSART__
↳ RxLevelInterruptEnable);
```

Parameters

- base – USART peripheral base address.
- mask – The interrupts to enable. Logical OR of `_usart_interrupt_enable`.

static inline void USART__DisableInterrupts(USART_Type *base, uint32_t mask)

Disables USART interrupts according to a provided mask.

This function disables the USART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See `_usart_interrupt_enable`. This example shows how to disable the TX empty interrupt and RX full interrupt:

```
USART__DisableInterrupts(USART1, kUSART__TxLevelInterruptEnable | kUSART__
↳ RxLevelInterruptEnable);
```

Parameters

- base – USART peripheral base address.
- mask – The interrupts to disable. Logical OR of `_usart_interrupt_enable`.

static inline uint32_t USART__GetEnabledInterrupts(USART_Type *base)

Returns enabled USART interrupts.

This function returns the enabled USART interrupts.

Parameters

- base – USART peripheral base address.

static inline void USART__EnableTxDMA(USART_Type *base, bool enable)

Enable DMA for Tx.

static inline void USART__EnableRxDMA(USART_Type *base, bool enable)

Enable DMA for Rx.

static inline void USART__EnableCTS(USART_Type *base, bool enable)

Enable CTS. This function will determine whether CTS is used for flow control.

Parameters

- base – USART peripheral base address.
- enable – Enable CTS or not, true for enable and false for disable.

static inline void USART__EnableContinuousSCLK(USART_Type *base, bool enable)

Continuous Clock generation. By default, SCLK is only output while data is being transmitted in synchronous mode. Enable this function, SCLK will run continuously in synchronous mode, allowing characters to be received on `Un_RxD` independently from transmission on `Un_TXD`.

Parameters

- base – USART peripheral base address.
- enable – Enable Continuous Clock generation mode or not, true for enable and false for disable.

static inline void USART__EnableAutoClearSCLK(USART_Type *base, bool enable)

Enable Continuous Clock generation bit auto clear. While enable this function, the Continuous Clock bit is automatically cleared when a complete character has been received. This bit is cleared at the same time.

Parameters

- base – USART peripheral base address.
- enable – Enable auto clear or not, true for enable and false for disable.


```
static inline void USART_SetRxFifoWatermark(USART_Type *base, uint8_t water)
```

Sets the rx FIFO watermark.

Parameters

- base – USART peripheral base address.
- water – Rx FIFO watermark.

```
static inline void USART_SetTxFifoWatermark(USART_Type *base, uint8_t water)
```

Sets the tx FIFO watermark.

Parameters

- base – USART peripheral base address.
- water – Tx FIFO watermark.

```
static inline void USART_WriteByte(USART_Type *base, uint8_t data)
```

Writes to the FIFOWR register.

This function writes data to the txFIFO directly. The upper layer must ensure that txFIFO has space for data to write before calling this function.

Parameters

- base – USART peripheral base address.
- data – The byte to write.

```
static inline uint8_t USART_ReadByte(USART_Type *base)
```

Reads the FIFORD register directly.

This function reads data from the rxFIFO directly. The upper layer must ensure that the rxFIFO is not empty before calling this function.

Parameters

- base – USART peripheral base address.

Returns

The byte read from USART data register.

```
static inline uint8_t USART_GetRxFifoCount(USART_Type *base)
```

Gets the rx FIFO data count.

Parameters

- base – USART peripheral base address.

Returns

rx FIFO data count.

```
static inline uint8_t USART_GetTxFifoCount(USART_Type *base)
```

Gets the tx FIFO data count.

Parameters

- base – USART peripheral base address.

Returns

tx FIFO data count.

```
void USART_SendAddress(USART_Type *base, uint8_t address)
```

Transmit an address frame in 9-bit data mode.

Parameters

- base – USART peripheral base address.
- address – USART slave address.

status_t USART_WriteBlocking(USART_Type *base, const uint8_t *data, size_t length)

Writes to the TX register using a blocking method.

This function polls the TX register, waits for the TX register to be empty or for the TX FIFO to have room and writes data to the TX buffer.

Parameters

- base – USART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_USART_Timeout – Transmission timed out and was aborted.
- kStatus_InvalidArgument – Invalid argument.
- kStatus_Success – Successfully wrote all data.

status_t USART_ReadBlocking(USART_Type *base, uint8_t *data, size_t length)

Read RX data register using a blocking method.

This function polls the RX register, waits for the RX register to be full or for RX FIFO to have data and read data from the TX register.

Parameters

- base – USART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

Return values

- kStatus_USART_FramingError – Receiver overrun happened while receiving data.
- kStatus_USART_ParityError – Noise error happened while receiving data.
- kStatus_USART_NoiseError – Framing error happened while receiving data.
- kStatus_USART_RxError – Overflow or underflow rxFIFO happened.
- kStatus_USART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

status_t USART_TransferCreateHandle(USART_Type *base, *usart_handle_t* *handle, *usart_transfer_callback_t* callback, void *userData)

Initializes the USART handle.

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

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

```
status_t USART_TransferSendNonBlocking(USART_Type *base, usart_handle_t *handle,  
                                       usart_transfer_t *xfer)
```

Transmits a buffer of data using the interrupt method.

This function sends data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data to be written to the TX register. When all data is written to the TX register in the IRQ handler, the USART driver calls the callback function and passes the `kStatus_USART_TxIdle` as status parameter.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- xfer – USART transfer structure. See `usart_transfer_t`.

Return values

- `kStatus_Success` – Successfully start the data transmission.
- `kStatus_USART_TxBusy` – Previous transmission still not finished, data not all written to TX register yet.
- `kStatus_InvalidArgument` – Invalid argument.

```
void USART_TransferStartRingBuffer(USART_Type *base, usart_handle_t *handle, uint8_t  
                                  *ringBuffer, size_t ringBufferSize)
```

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific USART handle.

When the RX ring buffer is used, data received are stored into the ring buffer even when the user doesn't call the `USART_TransferReceiveNonBlocking()` API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly.

Note: When using the RX ring buffer, one byte is reserved for internal use. In other words, if `ringBufferSize` is 32, then only 31 bytes are used for saving data.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- ringBuffer – Start address of the ring buffer for background receiving. Pass `NULL` to disable the ring buffer.
- ringBufferSize – size of the ring buffer.

```
void USART_TransferStopRingBuffer(USART_Type *base, usart_handle_t *handle)
```

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.

```
size_t USART_TransferGetRxRingBufferLength(usart_handle_t *handle)
```

Get the length of received data in RX ring buffer.

Parameters

- handle – USART handle pointer.

Returns

Length of received data in RX ring buffer.

void USART_TransferAbortSend(USART_Type *base, *usart_handle_t* *handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt driven data sending. The user can get the remainBytes to find out how many bytes are still not sent out.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.

status_t USART_TransferGetSendCount(USART_Type *base, *usart_handle_t* *handle, uint32_t *count)

Get the number of bytes that have been sent out to bus.

This function gets the number of bytes that have been sent out to bus by interrupt method.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t USART_TransferReceiveNonBlocking(USART_Type *base, *usart_handle_t* *handle, *usart_transfer_t* *xfer, size_t *receivedBytes)

Receives a buffer of data using an interrupt method.

This function receives data using an interrupt method. This is a non-blocking function, which returns without waiting for all data to be received. If the RX ring buffer is used and not empty, the data in the ring buffer is copied and the parameter `receivedBytes` shows how many bytes are copied from the ring buffer. After copying, if the data in the ring buffer is not enough to read, the receive request is saved by the USART driver. When the new data arrives, the receive request is serviced first. When all data is received, the USART driver notifies the upper layer through a callback function and passes the status parameter `kStatus_USART_RxIdle`. For example, the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer. The 5 bytes are copied to the `xfer->data` and this function returns with the parameter `receivedBytes` set to 5. For the left 5 bytes, newly arrived data is saved from the `xfer->data[5]`. When 5 bytes are received, the USART driver notifies the upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to the `xfer->data`. When all data is received, the upper layer is notified.

Parameters

- base – USART peripheral base address.
- handle – USART handle pointer.
- xfer – USART transfer structure, see `usart_transfer_t`.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into transmit queue.
- kStatus_USART_RxBusy – Previous receive request is not finished.

- `kStatus_InvalidArgument` – Invalid argument.

`void USART_TransferAbortReceive(USART_Type *base, usart_handle_t *handle)`

Aborts the interrupt-driven data receiving.

This function aborts the interrupt-driven data receiving. The user can get the `remainBytes` to find out how many bytes not received yet.

Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.

`status_t USART_TransferGetReceiveCount(USART_Type *base, usart_handle_t *handle, uint32_t *count)`

Get the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.
- `count` – Receive bytes count.

Return values

- `kStatus_NoTransferInProgress` – No receive in progress.
- `kStatus_InvalidArgument` – Parameter is invalid.
- `kStatus_Success` – Get successfully through the parameter count;

`void USART_TransferHandleIRQ(USART_Type *base, usart_handle_t *handle)`

USART IRQ handle function.

This function handles the USART transmit and receive IRQ request.

Parameters

- `base` – USART peripheral base address.
- `handle` – USART handle pointer.

`FSL_USART_DRIVER_VERSION`

USART driver version.

Error codes for the USART driver.

Values:

enumerator `kStatus_USART_TxBusy`
Transmitter is busy.

enumerator `kStatus_USART_RxBusy`
Receiver is busy.

enumerator `kStatus_USART_TxIdle`
USART transmitter is idle.

enumerator `kStatus_USART_RxIdle`
USART receiver is idle.

enumerator `kStatus_USART_TxError`
Error happens on txFIFO.

enumerator kStatus_USART_RxError

Error happens on rxFIFO.

enumerator kStatus_USART_RxRingBufferOverrun

Error happens on rx ring buffer

enumerator kStatus_USART_NoiseError

USART noise error.

enumerator kStatus_USART_FramingError

USART framing error.

enumerator kStatus_USART_ParityError

USART parity error.

enumerator kStatus_USART_BaudrateNotSupport

Baudrate is not support in current clock source

enumerator kStatus_USART_RxStart

Start is detected on the receiver input

enum _usart_sync_mode

USART synchronous mode.

Values:

enumerator kUSART_SyncModeDisabled

Asynchronous mode.

enumerator kUSART_SyncModeSlave

Synchronous slave mode.

enumerator kUSART_SyncModeMaster

Synchronous master mode.

enum _usart_parity_mode

USART parity mode.

Values:

enumerator kUSART_ParityDisabled

Parity disabled

enumerator kUSART_ParityEven

Parity enabled, type even, bit setting: PE | PT = 10

enumerator kUSART_ParityOdd

Parity enabled, type odd, bit setting: PE | PT = 11

enum _usart_stop_bit_count

USART stop bit count.

Values:

enumerator kUSART_OneStopBit

One stop bit

enumerator kUSART_TwoStopBit

Two stop bits

enum _usart_data_len

USART data size.

Values:

enumerator kUSART_7BitsPerChar

Seven bit mode

enumerator kUSART_8BitsPerChar

Eight bit mode

enum _usart_clock_polarity

USART clock polarity configuration, used in sync mode.

Values:

enumerator kUSART_RxSampleOnFallingEdge

Un_RXD is sampled on the falling edge of SCLK.

enumerator kUSART_RxSampleOnRisingEdge

Un_RXD is sampled on the rising edge of SCLK.

enum _usart_txfifo_watermark

txFIFO watermark values

Values:

enumerator kUSART_TxFifo0

USART tx watermark is empty

enumerator kUSART_TxFifo1

USART tx watermark at 1 item

enumerator kUSART_TxFifo2

USART tx watermark at 2 items

enumerator kUSART_TxFifo3

USART tx watermark at 3 items

enumerator kUSART_TxFifo4

USART tx watermark at 4 items

enumerator kUSART_TxFifo5

USART tx watermark at 5 items

enumerator kUSART_TxFifo6

USART tx watermark at 6 items

enumerator kUSART_TxFifo7

USART tx watermark at 7 items

enum _usart_rxfifo_watermark

rxFIFO watermark values

Values:

enumerator kUSART_RxFifo1

USART rx watermark at 1 item

enumerator kUSART_RxFifo2

USART rx watermark at 2 items

enumerator kUSART_RxFifo3

USART rx watermark at 3 items

enumerator kUSART_RxFifo4

USART rx watermark at 4 items

enumerator kUSART_RxFifo5
USART rx watermark at 5 items

enumerator kUSART_RxFifo6
USART rx watermark at 6 items

enumerator kUSART_RxFifo7
USART rx watermark at 7 items

enumerator kUSART_RxFifo8
USART rx watermark at 8 items

enum _usart_interrupt_enable
USART interrupt configuration structure, default settings all disabled.

Values:

enumerator kUSART_TxErrorInterruptEnable

enumerator kUSART_RxErrorInterruptEnable

enumerator kUSART_TxLevelInterruptEnable

enumerator kUSART_RxLevelInterruptEnable

enumerator kUSART_TxIdleInterruptEnable
Transmitter idle.

enumerator kUSART_CtsChangeInterruptEnable
Change in the state of the CTS input.

enumerator kUSART_RxBreakChangeInterruptEnable
Break condition asserted or deasserted.

enumerator kUSART_RxStartInterruptEnable
Rx start bit detected.

enumerator kUSART_FramingErrorInterruptEnable
Framing error detected.

enumerator kUSART_ParityErrorInterruptEnable
Parity error detected.

enumerator kUSART_NoiseErrorInterruptEnable
Noise error detected.

enumerator kUSART_AutoBaudErrorInterruptEnable
Auto baudrate error detected.

enumerator kUSART_AllInterruptEnables

enum _usart_flags
USART status flags.
This provides constants for the USART status flags for use in the USART functions.

Values:

enumerator kUSART_TxError
TXERR bit, sets if TX buffer is error

enumerator kUSART_RxError
RXERR bit, sets if RX buffer is error

enumerator `kUSART_TxFifoEmptyFlag`
TXEMPTY bit, sets if TX buffer is empty

enumerator `kUSART_TxFifoNotFullFlag`
TXNOTFULL bit, sets if TX buffer is not full

enumerator `kUSART_RxFifoNotEmptyFlag`
RXNOEMPTY bit, sets if RX buffer is not empty

enumerator `kUSART_RxFifoFullFlag`
RXFULL bit, sets if RX buffer is full

enumerator `kUSART_RxIdleFlag`
Receiver idle.

enumerator `kUSART_TxIdleFlag`
Transmitter idle.

enumerator `kUSART_CtsAssertFlag`
CTS signal high.

enumerator `kUSART_CtsChangeFlag`
CTS signal changed interrupt status.

enumerator `kUSART_BreakDetectFlag`
Break detected. Self cleared when rx pin goes high again.

enumerator `kUSART_BreakDetectChangeFlag`
Break detect change interrupt flag. A change in the state of receiver break detection.

enumerator `kUSART_RxStartFlag`
Rx start bit detected interrupt flag.

enumerator `kUSART_FramingErrorFlag`
Framing error interrupt flag.

enumerator `kUSART_ParityErrorFlag`
parity error interrupt flag.

enumerator `kUSART_NoiseErrorFlag`
Noise error interrupt flag.

enumerator `kUSART_AutobaudErrorFlag`
Auto baudrate error interrupt flag, caused by the baudrate counter timeout before the end of start bit.

enumerator `kUSART_AllClearFlags`

typedef enum `_usart_sync_mode` `usart_sync_mode_t`
USART synchronous mode.

typedef enum `_usart_parity_mode` `usart_parity_mode_t`
USART parity mode.

typedef enum `_usart_stop_bit_count` `usart_stop_bit_count_t`
USART stop bit count.

typedef enum `_usart_data_len` `usart_data_len_t`
USART data size.

typedef enum `_usart_clock_polarity` `usart_clock_polarity_t`
USART clock polarity configuration, used in sync mode.

typedef enum *_usart_txfifo_watermark* usart_txfifo_watermark_t
txFIFO watermark values

typedef enum *_usart_rxfifo_watermark* usart_rxfifo_watermark_t
rxFIFO watermark values

typedef struct *_usart_config* usart_config_t
USART configuration structure.

typedef struct *_usart_transfer* usart_transfer_t
USART transfer structure.

typedef struct *_usart_handle* usart_handle_t

typedef void (*usart_transfer_callback_t)(USART_Type *base, usart_handle_t *handle, status_t status, void *userData)

USART transfer callback function.

typedef void (*flexcomm_usart_irq_handler_t)(USART_Type *base, usart_handle_t *handle)
Typedef for usart interrupt handler.

uint32_t USART_GetInstance(USART_Type *base)
Returns instance number for USART peripheral base address.

USART_FIFOTRIG_TXLVL_GET(base)

USART_FIFOTRIG_RXLVL_GET(base)

UART_RETRY_TIMES
Retry times for waiting flag.

Defining to zero means to keep waiting for the flag until it is assert/deassert in blocking transfer; otherwise the program will wait until the UART_RETRY_TIMES counts down to 0, if the flag still remains unchanged then program will return kStatus_USART_Timeout. It is not advised to use this macro in formal application to prevent any hardware error because the actual wait period is affected by the compiler and optimization.

struct *_usart_config*
#include <fsl_usart.h> USART configuration structure.

Public Members

uint32_t baudRate_Bps
USART baud rate

usart_parity_mode_t parityMode
Parity mode, disabled (default), even, odd

usart_stop_bit_count_t stopBitCount
Number of stop bits, 1 stop bit (default) or 2 stop bits

usart_data_len_t bitCountPerChar
Data length - 7 bit, 8 bit

bool loopback
Enable peripheral loopback

bool enableRx
Enable RX

bool enableTx
Enable TX

`bool enableContinuousSCLK`

USART continuous Clock generation enable in synchronous master mode.

`bool enableMode32k`

USART uses 32 kHz clock from the RTC oscillator as the clock source.

`bool enableHardwareFlowControl`

Enable hardware control RTS/CTS

`bool enable485ControlOutput`

Configure RTS signal to provide an output enable signal to control an RS-485 transceiver.

`bool enableActiveHighRts`

Output enable polarity.

`bool extendRtsOutput`

Output Enable Turnaround time enable for RS-485 operation.

`usart_txfifo_watermark_t txWatermark`

txFIFO watermark

`usart_rxfifo_watermark_t rxWatermark`

rxFIFO watermark

`usart_sync_mode_t syncMode`

Transfer mode select - asynchronous, synchronous master, synchronous slave.

`usart_clock_polarity_t clockPolarity`

Selects the clock polarity and sampling edge in synchronous mode.

`struct __usart_transfer`

#include <fsl_usart.h> USART transfer structure.

Public Members

`size_t dataSize`

The byte count to be transfer.

`struct __usart_handle`

#include <fsl_usart.h> USART handle structure.

Public Members

`const uint8_t *volatile txData`

Address of remaining data to send.

`volatile size_t txDataSize`

Size of the remaining data to send.

`size_t txDataSizeAll`

Size of the data to send out.

`uint8_t *volatile rxData`

Address of remaining data to receive.

`volatile size_t rxDataSize`

Size of the remaining data to receive.

`size_t rxDataSizeAll`
Size of the data to receive.

`uint8_t *rxRingBuffer`
Start address of the receiver ring buffer.

`size_t rxRingBufferSize`
Size of the ring buffer.

`volatile uint16_t rxRingBufferHead`
Index for the driver to store received data into ring buffer.

`volatile uint16_t rxRingBufferTail`
Index for the user to get data from the ring buffer.

`usart_transfer_callback_t callback`
Callback function.

`void *userData`
USART callback function parameter.

`volatile uint8_t txState`
TX transfer state.

`volatile uint8_t rxState`
RX transfer state

`uint8_t txWatermark`
txFIFO watermark

`uint8_t rxWatermark`
rxFIFO watermark

`union __unnamed36__`

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.

2.53 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.
```

2.54 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 0xFFFF (maximum possible timer value) so windowing is not in effect.

Parameters

- base – WWDT peripheral base address
- windowValue – WWDT window value.

void WWDT_Refresh(WWDT_Type *base)

Refreshes the WWDT timer.

This function feeds the WWDT. This function should be called before WWDT timer is in timeout. Otherwise, a reset is asserted.

Parameters

- base – WWDT peripheral base address

FSL_WWDT_DRIVER_VERSION

Defines WWDT driver version.

WWDT_FIRST_WORD_OF_REFRESH

First word of refresh sequence

WWDT_SECOND_WORD_OF_REFRESH

Second word of refresh sequence

enum __wwdt_status_flags_t

WWDT status flags.

This structure contains the WWDT status flags for use in the WWDT functions.

Values:

enumerator kWWDT_TimeoutFlag

Time-out flag, set when the timer times out

enumerator kWWDT_WarningFlag

Warning interrupt flag, set when timer is below the value WDWARNINT


```
typedef struct _wwdt_config wwdt_config_t
```

Describes WWDT configuration structure.

```
struct _wwdt_config
```

#include <fsl_wwdt.h> Describes WWDT configuration structure.

Public Members

```
bool enableWwdt
```

Enables or disables WWDT

```
bool enableWatchdogReset
```

true: Watchdog timeout will cause a chip reset false: Watchdog timeout will not cause a chip reset

```
bool enableWatchdogProtect
```

true: Enable watchdog protect i.e timeout value can only be changed after counter is below warning & window values false: Disable watchdog protect; timeout value can be changed at any time

```
bool enableLockOscillator
```

true: Disabling or powering down the watchdog oscillator is prevented Once set, this bit can only be cleared by a reset false: Do not lock oscillator

```
uint32_t windowValue
```

Window value, set this to 0xFFFFFFFF if windowing is not in effect

```
uint32_t timeoutValue
```

Timeout value

```
uint32_t warningValue
```

Watchdog time counter value that will generate a warning interrupt. Set this to 0 for no warning

```
uint32_t clockFreq_Hz
```

Watchdog clock source frequency.

Chapter 3

Middleware

3.1 Connectivity

3.1.1 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.

3.2 File System

3.2.1 FatFs

MCUXpresso SDK : `mcuxsdk-middleware-fatfs`

Overview This repository is for FatFs middleware delivery and it contains the components of 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](#)

[R0.16_rev0]

- Upgraded to version 0.16
- Applied patch <https://elm-chan.org/fsw/ff/patch/ff16p1.diff>
- Applied patch <https://elm-chan.org/fsw/ff/patch/ffunicode.zip>
- Make lb and hb variables conditional. Fix 'unused variable' issue:
 - ffunicode.c:10622:28: error: unused variable 'lb'
 - ffunicode.c:10622:7: error: unused variable 'hb'

[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.

3.3 Motor Control

3.3.1 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:

$N * T_{char}$

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.
- T_{char} 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.

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 ChangeLog](#)

[FreeRTOS kernel Readme](#)

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](#)

4.1.4 corehttp

C language HTTP client library designed for embedded platforms.

4.1.5 corejson

JSON parser.

Readme

4.1.6 coremqtt

MQTT publish/subscribe messaging library.

4.1.7 corepkcs11

PKCS #11 key management library.

Readme

4.1.8 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

Readme