MCUXpresso SDK Documentation

Release 25.06.00

NXP
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Table of contents

This documentation contains information specific to the frdmk32l2b board.

Chapter 1

FRDM-K32L2B

1.1 Overview

The FRDM-K32L2B3 is supported by a range of NXP and third-party development software.

MCU device and part on board is shown below:

- Device: K32L2B31A
- PartNumber: K32L2B31VLH0A

1.2 Getting Started with MCUXpresso SDK Package

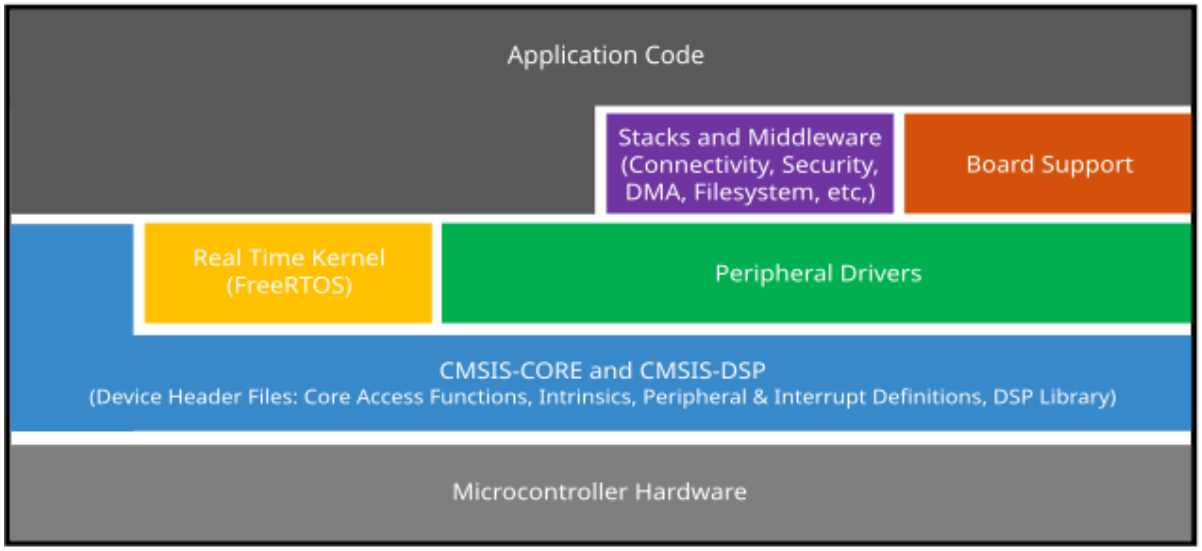
1.2.1 Getting Started with MCUXpresso SDK Package

Overview

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

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

For more details about MCUXpresso SDK, see MCUXpresso Software Development Kit (SDK).



MCUXpresso SDK board support package folders

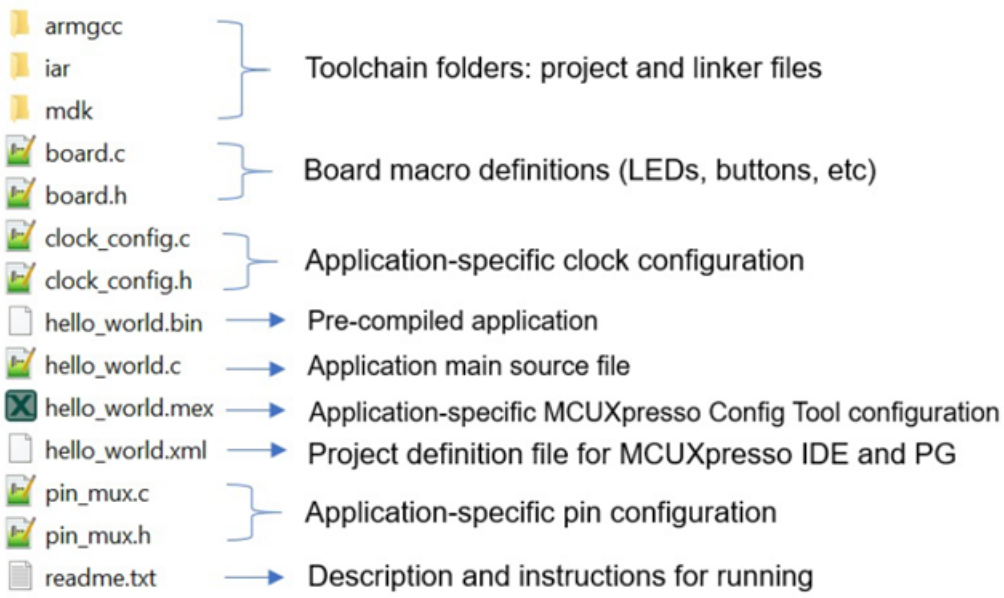
MCUXpresso SDK board support package provides example applications for NXP development and evaluation boards for Arm Cortex-M cores including Freedom, Tower System, and LPCXpresso boards. Board support packages are found inside the top-level boards folder and each supported board has its own folder (an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

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

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

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

In the hello_world application folder you see the following contents:



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

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

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

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

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

Run a demo using MCUXpresso IDE

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

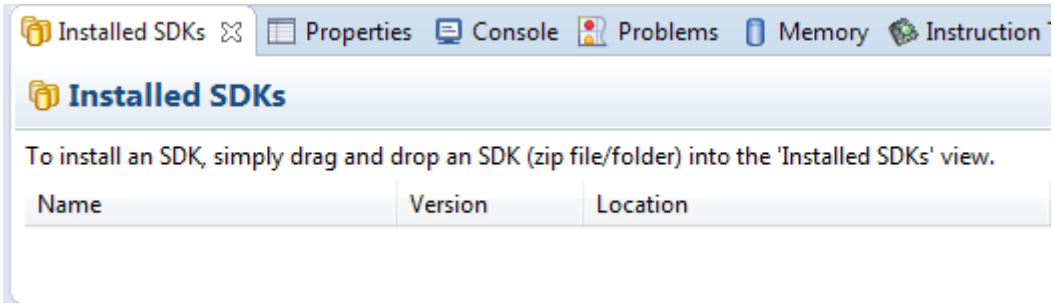
This section describes the steps required to configure MCUXpresso IDE to build, run, and debug example applications. The hello_world demo application targeted for the hardware platform is

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

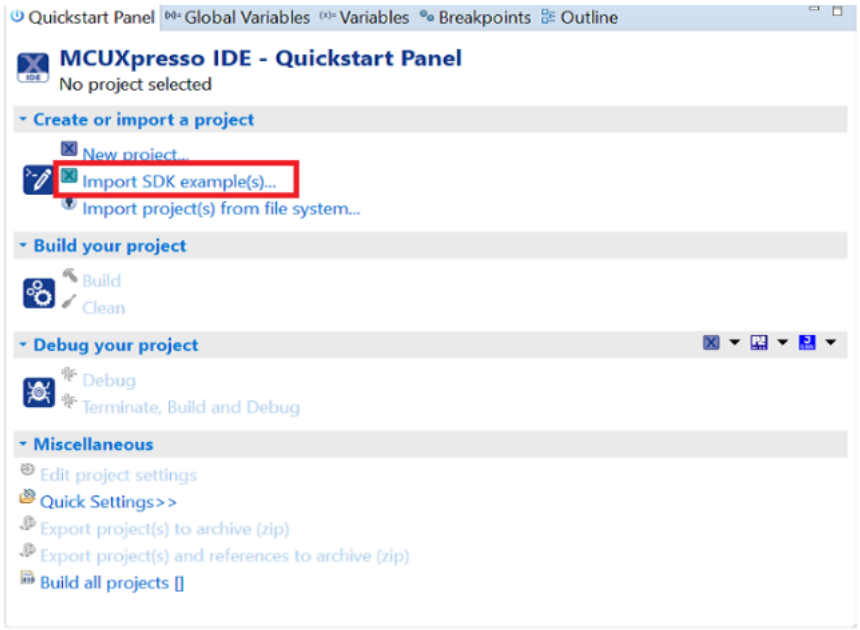
Select the workspace location Every time MCUXpresso IDE launches, it prompts the user to select a workspace location. MCUXpresso IDE is built on top of Eclipse which uses workspace to store information about its current configuration, and in some use cases, source files for the projects are in the workspace.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

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

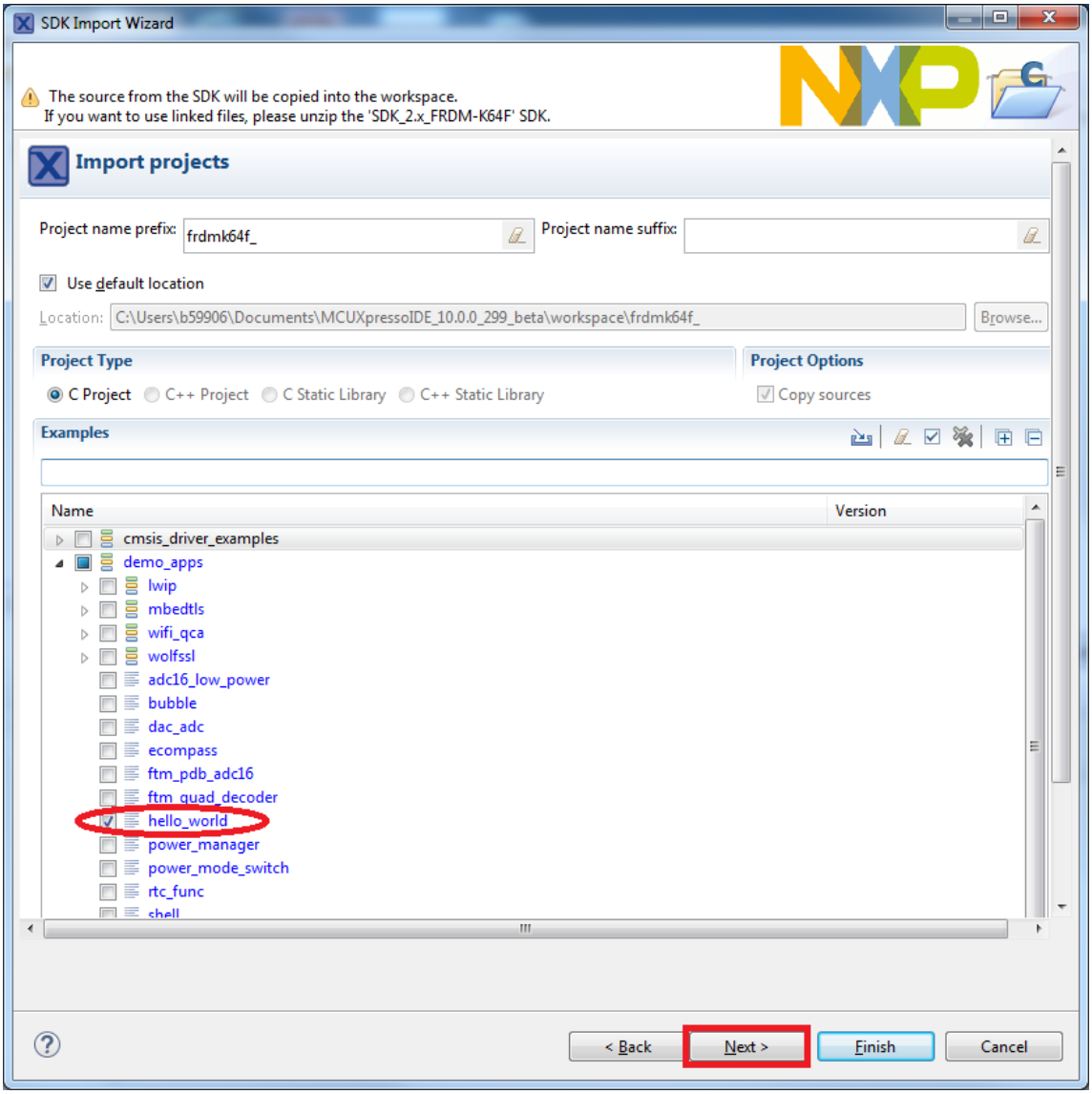
1. Drag and drop the SDK zip file into the **Installed SDKs** view to install an SDK. In the window that appears, click **OK** and wait until the import has finished.



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



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



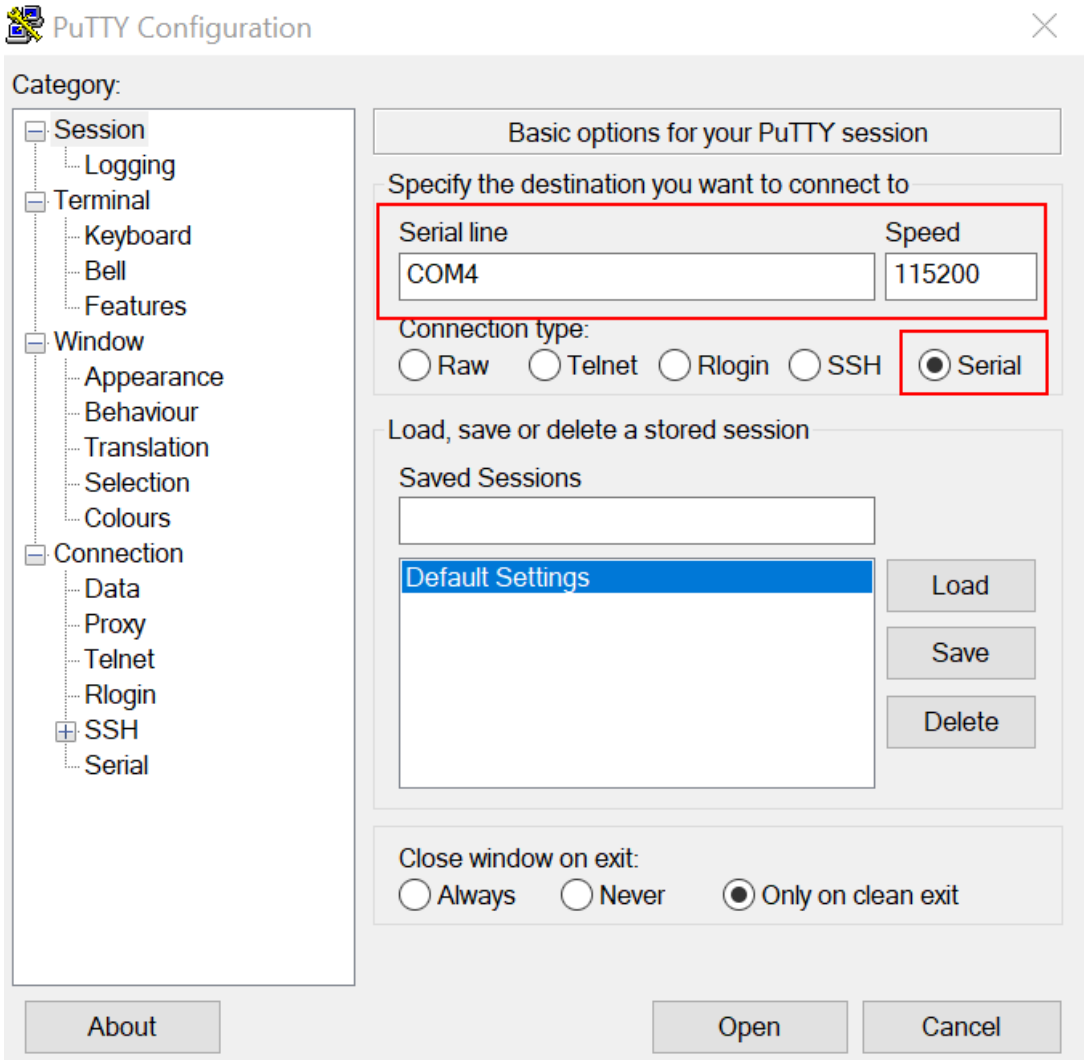
5. Ensure **Redlib: Use floating-point version of printf** is selected if the example prints floating-point numbers on the terminalfor demo applications such as adc_basic, adc_burst, adc_dma, and adc_interrupt. Otherwise, it is not necessary to select this option. Then, click **Finish**.

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

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

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

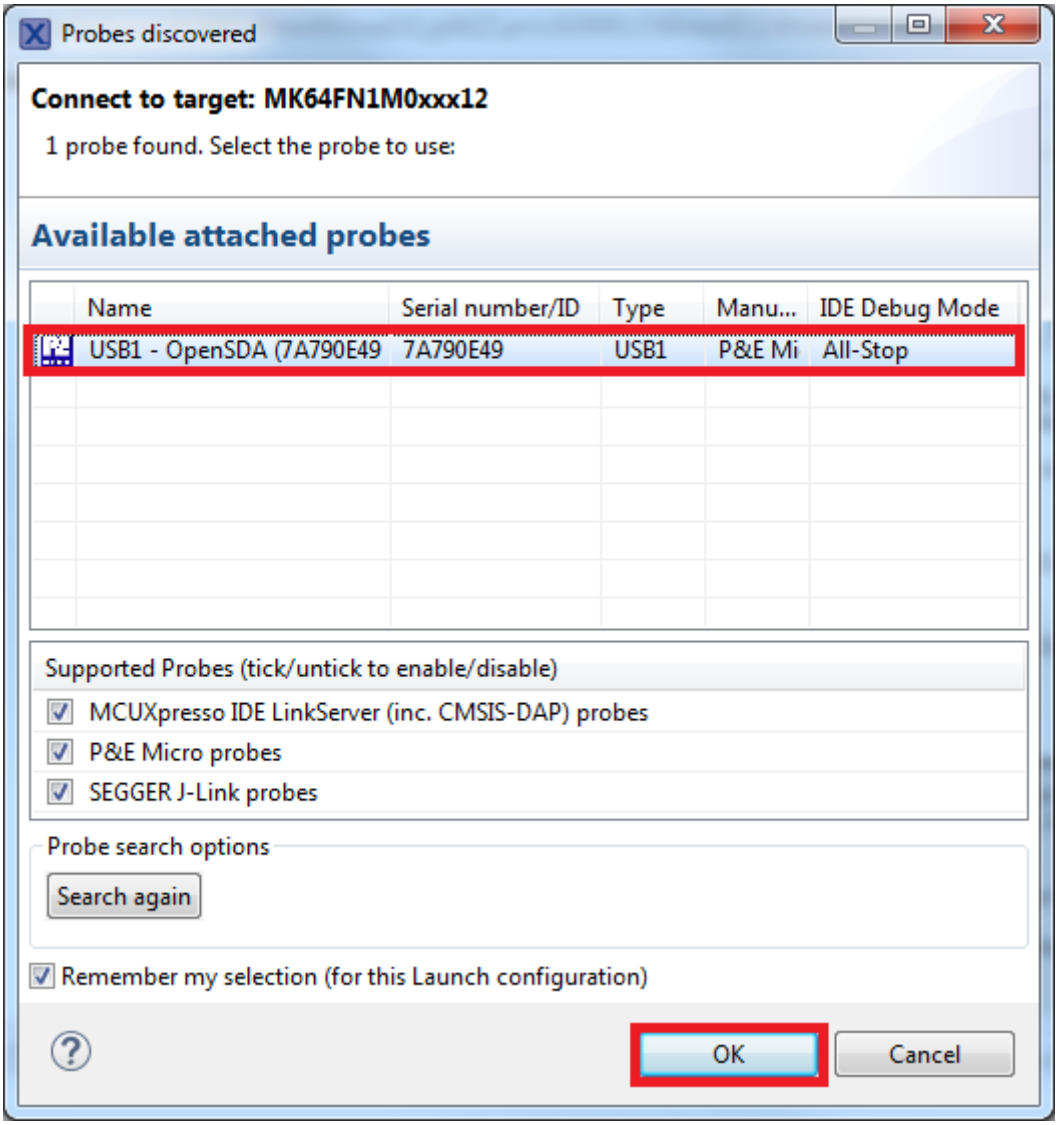
3. 8 data bits



4. 1 stop bit

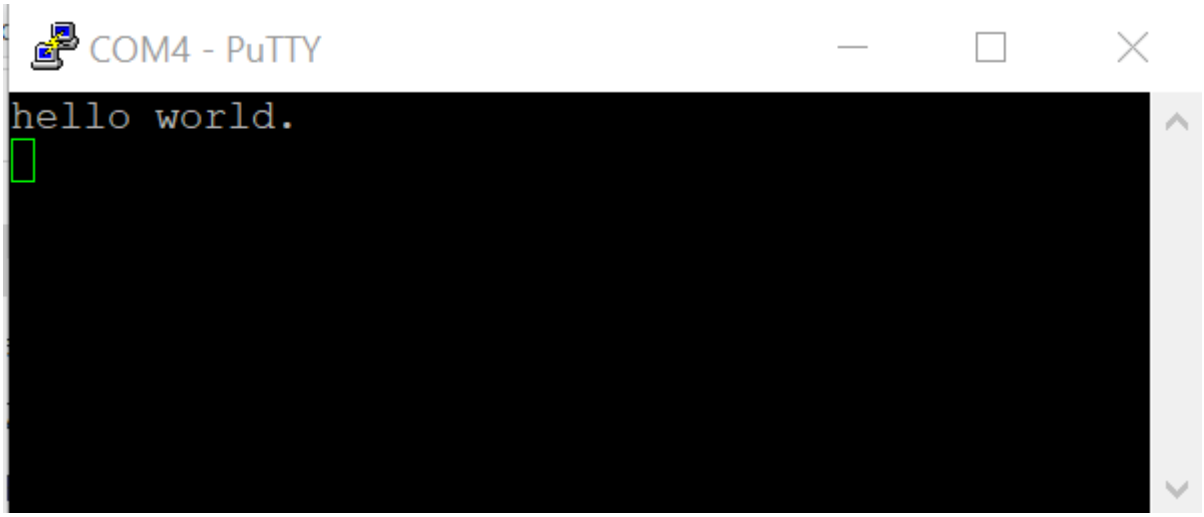
4. On the **Quickstart Panel**, click **Debug** to launch the debug session.

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



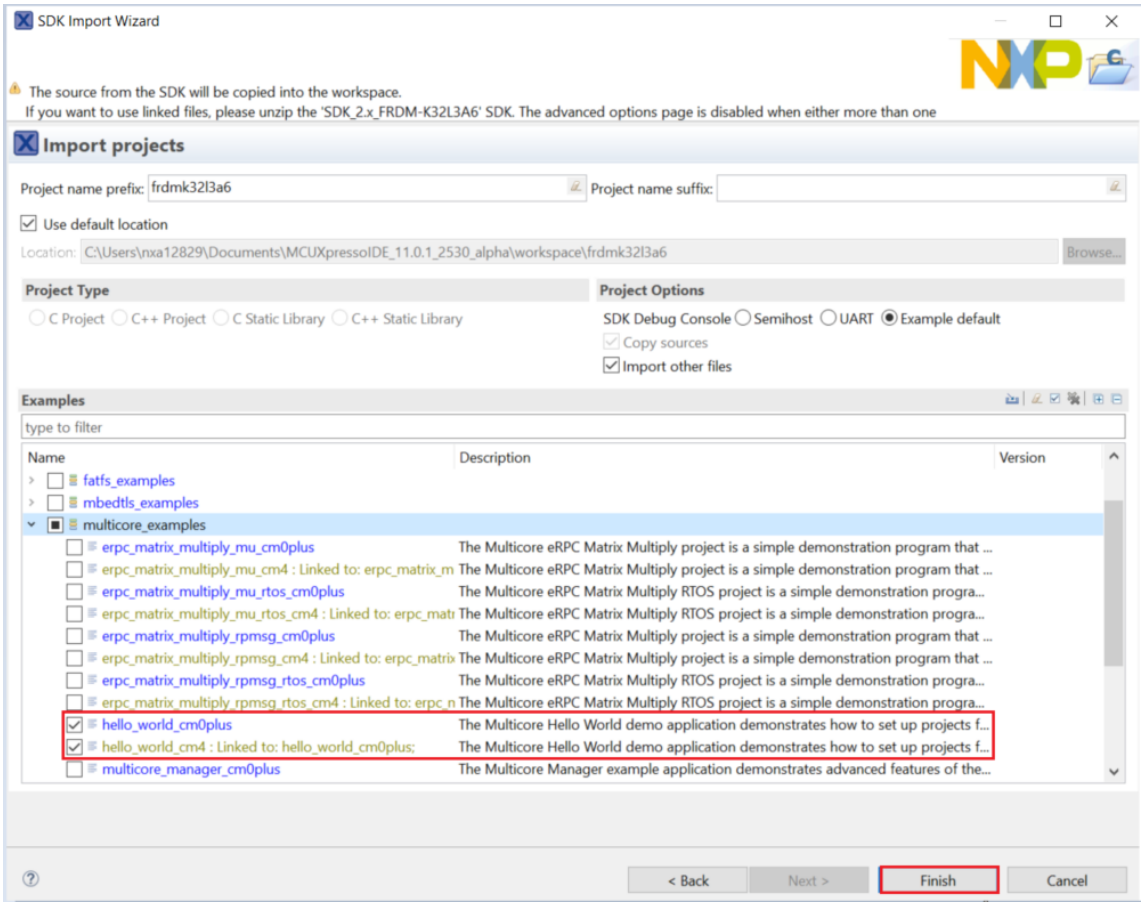
6. The application is downloaded to the target and automatically runs to main().
7. Start the application by clicking **Resume**.

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

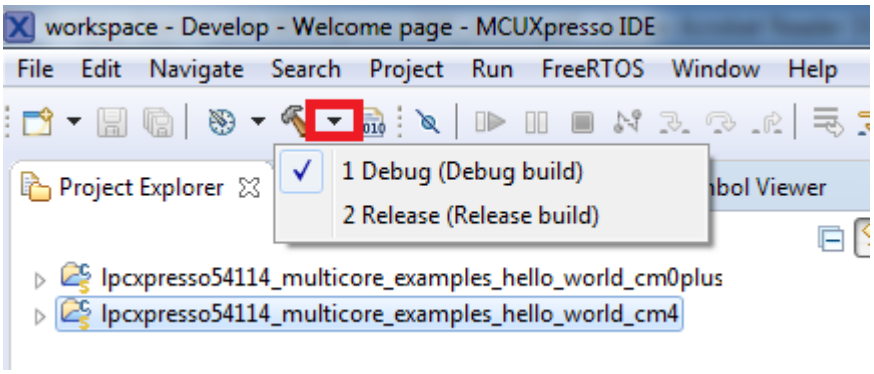


Build a multicore example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug multicore example applications. The following steps can be applied to any multicore example application in the MCUXpresso SDK. Here, the dual-core version of hello_world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

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

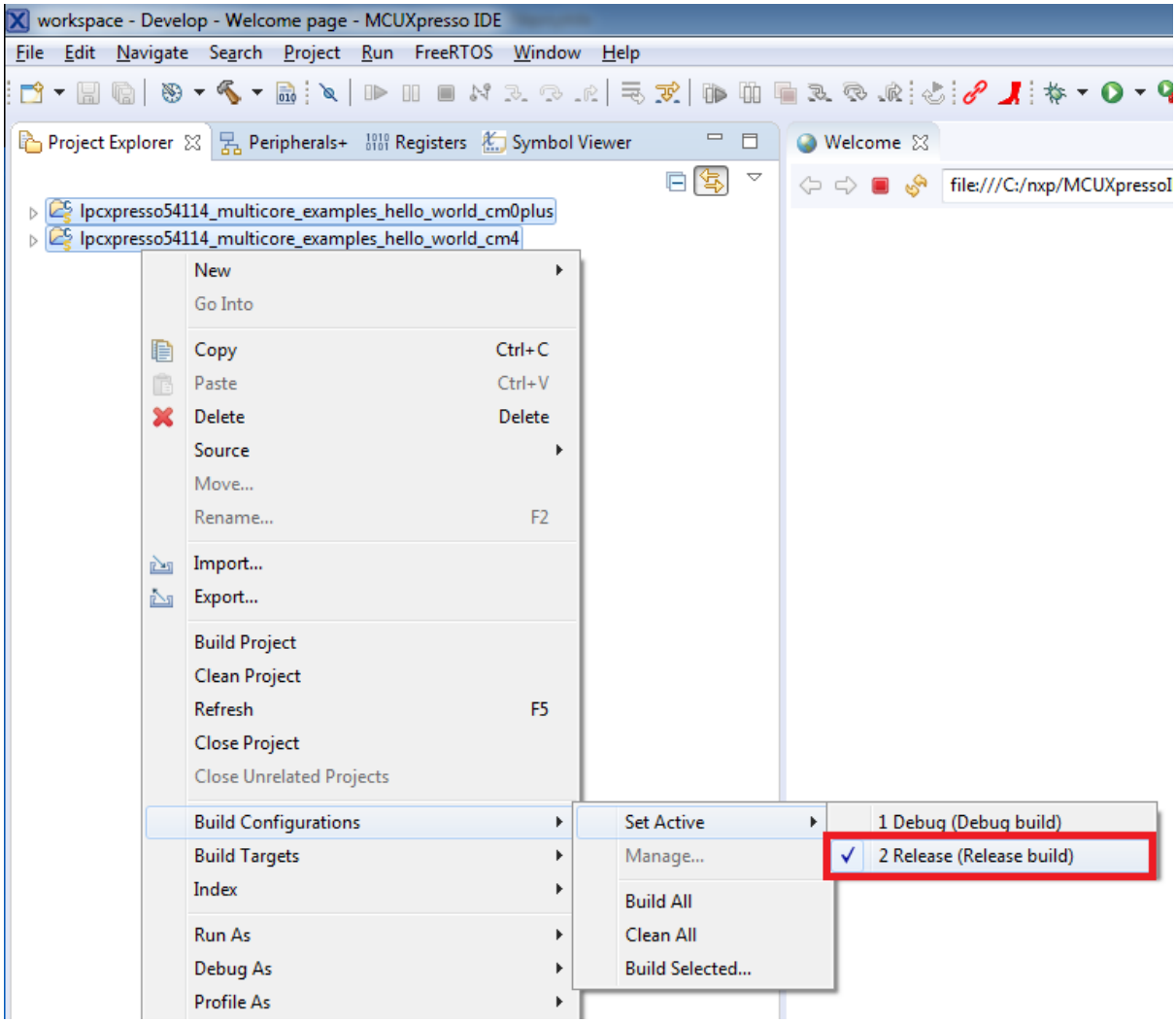


3. Now, two projects should be imported into the workspace. To start building the multicore application, highlight the lpcxpresso54114_multicore_examples_hello_world_cm4 project (multicore master project) in the Project Explorer. Then choose the appropriate build target, **Debug** or **Release**, by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

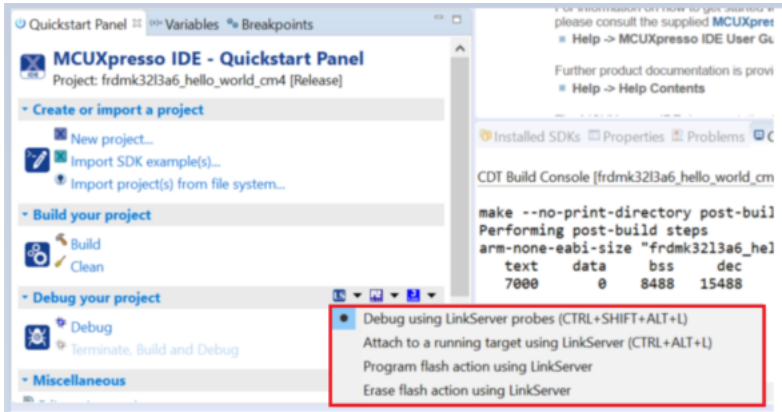


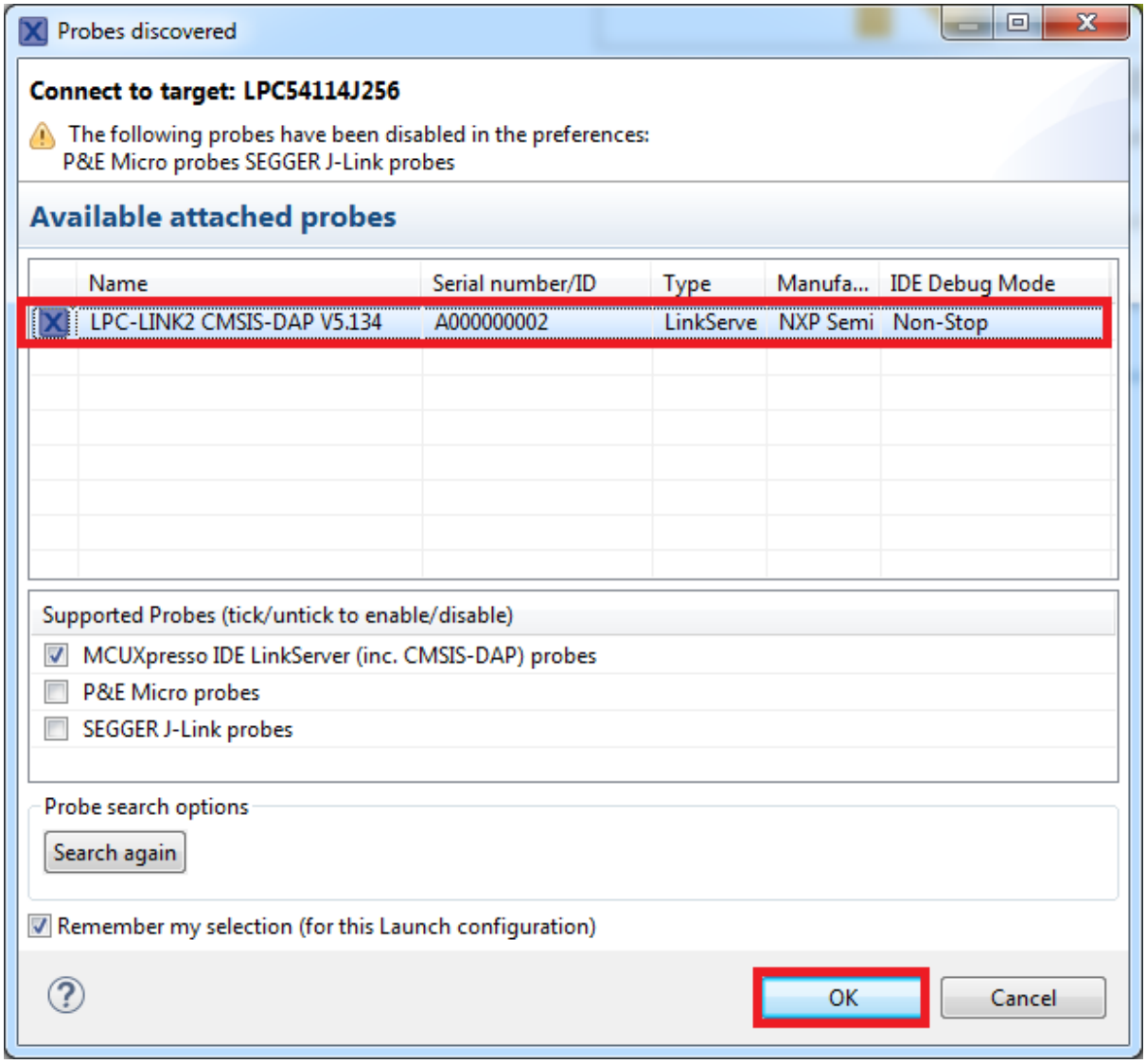
The project starts building after the build target is selected. Because of the project reference settings in multicore projects, triggering the build of the primary core application (cm4) also causes the referenced auxiliary core application (cm0plus) to build.

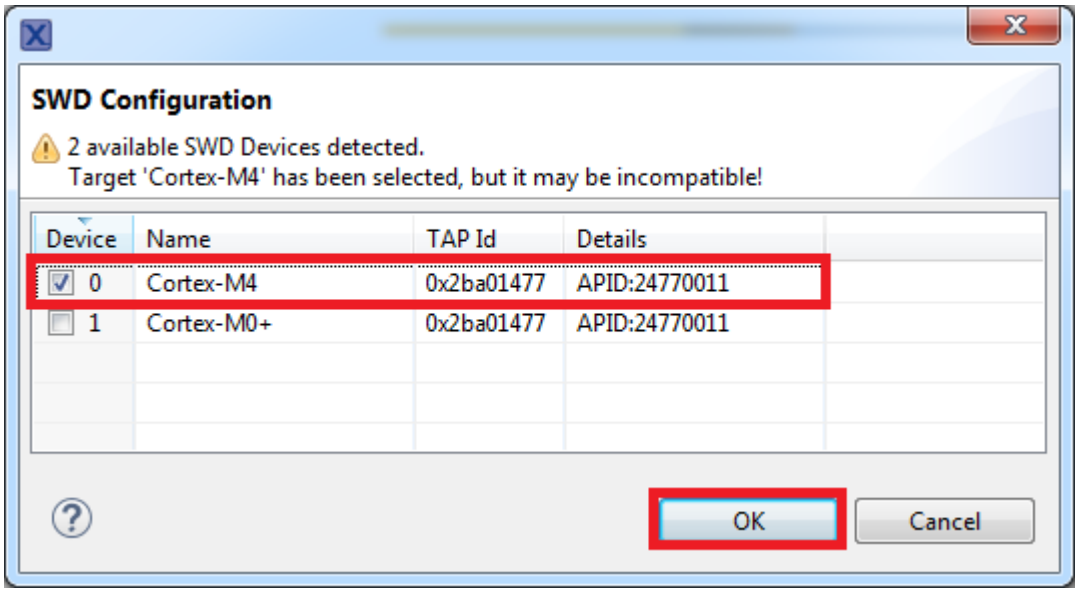
Note: When the **Release** build is requested, it is necessary to change the build configuration of both the primary and auxiliary core application projects first. To do this, select both projects in the Project Explorer view and then right click which displays the context-sensitive menu. Select **Build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

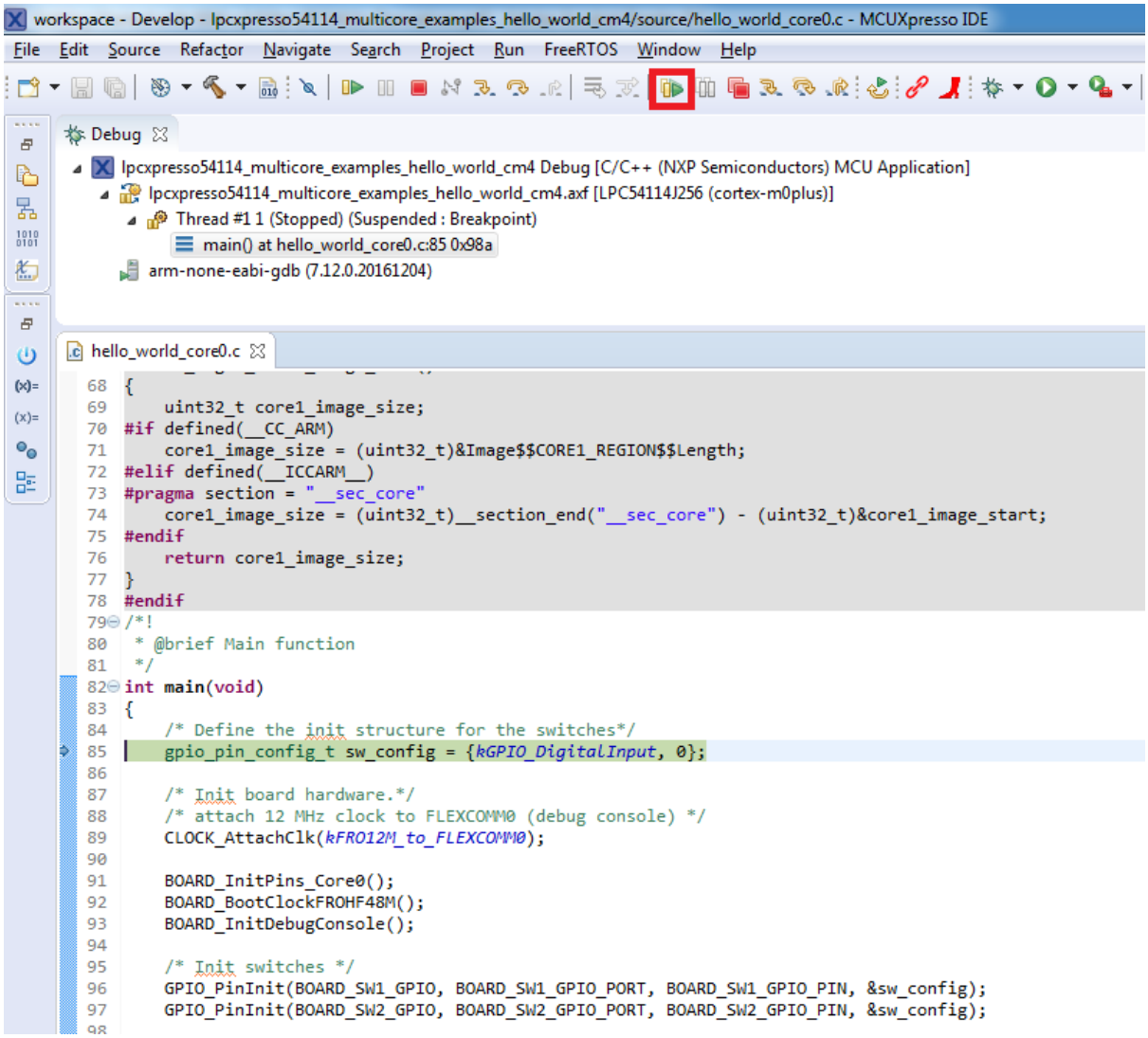


Run a multicore example application The primary core debugger handles flashing of both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform all steps as described in **Run an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

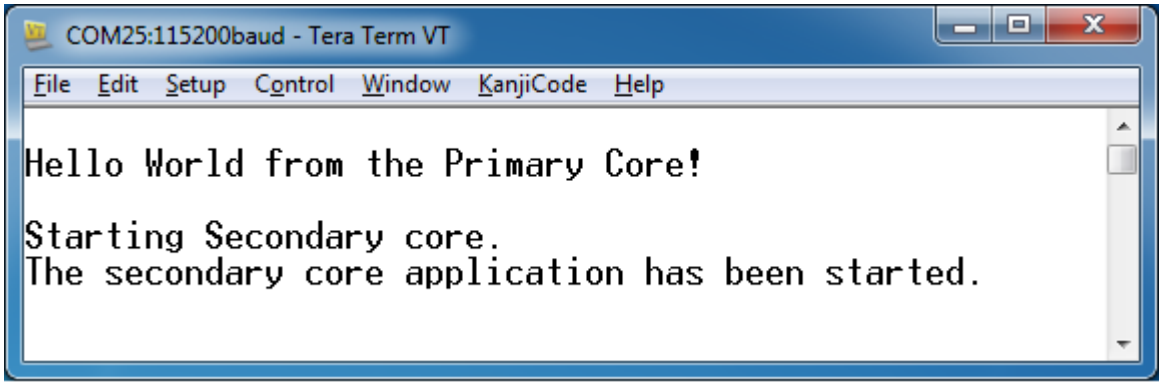



Probes discovered
Connect to target: LPC54114J256
The following probes have been disabled in the preferences:
P&E Micro probes SEGGER J-Link probes
Available attached probes
Name
Serial number/ID
Type
Manufa...
IDE Debug Mode
LPC-LINK2 CMSIS-DAP V5.134
A000000002
LinkServe
NXP Semi
Non-Stop
Supported Probes (tick/untick to enable/disable)
MCUXpresso IDE LinkServer (inc. CMSIS-DAP) probes
P&E Micro probes
SEGGER J-Link probes
Probe search options
Search again
Remember my selection (for this Launch configuration)
OK
Cancel


SWD Configuration
2 available SWD Devices detected.
Target 'Cortex-M4' has been selected, but it may be incompatible!
Device
Name
TAP Id
Details
0
Cortex-M4
0x2ba01477
APID:24770011
1
Cortex-M0+
0x2ba01477
APID:24770011
OK
Cancel

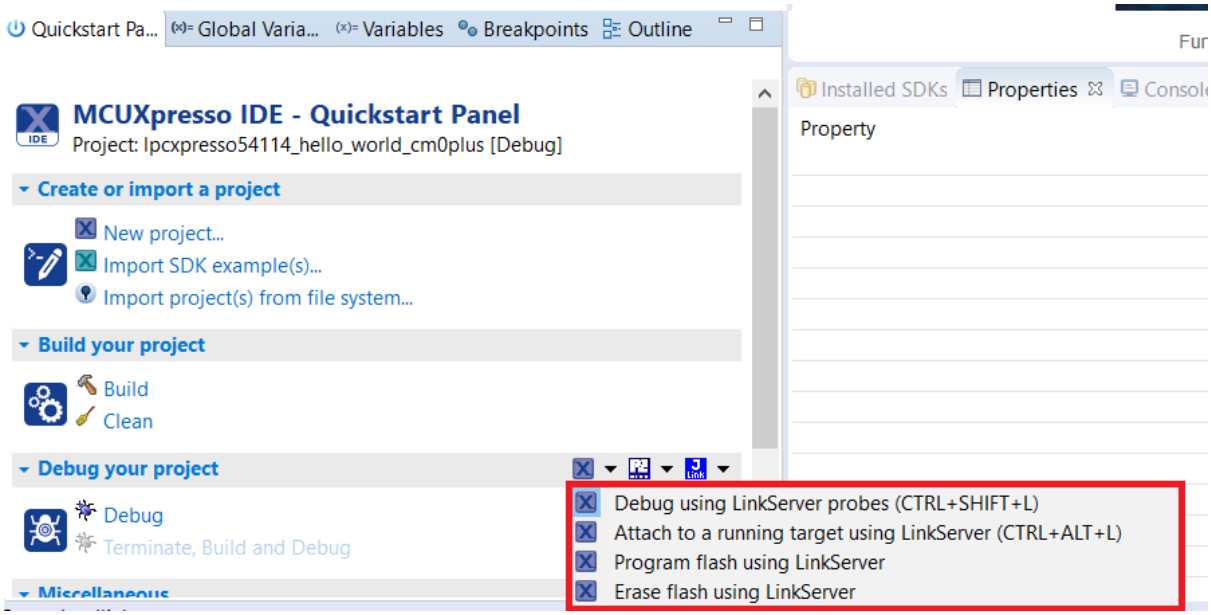


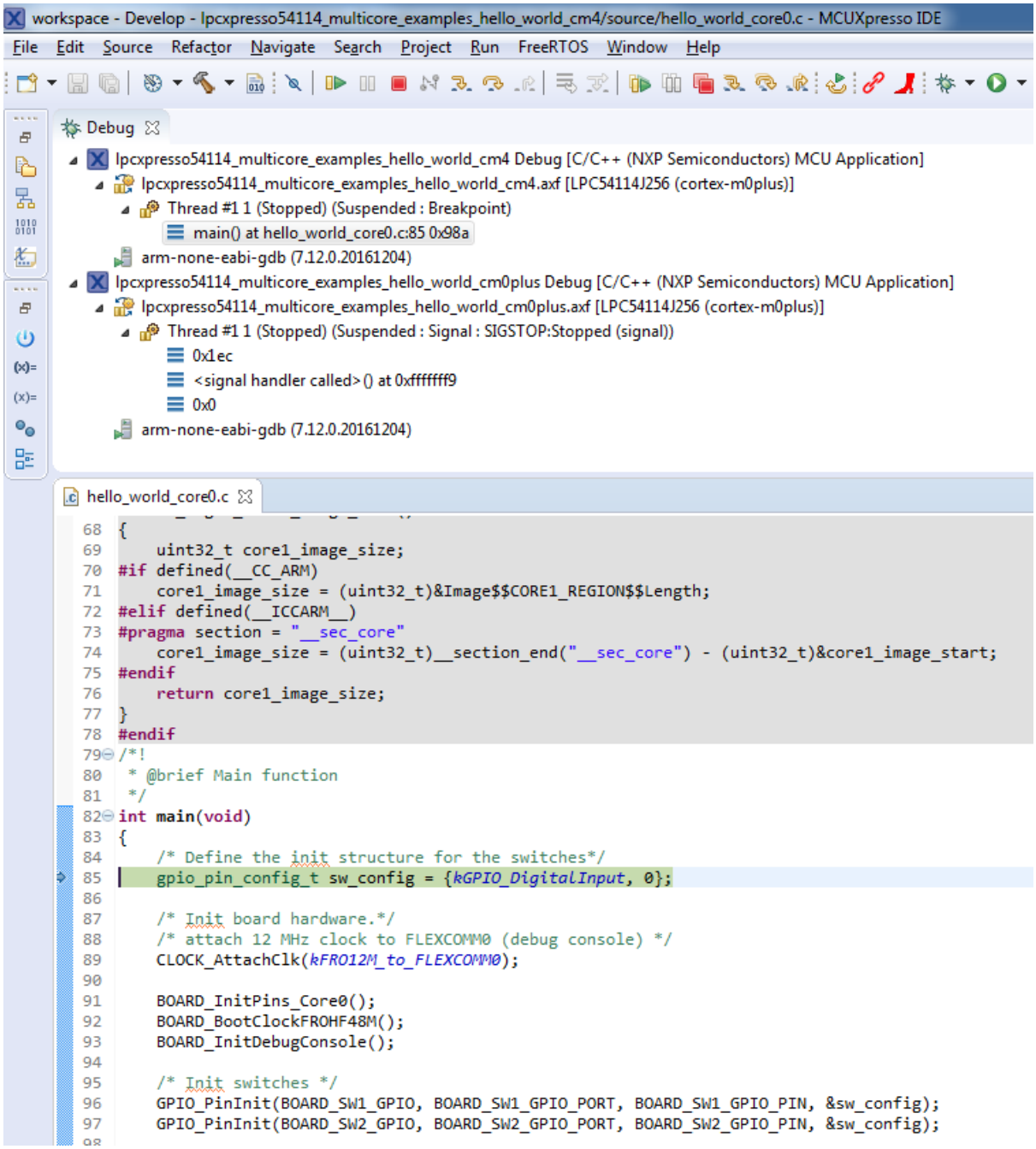
After clicking the “Resume All Debug sessions” button, the hello_world multicore application runs and a banner is displayed on the terminal. If this is not the case, check your terminal settings and connections.



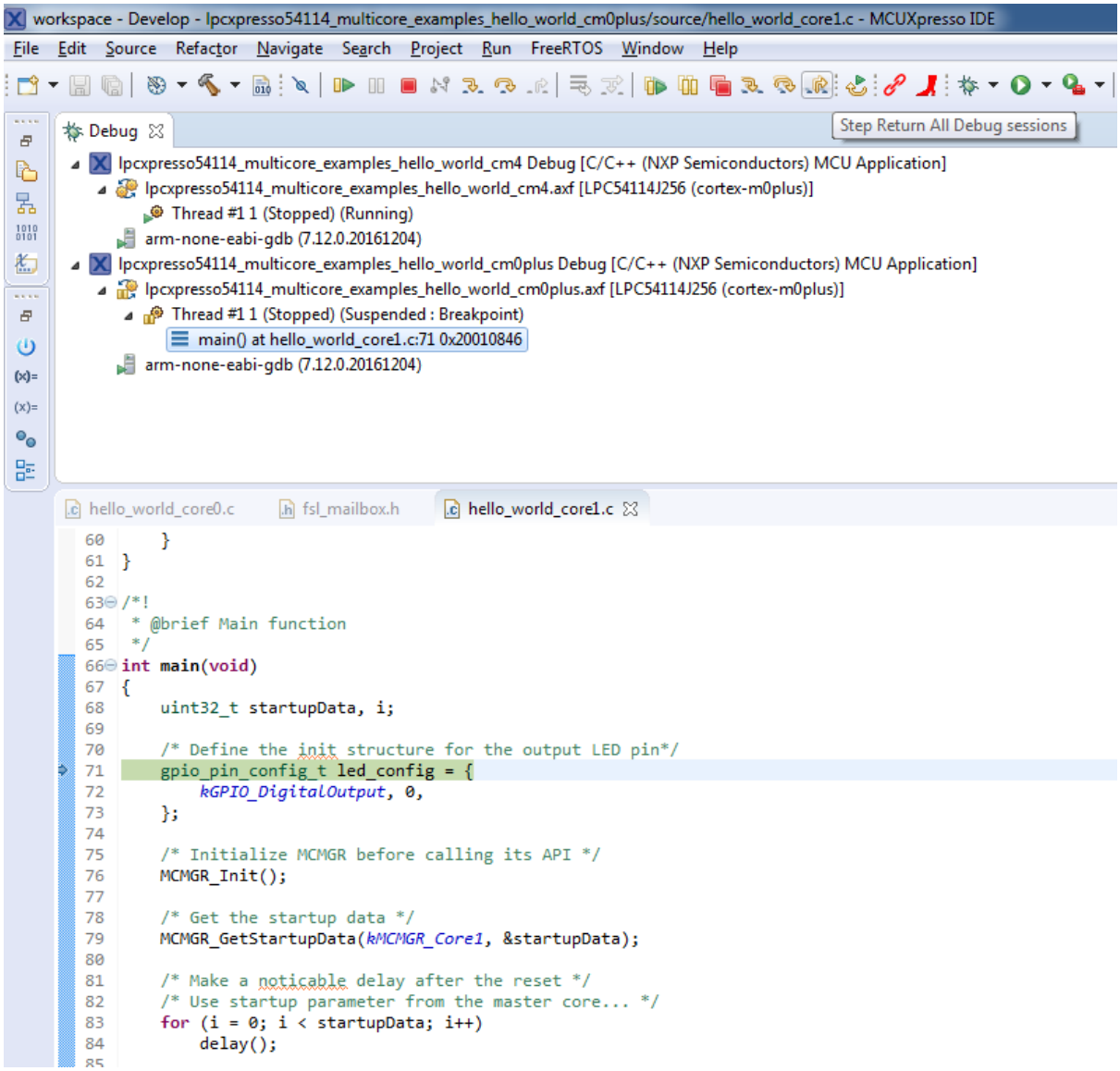
An LED controlled by the auxiliary core starts flashing, indicating that the auxiliary core has been released from the reset and running correctly. It is also possible to debug both sides of the multicore application in parallel. After creating the debug session for the primary core, perform same steps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

session.

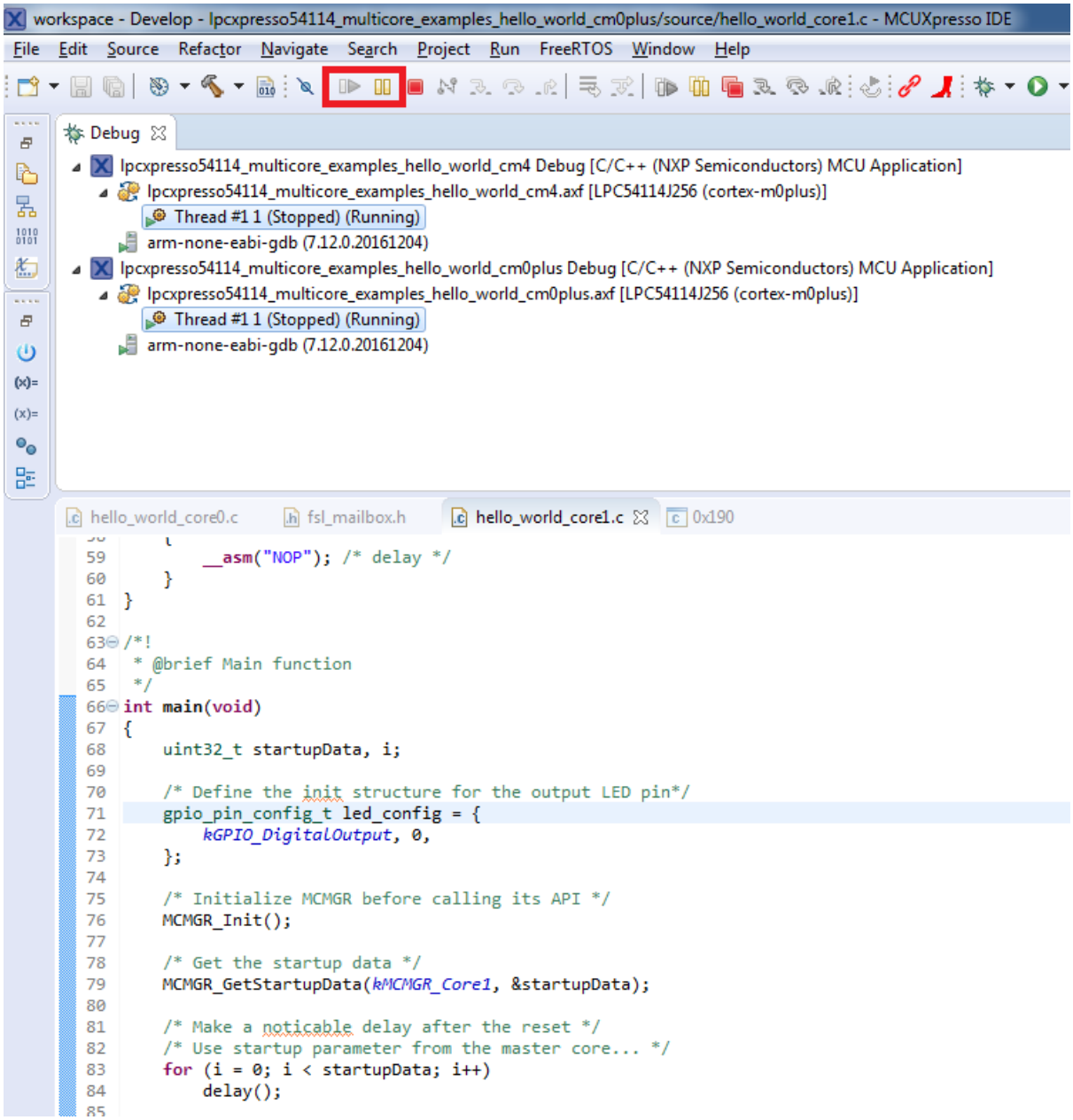

Quickstart Pa...
Global Varia...
Variables
Breakpoints
Outline
MCUXpresso IDE - Quickstart Panel
Project: lpcxpresso54114_hello_world_cm0plus [Debug]
Create or import a project
New project...
Import SDK example(s)...
Import project(s) from file system...
Build your project
Build
Clean
Debug your project
Debug
Terminate, Build and Debug
Miscellaneous
Installed SDKs
Properties
Property
Debug using LinkServer probes (CTRL+SHIFT+L)
Attach to a running target using LinkServer (CTRL+ALT+L)
Program flash using LinkServer
Erase flash using LinkServer

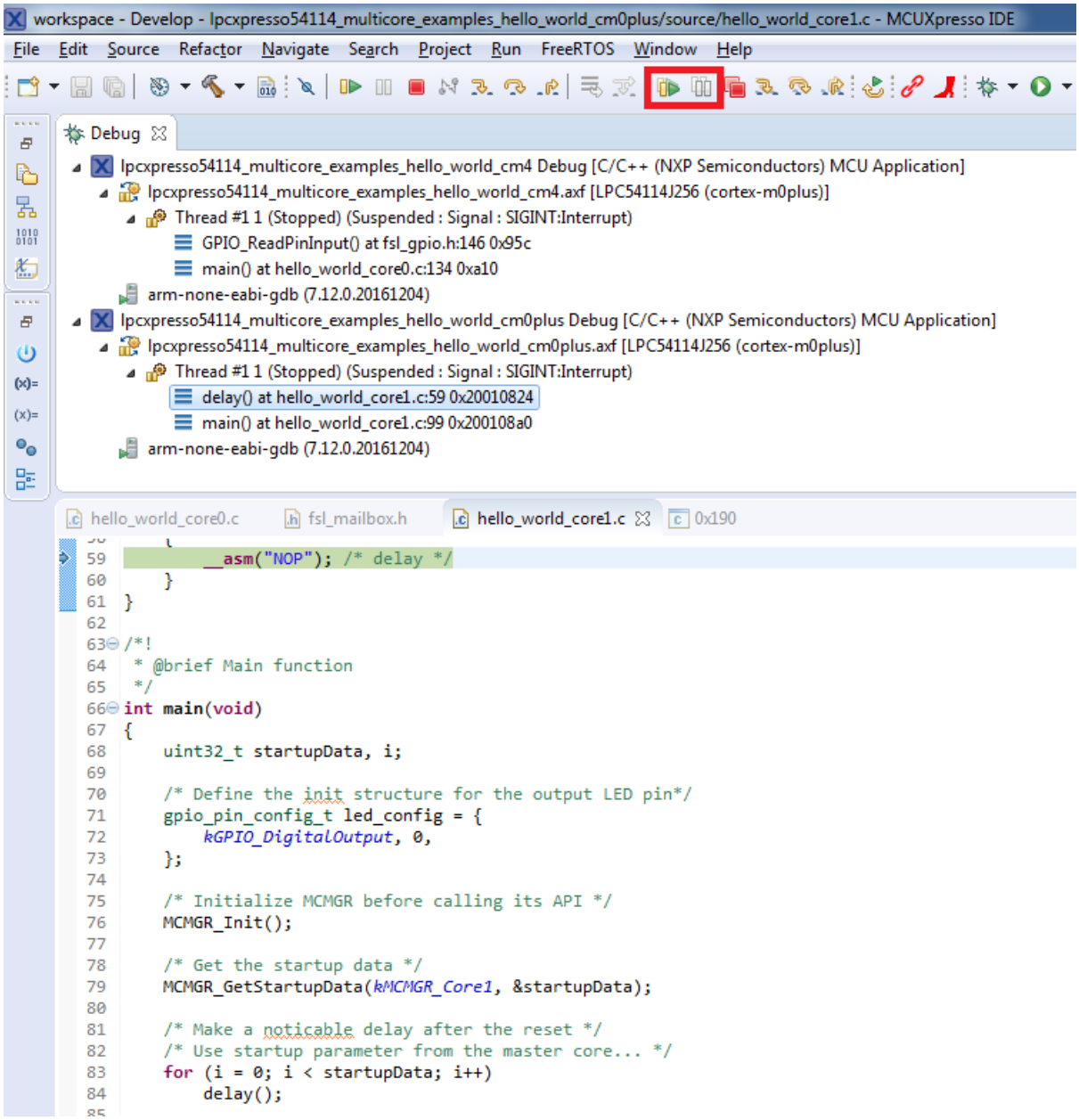


Now, the two debug sessions should be opened, and the debug controls can be used for both debug sessions depending on the debug session selection. Keep the primary core debug session selected by clicking the “Resume” button. The hello_world multicore application then starts running. The primary core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



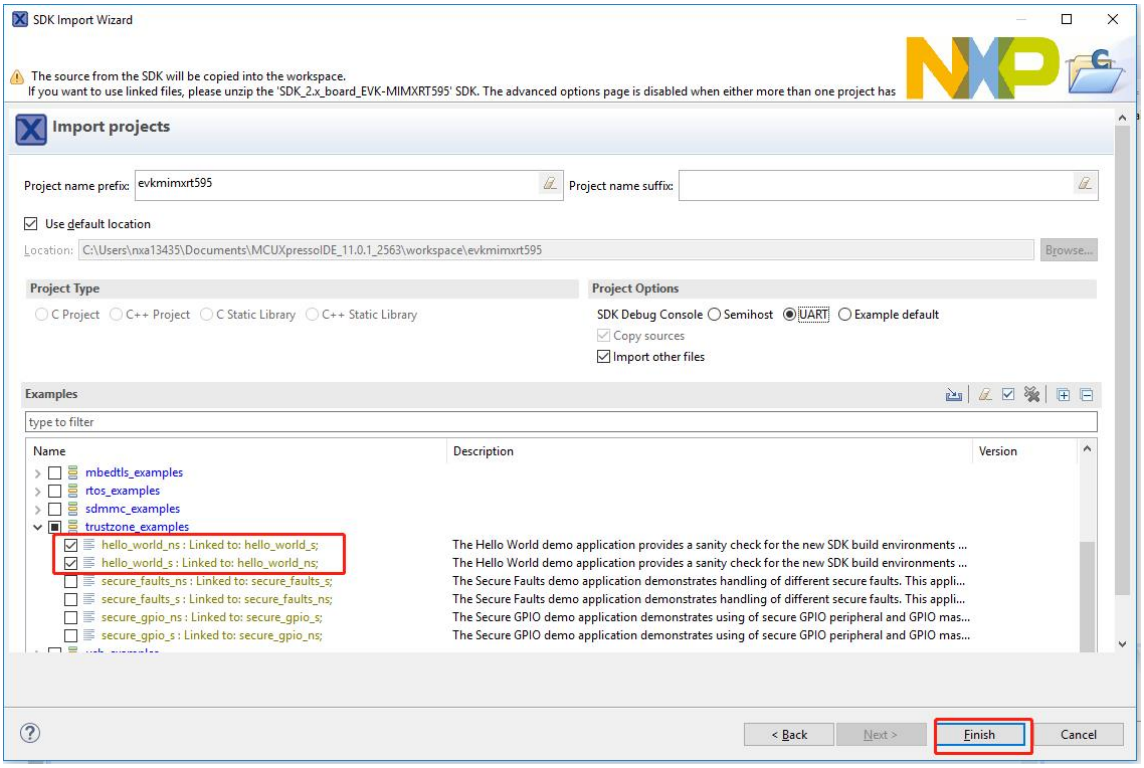
At this point, it is possible to suspend and resume individual cores independently. It is also possible to make synchronous suspension and resumption of both the cores. This is done either by selecting both opened debug sessions (multiple selections) and clicking the “Suspend” / “Resume” control button,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


workspace - Develop - lpcxpresso54114_multicore_examples_hello_world_cm0plus/source/hello_world_core1.c - MCUXpresso IDE
File Edit Source Refactor Navigate Search Project Run FreeRTOS Window Help
Debug
lpcxpresso54114_multicore_examples_hello_world_cm4 Debug [C/C++ (NXP Semiconductors) MCU Application]
lpcxpresso54114_multicore_examples_hello_world_cm4.axf [LPC54114J256 (cortex-m0plus)]
Thread #1 1 (Stopped) (Running)
arm-none-eabi-gdb (7.12.0.20161204)
lpcxpresso54114_multicore_examples_hello_world_cm0plus Debug [C/C++ (NXP Semiconductors) MCU Application]
lpcxpresso54114_multicore_examples_hello_world_cm0plus.axf [LPC54114J256 (cortex-m0plus)]
Thread #1 1 (Stopped) (Running)
arm-none-eabi-gdb (7.12.0.20161204)
hello_world_core0.c
fsl_mailbox.h
hello_world_core1.c
0x190
59 __asm("NOP"); /* delay */
60 }
61 }
62
63 /*!
64 * @brief Main function
65 */
66 int main(void)
67 {
68 uint32_t startupData, i;
69
70 /* Define the init structure for the output LED pin*/
71 gpio_pin_config_t led_config = {
72 kGPIO_DigitalOutput, 0,
73 };
74
75 /* Initialize MCMGR before calling its API */
76 MCMGR_Init();
77
78 /* Get the startup data */
79 MCMGR_GetStartupData(kMCMGR_Core1, &startupData);
80
81 /* Make a noticable delay after the reset */
82 /* Use startup parameter from the master core... */
83 for (i = 0; i < startupData; i++)
84 delay();
85

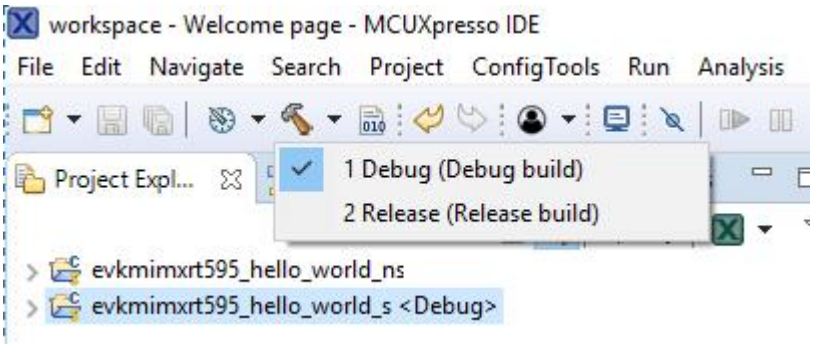


Build a TrustZone example application This section describes the steps required to configure MCUXpresso IDE to build, run, and debug TrustZone example applications. The TrustZone version of the hello_world example application targeted for the MIMXRT595-EVK hardware platform is used as an example, though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

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

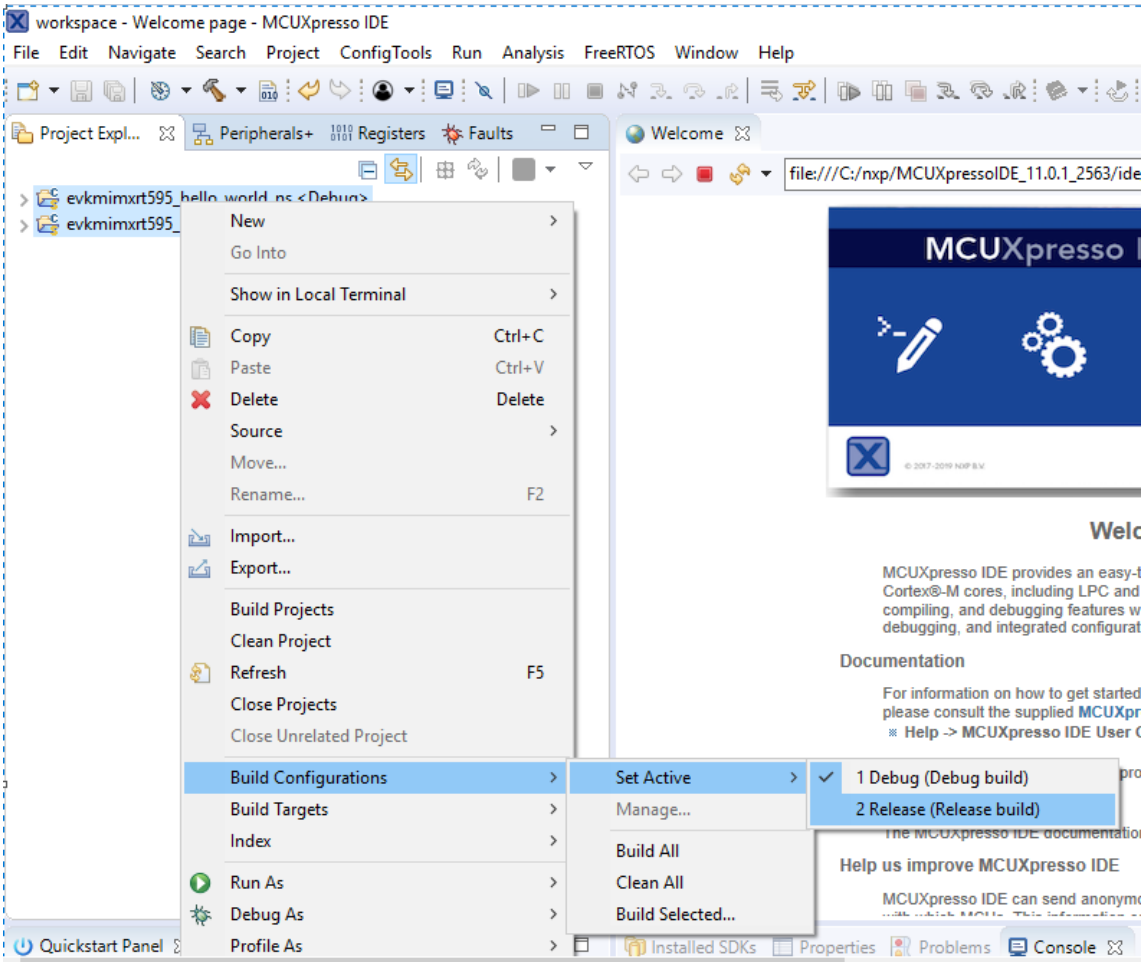


3. Now, two projects should be imported into the workspace. To start building the TrustZone application, highlight the evkmimxrt595_hello_world_s project (TrustZone master project) in the Project Explorer. Then, choose the appropriate build target, **Debug** or **Release**, by clicking the downward facing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



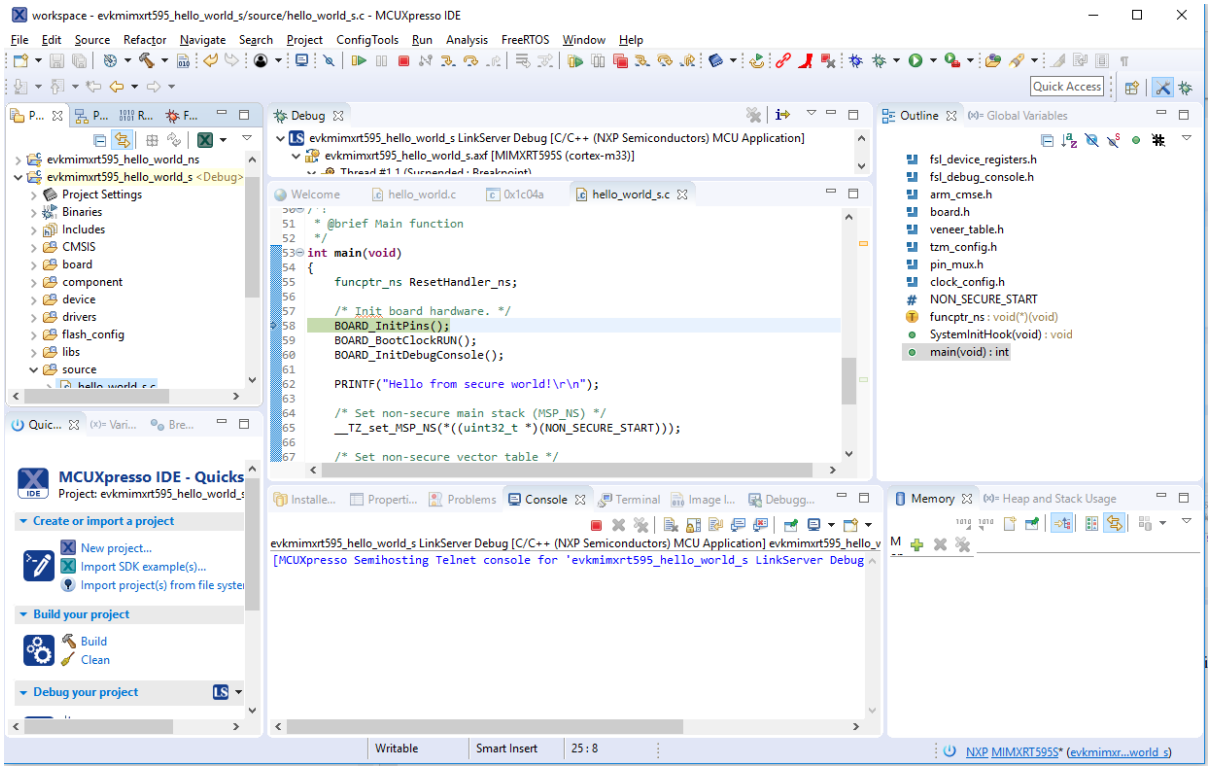
The project starts building after the build target is selected. It is requested to build the application for the secure project first, because the non-secure project must know the secure project since CMSE library when running the linker. It is not possible to finish the non-secure project linker when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

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



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

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



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

Run a demo application using IAR

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

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

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

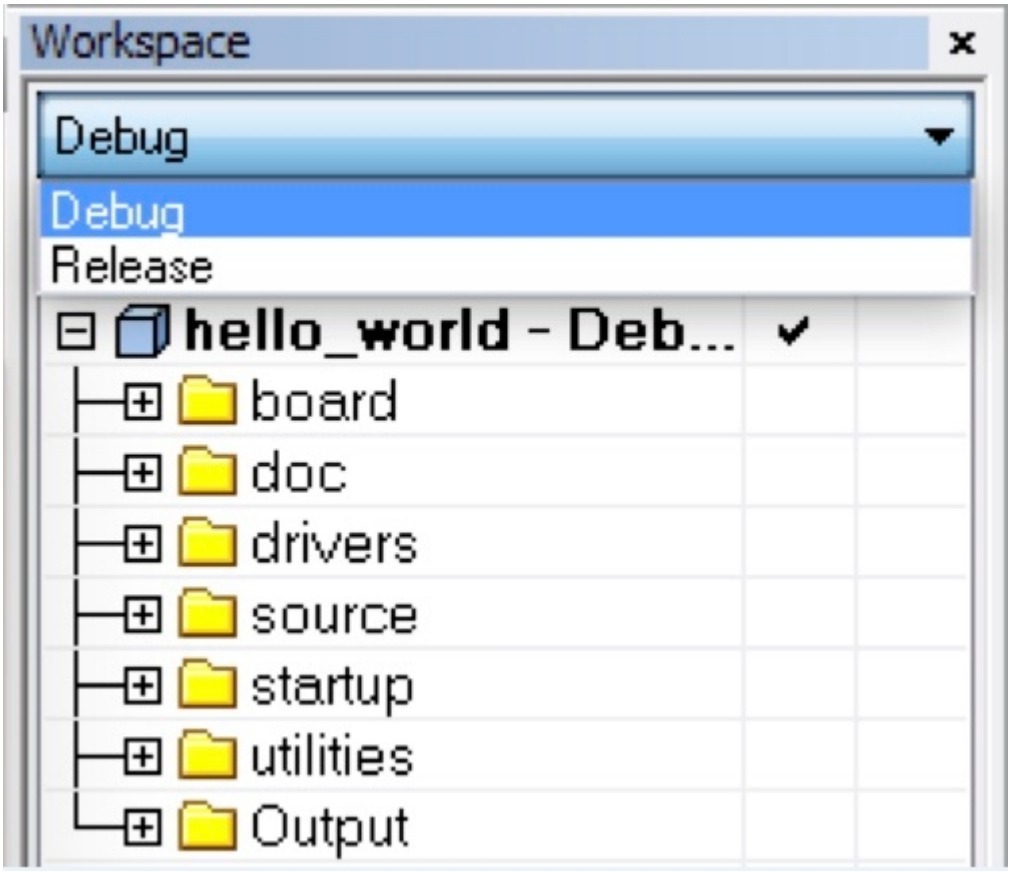
1. Open the desired demo application workspace. Most example application workspace files can be located using the following path:

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

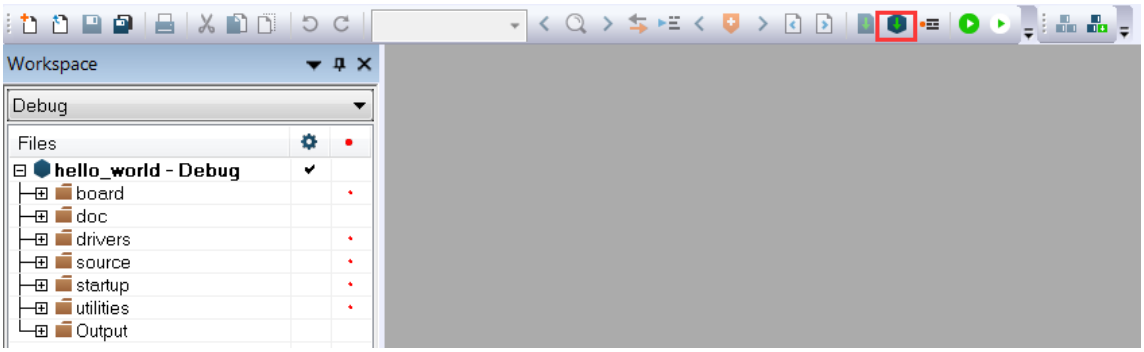
   Other example applications may have additional folders in their path.

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

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



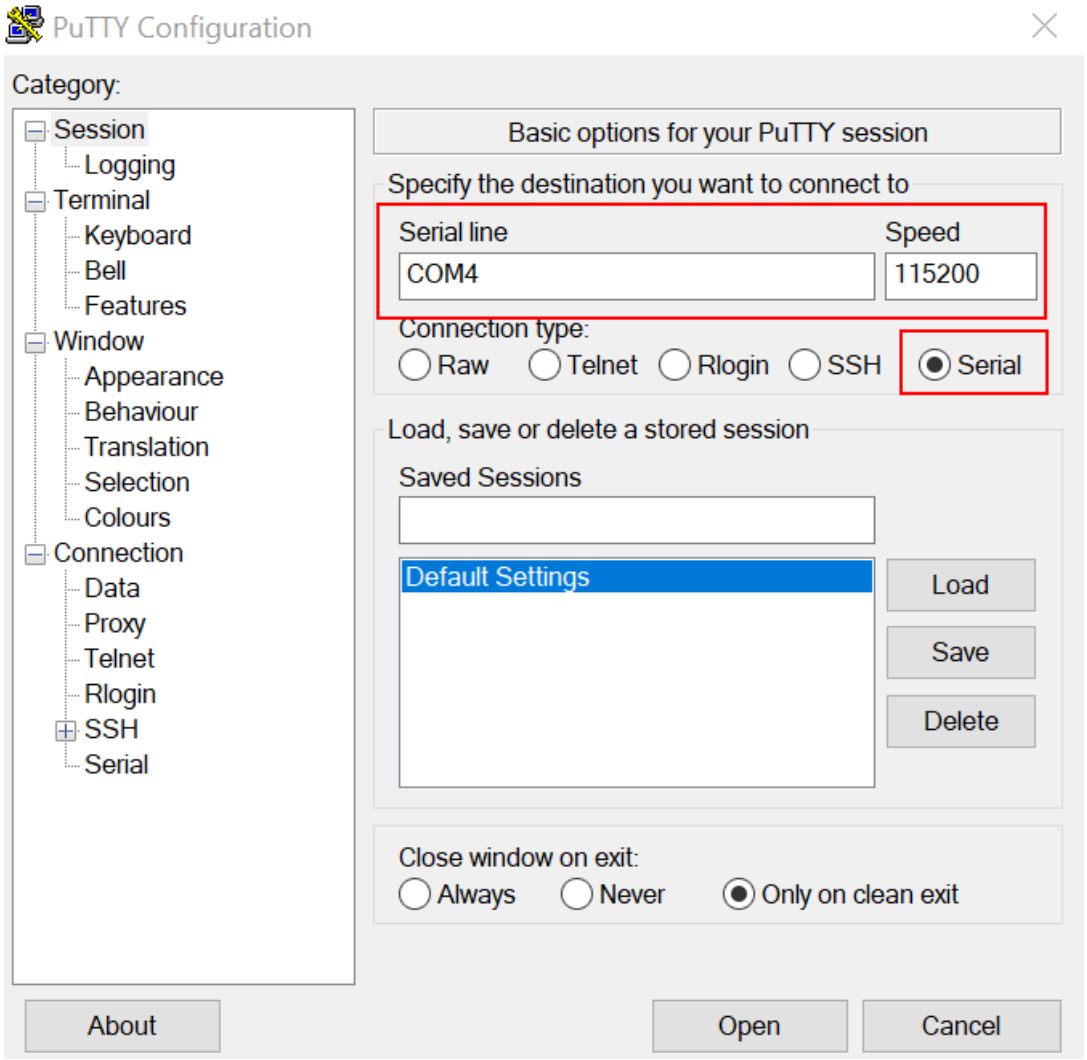
3. To build the demo application, click **Make**, highlighted in red in following figure.



4. The build completes without errors.

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

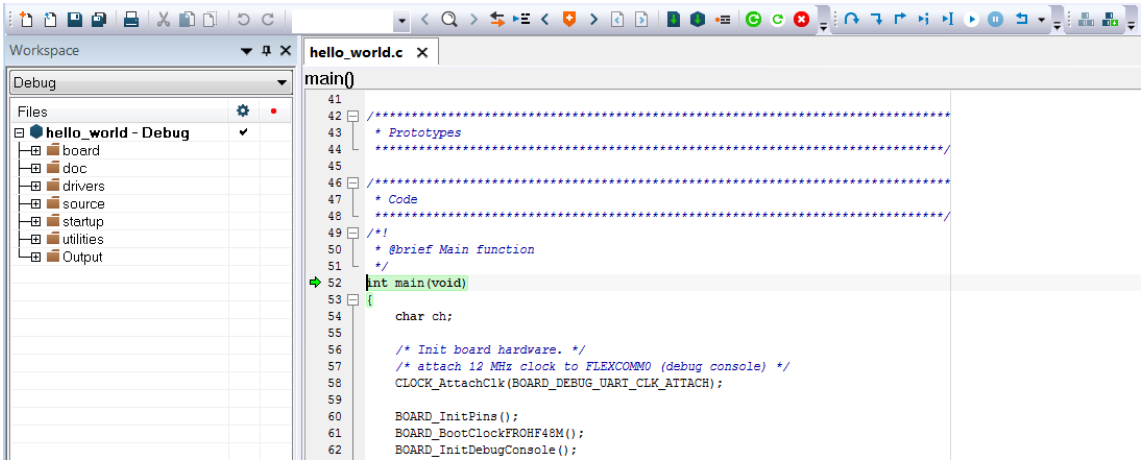
1. Ensure the host driver for the debugger firmware has been installed. See *On-board debugger*.
2. Connect the development platform to your PC via USB cable.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm, and connect to the debug COM port (to determine the COM port number, see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



4. 1 stop bit

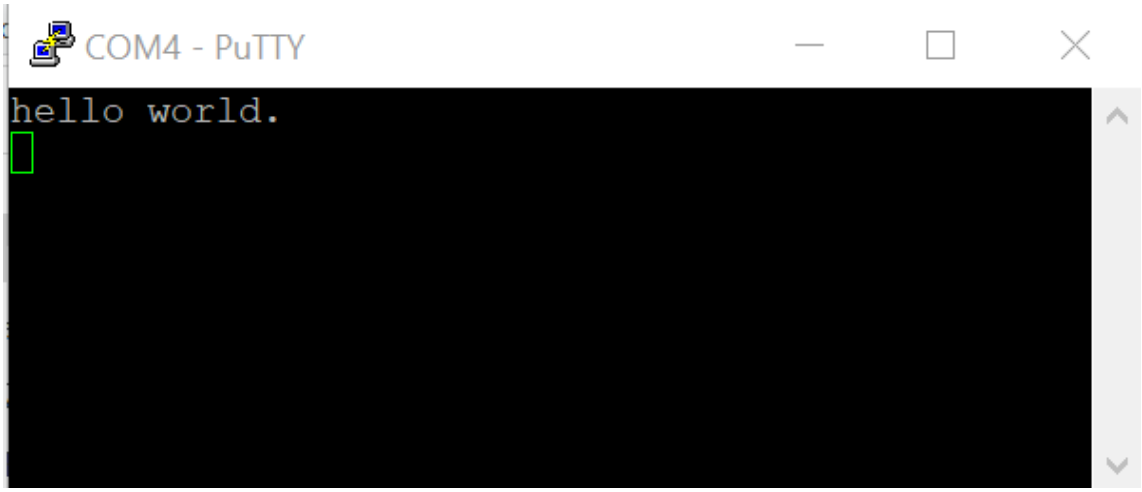
4. In IAR, click the **Download and Debug** button to download the application to the target.

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



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

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



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

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

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

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

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

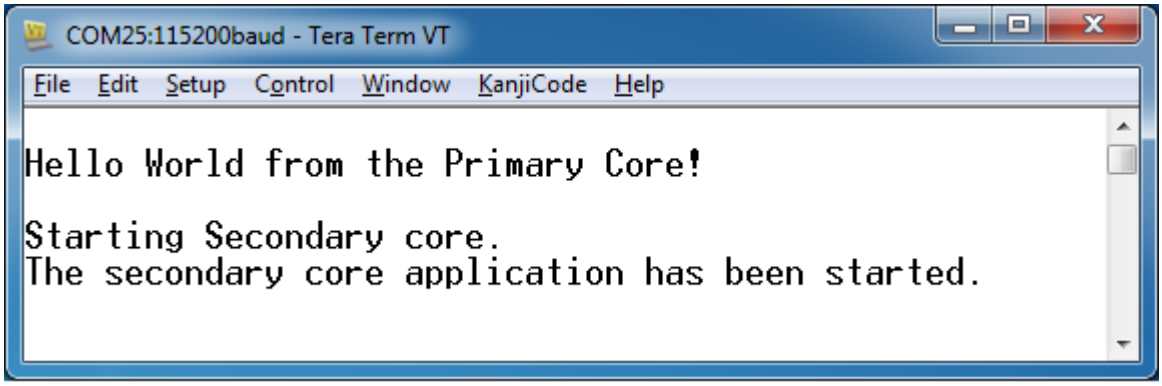
Build both applications separately by clicking the **Make** button. Build the application for the auxiliary core (cm0plus) first, because the primary core application project (cm4) must know the auxiliary core application binary when running the linker. It is not possible to finish the primary core linker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

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

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

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

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



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

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

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

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

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

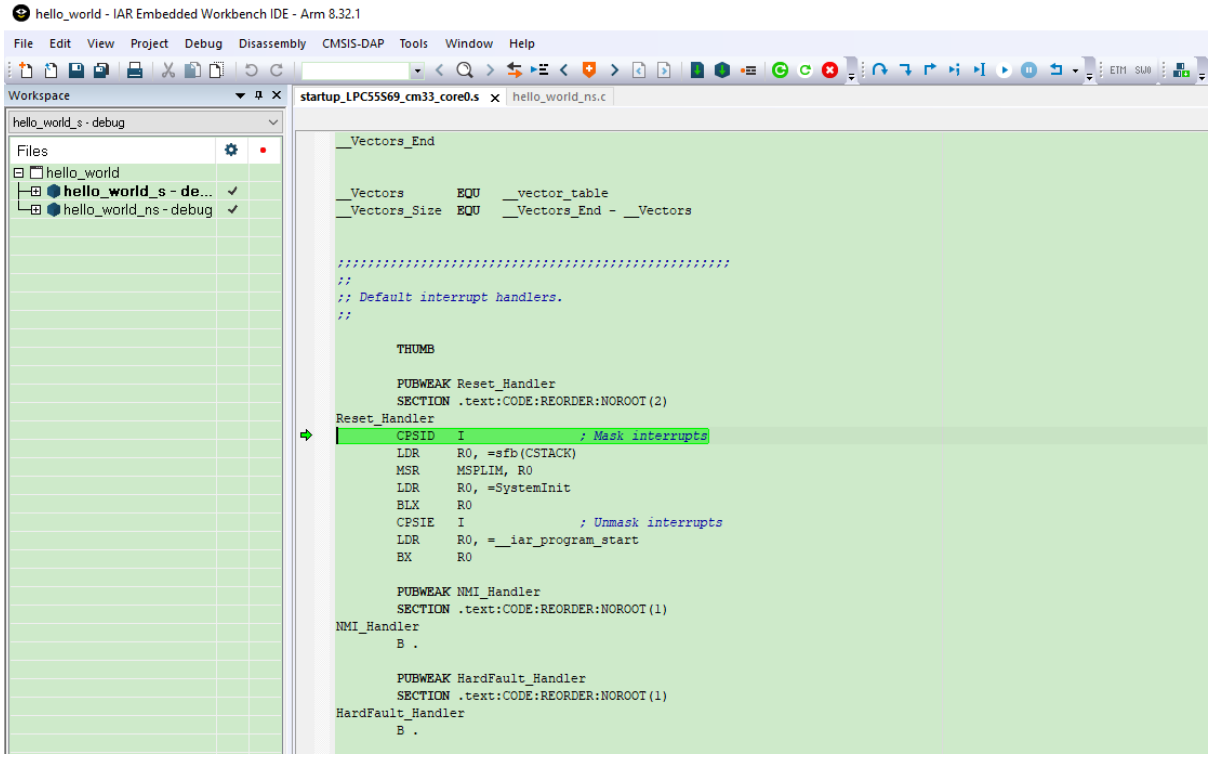
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_ns/iar/hello_world_
↪ns.eww
```

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

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

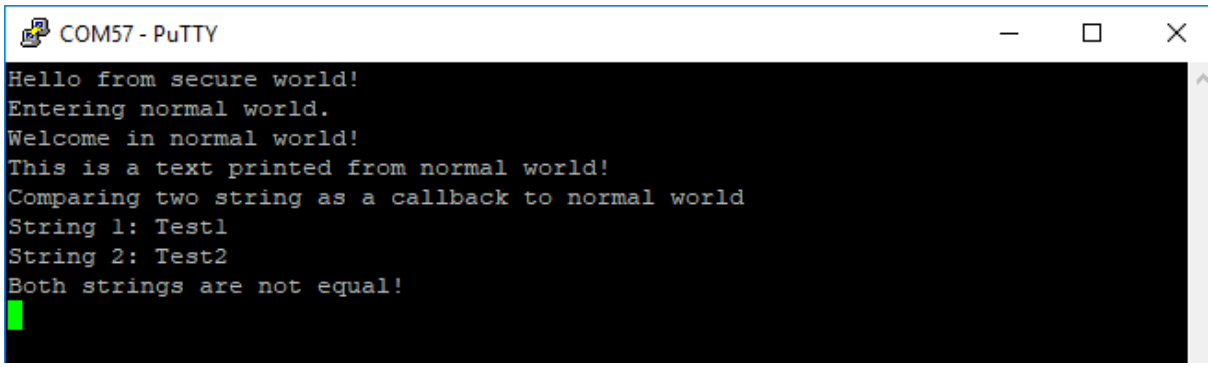
This project hello_world.eww contains both secure and non-secure projects in one workspace and it allows the user to easily transition from one project to another. Build both applications separately by clicking **Make**. It is requested to build the application for the secure project first, because the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

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

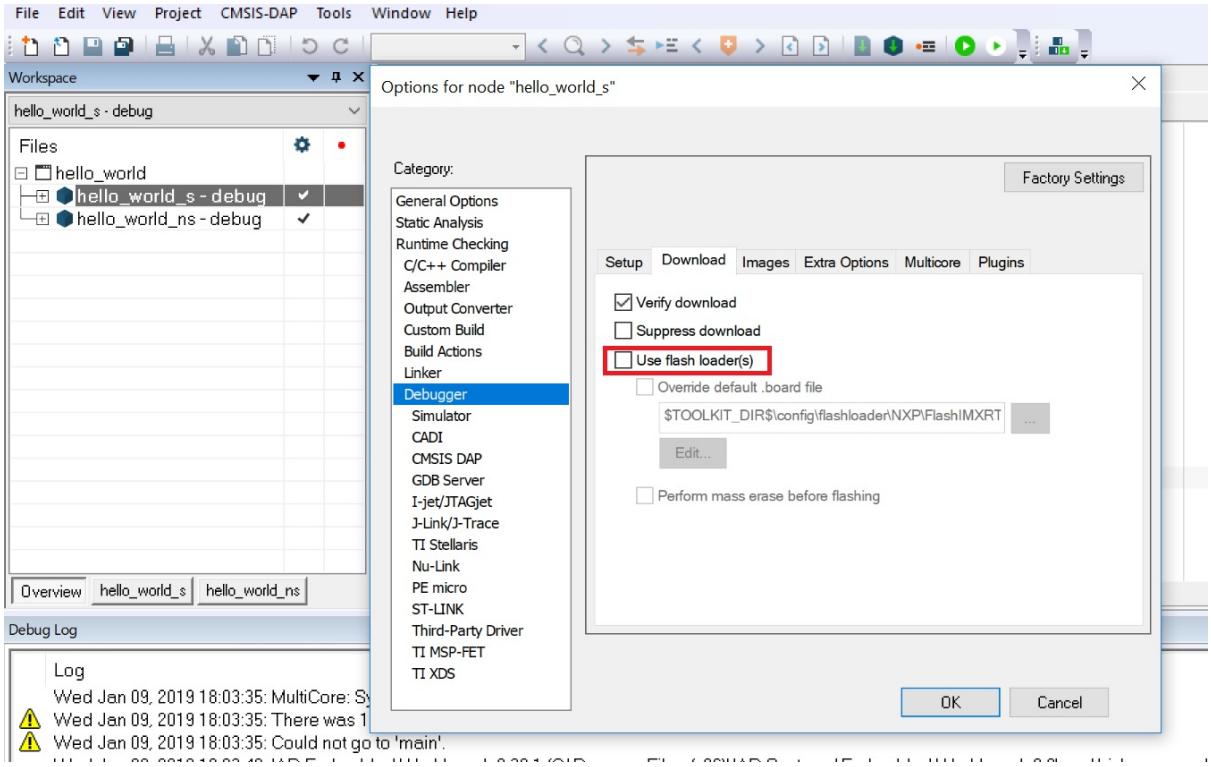


Run the code by clicking **Go** to start the application.

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



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

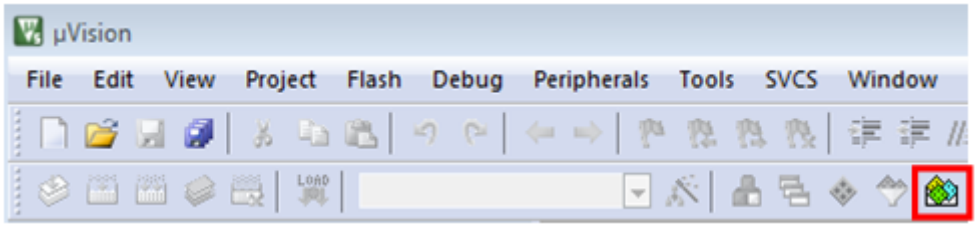


Run a demo using Keil MDK/µVision

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

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

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



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

Build an example application

1. Open the desired example application workspace in:

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

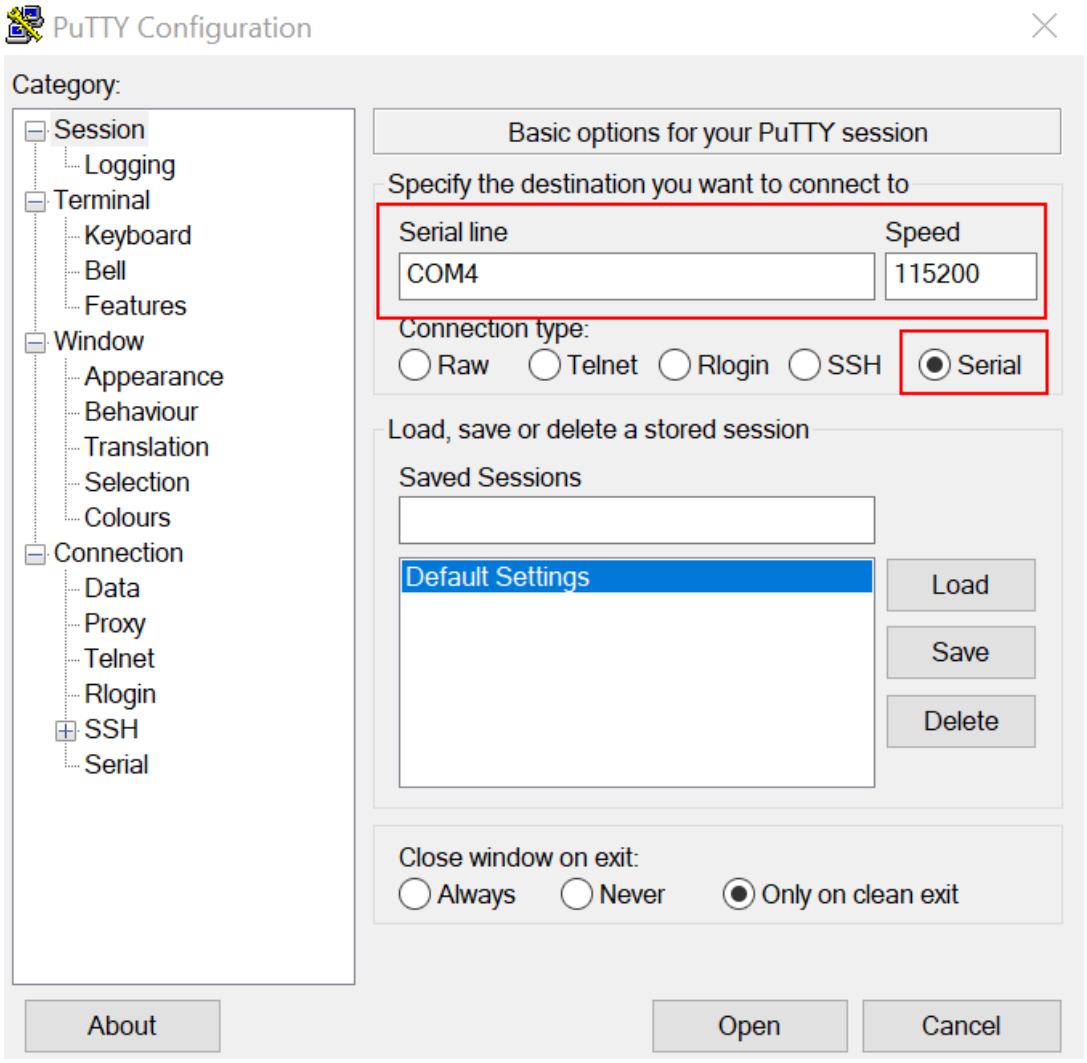
   The workspace file is named as <demo_name>.uvmpw. For this specific example, the actual path is:

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

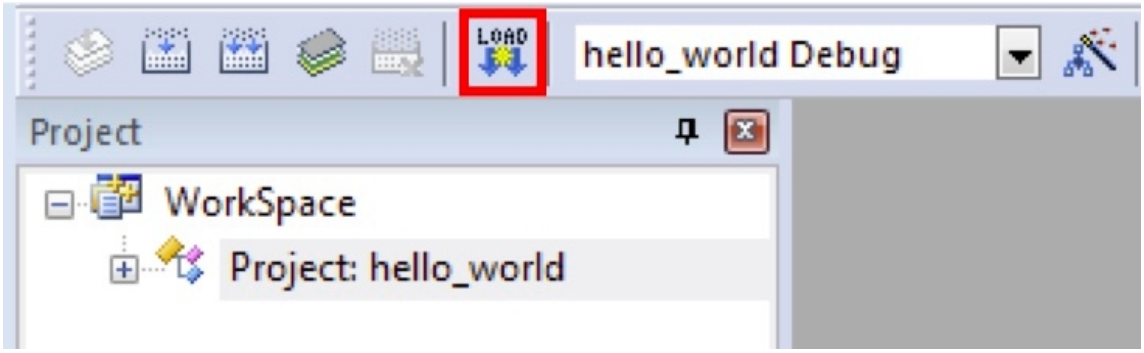
3. The build completes without errors.

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

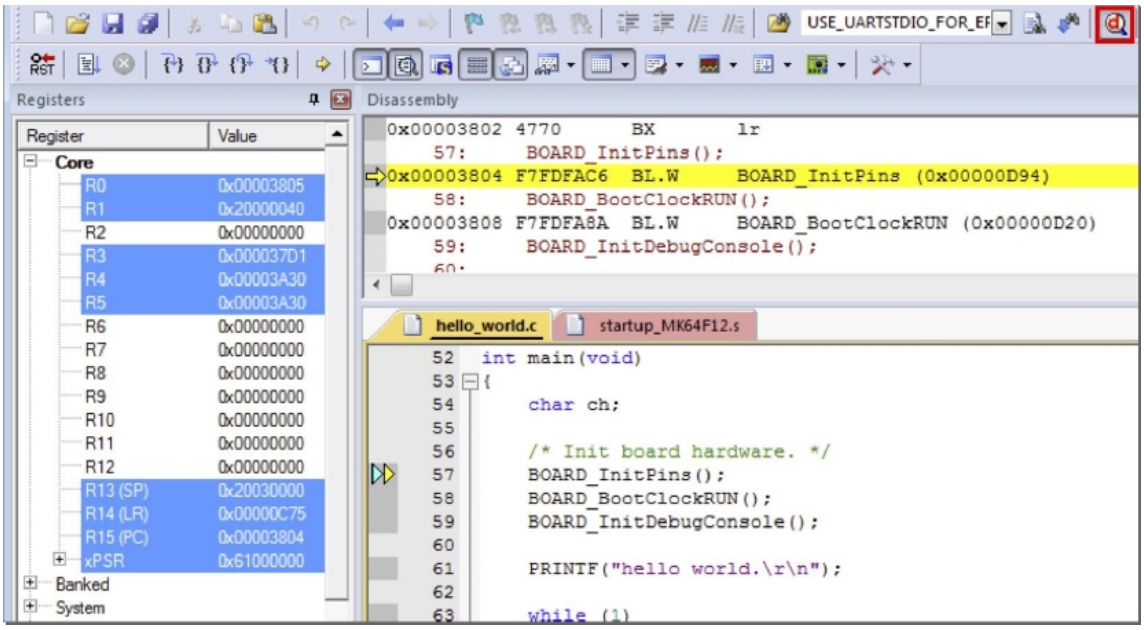
1. Ensure the host driver for the debugger firmware has been installed. See *On-board debugger*.
2. Connect the development platform to your PC via USB cable using USB connector.
3. Open the terminal application on the PC, such as PuTTY or TeraTerm and connect to the debug serial port number (to determine the COM port number, see *How to determine COM port*. Configure the terminal with these settings:
    1. 115200 or 9600 baud rate, depending on your board (reference BOARD_DEBUG_UART_BAUDRATE variable in the board.h file)
    2. No parity
    3. 8 data bits
    4. 1 stop bit



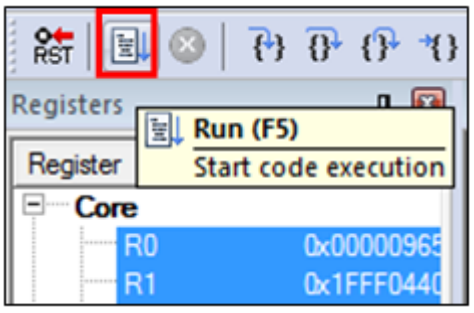
4. In µVision, after the application is built, click the **Download** button to download the application to the target.



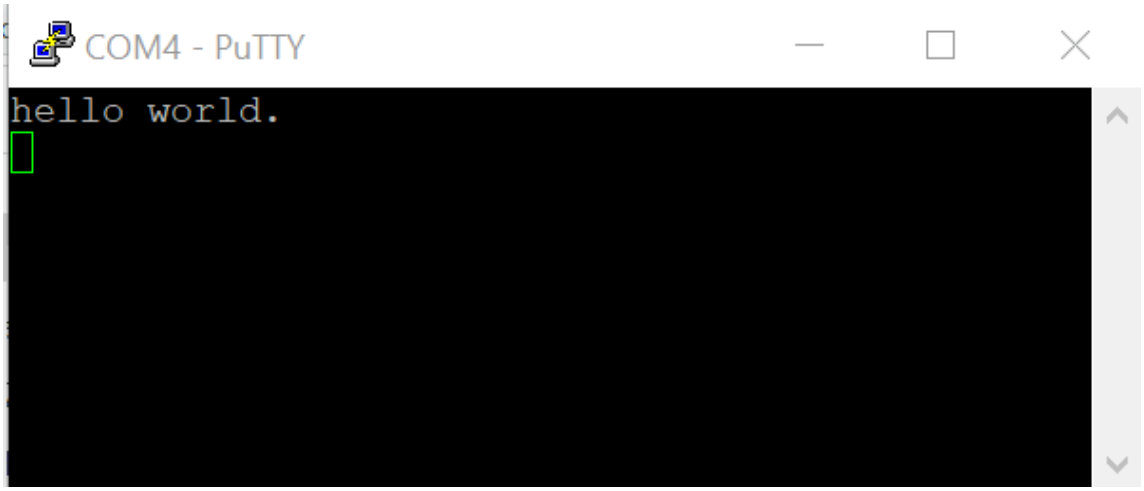
5. After clicking the **Download** button, the application downloads to the target and is running. To debug the application, click the **Start/Stop Debug Session** button, highlighted in red.



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



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



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

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

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

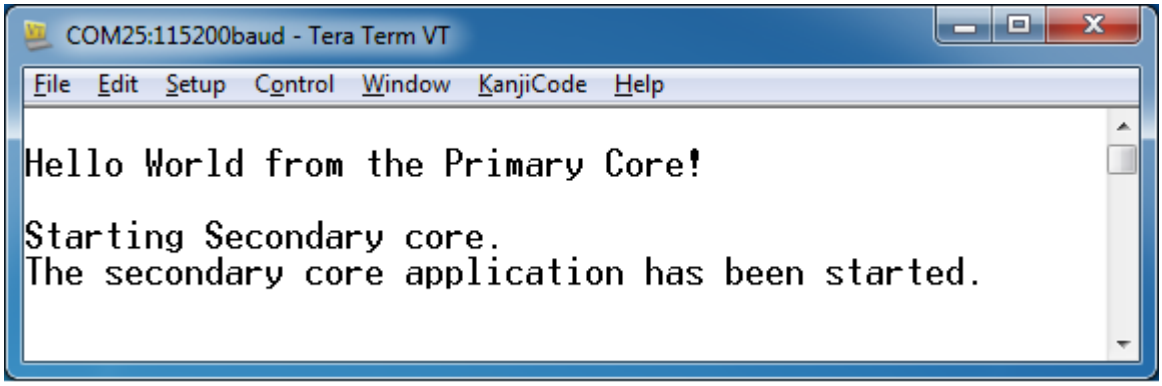
```
<install_dir>/boards/lpcxpresso54114/multicore_examples/hello_world/cm0plus/mdk/hello_world_
↪cm0plus.uvmpw
```

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

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

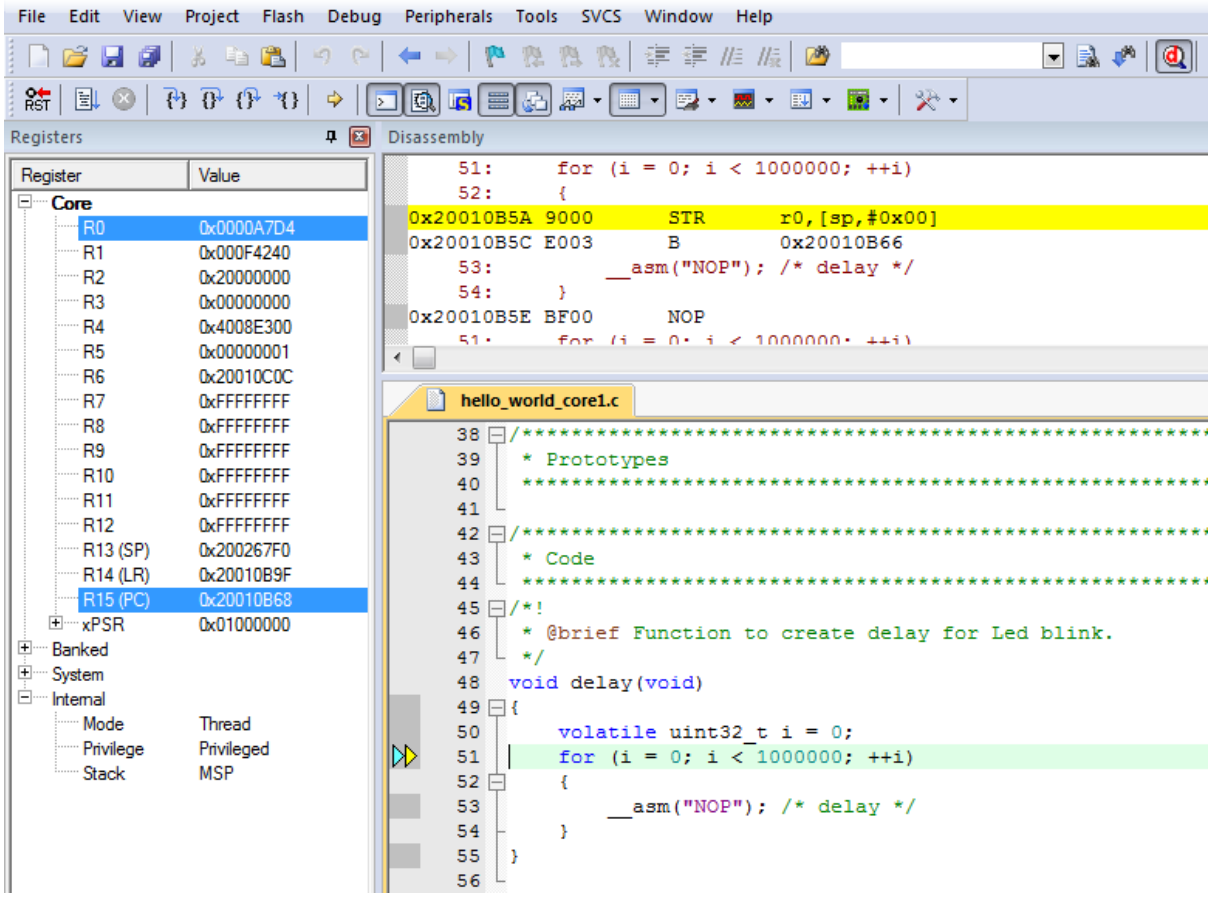
Run a multicore example application The primary core debugger flashes both the primary and the auxiliary core applications into the SoC flash memory. To download and run the multicore application, switch to the primary core application project and perform steps 1 – 5 as described in **Run an example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

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



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

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



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

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

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

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

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

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

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

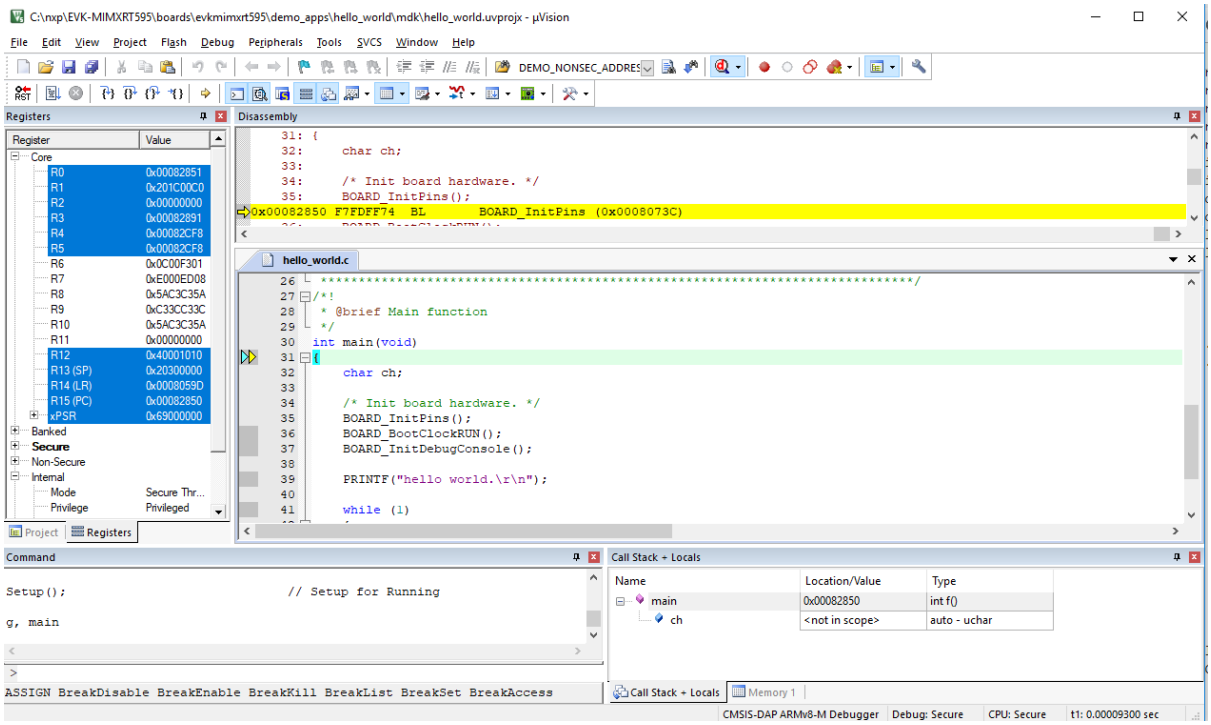
```
<install_dir>/boards/<board_name>/trustzone_examples/hello_world/hello_world_s/mdk/hello_world.
↪uvmpw
```

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

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

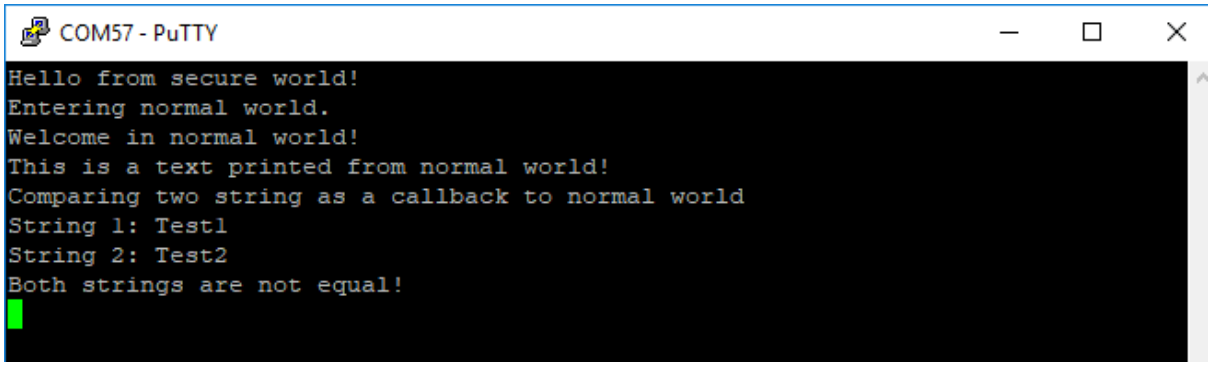
Run a TrustZone example application The secure project is configured to download both secure and non-secure output files so debugging can be fully managed from the secure project.

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



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

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



Run a demo using Arm GCC

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

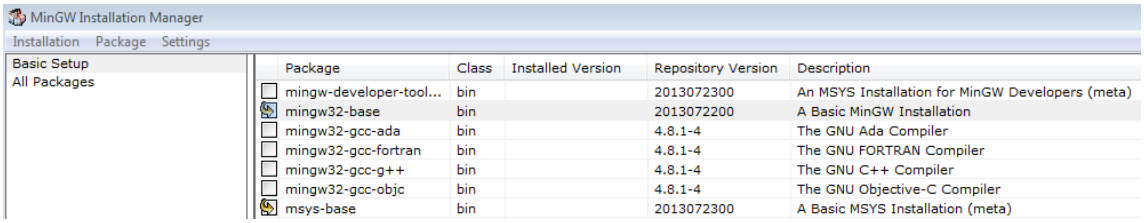
Set up toolchain This section contains the steps to install the necessary components required to build and run an MCUXpresso SDK demo application with the Arm GCC toolchain, as supported by the MCUXpresso SDK. There are many ways to use Arm GCC tools, but this example focuses on a Windows operating system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

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

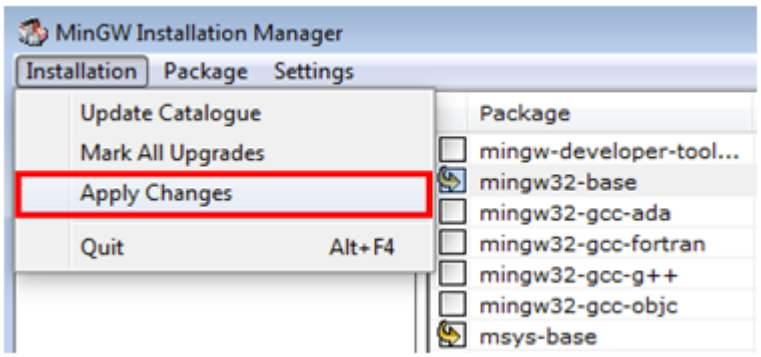
Install MinGW (only required on Windows OS) The Minimalist GNU for Windows (MinGW) development tools provide a set of tools that are not dependent on third-party C-Runtime DLLs (such as Cygwin). The build environment used by the MCUXpresso SDK does not use the MinGW build tools, but does leverage the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

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

   Note: The installation path cannot contain any spaces.
3. Ensure that the **mingw32-base** and **msys-base** are selected under **Basic Setup**.



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

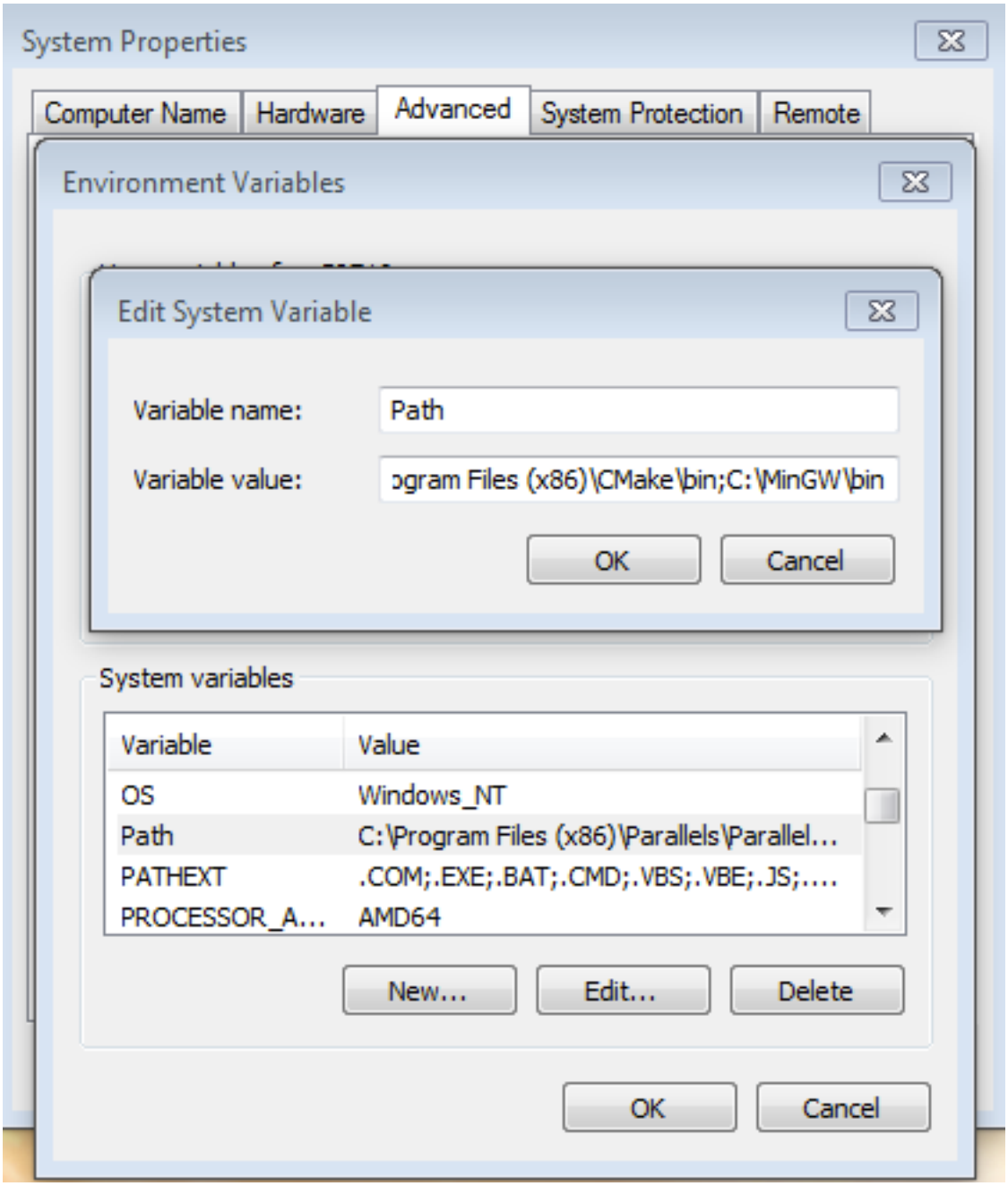


5. Add the appropriate item to the Windows operating system path environment variable. It can be found under **Control Panel->System and Security->System->Advanced System Settings** in the **Environment Variables...** section. The path is:

```
<mingw_install_dir>\bin
```

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

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



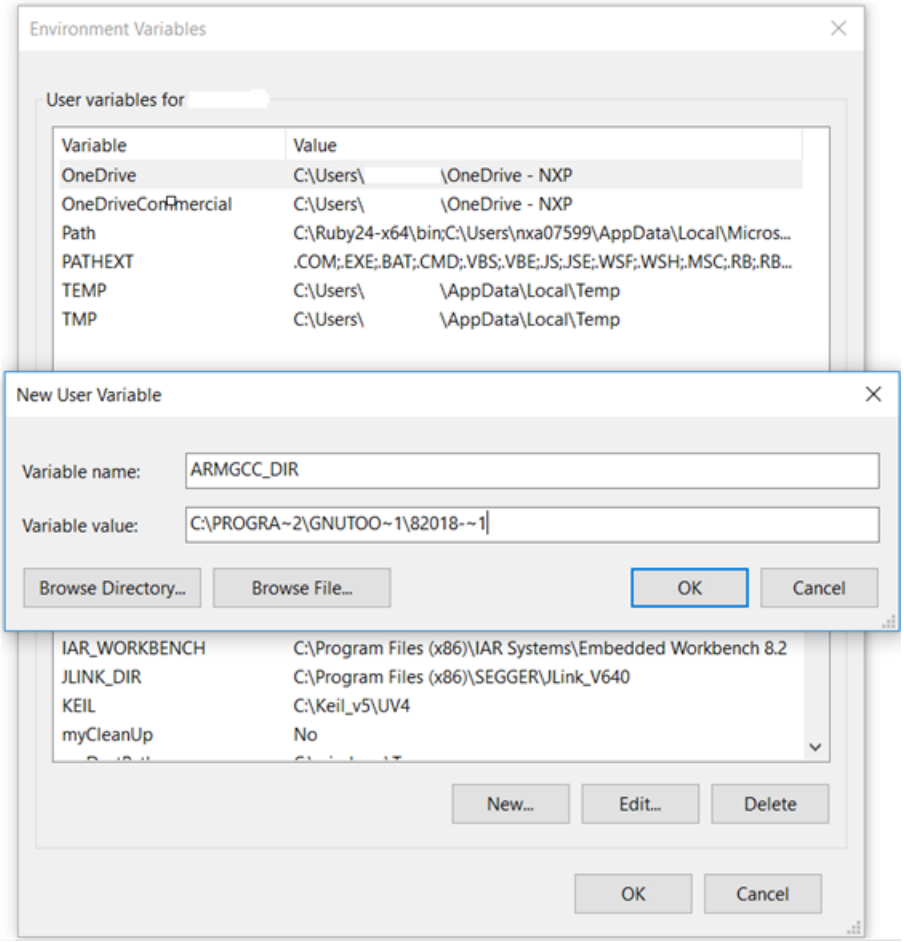
Add a new system environment variable for ARMGCC_DIR Create a new *system* environment variable and name it as ARMGCC_DIR. The value of this variable should point to the Arm GCC Embedded tool chain installation path. For this example, the path is:

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

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

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

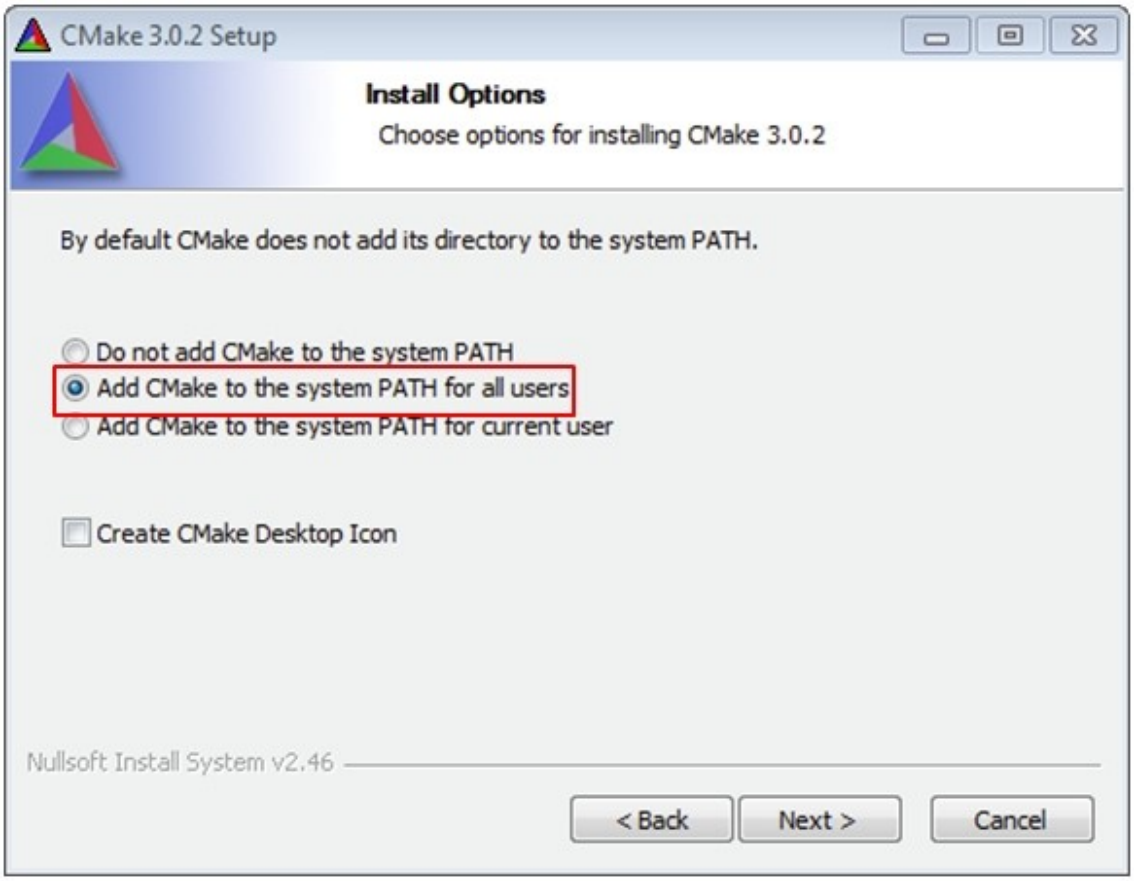
```
C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>for %I in (.) do echo %~sI

C:\Program Files (x86)\GNU Tools Arm Embedded\8 2018-q4-major>echo C:\PROGRA~2\GNUTOO~1\82018-~1
C:\PROGRA~2\GNUTOO~1\82018-~1
```



Install CMake

Windows OS

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



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

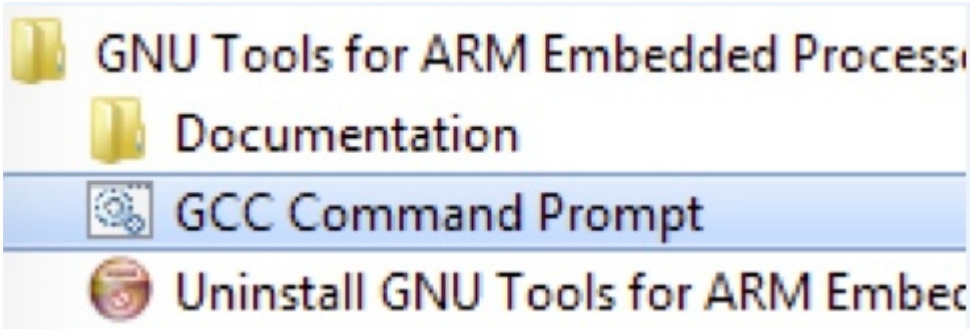
Linux OS It depends on the distributions of Linux Operation System. Here we use Ubuntu as an example.

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

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

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

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



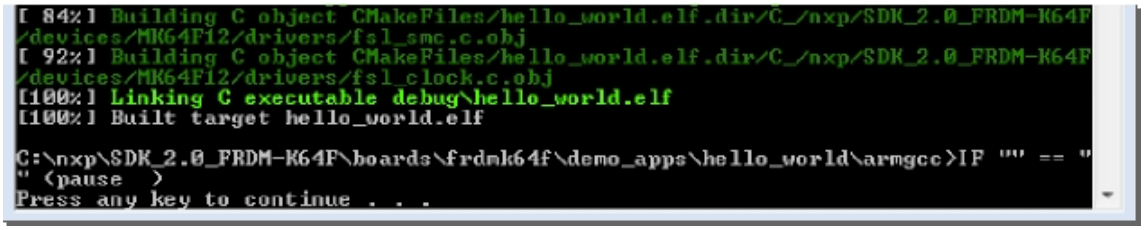
2. Change the directory to the example application project directory which has a path similar to the following:

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

   For this example, the exact path is:

   Note: To change directories, use the cd command.

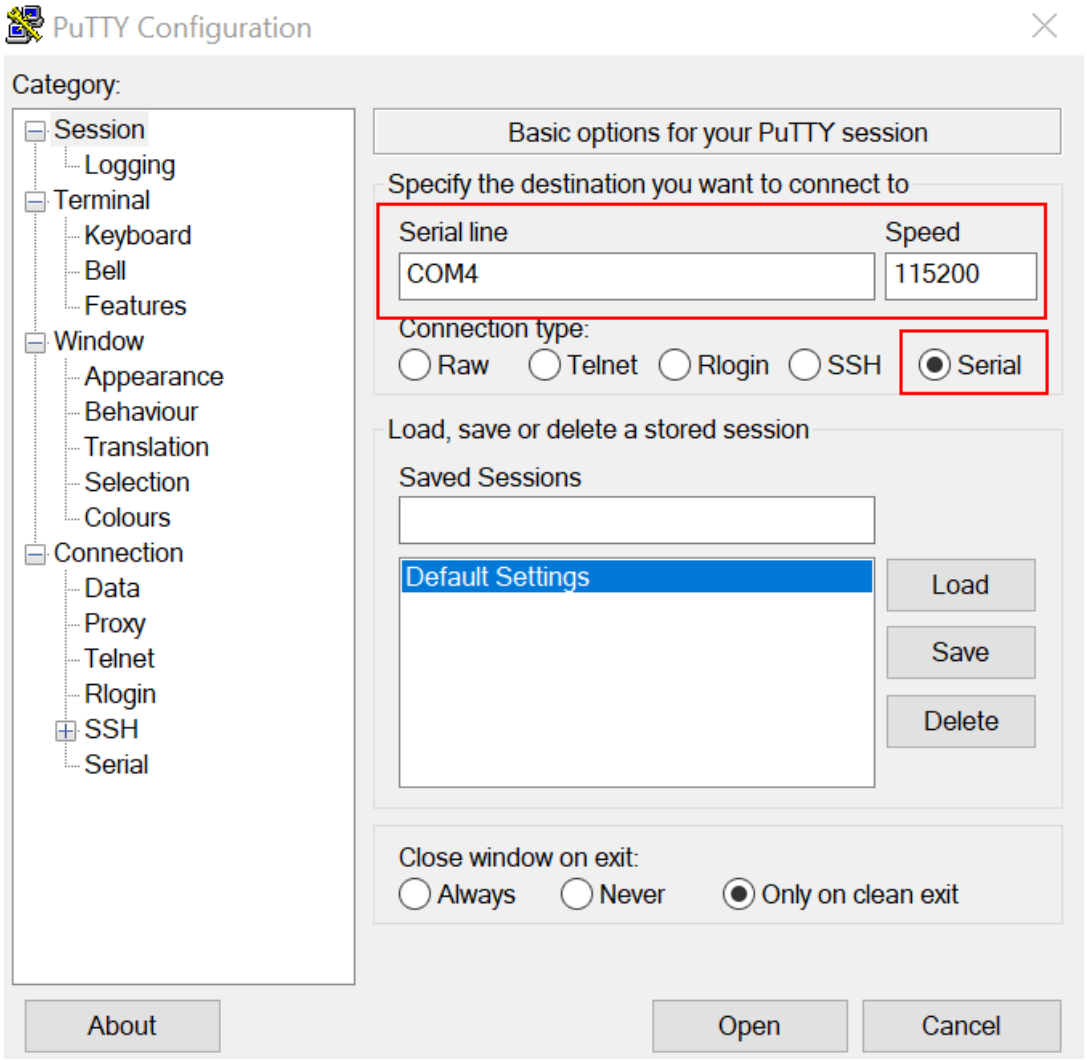
3. Type **build_debug.bat** on the command line or double click on **build_debug.bat** file in Windows Explorer to build it. The output is as shown in following figure.



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

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

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



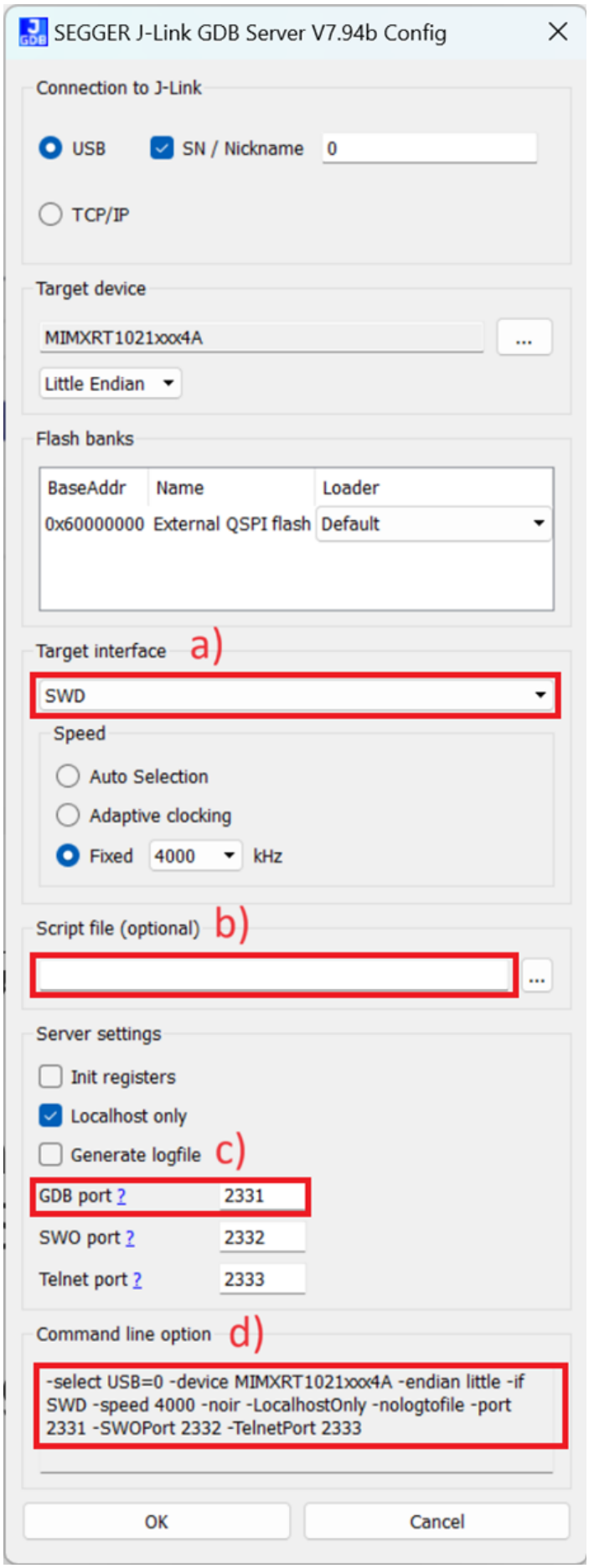
3. To launch the application, open the Windows **Start** menu and select **Programs** > **SEGGER** > **J-Link <version> J-Link GDB Server**.

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

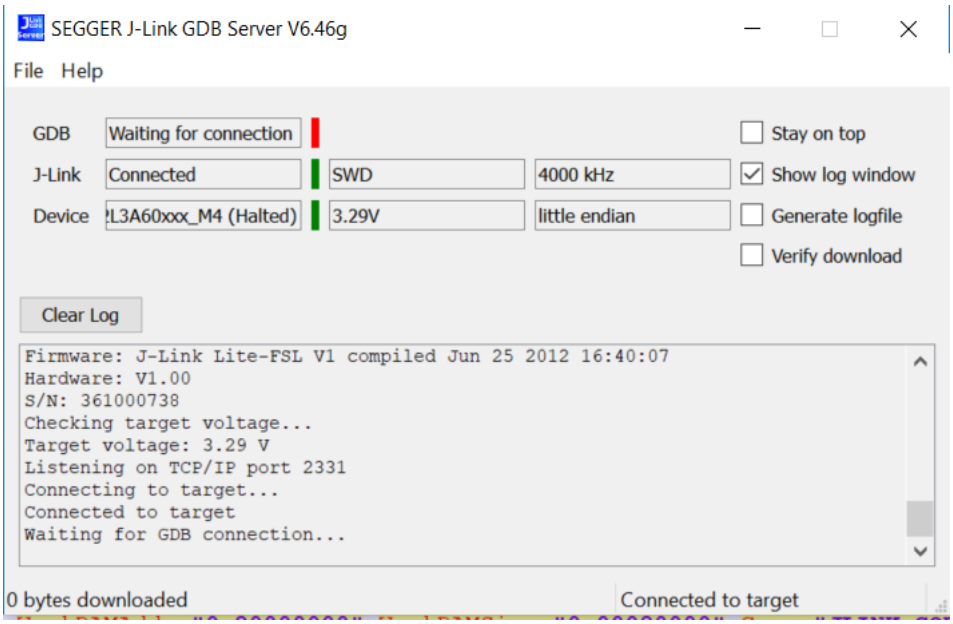
   The **SEGGER J-Link GDB Server Config** settings dialog appears.

4. Make sure to check the following options.

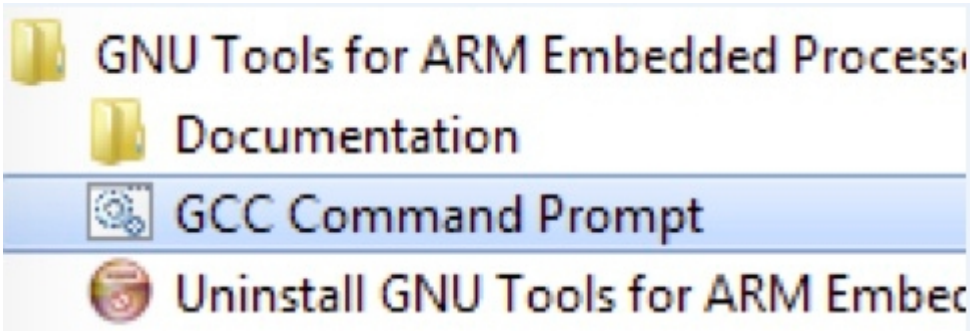
   1. **Target interface**: The debug connection on board uses internal SWD signaling. In case of a wrong setting J-Link is unable to communicate with device under test.
   2. **Script file**: If required, a J-Link init script file can be used for board initialization. The file with the ".jlinkscript" file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


SEGGER J-Link GDB Server V7.94b Config
Connection to J-Link
USB
SN / Nickname
0
TCP/IP
Target device
MIMXRT1021xxx4A
...
Little Endian
Flash banks
BaseAddr
Name
Loader
0x60000000
External QSPI flash
Default
Target interface
a)
SWD
Speed
Auto Selection
Adaptive clocking
Fixed
4000
kHz
Script file (optional)
b)
...
Server settings
Init registers
Localhost only
Generate logfile
c)
GDB port ?
2331
SWO port ?
2332
Telnet port ?
2333
Command line option
d)
-select USB=0 -device MIMXRT1021xxx4A -endian little -if SWD -speed 4000 -noir -LocalhostOnly -nologtofile -port 2331 -SWOPort 2332 -TelnetPort 2333
OK
Cancel

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



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

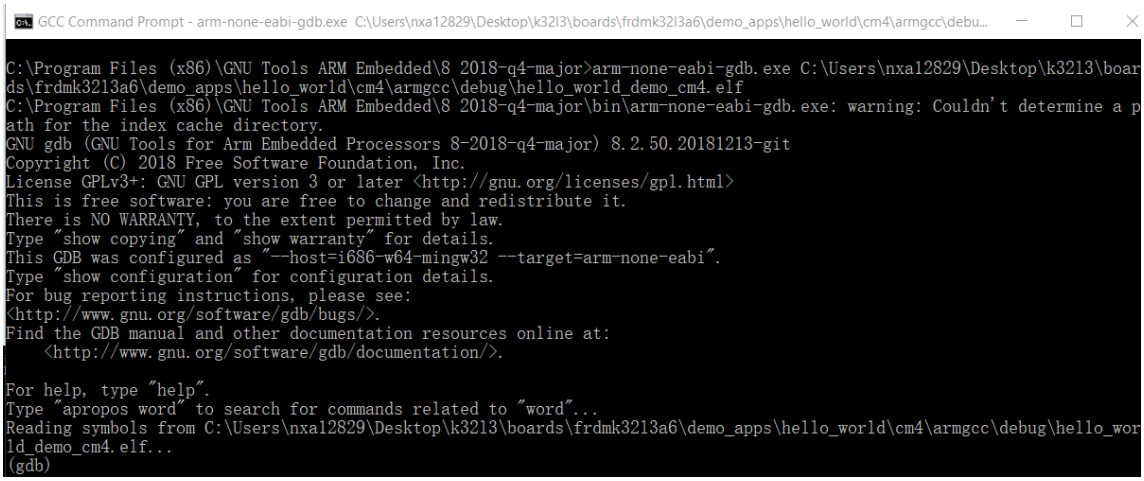


7. Change to the directory that contains the example application output. The output can be found in using one of these paths, depending on the build target selected:

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

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

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



9. Run these commands:
   1. target remote localhost:2331
   2. monitor reset
   3. monitor halt
   4. load
   5. monitor reset
10. The application is now downloaded and halted. Execute the monitor go command to start the demo application.

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

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

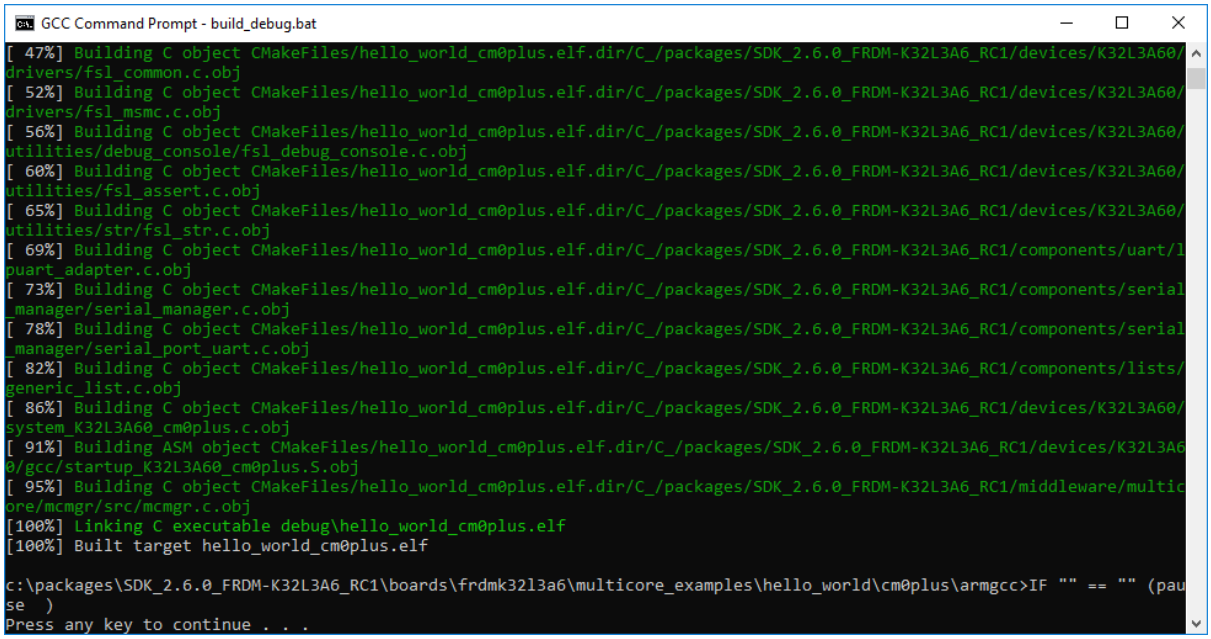
```
<install_dir>/boards/<board_name>/multicore_examples/<application_name>/<core_type>/armgcc
```

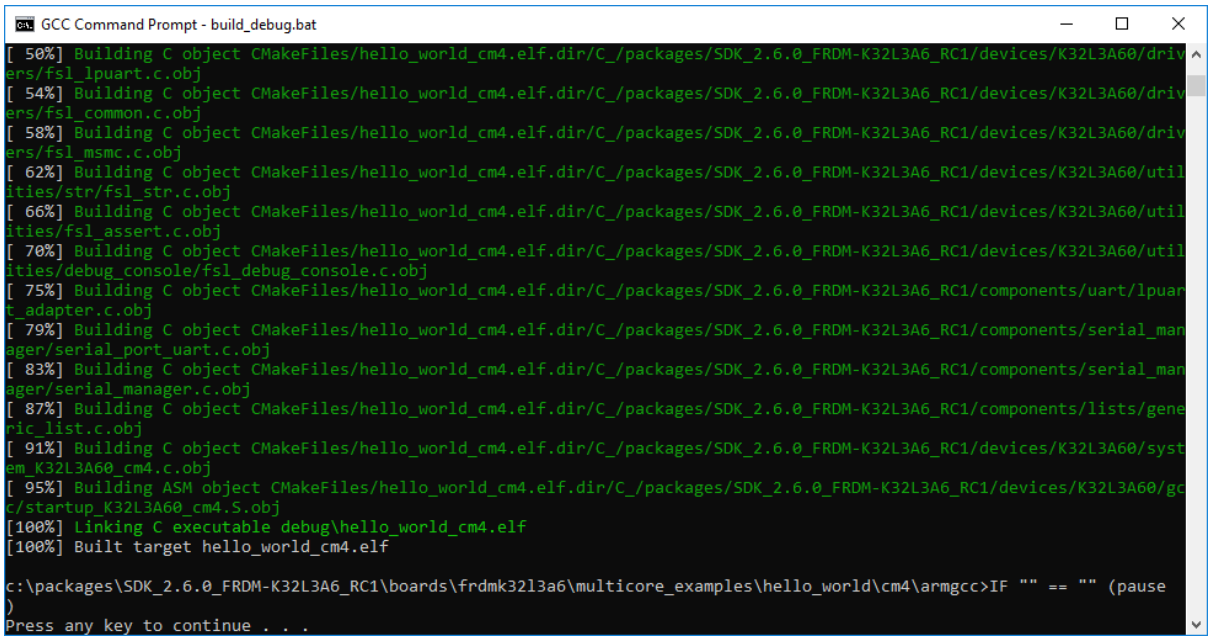
Begin with a simple dual-core version of the Hello World application. The multicore Hello World GCC build scripts are located in this folder:

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

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

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



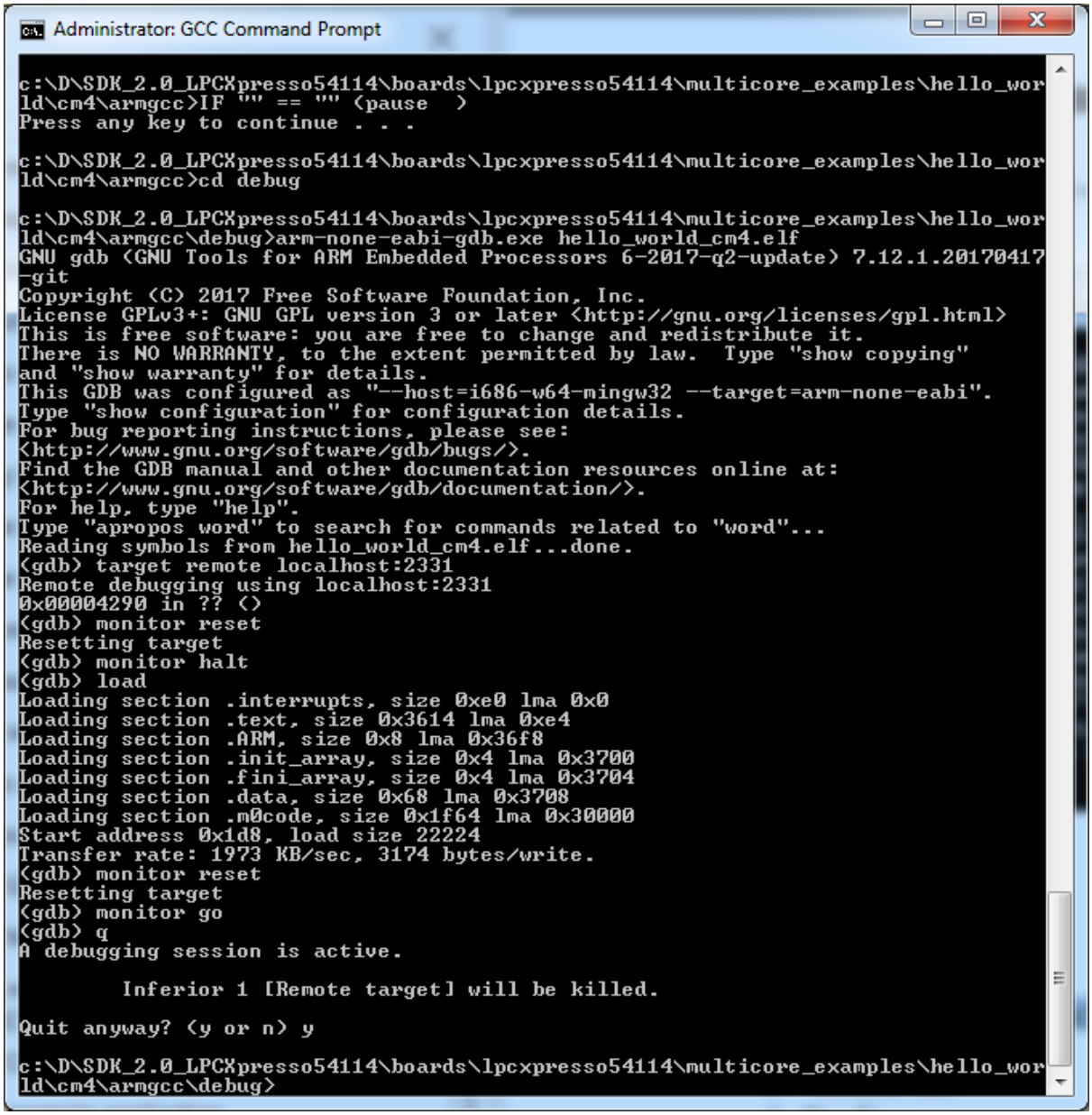


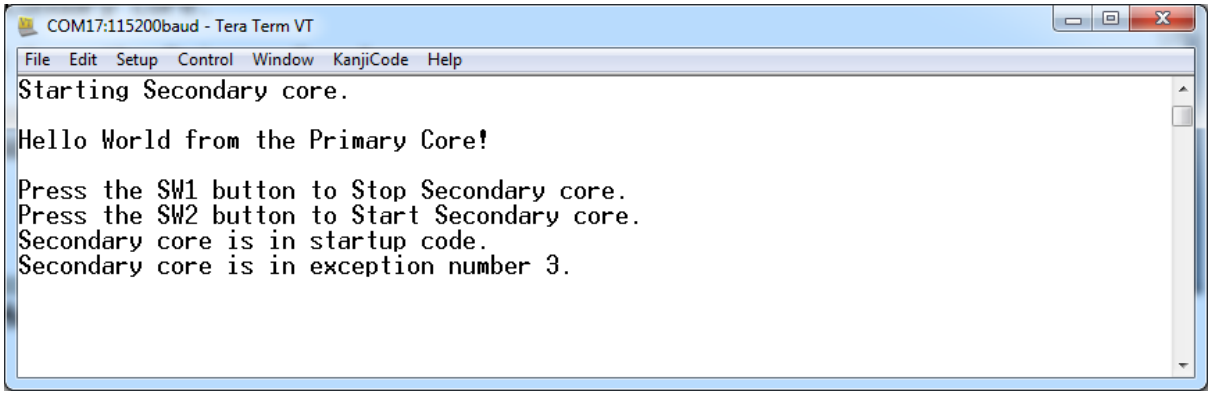
Run a multicore example application When running a multicore application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single-core application, applies, as described in **Run an example application**.

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

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

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





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

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

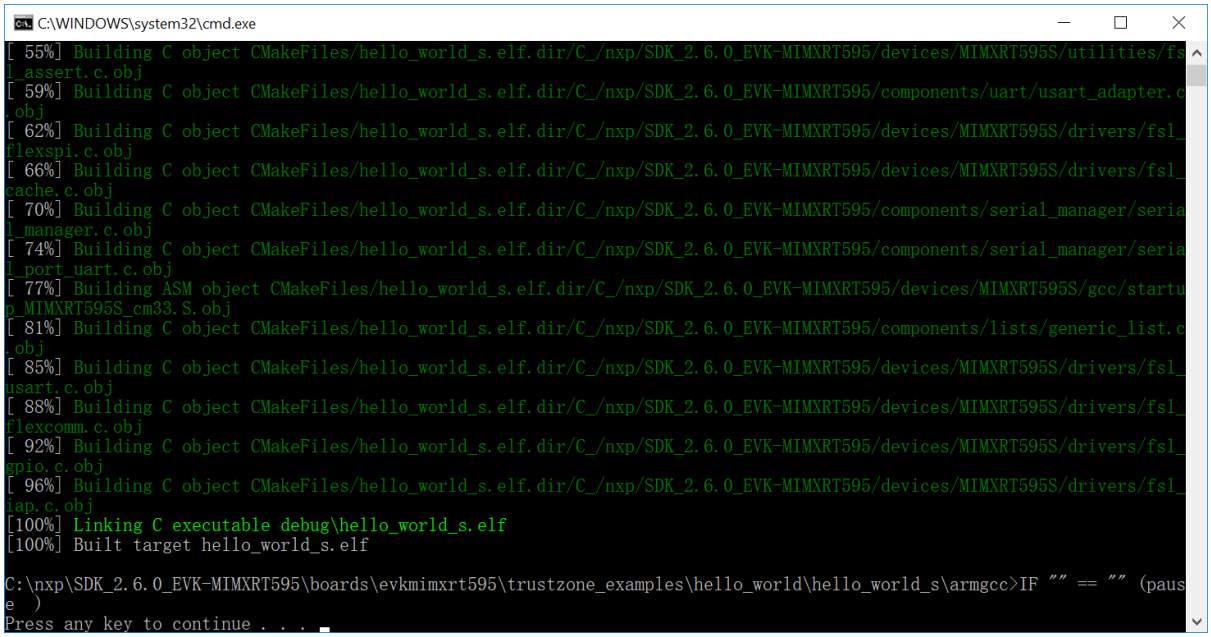
```
<install_dir>/boards/<board_name>/trustzone_examples/<application_name>/[<core_type>]/
↪<application_name>_s/armgcc
```

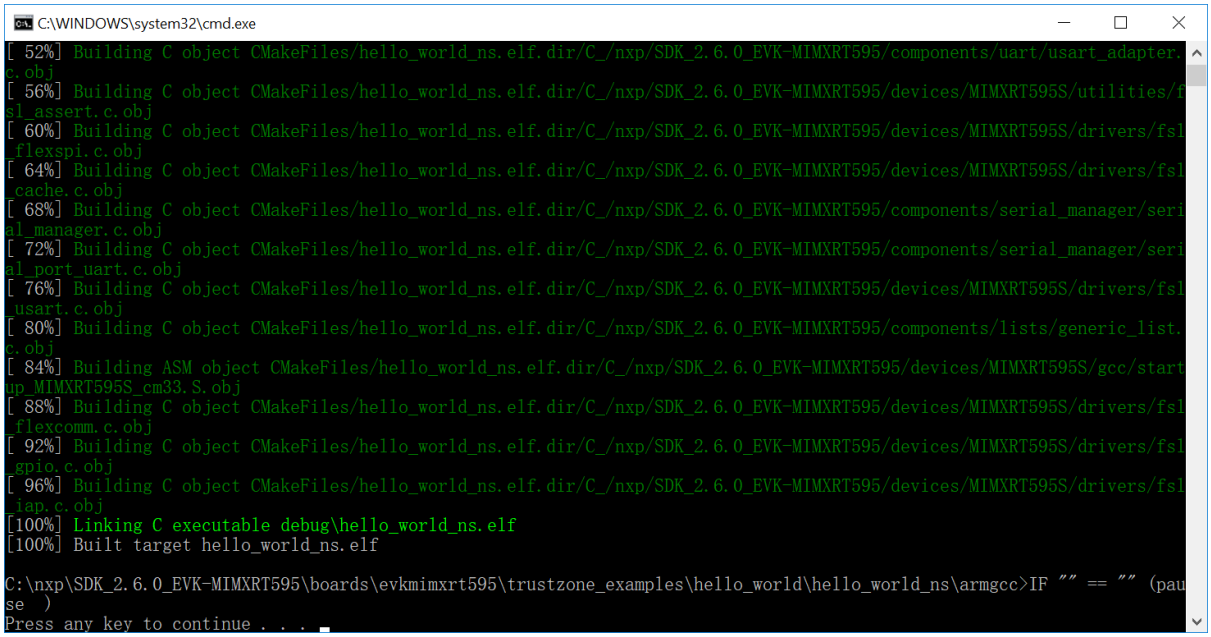
Begin with a simple TrustZone version of the Hello World application. The TrustZone Hello World GCC build scripts are located in this folder:

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

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

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





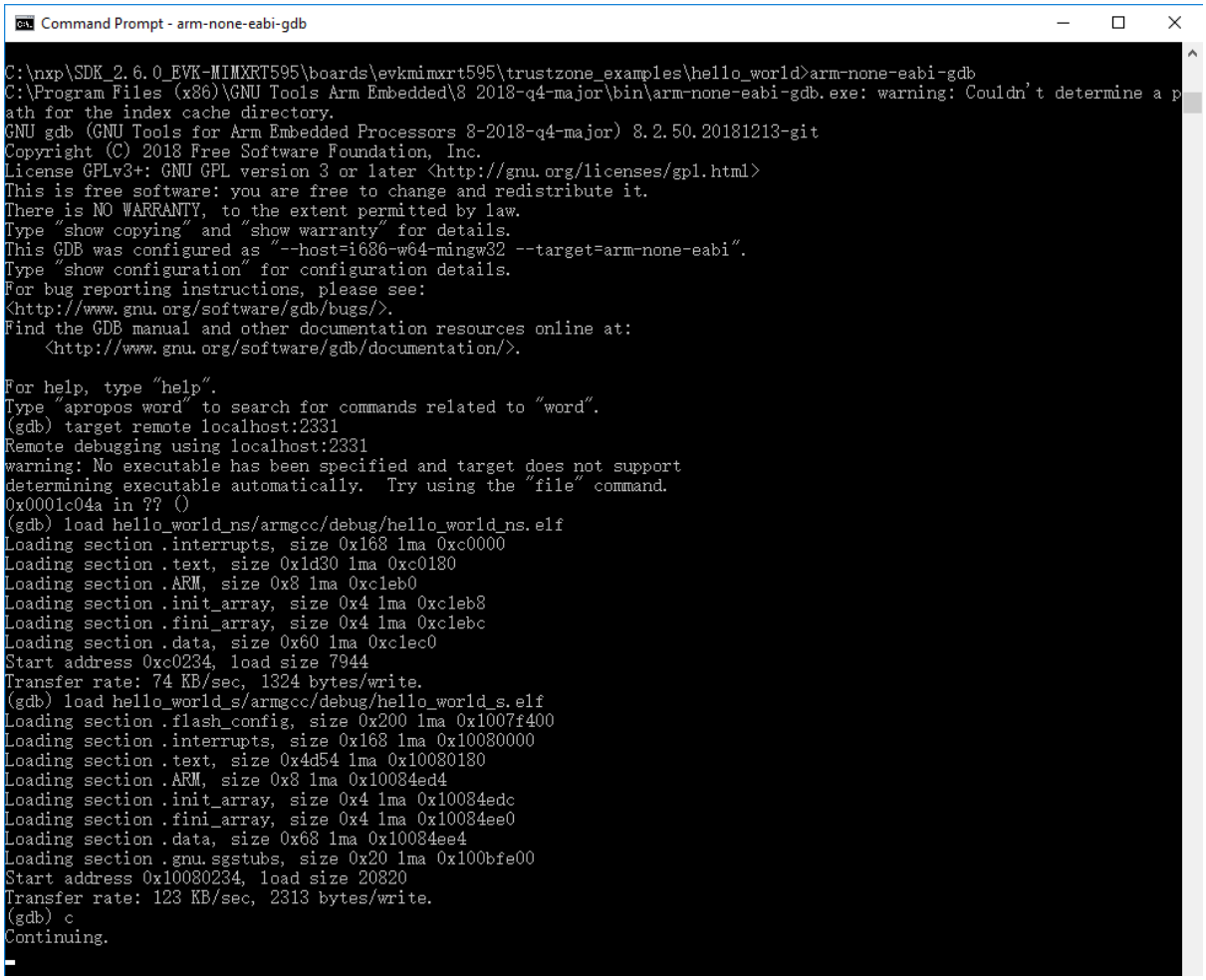
Run a TrustZone example application When running a TrustZone application, the same prerequisites for J-Link/J-Link OpenSDA firmware, and the serial console as for the single core application, apply, as described in **Run an example application**.

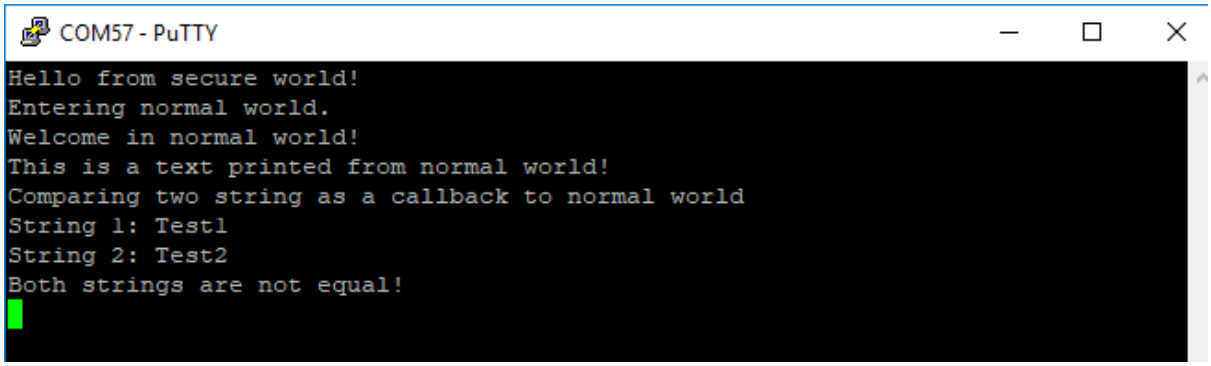
To download and run the TrustZone application, perform steps 1 to 10, as described in **Run an example application**. These steps are common for both single core and TrustZone applications in Arm GCC.

Then, run these commands:

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

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





MCUXpresso Config Tools

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

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

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

MCUXpresso Config Tools can be accessed in the following products:

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

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

How to determine COM port

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

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

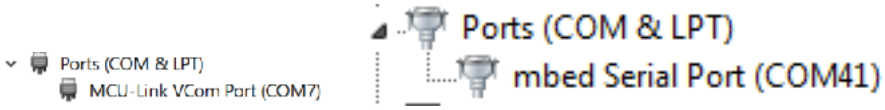
   ```
   $ dmesg | grep "ttyUSB"
     [503175.307873] usb 3-12: cp210x converter now attached to ttyUSB0
     [503175.309372] usb 3-12: cp210x converter now attached to ttyUSB1
   ```

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

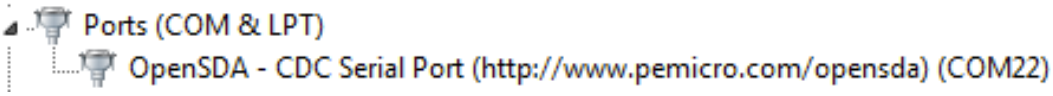
2. **Windows**: To determine the COM port open Device Manager in the Windows operating system. Click the **Start** menu and type **Device Manager** in the search bar.

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

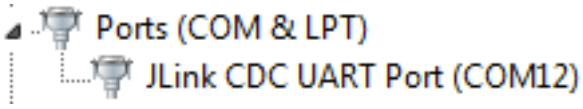
   1. **CMSIS-DAP/mbed/DAPLink** interface:



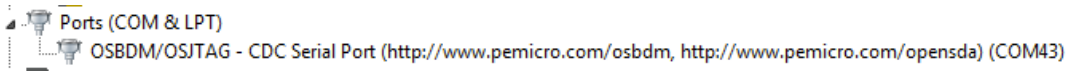
2. **P&E Micro**:



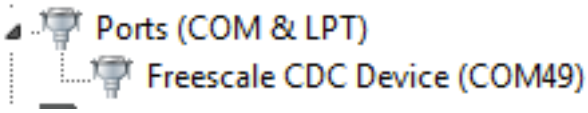
3. **J-Link**:



4. **P&E Micro OSJTAG**:



5. **MRB-KW01**:



On-board Debugger

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

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

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

The corresponding host driver must be installed before debugging.

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

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

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

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

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

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

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

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

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

The corresponding host driver must be installed before debugging.

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

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

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

NXP provides the LPCScrypt 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 LPCScrypt.

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

1. Install the LPCScript utility.
2. Unplug the board's USB cable.
3. Make the DFU link (install the jumper labeled DFUlink).
4. Connect the probe to the host via USB (use Link USB connector).
5. Open a command shell and call the appropriate script located in the 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. Repower the board by removing the USB cable and plugging it in again.

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

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

See the table in *Default debug interfaces* to determine the default debug interface that comes loaded on your specific hardware platform.

The corresponding host driver must be installed before debugging.

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

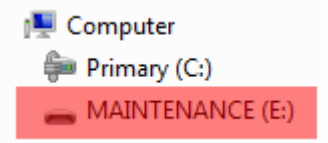
Updating OpenSDA firmware Any NXP hardware platform that comes with an OpenSDA-compatible debug interface has the ability to update the OpenSDA firmware. This typically means to switch from the default application (either CMSIS-DAP or P&E Micro) to a SEGGER J-Link. This section contains the steps to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

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

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

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

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



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

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

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

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

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

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

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

The host driver must be installed before debugging.

- See PE micro to download and install the P&E Micro Hardware Interface Drivers package.

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

The host driver must be installed before debugging.

- See PE micro to download and install the P&E Micro Hardware Interface Drivers package.

Default debug interfaces

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

Hardware platform	Default debugger firmware	On-board debugger probe
EVK-MCIMX7ULP	N/A	N/A
EVK-MIMX8MM	N/A	N/A
EVK-MIMX8MN	N/A	N/A
EVK-MIMX8MNDDR3L	N/A	N/A
EVK-MIMX8MP	N/A	N/A
EVK-MIMX8MQ	N/A	N/A
EVK-MIMX8ULP	N/A	N/A
EVK-MIMXRT1010	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1015	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1020	CMSIS-DAP	LPC-Link2
EVK-MIMXRT1064	CMSIS-DAP	LPC-Link2
EVK-MIMXRT595	CMSIS-DAP	LPC-Link2
EVK-MIMXRT685	CMSIS-DAP	LPC-Link2
EVK9-MIMX8ULP	N/A	N/A
EVKB-IMXRT1050	CMSIS-DAP	LPC-Link2
FRDM-K22F	CMSIS-DAP	OpenSDA v2
FRDM-K32L2A4S	CMSIS-DAP	OpenSDA v2
FRDM-K32L2B	CMSIS-DAP	OpenSDA v2
FRDM-K32L3A6	CMSIS-DAP	OpenSDA v2
FRDM-KE02Z40M	P&E Micro	OpenSDA v1
FRDM-KE15Z	CMSIS-DAP	OpenSDA v2
FRDM-KE16Z	CMSIS-DAP	OpenSDA v2
FRDM-KE17Z	CMSIS-DAP	OpenSDA v2
FRDM-KE17Z512	CMSIS-DAP	MCU-Link
FRDM-MCXA153	CMSIS-DAP	MCU-Link
FRDM-MCXA156	CMSIS-DAP	MCU-Link
FRDM-MCXA346	CMSIS-DAP	MCU-Link
FRDM-MCXC041	CMSIS-DAP	MCU-Link
FRDM-MCXC242	CMSIS-DAP	MCU-Link
FRDM-MCXC444	CMSIS-DAP	MCU-Link
FRDM-MCXE247	CMSIS-DAP	MCU-Link
FRDM-MCXN236	CMSIS-DAP	MCU-Link
FRDM-MCXN947	CMSIS-DAP	MCU-Link
FRDM-MCXW23	CMSIS-DAP	MCU-Link
FRDM-MCXW71	CMSIS-DAP	MCU-Link
FRDM-MCXW72	CMSIS-DAP	MCU-Link
FRDM-RW612	CMSIS-DAP	MCU-Link
IMX943-EVK	N/A	N/A
IMX95LP4XEVK-15	N/A	N/A
IMX95LPD5EVK-19	N/A	N/A
IMX95VERDINEVK	N/A	N/A
KW45B41Z-EVK	CMSIS-DAP	MCU-Link
KW45B41Z-LOC	CMSIS-DAP	MCU-Link
KW47-EVK	CMSIS-DAP	MCU-Link
KW47-LOC	CMSIS-DAP	MCU-Link
LPC845BREAKOUT	CMSIS-DAP	LPC-Link2
LPCXpresso51U68	CMSIS-DAP	LPC-Link2
LPCXpresso54628	CMSIS-DAP	LPC-Link2

continues on next page

Table 1 – continued from previous page

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

How to define IRQ handler in CPP files

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

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

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

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

1.3 Getting Started with MCUXpresso SDK GitHub

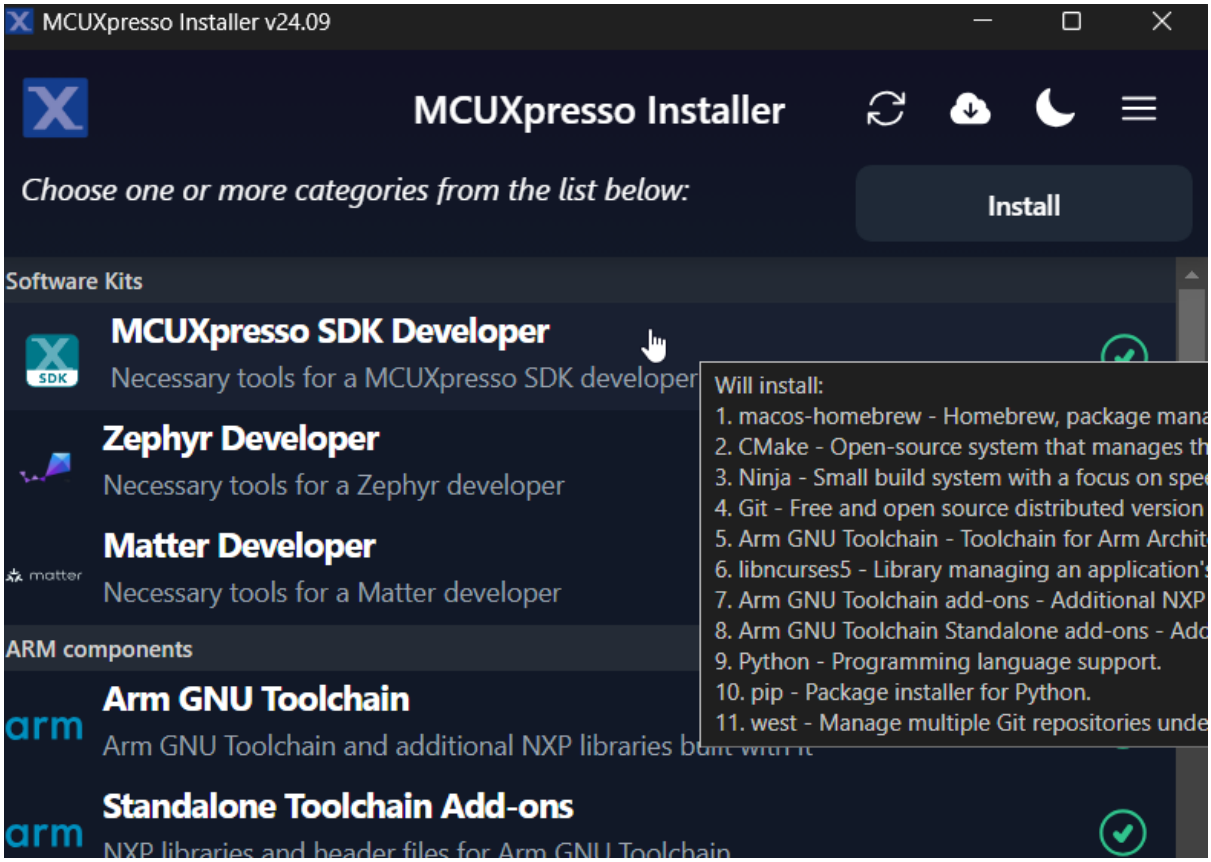
1.3.1 Getting Started with MCUXpresso SDK Repository

Installation

NOTE

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

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



Alternative: Manual Installation

Basic tools

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

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

Then configure your username and email using the commands:

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

Python Install python 3.10 or latest. Follow the Python Download guide.

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

West Please use the west version equal or greater than 1.2.0

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

Build And Configuration System

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

For Windows, you can directly use the .msi installer like cmake-3.31.4-windows-x86_64.msi to install.

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

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

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

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

For Linux, you can use your system package manager or you can directly download the ninja binary to work.

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

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

Please make sure *python* environment is setup ready then you can use the Kconfig.

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

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

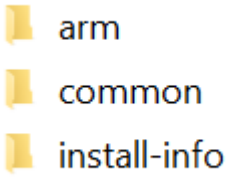
Toolchain MCUXpresso SDK supports all mainstream toolchains for embedded development. You can install your used or interested toolchains following the guides.

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

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

Toolchain	Environment Variable	Example	Cmd Line Argument
Armgcc	ARMGCC_DIR	C:\armgcc for windows/usr for Linux. Typically arm-none-eabi-* is installed under /usr/bin	–toolchain armgcc
IAR	IAR_DIR	C:\iar\ewarm-9.60.3 for Windows/opt/iarsystems/bxarm-9.60.3 for Linux	–toolchain iar
MDK	MDK_DIR	C:\Keil_v5 for Windows.MDK IDE is not officially supported with Linux.	–toolchain mdk
Armclang	ARMCLANG_DIR	C:\ArmCompilerforEmbedded6.22 for Windows/opt/ArmCompilerforEmbedded6.21 for Linux	–toolchain mdk
Zephyr	ZEPHYR_SDK	c:\NXP\zephyr-sdk-<version> for windows/opt/zephyr-sdk-<version> for Linux	–toolchain zephyr
CodeWarrior	CW_DIR	C:\Freescale\CW MCU v11.2 for windowsCodeWarrior is not supported with Linux	–toolchain codewarrior
Xtensa	XCC_DIR	C:\xtensa\XtDevTools\install\tools\RI-2023.11-win32\XtensaTools for windows/opt/xtensa/XtDevTools/install/tools/RI-2023.11-Linux/XtensaTools for Linux	–toolchain xtensa
NXP S32Compiler RISC-V Zen-V	RISCVLLVM_DIR	C:\riscv-llvm-win32_b298_b298_2024.08.12 for Windows/opt/riscv-llvm-Linux-x64_b298_b298_2024.08.12 for Linux	–toolchain riscvllvm

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



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

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

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

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

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

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

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

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

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

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

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

Get MCUXpresso SDK Repo

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

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

# Update the west projects
cd mcuxpresso-sdk
west update

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

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

1. Navigate to the core directory:

   ```
   cd mcuxsdk
   ```

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

   ```
   python -m venv .venv

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

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

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

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

3. Install the required Python packages:

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

Explore Contents

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

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

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

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

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

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

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

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

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

Run a demo using MCUXpresso for VS Code

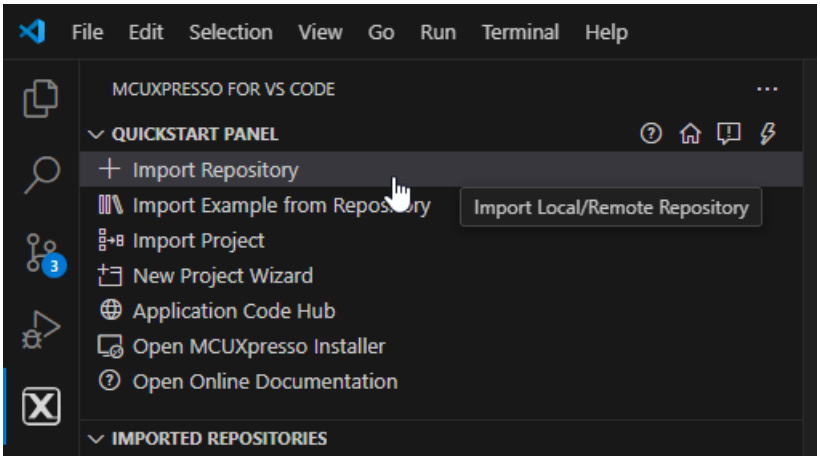
This section explains how to configure MCUXpresso for VS Code to build, run, and debug example applications. This guide uses the hello_world demo application as an example. However, these

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

Build an example application This section assumes that the user has already obtained the SDK as outlined in *Get MCUXpresso SDK Repo*.

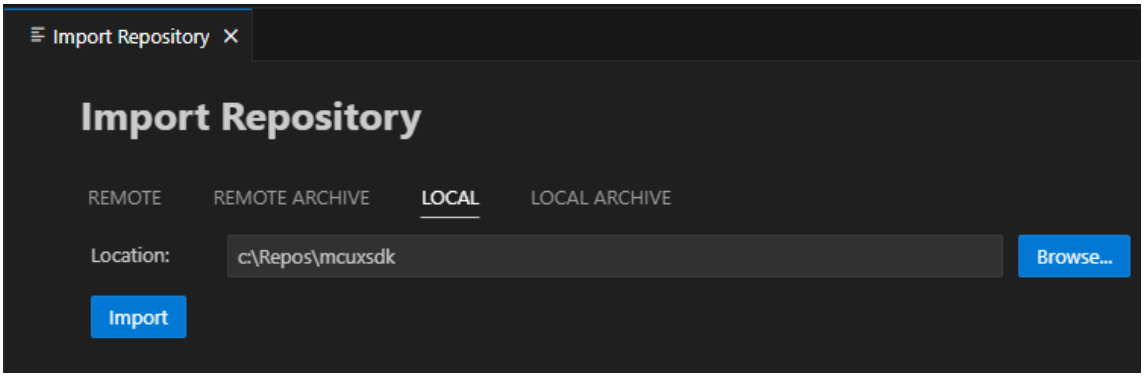
To build an example application:

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

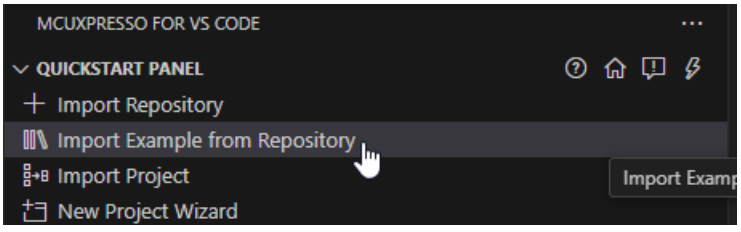


Note: You can import the SDK in several ways. Refer to MCUXpresso for VS Code Wiki for details.

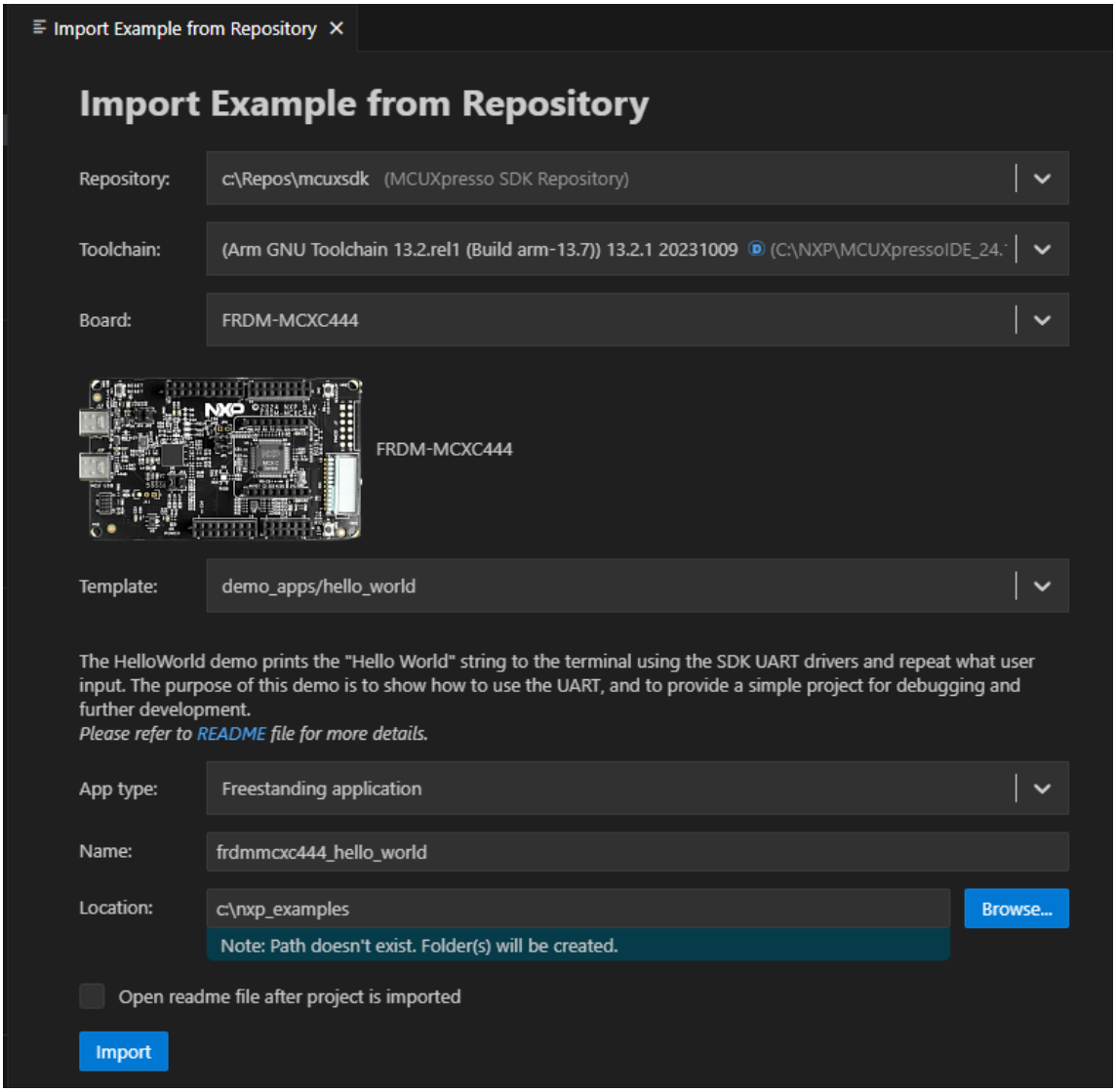
Select **Local** if you've already obtained the SDK as seen in *Get MCUXpresso SDK Repo*. Select your location and click **Import**.



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

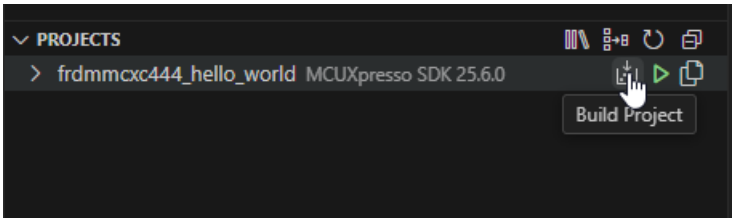


In the dropdown menu, select the MCUXpresso SDK, the Arm GNU Toolchain, your board, template, and application type. Click **Import**.

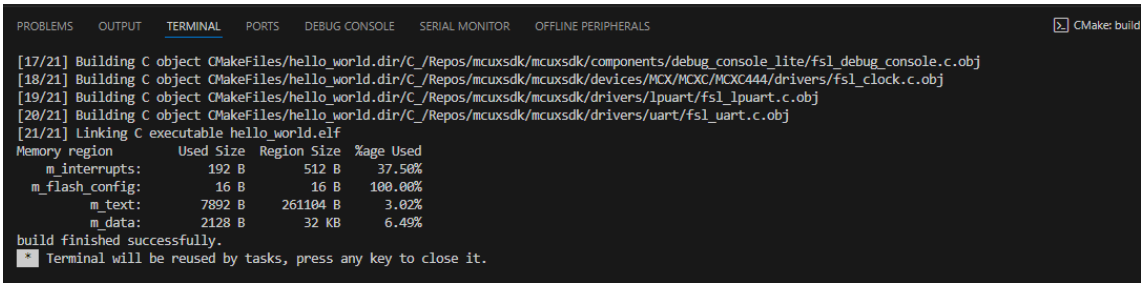


Note: The MCUXpresso SDK projects can be imported as **Repository applications** or **Freestanding applications**. The difference between the two is the import location. Projects imported as Repository examples will be located inside the MCUXpresso SDK, whereas Freestanding examples can be imported to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

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

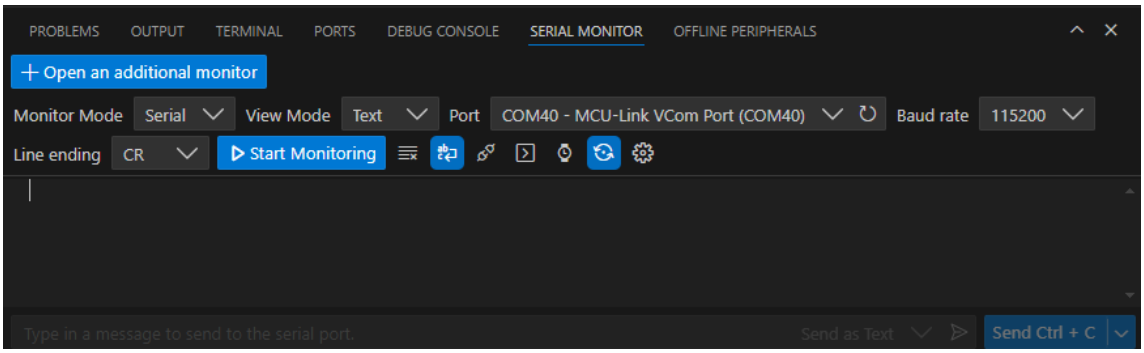


The integrated terminal will open at the bottom and will display the build output.

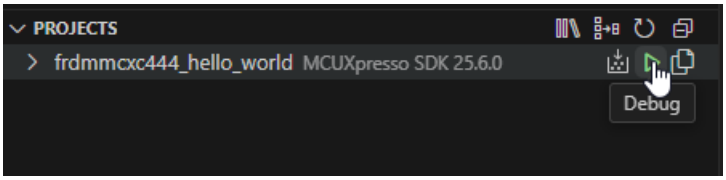


Run an example application **Note:** for full details on MCUXpresso for VS Code debug probe support, see MCUXpresso for VS Code Wiki.

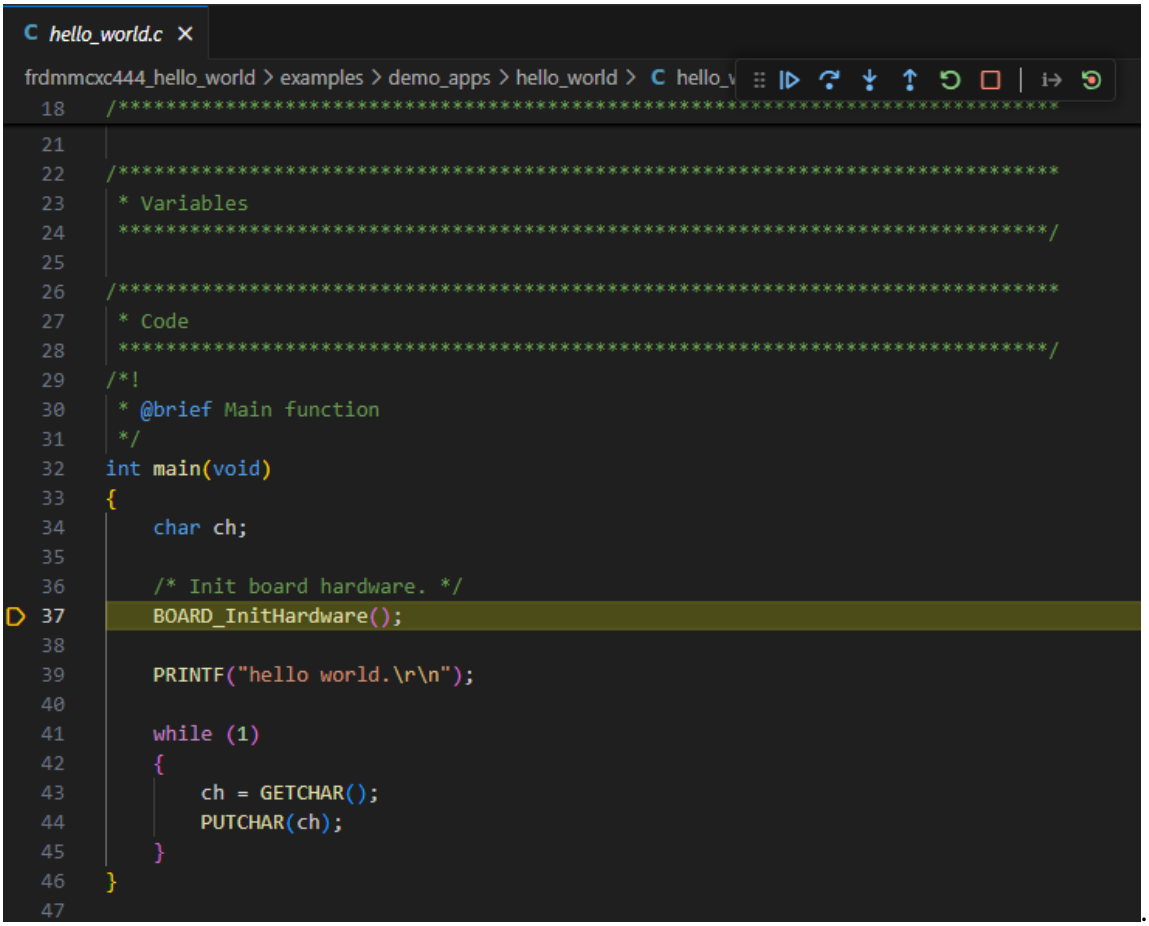
1. Open the **Serial Monitor** from the VS Code's integrated terminal. Select the VCom Port for your device and set the baud rate to 115200.



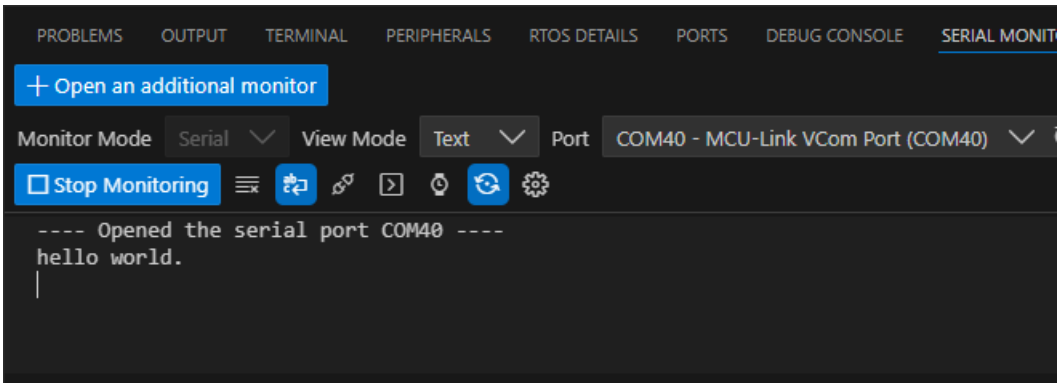
2. Navigate to the **PROJECTS** view and click the play button to initiate a debug session.



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



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



Running a demo using ARMGCC CLI/IAR/MDK

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

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

INFO: [  1][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evk9mimx8ulp -Dcore_id=cm33]
INFO: [  2][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbimxrt1050]
INFO: [  3][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
```

(continues on next page)

(continued from previous page)

```
↪evkbmimxrt1060]
INFO: [  4][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbmimxrt1170 -Dcore_id=cm4]
INFO: [  5][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkbmimxrt1170 -Dcore_id=cm7]
INFO: [  6][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkcmimxrt1060]
INFO: [  7][west build -p always examples/demo_apps/hello_world --toolchain armgcc --config release -b␣
↪evkmcimx7ulp]
...
```

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

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

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

Here are some typical usages for generating a SDK example:

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

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

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

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

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

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

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

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

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

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

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

For more details, please refer to System build.

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

1. Run cmake configuration

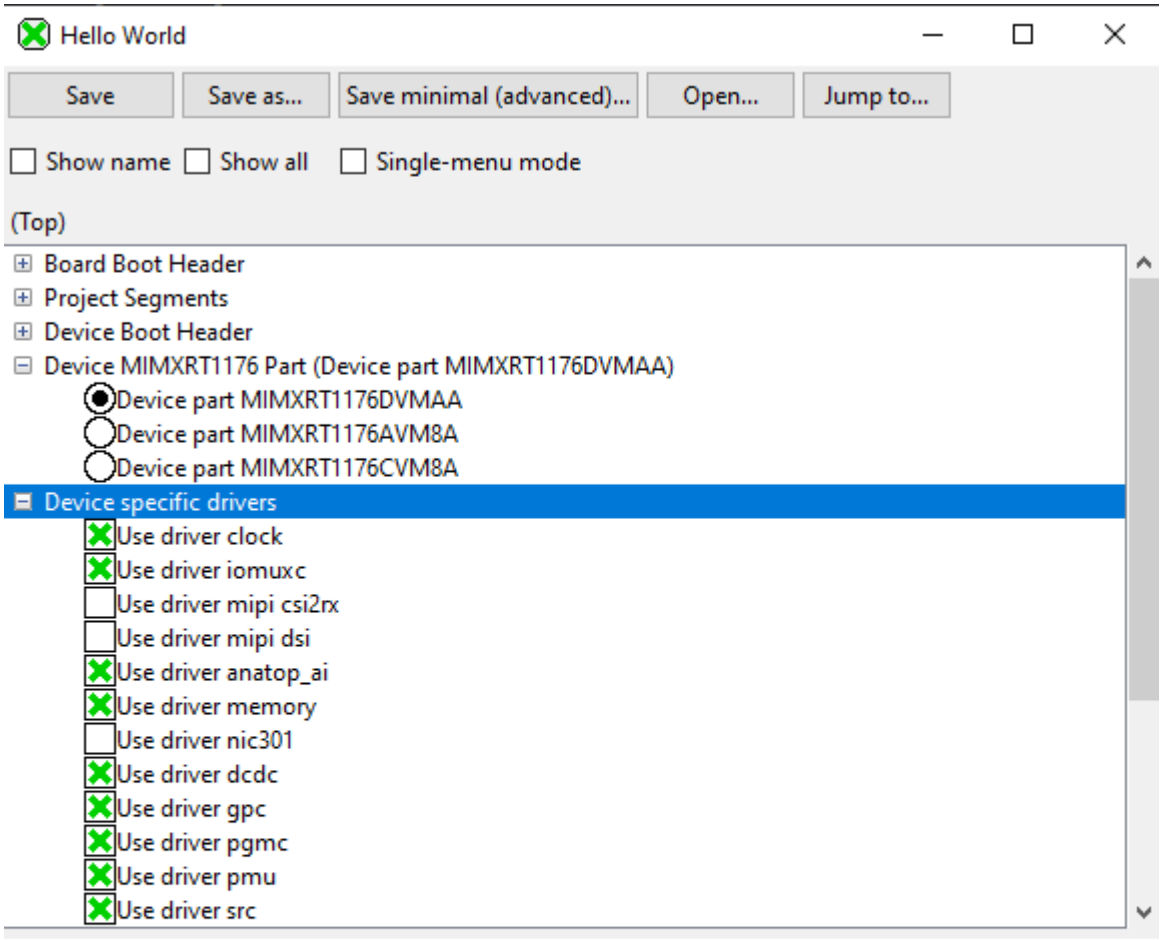
```
west build -b evkbmimxrt1170 examples/demo_apps/hello_world -Dcore_id=cm7 --cmake-only -p
```

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

2. Run guiconfig target

```
west build -t guiconfig
```

Then you will get the Kconfig GUI launched, like




```
Kconfig definition, with parent deps. propagated to 'depends on'
===============================================================

At D:/sdk_next/mcuxsdk\devices\../devices/RT/RT1170/MIMXRT1176\drivers/Kconfig:5
Included via D:/sdk_next/mcuxsdk/examples/demo_apps/hello_world/Kconfig:6 ->
D:/sdk_next/mcuxsdk/Kconfig.mcuxpresso:9 -> D:/sdk_next/mcuxsdk\devices/Kconfig:1
-> D:/sdk_next/mcuxsdk\devices\../devices/RT/RT1170/MIMXRT1176/Kconfig:8
Menu path: (Top)

menu "Device specific drivers"
```

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

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

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

Flash the hello_world example:

```
west flash -r linkserver
```

Debug Start a gdb interface by following command:

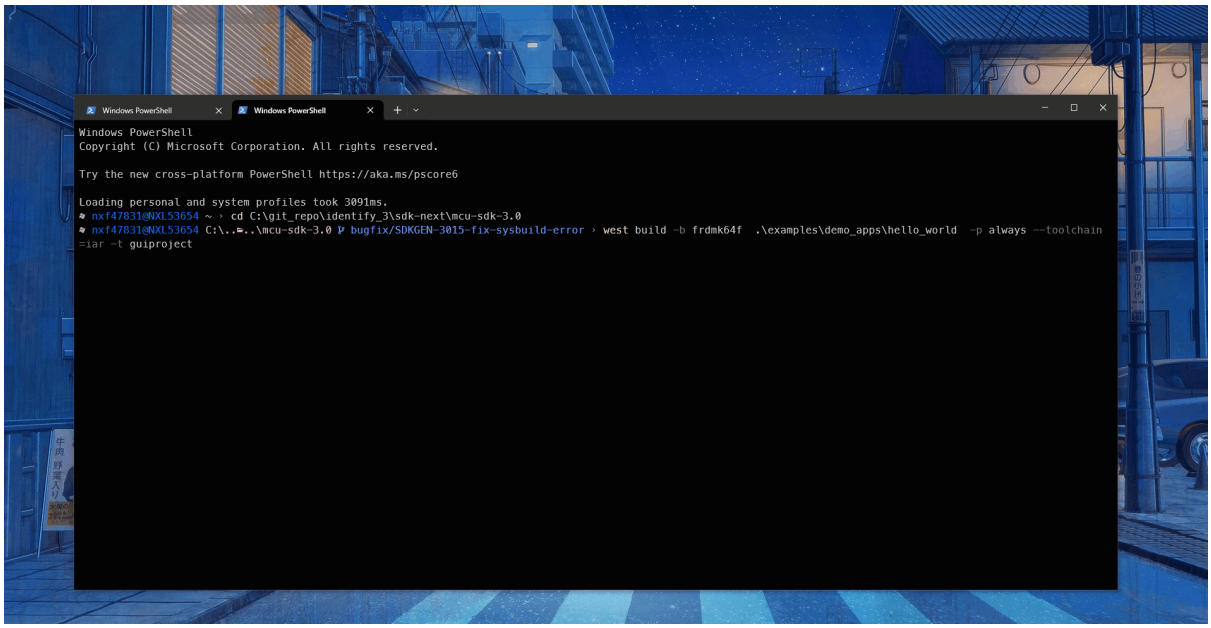
```
west debug -r linkserver
```

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

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

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

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



Note, please follow the *Installation* to setup the environment especially make sure that *ruby* has been installed.

1.4 Release Notes

1.4.1 MCUXpresso SDK Release Notes

Overview

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

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

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

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

MCUXpresso SDK

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

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

Development tools

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

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

Supported development systems

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

Development boards	MCU devices
FRDM-K32L2B	K32L2B11VFM0A, K32L2B11VFT0A, K32L2B11VLH0A, K32L2B11VMP0A, K32L2B21VFM0A, K32L2B21VFT0A, K32L2B21VLH0A, K32L2B21VMP0A, K32L2B31VFM0A, K32L2B31VFT0A, **K32L2B31VLH0A**, K32L2B31VMP0A

MCUXpresso SDK release package

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

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

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

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

RTOS

FreeRTOS Real-time operating system for microcontrollers from Amazon

Middleware

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

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

TinyCBOR Concise Binary Object Representation (CBOR) Library

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

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

Multicore Multicore Software Development Kit

llhttp HTTP parser llhttp

FreeMASTER FreeMASTER communication driver for 32-bit platforms.

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

Release contents

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

Deliverable	Location
Boards	INSTALL_DIR/boards
Demo Applications	INSTALL_DIR/boards/<board_name>/demo_apps
Driver Examples	INSTALL_DIR/boards/<board_name>/driver_examples
eIQ examples	INSTALL_DIR/boards/<board_name>/eiq_examples
Board Project Template for MCUXpresso IDE NPW	INSTALL_DIR/boards/<board_name>/project_template
Driver, SoC header files, extension header files and feature header files, utilities	INSTALL_DIR/devices/<device_name>
CMSIS drivers	INSTALL_DIR/devices/<device_name>/cmsis_drivers
Peripheral drivers	INSTALL_DIR/devices/<device_name>/drivers
Toolchain linker files and startup code	INSTALL_DIR/devices/<device_name>/<toolchain_nam
Utilities such as debug console	INSTALL_DIR/devices/<device_name>/utilities
Device Project Template for MCUXpresso IDE NPW	INSTALL_DIR/devices/<device_name>/project_templat
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.

Safety_iec60730b cloned project fails to build

When you use the MCUXpresso Config Tool to clone the “safety_iec60730b” project in MCUXpresso SDK package, the created project fails to build.

The build fails because the post-build setup for CRC is incorrect. Therefore, It is recommended to use the “safety_iec60730b” project in MCUXpresso SDK package.

USBFS controller issue

Due to the USBFS controller design issues, the USB host suspend/resume demos (usb_suspend_resume_host_hid_mouse) of the full speed controller do not support the low speed device directly.

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

ADC16

[2.3.0]

- Improvements
  - Added new API ADC16_EnableAsynchronousClockOutput() to enable/disable ADACK output.
  - In ADC16_GetDefaultConfig(), set enableAsynchronousClock to false.

[2.2.0]

- Improvements
  - Added hardware average mode in adc_config_t structure, then the hardware average mode can be set by invoking ADC16_Init() function.

[2.1.0]

- New Features:
  - Supported KM series' new ADC reference voltage source, bandgap from PMC.

[2.0.3]

- Bug Fixes
  - Fixed IAR warning Pa082: the order of volatile access should be defined.

[2.0.2]

- Improvements
  - Used conversion control feature macro instead of that in IO map.

[2.0.1]

- Bug Fixes
  - Fixed MISRA-2012 rules.
    - Rule 16.4, 10.1, 13.2, 14.4 and 17.7.

[2.0.0]

- Initial version

CMP

[2.0.3]

- Improvements
  - Updated to clear CMP settings in DeInit function.

[2.0.2]

- Bug Fixes
  - Fixed the violations of MISRA 2012 rules:
    - Rule 10.3

[2.0.1]

- Bug Fixes
  - Fixed MISRA-2012 rules.
    - Rule 14.4, rule 10.3, rule 10.1, rule 10.4 and rule 17.7.

[2.0.0]

- Initial version.

COMMON

[2.6.0]

- Bug Fixes
  - Fix CERT-C violations.

[2.5.0]

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

[2.4.3]

- Improvements
  - Enable irqs 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.

COP

[2.0.2]

- Bug Fixes
  - Fixed CERT INT31-C violations.

[2.0.1]

- Bug Fixes
  - Fixed MISRA-2012 issues.
    - Rule 10.1 and rule 17.7.

[2.0.0]

- Initial version.

DAC

[2.0.2]

- Bug Fixes
  - Fixed MISRA-2012 issues:
    - Rule 10.3, 10.8 and 17.7.

[2.0.1]

- Bug Fixes
  - Moved the default DAC_Enable(..., true) from DAC_Init() to the application code so that users can enable the DAC's output.

[2.0.0]

- Initial version.

DMA

[2.1.2]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.3.

[2.1.1]

- Improvements
  - Corrected the dma channel feature macro from FSL_FEATURE_DMAMUX_MODULE_CHANNEL to FSL_FEATURE_DMA_MODULE_CHANNEL.

[2.1.0]

- Improvements
  - Added api DMA_PrepareTransferConfig to expose option address increment.
  - Added api DMA_EnableAutoStopRequest to support auto stop request feature.

[2.0.2]

- Bug Fixes
  - Fixed violations of MISRA C-2012 rule 10.4, 10.3, 14.4, 16.4, 11.6, 10.1.

[2.0.1]

- Bug Fixes
  - By adding parenthesis, fixed the build fail of DMA driver due to rule 12.5, MISRA C 2004.

[2.0.0]

- Initial version.

DMAMUX

[2.1.2]

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

[2.1.1]

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

[2.1.0]

- Improvements
  - Modify the type of parameter source from uint32_t to int32_t in the DMAMUX_SetSource.

[2.0.5]

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

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

- Bug Fixes
  - Fixed the build warning issue by changing the type of parameter source from uint8_t to uint32_t when setting DMA request source in DMAMUX_SetSourceChange.

[2.0.0]

- Initial version.

FLASH

[3.2.0]

- New Feature
  - Basic support for FTFC

[3.1.3]

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

[3.1.2]

- Bug Fixes — Remove redundant comments.

[3.1.1]

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

[3.1.0]

- New Feature
  - Support erase flash asynchronously.

[3.0.2]

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

[3.0.1]

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

[3.0.0]

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

[2.3.1]

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

[2.3.0]

- New Features
  - Added support for device with LP flash (K3S/G).
  - Added flash prefetch speculation APIs.
- Improvements
  - Refined flash_cache_clear function.
  - Reorganized the member of flash_config_t struct.

[2.2.0]

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

[2.1.0]

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

[2.0.0]

- Initial version

FLEXIO

[2.3.0]

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

[2.2.3]

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

[2.2.2]

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

[2.2.1]

- Improvements
  - Added doxygen index parameter comment in FLEXIO_SetClockMode.

[2.2.0]

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

[2.1.0]

- Improvements
  - Added API FLEXIO_SetClockMode to set flexio channel counter and source clock.

[2.0.4]

- Bug Fixes
  - Fixed MISRA 8.4 issues.

[2.0.3]

- Bug Fixes
  - Fixed MISRA 10.4 issues.

[2.0.2]

- Improvements
  - Split FLEXIO component which combines all flexio/flexio_uart/flexio_i2c/flexio_i2s drivers into several components: FlexIO component, flexio_uart component, flexio_i2c_master component, and flexio_i2s component.
- Bug Fixes
  - Fixed MISRA issues
    * Fixed rules 10.1, 10.3, 10.4, 10.7, 11.6, 11.9, 14.4, 17.7.

[2.0.1]

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

FLEXIO_I2C

[2.6.1]

- Bug Fixes
  - Fixed coverity issues

[2.6.0]

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

[2.5.1]

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

[2.5.0]

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

[2.4.0]

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

[2.3.0]

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

[2.2.0]

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

[2.1.7]

- Bug Fixes
  - Fixed the issue that FLEXIO_I2C_MasterTransferBlocking did not wait for STOP bit sent.
  - Fixed COVERITY issue of useless call in FLEXIO_I2C_MasterTransferRunStateMachine.
  - Fixed the issue that I2C master did not check whether bus was busy before transfer.

[2.1.6]

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

[2.1.5]

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

[2.1.4]

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

[2.1.3]

- Improvements
  - Changed the prototype of FLEXIO_I2C_MasterInit to return kStatus_Success if initialized successfully or to return kStatus_InvalidArgument if "(srcClock_Hz / masterConfig->baudRate_Bps) / 2 - 1" exceeds 0xFFU.

[2.1.2]

- Bug Fixes
  - Fixed the FLEXIO I2C issue where the master could not receive data from I2C slave in high baudrate.
  - Fixed the FLEXIO I2C issue where the master could not receive NAK when master sent non-existent addr.
  - Fixed the FLEXIO I2C issue where the master could not get transfer count successfully.
  - Fixed the FLEXIO I2C issue where the master could not receive data successfully when sending data first.
  - Fixed the Dozen mode configuration error in FLEXIO_I2C_MasterInit API. For enableInDoze = true, the configuration should be 0; for enableInDoze = false, the configuration should be 1.
  - Fixed the issue that FLEXIO_I2C_MasterTransferBlocking API called FLEXIO_I2C_MasterTransferCreateHandle, which lead to the s_flexioHandle/s_flexioIsr/s_flexioType variable being written. Then, if calling FLEXIO_I2C_MasterTransferBlocking API multiple times, the s_flexioHandle/s_flexioIsr/s_flexioType variable would not be written any more due to it being out of range. This lead to the following situation: NonBlocking transfer APIs could not work due to the fail of register IRQ.

[2.1.1]

- Bug Fixes
  - Implemented the FLEXIO_I2C_MasterTransferBlocking API which is defined in header file but has no implementation in the C file.

[2.1.0]

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

FLEXIO_I2S

[2.2.2]

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

[2.2.1]

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

[2.2.0]

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

[2.1.6]

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

[2.1.5]

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

[2.1.4]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

FLEXIO_SPI

[2.4.2]

- Bug Fixes
  - Fixed FLEXIO_SPI_MasterTransferBlocking and FLEXIO_SPI_MasterTransferNonBlocking issue in CS continuous mode, the CS might not be continuous.

[2.4.1]

- Bug Fixes
  - Fixed coverity issues

[2.4.0]

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

[2.3.5]

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

[2.3.4]

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

[2.3.3]

- Bugfixes
  - Fixed cs-continuous mode.

[2.3.2]

- Improvements
  - Changed FLEXIO_SPI_DUMMYDATA to 0x00.

[2.3.1]

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

[2.3.0]

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

[2.2.1]

- Bug Fixes
  - Fixed bug in FLEXIO_SPI_MasterTransferAbortEDMA that when aborting EDMA transfer EDMA_AbortTransfer should be used rather than EDMA_StopTransfer.

[2.2.0]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

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

[2.1.0]

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

FLEXIO_UART

[2.6.2]

- Bug Fixes
  - Fixed coverity issues

[2.6.1]

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

[2.6.0]

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

[2.5.1]

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

[2.5.0]

- Improvements
  - Added API FLEXIO_UART_FlushShifters to flush UART fifo.

[2.4.0]

- Improvements
  - Use separate data for TX and RX in flexio_uart_transfer_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling FLEXIO_UART_TransferReceiveNonBlocking, the received data count returned by FLEXIO_UART_TransferGetReceiveCount is wrong.

[2.3.0]

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

[2.2.0]

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

[2.1.6]

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

[2.1.5]

- Improvements
  - Triggered user callback after all the data in ringbuffer were received in FLEXIO_UART_TransferReceiveNonBlocking.

[2.1.4]

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

[2.1.3]

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

[2.1.2]

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

[2.1.1]

- Bug Fixes
  - Changed the API name FLEXIO_UART_StopRingBuffer to FLEXIO_UART_TransferStopRingBuffer to align with the definition in C file.

[2.1.0]

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

FLEXIO_UART_DMA

[2.3.0]

- Refer FLEXIO_UART driver change log to 2.3.0

GPIO

[2.8.2]

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

[2.8.1]

- Bug Fixes
  - Fixed CERT INT31-C issues.

[2.8.0]

- Improvements
  - Add API GPIO_PortInit/GPIO_PortDeinit to set GPIO clock enable and releasing GPIO reset.

[2.8.0]

- Improvements
  - Add API GPIO_PortInit/GPIO_PortDeinit to set GPIO clock enable and releasing GPIO reset.
  - Remove support for API GPIO_GetPinsDMARequestFlags with GPIO_ISFR_COUNT <= 1.

[2.7.3]

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

[2.7.2]

- New Features
  - Support devices without PORT module.

[2.7.1]

- Bug Fixes
  - Fixed MISRA C-2012 rule 10.4 issues in GPIO_GpioGetInterruptChannelFlags() function and GPIO_GpioClearInterruptChannelFlags() function.

[2.7.0]

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

[2.6.0]

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

[2.5.3]

- Bug Fixes
  - Correct the feature macro typo: FSL_FEATURE_GPIO_HAS_NO_INDEP_OUTPUT_CONTORL.

[2.5.2]

- Improvements
  - Improved GPIO_PortSet/GPIO_PortClear/GPIO_PortToggle functions to support devices without Set/Clear/Toggle registers.

[2.5.1]

- Bug Fixes
  - Fixed wrong macro definition.
  - Fixed MISRA C-2012 rule issues in the FGPIO_CheckAttributeBytes() function.
  - Defined the new macro to separate the scene when the width of registers is different.
  - Removed some redundant macros.
- New Features
  - Added some APIs to get/clear the interrupt status flag when the port doesn't control pins' interrupt.

[2.4.1]

- Improvements
  - Improved GPIO_CheckAttributeBytes() function to support 8 bits width GACR register.

[2.4.0]

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

[2.3.2]

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

[2.3.1]

- Improvements
  - Removed deprecated APIs.

[2.3.0]

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

[2.2.1]

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

[2.1.1]

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

[2.1.0]

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

I2C

[2.0.10]

- Bug Fixes
  - Fixed coverity issues.

[2.0.9]

- Bug Fixes
  - Fixed the MISRA-2012 violations.
    * Fixed rule 8.4, 10.1, 10.4, 13.5, 20.8.

[2.0.8]

- Bug Fixes
  - Fixed the bug that DFEN bit of I2C Status register 2 could not be set in I2C_MasterInit.
  - MISRA C-2012 issue fixed: rule 14.2, 15.7, and 16.4.
  - Eliminated IAR Pa082 warnings from I2C_MasterTransferDMA and I2C_MasterTransferCallbackDMA by assigning volatile variables to local variables and using local variables instead.
  - Fixed MISRA issues.
    * Fixed rules 10.1, 10.3, 10.4, 11.9, 14.4, 15.7, 17.7.
- Improvements
  - Improved timeout mechanism when waiting certain state in transfer API.
  - Updated the I2C_WAIT_TIMEOUT macro to unified name I2C_RETRY_TIMES.
  - Moved the master manually acknowledge byte operation into static function I2C_MasterAckByte.
  - Fixed control/status clean flow issue inside I2C_MasterReadBlocking to avoid potential issue that pending status is cleaned before it’s proceeded.

[2.0.7]

- Bug Fixes
  - Fixed the issue for MISRA-2012 check.
    * Fixed rule 11.9 ,15.7 ,14.4 ,10.4 ,10.8 ,10.3, 10.1, 10.6, 13.5, 11.3, 13.2, 17.7, 5.7, 8.3, 8.5, 11.1, 16.1.
  - Fixed Coverity issue of unchecked return value in I2C_RTOS_Transfer.

  - Fixed variable redefine issue by moving i2cBases from fsl_i2c.h to fsl_i2c.c.

- Improvements
  - Added I2C_MASTER_FACK_CONTROL macro to enable FACK control for master transfer receive flow with IP supporting double buffer, then master could hold the SCL by manually setting TX AK/NAK during data transfer.

[2.0.6]

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

[2.0.5]

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

[2.0.4]

- Bug Fixes
  - Added a proper handle for transfer config flag kI2C_TransferNoStartFlag to support transmit with kI2C_TransferNoStartFlag flag. Support write only or write+read with no start flag; does not support read only with no start flag.

[2.0.3]

- Bug Fixes
  - Removed enableHighDrive member in the master/slave configuration structure because the operation to HDRS bit is useless, the user need to use DSE bit in port register to configure the high drive capability.
  - Added register reset operation in I2C_MasterInit and I2C_SlaveInit APIs. Fixed issue where I2C could not switch between master and slave mode.
  - Improved slave IRQ handler to handle the corner case that stop flag and address match flag come synchronously.

[2.0.2]

- Bug Fixes
  - Fixed issue in master receive and slave transmit mode with no stop flag. The master could not succeed to start next transfer because the master could not send out re-start signal.
  - Fixed the out-of-order issue of data transfer due to memory barrier.
  - Added hold time configuration for slave. By leaving the SCL divider and MULT reset values when configured to slave mode, the setup and hold time of the slave is then reduced outside of spec for lower baudrates. This can cause intermittent arbitration loss on the master side.
- New Features

  - Added address nak event for master.
  - Added general call event for slave.

[2.0.1]

- New Features
  - Added double buffer enable configuration for SoCs which have the DFEN bit in S2 register.
  - Added flexible transmit/receive buffer size support in I2C_SlaveHandleIRQ.
  - Added start flag clear, address match, and release bus operation in I2C_SlaveWrite/ReadBlocking API.
- Bug Fixes
  - Changed the kI2C_SlaveRepeatedStartEvent to kI2C_SlaveStartEvent.

[2.0.0]

- Initial version.

LLWU

[2.0.5]

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

[2.0.4]

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

[2.0.3]

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

[2.0.2]

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

[2.0.1]

- Other Changes
  - Updates for KL8x.

[2.0.0]

- Initial version.

LPTMR

[2.2.0]

- Improvements
  - Updated lptmr_prescaler_clock_select_t, only define the valid options.

[2.1.1]

- Improvements
  - Updated the characters from "PTMR" to "LPTMR" in "FSL_FEATURE_PTMR_HAS_NO_PRESCALER_CLOCK_SOURCE_1_SUPPORT" feature definition.

[2.1.0]

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

[2.0.2]

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

[2.0.1]

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

[2.0.0]

- Initial version.

LPUART

[2.9.1]

- Bug Fixes
  - Fixed coverity issues.

[2.9.0]

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

[2.8.3]

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

[2.8.2]

- Bug Fix
  - Fixed the bug that LPUART_TransferEnable16Bit controled by wrong feature macro.

[2.8.1]

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

[2.8.0]

- Improvements
  - Added support of DATA register for 9bit or 10bit data transmit in write and read API. Such as: LPUART_WriteBlocking16bit, LPUART_ReadBlocking16bit, LPUART_TransferEnable16Bit LPUART_WriteNonBlocking16bit, LPUART_ReadNonBlocking16bit.

[2.7.7]

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

[2.7.6]

- Bug Fixes
  - Fixed LPUART_EnableInterrupts and LPUART_DisableInterrupts bug that blocks if the LPUART address doesn't support exclusive access.

[2.7.5]

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

[2.7.4]

- Improvements
  - Added support for atomic register accessing in LPUART_EnableInterrupts and LPUART_DisableInterrupts.

[2.7.3]

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

[2.7.2]

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

[2.7.1]

- Improvements
  - Added support for LPUART_BASE_PTRS_NS in security mode in file fsl_lpuart.c.

[2.7.0]

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

[2.6.0]

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

[2.5.3]

- Bug Fixes
  - Fixed comments by replacing unused status flags kLPUART_NoiseErrorInRxDataRegFlag and kLPUART_ParityErrorInRxDataRegFlag with kLPUART_NoiseErrorFlag and kLPUART_ParityErrorFlag.

[2.5.2]

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

[2.5.1]

- Improvements
  - Use separate data for TX and RX in lpuart_transfer_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling LPUART_TransferReceiveNonBlocking, the received data count returned by LPUART_TransferGetReceiveCount is wrong.

[2.5.0]

- Bug Fixes
  - Added missing interrupt enable masks kLPUART_Match1InterruptEnable and kLPUART_Match2InterruptEnable.
  - Fixed bug in LPUART_EnableInterrupts, LPUART_DisableInterrupts and LPUART_GetEnabledInterrupts that the BAUD[LBKDIE] bit field should be soc specific.
  - Fixed bug in LPUART_TransferHandleIRQ that idle line interrupt should be disabled when rx data size is zero.
  - Deleted unused status flags kLPUART_NoiseErrorInRxDataRegFlag and kLPUART_ParityErrorInRxDataRegFlag, since firstly their function are the same as kLPUART_NoiseErrorFlag and kLPUART_ParityErrorFlag, secondly to obtain them one data word must be read out thus interfering with the receiving process.
  - Fixed bug in LPUART_GetStatusFlags that the STAT[LBKDIF], STAT[MA1F] and STAT[MA2F] should be soc specific.
  - Fixed bug in LPUART_ClearStatusFlags that tx/rx FIFO is reset by mistake when clearing flags.
  - Fixed bug in LPUART_TransferHandleIRQ that while clearing idle line flag the other bits should be masked in case other status bits be cleared by accident.
  - Fixed bug of race condition during LPUART transfer using transactional APIs, by disabling and re-enabling the global interrupt before and after critical operations on interrupt enable register.
  - Fixed DMA/eDMA transfer blocking issue by enabling tx idle interrupt after DMA/eDMA transmission finishes.
- New Features
  - Added APIs LPUART_GetRxFifoCount/LPUART_GetTxFifoCount to get rx/tx FIFO data count.
  - Added APIs LPUART_SetRxFifoWatermark/LPUART_SetTxFifoWatermark to set rx/tx FIFO water mark.

[2.4.1]

- Bug Fixes
  - Fixed MISRA advisory 17.7 issues.

[2.4.0]

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

[2.3.1]

- Bug Fixes
  - Fixed MISRA advisory 15.5 issues.

[2.3.0]

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

[2.2.8]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule-10.3, rule-14.4, rule-15.5.
  - Eliminated Pa082 warnings by assigning volatile variables to local variables and using local variables instead.
  - Fixed MISRA issues.
    - Fixed rules 10.1, 10.3, 10.4, 10.8, 14.4, 11.6, 17.7.
- Improvements
  - Added check for kLPUART_TransmissionCompleteFlag in LPUART_WriteBlocking, LPUART_TransferHandleIRQ, LPUART_TransferSendDMACallback and LPUART_SendEDMACallback to ensure all the data would be sent out to bus.
  - Rounded up the calculated sbr value in LPUART_SetBaudRate and LPUART_Init to achieve more acurate baudrate setting. Changed osr from uint32_t to uint8_t since osr's bigest value is 31.
  - Modified LPUART_ReadBlocking so that if more than one receiver errors occur, all status flags will be cleared and the most severe error status will be returned.

[2.2.7]

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

[2.2.6]

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

[2.2.5]

- Bug Fixes
  - Do not set or clear the TIE/RIE bits when using LPUART_EnableTxDMA and LPUART_EnableRxDMA.

[2.2.4]

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

[2.2.3]

- Improvements
  - Changed parameter type in LPUART_RTOS_Init struct from rtos_lpuart_config to lpuart_rtos_config_t.
- Bug Fixes
  - Disabled LPUART receive interrupt instead of all NVICs when reading data from ring buffer. Otherwise when the ring buffer is used, receive nonblocking method will disable all NVICs to protect the ring buffer. This may has a negative effect on other IPs that are using the interrupt.

[2.2.2]

- Improvements
  - Added software reset feature support.
  - Added software reset API in LPUART_Init.

[2.2.1]

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

[2.2.0]

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

[2.1.1]

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

[2.1.0]

- Improvements
  - Update transactional APIs.

LPUART_DMA

[2.4.0]

- Refer LPUART driver change log 2.1.0 to 2.4.0

MCM

[2.2.0]

- Improvements
  - Support platforms with less features.

[2.1.0]

- Others
  - Remove byteID from mcm_lmem_fault_attribute_t for document update.

[2.0.0]

- Initial version.

PIT

[2.2.0]

- Bug Fixes
  - According to ERR050763, PIT_LDVAL_STAT register is not reliable in dynamic load mode, so remove the status check in PIT_SetRtiTimerPeriod which added since 2.1.1.
  - Removed not used bit PIT_RTI_TCTRL_CHN_MASK.
- Improvements
  - Added more guide about get RTI load status in PIT_SetRtiTimerPeriod's API comment.
  - Change PIT_RTI_Deinit to inline API.
  - Ensure PIT peripheral clock enabled in PIT_RTI_Init.
- New Features
  - Added PIT_ClearRtiSyncStatus API to clear the RTI_LDVAL_STAT register.

[2.1.1]

- Bug Fixes
  - Enable PIT when using RTI to ensure RTI can work properly in debug mode.
- Improvements
  - Added status check in PIT_SetRtiTimerPeriod to ensure the load value is synchronized into the RTI clock domain.
  - Added note for PIT_RTI_Init to remind users wait RTI sync.

[2.1.0]

- New Features
  - Support RTI (Real Time Interrupt) timer.

[2.0.5]

- Improvements
  - Support workaround for ERR007914. This workaround guarantee the write to MCR register is not ignored.

[2.0.4]

- Bug Fixes
  - Fixed PIT_SetTimerPeriod implementation, the load value trigger should be PIT clock cycles minus 1.

[2.0.3]

- Bug Fixes
  - Clear all status bits for all channels to make sure the status of all TCTRL registers is clean.

[2.0.2]

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

[2.0.1]

- Bug Fixes
  - Cleared timer enable bit for all channels in function PIT_Init() to make sure all channels stay in disable status before setting other configurations.
  - Fixed MISRA-2012 rules.
    - Rule 14.4, rule 10.4.

[2.0.0]

- Initial version.

PMC

[2.0.3]

- Bug Fixes
  - Fixed the violation of MISRA C-2012 rule 11.3.

[2.0.2]

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

[2.0.1]

- Bug Fixes
  - Fixed MISRA issues.
    - Rule 10.8, Rule 10.3.

[2.0.0]

- Initial version.

PORT

[2.5.1]

- Bug Fixes
  - Fix CERT INT31-C issues.

[2.5.0]

- Bug Fixes
  - Correct the kPORT_MuxAsGpio for some platforms.

[2.4.1]

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

[2.4.0]

- New Features
  - Updated port_pin_config_t to support input buffer and input invert.

[2.3.0]

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

[2.2.0]

- New Features
  - Added new api PORT_EnablePinDoubleDriveStrength.

[2.1.1]

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

[2.1.0]

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

[2.0.2]

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

[2.0.1]

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

RCM

[2.0.4]

- Bug Fixes
  - Fixed violation of MISRA C-2012 rule 10.3

[2.0.3]

- Bug Fixes
  - Fixed violation of MISRA C-2012 rules.

[2.0.2]

- Bug Fixes
  - Fixed MISRA issue.
    - Rule 10.8, rule 10.1, rule 13.2, rule 3.1.

[2.0.1]

- Bug Fixes
  - Fixed kRCM_SourceSw bit shift issue.

[2.0.0]

- Initial version.

RTC

[2.3.3]

- Bug Fixes
  - Fix RTC_GetDatetime function validating datetime issue.

[2.3.2]

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

[2.3.1]

- Bug Fixes
  - Fixed CERT INT31-C violations.

[2.3.0]

- Improvements
  - Added API RTC_EnableLPOClock to set 1kHz LPO clock.
  - Added API RTC_EnableCrystalClock to replace API RTC_SetClockSource.

[2.2.2]

- Improvements
  - Refine _rtc_interrupt_enable order.

[2.2.1]

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

[2.2.0]

- Bug Fixes
  - Fixed MISRA C-2012 issue.
    - Fixed rule contain: rule-17.7, rule-14.4, rule-10.4, rule-10.7, rule-10.1, rule-10.3.
  - Fixed central repository code formatting issue.
- Improvements
  - Added an API for enabling wakeup pin.

[2.1.0]

- Improvements
  - Added feature macro check for many features.

[2.0.0]

- Initial version.

SIM

[2.2.0]

- Improvements
  - Added API to trigger TRGMUX.

[2.1.3]

- Improvements
  - Updated function SIM_GetUniqueId to support different register names.

[2.1.2]

- Bug Fixes
  - Fixed SIM_GetUniqueId bug that could not get UIDH.

[2.1.1]

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

[2.1.0]

- Improvements
  - Added new APIs: SIM_GetRfAddr() and SIM_EnableSystickClock().

[2.0.0]

- Initial version.

SLCD

[2.1.0]

- New Features
  - Added new enumerations, updated SLCD_Init and SLCD_GetDefaultConfig to support new low power IP on new SoCs.

[2.0.4]

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

[2.0.3]

- Bug Fixes
  - Fixed SLCD_Init bug that some bit-fileds are cleared by mistake.

[2.0.2]

- Bug Fixes
  - Fixed violations of the MISRA C-2012 rules 3.1, 10.1, 10.3, 10.3, 10.4 11.4, 17.7

[2.0.1]

- Bug Fixes
  - Changed the Blink mode start setting flow.
- Other Changes
  - Added static to SLCD global variables.

[2.0.0]

- Initial version.

SMC

[2.0.7]

- Bug Fixes
  - Fixed MISRA-2012 issue 10.3.

[2.0.6]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule 10.3, rule 11.3.

[2.0.5]

- Bug Fixes
  - Fixed issue for MISRA-2012 check.
    - Fixed rule 15.7, rule 14.4, rule 10.3, rule 10.1, rule 10.4.

[2.0.4]

- Bug Fixes
  - When entering stop modes, used RAM function for the flash synchronization issue. Application should make sure that, the RW data of fsl_smc.c is located in memory region which is not powered off in stop modes.

[2.0.3]

- Improvements
  - Added APIs SMC_PreEnterStopModes, SMC_PreEnterWaitModes, SMC_PostExitWaitModes, and SMC_PostExitStopModes.

[2.0.2]

- Bug Fixes
  - Added DSB before WFI while ISB after WFI.
- Other Changes
  - Updated SMC_SetPowerModeVlpw implementation.

[2.0.1]

- Other Changes
  - Updated for KL8x.

[2.0.0]

- Initial version.

SPI

[2.1.4]

- Bug Fixes
  - Fixed coverity issues.

[2.1.3]

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

[2.1.2]

- Improvements
  - Changed SPI_DUMMYDATA to 0x00.

[2.1.1]

- Bug Fixes
  - Fixed MISRA 10.3 violation.

[2.1.0]

- Improvements
  - Added timeout mechanism when waiting certain states in transfer driver.
- Bug Fixes
  - Fixed the bug that, when working as a slave, instance that does not have FIFO may miss some rx data.
  - Fixed master RX data overflow issue by synchronizing transmit and receive process.
  - Fixed issue that slave should not share the same non-blocking initialization API and IRQ handler with master to prevent dead lock issue.
  - Fixed issue that callback should be invoked after all data is sent out to bus.
  - Added code in SPI_SlaveTransferNonBlocking to empty rx buffer before initializing transfer.

[2.0.5]

- Bug Fixes
  - Eliminated Pa082 warnings from SPI_WriteNonBlocking and SPI_GetStatusFlags.
  - Fixed MISRA issues.
    - Fixed issues 10.1, 10.3, 10.4, 10.7, 10.8, 11.9, 14.4, 17.7.

[2.0.4]

- New Features
  - Supported 3-wire mode for SPI driver. Added new API SPI_SetPinMode() to control the transfer direction of the single wire. For master instance, MOSI is selected as I/O pin. For slave instance, MISO is selected as I/O pin.
  - Added dummy data setup API to allow users to configure the dummy data to be transferred.

[2.0.3]

- Bug Fixes
  - Fixed the potential interrupt race condition at high baudrate when calling API SPI_MasterTransferNonBlocking.

[2.0.2]

- New Features
  - Allowed users to set the transfer size for SPI_TransferNoBlocking non-integer times of watermark.
  - Allowed users to define the dummy data. Users only need to define the macro SPI_DUMMYDATA in applications.

[2.0.1]

- Bug Fixes
  - Fixed SPI_Enable function parameter error.
  - Set the s_dummy variable as static variable in fsl_spi_dma.c.
- Improvements
  - Optimized the code size while not using transactional API.
  - Improved performance in polling method.
  - Added #ifndef/#endif to allow users to change the default tx value at compile time.

[2.0.0]

- Initial version.

SPI DMA Driver

[2.1.1]

- Bug Fixes
  - Fixed the bug that TX data not sent to bus when transfer finish callback is called.

[2.1.0]

- Improvements
  - Added timeout mechanism when waiting certain states in transfer driver.
- Bug Fixes
  - Fixed the bug that, when working as a slave, instance that does not have FIFO may miss some rx data.
  - Fixed master RX data overflow issue by synchronizing transmit and receive process.
  - Fixed issue that slave should not share the same non-blocking initialization API and IRQ handler with master to prevent dead lock issue.
  - Fixed issue that callback should be invoked after all data is sent out to bus.
  - Added code in SPI_SlaveTransferNonBlocking to empty rx buffer before initializing transfer.

[2.0.5]

- Bug Fixes
  - Eliminated Pa082 warnings from SPI_WriteNonBlocking and SPI_GetStatusFlags.
  - Fixed MISRA issues.
    - Fixed issues 10.1, 10.3, 10.4, 10.7, 10.8, 11.9, 14.4, 17.7.

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  - Supported 3-wire mode for SPI driver. Added new API SPI_SetPinMode() to control the transfer direction of the single wire. For master instance, MOSI is selected as I/O pin. For slave instance, MISO is selected as I/O pin.
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[2.0.3]

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  - Fixed SPI_Enable function parameter error.
  - Set the s_dummy variable as static variable in fsl_spi_dma.c.
- Improvements
  - Optimized the code size while not using transactional API.
  - Improved performance in polling method.
  - Added #ifndef/#endif to allow users to change the default tx value at compile time.

[2.0.0]

- Initial version.

TPM

[2.3.5]

- New Feature
  - Added IRQ handler entry for TPM2.

[2.3.4]

- New Feature
  - Added common IRQ handler entry TPM_DriverIRQHandler.

[2.3.3]

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

[2.3.2]

- Bug Fixes
  - Fixed ERR008085 TPM writing the TPMx_MOD or TPMx_CnV registers more than once may fail when the timer is disabled.

[2.3.1]

- Bug Fixes
  - Fixed compilation error when macro FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL is 1.

[2.3.0]

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

[2.2.4]

- Improvements
  - Add feature macros(FSL_FEATURE_TPM_HAS_GLOBAL_TIME_BASE_EN, FSL_FEATURE_TPM_HAS_GLOBAL_TIME_BASE_SYNC).

[2.2.3]

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

[2.2.2]

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

[2.2.1]

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

[2.2.0]

- Improvements
  - Added TPM_SetChannelPolarity to support select channel input/output polarity.
  - Added TPM_EnableChannelExtTrigger to support enable external trigger input to be used by channel.
  - Added TPM_CalculateCounterClkDiv to help calculates the counter clock prescaler.
  - Added TPM_GetChannelValue to support get TPM channel value.
  - Added new TPM configuration.
    - syncGlobalTimeBase
    - extTriggerPolarity
    - chnlPolarity
  - Added new PWM signal configuration.
    - secPauseLevel
- Bug Fixes
  - Fixed TPM_SetupPwm can't configure 0% combined PWM issues.

[2.1.1]

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

[2.1.0]

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

[2.0.8]

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

[2.0.7]

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

[2.0.6]

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

[2.0.5]

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

[2.0.4]

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

[2.0.3]

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

[2.0.2]

- Bug Fixes
  - Fixed issues in functions TPM_SetupPwm/TPM_UpdateChnlEdgeLevelSelect /TPM_SetupInputCapture/TPM_SetupOutputCompare/TPM_SetupDualEdgeCapture, wait acknowledgement when the channel is disabled.

[2.0.1]

- Bug Fixes
  - Fixed TPM_UpdateChnIEdgeLevelSelect ACK wait issue.
  - Fixed the issue that TPM_SetupdualEdgeCapture could not set FILTER register.
  - Fixed TPM_UpdateChnEdgeLevelSelect ACK wait issue.

[2.0.0]

- Initial version.

UART

[2.5.1]

- Improvements
  - Use separate data for TX and RX in uart_transfer_t.
- Bug Fixes
  - Fixed bug that when ring buffer is used, if some data is received in ring buffer first before calling UART_TransferReceiveNonBlocking, the received data count returned by UART_TransferGetReceiveCount is wrong.

[2.5.0]

- New Features
  - Added APIs UART_GetRxFifoCount/UART_GetTxFifoCount to get rx/tx FIFO data count.
  - Added APIs UART_SetRxFifoWatermark/UART_SetTxFifoWatermark to set rx/tx FIFO water mark.
- Bug Fixes
  - Fixed bug of race condition during UART transfer using transactional APIs, by disabling and re-enabling the global interrupt before and after critical operations on interrupt enable registers.
  - Fixed DMA/eDMA transfer blocking issue by enabling tx idle interrupt after DMA/eDMA transmission finishes.

[2.4.0]

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

[2.3.0]

- Bug Fixes
  - Fixed the bug that, when framing/parity/noise/overflow flag or idle line detect flag is set, receive FIFO should be flushed to avoid FIFO pointer being in unknown state, since FIFO has no valid data.
- Improvements
  - Modified UART_TransferHandleIRQ so that txState will be set to idle only when all data has been sent out to bus.
  - Modified UART_TransferGetSendCount so that this API returns the real byte count that UART has sent out rather than the software buffer status.
  - Added timeout mechanism when waiting for certain states in transfer driver.

[2.2.0]

- New Features
  - Added UART hardware FIFO enable/disable API.
- Improvements
  - Added check for kUART_TransmissionCompleteFlag in UART_TransferHandleIRQ, UART_SendEDMACallback and UART_TransferSendDMACallback to ensure all the data would be sent out to bus.
- Bug Fixes
  - Eliminated IAR Pa082 warnings from UART_TransferGetRxRingBufferLength, UART_GetEnabledInterrupts, UART_GetStatusFlags and UART_TransferHandleIRQ.
  - Added code in UART_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.
  - Fixed MISRA issues.
    - Fixed rules 10.1, 10.3, 10.4, 14.4, 11.6, 17.7.

[2.1.6]

- Bug Fixes
  - Fixed the issue of register's being in repeatedly reading status while performing the IRQ routine.

[2.1.5]

- Improvements
  - Added hardware flow control function support.
  - Added idle-line-detecting feature in UART_TransferNonBlocking function. If an idle line is detected, a callback will be triggered with status kStatus_UART_IdleLineDetected returned. This feature may be useful when the number of received bytes is less than the expected receive data size. Before triggering the callback, data in the FIFO is read out (if it has FIFO), and no interrupt will be disabled except for the case that the receive data size reaches 0.
  - Enabled the RX FIFO watermark function. With the idle-line-detecting feature enabled, you can set the watermark value to whatever you want (should not be bigger than the RX FIFO size). Data is then received and a callback will be triggered when data receive ends.

[2.1.4]

- Improvements
  - Changed parameter type in UART_RTOS_Init() struct rtos_uart_config –> uart_rtos_config_t.
- Bug Fixes
  - Disabled UART receive interrupt instead of global interrupt when reading data from ring buffer. With ring buffer used, receive nonblocking will disable global interrupt to protect the ring buffer. This has a negative effect on other IPs using interrupt.

[2.1.3]

- New Features
  - Added RX framing error and parity error status check when using interrupt transfer.

[2.1.2]

- Bug Fixes
  - Fixed baud rate fine adjust bug to make the computed baud rate more accurate.

[2.1.1]

- Bug Fixes
  - Removed needless check of event flags and assert in UART_RTOS_Receive.
  - Always waited for RX event flag in UART_RTOS_Receive.

[2.1.0]

- Improvements
  - Added transactional API.

[2.0.0]

- Initial version.

UART_DMA

[2.5.0]

- Refer UART driver change log 2.1.0 to 2.5.0

VREF

[2.1.3]

- Improvements
  - Add timeout for APIs with dfmea issues.

[2.1.2]

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

[2.1.1]

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

[2.1.0]

- Improvements
  - Added new functions to support L5K board: added VREF_SetTrim2V1Val() and VREF_GetTrim2V1Val() functions to supply 2V1 output mode.

[2.0.0]

- Initial version.

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.

K32L2B31A

1.7 Middleware Documentation

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

1.7.1 Multicore

multicore

1.7.2 FreeMASTER

freemaster

1.7.3 FreeRTOS

FreeRTOS

1.7.4 File systemFatfs

fatfs

Chapter 2

K32L2B31A

2.1 ADC16: 16-bit SAR Analog-to-Digital Converter Driver

void ADC16_Init(ADC_Type *base, const *adc16_config_t* *config)

Initializes the ADC16 module.

Parameters

- base – ADC16 peripheral base address.
- config – Pointer to configuration structure. See “adc16_config_t”.

void ADC16_Deinit(ADC_Type *base)

De-initializes the ADC16 module.

Parameters

- base – ADC16 peripheral base address.

void ADC16_GetDefaultConfig(*adc16_config_t* *config)

Gets an available pre-defined settings for the converter’s configuration.

This function initializes the converter configuration structure with available settings. The default values are as follows.

```
config->referenceVoltageSource      = kADC16_ReferenceVoltageSourceVref;
config->clockSource                 = kADC16_ClockSourceAsynchronousClock;
config->enableAsynchronousClock     = false;
config->clockDivider                = kADC16_ClockDivider8;
config->resolution                  = kADC16_ResolutionSE12Bit;
config->longSampleMode              = kADC16_LongSampleDisabled;
config->enableHighSpeed             = false;
config->enableLowPower              = false;
config->enableContinuousConversion = false;
```

Parameters

- config – Pointer to the configuration structure.

status_t ADC16_DoAutoCalibration(ADC_Type *base)

Automates the hardware calibration.

This auto calibration helps to adjust the plus/minus side gain automatically. Execute the calibration before using the converter. Note that the hardware trigger should be used during the calibration.

Parameters

- base – ADC16 peripheral base address.

Return values

- kStatus_Success – Calibration is done successfully.
- kStatus_Fail – Calibration has failed.

Returns
Execution status.

static inline void ADC16_SetOffsetValue(ADC_Type *base, int16_t value)

Sets the offset value for the conversion result.

This offset value takes effect on the conversion result. If the offset value is not zero, the reading result is subtracted by it. Note, the hardware calibration fills the offset value automatically.

Parameters

- base – ADC16 peripheral base address.
- value – Setting offset value.

static inline void ADC16_EnableDMA(ADC_Type *base, bool enable)

Enables generating the DMA trigger when the conversion is complete.

Parameters

- base – ADC16 peripheral base address.
- enable – Switcher of the DMA feature. “true” means enabled, “false” means not enabled.

static inline void ADC16_EnableHardwareTrigger(ADC_Type *base, bool enable)

Enables the hardware trigger mode.

Parameters

- base – ADC16 peripheral base address.
- enable – Switcher of the hardware trigger feature. “true” means enabled, “false” means not enabled.

void ADC16_SetChannelMuxMode(ADC_Type *base, *adc16_channel_mux_mode_t* mode)

Sets the channel mux mode.

Some sample pins share the same channel index. The channel mux mode decides which pin is used for an indicated channel.

Parameters

- base – ADC16 peripheral base address.
- mode – Setting channel mux mode. See “adc16_channel_mux_mode_t”.

void ADC16_SetHardwareCompareConfig(ADC_Type *base, const *adc16_hardware_compare_config_t* *config)

Configures the hardware compare mode.

The hardware compare mode provides a way to process the conversion result automatically by using hardware. Only the result in the compare range is available. To compare the range, see “adc16_hardware_compare_mode_t” or the appopriate reference manual for more information.

Parameters

- base – ADC16 peripheral base address.

- config – Pointer to the "adc16_hardware_compare_config_t" structure. Passing "NULL" disables the feature.

void ADC16_SetHardwareAverage(ADC_Type *base, *adc16_hardware_average_mode_t* mode)

Sets the hardware average mode.

The hardware average mode provides a way to process the conversion result automatically by using hardware. The multiple conversion results are accumulated and averaged internally making them easier to read.

Parameters

- base – ADC16 peripheral base address.
- mode – Setting the hardware average mode. See "adc16_hardware_average_mode_t".

void ADC16_SetPGAConfig(ADC_Type *base, const *adc16_pga_config_t* *config)

Configures the PGA for the converter's front end.

Parameters

- base – ADC16 peripheral base address.
- config – Pointer to the "adc16_pga_config_t" structure. Passing "NULL" disables the feature.

uint32_t ADC16_GetStatusFlags(ADC_Type *base)

Gets the status flags of the converter.

Parameters

- base – ADC16 peripheral base address.

Returns

Flags' mask if indicated flags are asserted. See "_adc16_status_flags".

void ADC16_ClearStatusFlags(ADC_Type *base, uint32_t mask)

Clears the status flags of the converter.

Parameters

- base – ADC16 peripheral base address.
- mask – Mask value for the cleared flags. See "_adc16_status_flags".

static inline void ADC16_EnableAsynchronousClockOutput(ADC_Type *base, bool enable)

Enable/disable ADC Asynchronous clock output to other modules.

Parameters

- base – ADC16 peripheral base address.
- enable – Used to enable/disable ADC ADACK output.
  - **true** Asynchronous clock and clock output is enabled regardless of the state of the ADC.
  - **false** Asynchronous clock output disabled, asynchronous clock is enabled only if it is selected as input clock and a conversion is active.

void ADC16_SetChannelConfig(ADC_Type *base, uint32_t channelGroup, const *adc16_channel_config_t* *config)

Configures the conversion channel.

This operation triggers the conversion when in software trigger mode. When in hardware trigger mode, this API configures the channel while the external trigger source helps to trigger the conversion.

Note that the "Channel Group" has a detailed description. To allow sequential conversions of the ADC to be triggered by internal peripherals, the ADC has more than one group of status and control registers, one for each conversion. The channel group parameter indicates which group of registers are used, for example, channel group 0 is for Group A registers and channel group 1 is for Group B registers. The channel groups are used in a "ping-pong" approach to control the ADC operation. At any point, only one of the channel groups is actively controlling ADC conversions. The channel group 0 is used for both software and hardware trigger modes. Channel group 1 and greater indicates multiple channel group registers for use only in hardware trigger mode. See the chip configuration information in the appropriate MCU reference manual for the number of SC1n registers (channel groups) specific to this device. Channel group 1 or greater are not used for software trigger operation. Therefore, writing to these channel groups does not initiate a new conversion. Updating the channel group 0 while a different channel group is actively controlling a conversion is allowed and vice versa. Writing any of the channel group registers while that specific channel group is actively controlling a conversion aborts the current conversion.

Parameters

- base – ADC16 peripheral base address.
- channelGroup – Channel group index.
- config – Pointer to the "adc16_channel_config_t" structure for the conversion channel.

static inline uint32_t ADC16_GetChannelConversionValue(ADC_Type *base, uint32_t channelGroup)

Gets the conversion value.

Parameters

- base – ADC16 peripheral base address.
- channelGroup – Channel group index.

Returns

Conversion value.

uint32_t ADC16_GetChannelStatusFlags(ADC_Type *base, uint32_t channelGroup)

Gets the status flags of channel.

Parameters

- base – ADC16 peripheral base address.
- channelGroup – Channel group index.

Returns

Flags' mask if indicated flags are asserted. See "_adc16_channel_status_flags".

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ADC16 driver version 2.3.0.

enum _adc16_channel_status_flags

Channel status flags.

Values:

enumerator kADC16_ChannelConversionDoneFlag

Conversion done.

enum _adc16_status_flags

Converter status flags.

Values:

enumerator kADC16_ActiveFlag
Converter is active.

enumerator kADC16_CalibrationFailedFlag
Calibration is failed.

enum _adc_channel_mux_mode
Channel multiplexer mode for each channel.

For some ADC16 channels, there are two pin selections in channel multiplexer. For example, ADC0_SE4a and ADC0_SE4b are the different channels that share the same channel number.

Values:

enumerator kADC16_ChannelMuxA
For channel with channel mux a.

enumerator kADC16_ChannelMuxB
For channel with channel mux b.

enum _adc16_clock_divider
Clock divider for the converter.

Values:

enumerator kADC16_ClockDivider1
For divider 1 from the input clock to the module.

enumerator kADC16_ClockDivider2
For divider 2 from the input clock to the module.

enumerator kADC16_ClockDivider4
For divider 4 from the input clock to the module.

enumerator kADC16_ClockDivider8
For divider 8 from the input clock to the module.

enum _adc16_resolution
Converter's resolution.

Values:

enumerator kADC16_Resolution8or9Bit
Single End 8-bit or Differential Sample 9-bit.

enumerator kADC16_Resolution12or13Bit
Single End 12-bit or Differential Sample 13-bit.

enumerator kADC16_Resolution10or11Bit
Single End 10-bit or Differential Sample 11-bit.

enumerator kADC16_ResolutionSE8Bit
Single End 8-bit.

enumerator kADC16_ResolutionSE12Bit
Single End 12-bit.

enumerator kADC16_ResolutionSE10Bit
Single End 10-bit.

enumerator kADC16_ResolutionDF9Bit
Differential Sample 9-bit.

enumerator kADC16_ResolutionDF13Bit
Differential Sample 13-bit.

enumerator kADC16_ResolutionDF11Bit
Differential Sample 11-bit.

enum _adc16_clock_source
Clock source.

Values:

enumerator kADC16_ClockSourceAlt0
Selection 0 of the clock source.

enumerator kADC16_ClockSourceAlt1
Selection 1 of the clock source.

enumerator kADC16_ClockSourceAlt2
Selection 2 of the clock source.

enumerator kADC16_ClockSourceAlt3
Selection 3 of the clock source.

enumerator kADC16_ClockSourceAsynchronousClock
Using internal asynchronous clock.

enum _adc16_long_sample_mode
Long sample mode.

Values:

enumerator kADC16_LongSampleCycle24
20 extra ADCK cycles, 24 ADCK cycles total.

enumerator kADC16_LongSampleCycle16
12 extra ADCK cycles, 16 ADCK cycles total.

enumerator kADC16_LongSampleCycle10
6 extra ADCK cycles, 10 ADCK cycles total.

enumerator kADC16_LongSampleCycle6
2 extra ADCK cycles, 6 ADCK cycles total.

enumerator kADC16_LongSampleDisabled
Disable the long sample feature.

enum _adc16_reference_voltage_source
Reference voltage source.

Values:

enumerator kADC16_ReferenceVoltageSourceVref
For external pins pair of VrefH and VrefL.

enumerator kADC16_ReferenceVoltageSourceValt
For alternate reference pair of ValtH and ValtL.

enum _adc16_hardware_average_mode
Hardware average mode.

Values:

enumerator kADC16_HardwareAverageCount4
For hardware average with 4 samples.

enumerator kADC16_HardwareAverageCount8
For hardware average with 8 samples.

enumerator kADC16_HardwareAverageCount16
For hardware average with 16 samples.

enumerator kADC16_HardwareAverageCount32
For hardware average with 32 samples.

enumerator kADC16_HardwareAverageDisabled
Disable the hardware average feature.

enum _adc16_hardware_compare_mode
Hardware compare mode.

Values:

enumerator kADC16_HardwareCompareMode0
x < value1.

enumerator kADC16_HardwareCompareMode1
x > value1.

enumerator kADC16_HardwareCompareMode2
if value1 <= value2, then x < value1 || x > value2; else, value1 > x > value2.

enumerator kADC16_HardwareCompareMode3
if value1 <= value2, then value1 <= x <= value2; else x >= value1 || x <= value2.

enum _adc16_pga_gain
PGA's Gain mode.

Values:

enumerator kADC16_PGAGainValueOf1
For amplifier gain of 1.

enumerator kADC16_PGAGainValueOf2
For amplifier gain of 2.

enumerator kADC16_PGAGainValueOf4
For amplifier gain of 4.

enumerator kADC16_PGAGainValueOf8
For amplifier gain of 8.

enumerator kADC16_PGAGainValueOf16
For amplifier gain of 16.

enumerator kADC16_PGAGainValueOf32
For amplifier gain of 32.

enumerator kADC16_PGAGainValueOf64
For amplifier gain of 64.

typedef enum *_adc_channel_mux_mode* adc16_channel_mux_mode_t
Channel multiplexer mode for each channel.

For some ADC16 channels, there are two pin selections in channel multiplexer. For example, ADC0_SE4a and ADC0_SE4b are the different channels that share the same channel number.

typedef enum *_adc16_clock_divider* adc16_clock_divider_t
Clock divider for the converter.

typedef enum *_adc16_resolution* adc16_resolution_t
Converter's resolution.

typedef enum *_adc16_clock_source* adc16_clock_source_t
Clock source.

typedef enum *_adc16_long_sample_mode* adc16_long_sample_mode_t
Long sample mode.

typedef enum *_adc16_reference_voltage_source* adc16_reference_voltage_source_t
Reference voltage source.

typedef enum *_adc16_hardware_average_mode* adc16_hardware_average_mode_t
Hardware average mode.

typedef enum *_adc16_hardware_compare_mode* adc16_hardware_compare_mode_t
Hardware compare mode.

typedef enum *_adc16_pga_gain* adc16_pga_gain_t
PGA's Gain mode.

typedef struct *_adc16_config* adc16_config_t
ADC16 converter configuration.

typedef struct *_adc16_hardware_compare_config* adc16_hardware_compare_config_t
ADC16 Hardware comparison configuration.

typedef struct *_adc16_channel_config* adc16_channel_config_t
ADC16 channel conversion configuration.

typedef struct *_adc16_pga_config* adc16_pga_config_t
ADC16 programmable gain amplifier configuration.

struct _adc16_config
#include <fsl_adc16.h> ADC16 converter configuration.

Public Members

adc16_reference_voltage_source_t referenceVoltageSource
Select the reference voltage source.

adc16_clock_source_t clockSource
Select the input clock source to converter.

bool enableAsynchronousClock
Enable the asynchronous clock output.

adc16_clock_divider_t clockDivider
Select the divider of input clock source.

adc16_resolution_t resolution
Select the sample resolution mode.

adc16_long_sample_mode_t longSampleMode
Select the long sample mode.

bool enableHighSpeed
Enable the high-speed mode.

bool enableLowPower
Enable low power.

bool enableContinuousConversion

Enable continuous conversion mode.

adc16_hardware_average_mode_t hardwareAverageMode

Set hardware average mode.

struct __adc16__hardware__compare__config

#include <fsl_adc16.h> ADC16 Hardware comparison configuration.

Public Members

adc16_hardware_compare_mode_t hardwareCompareMode

Select the hardware compare mode. See "adc16_hardware_compare_mode_t".

int16_t value1

Setting value1 for hardware compare mode.

int16_t value2

Setting value2 for hardware compare mode.

struct __adc16__channel__config

#include <fsl_adc16.h> ADC16 channel conversion configuration.

Public Members

uint32_t channelNumber

Setting the conversion channel number. The available range is 0-31. See channel connection information for each chip in Reference Manual document.

bool enableInterruptOnConversionCompleted

Generate an interrupt request once the conversion is completed.

bool enableDifferentialConversion

Using Differential sample mode.

struct __adc16__pga__config

#include <fsl_adc16.h> ADC16 programmable gain amplifier configuration.

Public Members

adc16_pga_gain_t pgaGain

Setting PGA gain.

bool enableRunInNormalMode

Enable PGA working in normal mode, or low power mode by default.

bool disablePgaChopping

Disable the PGA chopping function. The PGA employs chopping to remove/reduce offset and 1/f noise and offers an offset measurement configuration that aids the offset calibration.

bool enableRunInOffsetMeasurement

Enable the PGA working in offset measurement mode. When this feature is enabled, the PGA disconnects itself from the external inputs and auto-configures into offset measurement mode. With this field set, run the ADC in the recommended settings and enable the maximum hardware averaging to get the PGA offset number. The output is the (PGA offset * (64+1)) for the given PGA setting.

2.2 Clock Driver

enum _clock_name

Clock name used to get clock frequency.

Values:

enumerator kCLOCK_CoreSysClk
Core/system clock

enumerator kCLOCK_PlatClk
Platform clock

enumerator kCLOCK_BusClk
Bus clock

enumerator kCLOCK_FlexBusClk
FlexBus clock

enumerator kCLOCK_FlashClk
Flash clock

enumerator kCLOCK_FastPeriphClk
Fast peripheral clock

enumerator kCLOCK_PllFllSelClk
The clock after SIM[PLLFLLSEL].

enumerator kCLOCK_Er32kClk
External reference 32K clock (ERCLK32K)

enumerator kCLOCK_Osc0ErClk
OSC0 external reference clock (OSC0ERCLK)

enumerator kCLOCK_Osc1ErClk
OSC1 external reference clock (OSC1ERCLK)

enumerator kCLOCK_Osc0ErClkUndiv
OSC0 external reference undivided clock(OSC0ERCLK_UNDIV).

enumerator kCLOCK_McgFixedFreqClk
MCG fixed frequency clock (MCGFFCLK)

enumerator kCLOCK_McgInternalRefClk
MCG internal reference clock (MCGIRCLK)

enumerator kCLOCK_McgFllClk
MCGFLLCLK

enumerator kCLOCK_McgPll0Clk
MCGPLL0CLK

enumerator kCLOCK_McgPll1Clk
MCGPLL1CLK

enumerator kCLOCK_McgExtPllClk
EXT_PLLCLK

enumerator kCLOCK_McgPeriphClk
MCG peripheral clock (MCGPCLK)

enumerator kCLOCK_McgIrc48MClk
MCG IRC48M clock

enumerator kCLOCK_LpoClk
LPO clock

enum _clock_usb_src
USB clock source definition.

Values:

enumerator kCLOCK_UsbSrcIrc48M
Use IRC48M.

enumerator kCLOCK_UsbSrcExt
Use USB_CLKIN.

enum _clock_ip_name
Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

Values:

enumerator kCLOCK_IpInvalid

enumerator kCLOCK_I2c0

enumerator kCLOCK_I2c1

enumerator kCLOCK_Uart2

enumerator kCLOCK_Usbfs0

enumerator kCLOCK_Cmp0

enumerator kCLOCK_Vref0

enumerator kCLOCK_Spi0

enumerator kCLOCK_Spi1

enumerator kCLOCK_Lptmr0

enumerator kCLOCK_PortA

enumerator kCLOCK_PortB

enumerator kCLOCK_PortC

enumerator kCLOCK_PortD

enumerator kCLOCK_PortE

enumerator kCLOCK_Slcd0

enumerator kCLOCK_Lpuart0

enumerator kCLOCK_Lpuart1

enumerator kCLOCK_Flexio0

enumerator kCLOCK_Ftf0

enumerator kCLOCK_Dmamux0

enumerator kCLOCK_Sai0

enumerator kCLOCK_Pit0

enumerator kCLOCK_Tpm0

enumerator kCLOCK_Tpm1

enumerator kCLOCK_Tpm2

enumerator kCLOCK_Adc0

enumerator kCLOCK_Rtc0

enumerator kCLOCK_Dac0

enumerator kCLOCK_Dma0

enum _osc_cap_load

Oscillator capacitor load setting.

Values:

enumerator kOSC_Cap2P

2 pF capacitor load

enumerator kOSC_Cap4P

4 pF capacitor load

enumerator kOSC_Cap8P

8 pF capacitor load

enumerator kOSC_Cap16P

16 pF capacitor load

enum _oscer_enable_mode

OSCERCLK enable mode.

Values:

enumerator kOSC_ErClkEnable

Enable.

enumerator kOSC_ErClkEnableInStop

Enable in stop mode.

enum _osc_mode

The OSC work mode.

Values:

enumerator kOSC_ModeExt

Use external clock.

enumerator kOSC_ModeOscLowPower

Oscillator low power.

enumerator kOSC_ModeOscHighGain

Oscillator high gain.

enum _mcglite_clkout_src

MCG_Lite clock source selection.

Values:

enumerator kMCGLITE_ClkSrcHirc

MCGOUTCLK source is HIRC

enumerator kMCGLITE_ClkSrcLirc
MCGOUTCLK source is LIRC

enumerator kMCGLITE_ClkSrcExt
MCGOUTCLK source is external clock source

enumerator kMCGLITE_ClkSrcReserved

enum _mcglite_lirc_mode
MCG_Lite LIRC select.

Values:

enumerator kMCGLITE_Lirc2M
Slow internal reference(LIRC) 2 MHz clock selected

enumerator kMCGLITE_Lirc8M
Slow internal reference(LIRC) 8 MHz clock selected

enum _mcglite_lirc_div
MCG_Lite divider factor selection for clock source.

Values:

enumerator kMCGLITE_LircDivBy1
Divider is 1

enumerator kMCGLITE_LircDivBy2
Divider is 2

enumerator kMCGLITE_LircDivBy4
Divider is 4

enumerator kMCGLITE_LircDivBy8
Divider is 8

enumerator kMCGLITE_LircDivBy16
Divider is 16

enumerator kMCGLITE_LircDivBy32
Divider is 32

enumerator kMCGLITE_LircDivBy64
Divider is 64

enumerator kMCGLITE_LircDivBy128
Divider is 128

enum _mcglite_mode
MCG_Lite clock mode definitions.

Values:

enumerator kMCGLITE_ModeHirc48M
Clock mode is HIRC 48 M

enumerator kMCGLITE_ModeLirc8M
Clock mode is LIRC 8 M

enumerator kMCGLITE_ModeLirc2M
Clock mode is LIRC 2 M

enumerator kMCGLITE_ModeExt
Clock mode is EXT

enumerator kMCGLITE_ModeError
Unknown mode

enum _mcglite_irclk_enable_mode
MCG internal reference clock (MCGIRCLK) enable mode definition.

Values:

enumerator kMCGLITE_IrclkEnable
MCGIRCLK enable.

enumerator kMCGLITE_IrclkEnableInStop
MCGIRCLK enable in stop mode.

typedef enum *_clock_name* clock_name_t
Clock name used to get clock frequency.

typedef enum *_clock_usb_src* clock_usb_src_t
USB clock source definition.

typedef enum *_clock_ip_name* clock_ip_name_t
Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.

typedef struct *_sim_clock_config* sim_clock_config_t
SIM configuration structure for clock setting.

typedef struct *_oscer_config* oscer_config_t
The OSC configuration for OSCERCLK.

typedef enum *_osc_mode* osc_mode_t
The OSC work mode.

typedef struct *_osc_config* osc_config_t
OSC Initialization Configuration Structure.

Defines the configuration data structure to initialize the OSC. When porting to a new board, set the following members according to the board settings:

a. freq: The external frequency.

b. workMode: The OSC module mode.

typedef enum *_mcglite_clkout_src* mcglite_clkout_src_t
MCG_Lite clock source selection.

typedef enum *_mcglite_lirc_mode* mcglite_lirc_mode_t
MCG_Lite LIRC select.

typedef enum *_mcglite_lirc_div* mcglite_lirc_div_t
MCG_Lite divider factor selection for clock source.

typedef enum *_mcglite_mode* mcglite_mode_t
MCG_Lite clock mode definitions.

typedef struct *_mcglite_config* mcglite_config_t
MCG_Lite configure structure for mode change.

volatile uint32_t g_xtal0Freq
External XTAL0 (OSC0) clock frequency.

The XTAL0/EXTAL0 (OSC0) clock frequency in Hz. When the clock is set up, use the function CLOCK_SetXtal0Freq to set the value in the clock driver. For example, if XTAL0 is 8 MHz:

```
CLOCK_InitOsc0(...);
CLOCK_SetXtal0Freq(80000000);
```

This is important for the multicore platforms where one core needs to set up the OSC0 using the CLOCK_InitOsc0. All other cores need to call the CLOCK_SetXtal0Freq to get a valid clock frequency.

volatile uint32_t g_xtal32Freq

The external XTAL32/EXTAL32/RTC_CLKIN clock frequency.

The XTAL32/EXTAL32/RTC_CLKIN clock frequency in Hz. When the clock is set up, use the function CLOCK_SetXtal32Freq to set the value in the clock driver.

This is important for the multicore platforms where one core needs to set up the clock. All other cores need to call the CLOCK_SetXtal32Freq to get a valid clock frequency.

static inline void CLOCK_EnableClock(*clock_ip_name_t* name)

Enable the clock for specific IP.

Parameters

- name – Which clock to enable, see clock_ip_name_t.

static inline void CLOCK_DisableClock(*clock_ip_name_t* name)

Disable the clock for specific IP.

Parameters

- name – Which clock to disable, see clock_ip_name_t.

static inline void CLOCK_SetEr32kClock(uint32_t src)

Set ERCLK32K source.

Parameters

- src – The value to set ERCLK32K clock source.

static inline void CLOCK_SetLpuart0Clock(uint32_t src)

Set LPUART0 clock source.

Parameters

- src – The value to set LPUART0 clock source.

static inline void CLOCK_SetLpuart1Clock(uint32_t src)

Set LPUART1 clock source.

Parameters

- src – The value to set LPUART1 clock source.

static inline void CLOCK_SetTpmClock(uint32_t src)

Set TPM clock source.

Parameters

- src – The value to set TPM clock source.

static inline void CLOCK_SetFlexio0Clock(uint32_t src)

Set FLEXIO clock source.

Parameters

- src – The value to set FLEXIO clock source.

bool CLOCK_EnableUsbfs0Clock(*clock_usb_src_t* src, uint32_t freq)

Enable USB FS clock.

Parameters

- src – USB FS clock source.
- freq – The frequency specified by src.

Return values

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

static inline void CLOCK_DisableUsbfs0Clock(void)

Disable USB FS clock.

Disable USB FS clock.

static inline void CLOCK_SetClkOutClock(uint32_t src)

Set CLKOUT source.

Parameters

- src – The value to set CLKOUT source.

static inline void CLOCK_SetRtcClkOutClock(uint32_t src)

Set RTC_CLKOUT source.

Parameters

- src – The value to set RTC_CLKOUT source.

static inline void CLOCK_SetOutDiv(uint32_t outdiv1, uint32_t outdiv4)

System clock divider.

Set the SIM_CLKDIV1[OUTDIV1], SIM_CLKDIV1[OUTDIV4].

Parameters

- outdiv1 – Clock 1 output divider value.
- outdiv4 – Clock 4 output divider value.

uint32_t CLOCK_GetFreq(*clock_name_t* clockName)

Gets the clock frequency for a specific clock name.

This function checks the current clock configurations and then calculates the clock frequency for a specific clock name defined in clock_name_t. The MCG must be properly configured before using this function.

Parameters

- clockName – Clock names defined in clock_name_t

Returns
Clock frequency value in Hertz

uint32_t CLOCK_GetCoreSysClkFreq(void)

Get the core clock or system clock frequency.

Returns
Clock frequency in Hz.

uint32_t CLOCK_GetPlatClkFreq(void)

Get the platform clock frequency.

Returns
Clock frequency in Hz.

uint32_t CLOCK_GetBusClkFreq(void)

Get the bus clock frequency.

Returns
Clock frequency in Hz.

uint32_t CLOCK_GetFlashClkFreq(void)

Get the flash clock frequency.

Returns
Clock frequency in Hz.

uint32_t CLOCK_GetEr32kClkFreq(void)

Get the external reference 32K clock frequency (ERCLK32K).

Returns
Clock frequency in Hz.

uint32_t CLOCK_GetOsc0ErClkFreq(void)

Get the OSC0 external reference clock frequency (OSC0ERCLK).

Returns
Clock frequency in Hz.

void CLOCK_SetSimConfig(*sim_clock_config_t* const *config)

Set the clock configure in SIM module.

This function sets system layer clock settings in SIM module.

Parameters

- config – Pointer to the configure structure.

static inline void CLOCK_SetSimSafeDivs(void)

Set the system clock dividers in SIM to safe value.

The system level clocks (core clock, bus clock, flexbus clock and flash clock) must be in allowed ranges. During MCG clock mode switch, the MCG output clock changes then the system level clocks may be out of range. This function could be used before MCG mode change, to make sure system level clocks are in allowed range.

FSL_CLOCK_DRIVER_VERSION

CLOCK driver version 2.3.1.

SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY

DMAMUX_CLOCKS

Clock ip name array for DMAMUX.

RTC_CLOCKS

Clock ip name array for RTC.

SAI_CLOCKS

Clock ip name array for SAI.

SPI_CLOCKS

Clock ip name array for SPI.

SLCD_CLOCKS

Clock ip name array for SLCD.

PIT_CLOCKS

Clock ip name array for PIT.

PORT_CLOCKS

Clock ip name array for PORT.

LPUART_CLOCKS

Clock ip name array for LPUART.

DAC_CLOCKS
: Clock ip name array for DAC.

LPTMR_CLOCKS
: Clock ip name array for LPTMR.

ADC16_CLOCKS
: Clock ip name array for ADC16.

FLEXIO_CLOCKS
: Clock ip name array for FLEXIO.

VREF_CLOCKS
: Clock ip name array for VREF.

DMA_CLOCKS
: Clock ip name array for DMA.

UART_CLOCKS
: Clock ip name array for UART.

TPM_CLOCKS
: Clock ip name array for TPM.

I2C_CLOCKS
: Clock ip name array for I2C.

FTF_CLOCKS
: Clock ip name array for FTF.

CMP_CLOCKS
: Clock ip name array for CMP.

LPO_CLK_FREQ
: LPO clock frequency.

SYS_CLK
: Peripherals clock source definition.

BUS_CLK

I2C0_CLK_SRC

I2C1_CLK_SRC

SPI0_CLK_SRC

SPI1_CLK_SRC

UART2_CLK_SRC

CLK_GATE_REG_OFFSET_SHIFT

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)

uint32_t CLOCK_GetOutClkFreq(void)

Gets the MCG_Lite output clock (MCGOUTCLK) frequency.

This function gets the MCG_Lite output clock frequency in Hz based on the current MCG_Lite register value.

Returns

The frequency of MCGOUTCLK.

uint32_t CLOCK_GetInternalRefClkFreq(void)

Gets the MCG internal reference clock (MCGIRCLK) frequency.

This function gets the MCG_Lite internal reference clock frequency in Hz based on the current MCG register value.

Returns

The frequency of MCGIRCLK.

uint32_t CLOCK_GetPeriphClkFreq(void)

Gets the current MCGPCLK frequency.

This function gets the MCGPCLK frequency in Hz based on the current MCG_Lite register settings.

Returns

The frequency of MCGPCLK.

mcglite_mode_t CLOCK_GetMode(void)

Gets the current MCG_Lite mode.

This function checks the MCG_Lite registers and determines the current MCG_Lite mode.

Returns

The current MCG_Lite mode or error code.

status_t CLOCK_SetMcgliteConfig(*mcglite_config_t* const *targetConfig)

Sets the MCG_Lite configuration.

This function configures the MCG_Lite, includes the output clock source, MCGIRCLK settings, HIRC settings, and so on. See mcglite_config_t for details.

Parameters

- targetConfig – Pointer to the target MCG_Lite mode configuration structure.

Returns

Error code.

static inline void OSC_SetExtRefClkConfig(OSC_Type *base, *oscer_config_t* const *config)

Configures the OSC external reference clock (OSCERCLK).

This function configures the OSC external reference clock (OSCERCLK). This is an example to enable the OSCERCLK in normal mode and stop mode, and set the output divider to 1.

```
oscer_config_t config =
{
    .enableMode = kOSC_ErClkEnable | kOSC_ErClkEnableInStop,
    .erclkDiv   = 1U,
};

OSC_SetExtRefClkConfig(OSC, &config);
```

Parameters

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

static inline void OSC_SetCapLoad(OSC_Type *base, uint8_t capLoad)

Sets the capacitor load configuration for the oscillator.

This function sets the specified capacitor configuration for the oscillator. This should be done in the early system level initialization function call based on the system configuration.

Example:

```
OSC_SetCapLoad(OSC, kOSC_Cap2P | kOSC_Cap8P);
```

Parameters

- base – OSC peripheral address.
- capLoad – OR'ed value for the capacitor load option.See _osc_cap_load.

void CLOCK_InitOsc0(*osc_config_t* const *config)

Initializes the OSC0.

This function initializes the OSC0 according to the board configuration.

Parameters

- config – Pointer to the OSC0 configuration structure.

void CLOCK_DeinitOsc0(void)

Deinitializes the OSC0.

This function deinitializes the OSC0.

static inline void CLOCK_SetXtal0Freq(uint32_t freq)

Sets the XTAL0 frequency based on board settings.

Parameters

- freq – The XTAL0/EXTAL0 input clock frequency in Hz.

static inline void CLOCK_SetXtal32Freq(uint32_t freq)

Sets the XTAL32/RTC_CLKIN frequency based on board settings.

Parameters

- freq – The XTAL32/EXTAL32/RTC_CLKIN input clock frequency in Hz.

uint8_t er32kSrc

ERCLK32K source selection.

uint32_t clkdiv1

SIM_CLKDIV1.

uint8_t enableMode

OSCERCLK enable mode. OR'ed value of _oscer_enable_mode.

uint32_t freq

External clock frequency.

uint8_t capLoad

Capacitor load setting.

osc_mode_t workMode

OSC work mode setting.

oscer_config_t oscerConfig

Configuration for OSCERCLK.

mcglite_clkout_src_t outSrc
MCGOUT clock select.

uint8_t ircIkEnableMode
MCGIRCLK enable mode, OR'ed value of _mcglite_irclk_enable_mode.

mcglite_lirc_mode_t ircs
MCG_C2[IRCS].

mcglite_lirc_div_t fcrdiv
MCG_SC[FCRDIV].

mcglite_lirc_div_t lircDiv2
MCG_MC[LIRC_DIV2].

bool hircEnableInNotHircMode
HIRC enable when not in HIRC mode.

FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL
Configure whether driver controls clock.

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

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

---

struct _sim_clock_config
#include <fsl_clock.h> SIM configuration structure for clock setting.

struct _oscer_config
#include <fsl_clock.h> The OSC configuration for OSCERCLK.

struct _osc_config
#include <fsl_clock.h> OSC Initialization Configuration Structure.

Defines the configuration data structure to initialize the OSC. When porting to a new board, set the following members according to the board settings:

a. freq: The external frequency.
b. workMode: The OSC module mode.

struct _mcglite_config
#include <fsl_clock.h> MCG_Lite configure structure for mode change.

2.3 CMP: Analog Comparator Driver

void CMP_Init(CMP_Type *base, const *cmp_config_t* *config)
Initializes the CMP.

This function initializes the CMP module. The operations included are as follows.

- Enabling the clock for CMP module.
- Configuring the comparator.
- Enabling the CMP module. Note that for some devices, multiple CMP instances share the same clock gate. In this case, to enable the clock for any instance enables all CMPs. See the appropriate MCU reference manual for the clock assignment of the CMP.

Parameters

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

void CMP_Deinit(CMP_Type *base)

De-initializes the CMP module.

This function de-initializes the CMP module. The operations included are as follows.

- Disabling the CMP module.
- Disabling the clock for CMP module.

This function disables the clock for the CMP. Note that for some devices, multiple CMP instances share the same clock gate. In this case, before disabling the clock for the CMP, ensure that all the CMP instances are not used.

Parameters

- base – CMP peripheral base address.

static inline void CMP_Enable(CMP_Type *base, bool enable)

Enables/disables the CMP module.

Parameters

- base – CMP peripheral base address.
- enable – Enables or disables the module.

void CMP_GetDefaultConfig(*cmp_config_t* *config)

Initializes the CMP user configuration structure.

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

```
config->enableCmp          = true;
config->hysteresisMode     = kCMP_HysteresisLevel0;
config->enableHighSpeed    = false;
config->enableInvertOutput = false;
config->useUnfilteredOutput = false;
config->enablePinOut       = false;
config->enableTriggerMode  = false;
```

Parameters

- config – Pointer to the configuration structure.

void CMP_SetInputChannels(CMP_Type *base, uint8_t positiveChannel, uint8_t negativeChannel)

Sets the input channels for the comparator.

This function sets the input channels for the comparator. Note that two input channels cannot be set the same way in the application. When the user selects the same input from the analog mux to the positive and negative port, the comparator is disabled automatically.

Parameters

- base – CMP peripheral base address.
- positiveChannel – Positive side input channel number. Available range is 0-7.
- negativeChannel – Negative side input channel number. Available range is 0-7.

void CMP_EnableDMA(CMP_Type *base, bool enable)

Enables/disables the DMA request for rising/falling events.

This function enables/disables the DMA request for rising/falling events. Either event triggers the generation of the DMA request from CMP if the DMA feature is enabled. Both events are ignored for generating the DMA request from the CMP if the DMA is disabled.

Parameters

- base – CMP peripheral base address.
- enable – Enables or disables the feature.

static inline void CMP_EnableWindowMode(CMP_Type *base, bool enable)

Enables/disables the window mode.

Parameters

- base – CMP peripheral base address.
- enable – Enables or disables the feature.

static inline void CMP_EnablePassThroughMode(CMP_Type *base, bool enable)

Enables/disables the pass through mode.

Parameters

- base – CMP peripheral base address.
- enable – Enables or disables the feature.

void CMP_SetFilterConfig(CMP_Type *base, const *cmp_filter_config_t* *config)

Configures the filter.

Parameters

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

void CMP_SetDACConfig(CMP_Type *base, const *cmp_dac_config_t* *config)

Configures the internal DAC.

Parameters

- base – CMP peripheral base address.
- config – Pointer to the configuration structure. "NULL" disables the feature.

void CMP_EnableInterrupts(CMP_Type *base, uint32_t mask)

Enables the interrupts.

Parameters

- base – CMP peripheral base address.
- mask – Mask value for interrupts. See "_cmp_interrupt_enable".

void CMP_DisableInterrupts(CMP_Type *base, uint32_t mask)

Disables the interrupts.

Parameters

- base – CMP peripheral base address.
- mask – Mask value for interrupts. See "_cmp_interrupt_enable".

uint32_t CMP_GetStatusFlags(CMP_Type *base)

Gets the status flags.

Parameters

- base – CMP peripheral base address.

Returns

Mask value for the asserted flags. See "_cmp_status_flags".

void CMP_ClearStatusFlags(CMP_Type *base, uint32_t mask)

Clears the status flags.

Parameters

- base – CMP peripheral base address.
- mask – Mask value for the flags. See "_cmp_status_flags".

FSL_CMP_DRIVER_VERSION

CMP driver version 2.0.3.

enum _cmp_interrupt_enable

Interrupt enable/disable mask.

Values:

enumerator kCMP_OutputRisingInterruptEnable

Comparator interrupt enable rising.

enumerator kCMP_OutputFallingInterruptEnable

Comparator interrupt enable falling.

enum _cmp_status_flags

Status flags' mask.

Values:

enumerator kCMP_OutputRisingEventFlag

Rising-edge on the comparison output has occurred.

enumerator kCMP_OutputFallingEventFlag

Falling-edge on the comparison output has occurred.

enumerator kCMP_OutputAssertEventFlag

Return the current value of the analog comparator output.

enum _cmp_hysteresis_mode

CMP Hysteresis mode.

Values:

enumerator kCMP_HysteresisLevel0

Hysteresis level 0.

enumerator kCMP_HysteresisLevel1

Hysteresis level 1.

enumerator kCMP_HysteresisLevel2

Hysteresis level 2.

enumerator kCMP_HysteresisLevel3

Hysteresis level 3.

enum __cmp__reference__voltage__source

CMP Voltage Reference source.

Values:

enumerator kCMP__VrefSourceVin1

Vin1 is selected as a resistor ladder network supply reference Vin.

enumerator kCMP__VrefSourceVin2

Vin2 is selected as a resistor ladder network supply reference Vin.

typedef enum *_cmp_hysteresis_mode* cmp__hysteresis__mode__t

CMP Hysteresis mode.

typedef enum *_cmp_reference_voltage_source* cmp__reference__voltage__source__t

CMP Voltage Reference source.

typedef struct *_cmp_config* cmp__config__t

Configures the comparator.

typedef struct *_cmp_filter_config* cmp__filter__config__t

Configures the filter.

typedef struct *_cmp_dac_config* cmp__dac__config__t

Configures the internal DAC.

struct __cmp__config

#include <fsl_cmp.h> Configures the comparator.

Public Members

bool enableCmp

Enable the CMP module.

cmp_hysteresis_mode_t hysteresisMode

CMP Hysteresis mode.

bool enableHighSpeed

Enable High-speed (HS) comparison mode.

bool enableInvertOutput

Enable the inverted comparator output.

bool useUnfilteredOutput

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

bool enablePinOut

The comparator output is available on the associated pin.

bool enableTriggerMode

Enable the trigger mode.

struct __cmp__filter__config

#include <fsl_cmp.h> Configures the filter.

Public Members

bool enableSample

Using the external SAMPLE as a sampling clock input or using a divided bus clock.

uint8_t filterCount
Filter Sample Count. Available range is 1-7; 0 disables the filter.

uint8_t filterPeriod
Filter Sample Period. The divider to the bus clock. Available range is 0-255.

struct _cmp_dac_config
#include <fsl_cmp.h> Configures the internal DAC.

Public Members

cmp_reference_voltage_source_t referenceVoltageSource
Supply voltage reference source.

uint8_t DACValue
Value for the DAC Output Voltage. Available range is 0-63.

2.4 COP: Watchdog Driver

void COP_GetDefaultConfig(*cop_config_t* *config)
Initializes the COP configuration structure.

This function initializes the COP configuration structure to default values. The default values are:

```
copConfig->enableWindowMode = false;
copConfig->timeoutMode = kCOP_LongTimeoutMode;
copConfig->enableStop = false;
copConfig->enableDebug = false;
copConfig->clockSource = kCOP_LpoClock;
copConfig->timeoutCycles = kCOP_2Power10CyclesOr2Power18Cycles;
```

See also:

cop_config_t

Parameters

- config – Pointer to the COP configuration structure.

void COP_Init(SIM_Type *base, const *cop_config_t* *config)
Initializes the COP module.

This function configures the COP. After it is called, the COP starts running according to the configuration. Because all COP control registers are write-once only, the COP_Init function and the COP_Disable function can be called only once. A second call has no effect.

Example:

```
cop_config_t config;
COP_GetDefaultConfig(&config);
config.timeoutCycles = kCOP_2Power8CyclesOr2Power16Cycles;
COP_Init(sim_base,&config);
```

Parameters

- base – SIM peripheral base address.
- config – The configuration of COP.

static inline void COP_Disable(SIM_Type *base)

De-initializes the COP module. This dedicated function is not provided. Instead, the COP_Disable function can be used to disable the COP.

Disables the COP module.

This function disables the COP Watchdog. Note: The COP configuration register is a write-once after reset. To disable the COP Watchdog, call this function first.

Parameters

- base – SIM peripheral base address.

void COP_Refresh(SIM_Type *base)

Refreshes the COP timer.

This function feeds the COP.

Parameters

- base – SIM peripheral base address.

FSL_COP_DRIVER_VERSION

COP driver version 2.0.2.

COP_FIRST_BYTE_OF_REFRESH

First byte of refresh sequence

COP_SECOND_BYTE_OF_REFRESH

Second byte of refresh sequence

enum _cop_clock_source

COP clock source selection.

Values:

enumerator kCOP_LpoClock

COP clock sourced from LPO

enumerator kCOP_McgIrClock

COP clock sourced from MCGIRCLK

enumerator kCOP_OscErClock

COP clock sourced from OSCERCLK

enumerator kCOP_BusClock

COP clock sourced from Bus clock

enum _cop_timeout_cycles

Define the COP timeout cycles.

Values:

enumerator kCOP_2Power5CyclesOr2Power13Cycles

2^5 or 2^13 clock cycles

enumerator kCOP_2Power8CyclesOr2Power16Cycles

2^8 or 2^16 clock cycles

enumerator kCOP_2Power10CyclesOr2Power18Cycles

2^10 or 2^18 clock cycles

enum _cop_timeout_mode

Define the COP timeout mode.

Values:

enumerator kCOP_ShortTimeoutMode
COP selects long timeout

enumerator kCOP_LongTimeoutMode
COP selects short timeout

typedef enum *_cop_clock_source* cop_clock_source_t
COP clock source selection.

typedef enum *_cop_timeout_cycles* cop_timeout_cycles_t
Define the COP timeout cycles.

typedef enum *_cop_timeout_mode* cop_timeout_mode_t
Define the COP timeout mode.

typedef struct *_cop_config* cop_config_t
Describes COP configuration structure.

struct _cop_config
#include <fsl_cop.h> Describes COP configuration structure.

Public Members

bool enableWindowMode
COP run mode: window mode or normal mode

cop_timeout_mode_t timeoutMode
COP timeout mode: long timeout or short timeout

bool enableStop
Enable or disable COP in STOP mode

bool enableDebug
Enable or disable COP in DEBUG mode

cop_clock_source_t clockSource
Set COP clock source

cop_timeout_cycles_t timeoutCycles
Set COP timeout value

2.5 DAC: Digital-to-Analog Converter Driver

void DAC_Init(DAC_Type *base, const *dac_config_t* *config)
Initializes the DAC module.

This function initializes the DAC module including the following operations.

- Enabling the clock for DAC module.
- Configuring the DAC converter with a user configuration.
- Enabling the DAC module.

Parameters

- base – DAC peripheral base address.
- config – Pointer to the configuration structure. See “dac_config_t”.

void DAC_Deinit(DAC_Type *base)

De-initializes the DAC module.

This function de-initializes the DAC module including the following operations.

- Disabling the DAC module.
- Disabling the clock for the DAC module.

Parameters

- base – DAC peripheral base address.

void DAC_GetDefaultConfig(*dac_config_t* *config)

Initializes the DAC user configuration structure.

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

```
config->referenceVoltageSource = kDAC_ReferenceVoltageSourceVref2;
config->enableLowPowerMode = false;
```

Parameters

- config – Pointer to the configuration structure. See "dac_config_t".

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

Enables the DAC module.

Parameters

- base – DAC peripheral base address.
- enable – Enables or disables the feature.

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

Enables the DAC buffer.

Parameters

- base – DAC peripheral base address.
- enable – Enables or disables the feature.

void DAC_SetBufferConfig(DAC_Type *base, const *dac_buffer_config_t* *config)

Configures the CMP buffer.

Parameters

- base – DAC peripheral base address.
- config – Pointer to the configuration structure. See "dac_buffer_config_t".

void DAC_GetDefaultBufferConfig(*dac_buffer_config_t* *config)

Initializes the DAC buffer configuration structure.

This function initializes the DAC buffer configuration structure to default values. The default values are as follows.

```
config->triggerMode = kDAC_BufferTriggerBySoftwareMode;
config->watermark   = kDAC_BufferWatermark1Word;
config->workMode    = kDAC_BufferWorkAsNormalMode;
config->upperLimit  = DAC_DATL_COUNT - 1U;
```

Parameters

- config – Pointer to the configuration structure. See "dac_buffer_config_t".

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

Enables the DMA for DAC buffer.

Parameters

- base – DAC peripheral base address.
- enable – Enables or disables the feature.

void DAC_SetBufferValue(DAC_Type *base, uint8_t index, uint16_t value)

Sets the value for items in the buffer.

Parameters

- base – DAC peripheral base address.
- index – Setting the index for items in the buffer. The available index should not exceed the size of the DAC buffer.
- value – Setting the value for items in the buffer. 12-bits are available.

static inline void DAC_DoSoftwareTriggerBuffer(DAC_Type *base)

Triggers the buffer using software and updates the read pointer of the DAC buffer.

This function triggers the function using software. The read pointer of the DAC buffer is updated with one step after this function is called. Changing the read pointer depends on the buffer's work mode.

Parameters

- base – DAC peripheral base address.

static inline uint8_t DAC_GetBufferReadPointer(DAC_Type *base)

Gets the current read pointer of the DAC buffer.

This function gets the current read pointer of the DAC buffer. The current output value depends on the item indexed by the read pointer. It is updated either by a software trigger or a hardware trigger.

Parameters

- base – DAC peripheral base address.

Returns

The current read pointer of the DAC buffer.

void DAC_SetBufferReadPointer(DAC_Type *base, uint8_t index)

Sets the current read pointer of the DAC buffer.

This function sets the current read pointer of the DAC buffer. The current output value depends on the item indexed by the read pointer. It is updated either by a software trigger or a hardware trigger. After the read pointer changes, the DAC output value also changes.

Parameters

- base – DAC peripheral base address.
- index – Setting an index value for the pointer.

void DAC_EnableBufferInterrupts(DAC_Type *base, uint32_t mask)

Enables interrupts for the DAC buffer.

Parameters

- base – DAC peripheral base address.
- mask – Mask value for interrupts. See "_dac_buffer_interrupt_enable".

void DAC_DisableBufferInterrupts(DAC_Type *base, uint32_t mask)

Disables interrupts for the DAC buffer.

Parameters

- base – DAC peripheral base address.
- mask – Mask value for interrupts. See "_dac_buffer_interrupt_enable".

uint8_t DAC_GetBufferStatusFlags(DAC_Type *base)

Gets the flags of events for the DAC buffer.

Parameters

- base – DAC peripheral base address.

Returns

Mask value for the asserted flags. See "_dac_buffer_status_flags".

void DAC_ClearBufferStatusFlags(DAC_Type *base, uint32_t mask)

Clears the flags of events for the DAC buffer.

Parameters

- base – DAC peripheral base address.
- mask – Mask value for flags. See "_dac_buffer_status_flags_t".

FSL_DAC_DRIVER_VERSION

DAC driver version 2.0.2.

enum _dac_buffer_status_flags

DAC buffer flags.

Values:

enumerator kDAC_BufferWatermarkFlag

DAC Buffer Watermark Flag.

enumerator kDAC_BufferReadPointerTopPositionFlag

DAC Buffer Read Pointer Top Position Flag.

enumerator kDAC_BufferReadPointerBottomPositionFlag

DAC Buffer Read Pointer Bottom Position Flag.

enum _dac_buffer_interrupt_enable

DAC buffer interrupts.

Values:

enumerator kDAC_BufferWatermarkInterruptEnable

DAC Buffer Watermark Interrupt Enable.

enumerator kDAC_BufferReadPointerTopInterruptEnable

DAC Buffer Read Pointer Top Flag Interrupt Enable.

enumerator kDAC_BufferReadPointerBottomInterruptEnable

DAC Buffer Read Pointer Bottom Flag Interrupt Enable

enum _dac_reference_voltage_source

DAC reference voltage source.

Values:

enumerator kDAC_ReferenceVoltageSourceVref1

The DAC selects DACREF_1 as the reference voltage.

enumerator kDAC_ReferenceVoltageSourceVref2
The DAC selects DACREF_2 as the reference voltage.

enum _dac_buffer_trigger_mode
DAC buffer trigger mode.

Values:

enumerator kDAC_BufferTriggerByHardwareMode
The DAC hardware trigger is selected.

enumerator kDAC_BufferTriggerBySoftwareMode
The DAC software trigger is selected.

enum _dac_buffer_watermark
DAC buffer watermark.

Values:

enumerator kDAC_BufferWatermark1Word
1 word away from the upper limit.

enumerator kDAC_BufferWatermark2Word
2 words away from the upper limit.

enumerator kDAC_BufferWatermark3Word
3 words away from the upper limit.

enumerator kDAC_BufferWatermark4Word
4 words away from the upper limit.

enum _dac_buffer_work_mode
DAC buffer work mode.

Values:

enumerator kDAC_BufferWorkAsNormalMode
Normal mode.

enumerator kDAC_BufferWorkAsSwingMode
Swing mode.

enumerator kDAC_BufferWorkAsOneTimeScanMode
One-Time Scan mode.

enumerator kDAC_BufferWorkAsFIFOMode
FIFO mode.

typedef enum *_dac_reference_voltage_source* dac_reference_voltage_source_t
DAC reference voltage source.

typedef enum *_dac_buffer_trigger_mode* dac_buffer_trigger_mode_t
DAC buffer trigger mode.

typedef enum *_dac_buffer_watermark* dac_buffer_watermark_t
DAC buffer watermark.

typedef enum *_dac_buffer_work_mode* dac_buffer_work_mode_t
DAC buffer work mode.

typedef struct *_dac_config* dac_config_t
DAC module configuration.

typedef struct *_dac_buffer_config* dac_buffer_config_t
DAC buffer configuration.

struct _dac_config
#include <fsl_dac.h> DAC module configuration.

Public Members

dac_reference_voltage_source_t referenceVoltageSource
Select the DAC reference voltage source.

bool enableLowPowerMode
Enable the low-power mode.

struct _dac_buffer_config
#include <fsl_dac.h> DAC buffer configuration.

Public Members

dac_buffer_trigger_mode_t triggerMode
Select the buffer's trigger mode.

dac_buffer_watermark_t watermark
Select the buffer's watermark.

dac_buffer_work_mode_t workMode
Select the buffer's work mode.

uint8_t upperLimit
Set the upper limit for the buffer index. Normally, 0-15 is available for a buffer with 16 items.

2.6 DMA: Direct Memory Access Controller Driver

void DMA_Init(DMA_Type *base)
Initializes the DMA peripheral.

This function ungates the DMA clock.

Parameters

- base – DMA peripheral base address.

void DMA_Deinit(DMA_Type *base)
Deinitializes the DMA peripheral.

This function gates the DMA clock.

Parameters

- base – DMA peripheral base address.

void DMA_ResetChannel(DMA_Type *base, uint32_t channel)
Resets the DMA channel.

Sets all register values to reset values and enables the cycle steal and auto stop channel request features.

Parameters

- base – DMA peripheral base address.

- channel – DMA channel number.

void DMA_SetTransferConfig(DMA_Type *base, uint32_t channel, const *dma_transfer_config_t* *config)

Configures the DMA transfer attribute.

This function configures the transfer attribute including the source address, destination address, transfer size, and so on. This example shows how to set up the dma_transfer_config_t parameters and how to call the DMA_ConfigBasicTransfer function.

```
dma_transfer_config_t transferConfig;
memset(&transferConfig, 0, sizeof(transferConfig));
transferConfig.srcAddr = (uint32_t)srcAddr;
transferConfig.destAddr = (uint32_t)destAddr;
transferConfig.enbaleSrcIncrement = true;
transferConfig.enableDestIncrement = true;
transferConfig.srcSize = kDMA_Transfersize32bits;
transferConfig.destSize = kDMA_Transfersize32bits;
transferConfig.transferSize = sizeof(uint32_t) * BUFF_LENGTH;
DMA_SetTransferConfig(DMA0, 0, &transferConfig);
```

Parameters

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

void DMA_SetChannelLinkConfig(DMA_Type *base, uint32_t channel, const *dma_channel_link_config_t* *config)

Configures the DMA channel link feature.

This function allows DMA channels to have their transfers linked. The current DMA channel triggers a DMA request to the linked channels (LCH1 or LCH2) depending on the channel link type. Perform a link to channel LCH1 after each cycle-steal transfer followed by a link to LCH2 after the BCR decrements to 0 if the type is kDMA_ChannelLinkChannel1AndChannel2. Perform a link to LCH1 after each cycle-steal transfer if the type is kDMA_ChannelLinkChannel1. Perform a link to LCH1 after the BCR decrements to 0 if the type is kDMA_ChannelLinkChannel1AfterBCR0.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- config – Pointer to the channel link configuration structure.

static inline void DMA_SetSourceAddress(DMA_Type *base, uint32_t channel, uint32_t srcAddr)

Sets the DMA source address for the DMA transfer.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- srcAddr – DMA source address.

static inline void DMA_SetDestinationAddress(DMA_Type *base, uint32_t channel, uint32_t destAddr)

Sets the DMA destination address for the DMA transfer.

Parameters

- base – DMA peripheral base address.

- channel – DMA channel number.
- destAddr – DMA destination address.

static inline void DMA_SetTransferSize(DMA_Type *base, uint32_t channel, uint32_t size)

Sets the DMA transfer size for the DMA transfer.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- size – The number of bytes to be transferred.

void DMA_SetModulo(DMA_Type *base, uint32_t channel, *dma_modulo_t* srcModulo, *dma_modulo_t* destModulo)

Sets the DMA modulo for the DMA transfer.

This function defines a specific address range specified to be the value after (SAR + SSIZE)/(DAR + DSIZE) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- srcModulo – source address modulo.
- destModulo – destination address modulo.

static inline void DMA_EnableCycleSteal(DMA_Type *base, uint32_t channel, bool enable)

Enables the DMA cycle steal for the DMA transfer.

If the cycle steal feature is enabled (true), the DMA controller forces a single read/write transfer per request, or it continuously makes read/write transfers until the BCR decrements to 0.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- enable – The command for enable (true) or disable (false).

static inline void DMA_EnableAutoAlign(DMA_Type *base, uint32_t channel, bool enable)

Enables the DMA auto align for the DMA transfer.

If the auto align feature is enabled (true), the appropriate address register increments regardless of DINC or SINC.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- enable – The command for enable (true) or disable (false).

static inline void DMA_EnableAsyncRequest(DMA_Type *base, uint32_t channel, bool enable)

Enables the DMA async request for the DMA transfer.

If the async request feature is enabled (true), the DMA supports asynchronous DREQs while the MCU is in stop mode.

Parameters

- base – DMA peripheral base address.

- channel – DMA channel number.
- enable – The command for enable (true) or disable (false).

static inline void DMA_EnableInterrupts(DMA_Type *base, uint32_t channel)

Enables an interrupt for the DMA transfer.

Parameters

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

static inline void DMA_DisableInterrupts(DMA_Type *base, uint32_t channel)

Disables an interrupt for the DMA transfer.

Parameters

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

static inline void DMA_EnableChannelRequest(DMA_Type *base, uint32_t channel)

Enables the DMA hardware channel request.

Parameters

- base – DMA peripheral base address.
- channel – The DMA channel number.

static inline void DMA_DisableChannelRequest(DMA_Type *base, uint32_t channel)

Disables the DMA hardware channel request.

Parameters

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

static inline void DMA_TriggerChannelStart(DMA_Type *base, uint32_t channel)

Starts the DMA transfer with a software trigger.

This function starts only one read/write iteration.

Parameters

- base – DMA peripheral base address.
- channel – The DMA channel number.

static inline void DMA_EnableAutoStopRequest(DMA_Type *base, uint32_t channel, bool enable)

Starts the DMA enable/disable auto disable request.

Parameters

- base – DMA peripheral base address.
- channel – The DMA channel number.
- enable – true is enable, false is disable.

static inline uint32_t DMA_GetRemainingBytes(DMA_Type *base, uint32_t channel)

Gets the remaining bytes of the current DMA transfer.

Parameters

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

Returns

The number of bytes which have not been transferred yet.

static inline uint32_t DMA_GetChannelStatusFlags(DMA_Type *base, uint32_t channel)

Gets the DMA channel status flags.

Parameters

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

Returns

The mask of the channel status. Use the _dma_channel_status_flags type to decode the return 32 bit variables.

static inline void DMA_ClearChannelStatusFlags(DMA_Type *base, uint32_t channel, uint32_t mask)

Clears the DMA channel status flags.

Parameters

- base – DMA peripheral base address.
- channel – DMA channel number.
- mask – The mask of the channel status to be cleared. Use the defined _dma_channel_status_flags type.

void DMA_CreateHandle(*dma_handle_t* *handle, DMA_Type *base, uint32_t channel)

Creates the DMA handle.

This function is called first if using the transactional API for the DMA. This function initializes the internal state of the 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)

Sets the DMA callback function.

This callback is called in the DMA IRQ handler. Use the callback to do something after the current transfer complete.

Parameters

- handle – DMA handle pointer.
- callback – DMA callback function pointer.
- userData – Parameter for callback function. If it is not needed, just set to NULL.

void DMA_PrepareTransferConfig(*dma_transfer_config_t* *config, void *srcAddr, uint32_t srcWidth, void *destAddr, uint32_t destWidth, uint32_t transferBytes, *dma_addr_increment_t* srcIncrement, *dma_addr_increment_t* destIncrement)

Prepares the DMA transfer configuration structure.

This function prepares the transfer configuration structure according to the user input. The difference between this function and DMA_PrepareTransfer is that this function expose the address increment parameter to application, but in DMA_PrepareTransfer, only parts of the address increment option can be selected by dma_transfer_type_t.

Parameters

- config – Pointer to the user configuration structure of type dma_transfer_config_t.
- srcAddr – DMA transfer source address.
- srcWidth – DMA transfer source address width (byte).
- destAddr – DMA transfer destination address.
- destWidth – DMA transfer destination address width (byte).
- transferBytes – DMA transfer bytes to be transferred.
- srcIncrement – source address increment type.
- destIncrement – dest address increment type.

void DMA_PrepareTransfer(*dma_transfer_config_t* *config, void *srcAddr, uint32_t srcWidth, void *destAddr, uint32_t destWidth, uint32_t transferBytes, *dma_transfer_type_t* type)

Prepares the DMA transfer configuration structure.

This function prepares the transfer configuration structure according to the user input.

Parameters

- config – Pointer to the user configuration structure of type dma_transfer_config_t.
- srcAddr – DMA transfer source address.
- srcWidth – DMA transfer source address width (byte).
- destAddr – DMA transfer destination address.
- destWidth – DMA transfer destination address width (byte).
- transferBytes – DMA transfer bytes to be transferred.
- type – DMA transfer type.

status_t DMA_SubmitTransfer(*dma_handle_t* *handle, const *dma_transfer_config_t* *config, uint32_t options)

Submits the DMA transfer request.

This function submits the DMA transfer request according to the transfer configuration structure.

Note: This function can't process multi transfer request.

Parameters

- handle – DMA handle pointer.
- config – Pointer to DMA transfer configuration structure.
- options – Additional configurations for transfer. Use the defined dma_transfer_options_t type.

Return values

- kStatus_DMA_Success – It indicates that the DMA submit transfer request succeeded.
- kStatus_DMA_Busy – It indicates that the DMA is busy. Submit transfer request is not allowed.

static inline void DMA_StartTransfer(*dma_handle_t* *handle)

DMA starts a transfer.

This function enables the channel request. Call this function after submitting a transfer request.

Parameters

- handle – DMA handle pointer.

Return values

- kStatus_DMA_Success – It indicates that the DMA start transfer succeed.
- kStatus_DMA_Busy – It indicates that the DMA has started a transfer.

static inline void DMA_StopTransfer(*dma_handle_t* *handle)

DMA stops a transfer.

This function disables the channel request to stop a DMA transfer. The transfer can be resumed by calling the DMA_StartTransfer.

Parameters

- handle – DMA handle pointer.

void DMA_AbortTransfer(*dma_handle_t* *handle)

DMA aborts a transfer.

This function disables the channel request and clears all status bits. Submit another transfer after calling this API.

Parameters

- handle – DMA handle pointer.

void DMA_HandleIRQ(*dma_handle_t* *handle)

DMA IRQ handler for current transfer complete.

This function clears the channel interrupt flag and calls the callback function if it is not NULL.

Parameters

- handle – DMA handle pointer.

FSL_DMA_DRIVER_VERSION

DMA driver version 2.1.2.

_dma_channel_status_flags status flag for the DMA driver.

Values:

enumerator kDMA_TransactionsBCRFlag

Contains the number of bytes yet to be transferred for a given block

enumerator kDMA_TransactionsDoneFlag

Transactions Done

enumerator kDMA_TransactionsBusyFlag

Transactions Busy

enumerator kDMA_TransactionsRequestFlag

Transactions Request

enumerator kDMA_BusErrorOnDestinationFlag

Bus Error on Destination

enumerator kDMA_BusErrorOnSourceFlag
Bus Error on Source

enumerator kDMA_ConfigurationErrorFlag
Configuration Error

enum _dma_transfer_size
DMA transfer size type.

Values:

enumerator kDMA_Transfersize32bits
32 bits are transferred for every read/write

enumerator kDMA_Transfersize8bits
8 bits are transferred for every read/write

enumerator kDMA_Transfersize16bits
16b its are transferred for every read/write

enum _dma_modulo
Configuration type for the DMA modulo.

Values:

enumerator kDMA_ModuloDisable
Buffer disabled

enumerator kDMA_Modulo16Bytes
Circular buffer size is 16 bytes.

enumerator kDMA_Modulo32Bytes
Circular buffer size is 32 bytes.

enumerator kDMA_Modulo64Bytes
Circular buffer size is 64 bytes.

enumerator kDMA_Modulo128Bytes
Circular buffer size is 128 bytes.

enumerator kDMA_Modulo256Bytes
Circular buffer size is 256 bytes.

enumerator kDMA_Modulo512Bytes
Circular buffer size is 512 bytes.

enumerator kDMA_Modulo1KBytes
Circular buffer size is 1 KB.

enumerator kDMA_Modulo2KBytes
Circular buffer size is 2 KB.

enumerator kDMA_Modulo4KBytes
Circular buffer size is 4 KB.

enumerator kDMA_Modulo8KBytes
Circular buffer size is 8 KB.

enumerator kDMA_Modulo16KBytes
Circular buffer size is 16 KB.

enumerator kDMA_Modulo32KBytes
Circular buffer size is 32 KB.

enumerator kDMA_Modulo64KBytes
Circular buffer size is 64 KB.

enumerator kDMA_Modulo128KBytes
Circular buffer size is 128 KB.

enumerator kDMA_Modulo256KBytes
Circular buffer size is 256 KB.

enum _dma_channel_link_type
DMA channel link type.

Values:

enumerator kDMA_ChannelLinkDisable
No channel link.

enumerator kDMA_ChannelLinkChannel1AndChannel2
Perform a link to channel LCH1 after each cycle-steal transfer. followed by a link to LCH2 after the BCR decrements to 0.

enumerator kDMA_ChannelLinkChannel1
Perform a link to LCH1 after each cycle-steal transfer.

enumerator kDMA_ChannelLinkChannel1AfterBCR0
Perform a link to LCH1 after the BCR decrements.

enum _dma_transfer_type
DMA transfer type.

Values:

enumerator kDMA_MemoryToMemory
Memory to Memory transfer.

enumerator kDMA_PeripheralToMemory
Peripheral to Memory transfer.

enumerator kDMA_MemoryToPeripheral
Memory to Peripheral transfer.

enum _dma_transfer_options
DMA transfer options.

Values:

enumerator kDMA_NoOptions
Transfer without options.

enumerator kDMA_EnableInterrupt
Enable interrupt while transfer complete.

enum _dma_addr_increment
dma addre increment type

Values:

enumerator kDMA_AddrNoIncrement
Transfer address not increment.

enumerator kDMA_AddrIncrementPerTransferWidth
Transfer address increment per transfer width

_dma_transfer_status DMA transfer status

Values:

enumerator kStatus_DMA_Busy
DMA is busy.

typedef enum *_dma_transfer_size* dma_transfer_size_t
DMA transfer size type.

typedef enum *_dma_modulo* dma_modulo_t
Configuration type for the DMA modulo.

typedef enum *_dma_channel_link_type* dma_channel_link_type_t
DMA channel link type.

typedef enum *_dma_transfer_type* dma_transfer_type_t
DMA transfer type.

typedef enum *_dma_transfer_options* dma_transfer_options_t
DMA transfer options.

typedef enum *_dma_addr_increment* dma_addr_increment_t
dma addre increment type

typedef struct *_dma_transfer_config* dma_transfer_config_t
DMA transfer configuration structure.

typedef struct *_dma_channel_link_config* dma_channel_link_config_t
DMA transfer configuration structure.

typedef void (*dma_callback)(struct *_dma_handle* *handle, void *userData)
Callback function prototype for the DMA driver.

typedef struct *_dma_handle* dma_handle_t
DMA DMA handle structure.

struct _dma_transfer_config
#include <fsl_dma.h> DMA transfer configuration structure.

Public Members

uint32_t srcAddr
DMA transfer source address.

uint32_t destAddr
DMA destination address.

bool enableSrcIncrement
Source address increase after each transfer.

dma_transfer_size_t srcSize
Source transfer size unit.

bool enableDestIncrement
Destination address increase after each transfer.

dma_transfer_size_t destSize
Destination transfer unit.

uint32_t transferSize
The number of bytes to be transferred.

struct __dma__channel__link__config
#include <fsl_dma.h> DMA transfer configuration structure.

Public Members

dma_channel_link_type_t linkType
Channel link type.

uint32_t channel1
The index of channel 1.

uint32_t channel2
The index of channel 2.

struct __dma__handle
#include <fsl_dma.h> DMA DMA handle structure.

Public Members

DMA_Type *base
DMA peripheral address.

uint8_t channel
DMA channel used.

dma_callback callback
DMA callback function.

void *userData
Callback parameter.

2.7 DMAMUX: Direct Memory Access Multiplexer Driver

void DMAMUX__Init(DMAMUX_Type *base)
Initializes the DMAMUX peripheral.

This function ungates the DMAMUX clock.

Parameters

- base – DMAMUX peripheral base address.

void DMAMUX__Deinit(DMAMUX_Type *base)
Deinitializes the DMAMUX peripheral.

This function gates the DMAMUX clock.

Parameters

- base – DMAMUX peripheral base address.

static inline void DMAMUX__EnableChannel(DMAMUX_Type *base, uint32_t channel)
Enables the DMAMUX channel.

This function enables the DMAMUX channel.

Parameters

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

static inline void DMAMUX_DisableChannel(DMAMUX_Type *base, uint32_t channel)

Disables the DMAMUX channel.

This function disables the DMAMUX channel.

Note: The user must disable the DMAMUX channel before configuring it.

Parameters

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

static inline void DMAMUX_SetSource(DMAMUX_Type *base, uint32_t channel, int32_t source)

Configures the DMAMUX channel source.

Parameters

- base – DMAMUX peripheral base address.
- channel – DMAMUX channel number.
- source – Channel source, which is used to trigger the DMA transfer.User need to use the dma_request_source_t type as the input parameter.

static inline void DMAMUX_EnablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)

Enables the DMAMUX period trigger.

This function enables the DMAMUX period trigger feature.

Parameters

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

static inline void DMAMUX_DisablePeriodTrigger(DMAMUX_Type *base, uint32_t channel)

Disables the DMAMUX period trigger.

This function disables the DMAMUX period trigger.

Parameters

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

FSL_DMAMUX_DRIVER_VERSION

DMAMUX driver version 2.1.1.

2.8 FGPIO Driver

void FGPIO_PinInit(FGPIO_Type *base, uint32_t pin, const *gpio_pin_config_t* *config)

Initializes a FGPIO pin used by the board.

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

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

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

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO port pin number
- config – FGPIO pin configuration pointer

static inline void FGPIO_PinWrite(FGPIO_Type *base, uint32_t pin, uint8_t output)

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

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO pin number
- output – FGPIOpin output logic level.
  - 0: corresponding pin output low-logic level.
  - 1: corresponding pin output high-logic level.

static inline void FGPIO_PortSet(FGPIO_Type *base, uint32_t mask)

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

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline void FGPIO_PortClear(FGPIO_Type *base, uint32_t mask)

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

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline void FGPIO_PortToggle(FGPIO_Type *base, uint32_t mask)

Reverses the current output logic of the multiple FGPIO pins.

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

static inline uint32_t FGPIO_PinRead(FGPIO_Type *base, uint32_t pin)

Reads the current input value of the FGPIO port.

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- pin – FGPIO pin number

Return values

FGPIO – port input value

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

uint32_t FGPIO_PortGetInterruptFlags(FGPIO_Type *base)

Reads the FGPIO port interrupt status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains set until a logic one is written to that flag. If configured for a level-sensitive interrupt that remains asserted, the flag is set again immediately.

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)

Return values

The – current FGPIO port interrupt status flags, for example, 0x00010001 means the pin 0 and 17 have the interrupt.

void FGPIO_PortClearInterruptFlags(FGPIO_Type *base, uint32_t mask)

Clears the multiple FGPIO pin interrupt status flag.

Parameters

- base – FGPIO peripheral base pointer (FGPIOA, FGPIOB, FGPIOC, and so on.)
- mask – FGPIO pin number macro

2.9 C90TFS Flash Driver

2.10 FlexIO: FlexIO Driver

2.11 FlexIO DMA I2S Driver

void FLEXIO_I2S_TransferTxCreateHandleDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *flexio_i2s_dma_callback_t* callback, void *userData, *dma_handle_t* *dmaHandle)

Initializes the FlexIO I2S DMA handle.

This function initializes the FlexIO I2S master DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- callback – FlexIO I2S DMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – DMA handle for FlexIO I2S. This handle is a static value allocated by users.

void FLEXIO_I2S_TransferRxCreateHandleDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *flexio_i2s_dma_callback_t* callback, void *userData, *dma_handle_t* *dmaHandle)

Initializes the FlexIO I2S Rx DMA handle.

This function initializes the FlexIO I2S slave DMA handle which can be used for other FlexIO I2S master transactional APIs. Usually, for a specified FlexIO I2S instance, call this API once to get the initialized handle.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- callback – FlexIO I2S DMA callback function called while finished a block.
- userData – User parameter for callback.
- dmaHandle – DMA handle for FlexIO I2S. This handle is a static value allocated by users.

void FLEXIO_I2S_TransferSetFormatDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S Tx audio format.

Audio format can be changed at run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred. This function also sets the DMA parameter according to the format.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock_Hz – FlexIO I2S clock source frequency in Hz. It should be 0 while in slave mode.

status_t FLEXIO_I2S_TransferSendDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs a non-blocking FlexIO I2S transfer using DMA.

Note: This interface returns immediately after transfer initiates. Call FLEXIO_I2S_GetTransferStatus to poll the transfer status and check whether FLEXIO I2S transfer finished.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.

- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a FlexIO I2S DMA send successfully.
- kStatus_InvalidArgument – The input arguments is invalid.
- kStatus_TxBusy – FlexIO I2S is busy sending data.

status_t FLEXIO_I2S_TransferReceiveDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs a non-blocking FlexIO I2S receive using DMA.

Note: This interface returns immediately after transfer initiates. Call FLEXIO_I2S_GetReceiveRemainingBytes to poll the transfer status to check whether the FlexIO I2S transfer is finished.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- xfer – Pointer to DMA transfer structure.

Return values

- kStatus_Success – Start a FlexIO I2S DMA receive successfully.
- kStatus_InvalidArgument – The input arguments is invalid.
- kStatus_RxBusy – FlexIO I2S is busy receiving data.

void FLEXIO_I2S_TransferAbortSendDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle)

Aborts a FlexIO I2S transfer using DMA.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.

void FLEXIO_I2S_TransferAbortReceiveDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle)

Aborts a FlexIO I2S receive using DMA.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.

status_t FLEXIO_I2S_TransferGetSendCountDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, size_t *count)

Gets the remaining bytes to be sent.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes sent.

Return values

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

status_t FLEXIO_I2S_TransferGetReceiveCountDMA(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, size_t *count)

Gets the remaining bytes to be received.

Parameters

- base – FlexIO I2S peripheral base address.
- handle – FlexIO I2S DMA handle pointer.
- count – Bytes received.

Return values

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

FSL_FLEXIO_I2S_DMA_DRIVER_VERSION

FlexIO I2S DMA driver version 2.1.7.

typedef struct *_flexio_i2s_dma_handle* flexio_i2s_dma_handle_t

typedef void (*flexio_i2s_dma_callback_t)(*FLEXIO_I2S_Type* *base, *flexio_i2s_dma_handle_t* *handle, *status_t* status, void *userData)

FlexIO I2S DMA transfer callback function for finish and error.

struct _flexio_i2s_dma_handle

#include <fsl_flexio_i2s_dma.h> FlexIO I2S DMA transfer handle, users should not touch the content of the handle.

Public Members

dma_handle_t *dmaHandle

DMA handler for FlexIO I2S send

uint8_t bytesPerFrame

Bytes in a frame

uint32_t state

Internal state for FlexIO I2S DMA transfer

flexio_i2s_dma_callback_t callback

Callback for users while transfer finish or error occurred

void *userData

User callback parameter

flexio_i2s_transfer_t queue[(4U)]

Transfer queue storing queued transfer.

size_t transferSize[(4U)]

Data bytes need to transfer

volatile uint8_t queueUser

Index for user to queue transfer.

volatile uint8_t queueDriver

Index for driver to get the transfer data and size

2.12 FlexIO DMA SPI Driver

status_t FLEXIO_SPI_MasterTransferCreateHandleDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_dma_handle_t* *handle, *flexio_spi_master_dma_transfer_callback_t* callback, void *userData, *dma_handle_t* *txHandle, *dma_handle_t* *rxHandle)

Initializes the FLEXO SPI master DMA handle.

This function initializes the FLEXO SPI master DMA handle which can be used for other FLEXO SPI master transactional APIs. Usually, for a specified FLEXO SPI instance, call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_master_dma_handle_t structure to store the transfer state.
- callback – SPI callback, NULL means no callback.
- userData – callback function parameter.
- txHandle – User requested DMA handle for FlexIO SPI RX DMA transfer.
- rxHandle – User requested DMA handle for FlexIO SPI TX DMA transfer.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO SPI DMA type/handle table out of range.

status_t FLEXIO_SPI_MasterTransferDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_dma_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Performs a non-blocking FlexIO SPI transfer using DMA.

Note: This interface returned immediately after transfer initiates. Call FLEXIO_SPI_MasterGetTransferCountDMA to poll the transfer status to check whether the FlexIO SPI transfer is finished.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_master_dma_handle_t structure to store the transfer state.
- xfer – Pointer to FlexIO SPI transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.

- kStatus_FLEXIO_SPI_Busy – FlexIO SPI is not idle, is running another transfer.

void FLEXIO_SPI_MasterTransferAbortDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_dma_handle_t* *handle)

Aborts a FlexIO SPI transfer using DMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI DMA handle pointer.

status_t FLEXIO_SPI_MasterTransferGetCountDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_master_dma_handle_t* *handle, size_t *count)

Gets the remaining bytes for FlexIO SPI DMA transfer.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI DMA handle pointer.
- count – Number of bytes transferred so far by the non-blocking transaction.

static inline void FLEXIO_SPI_SlaveTransferCreateHandleDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_dma_handle_t* *handle, *flexio_spi_slave_dma_transfer_callback_t* callback, void *userData, *dma_handle_t* *txHandle, *dma_handle_t* *rxHandle)

Initializes the FlexIO SPI slave DMA handle.

This function initializes the FlexIO SPI slave DMA handle.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_slave_dma_handle_t structure to store the transfer state.
- callback – SPI callback, NULL means no callback.
- userData – callback function parameter.
- txHandle – User requested DMA handle for FlexIO SPI TX DMA transfer.
- rxHandle – User requested DMA handle for FlexIO SPI RX DMA transfer.

status_t FLEXIO_SPI_SlaveTransferDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_dma_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Performs a non-blocking FlexIO SPI transfer using DMA.

Note: This interface returns immediately after transfer initiates. Call FLEXIO_SPI_SlaveGetTransferCountDMA to poll the transfer status and check whether the FlexIO SPI transfer is finished.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.

- handle – Pointer to flexio_spi_slave_dma_handle_t structure to store the transfer state.
- xfer – Pointer to FlexIO SPI transfer structure.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – FlexIO SPI is not idle, is running another transfer.

static inline void FLEXIO_SPI_SlaveTransferAbortDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_dma_handle_t* *handle)

Aborts a FlexIO SPI transfer using DMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – Pointer to flexio_spi_slave_dma_handle_t structure to store the transfer state.

static inline *status_t* FLEXIO_SPI_SlaveTransferGetCountDMA(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_dma_handle_t* *handle, size_t *count)

Gets the remaining bytes to be transferred for FlexIO SPI DMA.

Parameters

- base – Pointer to FLEXIO_SPI_Type structure.
- handle – FlexIO SPI DMA handle pointer.
- count – Number of bytes transferred so far by the non-blocking transaction.

FSL_FLEXIO_SPI_DMA_DRIVER_VERSION

FlexIO SPI DMA driver version 2.3.0.

typedef struct *_flexio_spi_master_dma_handle* flexio_spi_master_dma_handle_t

typedef for flexio_spi_master_dma_handle_t in advance.

typedef *flexio_spi_master_dma_handle_t* flexio_spi_slave_dma_handle_t

Slave handle is the same with master handle.

typedef void (*flexio_spi_master_dma_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_master_dma_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI master callback for finished transmit.

typedef void (*flexio_spi_slave_dma_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_dma_handle_t* *handle, *status_t* status, void *userData)

FlexIO SPI slave callback for finished transmit.

struct _flexio_spi_master_dma_handle

#include <fsl_flexio_spi_dma.h> FlexIO SPI DMA transfer handle, users should not touch the content of the handle.

Public Members

size_t transferSize

Total bytes to be transferred.

bool txInProgress
: Send transfer in progress

bool rxInProgress
: Receive transfer in progress

dma_handle_t *txHandle
: DMA handler for SPI send

dma_handle_t *rxHandle
: DMA handler for SPI receive

flexio_spi_master_dma_transfer_callback_t callback
: Callback for SPI DMA transfer

void *userData
: User Data for SPI DMA callback

2.13 FlexIO DMA UART Driver

status_t FLEXIO_UART_TransferCreateHandleDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, *flexio_uart_dma_transfer_callback_t* callback, void *userData, *dma_handle_t* *txDmaHandle, *dma_handle_t* *rxDmaHandle)

Initializes the FLEXIO_UART handle which is used in transactional functions.

Parameters

- base – Pointer to FLEXIO_UART_Type structure.
- handle – Pointer to flexio_uart_dma_handle_t structure.
- callback – FlexIO UART callback, NULL means no callback.
- userData – User callback function data.
- txDmaHandle – User requested DMA handle for TX DMA transfer.
- rxDmaHandle – User requested DMA handle for RX DMA transfer.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO UART DMA type/handle table out of range.

status_t FLEXIO_UART_TransferSendDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Sends data using DMA.

This function send data using DMA. This is non-blocking function, which returns right away. When all data is sent out, the send callback function is called.

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure
- xfer – FLEXIO_UART DMA transfer structure, see flexio_uart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXIO_UART_TxBusy – Previous transfer on going.

status_t FLEXIO_UART_TransferReceiveDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Receives data using DMA.

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

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure
- xfer – FLEXIO_UART DMA transfer structure, see flexio_uart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_FLEXIO_UART_RxBusy – Previous transfer on going.

void FLEXIO_UART_TransferAbortSendDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle)

Aborts the sent data which using DMA.

This function aborts the sent data which using DMA.

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure

void FLEXIO_UART_TransferAbortReceiveDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle)

Aborts the receive data which using DMA.

This function aborts the receive data which using DMA.

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure

status_t FLEXIO_UART_TransferGetSendCountDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, size_t *count)

Gets the number of bytes sent out.

This function gets the number of bytes sent out.

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure
- count – Number of bytes sent so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.

- kStatus_Success – Successfully return the count.

status_t FLEXIO_UART_TransferGetReceiveCountDMA(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, size_t *count)

Gets the number of bytes received.

This function gets the number of bytes received.

Parameters

- base – Pointer to FLEXIO_UART_Type structure
- handle – Pointer to flexio_uart_dma_handle_t structure
- count – Number of bytes received so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

FSL_FLEXIO_UART_DMA_DRIVER_VERSION

FlexIO UART DMA driver version.

typedef struct *_flexio_uart_dma_handle* flexio_uart_dma_handle_t

typedef void (*flexio_uart_dma_transfer_callback_t)(*FLEXIO_UART_Type* *base, *flexio_uart_dma_handle_t* *handle, *status_t* status, void *userData)

UART transfer callback function.

struct _flexio_uart_dma_handle

#include <fsl_flexio_uart_dma.h> UART DMA handle.

Public Members

flexio_uart_dma_transfer_callback_t callback

Callback function.

void *userData

UART callback function parameter.

size_t txDataSizeAll

Total bytes to be sent.

size_t rxDataSizeAll

Total bytes to be received.

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

2.14 FlexIO Driver

void FLEXIO_GetDefaultConfig(*flexio_config_t* *userConfig)

Gets the default configuration to configure the FlexIO module. The configuration can used directly to call the FLEXIO_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

Parameters

- userConfig – pointer to flexio_config_t structure

void FLEXIO_Init(FLEXIO_Type *base, const *flexio_config_t* *userConfig)

Configures the FlexIO with a FlexIO configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO_GetDefaultConfig().

Example

```
flexio_config_t config = {
.enableFlexio = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false
};
FLEXIO_Configure(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- userConfig – pointer to flexio_config_t structure

void FLEXIO_Deinit(FLEXIO_Type *base)

Gates the FlexIO clock. Call this API to stop the FlexIO clock.

Note: After calling this API, call the FLEXO_Init to use the FlexIO module.

Parameters

- base – FlexIO peripheral base address

uint32_t FLEXIO_GetInstance(FLEXIO_Type *base)

Get instance number for FLEXIO module.

Parameters

- base – FLEXIO peripheral base address.

void FLEXIO_Reset(FLEXIO_Type *base)

Resets the FlexIO module.

Parameters

- base – FlexIO peripheral base address

static inline void FLEXIO_Enable(FLEXIO_Type *base, bool enable)

Enables the FlexIO module operation.

Parameters

- base – FlexIO peripheral base address
- enable – true to enable, false to disable.

static inline uint32_t FLEXIO_ReadPinInput(FLEXIO_Type *base)

Reads the input data on each of the FlexIO pins.

Parameters

- base – FlexIO peripheral base address

Returns

FlexIO pin input data

static inline uint8_t FLEXIO_GetShifterState(FLEXIO_Type *base)

Gets the current state pointer for state mode use.

Parameters

- base – FlexIO peripheral base address

Returns

current State pointer

void FLEXIO_SetShifterConfig(FLEXIO_Type *base, uint8_t index, const *flexio_shifter_config_t* *shifterConfig)

Configures the shifter with the shifter configuration. The configuration structure covers both the SHIFTCTL and SHIFTCFG registers. To configure the shifter to the proper mode, select which timer controls the shifter to shift, whether to generate start bit/stop bit, and the polarity of start bit and stop bit.

Example

```
flexio_shifter_config_t config = {
.timerSelect = 0,
.timerPolarity = kFLEXIO_ShifterTimerPolarityOnPositive,
.pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
.pinPolarity = kFLEXIO_PinActiveLow,
.shifterMode = kFLEXIO_ShifterModeTransmit,
.inputSource = kFLEXIO_ShifterInputFromPin,
.shifterStop = kFLEXIO_ShifterStopBitHigh,
.shifterStart = kFLEXIO_ShifterStartBitLow
};
FLEXIO_SetShifterConfig(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- index – Shifter index
- shifterConfig – Pointer to flexio_shifter_config_t structure

void FLEXIO_SetTimerConfig(FLEXIO_Type *base, uint8_t index, const *flexio_timer_config_t* *timerConfig)

Configures the timer with the timer configuration. The configuration structure covers both the TIMCTL and TIMCFG registers. To configure the timer to the proper mode, select trigger source for timer and the timer pin output and the timing for timer.

Example

```
flexio_timer_config_t config = {
.triggerSelect = FLEXIO_TIMER_TRIGGER_SEL_SHIFTnSTAT(0),
.triggerPolarity = kFLEXIO_TimerTriggerPolarityActiveLow,
.triggerSource = kFLEXIO_TimerTriggerSourceInternal,
```

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```
.pinConfig = kFLEXIO_PinConfigOpenDrainOrBidirection,
.pinSelect = 0,
.pinPolarity = kFLEXIO_PinActiveHigh,
.timerMode = kFLEXIO_TimerModeDual8BitBaudBit,
.timerOutput = kFLEXIO_TimerOutputZeroNotAffectedByReset,
.timerDecrement = kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput,
.timerReset = kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput,
.timerDisable = kFLEXIO_TimerDisableOnTimerCompare,
.timerEnable = kFLEXIO_TimerEnableOnTriggerHigh,
.timerStop = kFLEXIO_TimerStopBitEnableOnTimerDisable,
.timerStart = kFLEXIO_TimerStartBitEnabled
};
FLEXIO_SetTimerConfig(base, &config);
```

Parameters

- base – FlexIO peripheral base address
- index – Timer index
- timerConfig – Pointer to the flexio_timer_config_t structure

static inline void FLEXIO_SetClockMode(FLEXIO_Type *base, uint8_t index, *flexio_timer_decrement_source_t* clocksource)

This function set the value of the prescaler on flexio channels.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.
- index – Timer index
- clocksource – Set clock value

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

Enables the shifter status interrupt. The interrupt generates when the corresponding SSF is set.

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

Parameters

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

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

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

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

Parameters

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

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

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

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

Parameters

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

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

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

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

Parameters

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

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

Enables the timer status interrupt. The interrupt generates when the corresponding SSF is set.

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

Parameters

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

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

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

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

Parameters

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

static inline uint32_t FLEXIO_GetShifterStatusFlags(FLEXIO_Type *base)

Gets the shifter status flags.

Parameters

- base – FlexIO peripheral base address

Returns
Shifter status flags

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

Clears the shifter status flags.

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

Parameters

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

static inline uint32_t FLEXIO_GetShifterErrorFlags(FLEXIO_Type *base)

Gets the shifter error flags.

Parameters

- base – FlexIO peripheral base address

Returns
Shifter error flags

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

Clears the shifter error flags.

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

Parameters

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

static inline uint32_t FLEXIO_GetTimerStatusFlags(FLEXIO_Type *base)

Gets the timer status flags.

Parameters

- base – FlexIO peripheral base address

Returns
Timer status flags

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

Clears the timer status flags.

Note: For clearing multiple timer status flags, for example, two timer status flags, can calculate the mask by using ((1 « timer index0) | (1 « timer index1))

Parameters

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

static inline void FLEXIO_EnableShifterStatusDMA(FLEXIO_Type *base, uint32_t mask, bool enable)

Enables/disables the shifter status DMA. The DMA request generates when the corresponding SSF is set.

Note: For multiple shifter status DMA enables, for example, calculate the mask by using ((1 « shifter index0) | (1 « shifter index1))

Parameters

- base – FlexIO peripheral base address
- mask – The shifter status mask which can be calculated by (1 « shifter index)
- enable – True to enable, false to disable.

uint32_t FLEXIO_GetShifterBufferAddress(FLEXIO_Type *base, *flexio_shifter_buffer_type_t* type, uint8_t index)

Gets the shifter buffer address for the DMA transfer usage.

Parameters

- base – FlexIO peripheral base address
- type – Shifter type of flexio_shifter_buffer_type_t
- index – Shifter index

Returns

Corresponding shifter buffer index

status_t FLEXIO_RegisterHandleIRQ(void *base, void *handle, *flexio_isr_t* isr)

Registers the handle and the interrupt handler for the FlexIO-simulated peripheral.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.
- handle – Pointer to the handler for FlexIO simulated peripheral.
- isr – FlexIO simulated peripheral interrupt handler.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_UnregisterHandleIRQ(void *base)

Unregisters the handle and the interrupt handler for the FlexIO-simulated peripheral.

Parameters

- base – Pointer to the FlexIO simulated peripheral type.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

FSL_FLEXIO_DRIVER_VERSION

FlexIO driver version.

enum _flexio_timer_trigger_polarity
Define time of timer trigger polarity.

Values:

enumerator kFLEXIO_TimerTriggerPolarityActiveHigh
Active high.

enumerator kFLEXIO_TimerTriggerPolarityActiveLow
Active low.

enum _flexio_timer_trigger_source
Define type of timer trigger source.

Values:

enumerator kFLEXIO_TimerTriggerSourceExternal
External trigger selected.

enumerator kFLEXIO_TimerTriggerSourceInternal
Internal trigger selected.

enum _flexio_pin_config
Define type of timer/shifter pin configuration.

Values:

enumerator kFLEXIO_PinConfigOutputDisabled
Pin output disabled.

enumerator kFLEXIO_PinConfigOpenDrainOrBidirection
Pin open drain or bidirectional output enable.

enumerator kFLEXIO_PinConfigBidirectionOutputData
Pin bidirectional output data.

enumerator kFLEXIO_PinConfigOutput
Pin output.

enum _flexio_pin_polarity
Definition of pin polarity.

Values:

enumerator kFLEXIO_PinActiveHigh
Active high.

enumerator kFLEXIO_PinActiveLow
Active low.

enum _flexio_timer_mode
Define type of timer work mode.

Values:

enumerator kFLEXIO_TimerModeDisabled
Timer Disabled.

enumerator kFLEXIO_TimerModeDual8BitBaudBit
Dual 8-bit counters baud/bit mode.

enumerator kFLEXIO_TimerModeDual8BitPWM
Dual 8-bit counters PWM mode.

enumerator kFLEXIO_TimerModeSingle16Bit
Single 16-bit counter mode.

enumerator kFLEXIO_TimerModeDual8BitPWMLow
Dual 8-bit counters PWM Low mode.

enum _flexio_timer_output
Define type of timer initial output or timer reset condition.

Values:

enumerator kFLEXIO_TimerOutputOneNotAffectedByReset
Logic one when enabled and is not affected by timer reset.

enumerator kFLEXIO_TimerOutputZeroNotAffectedByReset
Logic zero when enabled and is not affected by timer reset.

enumerator kFLEXIO_TimerOutputOneAffectedByReset
Logic one when enabled and on timer reset.

enumerator kFLEXIO_TimerOutputZeroAffectedByReset
Logic zero when enabled and on timer reset.

enum _flexio_timer_decrement_source
Define type of timer decrement.

Values:

enumerator kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput
Decrement counter on FlexIO clock, Shift clock equals Timer output.

enumerator kFLEXIO_TimerDecSrcOnTriggerInputShiftTimerOutput
Decrement counter on Trigger input (both edges), Shift clock equals Timer output.

enumerator kFLEXIO_TimerDecSrcOnPinInputShiftPinInput
Decrement counter on Pin input (both edges), Shift clock equals Pin input.

enumerator kFLEXIO_TimerDecSrcOnTriggerInputShiftTriggerInput
Decrement counter on Trigger input (both edges), Shift clock equals Trigger input.

enum _flexio_timer_reset_condition
Define type of timer reset condition.

Values:

enumerator kFLEXIO_TimerResetNever
Timer never reset.

enumerator kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput
Timer reset on Timer Pin equal to Timer Output.

enumerator kFLEXIO_TimerResetOnTimerTriggerEqualToTimerOutput
Timer reset on Timer Trigger equal to Timer Output.

enumerator kFLEXIO_TimerResetOnTimerPinRisingEdge
Timer reset on Timer Pin rising edge.

enumerator kFLEXIO_TimerResetOnTimerTriggerRisingEdge
Timer reset on Trigger rising edge.

enumerator kFLEXIO_TimerResetOnTimerTriggerBothEdge
Timer reset on Trigger rising or falling edge.

enum _flexio_timer_disable_condition

Define type of timer disable condition.

Values:

enumerator kFLEXIO_TimerDisableNever

Timer never disabled.

enumerator kFLEXIO_TimerDisableOnPreTimerDisable

Timer disabled on Timer N-1 disable.

enumerator kFLEXIO_TimerDisableOnTimerCompare

Timer disabled on Timer compare.

enumerator kFLEXIO_TimerDisableOnTimerCompareTriggerLow

Timer disabled on Timer compare and Trigger Low.

enumerator kFLEXIO_TimerDisableOnPinBothEdge

Timer disabled on Pin rising or falling edge.

enumerator kFLEXIO_TimerDisableOnPinBothEdgeTriggerHigh

Timer disabled on Pin rising or falling edge provided Trigger is high.

enumerator kFLEXIO_TimerDisableOnTriggerFallingEdge

Timer disabled on Trigger falling edge.

enum _flexio_timer_enable_condition

Define type of timer enable condition.

Values:

enumerator kFLEXIO_TimerEnabledAlways

Timer always enabled.

enumerator kFLEXIO_TimerEnableOnPrevTimerEnable

Timer enabled on Timer N-1 enable.

enumerator kFLEXIO_TimerEnableOnTriggerHigh

Timer enabled on Trigger high.

enumerator kFLEXIO_TimerEnableOnTriggerHighPinHigh

Timer enabled on Trigger high and Pin high.

enumerator kFLEXIO_TimerEnableOnPinRisingEdge

Timer enabled on Pin rising edge.

enumerator kFLEXIO_TimerEnableOnPinRisingEdgeTriggerHigh

Timer enabled on Pin rising edge and Trigger high.

enumerator kFLEXIO_TimerEnableOnTriggerRisingEdge

Timer enabled on Trigger rising edge.

enumerator kFLEXIO_TimerEnableOnTriggerBothEdge

Timer enabled on Trigger rising or falling edge.

enum _flexio_timer_stop_bit_condition

Define type of timer stop bit generate condition.

Values:

enumerator kFLEXIO_TimerStopBitDisabled

Stop bit disabled.

enumerator kFLEXIO_TimerStopBitEnableOnTimerCompare
Stop bit is enabled on timer compare.

enumerator kFLEXIO_TimerStopBitEnableOnTimerDisable
Stop bit is enabled on timer disable.

enumerator kFLEXIO_TimerStopBitEnableOnTimerCompareDisable
Stop bit is enabled on timer compare and timer disable.

enum _flexio_timer_start_bit_condition
Define type of timer start bit generate condition.

Values:

enumerator kFLEXIO_TimerStartBitDisabled
Start bit disabled.

enumerator kFLEXIO_TimerStartBitEnabled
Start bit enabled.

enum _flexio_timer_output_state
FlexIO as PWM channel output state.

Values:

enumerator kFLEXIO_PwmLow
The output state of PWM channel is low

enumerator kFLEXIO_PwmHigh
The output state of PWM channel is high

enum _flexio_shifter_timer_polarity
Define type of timer polarity for shifter control.

Values:

enumerator kFLEXIO_ShifterTimerPolarityOnPositive
Shift on positive edge of shift clock.

enumerator kFLEXIO_ShifterTimerPolarityOnNegitive
Shift on negative edge of shift clock.

enum _flexio_shifter_mode
Define type of shifter working mode.

Values:

enumerator kFLEXIO_ShifterDisabled
Shifter is disabled.

enumerator kFLEXIO_ShifterModeReceive
Receive mode.

enumerator kFLEXIO_ShifterModeTransmit
Transmit mode.

enumerator kFLEXIO_ShifterModeMatchStore
Match store mode.

enumerator kFLEXIO_ShifterModeMatchContinuous
Match continuous mode.

enumerator kFLEXIO_ShifterModeState
SHIFTBUF contents are used for storing programmable state attributes.

enumerator kFLEXIO_ShifterModeLogic
SHIFTBUF contents are used for implementing programmable logic look up table.

enum _flexio_shifter_input_source
Define type of shifter input source.

Values:

enumerator kFLEXIO_ShifterInputFromPin
Shifter input from pin.

enumerator kFLEXIO_ShifterInputFromNextShifterOutput
Shifter input from Shifter N+1.

enum _flexio_shifter_stop_bit
Define of STOP bit configuration.

Values:

enumerator kFLEXIO_ShifterStopBitDisable
Disable shifter stop bit.

enumerator kFLEXIO_ShifterStopBitLow
Set shifter stop bit to logic low level.

enumerator kFLEXIO_ShifterStopBitHigh
Set shifter stop bit to logic high level.

enum _flexio_shifter_start_bit
Define type of START bit configuration.

Values:

enumerator kFLEXIO_ShifterStartBitDisabledLoadDataOnEnable
Disable shifter start bit, transmitter loads data on enable.

enumerator kFLEXIO_ShifterStartBitDisabledLoadDataOnShift
Disable shifter start bit, transmitter loads data on first shift.

enumerator kFLEXIO_ShifterStartBitLow
Set shifter start bit to logic low level.

enumerator kFLEXIO_ShifterStartBitHigh
Set shifter start bit to logic high level.

enum _flexio_shifter_buffer_type
Define FlexIO shifter buffer type.

Values:

enumerator kFLEXIO_ShifterBuffer
Shifter Buffer N Register.

enumerator kFLEXIO_ShifterBufferBitSwapped
Shifter Buffer N Bit Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferByteSwapped
Shifter Buffer N Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferBitByteSwapped
Shifter Buffer N Bit Swapped Register.

enumerator kFLEXIO_ShifterBufferNibbleByteSwapped
Shifter Buffer N Nibble Byte Swapped Register.

enumerator kFLEXIO_ShifterBufferHalfWordSwapped
Shifter Buffer N Half Word Swapped Register.

enumerator kFLEXIO_ShifterBufferNibbleSwapped
Shifter Buffer N Nibble Swapped Register.

typedef enum *_flexio_timer_trigger_polarity* flexio_timer_trigger_polarity_t
Define time of timer trigger polarity.

typedef enum *_flexio_timer_trigger_source* flexio_timer_trigger_source_t
Define type of timer trigger source.

typedef enum *_flexio_pin_config* flexio_pin_config_t
Define type of timer/shifter pin configuration.

typedef enum *_flexio_pin_polarity* flexio_pin_polarity_t
Definition of pin polarity.

typedef enum *_flexio_timer_mode* flexio_timer_mode_t
Define type of timer work mode.

typedef enum *_flexio_timer_output* flexio_timer_output_t
Define type of timer initial output or timer reset condition.

typedef enum *_flexio_timer_decrement_source* flexio_timer_decrement_source_t
Define type of timer decrement.

typedef enum *_flexio_timer_reset_condition* flexio_timer_reset_condition_t
Define type of timer reset condition.

typedef enum *_flexio_timer_disable_condition* flexio_timer_disable_condition_t
Define type of timer disable condition.

typedef enum *_flexio_timer_enable_condition* flexio_timer_enable_condition_t
Define type of timer enable condition.

typedef enum *_flexio_timer_stop_bit_condition* flexio_timer_stop_bit_condition_t
Define type of timer stop bit generate condition.

typedef enum *_flexio_timer_start_bit_condition* flexio_timer_start_bit_condition_t
Define type of timer start bit generate condition.

typedef enum *_flexio_timer_output_state* flexio_timer_output_state_t
FlexIO as PWM channel output state.

typedef enum *_flexio_shifter_timer_polarity* flexio_shifter_timer_polarity_t
Define type of timer polarity for shifter control.

typedef enum *_flexio_shifter_mode* flexio_shifter_mode_t
Define type of shifter working mode.

typedef enum *_flexio_shifter_input_source* flexio_shifter_input_source_t
Define type of shifter input source.

typedef enum *_flexio_shifter_stop_bit* flexio_shifter_stop_bit_t
Define of STOP bit configuration.

typedef enum *_flexio_shifter_start_bit* flexio_shifter_start_bit_t
Define type of START bit configuration.

typedef enum *_flexio_shifter_buffer_type* flexio_shifter_buffer_type_t
Define FlexIO shifter buffer type.

typedef struct *_flexio_config_* flexio_config_t
Define FlexIO user configuration structure.

typedef struct *_flexio_timer_config* flexio_timer_config_t
Define FlexIO timer configuration structure.

typedef struct *_flexio_shifter_config* flexio_shifter_config_t
Define FlexIO shifter configuration structure.

typedef void (*flexio_isr_t)(void *base, void *handle)
typedef for FlexIO simulated driver interrupt handler.

FLEXIO_Type *const s_flexioBases[]
Pointers to flexio bases for each instance.

const *clock_ip_name_t* s_flexioClocks[]
Pointers to flexio clocks for each instance.

FLEXIO_TIMER_TRIGGER_SEL_PININPUT(**x**)
Calculate FlexIO timer trigger.

FLEXIO_TIMER_TRIGGER_SEL_SHIFTnSTAT(**x**)

FLEXIO_TIMER_TRIGGER_SEL_TIMn(**x**)

struct _flexio_config_
#include <fsl_flexio.h> Define FlexIO user configuration structure.

Public Members

bool enableFlexio
Enable/disable FlexIO module

bool enableInDoze
Enable/disable FlexIO operation in doze mode

bool enableInDebug
Enable/disable FlexIO operation in debug mode

bool enableFastAccess
Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

struct _flexio_timer_config
#include <fsl_flexio.h> Define FlexIO timer configuration structure.

Public Members

uint32_t triggerSelect
The internal trigger selection number using MACROs.

flexio_timer_trigger_polarity_t triggerPolarity
Trigger Polarity.

flexio_timer_trigger_source_t triggerSource
Trigger Source, internal (see 'trgsel') or external.

flexio_pin_config_t pinConfig
Timer Pin Configuration.

uint32_t pinSelect
: Timer Pin number Select.

flexio_pin_polarity_t pinPolarity
: Timer Pin Polarity.

flexio_timer_mode_t timerMode
: Timer work Mode.

flexio_timer_output_t timerOutput
: Configures the initial state of the Timer Output and whether it is affected by the Timer reset.

flexio_timer_decrement_source_t timerDecrement
: Configures the source of the Timer decrement and the source of the Shift clock.

flexio_timer_reset_condition_t timerReset
: Configures the condition that causes the timer counter (and optionally the timer output) to be reset.

flexio_timer_disable_condition_t timerDisable
: Configures the condition that causes the Timer to be disabled and stop decrementing.

flexio_timer_enable_condition_t timerEnable
: Configures the condition that causes the Timer to be enabled and start decrementing.

flexio_timer_stop_bit_condition_t timerStop
: Timer STOP Bit generation.

flexio_timer_start_bit_condition_t timerStart
: Timer STRAT Bit generation.

uint32_t timerCompare
: Value for Timer Compare N Register.

struct __flexio_shifter_config
: *#include <fsl_flexio.h>* Define FlexIO shifter configuration structure.

Public Members

uint32_t timerSelect
: Selects which Timer is used for controlling the logic/shift register and generating the Shift clock.

flexio_shifter_timer_polarity_t timerPolarity
: Timer Polarity.

flexio_pin_config_t pinConfig
: Shifter Pin Configuration.

uint32_t pinSelect
: Shifter Pin number Select.

flexio_pin_polarity_t pinPolarity
: Shifter Pin Polarity.

flexio_shifter_mode_t shifterMode
: Configures the mode of the Shifter.

uint32_t parallelWidth
: Configures the parallel width when using parallel mode.

flexio_shifter_input_source_t inputSource
Selects the input source for the shifter.

flexio_shifter_stop_bit_t shifterStop
Shifter STOP bit.

flexio_shifter_start_bit_t shifterStart
Shifter START bit.

2.15 FlexIO I2C Master Driver

status_t FLEXIO_I2C_CheckForBusyBus(*FLEXIO_I2C_Type* *base)
Make sure the bus isn't already pulled down.

Check the FLEXIO pin status to see whether either of SDA and SCL pin is pulled down.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure..

Return values

- kStatus_Success –
- kStatus_FLEXIO_I2C_Busy –

status_t FLEXIO_I2C_MasterInit(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_config_t* *masterConfig, uint32_t srcClock_Hz)
Ungates the FlexIO clock, resets the FlexIO module, and configures the FlexIO I2C hardware configuration.

Example

```
FLEXIO_I2C_Type base = {
.flexioBase = FLEXIO,
.SDAPinIndex = 0,
.SCLPinIndex = 1,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_i2c_master_config_t config = {
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 100000
};
FLEXIO_I2C_MasterInit(base, &config, srcClock_Hz);
```

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- masterConfig – Pointer to flexio_i2c_master_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

Return values

- kStatus_Success – Initialization successful
- kStatus_InvalidArgument – The source clock exceed upper range limitation

void FLEXIO_I2C_MasterDeinit(*FLEXIO_I2C_Type* *base)

De-initializes the FlexIO I2C master peripheral. Calling this API Resets the FlexIO I2C master shifer and timer config, module can't work unless the FLEXIO_I2C_MasterInit is called.

Parameters

- base – pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterGetDefaultConfig(*flexio_i2c_master_config_t* *masterConfig)

Gets the default configuration to configure the FlexIO module. The configuration can be used directly for calling the FLEXIO_I2C_MasterInit().

Example:

```
flexio_i2c_master_config_t config;
FLEXIO_I2C_MasterGetDefaultConfig(&config);
```

Parameters

- masterConfig – Pointer to flexio_i2c_master_config_t structure.

static inline void FLEXIO_I2C_MasterEnable(*FLEXIO_I2C_Type* *base, bool enable)

Enables/disables the FlexIO module operation.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- enable – Pass true to enable module, false does not have any effect.

uint32_t FLEXIO_I2C_MasterGetStatusFlags(*FLEXIO_I2C_Type* *base)

Gets the FlexIO I2C master status flags.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure

Returns

Status flag, use status flag to AND _flexio_i2c_master_status_flags can get the related status.

void FLEXIO_I2C_MasterClearStatusFlags(*FLEXIO_I2C_Type* *base, uint32_t mask)

Clears the FlexIO I2C master status flags.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO_I2C_RxFullFlag
  - kFLEXIO_I2C_ReceiveNakFlag

void FLEXIO_I2C_MasterEnableInterrupts(*FLEXIO_I2C_Type* *base, uint32_t mask)

Enables the FlexIO i2c master interrupt requests.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- mask – Interrupt source. Currently only one interrupt request source:
  - kFLEXIO_I2C_TransferCompleteInterruptEnable

void FLEXIO_I2C_MasterDisableInterrupts(*FLEXIO_I2C_Type* *base, uint32_t mask)

Disables the FlexIO I2C master interrupt requests.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- mask – Interrupt source.

void FLEXIO_I2C_MasterSetBaudRate(*FLEXIO_I2C_Type* *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the FlexIO I2C master transfer baudrate.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- baudRate_Bps – the baud rate value in HZ
- srcClock_Hz – source clock in HZ

void FLEXIO_I2C_MasterStart(*FLEXIO_I2C_Type* *base, uint8_t address, *flexio_i2c_direction_t* direction)

Sends START + 7-bit address to the bus.

Note: This API should be called when the transfer configuration is ready to send a START signal and 7-bit address to the bus. This is a non-blocking API, which returns directly after the address is put into the data register but the address transfer is not finished on the bus. Ensure that the kFLEXIO_I2C_RxFullFlag status is asserted before calling this API.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- address – 7-bit address.
- direction – transfer direction. This parameter is one of the values in flexio_i2c_direction_t:
  - kFLEXIO_I2C_Write: Transmit
  - kFLEXIO_I2C_Read: Receive

void FLEXIO_I2C_MasterStop(*FLEXIO_I2C_Type* *base)

Sends the stop signal on the bus.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterRepeatedStart(*FLEXIO_I2C_Type* *base)

Sends the repeated start signal on the bus.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterAbortStop(*FLEXIO_I2C_Type* *base)

Sends the stop signal when transfer is still on-going.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

void FLEXIO_I2C_MasterEnableAck(*FLEXIO_I2C_Type* *base, bool enable)

Configures the sent ACK/NAK for the following byte.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- enable – True to configure send ACK, false configure to send NAK.

status_t FLEXIO_I2C_MasterSetTransferCount(*FLEXIO_I2C_Type* *base, uint16_t count)

Sets the number of bytes to be transferred from a start signal to a stop signal.

Note: Call this API before a transfer begins because the timer generates a number of clocks according to the number of bytes that need to be transferred.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- count – Number of bytes need to be transferred from a start signal to a re-start/stop signal

Return values

- kStatus_Success – Successfully configured the count.
- kStatus_InvalidArgument – Input argument is invalid.

static inline void FLEXIO_I2C_MasterWriteByte(*FLEXIO_I2C_Type* *base, uint32_t data)

Writes one byte of data to the I2C bus.

Note: This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- data – a byte of data.

static inline uint8_t FLEXIO_I2C_MasterReadByte(*FLEXIO_I2C_Type* *base)

Reads one byte of data from the I2C bus.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the data is ready in the register.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.

Returns

data byte read.

status_t FLEXIO_I2C_MasterWriteBlocking(*FLEXIO_I2C_Type* *base, const uint8_t *txBuff, uint8_t txSize)

Sends a buffer of data in bytes.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- txBuff – The data bytes to send.
- txSize – The number of data bytes to send.

Return values

- kStatus_Success – Successfully write data.
- kStatus_FLEXIO_I2C_Nak – Receive NAK during writing data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

status_t FLEXIO_I2C_MasterReadBlocking(*FLEXIO_I2C_Type* *base, uint8_t *rxBuff, uint8_t rxSize)

Receives a buffer of bytes.

Note: This function blocks via polling until all bytes have been received.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- rxBuff – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

Return values

- kStatus_Success – Successfully read data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

status_t FLEXIO_I2C_MasterTransferBlocking(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_transfer_t* *xfer)

Performs a master polling transfer on the I2C bus.

Note: The API does not return until the transfer succeeds or fails due to receiving NAK.

Parameters

- base – pointer to FLEXIO_I2C_Type structure.
- xfer – pointer to flexio_i2c_master_transfer_t structure.

Returns

status of status_t.

status_t FLEXIO_I2C_MasterTransferCreateHandle(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *flexio_i2c_master_transfer_callback_t* callback, void *userData)

Initializes the I2C handle which is used in transactional functions.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- handle – Pointer to flexio_i2c_master_handle_t structure to store the transfer state.
- callback – Pointer to user callback function.

- userData – User param passed to the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/isr table out of range.

status_t FLEXIO_I2C_MasterTransferNonBlocking(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *flexio_i2c_master_transfer_t* *xfer)

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

Note: The API returns immediately after the transfer initiates. Call FLEXIO_I2C_MasterTransferGetCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_FLEXIO_I2C_Busy, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state
- xfer – pointer to flexio_i2c_master_transfer_t structure

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_FLEXIO_I2C_Busy – FlexIO I2C is not idle, is running another transfer.

status_t FLEXIO_I2C_MasterTransferGetCount(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, size_t *count)

Gets the master transfer status during a interrupt non-blocking transfer.

Parameters

- base – Pointer to FLEXIO_I2C_Type structure.
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.
- kStatus_Success – Successfully return the count.

void FLEXIO_I2C_MasterTransferAbort(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle)

Aborts an interrupt non-blocking transfer early.

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

Parameters

- base – Pointer to FLEXIO_I2C_Type structure
- handle – Pointer to flexio_i2c_master_handle_t structure which stores the transfer state

void FLEXIO_I2C_MasterTransferHandleIRQ(void *i2cType, void *i2cHandle)

Master interrupt handler.

Parameters

- i2cType – Pointer to FLEXIO_I2C_Type structure
- i2cHandle – Pointer to flexio_i2c_master_transfer_t structure

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FlexIO I2C transfer status.

Values:

enumerator kStatus_FLEXIO_I2C_Busy
I2C is busy doing transfer.

enumerator kStatus_FLEXIO_I2C_Idle
I2C is busy doing transfer.

enumerator kStatus_FLEXIO_I2C_Nak
NAK received during transfer.

enumerator kStatus_FLEXIO_I2C_Timeout
Timeout polling status flags.

enum _flexio_i2c_master_interrupt

Define FlexIO I2C master interrupt mask.

Values:

enumerator kFLEXIO_I2C_TxEmptyInterruptEnable
Tx buffer empty interrupt enable.

enumerator kFLEXIO_I2C_RxFullInterruptEnable
Rx buffer full interrupt enable.

enum _flexio_i2c_master_status_flags

Define FlexIO I2C master status mask.

Values:

enumerator kFLEXIO_I2C_TxEmptyFlag
Tx shifter empty flag.

enumerator kFLEXIO_I2C_RxFullFlag
Rx shifter full/Transfer complete flag.

enumerator kFLEXIO_I2C_ReceiveNakFlag
Receive NAK flag.

enum _flexio_i2c_direction

Direction of master transfer.

Values:

enumerator kFLEXIO_I2C_Write
Master send to slave.

enumerator kFLEXIO_I2C_Read
Master receive from slave.

typedef enum *_flexio_i2c_direction* flexio_i2c_direction_t
Direction of master transfer.

typedef struct *_flexio_i2c_type* FLEXIO_I2C_Type
Define FlexIO I2C master access structure typedef.

typedef struct *_flexio_i2c_master_config* flexio_i2c_master_config_t
Define FlexIO I2C master user configuration structure.

typedef struct *_flexio_i2c_master_transfer* flexio_i2c_master_transfer_t
Define FlexIO I2C master transfer structure.

typedef struct *_flexio_i2c_master_handle* flexio_i2c_master_handle_t
FlexIO I2C master handle typedef.

typedef void (*flexio_i2c_master_transfer_callback_t)(*FLEXIO_I2C_Type* *base, *flexio_i2c_master_handle_t* *handle, *status_t* status, void *userData)
FlexIO I2C master transfer callback typedef.

I2C_RETRY_TIMES
Retry times for waiting flag.

struct _flexio_i2c_type
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master access structure typedef.

Public Members

FLEXIO_Type *flexioBase
FlexIO base pointer.

uint8_t SDAPinIndex
Pin select for I2C SDA.

uint8_t SCLPinIndex
Pin select for I2C SCL.

uint8_t shifterIndex[2]
Shifter index used in FlexIO I2C.

uint8_t timerIndex[3]
Timer index used in FlexIO I2C.

uint32_t baudrate
Master transfer baudrate, used to calculate delay time.

struct _flexio_i2c_master_config
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master user configuration structure.

Public Members

bool enableMaster
Enables the FlexIO I2C peripheral at initialization time.

bool enableInDoze
Enable/disable FlexIO operation in doze mode.

bool enableInDebug
: Enable/disable FlexIO operation in debug mode.

bool enableFastAccess
: Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps
: Baud rate in Bps.

struct __flexio_i2c_master_transfer
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master transfer structure.

Public Members

uint32_t flags
: Transfer flag which controls the transfer, reserved for FlexIO I2C.

uint8_t slaveAddress
: 7-bit slave address.

flexio_i2c_direction_t direction
: Transfer direction, read or write.

uint32_t subaddress
: Sub address. Transferred MSB first.

uint8_t subaddressSize
: Size of sub address.

uint8_t volatile *data
: Transfer buffer.

volatile size_t dataSize
: Transfer size.

struct __flexio_i2c_master_handle
#include <fsl_flexio_i2c_master.h> Define FlexIO I2C master handle structure.

Public Members

flexio_i2c_master_transfer_t transfer
: FlexIO I2C master transfer copy.

size_t transferSize
: Total bytes to be transferred.

uint8_t state
: Transfer state maintained during transfer.

flexio_i2c_master_transfer_callback_t completionCallback
: Callback function called at transfer event. Callback function called at transfer event.

void *userData
: Callback parameter passed to callback function.

bool needRestart
: Whether master needs to send re-start signal.

2.16 FlexIO I2S Driver

void FLEXIO_I2S_Init(*FLEXIO_I2S_Type* *base, const *flexio_i2s_config_t* *config)

Initializes the FlexIO I2S.

This API configures FlexIO pins and shifter to I2S and configures the FlexIO I2S with a configuration structure. The configuration structure can be filled by the user, or be set with default values by FLEXIO_I2S_GetDefaultConfig().

Note: This API should be called at the beginning of the application to use the FlexIO I2S driver. Otherwise, any access to the FlexIO I2S module can cause hard fault because the clock is not enabled.

Parameters

- base – FlexIO I2S base pointer
- config – FlexIO I2S configure structure.

void FLEXIO_I2S_GetDefaultConfig(*flexio_i2s_config_t* *config)

Sets the FlexIO I2S configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in FLEXIO_I2S_Init(). Users may use the initialized structure unchanged in FLEXIO_I2S_Init() or modify some fields of the structure before calling FLEXIO_I2S_Init().

Parameters

- config – pointer to master configuration structure

void FLEXIO_I2S_Deinit(*FLEXIO_I2S_Type* *base)

De-initializes the FlexIO I2S.

Calling this API resets the FlexIO I2S shifter and timer config. After calling this API, call the FLEXO_I2S_Init to use the FlexIO I2S module.

Parameters

- base – FlexIO I2S base pointer

static inline void FLEXIO_I2S_Enable(*FLEXIO_I2S_Type* *base, bool enable)

Enables/disables the FlexIO I2S module operation.

Parameters

- base – Pointer to FLEXIO_I2S_Type
- enable – True to enable, false dose not have any effect.

uint32_t FLEXIO_I2S_GetStatusFlags(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S status flags.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns

Status flag, which are ORed by the enumerators in the _flexio_i2s_status_flags.

void FLEXIO_I2S_EnableInterrupts(*FLEXIO_I2S_Type* *base, uint32_t mask)

Enables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- mask – interrupt source

void FLEXIO_I2S_DisableInterrupts(*FLEXIO_I2S_Type* *base, uint32_t mask)

Disables the FlexIO I2S interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – pointer to FLEXIO_I2S_Type structure
- mask – interrupt source

static inline void FLEXIO_I2S_TxEnableDMA(*FLEXIO_I2S_Type* *base, bool enable)

Enables/disables the FlexIO I2S Tx DMA requests.

Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline void FLEXIO_I2S_RxEnableDMA(*FLEXIO_I2S_Type* *base, bool enable)

Enables/disables the FlexIO I2S Rx DMA requests.

Parameters

- base – FlexIO I2S base pointer
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t FLEXIO_I2S_TxGetDataRegisterAddress(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S send data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns

FlexIO i2s send data register address.

static inline uint32_t FLEXIO_I2S_RxGetDataRegisterAddress(*FLEXIO_I2S_Type* *base)

Gets the FlexIO I2S receive data register address.

This function returns the I2S data register address, mainly used by DMA/eDMA.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure

Returns

FlexIO i2s receive data register address.

void FLEXIO_I2S_MasterSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S audio format in master mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- format – Pointer to FlexIO I2S audio data format structure.
- srcClock_Hz – I2S master clock source frequency in Hz.

void FLEXIO_I2S_SlaveSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_format_t* *format)

Configures the FlexIO I2S audio format in slave mode.

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- format – Pointer to FlexIO I2S audio data format structure.

status_t FLEXIO_I2S_WriteBlocking(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint8_t *txData, size_t size)

Sends data using a blocking method.

Note: This function blocks via polling until data is ready to be sent.

Parameters

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- txData – Pointer to the data to be written.
- size – Bytes to be written.

Return values

- kStatus_Success – Successfully write data.
- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

static inline void FLEXIO_I2S_WriteData(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint32_t data)

Writes data into a data register.

Parameters

- base – FlexIO I2S base pointer.
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- data – Data to be written.

status_t FLEXIO_I2S_ReadBlocking(*FLEXIO_I2S_Type* *base, uint8_t bitWidth, uint8_t *rxData, size_t size)

Receives a piece of data using a blocking method.

Note: This function blocks via polling until data is ready to be sent.

Parameters

- base – FlexIO I2S base pointer
- bitWidth – How many bits in a audio word, usually 8/16/24/32 bits.
- rxData – Pointer to the data to be read.
- size – Bytes to be read.

Return values

- kStatus_Success – Successfully read data.

- kStatus_FLEXIO_I2C_Timeout – Timeout polling status flags.

static inline uint32_t FLEXIO_I2S_ReadData(*FLEXIO_I2S_Type* *base)

Reads a data from the data register.

Parameters

- base – FlexIO I2S base pointer

Returns

Data read from data register.

void FLEXIO_I2S_TransferTxCreateHandle(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_callback_t* callback, void *userData)

Initializes the FlexIO I2S handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure
- handle – Pointer to flexio_i2s_handle_t structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

void FLEXIO_I2S_TransferSetFormat(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_format_t* *format, uint32_t srcClock_Hz)

Configures the FlexIO I2S audio format.

Audio format can be changed at run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – FlexIO I2S handle pointer.
- format – Pointer to audio data format structure.
- srcClock_Hz – FlexIO I2S bit clock source frequency in Hz. This parameter should be 0 while in slave mode.

void FLEXIO_I2S_TransferRxCreateHandle(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_callback_t* callback, void *userData)

Initializes the FlexIO I2S receive handle.

This function initializes the FlexIO I2S handle which can be used for other FlexIO I2S transactional APIs. Call this API once to get the initialized handle.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure to store the transfer state.
- callback – FlexIO I2S callback function, which is called while finished a block.
- userData – User parameter for the FlexIO I2S callback.

status_t FLEXIO_I2S_TransferSendNonBlocking(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs an interrupt non-blocking send transfer on FlexIO I2S.

Note: The API returns immediately after transfer initiates. Call FLEXIO_I2S_GetRemainingBytes to poll the transfer status and check whether the transfer is finished. If the return status is 0, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- xfer – Pointer to flexio_i2s_transfer_t structure

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_FLEXIO_I2S_TxBusy – Previous transmission still not finished, data not all written to TX register yet.
- kStatus_InvalidArgument – The input parameter is invalid.

status_t FLEXIO_I2S_TransferReceiveNonBlocking(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *flexio_i2s_transfer_t* *xfer)

Performs an interrupt non-blocking receive transfer on FlexIO I2S.

Note: The API returns immediately after transfer initiates. Call FLEXIO_I2S_GetRemainingBytes to poll the transfer status to check whether the transfer is finished. If the return status is 0, the transfer is finished.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- xfer – Pointer to flexio_i2s_transfer_t structure

Return values

- kStatus_Success – Successfully start the data receive.
- kStatus_FLEXIO_I2S_RxBusy – Previous receive still not finished.
- kStatus_InvalidArgument – The input parameter is invalid.

void FLEXIO_I2S_TransferAbortSend(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle)

Aborts the current send.

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

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.

- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state

void FLEXIO_I2S_TransferAbortReceive(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle)

Aborts the current receive.

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

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state

status_t FLEXIO_I2S_TransferGetSendCount(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, size_t *count)

Gets the remaining bytes to be sent.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- count – Bytes sent.

Return values

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

status_t FLEXIO_I2S_TransferGetReceiveCount(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, size_t *count)

Gets the remaining bytes to be received.

Parameters

- base – Pointer to FLEXIO_I2S_Type structure.
- handle – Pointer to flexio_i2s_handle_t structure which stores the transfer state
- count – Bytes recieved.

Return values

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

Returns

count Bytes received.

void FLEXIO_I2S_TransferTxHandleIRQ(void *i2sBase, void *i2sHandle)

Tx interrupt handler.

Parameters

- i2sBase – Pointer to FLEXIO_I2S_Type structure.
- i2sHandle – Pointer to flexio_i2s_handle_t structure

void FLEXIO_I2S_TransferRxHandleIRQ(void *i2sBase, void *i2sHandle)

Rx interrupt handler.

Parameters

- i2sBase – Pointer to FLEXIO_I2S_Type structure.
- i2sHandle – Pointer to flexio_i2s_handle_t structure.

FSL_FLEXIO_I2S_DRIVER_VERSION

FlexIO I2S driver version 2.2.2.

FlexIO I2S transfer status.

Values:

enumerator kStatus_FLEXIO_I2S_Idle

FlexIO I2S is in idle state

enumerator kStatus_FLEXIO_I2S_TxBusy

FlexIO I2S Tx is busy

enumerator kStatus_FLEXIO_I2S_RxBusy

FlexIO I2S Tx is busy

enumerator kStatus_FLEXIO_I2S_Error

FlexIO I2S error occurred

enumerator kStatus_FLEXIO_I2S_QueueFull

FlexIO I2S transfer queue is full.

enumerator kStatus_FLEXIO_I2S_Timeout

FlexIO I2S timeout polling status flags.

enum _flexio_i2s_master_slave

Master or slave mode.

Values:

enumerator kFLEXIO_I2S_Master

Master mode

enumerator kFLEXIO_I2S_Slave

Slave mode

_flexio_i2s_interrupt_enable Define FlexIO FlexIO I2S interrupt mask.

Values:

enumerator kFLEXIO_I2S_TxDataRegEmptyInterruptEnable

Transmit buffer empty interrupt enable.

enumerator kFLEXIO_I2S_RxDataRegFullInterruptEnable

Receive buffer full interrupt enable.

_flexio_i2s_status_flags Define FlexIO FlexIO I2S status mask.

Values:

enumerator kFLEXIO_I2S_TxDataRegEmptyFlag

Transmit buffer empty flag.

enumerator kFLEXIO_I2S_RxDataRegFullFlag
Receive buffer full flag.

enum _flexio_i2s_sample_rate
Audio sample rate.

Values:

enumerator kFLEXIO_I2S_SampleRate8KHz
Sample rate 8000Hz

enumerator kFLEXIO_I2S_SampleRate11025Hz
Sample rate 11025Hz

enumerator kFLEXIO_I2S_SampleRate12KHz
Sample rate 12000Hz

enumerator kFLEXIO_I2S_SampleRate16KHz
Sample rate 16000Hz

enumerator kFLEXIO_I2S_SampleRate22050Hz
Sample rate 22050Hz

enumerator kFLEXIO_I2S_SampleRate24KHz
Sample rate 24000Hz

enumerator kFLEXIO_I2S_SampleRate32KHz
Sample rate 32000Hz

enumerator kFLEXIO_I2S_SampleRate44100Hz
Sample rate 44100Hz

enumerator kFLEXIO_I2S_SampleRate48KHz
Sample rate 48000Hz

enumerator kFLEXIO_I2S_SampleRate96KHz
Sample rate 96000Hz

enum _flexio_i2s_word_width
Audio word width.

Values:

enumerator kFLEXIO_I2S_WordWidth8bits
Audio data width 8 bits

enumerator kFLEXIO_I2S_WordWidth16bits
Audio data width 16 bits

enumerator kFLEXIO_I2S_WordWidth24bits
Audio data width 24 bits

enumerator kFLEXIO_I2S_WordWidth32bits
Audio data width 32 bits

typedef struct *_flexio_i2s_type* FLEXIO_I2S_Type
Define FlexIO I2S access structure typedef.

typedef enum *_flexio_i2s_master_slave* flexio_i2s_master_slave_t
Master or slave mode.

typedef struct *_flexio_i2s_config* flexio_i2s_config_t
FlexIO I2S configure structure.

typedef struct *_flexio_i2s_format* flexio_i2s_format_t
FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

typedef enum *_flexio_i2s_sample_rate* flexio_i2s_sample_rate_t
Audio sample rate.

typedef enum *_flexio_i2s_word_width* flexio_i2s_word_width_t
Audio word width.

typedef struct *_flexio_i2s_transfer* flexio_i2s_transfer_t
Define FlexIO I2S transfer structure.

typedef struct *_flexio_i2s_handle* flexio_i2s_handle_t

typedef void (*flexio_i2s_callback_t)(*FLEXIO_I2S_Type* *base, *flexio_i2s_handle_t* *handle, *status_t* status, void *userData)
FlexIO I2S xfer callback prototype.

I2S_RETRY_TIMES
Retry times for waiting flag.

FLEXIO_I2S_XFER_QUEUE_SIZE
FlexIO I2S transfer queue size, user can refine it according to use case.

struct _flexio_i2s_type
#include <fsl_flexio_i2s.h> Define FlexIO I2S access structure typedef.

Public Members

FLEXIO_Type *flexioBase
FlexIO base pointer

uint8_t txPinIndex
Tx data pin index in FlexIO pins

uint8_t rxPinIndex
Rx data pin index

uint8_t bclkPinIndex
Bit clock pin index

uint8_t fsPinIndex
Frame sync pin index

uint8_t txShifterIndex
Tx data shifter index

uint8_t rxShifterIndex
Rx data shifter index

uint8_t bclkTimerIndex
Bit clock timer index

uint8_t fsTimerIndex
Frame sync timer index

struct _flexio_i2s_config
#include <fsl_flexio_i2s.h> FlexIO I2S configure structure.

Public Members

bool enableI2S
: Enable FlexIO I2S

flexio_i2s_master_slave_t masterSlave
: Master or slave

flexio_pin_polarity_t txPinPolarity
: Tx data pin polarity, active high or low

flexio_pin_polarity_t rxPinPolarity
: Rx data pin polarity

flexio_pin_polarity_t bclkPinPolarity
: Bit clock pin polarity

flexio_pin_polarity_t fsPinPolarity
: Frame sync pin polarity

flexio_shifter_timer_polarity_t txTimerPolarity
: Tx data valid on bclk rising or falling edge

flexio_shifter_timer_polarity_t rxTimerPolarity
: Rx data valid on bclk rising or falling edge

struct __flexio_i2s_format
: *#include <fsl_flexio_i2s.h>* FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx.

Public Members

uint8_t bitWidth
: Bit width of audio data, always 8/16/24/32 bits

uint32_t sampleRate_Hz
: Sample rate of the audio data

struct __flexio_i2s_transfer
: *#include <fsl_flexio_i2s.h>* Define FlexIO I2S transfer structure.

Public Members

uint8_t *data
: Data buffer start pointer

size_t dataSize
: Bytes to be transferred.

struct __flexio_i2s_handle
: *#include <fsl_flexio_i2s.h>* Define FlexIO I2S handle structure.

Public Members

uint32_t state
: Internal state

flexio_i2s_callback_t callback
: Callback function called at transfer event

void *userData
: Callback parameter passed to callback function

uint8_t bitWidth
: Bit width for transfer, 8/16/24/32bits

flexio_i2s_transfer_t queue[(4U)]
: Transfer queue storing queued transfer

size_t transferSize[(4U)]
: Data bytes need to transfer

volatile uint8_t queueUser
: Index for user to queue transfer

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

2.17 FlexIO SPI Driver

void FLEXIO_SPI_MasterInit(*FLEXIO_SPI_Type* *base, *flexio_spi_master_config_t* *masterConfig, uint32_t srcClock_Hz)

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI master hardware, and configures the FlexIO SPI with FlexIO SPI master configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_MasterGetDefaultConfig().

Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_spi_master_config_t config = {
.enableMaster = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 500000,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_MasterInit(&spiDev, &config, srcClock_Hz);
```

Note: 1.FlexIO SPI master only support CPOL = 0, which means clock inactive low. 2.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI master communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by 2*2=4. If FlexIO SPI master communicates with FlexIO SPI slave, the maximum baud rate is FlexIO clock frequency divided by (1.5+2.5)*2=8.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- masterConfig – Pointer to the flexio_spi_master_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

void FLEXIO_SPI_MasterDeinit(*FLEXIO_SPI_Type* *base)

Resets the FlexIO SPI timer and shifter config.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_MasterGetDefaultConfig(*flexio_spi_master_config_t* *masterConfig)

Gets the default configuration to configure the FlexIO SPI master. The configuration can be used directly by calling the FLEXIO_SPI_MasterConfigure(). Example:

```
flexio_spi_master_config_t masterConfig;
FLEXIO_SPI_MasterGetDefaultConfig(&masterConfig);
```

Parameters

- masterConfig – Pointer to the flexio_spi_master_config_t structure.

void FLEXIO_SPI_SlaveInit(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_config_t* *slaveConfig)

Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO SPI slave hardware configuration, and configures the FlexIO SPI with FlexIO SPI slave configuration. The configuration structure can be filled by the user, or be set with default values by the FLEXIO_SPI_SlaveGetDefaultConfig().

Note: 1.Only one timer is needed in the FlexIO SPI slave. As a result, the second timer index is ignored. 2.FlexIO SPI slave only support CPOL = 0, which means clock inactive low. 3.For FlexIO SPI master, the input valid time is 1.5 clock cycles, for slave the output valid time is 2.5 clock cycles. So if FlexIO SPI slave communicates with other spi IPs, the maximum baud rate is FlexIO clock frequency divided by 3*2=6. If FlexIO SPI slave communicates with FlexIO SPI master, the maximum baud rate is FlexIO clock frequency divided by (1.5+2.5)*2=8. Example

```
FLEXIO_SPI_Type spiDev = {
.flexioBase = FLEXIO,
.SDOPinIndex = 0,
.SDIPinIndex = 1,
.SCKPinIndex = 2,
.CSnPinIndex = 3,
.shifterIndex = {0,1},
.timerIndex = {0}
};
flexio_spi_slave_config_t config = {
.enableSlave = true,
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.phase = kFLEXIO_SPI_ClockPhaseFirstEdge,
.direction = kFLEXIO_SPI_MsbFirst,
.dataMode = kFLEXIO_SPI_8BitMode
};
FLEXIO_SPI_SlaveInit(&spiDev, &config);
```

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

void FLEXIO_SPI_SlaveDeinit(*FLEXIO_SPI_Type* *base)

Gates the FlexIO clock.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.

void FLEXIO_SPI_SlaveGetDefaultConfig(*flexio_spi_slave_config_t* *slaveConfig)

Gets the default configuration to configure the FlexIO SPI slave. The configuration can be used directly for calling the FLEXIO_SPI_SlaveConfigure(). Example:

```
flexio_spi_slave_config_t slaveConfig;
FLEXIO_SPI_SlaveGetDefaultConfig(&slaveConfig);
```

Parameters

- slaveConfig – Pointer to the flexio_spi_slave_config_t structure.

uint32_t FLEXIO_SPI_GetStatusFlags(*FLEXIO_SPI_Type* *base)

Gets FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

Returns

status flag; Use the status flag to AND the following flag mask and get the status.

- kFLEXIO_SPI_TxEmptyFlag
- kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_ClearStatusFlags(*FLEXIO_SPI_Type* *base, uint32_t mask)

Clears FlexIO SPI status flags.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – status flag The parameter can be any combination of the following values:
  - kFLEXIO_SPI_TxEmptyFlag
  - kFLEXIO_SPI_RxEmptyFlag

void FLEXIO_SPI_EnableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Enables the FlexIO SPI interrupt.

This function enables the FlexIO SPI interrupt.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – interrupt source. The parameter can be any combination of the following values:
  - kFLEXIO_SPI_RxFullInterruptEnable
  - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_DisableInterrupts(*FLEXIO_SPI_Type* *base, uint32_t mask)

Disables the FlexIO SPI interrupt.

This function disables the FlexIO SPI interrupt.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – interrupt source The parameter can be any combination of the following values:
  - kFLEXIO_SPI_RxFullInterruptEnable
  - kFLEXIO_SPI_TxEmptyInterruptEnable

void FLEXIO_SPI_EnableDMA(*FLEXIO_SPI_Type* *base, uint32_t mask, bool enable)

Enables/disables the FlexIO SPI transmit DMA. This function enables/disables the FlexIO SPI Tx DMA, which means that asserting the kFLEXIO_SPI_TxEmptyFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- mask – SPI DMA source.
- enable – True means enable DMA, false means disable DMA.

static inline uint32_t FLEXIO_SPI_GetTxDataRegisterAddress(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Gets the FlexIO SPI transmit data register address for MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI transmit data register address.

static inline uint32_t FLEXIO_SPI_GetRxDataRegisterAddress(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Gets the FlexIO SPI receive data register address for the MSB first transfer.

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.

Returns

FlexIO SPI receive data register address.

static inline void FLEXIO_SPI_Enable(*FLEXIO_SPI_Type* *base, bool enable)

Enables/disables the FlexIO SPI module operation.

Parameters

- base – Pointer to the FLEXIO_SPI_Type.
- enable – True to enable, false does not have any effect.

void FLEXIO_SPI_MasterSetBaudRate(*FLEXIO_SPI_Type* *base, uint32_t baudRate_Bps, uint32_t srcClockHz)

Sets baud rate for the FlexIO SPI transfer, which is only used for the master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- baudRate_Bps – Baud Rate needed in Hz.
- srcClockHz – SPI source clock frequency in Hz.

static inline void FLEXIO_SPI_WriteData(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, uint32_t data)

Writes one byte of data, which is sent using the MSB method.

Note: This is a non-blocking API, which returns directly after the data is put into the data register but the data transfer is not finished on the bus. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- data – 8/16/32 bit data.

static inline uint32_t FLEXIO_SPI_ReadData(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction)

Reads 8 bit/16 bit data.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.

Returns

8 bit/16 bit data received.

status_t FLEXIO_SPI_WriteBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, const uint8_t *buffer, size_t size)

Sends a buffer of data bytes.

Note: This function blocks using the polling method until all bytes have been sent.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The data bytes to send.
- size – The number of data bytes to send.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_ReadBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_shift_direction_t* direction, uint8_t *buffer, size_t size)

Receives a buffer of bytes.

Note: This function blocks using the polling method until all bytes have been received.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- direction – Shift direction of MSB first or LSB first.
- buffer – The buffer to store the received bytes.
- size – The number of data bytes to be received.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

status_t FLEXIO_SPI_MasterTransferBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_transfer_t* *xfer)

Receives a buffer of bytes.

Note: This function blocks via polling until all bytes have been received.

Parameters

- base – pointer to FLEXIO_SPI_Type structure
- xfer – FlexIO SPI transfer structure, see flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_FLEXIO_SPI_Timeout – The transfer timed out and was aborted.

void FLEXIO_SPI_FlushShifters(*FLEXIO_SPI_Type* *base)

Flush tx/rx shifters.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

status_t FLEXIO_SPI_MasterTransferCreateHandle(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *flexio_spi_master_transfer_callback_t* callback, void *userData)

Initializes the FlexIO SPI Master handle, which is used in transactional functions.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- callback – The callback function.

- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_SPI_MasterTransferNonBlocking(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *flexio_spi_transfer_t* *xfer)

Master transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- xfer – FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – SPI is not idle, is running another transfer.

void FLEXIO_SPI_MasterTransferAbort(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle)

Aborts the master data transfer, which used IRQ.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

status_t FLEXIO_SPI_MasterTransferGetCount(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, size_t *count)

Gets the data transfer status which used IRQ.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXIO_SPI_MasterTransferHandleIRQ(void *spiType, void *spiHandle)

FlexIO SPI master IRQ handler function.

Parameters

- spiType – Pointer to the FLEXIO_SPI_Type structure.

- spiHandle – Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

status_t FLEXIO_SPI_SlaveTransferCreateHandle(*FLEXIO_SPI_Type* *base,
flexio_spi_slave_handle_t *handle,
flexio_spi_slave_transfer_callback_t callback,
void *userData)

Initializes the FlexIO SPI Slave handle, which is used in transactional functions.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

status_t FLEXIO_SPI_SlaveTransferNonBlocking(*FLEXIO_SPI_Type* *base,
flexio_spi_slave_handle_t *handle,
flexio_spi_transfer_t *xfer)

Slave transfer data using IRQ.

This function sends data using IRQ. This is a non-blocking function, which returns right away. When all data is sent out/received, the callback function is called.

Parameters

- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- base – Pointer to the FLEXIO_SPI_Type structure.
- xfer – FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.
- kStatus_FLEXIO_SPI_Busy – SPI is not idle; it is running another transfer.

static inline void FLEXIO_SPI_SlaveTransferAbort(*FLEXIO_SPI_Type* *base,
flexio_spi_slave_handle_t *handle)

Aborts the slave data transfer which used IRQ, share same API with master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.
- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

static inline *status_t* FLEXIO_SPI_SlaveTransferGetCount(*FLEXIO_SPI_Type* *base,
flexio_spi_slave_handle_t *handle,
size_t *count)

Gets the data transfer status which used IRQ, share same API with master.

Parameters

- base – Pointer to the FLEXIO_SPI_Type structure.

- handle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

void FLEXIO_SPI_SlaveTransferHandleIRQ(void *spiType, void *spiHandle)

FlexIO SPI slave IRQ handler function.

Parameters

- spiType – Pointer to the FLEXIO_SPI_Type structure.
- spiHandle – Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

FSL_FLEXIO_SPI_DRIVER_VERSION

FlexIO SPI driver version.

Error codes for the FlexIO SPI driver.

Values:

enumerator kStatus_FLEXIO_SPI_Busy

FlexIO SPI is busy.

enumerator kStatus_FLEXIO_SPI_Idle

SPI is idle

enumerator kStatus_FLEXIO_SPI_Error

FlexIO SPI error.

enumerator kStatus_FLEXIO_SPI_Timeout

FlexIO SPI timeout polling status flags.

enum _flexio_spi_clock_phase

FlexIO SPI clock phase configuration.

Values:

enumerator kFLEXIO_SPI_ClockPhaseFirstEdge

First edge on SPSCK occurs at the middle of the first cycle of a data transfer.

enumerator kFLEXIO_SPI_ClockPhaseSecondEdge

First edge on SPSCK occurs at the start of the first cycle of a data transfer.

enum _flexio_spi_shift_direction

FlexIO SPI data shifter direction options.

Values:

enumerator kFLEXIO_SPI_MsbFirst

Data transfers start with most significant bit.

enumerator kFLEXIO_SPI_LsbFirst

Data transfers start with least significant bit.

enum _flexio_spi_data_bitcount_mode

FlexIO SPI data length mode options.

Values:

enumerator kFLEXIO_SPI_8BitMode
8-bit data transmission mode.

enumerator kFLEXIO_SPI_16BitMode
16-bit data transmission mode.

enumerator kFLEXIO_SPI_32BitMode
32-bit data transmission mode.

enum _flexio_spi_interrupt_enable
Define FlexIO SPI interrupt mask.

Values:

enumerator kFLEXIO_SPI_TxEmptyInterruptEnable
Transmit buffer empty interrupt enable.

enumerator kFLEXIO_SPI_RxFullInterruptEnable
Receive buffer full interrupt enable.

enum _flexio_spi_status_flags
Define FlexIO SPI status mask.

Values:

enumerator kFLEXIO_SPI_TxBufferEmptyFlag
Transmit buffer empty flag.

enumerator kFLEXIO_SPI_RxBufferFullFlag
Receive buffer full flag.

enum _flexio_spi_dma_enable
Define FlexIO SPI DMA mask.

Values:

enumerator kFLEXIO_SPI_TxDmaEnable
Tx DMA request source

enumerator kFLEXIO_SPI_RxDmaEnable
Rx DMA request source

enumerator kFLEXIO_SPI_DmaAllEnable
All DMA request source

enum _flexio_spi_transfer_flags
Define FlexIO SPI transfer flags.

Note: Use kFLEXIO_SPI_csContinuous and one of the other flags to OR together to form the transfer flag.

Values:

enumerator kFLEXIO_SPI_8bitMsb
FlexIO SPI 8-bit MSB first

enumerator kFLEXIO_SPI_8bitLsb
FlexIO SPI 8-bit LSB first

enumerator kFLEXIO_SPI_16bitMsb
FlexIO SPI 16-bit MSB first

enumerator kFLEXIO_SPI_16bitLsb
FlexIO SPI 16-bit LSB first

enumerator kFLEXIO_SPI_32bitMsb
FlexIO SPI 32-bit MSB first

enumerator kFLEXIO_SPI_32bitLsb
FlexIO SPI 32-bit LSB first

enumerator kFLEXIO_SPI_csContinuous
Enable the CS signal continuous mode

typedef enum *_flexio_spi_clock_phase* flexio_spi_clock_phase_t
FlexIO SPI clock phase configuration.

typedef enum *_flexio_spi_shift_direction* flexio_spi_shift_direction_t
FlexIO SPI data shifter direction options.

typedef enum *_flexio_spi_data_bitcount_mode* flexio_spi_data_bitcount_mode_t
FlexIO SPI data length mode options.

typedef struct *_flexio_spi_type* FLEXIO_SPI_Type
Define FlexIO SPI access structure typedef.

typedef struct *_flexio_spi_master_config* flexio_spi_master_config_t
Define FlexIO SPI master configuration structure.

typedef struct *_flexio_spi_slave_config* flexio_spi_slave_config_t
Define FlexIO SPI slave configuration structure.

typedef struct *_flexio_spi_transfer* flexio_spi_transfer_t
Define FlexIO SPI transfer structure.

typedef struct *_flexio_spi_master_handle* flexio_spi_master_handle_t
typedef for flexio_spi_master_handle_t in advance.

typedef *flexio_spi_master_handle_t* flexio_spi_slave_handle_t
Slave handle is the same with master handle.

typedef void (*flexio_spi_master_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_master_handle_t* *handle, *status_t* status, void *userData)
FlexIO SPI master callback for finished transmit.

typedef void (*flexio_spi_slave_transfer_callback_t)(*FLEXIO_SPI_Type* *base, *flexio_spi_slave_handle_t* *handle, *status_t* status, void *userData)
FlexIO SPI slave callback for finished transmit.

FLEXIO_SPI_DUMMYDATA
FlexIO SPI dummy transfer data, the data is sent while txData is NULL.

SPI_RETRY_TIMES
Retry times for waiting flag.

FLEXIO_SPI_XFER_DATA_FORMAT(flag)
Get the transfer data format of width and bit order.

struct _flexio_spi_type
#include <fsl_flexio_spi.h> Define FlexIO SPI access structure typedef.

Public Members

FLEXIO_Type *flexioBase
: FlexIO base pointer.

uint8_t SDOPinIndex
: Pin select for data output. To set SDO pin in Hi-Z state, user needs to mux the pin as GPIO input and disable all pull up/down in application.

uint8_t SDIPinIndex
: Pin select for data input.

uint8_t SCKPinIndex
: Pin select for clock.

uint8_t CSnPinIndex
: Pin select for enable.

uint8_t shifterIndex[2]
: Shifter index used in FlexIO SPI.

uint8_t timerIndex[2]
: Timer index used in FlexIO SPI.

struct __flexio_spi_master_config
: *#include <fsl_flexio_spi.h>* Define FlexIO SPI master configuration structure.

Public Members

bool enableMaster
: Enable/disable FlexIO SPI master after configuration.

bool enableInDoze
: Enable/disable FlexIO operation in doze mode.

bool enableInDebug
: Enable/disable FlexIO operation in debug mode.

bool enableFastAccess
: Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps
: Baud rate in Bps.

flexio_spi_clock_phase_t phase
: Clock phase.

flexio_spi_data_bitcount_mode_t dataMode
: 8bit or 16bit mode.

struct __flexio_spi_slave_config
: *#include <fsl_flexio_spi.h>* Define FlexIO SPI slave configuration structure.

Public Members

bool enableSlave
: Enable/disable FlexIO SPI slave after configuration.

bool enableInDoze
: Enable/disable FlexIO operation in doze mode.

bool enableInDebug
: Enable/disable FlexIO operation in debug mode.

bool enableFastAccess
: Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

flexio_spi_clock_phase_t phase
: Clock phase.

flexio_spi_data_bitcount_mode_t dataMode
: 8bit or 16bit mode.

struct __flexio_spi_transfer
: *#include <fsl_flexio_spi.h>* Define FlexIO SPI transfer structure.

Public Members

const uint8_t *txData
: Send buffer.

uint8_t *rxData
: Receive buffer.

size_t dataSize
: Transfer bytes.

uint8_t flags
: FlexIO SPI control flag, MSB first or LSB first.

struct __flexio_spi_master_handle
: *#include <fsl_flexio_spi.h>* Define FlexIO SPI handle structure.

Public Members

const uint8_t *txData
: Transfer buffer.

uint8_t *rxData
: Receive buffer.

size_t transferSize
: Total bytes to be transferred.

volatile size_t txRemainingBytes
: Send data remaining in bytes.

volatile size_t rxRemainingBytes
: Receive data remaining in bytes.

volatile uint32_t state
: FlexIO SPI internal state.

uint8_t bytePerFrame
: SPI mode, 2bytes or 1byte in a frame

flexio_spi_shift_direction_t direction
Shift direction.

flexio_spi_master_transfer_callback_t callback
FlexIO SPI callback.

void *userData
Callback parameter.

bool isCsContinuous
Is current transfer using CS continuous mode.

uint32_t timer1Cfg
TIMER1 TIMCFG regiser value backup.

2.18 FlexIO UART Driver

status_t FLEXIO_UART_Init(*FLEXIO_UART_Type* *base, const *flexio_uart_config_t* *userConfig, uint32_t srcClock_Hz)

Ungates the FlexIO clock, resets the FlexIO module, configures FlexIO UART hardware, and configures the FlexIO UART with FlexIO UART configuration. The configuration structure can be filled by the user or be set with default values by FLEXIO_UART_GetDefaultConfig().

Example

```
FLEXIO_UART_Type base = {
.flexioBase = FLEXIO,
.TxPinIndex = 0,
.RxPinIndex = 1,
.shifterIndex = {0,1},
.timerIndex = {0,1}
};
flexio_uart_config_t config = {
.enableInDoze = false,
.enableInDebug = true,
.enableFastAccess = false,
.baudRate_Bps = 115200U,
.bitCountPerChar = 8
};
FLEXIO_UART_Init(base, &config, srcClock_Hz);
```

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- userConfig – Pointer to the flexio_uart_config_t structure.
- srcClock_Hz – FlexIO source clock in Hz.

Return values

- kStatus_Success – Configuration success.
- kStatus_FLEXIO_UART_BaudrateNotSupport – Baudrate is not supported for current clock source frequency.

void FLEXIO_UART_Deinit(*FLEXIO_UART_Type* *base)

Resets the FlexIO UART shifter and timer config.

Note: After calling this API, call the FLEXO_UART_Init to use the FlexIO UART module.

Parameters

- base – Pointer to FLEXIO_UART_Type structure

void FLEXIO_UART_GetDefaultConfig(*flexio_uart_config_t* *userConfig)

Gets the default configuration to configure the FlexIO UART. The configuration can be used directly for calling the FLEXIO_UART_Init(). Example:

```
flexio_uart_config_t config;
FLEXIO_UART_GetDefaultConfig(&userConfig);
```

Parameters

- userConfig – Pointer to the flexio_uart_config_t structure.

uint32_t FLEXIO_UART_GetStatusFlags(*FLEXIO_UART_Type* *base)

Gets the FlexIO UART status flags.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART status flags.

void FLEXIO_UART_ClearStatusFlags(*FLEXIO_UART_Type* *base, uint32_t mask)

Gets the FlexIO UART status flags.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Status flag. The parameter can be any combination of the following values:
  - kFLEXIO_UART_TxDataRegEmptyFlag
  - kFLEXIO_UART_RxEmptyFlag
  - kFLEXIO_UART_RxOverRunFlag

void FLEXIO_UART_EnableInterrupts(*FLEXIO_UART_Type* *base, uint32_t mask)

Enables the FlexIO UART interrupt.

This function enables the FlexIO UART interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Interrupt source.

void FLEXIO_UART_DisableInterrupts(*FLEXIO_UART_Type* *base, uint32_t mask)

Disables the FlexIO UART interrupt.

This function disables the FlexIO UART interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- mask – Interrupt source.

static inline uint32_t FLEXIO_UART_GetTxDataRegisterAddress(*FLEXIO_UART_Type* *base)

Gets the FlexIO UARt transmit data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns
FlexIO UART transmit data register address.

static inline uint32_t FLEXIO_UART_GetRxDataRegisterAddress(*FLEXIO_UART_Type* *base)

Gets the FlexIO UART receive data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

Returns
FlexIO UART receive data register address.

static inline void FLEXIO_UART_EnableTxDMA(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART transmit DMA. This function enables/disables the FlexIO UART Tx DMA, which means asserting the kFLEXIO_UART_TxDataRegEmptyFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- enable – True to enable, false to disable.

static inline void FLEXIO_UART_EnableRxDMA(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART receive DMA. This function enables/disables the FlexIO UART Rx DMA, which means asserting kFLEXIO_UART_RxDataRegFullFlag does/doesn't trigger the DMA request.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- enable – True to enable, false to disable.

static inline void FLEXIO_UART_Enable(*FLEXIO_UART_Type* *base, bool enable)

Enables/disables the FlexIO UART module operation.

Parameters

- base – Pointer to the FLEXIO_UART_Type.
- enable – True to enable, false does not have any effect.

static inline void FLEXIO_UART_WriteByte(*FLEXIO_UART_Type* *base, const uint8_t *buffer)

Writes one byte of data.

Note: This is a non-blocking API, which returns directly after the data is put into the data register. Ensure that the TxEmptyFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- buffer – The data bytes to send.

static inline void FLEXIO_UART_ReadByte(*FLEXIO_UART_Type* *base, uint8_t *buffer)

Reads one byte of data.

Note: This is a non-blocking API, which returns directly after the data is read from the data register. Ensure that the RxFullFlag is asserted before calling this API.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- buffer – The buffer to store the received bytes.

status_t FLEXIO_UART_WriteBlocking(*FLEXIO_UART_Type* *base, const uint8_t *txData, size_t txSize)

Sends a buffer of data bytes.

Note: This function blocks using the polling method until all bytes have been sent.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- txData – The data bytes to send.
- txSize – The number of data bytes to send.

Return values

- kStatus_FLEXIO_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t FLEXIO_UART_ReadBlocking(*FLEXIO_UART_Type* *base, uint8_t *rxData, size_t rxSize)

Receives a buffer of bytes.

Note: This function blocks using the polling method until all bytes have been received.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- rxData – The buffer to store the received bytes.
- rxSize – The number of data bytes to be received.

Return values

- kStatus_FLEXIO_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

status_t FLEXIO_UART_TransferCreateHandle(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_callback_t* callback, void *userData)

Initializes the UART handle.

This function initializes the FlexIO UART handle, which can be used for other FlexIO UART transactional APIs. Call this API once to get the initialized handle.

The UART driver supports the “background” receiving, which means that users can set up a RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn’t call the FLEXIO_UART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as ringBuffer.

Parameters

- base – to FLEXIO_UART_Type structure.

- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- callback – The callback function.
- userData – The parameter of the callback function.

Return values

- kStatus_Success – Successfully create the handle.
- kStatus_OutOfRange – The FlexIO type/handle/ISR table out of range.

void FLEXIO_UART_TransferStartRingBuffer(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, uint8_t *ringBuffer, size_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn't call the UART_ReceiveNonBlocking() API. If there is already data received in the ring buffer, users can get the received data from the ring buffer directly.

Note: When using the RX ring buffer, one byte is reserved for internal use. In other words, if ringBufferSize is 32, only 31 bytes are used for saving data.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- ringBuffer – Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
- ringBufferSize – Size of the ring buffer.

void FLEXIO_UART_TransferStopRingBuffer(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferSendNonBlocking(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_t* *xfer)

Transmits a buffer of data using the interrupt method.

This function sends data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data to be written to the TX register. When all data is written to the TX register in ISR, the FlexIO UART driver calls the callback function and passes the kStatus_FLEXIO_UART_TxIdle as status parameter.

Note: The kStatus_FLEXIO_UART_TxIdle is passed to the upper layer when all data is written to the TX register. However, it does not ensure that all data is sent out.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- xfer – FlexIO UART transfer structure. See flexio_uart_transfer_t.

Return values

- kStatus_Success – Successfully starts the data transmission.
- kStatus_UART_TxBusy – Previous transmission still not finished, data not written to the TX register.

void FLEXIO_UART_TransferAbortSend(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt-driven data sending. Get the remainBytes to find out how many bytes are still not sent out.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferGetSendCount(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, size_t *count)

Gets the number of bytes sent.

This function gets the number of bytes sent driven by interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- count – Number of bytes sent so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

status_t FLEXIO_UART_TransferReceiveNonBlocking(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *flexio_uart_transfer_t* *xfer, size_t *receivedBytes)

Receives a buffer of data using the interrupt method.

This function receives data using the interrupt method. This is a non-blocking function, which returns without waiting for all data to be received. If the RX ring buffer is used and not empty, the data in ring buffer is copied and the parameter receivedBytes shows how many bytes are copied from the ring buffer. After copying, if the data in ring buffer is not enough to read, the receive request is saved by the UART driver. When new data arrives, the receive request is serviced first. When all data is received, the UART driver notifies the upper layer through a callback function and passes the status parameter kStatus_UART_RxIdle. For example, if the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer, the 5 bytes are copied to xfer->data. This function returns with the parameter receivedBytes set to 5. For the last 5 bytes, newly arrived data is saved from the

xfer->data[5]. When 5 bytes are received, the UART driver notifies upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to xfer->data. When all data is received, the upper layer is notified.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- xfer – UART transfer structure. See flexio_uart_transfer_t.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into the transmit queue.
- kStatus_FLEXIO_UART_RxBusy – Previous receive request is not finished.

void FLEXIO_UART_TransferAbortReceive(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle)

Aborts the receive data which was using IRQ.

This function aborts the receive data which was using IRQ.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

status_t FLEXIO_UART_TransferGetReceiveCount(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, size_t *count)

Gets the number of bytes received.

This function gets the number of bytes received driven by interrupt.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.
- handle – Pointer to the flexio_uart_handle_t structure to store the transfer state.
- count – Number of bytes received so far by the non-blocking transaction.

Return values

- kStatus_NoTransferInProgress – transfer has finished or no transfer in progress.
- kStatus_Success – Successfully return the count.

void FLEXIO_UART_TransferHandleIRQ(void *uartType, void *uartHandle)

FlexIO UART IRQ handler function.

This function processes the FlexIO UART transmit and receives the IRQ request.

Parameters

- uartType – Pointer to the FLEXIO_UART_Type structure.
- uartHandle – Pointer to the flexio_uart_handle_t structure to store the transfer state.

void FLEXIO_UART_FlushShifters(*FLEXIO_UART_Type* *base)

Flush tx/rx shifters.

Parameters

- base – Pointer to the FLEXIO_UART_Type structure.

FSL_FLEXIO_UART_DRIVER_VERSION

FlexIO UART driver version.

Error codes for the UART driver.

Values:

enumerator kStatus_FLEXIO_UART_TxBusy

Transmitter is busy.

enumerator kStatus_FLEXIO_UART_RxBusy

Receiver is busy.

enumerator kStatus_FLEXIO_UART_TxIdle

UART transmitter is idle.

enumerator kStatus_FLEXIO_UART_RxIdle

UART receiver is idle.

enumerator kStatus_FLEXIO_UART_ERROR

ERROR happens on UART.

enumerator kStatus_FLEXIO_UART_RxRingBufferOverrun

UART RX software ring buffer overrun.

enumerator kStatus_FLEXIO_UART_RxHardwareOverrun

UART RX receiver overrun.

enumerator kStatus_FLEXIO_UART_Timeout

UART times out.

enumerator kStatus_FLEXIO_UART_BaudrateNotSupport

Baudrate is not supported in current clock source

enum _flexio_uart_bit_count_per_char

FlexIO UART bit count per char.

Values:

enumerator kFLEXIO_UART_7BitsPerChar

7-bit data characters

enumerator kFLEXIO_UART_8BitsPerChar

8-bit data characters

enumerator kFLEXIO_UART_9BitsPerChar

9-bit data characters

enum _flexio_uart_interrupt_enable

Define FlexIO UART interrupt mask.

Values:

enumerator kFLEXIO_UART_TxDataRegEmptyInterruptEnable

Transmit buffer empty interrupt enable.

enumerator kFLEXIO_UART_RxDataRegFullInterruptEnable
Receive buffer full interrupt enable.

enum _flexio_uart_status_flags
Define FlexIO UART status mask.

Values:

enumerator kFLEXIO_UART_TxDataRegEmptyFlag
Transmit buffer empty flag.

enumerator kFLEXIO_UART_RxDataRegFullFlag
Receive buffer full flag.

enumerator kFLEXIO_UART_RxOverRunFlag
Receive buffer over run flag.

typedef enum *_flexio_uart_bit_count_per_char* flexio_uart_bit_count_per_char_t
FlexIO UART bit count per char.

typedef struct *_flexio_uart_type* FLEXIO_UART_Type
Define FlexIO UART access structure typedef.

typedef struct *_flexio_uart_config* flexio_uart_config_t
Define FlexIO UART user configuration structure.

typedef struct *_flexio_uart_transfer* flexio_uart_transfer_t
Define FlexIO UART transfer structure.

typedef struct *_flexio_uart_handle* flexio_uart_handle_t

typedef void (*flexio_uart_transfer_callback_t)(*FLEXIO_UART_Type* *base, *flexio_uart_handle_t* *handle, *status_t* status, void *userData)
FlexIO UART transfer callback function.

UART_RETRY_TIMES
Retry times for waiting flag.

struct _flexio_uart_type
#include <fsl_flexio_uart.h> Define FlexIO UART access structure typedef.

Public Members

FLEXIO_Type *flexioBase
FlexIO base pointer.

uint8_t TxPinIndex
Pin select for UART_Tx.

uint8_t RxPinIndex
Pin select for UART_Rx.

uint8_t shifterIndex[2]
Shifter index used in FlexIO UART.

uint8_t timerIndex[2]
Timer index used in FlexIO UART.

struct _flexio_uart_config
#include <fsl_flexio_uart.h> Define FlexIO UART user configuration structure.

Public Members

bool enableUart
: Enable/disable FlexIO UART TX & RX.

bool enableInDoze
: Enable/disable FlexIO operation in doze mode

bool enableInDebug
: Enable/disable FlexIO operation in debug mode

bool enableFastAccess
: Enable/disable fast access to FlexIO registers, fast access requires the FlexIO clock to be at least twice the frequency of the bus clock.

uint32_t baudRate_Bps
: Baud rate in Bps.

flexio_uart_bit_count_per_char_t bitCountPerChar
: number of bits, 7/8/9 -bit

struct __flexio_uart_transfer
: *#include <fsl_flexio_uart.h>* Define FlexIO UART transfer structure.

Public Members

size_t dataSize
: Transfer size

struct __flexio_uart_handle
: *#include <fsl_flexio_uart.h>* Define FLEXIO UART handle structure.

Public Members

const uint8_t *volatile txData
: Address of remaining data to send.

volatile size_t txDataSize
: Size of the remaining data to send.

uint8_t *volatile rxData
: Address of remaining data to receive.

volatile size_t rxDataSize
: Size of the remaining data to receive.

size_t txDataSizeAll
: Total bytes to be sent.

size_t rxDataSizeAll
: Total bytes to be received.

uint8_t *rxRingBuffer
: Start address of the receiver ring buffer.

size_t rxRingBufferSize
: Size of the ring buffer.

volatile uint16_t rxRingBufferHead
: Index for the driver to store received data into ring buffer.

volatile uint16_t rxRingBufferTail
: Index for the user to get data from the ring buffer.

flexio_uart_transfer_callback_t callback
: Callback function.

void *userData
: UART callback function parameter.

volatile uint8_t txState
: TX transfer state.

volatile uint8_t rxState
: RX transfer state

union ___unnamed37___

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.

2.19 ftfx adapter

2.20 Ftftx CACHE Driver

enum _ftfx_cache_ram_func_constants
: Constants for execute-in-RAM flash function.

Values:

enumerator kFTFx_CACHE_RamFuncMaxSizeInWords
: The maximum size of execute-in-RAM function.

typedef struct *_flash_prefetch_speculation_status* ftfx_prefetch_speculation_status_t
: FTFx prefetch speculation status.

typedef struct *_ftfx_cache_config* ftfx_cache_config_t
: FTFx cache driver state information.

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

status_t FTFx_CACHE_Init(*ftfx_cache_config_t* *config)
: Initializes the global FTFx cache structure members.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

status_t FTFx_CACHE_ClearCachePrefetchSpeculation(*ftfx_cache_config_t* *config, bool isPreProcess)

Process the cache/prefetch/speculation to the flash.

Parameters

- config – A pointer to the storage for the driver runtime state.
- isPreProcess – The possible option used to control flash cache/prefetch/speculation

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – Invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

status_t FTFx_CACHE_PflashSetPrefetchSpeculation(*ftfx_prefetch_speculation_status_t* *speculationStatus)

Sets the PFlash prefetch speculation to the intended speculation status.

Parameters

- speculationStatus – The expected protect status to set to the PFlash protection register. Each bit is

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidSpeculationOption – An invalid speculation option argument is provided.

status_t FTFx_CACHE_PflashGetPrefetchSpeculation(*ftfx_prefetch_speculation_status_t* *speculationStatus)

Gets the PFlash prefetch speculation status.

Parameters

- speculationStatus – Speculation status returned by the PFlash IP.

Return values

kStatus_FTFx_Success – API was executed successfully.

struct _flash_prefetch_speculation_status

#include <fsl_ftfx_cache.h> FTFx prefetch speculation status.

Public Members

bool instructionOff

Instruction speculation.

bool dataOff

Data speculation.

union function_bit_operation_ptr_t

#include <fsl_ftfx_cache.h>

Public Members

uint32_t commadAddr

void (*callFlashCommand)(volatile uint32_t *base, uint32_t bitMask, uint32_t bitShift, uint32_t bitValue)

struct __ftfx_cache_config

#include <fsl_ftfx_cache.h> FTFx cache driver state information.

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

Public Members

uint8_t flashMemoryIndex

0 - primary flash; 1 - secondary flash

function_bit_operation_ptr_t bitOperFuncAddr

An buffer point to the flash execute-in-RAM function.

2.21 ftfx controller

FTFx driver status codes.

Values:

enumerator kStatus_FTFx_Success

API is executed successfully

enumerator kStatus_FTFx_InvalidArgument

Invalid argument

enumerator kStatus_FTFx_SizeError

Error size

enumerator kStatus_FTFx_AlignmentError

Parameter is not aligned with the specified baseline

enumerator kStatus_FTFx_AddressError

Address is out of range

enumerator kStatus_FTFx_AccessError

Invalid instruction codes and out-of bound addresses

enumerator kStatus_FTFx_ProtectionViolation

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

enumerator kStatus_FTFx_CommandFailure

Run-time error during command execution.

enumerator kStatus_FTFx_UnknownProperty

Unknown property.

enumerator kStatus_FTFx_EraseKeyError

API erase key is invalid.

enumerator kStatus_FTFx_RegionExecuteOnly
The current region is execute-only.

enumerator kStatus_FTFx_ExecuteInRamFunctionNotReady
Execute-in-RAM function is not available.

enumerator kStatus_FTFx_PartitionStatusUpdateFailure
Failed to update partition status.

enumerator kStatus_FTFx_SetFlexramAsEepromError
Failed to set FlexRAM as EEPROM.

enumerator kStatus_FTFx_RecoverFlexramAsRamError
Failed to recover FlexRAM as RAM.

enumerator kStatus_FTFx_SetFlexramAsRamError
Failed to set FlexRAM as RAM.

enumerator kStatus_FTFx_RecoverFlexramAsEepromError
Failed to recover FlexRAM as EEPROM.

enumerator kStatus_FTFx_CommandNotSupported
Flash API is not supported.

enumerator kStatus_FTFx_SwapSystemNotInUninitialized
Swap system is not in an uninitialzed state.

enumerator kStatus_FTFx_SwapIndicatorAddressError
The swap indicator address is invalid.

enumerator kStatus_FTFx_ReadOnlyProperty
The flash property is read-only.

enumerator kStatus_FTFx_InvalidPropertyValue
The flash property value is out of range.

enumerator kStatus_FTFx_InvalidSpeculationOption
The option of flash prefetch speculation is invalid.

enumerator kStatus_FTFx_CommandOperationInProgress
The option of flash command is processing.

enum _ftfx_driver_api_keys
Enumeration for FTFx driver API keys.

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

Values:

enumerator kFTFx_ApiEraseKey
Key value used to validate all FTFx erase APIs.

void FTFx_API_Init(*ftfx_config_t* *config)
Initializes the global flash properties structure members.

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

Parameters

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

status_t FTFx_API_UpdateFlexnvmPartitionStatus(*ftfx_config_t* *config)

Updates FlexNVM memory partition status according to data flash 0 IFR.

This function updates FlexNVM memory partition status.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FTFx_CMD_Erase(*ftfx_config_t* *config, uint32_t start, uint32_t lengthInBytes, uint32_t key)

Erases the flash sectors encompassed by parameters passed into function.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.
- kStatus_FTFx_EraseKeyError – The API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_EraseSectorNonBlocking(*ftfx_config_t* *config, uint32_t start, uint32_t key)

Erases the flash sectors encompassed by parameters passed into function.

This function erases one flash sector size based on the start address.

Parameters

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

- start – The start address of the desired flash memory to be erased. The start address does not need to be sector-aligned but must be word-aligned.
- key – The value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.
- kStatus_FTFx_EraseKeyError – The API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

status_t FTFx_CMD_EraseAll(*ftfx_config_t* *config, uint32_t key)

Erases entire flash.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FTFx_CMD_EraseAllUnsecure(*ftfx_config_t* *config, uint32_t key)

Erases the entire flash, including protected sectors.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FTFx_CMD_EraseAllExecuteOnlySegments(*ftfx_config_t* *config, uint32_t key)

Erases all program flash execute-only segments defined by the FXACC registers.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_Program(*ftfx_config_t* *config, uint32_t start, const uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.

- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_ProgramOnce(*ftfx_config_t* *config, uint32_t index, const uint8_t *src, uint32_t lengthInBytes)

Programs Program Once Field through parameters.

This function programs the Program Once Field with the desired data for a given flash area as determined by the index and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating which area of the Program Once Field to be programmed.
- src – A pointer to the source buffer of data that is to be programmed into the Program Once Field.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_ProgramSection(*ftfx_config_t* *config, uint32_t start, const uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters via the Program Section command.

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be word-aligned.
- src – A pointer to the source buffer of data that is to be programmed into the flash.

- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_SetFlexramAsRamError – Failed to set flexram as RAM.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_RecoverFlexramAsEepromError – Failed to recover FlexRAM as EEPROM.

status_t FTFx_CMD_ProgramPartition(*ftfx_config_t* *config, *ftfx_partition_flexram_load_opt_t* option, uint32_t eepromDataSizeCode, uint32_t flexnvmPartitionCode, uint8_t CSEcKeySize, uint8_t CFE)

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM.

Parameters

- config – Pointer to storage for the driver runtime state.
- option – The option used to set FlexRAM load behavior during reset.
- eepromDataSizeCode – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- flexnvmPartitionCode – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – Invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FTFx_CMD_ReadOnce(*ftfx_config_t* *config, uint32_t index, uint8_t *dst, uint32_t lengthInBytes)

Reads the Program Once Field through parameters.

This function reads the read once feild with given index and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating the area of program once field to be read.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_ReadResource(*ftfx_config_t* *config, uint32_t start, uint8_t *dst, uint32_t lengthInBytes, *ftfx_read_resource_opt_t* option)

Reads the resource with data at locations passed in through parameters.

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be word-aligned.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- option – The resource option which indicates which area should be read back.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_VerifyErase(*ftfx_config_t* *config, uint32_t start, uint32_t lengthInBytes, *ftfx_margin_value_t* margin)

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

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be verified. The start address does not need to be sector-aligned but must be word-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- margin – Read margin choice.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_VerifyEraseAll(*ftfx_config_t* *config, *ftfx_margin_value_t* margin)

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_VerifyEraseAllExecuteOnlySegments(*ftfx_config_t* *config, *ftfx_margin_value_t* margin)

Verifies whether the program flash execute-only segments have been erased to the specified read margin level.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_VerifyProgram(*ftfx_config_t* *config, uint32_t start, uint32_t lengthInBytes, const uint8_t *expectedData, *ftfx_margin_value_t* margin, uint32_t *failedAddress, uint32_t *failedData)

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

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.

- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_REG_GetSecurityState(*ftfx_config_t* *config, *ftfx_security_state_t* *state)

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

Parameters

- config – A pointer to storage for the driver runtime state.
- state – A pointer to the value returned for the current security status code:

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

status_t FTFx_CMD_SecurityBypass(*ftfx_config_t* *config, const uint8_t *backdoorKey)

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

Parameters

- config – A pointer to the storage for the driver runtime state.
- backdoorKey – A pointer to the user buffer containing the backdoor key.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_SetFlexramFunction(*ftfx_config_t* *config, *ftfx_flexram_func_opt_t* option)

Sets the FlexRAM function command.

Parameters

- config – A pointer to the storage for the driver runtime state.
- option – The option used to set the work mode of FlexRAM.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FTFx_CMD_SwapControl(*ftfx_config_t* *config, uint32_t address, *ftfx_swap_control_opt_t* option, *ftfx_swap_state_config_t* *returnInfo)

Configures the Swap function or checks the swap state of the Flash module.

Parameters

- config – A pointer to the storage for the driver runtime state.
- address – Address used to configure the flash Swap function.
- option – The possible option used to configure Flash Swap function or check the flash Swap status
- returnInfo – A pointer to the data which is used to return the information of flash Swap.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_SwapIndicatorAddressError – Swap indicator address is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

enum _ftfx_partition_flexram_load_option

Enumeration for the FlexRAM load during reset option.

Values:

enumerator kFTFx_PartitionFlexramLoadOptLoadedWithValidEepromData

FlexRAM is loaded with valid EEPROM data during reset sequence.

enumerator kFTFx_PartitionFlexramLoadOptNotLoaded
FlexRAM is not loaded during reset sequence.

enum _ftfx_read_resource_opt
Enumeration for the two possible options of flash read resource command.

Values:

enumerator kFTFx_ResourceOptionFlashIfr
Select code for Program flash 0 IFR, Program flash swap 0 IFR, Data flash 0 IFR

enumerator kFTFx_ResourceOptionVersionId
Select code for the version ID

enum _ftfx_margin_value
Enumeration for supported FTFx margin levels.

Values:

enumerator kFTFx_MarginValueNormal
Use the 'normal' read level for 1s.

enumerator kFTFx_MarginValueUser
Apply the 'User' margin to the normal read-1 level.

enumerator kFTFx_MarginValueFactory
Apply the 'Factory' margin to the normal read-1 level.

enumerator kFTFx_MarginValueInvalid
Not real margin level, Used to determine the range of valid margin level.

enum _ftfx_security_state
Enumeration for the three possible FTFx security states.

Values:

enumerator kFTFx_SecurityStateNotSecure
Flash is not secure.

enumerator kFTFx_SecurityStateBackdoorEnabled
Flash backdoor is enabled.

enumerator kFTFx_SecurityStateBackdoorDisabled
Flash backdoor is disabled.

enum _ftfx_flexram_function_option
Enumeration for the two possilbe options of set FlexRAM function command.

Values:

enumerator kFTFx_FlexramFuncOptAvailableAsRam
An option used to make FlexRAM available as RAM

enumerator kFTFx_FlexramFuncOptAvailableForEeprom
An option used to make FlexRAM available for EEPROM

enum _flash_acceleration_ram_property
Enumeration for acceleration ram property.

Values:

enumerator kFLASH_AccelerationRamSize

enum _ftfx_swap_control_option

Enumeration for the possible options of Swap control commands.

Values:

enumerator kFTFx_SwapControlOptionIntializeSystem

An option used to initialize the Swap system

enumerator kFTFx_SwapControlOptionSetInUpdateState

An option used to set the Swap in an update state

enumerator kFTFx_SwapControlOptionSetInCompleteState

An option used to set the Swap in a complete state

enumerator kFTFx_SwapControlOptionReportStatus

An option used to report the Swap status

enumerator kFTFx_SwapControlOptionDisableSystem

An option used to disable the Swap status

enum _ftfx_swap_state

Enumeration for the possible flash Swap status.

Values:

enumerator kFTFx_SwapStateUninitialized

Flash Swap system is in an uninitialized state.

enumerator kFTFx_SwapStateReady

Flash Swap system is in a ready state.

enumerator kFTFx_SwapStateUpdate

Flash Swap system is in an update state.

enumerator kFTFx_SwapStateUpdateErased

Flash Swap system is in an updateErased state.

enumerator kFTFx_SwapStateComplete

Flash Swap system is in a complete state.

enumerator kFTFx_SwapStateDisabled

Flash Swap system is in a disabled state.

enum _ftfx_swap_block_status

Enumeration for the possible flash Swap block status.

Values:

enumerator kFTFx_SwapBlockStatusLowerHalfProgramBlocksAtZero

Swap block status is that lower half program block at zero.

enumerator kFTFx_SwapBlockStatusUpperHalfProgramBlocksAtZero

Swap block status is that upper half program block at zero.

enum _ftfx_memory_type

Enumeration for FTFx memory type.

Values:

enumerator kFTFx_MemTypePflash

enumerator kFTFx_MemTypeFlexnvm

typedef enum *_ftfx_partition_flexram_load_option* ftfx_partition_flexram_load_opt_t
Enumeration for the FlexRAM load during reset option.

typedef enum *_ftfx_read_resource_opt* ftfx_read_resource_opt_t
Enumeration for the two possible options of flash read resource command.

typedef enum *_ftfx_margin_value* ftfx_margin_value_t
Enumeration for supported FTFx margin levels.

typedef enum *_ftfx_security_state* ftfx_security_state_t
Enumeration for the three possible FTFx security states.

typedef enum *_ftfx_flexram_function_option* ftfx_flexram_func_opt_t
Enumeration for the two possilbe options of set FlexRAM function command.

typedef enum *_ftfx_swap_control_option* ftfx_swap_control_opt_t
Enumeration for the possible options of Swap control commands.

typedef enum *_ftfx_swap_state* ftfx_swap_state_t
Enumeration for the possible flash Swap status.

typedef enum *_ftfx_swap_block_status* ftfx_swap_block_status_t
Enumeration for the possible flash Swap block status.

typedef struct *_ftfx_swap_state_config* ftfx_swap_state_config_t
Flash Swap information.

typedef struct *_ftfx_special_mem* ftfx_spec_mem_t
ftfx special memory access information.

typedef struct *_ftfx_mem_descriptor* ftfx_mem_desc_t
Flash memory descriptor.

typedef struct *_ftfx_ops_config* ftfx_ops_config_t
Active FTFx information for the current operation.

typedef struct *_ftfx_ifr_descriptor* ftfx_ifr_desc_t
Flash IFR memory descriptor.

typedef struct *_ftfx_config* ftfx_config_t
Flash driver state information.

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

struct _ftfx_swap_state_config
#include <fsl_ftfx_controller.h> Flash Swap information.

Public Members

ftfx_swap_state_t flashSwapState
The current Swap system status.

ftfx_swap_block_status_t currentSwapBlockStatus
The current Swap block status.

ftfx_swap_block_status_t nextSwapBlockStatus
The next Swap block status.

struct _ftfx_special_mem
#include <fsl_ftfx_controller.h> ftfx special memory access information.

Public Members

uint32_t base
: Base address of flash special memory.

uint32_t size
: size of flash special memory.

uint32_t count
: flash special memory count.

struct __ftfx_mem_descriptor
: *#include <fsl_ftfx_controller.h>* Flash memory descriptor.

Public Members

uint32_t blockBase
: A base address of the flash block

uint32_t aliasBlockBase
: A base address of the alias flash block

uint32_t totalSize
: The size of the flash block.

uint32_t sectorSize
: The size in bytes of a sector of flash.

uint32_t blockCount
: A number of flash blocks.

struct __ftfx_ops_config
: *#include <fsl_ftfx_controller.h>* Active FTFx information for the current operation.

Public Members

uint32_t convertedAddress
: A converted address for the current flash type.

struct __ftfx_ifr_descriptor
: *#include <fsl_ftfx_controller.h>* Flash IFR memory descriptor.

union function_ptr_t
: *#include <fsl_ftfx_controller.h>*

Public Members

uint32_t commadAddr

void (*callFlashCommand)(volatile uint8_t *FTMRx_fstat)

struct __ftfx_config
: *#include <fsl_ftfx_controller.h>* Flash driver state information.

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

Public Members

uint32_t flexramBlockBase
: The base address of the FlexRAM/acceleration RAM

uint32_t flexramTotalSize
: The size of the FlexRAM/acceleration RAM

uint16_t eepromTotalSize
: The size of EEPROM area which was partitioned from FlexRAM

function_ptr_t runCmdFuncAddr
: An buffer point to the flash execute-in-RAM function.

struct ___unnamed5___

Public Members

uint8_t type
: Type of flash block.

uint8_t index
: Index of flash block.

struct feature

struct addrAligment

struct feature

struct resRange

Public Members

uint8_t versionIdStart
: Version ID start address

uint32_t pflashIfrStart
: Program Flash 0 IFR start address

uint32_t dflashIfrStart
: Data Flash 0 IFR start address

uint32_t pflashSwapIfrStart
: Program Flash Swap IFR start address

struct idxInfo

2.22 ftfx feature

FTFx_DRIVER_IS_FLASH_RESIDENT
: Flash driver location.

  Used for the flash resident application.

FTFx_DRIVER_IS_EXPORTED
: Flash Driver Export option.

  Used for the MCUXpresso SDK application.

FTFx_FLASH1_HAS_PROT_CONTROL

Indicates whether the secondary flash has its own protection register in flash module.

FTFx_FLASH1_HAS_XACC_CONTROL

Indicates whether the secondary flash has its own Execute-Only access register in flash module.

FTFx_DRIVER_HAS_FLASH1_SUPPORT

Indicates whether the secondary flash is supported in the Flash driver.

FTFx_FLASH_COUNT

FTFx_FLASH1_IS_INDEPENDENT_BLOCK

2.23 Ftftx FLASH Driver

status_t FLASH_Init(*flash_config_t* *config)

Initializes the global flash properties structure members.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

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

Erases the Dflash sectors encompassed by parameters passed into function.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the appropriate number of flash sectors based on the desired start address and length were erased successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – The parameter is not aligned with the specified baseline.

- kStatus_FTFx_AddressError – The address is out of range.
- kStatus_FTFx_EraseKeyError – The API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_EraseSectorNonBlocking(***flash_config_t*** *config, uint32_t start, uint32_t key)

Erases the Dflash sectors encompassed by parameters passed into function.

This function erases one flash sector size based on the start address, and it is executed asynchronously.

NOTE: This function can only erase one flash sector at a time, and the other commands can be executed after the previous command has been completed.

Parameters

- config – The pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be erased. The start address does not need to be sector-aligned but must be word-aligned.
- key – The value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.
- kStatus_FTFx_EraseKeyError – The API erase key is invalid.

status_t FLASH_EraseAll(***flash_config_t*** *config, uint32_t key)

Erases entire flexnvm.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully; the all pflash and flexnvm were erased successfully, the swap and eeprom have been reset to unconfigured state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.

- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FLASH_EraseAllUnsecure(*flash_config_t* *config, uint32_t key)

Erases the entire flexnvm, including protected sectors.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully; the protected sectors of flash were reset to unprotected status.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

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

Programs flash with data at locations passed in through parameters.

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

Parameters

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

Return values

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

- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_ProgramOnce(*flash_config_t* *config, uint32_t index, uint8_t *src, uint32_t lengthInBytes)

Program the Program-Once-Field through parameters.

This function Program the Program-once-feild with given index and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating the area of program once field to be read.
- src – A pointer to the source buffer of data that is used to store data to be write.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully; The index indicating the area of program once field was programed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

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

Programs flash with data at locations passed in through parameters via the Program Section command.

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be word-aligned.

- src – A pointer to the source buffer of data that is to be programmed into the flash.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully; the desired data have been programed successfully into flash based on start address and length.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_SetFlexramAsRamError – Failed to set flexram as RAM.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_RecoverFlexramAsEepromError – Failed to recover FlexRAM as EEPROM.

status_t FLASH_ReadResource(*flash_config_t* *config, uint32_t start, uint8_t *dst, uint32_t lengthInBytes, *ftfx_read_resource_opt_t* option)

Reads the resource with data at locations passed in through parameters.

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be word-aligned.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- option – The resource option which indicates which area should be read back.

Return values

- kStatus_FTFx_Success – API was executed successfully; the data have been read successfully from program flash IFR, data flash IFR space, and the Version ID field.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.

- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_ReadOnce(*flash_config_t* *config, uint32_t index, uint8_t *dst, uint32_t lengthInBytes)

Reads the Program Once Field through parameters.

This function reads the read once feild with given index and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- index – The index indicating the area of program once field to be read.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

- kStatus_FTFx_Success – API was executed successfully; the data have been successfuly read form Program flash0 IFR map and Program Once field based on index and length.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_VerifyErase(*flash_config_t* *config, uint32_t start, uint32_t lengthInBytes, *ftfx_margin_value_t* margin)

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

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be verified. The start address does not need to be sector-aligned but must be word-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- margin – Read margin choice.

Return values

- kStatus_FTFx_Success – API was executed successfully; the specified FLASH region has been erased.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_VerifyEraseAll(*flash_config_t* *config, *ftfx_margin_value_t* margin)

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; all program flash and flexnvm were in erased state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

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

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

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

Parameters

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

- expectedData – A pointer to the expected data that is to be verified against.
- margin – Read margin choice.
- failedAddress – A pointer to the returned failing address.
- failedData – A pointer to the returned failing data. Some derivatives do not include failed data as part of the FCCOBx registers. In this case, zeros are returned upon failure.

Return values

- kStatus_FTFx_Success – API was executed successfully; the desired data have been successfully programed into specified FLASH region.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_GetSecurityState(*flash_config_t* *config, *ftfx_security_state_t* *state)

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

Parameters

- config – A pointer to storage for the driver runtime state.
- state – A pointer to the value returned for the current security status code:

Return values

- kStatus_FTFx_Success – API was executed successfully; the security state of flash was stored to state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

status_t FLASH_SecurityBypass(*flash_config_t* *config, const uint8_t *backdoorKey)

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

Parameters

- config – A pointer to the storage for the driver runtime state.
- backdoorKey – A pointer to the user buffer containing the backdoor key.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_SetFlexramFunction(*flash_config_t* *config, *ftfx_flexram_func_opt_t* option)

Sets the FlexRAM function command.

Parameters

- config – A pointer to the storage for the driver runtime state.
- option – The option used to set the work mode of FlexRAM.

Return values

- kStatus_FTFx_Success – API was executed successfully; the FlexRAM has been successfully configured as RAM or EEPROM.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLASH_Swap(*flash_config_t* *config, uint32_t address, bool isSetEnable)

Swaps the lower half flash with the higher half flash.

Parameters

- config – A pointer to the storage for the driver runtime state.
- address – Address used to configure the flash swap function
- isSetEnable – The possible option used to configure the Flash Swap function or check the flash Swap status.

Return values

- kStatus_FTFx_Success – API was executed successfully; the lower half flash and higher half flash have been swaped.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_SwapIndicatorAddressError – Swap indicator address is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.

- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_SwapSystemNotInUninitialized – Swap system is not in an uninitialized state.

status_t FLASH_IsProtected(*flash_config_t* *config, uint32_t start, uint32_t lengthInBytes, *flash_prot_state_t* *protection_state)

Returns the protection state of the desired flash area via the pointer passed into the function.

This function retrieves the current flash protect status for a given flash area as determined by the start address and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be checked. Must be word-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words) to be checked. Must be word-aligned.
- protection_state – A pointer to the value returned for the current protection status code for the desired flash area.

Return values

- kStatus_FTFx_Success – API was executed successfully; the protection state of specified FLASH region was stored to protection_state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.

status_t FLASH_IsExecuteOnly(*flash_config_t* *config, uint32_t start, uint32_t lengthInBytes, *flash_xacc_state_t* *access_state)

Returns the access state of the desired flash area via the pointer passed into the function.

This function retrieves the current flash access status for a given flash area as determined by the start address and length.

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be checked. Must be word-aligned.
- lengthInBytes – The length, given in bytes (not words or long-words), to be checked. Must be word-aligned.
- access_state – A pointer to the value returned for the current access status code for the desired flash area.

Return values

- kStatus_FTFx_Success – API was executed successfully; the executeOnly state of specified FLASH region was stored to access_state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

- kStatus_FTFx_AlignmentError – The parameter is not aligned to the specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.

status_t FLASH_PflashSetProtection(*flash_config_t* *config, *pflash_prot_status_t* *protectStatus)

Sets the PFlash Protection to the intended protection status.

Parameters

- config – A pointer to storage for the driver runtime state.
- protectStatus – The expected protect status to set to the PFlash protection register. Each bit is corresponding to protection of 1/32(64) of the total PFlash. The least significant bit is corresponding to the lowest address area of PFlash. The most significant bit is corresponding to the highest address area of PFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully; the specified FLASH region is protected.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FLASH_PflashGetProtection(*flash_config_t* *config, *pflash_prot_status_t* *protectStatus)

Gets the PFlash protection status.

Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – Protect status returned by the PFlash IP. Each bit is corresponding to the protection of 1/32(64) of the total PFlash. The least significant bit corresponds to the lowest address area of the PFlash. The most significant bit corresponds to the highest address area of PFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully; the Protection state was stored to protectStatus;
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

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

Returns the desired flash property.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the flash property was stored to value.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

- kStatus_FTFx_UnknownProperty – An unknown property tag.

status_t FLASH_GetCommandState(void)

Get previous command status.

This function is used to obtain the execution status of the previous command.

Return values

- kStatus_FTFx_Success – The previous command is executed successfully.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

FSL_FLASH_DRIVER_VERSION

Flash driver version for SDK.

Version 3.1.3.

FSL_FLASH_DRIVER_VERSION_ROM

Flash driver version for ROM.

Version 3.0.0.

enum _flash_protection_state

Enumeration for the three possible flash protection levels.

Values:

enumerator kFLASH_ProtectionStateUnprotected

Flash region is not protected.

enumerator kFLASH_ProtectionStateProtected

Flash region is protected.

enumerator kFLASH_ProtectionStateMixed

Flash is mixed with protected and unprotected region.

enum _flash_execute_only_access_state

Enumeration for the three possible flash execute access levels.

Values:

enumerator kFLASH_AccessStateUnLimited

Flash region is unlimited.

enumerator kFLASH_AccessStateExecuteOnly

Flash region is execute only.

enumerator kFLASH_AccessStateMixed

Flash is mixed with unlimited and execute only region.

enum _flash_property_tag

Enumeration for various flash properties.

Values:

enumerator kFLASH_PropertyPflash0SectorSize
Pflash sector size property.

enumerator kFLASH_PropertyPflash0TotalSize
Pflash total size property.

enumerator kFLASH_PropertyPflash0BlockSize
Pflash block size property.

enumerator kFLASH_PropertyPflash0BlockCount
Pflash block count property.

enumerator kFLASH_PropertyPflash0BlockBaseAddr
Pflash block base address property.

enumerator kFLASH_PropertyPflash0FacSupport
Pflash fac support property.

enumerator kFLASH_PropertyPflash0AccessSegmentSize
Pflash access segment size property.

enumerator kFLASH_PropertyPflash0AccessSegmentCount
Pflash access segment count property.

enumerator kFLASH_PropertyPflash1SectorSize
Pflash sector size property.

enumerator kFLASH_PropertyPflash1TotalSize
Pflash total size property.

enumerator kFLASH_PropertyPflash1BlockSize
Pflash block size property.

enumerator kFLASH_PropertyPflash1BlockCount
Pflash block count property.

enumerator kFLASH_PropertyPflash1BlockBaseAddr
Pflash block base address property.

enumerator kFLASH_PropertyPflash1FacSupport
Pflash fac support property.

enumerator kFLASH_PropertyPflash1AccessSegmentSize
Pflash access segment size property.

enumerator kFLASH_PropertyPflash1AccessSegmentCount
Pflash access segment count property.

enumerator kFLASH_PropertyFlexRamBlockBaseAddr
FlexRam block base address property.

enumerator kFLASH_PropertyFlexRamTotalSize
FlexRam total size property.

typedef enum *_flash_protection_state* flash_prot_state_t
Enumeration for the three possible flash protection levels.

typedef union *_pflash_protection_status* pflash_prot_status_t
PFlash protection status.

typedef enum *_flash_execute_only_access_state* flash_xacc_state_t
Enumeration for the three possible flash execute access levels.

typedef enum *_flash_property_tag* flash_property_tag_t

Enumeration for various flash properties.

typedef struct *_flash_config* flash_config_t

Flash driver state information.

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

kStatus_FLASH_Success

kFLASH_ApiEraseKey

union _pflash_protection_status

#include <fsl_ftfx_flash.h> PFlash protection status.

Public Members

uint32_t protl

PROT[31:0] .

uint32_t proth

PROT[63:32].

uint8_t protsl

PROTS[7:0] .

uint8_t protsh

PROTS[15:8] .

uint8_t reserved[2]

struct _flash_config

#include <fsl_ftfx_flash.h> Flash driver state information.

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

2.24 Ftftx FLEXNVM Driver

status_t FLEXNVM_Init(*flexnvm_config_t* *config)

Initializes the global flash properties structure members.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FLEXNVM_DflashErase(*flexnvm_config_t* *config, uint32_t start, uint32_t lengthInBytes, uint32_t key)

Erases the Dflash sectors encompassed by parameters passed into function.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the appropriate number of date flash sectors based on the desired start address and length were erased successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – The parameter is not aligned with the specified baseline.
- kStatus_FTFx_AddressError – The address is out of range.
- kStatus_FTFx_EraseKeyError – The API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_EraseAll(*flexnvm_config_t* *config, uint32_t key)

Erases entire flexnvm.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully; the entire flexnvm has been erased successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.

- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FLEXNVM_EraseAllUnsecure(*flexnvm_config_t* *config, uint32_t key)

Erases the entire flexnvm, including protected sectors.

Parameters

- config – Pointer to the storage for the driver runtime state.
- key – A value used to validate all flash erase APIs.

Return values

- kStatus_FTFx_Success – API was executed successfully; the flexnvm is not in securityi state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_EraseKeyError – API erase key is invalid.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_PartitionStatusUpdateFailure – Failed to update the partition status.

status_t FLEXNVM_DflashProgram(*flexnvm_config_t* *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the desired date have been successfully programed into specified date flash region.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.

- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_DflashProgramSection(*flexnvm_config_t* *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)

Programs flash with data at locations passed in through parameters via the Program Section command.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the desired date have been successfully programed into specified date flash area.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_SetFlexramAsRamError – Failed to set flexram as RAM.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.
- kStatus_FTFx_RecoverFlexramAsEepromError – Failed to recover FlexRAM as EEPROM.

status_t FLEXNVM_ProgramPartition(*flexnvm_config_t* *config, *ftfx_partition_flexram_load_opt_t* option, uint32_t eepromDataSizeCode, uint32_t flexnvmPartitionCode)

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM.

Parameters

- config – Pointer to storage for the driver runtime state.
- option – The option used to set FlexRAM load behavior during reset.
- eepromDataSizeCode – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- flexnvmPartitionCode – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.

Return values

- kStatus_FTFx_Success – API was executed successfully; the FlexNVM block for use as data flash, EEPROM backup, or a combination of both have been Prepared.
- kStatus_FTFx_InvalidArgument – Invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FLEXNVM_ProgramPartition_CSE(*flexnvm_config_t* *config, *ftfx_partition_flexram_load_opt_t* option, uint32_t eepromDataSizeCode, uint32_t flexnvmPartitionCode, uint8_t CSEcKeySize, uint8_t SFE)

Prepares the FlexNVM block for use as data flash, EEPROM backup, or a combination of both and initializes the FlexRAM. This is the CSE enabled version for IP's like FTFC.

Parameters

- config – Pointer to storage for the driver runtime state.
- option – The option used to set FlexRAM load behavior during reset.
- eepromDataSizeCode – Determines the amount of FlexRAM used in each of the available EEPROM subsystems.
- flexnvmPartitionCode – Specifies how to split the FlexNVM block between data flash memory and EEPROM backup memory supporting EEPROM functions.
- CSEcKeySize – CSEc/SHE key size, see RM for details and possible values
- SFE – Security Flag Extension (SFE), see RM for details and possible values

Return values

- kStatus_FTFx_Success – API was executed successfully; the FlexNVM block for use as data flash, EEPROM backup, or a combination of both have been Prepared.
- kStatus_FTFx_InvalidArgument – Invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.

- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FLEXNVM_ReadResource(*flexnvm_config_t* *config, uint32_t start, uint8_t *dst, uint32_t lengthInBytes, *ftfx_read_resource_opt_t* option)

Reads the resource with data at locations passed in through parameters.

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be programmed. Must be word-aligned.
- dst – A pointer to the destination buffer of data that is used to store data to be read.
- lengthInBytes – The length, given in bytes (not words or long-words), to be read. Must be word-aligned.
- option – The resource option which indicates which area should be read back.

Return values

- kStatus_FTFx_Success – API was executed successfully; the data have been read successfully from program flash IFR, data flash IFR space, and the Version ID field
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with the specified baseline.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_DflashVerifyErase(*flexnvm_config_t* *config, uint32_t start, uint32_t lengthInBytes, *ftfx_margin_value_t* margin)

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

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

Parameters

- config – A pointer to the storage for the driver runtime state.
- start – The start address of the desired flash memory to be verified. The start address does not need to be sector-aligned but must be word-aligned.

- lengthInBytes – The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.
- margin – Read margin choice.

Return values

- kStatus_FTFx_Success – API was executed successfully; the specified data flash region is in erased state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_VerifyEraseAll(*flexnvm_config_t* *config, *ftfx_margin_value_t* margin)

Verifies erasure of the entire flash at a specified margin level.

This function checks whether the flash is erased to the specified read margin level.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the entire flexnvm region is in erased state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_DflashVerifyProgram(*flexnvm_config_t* *config, uint32_t start, uint32_t lengthInBytes, const uint8_t *expectedData, *ftfx_margin_value_t* margin, uint32_t *failedAddress, uint32_t *failedData)

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

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the desired data hve been programed successfully into specified data flash region.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AlignmentError – Parameter is not aligned with specified baseline.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_GetSecurityState(*flexnvm_config_t* *config, *ftfx_security_state_t* *state)

Returns the security state via the pointer passed into the function.

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

Parameters

- config – A pointer to storage for the driver runtime state.
- state – A pointer to the value returned for the current security status code:

Return values

- kStatus_FTFx_Success – API was executed successfully; the security state of flexnvm was stored to state.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

status_t FLEXNVM_SecurityBypass(*flexnvm_config_t* *config, const uint8_t *backdoorKey)

Allows users to bypass security with a backdoor key.

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

Parameters

- config – A pointer to the storage for the driver runtime state.
- backdoorKey – A pointer to the user buffer containing the backdoor key.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_SetFlexramFunction(*flexnvm_config_t* *config, *ftfx_flexram_func_opt_t* option)

Sets the FlexRAM function command.

Parameters

- config – A pointer to the storage for the driver runtime state.
- option – The option used to set the work mode of FlexRAM.

Return values

- kStatus_FTFx_Success – API was executed successfully; the FlexRAM has been successfully configured as RAM or EEPROM
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_ExecuteInRamFunctionNotReady – Execute-in-RAM function is not available.
- kStatus_FTFx_AccessError – Invalid instruction codes and out-of bounds addresses.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_CommandFailure – Run-time error during the command execution.

status_t FLEXNVM_DflashSetProtection(*flexnvm_config_t* *config, uint8_t protectStatus)

Sets the DFlash protection to the intended protection status.

Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – The expected protect status to set to the DFlash protection register. Each bit corresponds to the protection of the 1/8 of the total DFlash. The least significant bit corresponds to the lowest address area of the DFlash. The most significant bit corresponds to the highest address area of the DFlash. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully; the specified DFlash region is protected.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_CommandNotSupported – Flash API is not supported.

- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FLEXNVM_DflashGetProtection(*flexnvm_config_t* *config, uint8_t *protectStatus)

Gets the DFlash protection status.

Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – DFlash Protect status returned by the PFlash IP. Each bit corresponds to the protection of the 1/8 of the total DFlash. The least significant bit corresponds to the lowest address area of the DFlash. The most significant bit corresponds to the highest address area of the DFlash, and so on. There are two possible cases as below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_CommandNotSupported – Flash API is not supported.

status_t FLEXNVM_EepromSetProtection(*flexnvm_config_t* *config, uint8_t protectStatus)

Sets the EEPROM protection to the intended protection status.

Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – The expected protect status to set to the EEPROM protection register. Each bit corresponds to the protection of the 1/8 of the total EEPROM. The least significant bit corresponds to the lowest address area of the EEPROM. The most significant bit corresponds to the highest address area of EEPROM, and so on. There are two possible cases as shown below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_CommandNotSupported – Flash API is not supported.
- kStatus_FTFx_CommandFailure – Run-time error during command execution.

status_t FLEXNVM_EepromGetProtection(*flexnvm_config_t* *config, uint8_t *protectStatus)

Gets the EEPROM protection status.

Parameters

- config – A pointer to the storage for the driver runtime state.
- protectStatus – DFlash Protect status returned by the PFlash IP. Each bit corresponds to the protection of the 1/8 of the total EEPROM. The least significant bit corresponds to the lowest address area of the EEPROM. The most significant bit corresponds to the highest address area of the EEPROM. There are two possible cases as below: 0: this area is protected. 1: this area is unprotected.

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.

- kStatus_FTFx_CommandNotSupported – Flash API is not supported.

status_t FLEXNVM_GetProperty(*flexnvm_config_t* *config, *flexnvm_property_tag_t* whichProperty, uint32_t *value)

Returns the desired flexnvm property.

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_UnknownProperty – An unknown property tag.

enum _flexnvm_property_tag

Enumeration for various flexnvm properties.

Values:

enumerator kFLEXNVM_PropertyDflashSectorSize

Dflash sector size property.

enumerator kFLEXNVM_PropertyDflashTotalSize

Dflash total size property.

enumerator kFLEXNVM_PropertyDflashBlockSize

Dflash block size property.

enumerator kFLEXNVM_PropertyDflashBlockCount

Dflash block count property.

enumerator kFLEXNVM_PropertyDflashBlockBaseAddr

Dflash block base address property.

enumerator kFLEXNVM_PropertyAliasDflashBlockBaseAddr

Dflash block base address Alias property.

enumerator kFLEXNVM_PropertyFlexRamBlockBaseAddr

FlexRam block base address property.

enumerator kFLEXNVM_PropertyFlexRamTotalSize

FlexRam total size property.

enumerator kFLEXNVM_PropertyEepromTotalSize

EEPROM total size property.

typedef enum *_flexnvm_property_tag* flexnvm_property_tag_t

Enumeration for various flexnvm properties.

typedef struct *_flexnvm_config* flexnvm_config_t

Flexnvm driver state information.

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

status_t FLEXNVM_EepromWrite(*flexnvm_config_t* *config, uint32_t start, uint8_t *src, uint32_t lengthInBytes)

Programs the EEPROM with data at locations passed in through parameters.

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

Parameters

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

Return values

- kStatus_FTFx_Success – API was executed successfully; the desires data have been successfully programed into specified eeprom region.
- kStatus_FTFx_InvalidArgument – An invalid argument is provided.
- kStatus_FTFx_AddressError – Address is out of range.
- kStatus_FTFx_SetFlexramAsEepromError – Failed to set flexram as eeprom.
- kStatus_FTFx_ProtectionViolation – The program/erase operation is requested to execute on protected areas.
- kStatus_FTFx_RecoverFlexramAsRamError – Failed to recover the FlexRAM as RAM.

struct _flexnvm_config

#include <fsl_ftfx_flexnvm.h> Flexnvm driver state information.

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

2.25 ftfx utilities

ALIGN_DOWN(x, a)

Alignment(down) utility.

ALIGN_UP(x, a)

Alignment(up) utility.

MAKE_VERSION(major, minor, bugfix)

Constructs the version number for drivers.

MAKE_STATUS(group, code)

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

FOUR_CHAR_CODE(a, b, c, d)

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

B1P4(b)

bytes2word utility.

B1P3(b)

B1P2(b)

B1P1(b)

B2P3(b)

B2P2(b)

B2P1(b)

B3P2(b)

B3P1(b)

BYTE2WORD_1_3(x, y)

BYTE2WORD_2_2(x, y)

BYTE2WORD_3_1(x, y)

BYTE2WORD_1_1_2(x, y, z)

BYTE2WORD_1_2_1(x, y, z)

BYTE2WORD_2_1_1(x, y, z)

BYTE2WORD_1_1_1_1(x, y, z, w)

2.26 GPIO: General-Purpose Input/Output Driver

FSL_GPIO_DRIVER_VERSION
GPIO driver version.

enum _gpio_pin_direction
GPIO direction definition.

Values:

enumerator kGPIO_DigitalInput
Set current pin as digital input

enumerator kGPIO_DigitalOutput
Set current pin as digital output

enum _gpio_checker_attribute
GPIO checker attribute.

Values:

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

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

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

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

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

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

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

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

enumerator kGPIO_IgnoreAttributeCheck
Ignores the attribute check

typedef enum *_gpio_pin_direction* gpio_pin_direction_t
GPIO direction definition.

typedef enum *_gpio_checker_attribute* gpio_checker_attribute_t
GPIO checker attribute.

typedef struct *_gpio_pin_config* gpio_pin_config_t
The GPIO pin configuration structure.

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

GPIO_FIT_REG(value)

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

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

Public Members

gpio_pin_direction_t pinDirection
GPIO direction, input or output

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

2.27 GPIO Driver

void GPIO_PortInit(GPIO_Type *base)
Initializes the GPIO peripheral.

This function ungates the GPIO clock.

Parameters

- base – GPIO peripheral base pointer.

void GPIO_PortDenit(GPIO_Type *base)
Denitializes the GPIO peripheral.

Parameters

- base – GPIO peripheral base pointer.

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

Initializes a GPIO pin used by the board.

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

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

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

Parameters

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

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

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

Parameters

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

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

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

Parameters

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

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

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

Parameters

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

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

Reverses the current output logic of the multiple GPIO pins.

Parameters

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

- mask – GPIO pin number macro

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

Reads the current input value of the GPIO port.

Parameters

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

Return values

GPIO – port input value

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

uint32_t GPIO_PortGetInterruptFlags(GPIO_Type *base)

Reads the GPIO port interrupt status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains set until a logic one is written to that flag. If configured for a level sensitive interrupt that remains asserted, the flag is set again immediately.

Parameters

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

Return values

The – current GPIO port interrupt status flag, for example, 0x00010001 means the pin 0 and 17 have the interrupt.

void GPIO_PortClearInterruptFlags(GPIO_Type *base, uint32_t mask)

Clears multiple GPIO pin interrupt status flags.

Parameters

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

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

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

Parameters

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

2.28 I2C: Inter-Integrated Circuit Driver

2.29 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)

Initializes the I2C handle which is used in transactional functions.

Parameters

- base – I2C peripheral base address
- handle – Pointer to the i2c_master_dma_handle_t structure
- callback – Pointer to the user callback function
- userData – A user parameter 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 – A pointer to the i2c_master_dma_handle_t structure
- xfer – A pointer to the transfer structure of the i2c_master_transfer_t

Return values

- kStatus_Success – Successfully completes the data transmission.
- kStatus_I2C_Busy – A previous transmission is still not finished.
- kStatus_I2C_Timeout – A transfer error, waits for the signal timeout.
- kStatus_I2C_ArbitrationLost – A transfer error, arbitration lost.
- kStataus_I2C_Nak – A transfer error, receives NAK during transfer.

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

Gets a master transfer status during a DMA non-blocking transfer.

Parameters

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

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

Aborts a master DMA non-blocking transfer early.

Parameters

- base – I2C peripheral base address
- handle – A pointer to the 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

Retry times for waiting flag.

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.

struct _i2c_master_dma_handle

#include <fsl_i2c_dma.h> I2C master DMA transfer structure.

Public Members

i2c_master_transfer_t transfer
: I2C master transfer struct.

size_t transferSize
: Total bytes to be transferred.

uint8_t state
: I2C master transfer status.

dma_handle_t *dmaHandle
: The DMA handler used.

i2c_master_dma_transfer_callback_t completionCallback
: A callback function called after the DMA transfer finished.

void *userData
: A callback parameter passed to the callback function.

2.30 I2C Driver

void I2C_MasterInit(I2C_Type *base, const *i2c_master_config_t* *masterConfig, uint32_t srcClock_Hz)

Initializes the I2C peripheral. Call this API to ungate the I2C clock and configure the I2C with master configuration.

Note: This API should be called at the beginning of the application. Otherwise, any operation to the I2C module can cause a hard fault because the clock is not enabled. The configuration structure can be custom filled or it can be set with default values by using the I2C_MasterGetDefaultConfig(). After calling this API, the master is ready to transfer. This is an example.

```
i2c_master_config_t config = {
.enableMaster = true,
.enableStopHold = false,
.highDrive = false,
.baudRate_Bps = 100000,
.glitchFilterWidth = 0
};
I2C_MasterInit(I2C0, &config, 12000000U);
```

Parameters

- base – I2C base pointer
- masterConfig – A pointer to the master configuration structure
- srcClock_Hz – I2C peripheral clock frequency in Hz

void I2C_SlaveInit(I2C_Type *base, const *i2c_slave_config_t* *slaveConfig, uint32_t srcClock_Hz)

Initializes the I2C peripheral. Call this API to ungate the I2C clock and initialize the I2C with the slave configuration.

Note: This API should be called at the beginning of the application. Otherwise, any operation to the I2C module can cause a hard fault because the clock is not enabled. The configuration structure can partly be set with default values by I2C_SlaveGetDefaultConfig() or it can be custom filled by the user. This is an example.

```
i2c_slave_config_t config = {
.enableSlave = true,
.enableGeneralCall = false,
.addressingMode = kI2C_Address7bit,
.slaveAddress = 0x1DU,
.enableWakeUp = false,
.enablehighDrive = false,
.enableBaudRateCtl = false,
.sclStopHoldTime_ns = 4000
};
I2C_SlaveInit(I2C0, &config, 12000000U);
```

Parameters

- base – I2C base pointer
- slaveConfig – A pointer to the slave configuration structure
- srcClock_Hz – I2C peripheral clock frequency in Hz

void I2C_MasterDeinit(I2C_Type *base)

De-initializes the I2C master peripheral. Call this API to gate the I2C clock. The I2C master module can't work unless the I2C_MasterInit is called.

Parameters

- base – I2C base pointer

void I2C_SlaveDeinit(I2C_Type *base)

De-initializes the I2C slave peripheral. Calling this API gates the I2C clock. The I2C slave module can't work unless the I2C_SlaveInit is called to enable the clock.

Parameters

- base – I2C base pointer

uint32_t I2C_GetInstance(I2C_Type *base)

Get instance number for I2C module.

Parameters

- base – I2C peripheral base address.

void I2C_MasterGetDefaultConfig(*i2c_master_config_t* *masterConfig)

Sets the I2C master configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in the I2C_MasterConfigure(). Use the initialized structure unchanged in the I2C_MasterConfigure() or modify the structure before calling the I2C_MasterConfigure(). This is an example.

```
i2c_master_config_t config;
I2C_MasterGetDefaultConfig(&config);
```

Parameters

- masterConfig – A pointer to the master configuration structure.

void I2C_SlaveGetDefaultConfig(*i2c_slave_config_t* *slaveConfig)

Sets the I2C slave configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in the I2C_SlaveConfigure(). Modify fields of the structure before calling the I2C_SlaveConfigure(). This is an example.

```
i2c_slave_config_t config;
I2C_SlaveGetDefaultConfig(&config);
```

Parameters

- slaveConfig – A pointer to the slave configuration structure.

static inline void I2C_Enable(I2C_Type *base, bool enable)

Enables or disables the I2C peripheral operation.

Parameters

- base – I2C base pointer
- enable – Pass true to enable and false to disable the module.

uint32_t I2C_MasterGetStatusFlags(I2C_Type *base)

Gets the I2C status flags.

Parameters

- base – I2C base pointer

Returns

status flag, use status flag to AND _i2c_flags to get the related status.

static inline uint32_t I2C_SlaveGetStatusFlags(I2C_Type *base)

Gets the I2C status flags.

Parameters

- base – I2C base pointer

Returns

status flag, use status flag to AND _i2c_flags to get the related status.

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

Clears the I2C status flag state.

The following status register flags can be cleared kI2C_ArbitrationLostFlag and kI2C_IntPendingFlag.

Parameters

- base – I2C base pointer
- statusMask – The status flag mask, defined in type i2c_status_flag_t. The parameter can be any combination of the following values:
  - kI2C_StartDetectFlag (if available)
  - kI2C_StopDetectFlag (if available)
  - kI2C_ArbitrationLostFlag
  - kI2C_IntPendingFlagFlag

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 kI2C_ArbitrationLostFlag and kI2C_IntPendingFlag

Parameters

- base – I2C base pointer
- statusMask – The status flag mask, defined in type i2c_status_flag_t. The parameter can be any combination of the following values:

- kI2C_StartDetectFlag (if available)
- kI2C_StopDetectFlag (if available)
- kI2C_ArbitrationLostFlag
- kI2C_IntPendingFlagFlag

void I2C_EnableInterrupts(I2C_Type *base, uint32_t mask)

Enables I2C interrupt requests.

Parameters

- base – I2C base pointer
- mask – interrupt source The parameter can be combination of the following source if defined:
  - kI2C_GlobalInterruptEnable
  - kI2C_StopDetectInterruptEnable/kI2C_StartDetectInterruptEnable
  - kI2C_SdaTimeoutInterruptEnable

void I2C_DisableInterrupts(I2C_Type *base, uint32_t mask)

Disables I2C interrupt requests.

Parameters

- base – I2C base pointer
- mask – interrupt source The parameter can be combination of the following source if defined:
  - kI2C_GlobalInterruptEnable
  - kI2C_StopDetectInterruptEnable/kI2C_StartDetectInterruptEnable
  - kI2C_SdaTimeoutInterruptEnable

static inline void I2C_EnableDMA(I2C_Type *base, bool enable)

Enables/disables the I2C DMA interrupt.

Parameters

- base – I2C base pointer
- enable – true to enable, false to disable

static inline uint32_t I2C_GetDataRegAddr(I2C_Type *base)

Gets the I2C tx/rx data register address. This API is used to provide a transfer address for I2C DMA transfer configuration.

Parameters

- base – I2C base pointer

Returns

data register address

void I2C_MasterSetBaudRate(I2C_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the I2C master transfer baud rate.

Parameters

- base – I2C base pointer
- baudRate_Bps – the baud rate value in bps
- srcClock_Hz – Source clock

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.

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 uint8_t *txBuff, size_t txSize, uint32_t flags)

Performs a polling send transaction on the I2C bus.

Parameters

- base – The I2C peripheral base pointer.
- 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 decide whether need to send a stop, use kI2C_TransferDefaultFlag to issue a stop and kI2C_TransferNoStop to not send a stop.

Return values

- kStatus_Success – Successfully complete the data transmission.
- kStatus_I2C_ArbitrationLost – Transfer error, arbitration lost.
- kStataus_I2C_Nak – Transfer error, receive NAK during transfer.

status_t I2C_MasterReadBlocking(I2C_Type *base, uint8_t *rxBuff, size_t rxSize, uint32_t flags)

Performs a polling receive transaction on the I2C bus.

Note: The I2C_MasterReadBlocking function stops the bus before reading the final byte. Without stopping the bus prior for the final read, the bus issues another read, resulting in garbage data being read into the data register.

Parameters

- base – I2C peripheral base pointer.
- rxBuff – The pointer to the data to store the received data.
- rxSize – The length in bytes of the data to be received.
- flags – Transfer control flag to decide whether need to send a stop, use kI2C_TransferDefaultFlag to issue a stop and kI2C_TransferNoStop to not send a stop.

Return values

- kStatus_Success – Successfully complete the data transmission.
- kStatus_I2C_Timeout – Send stop signal failed, timeout.

status_t I2C_SlaveWriteBlocking(I2C_Type *base, const uint8_t *txBuff, size_t txSize)

Performs a polling send transaction on the I2C bus.

Parameters

- base – The I2C peripheral base pointer.
- txBuff – The pointer to the data to be transferred.
- txSize – The length in bytes of the data to be transferred.

Return values

- kStatus_Success – Successfully complete the data transmission.
- kStatus_I2C_ArbitrationLost – Transfer error, arbitration lost.
- kStataus_I2C_Nak – Transfer error, receive NAK during transfer.

status_t I2C_SlaveReadBlocking(I2C_Type *base, uint8_t *rxBuff, size_t rxSize)

Performs a polling receive transaction on the I2C bus.

Parameters

- base – I2C peripheral base pointer.
- rxBuff – The pointer to the data to store the received data.
- rxSize – The length in bytes of the data to be received.

Return values

- kStatus_Success – Successfully complete data receive.
- kStatus_I2C_Timeout – Wait status flag timeout.

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.
- kStataus_I2C_Nak – Transfer error, receive NAK during transfer.

void I2C_MasterTransferCreateHandle(I2C_Type *base, *i2c_master_handle_t* *handle, *i2c_master_transfer_callback_t* callback, void *userData)

Initializes the I2C handle which is used in transactional functions.

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_master_handle_t structure to store the transfer state.
- callback – pointer to user callback function.
- userData – user parameter passed to the callback function.

status_t I2C_MasterTransferNonBlocking(I2C_Type *base, *i2c_master_handle_t* *handle, *i2c_master_transfer_t* *xfer)

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

Note: Calling the API returns immediately after transfer initiates. The user needs to call I2C_MasterGetTransferCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_I2C_Busy, the transfer is finished.

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_master_handle_t structure which stores the transfer state.
- xfer – pointer to i2c_master_transfer_t structure.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_I2C_Busy – Previous transmission still not finished.
- kStatus_I2C_Timeout – Transfer error, wait signal timeout.

status_t I2C_MasterTransferGetCount(I2C_Type *base, *i2c_master_handle_t* *handle, size_t *count)

Gets the master transfer status during a interrupt non-blocking transfer.

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_master_handle_t structure which stores the transfer state.

- count – Number of bytes transferred so far by the non-blocking transaction.

Return values

- kStatus_InvalidArgument – count is Invalid.
- kStatus_Success – Successfully return the count.

status_t I2C_MasterTransferAbort(I2C_Type *base, *i2c_master_handle_t* *handle)

Aborts an interrupt non-blocking transfer early.

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

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_master_handle_t structure which stores the transfer state

Return values

- kStatus_I2C_Timeout – Timeout during polling flag.
- kStatus_Success – Successfully abort the transfer.

void I2C_MasterTransferHandleIRQ(I2C_Type *base, void *i2cHandle)

Master interrupt handler.

Parameters

- base – I2C base pointer.
- i2cHandle – pointer to i2c_master_handle_t structure.

void I2C_SlaveTransferCreateHandle(I2C_Type *base, *i2c_slave_handle_t* *handle, *i2c_slave_transfer_callback_t* callback, void *userData)

Initializes the I2C handle which is used in transactional functions.

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_slave_handle_t structure to store the transfer state.
- callback – pointer to user callback function.
- userData – user parameter passed to the callback function.

status_t I2C_SlaveTransferNonBlocking(I2C_Type *base, *i2c_slave_handle_t* *handle, uint32_t eventMask)

Starts accepting slave transfers.

Call this API after calling the I2C_SlaveInit() and I2C_SlaveTransferCreateHandle() to start processing transactions driven by an I2C master. The slave monitors the I2C bus and passes events to the callback that was passed into the call to I2C_SlaveTransferCreateHandle(). The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of i2c_slave_transfer_event_t enumerators for the events you wish to receive. The kI2C_SlaveTransmitEvent and kLPI2C_SlaveReceiveEvent events are always enabled and do not need to be included in the mask. Alternatively, 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.

void I2C_SlaveTransferAbort(I2C_Type *base, *i2c_slave_handle_t* *handle)

Aborts the slave transfer.

Note: This API can be called at any time to stop slave for handling the bus events.

Parameters

- base – I2C base pointer.
- handle – pointer to i2c_slave_handle_t structure which stores the transfer state.

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, void *i2cHandle)

Slave interrupt handler.

Parameters

- base – I2C base pointer.
- i2cHandle – pointer to i2c_slave_handle_t structure which stores the transfer state

FSL_I2C_DRIVER_VERSION

I2C driver version.

I2C status return codes.

Values:

enumerator kStatus_I2C_Busy

I2C is busy with current transfer.

enumerator kStatus_I2C_Idle
Bus is Idle.

enumerator kStatus_I2C_Nak
NAK received during transfer.

enumerator kStatus_I2C_ArbitrationLost
Arbitration lost during transfer.

enumerator kStatus_I2C_Timeout
Timeout polling status flags.

enumerator kStatus_I2C_Addr_Nak
NAK received during the address probe.

enum _i2c_flags
I2C peripheral flags.

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

Values:

enumerator kI2C_ReceiveNakFlag
I2C receive NAK flag.

enumerator kI2C_IntPendingFlag
I2C interrupt pending flag. This flag can be cleared.

enumerator kI2C_TransferDirectionFlag
I2C transfer direction flag.

enumerator kI2C_RangeAddressMatchFlag
I2C range address match flag.

enumerator kI2C_ArbitrationLostFlag
I2C arbitration lost flag. This flag can be cleared.

enumerator kI2C_BusBusyFlag
I2C bus busy flag.

enumerator kI2C_AddressMatchFlag
I2C address match flag.

enumerator kI2C_TransferCompleteFlag
I2C transfer complete flag.

enumerator kI2C_StopDetectFlag
I2C stop detect flag. This flag can be cleared.

enumerator kI2C_StartDetectFlag
I2C start detect flag. This flag can be cleared.

enum _i2c_interrupt_enable
I2C feature interrupt source.

Values:

enumerator kI2C_GlobalInterruptEnable
I2C global interrupt.

enumerator kI2C_StopDetectInterruptEnable
I2C stop detect interrupt.

enumerator kI2C_StartStopDetectInterruptEnable
I2C start&stop detect interrupt.

enum _i2c_direction
The direction of master and slave transfers.

Values:

enumerator kI2C_Write
Master transmits to the slave.

enumerator kI2C_Read
Master receives from the slave.

enum _i2c_slave_address_mode
Addressing mode.

Values:

enumerator kI2C_Address7bit
7-bit addressing mode.

enumerator kI2C_RangeMatch
Range address match addressing mode.

enum _i2c_master_transfer_flags
I2C transfer control flag.

Values:

enumerator kI2C_TransferDefaultFlag
A transfer starts with a start signal, stops with a stop signal.

enumerator kI2C_TransferNoStartFlag
A transfer starts without a start signal, only support write only or write+read with no start flag, do not support read only with no start flag.

enumerator kI2C_TransferRepeatedStartFlag
A transfer starts with a repeated start signal.

enumerator kI2C_TransferNoStopFlag
A transfer ends without a stop signal.

enum _i2c_slave_transfer_event
Set of events sent to the callback for nonblocking 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() 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
A callback is requested to provide data to transmit (slave-transmitter role).

enumerator kI2C_SlaveReceiveEvent

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

enumerator kI2C_SlaveTransmitAckEvent

A callback needs to either transmit an ACK or NACK.

enumerator kI2C_SlaveStartEvent

A start/repeated start was detected.

enumerator kI2C_SlaveCompletionEvent

A stop was detected or finished transfer, completing the transfer.

enumerator kI2C_SlaveGenaralcallEvent

Received the general call address after a start or repeated start.

enumerator kI2C_SlaveAllEvents

A bit mask of all available events.

Common sets of flags used by the driver.

Values:

enumerator kClearFlags

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

enumerator kIrqFlags

typedef enum *_i2c_direction* i2c_direction_t

The direction of master and slave transfers.

typedef enum *_i2c_slave_address_mode* i2c_slave_address_mode_t

Addressing mode.

typedef enum *_i2c_slave_transfer_event* i2c_slave_transfer_event_t

Set of events sent to the callback for nonblocking 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() 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_master_config* i2c_master_config_t

I2C master user configuration.

typedef struct *_i2c_slave_config* i2c_slave_config_t

I2C slave user configuration.

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* status, void *userData)

I2C master transfer callback typedef.

typedef struct *_i2c_slave_handle* i2c_slave_handle_t

I2C slave handle typedef.

typedef struct *_i2c_master_transfer* i2c_master_transfer_t

I2C master transfer structure.

typedef struct *_i2c_slave_transfer* i2c_slave_transfer_t

I2C slave transfer structure.

typedef void (*i2c_slave_transfer_callback_t)(I2C_Type *base, *i2c_slave_transfer_t* *xfer, void *userData)

I2C slave transfer callback typedef.

I2C_RETRY_TIMES

Retry times for waiting flag.

I2C_MASTER_FACK_CONTROL

Mater Fast ack control, control if master needs to manually write ack, this is used to low the speed of transfer for SoCs with feature FSL_FEATURE_I2C_HAS_DOUBLE_BUFFERING.

I2C_HAS_STOP_DETECT

struct i2c_master_config

#include <fsl_i2c.h> I2C master user configuration.

Public Members

bool enableMaster

Enables the I2C peripheral at initialization time.

bool enableStopHold

Controls the stop hold enable.

bool enableDoubleBuffering

Controls double buffer enable; notice that enabling the double buffer disables the clock stretch.

uint32_t baudRate_Bps

Baud rate configuration of I2C peripheral.

uint8_t glitchFilterWidth

Controls the width of the glitch.

struct i2c_slave_config

#include <fsl_i2c.h> I2C slave user configuration.

Public Members

bool enableSlave

Enables the I2C peripheral at initialization time.

bool enableGeneralCall

Enables the general call addressing mode.

bool enableWakeUp

Enables/disables waking up MCU from low-power mode.

bool enableDoubleBuffering

Controls a double buffer enable; notice that enabling the double buffer disables the clock stretch.

bool enableBaudRateCtl

Enables/disables independent slave baud rate on SCL in very fast I2C modes.

uint16_t slaveAddress
: A slave address configuration.

uint16_t upperAddress
: A maximum boundary slave address used in a range matching mode.

i2c_slave_address_mode_t addressingMode
: An addressing mode configuration of i2c_slave_address_mode_config_t.

uint32_t sclStopHoldTime_ns
: the delay from the rising edge of SCL (I2C clock) to the rising edge of SDA (I2C data) while SCL is high (stop condition), SDA hold time and SCL start hold time are also configured according to the SCL stop hold time.

struct __i2c_master_transfer
#include <fsl_i2c.h> I2C master transfer structure.

Public Members

uint32_t flags
: A transfer flag which controls the transfer.

uint8_t slaveAddress
: 7-bit slave address.

i2c_direction_t direction
: A transfer direction, read or write.

uint32_t subaddress
: A sub address. Transferred MSB first.

uint8_t subaddressSize
: A size of the command buffer.

uint8_t *volatile data
: A transfer buffer.

volatile size_t dataSize
: A transfer size.

struct __i2c_master_handle
#include <fsl_i2c.h> I2C master handle structure.

Public Members

i2c_master_transfer_t transfer
: I2C master transfer copy.

size_t transferSize
: Total bytes to be transferred.

uint8_t state
: A transfer state maintained during transfer.

i2c_master_transfer_callback_t completionCallback
: A callback function called when the transfer is finished.

void *userData
: A callback parameter passed to the callback function.

struct __i2c_slave_transfer
#include <fsl_i2c.h> I2C slave transfer structure.

Public Members

i2c_slave_transfer_event_t event
A reason that the callback is invoked.

uint8_t *volatile data
A transfer buffer.

volatile size_t dataSize
A transfer size.

status_t completionStatus
Success or error code describing how the transfer completed. Only applies for kI2C_SlaveCompletionEvent.

size_t transferredCount
A number of bytes actually transferred since the start or since the last repeated start.

struct __i2c__slave__handle
#include <fsl_i2c.h> I2C slave handle structure.

Public Members

volatile bool isBusy
Indicates whether a transfer is busy.

i2c_slave_transfer_t transfer
I2C slave transfer copy.

uint32_t eventMask
A mask of enabled events.

i2c_slave_transfer_callback_t callback
A callback function called at the transfer event.

void *userData
A callback parameter passed to the callback.

2.31 Common Driver

FSL__COMMON__DRIVER__VERSION
common driver version.

DEBUG__CONSOLE__DEVICE__TYPE__NONE
No debug console.

DEBUG__CONSOLE__DEVICE__TYPE__UART
Debug console based on UART.

DEBUG__CONSOLE__DEVICE__TYPE__LPUART
Debug console based on LPUART.

DEBUG__CONSOLE__DEVICE__TYPE__LPSCI
Debug console based on LPSCI.

DEBUG__CONSOLE__DEVICE__TYPE__USBCDC
Debug console based on USBCDC.

DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM
: Debug console based on FLEXCOMM.

DEBUG_CONSOLE_DEVICE_TYPE_IUART
: Debug console based on i.MX UART.

DEBUG_CONSOLE_DEVICE_TYPE_VUSART
: Debug console based on LPC_VUSART.

DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART
: Debug console based on LPC_USART.

DEBUG_CONSOLE_DEVICE_TYPE_SWO
: Debug console based on SWO.

DEBUG_CONSOLE_DEVICE_TYPE_QSCI
: Debug console based on QSCI.

MIN(a, b)
: Computes the minimum of *a* and *b*.

MAX(a, b)
: Computes the maximum of *a* and *b*.

UINT16_MAX
: Max value of uint16_t type.

UINT32_MAX
: Max value of uint32_t type.

SDK_ATOMIC_LOCAL_ADD(addr, val)
: Add value *val* from the variable at address *address*.

SDK_ATOMIC_LOCAL_SUB(addr, val)
: Subtract value *val* to the variable at address *address*.

SDK_ATOMIC_LOCAL_SET(addr, bits)
: Set the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR(addr, bits)
: Clear the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_TOGGLE(addr, bits)
: Toggle the bits specifiled by *bits* to the variable at address *address*.

SDK_ATOMIC_LOCAL_CLEAR_AND_SET(addr, clearBits, setBits)
: For the variable at address *address*, clear the bits specifiled by *clearBits* and set the bits specifiled by *setBits*.

SDK_ATOMIC_LOCAL_COMPARE_AND_SET(addr, expected, newValue)
: For the variable at address *address*, check whether the value equal to *expected*. If value same as *expected* then update *newValue* to address and return **true** , else return **false** .

SDK_ATOMIC_LOCAL_TEST_AND_SET(addr, newValue)
: For the variable at address *address*, set as *newValue* value and return old value.

USEC_TO_COUNT(us, clockFreqInHz)
: Macro to convert a microsecond period to raw count value

COUNT_TO_USEC(count, clockFreqInHz)
: Macro to convert a raw count value to microsecond

MSEC_TO_COUNT(ms, clockFreqInHz)

Macro to convert a millisecond period to raw count value

COUNT_TO_MSEC(count, clockFreqInHz)

Macro to convert a raw count value to millisecond

SDK_ISR_EXIT_BARRIER

SDK_SIZEALIGN(var, alignbytes)

Macro to define a variable with L1 d-cache line size alignment

Macro to define a variable with L2 cache line size alignment

Macro to change a value to a given size aligned value

AT_NONCACHEABLE_SECTION(var)

Define a variable *var*, and place it in non-cacheable section.

AT_NONCACHEABLE_SECTION_ALIGN(var, alignbytes)

Define a variable *var*, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

AT_NONCACHEABLE_SECTION_INIT(var)

Define a variable *var* with initial value, and place it in non-cacheable section.

AT_NONCACHEABLE_SECTION_ALIGN_INIT(var, alignbytes)

Define a variable *var* with initial value, and place it in non-cacheable section, the start address of the variable is aligned to *alignbytes*.

enum _status_groups

Status group numbers.

Values:

enumerator kStatusGroup_Generic

Group number for generic status codes.

enumerator kStatusGroup_FLASH

Group number for FLASH status codes.

enumerator kStatusGroup_LPSPI

Group number for LPSPI status codes.

enumerator kStatusGroup_FLEXIO_SPI

Group number for FLEXIO SPI status codes.

enumerator kStatusGroup_DSPI

Group number for DSPI status codes.

enumerator kStatusGroup_FLEXIO_UART

Group number for FLEXIO UART status codes.

enumerator kStatusGroup_FLEXIO_I2C

Group number for FLEXIO I2C status codes.

enumerator kStatusGroup_LPI2C

Group number for LPI2C status codes.

enumerator kStatusGroup_UART

Group number for UART status codes.

enumerator kStatusGroup_I2C

Group number for UART status codes.

enumerator kStatusGroup_LPSCI
Group number for LPSCI status codes.

enumerator kStatusGroup_LPUART
Group number for LPUART status codes.

enumerator kStatusGroup_SPI
Group number for SPI status code.

enumerator kStatusGroup_XRDC
Group number for XRDC status code.

enumerator kStatusGroup_SEMA42
Group number for SEMA42 status code.

enumerator kStatusGroup_SDHC
Group number for SDHC status code

enumerator kStatusGroup_SDMMC
Group number for SDMMC status code

enumerator kStatusGroup_SAI
Group number for SAI status code

enumerator kStatusGroup_MCG
Group number for MCG status codes.

enumerator kStatusGroup_SCG
Group number for SCG status codes.

enumerator kStatusGroup_SDSPI
Group number for SDSPI status codes.

enumerator kStatusGroup_FLEXIO_I2S
Group number for FLEXIO I2S status codes

enumerator kStatusGroup_FLEXIO_MCULCD
Group number for FLEXIO LCD status codes

enumerator kStatusGroup_FLASHIAP
Group number for FLASHIAP status codes

enumerator kStatusGroup_FLEXCOMM_I2C
Group number for FLEXCOMM I2C status codes

enumerator kStatusGroup_I2S
Group number for I2S status codes

enumerator kStatusGroup_IUART
Group number for IUART status codes

enumerator kStatusGroup_CSI
Group number for CSI status codes

enumerator kStatusGroup_MIPI_DSI
Group number for MIPI DSI status codes

enumerator kStatusGroup_SDRAMC
Group number for SDRAMC status codes.

enumerator kStatusGroup_POWER
Group number for POWER status codes.

enumerator kStatusGroup_ENET
Group number for ENET status codes.

enumerator kStatusGroup_PHY
Group number for PHY status codes.

enumerator kStatusGroup_TRGMUX
Group number for TRGMUX status codes.

enumerator kStatusGroup_SMARTCARD
Group number for SMARTCARD status codes.

enumerator kStatusGroup_LMEM
Group number for LMEM status codes.

enumerator kStatusGroup_QSPI
Group number for QSPI status codes.

enumerator kStatusGroup_DMA
Group number for DMA status codes.

enumerator kStatusGroup_EDMA
Group number for EDMA status codes.

enumerator kStatusGroup_DMAMGR
Group number for DMAMGR status codes.

enumerator kStatusGroup_FLEXCAN
Group number for FlexCAN status codes.

enumerator kStatusGroup_LTC
Group number for LTC status codes.

enumerator kStatusGroup_FLEXIO_CAMERA
Group number for FLEXIO CAMERA status codes.

enumerator kStatusGroup_LPC_SPI
Group number for LPC_SPI status codes.

enumerator kStatusGroup_LPC_USART
Group number for LPC_USART status codes.

enumerator kStatusGroup_DMIC
Group number for DMIC status codes.

enumerator kStatusGroup_SDIF
Group number for SDIF status codes.

enumerator kStatusGroup_SPIFI
Group number for SPIFI status codes.

enumerator kStatusGroup_OTP
Group number for OTP status codes.

enumerator kStatusGroup_MCAN
Group number for MCAN status codes.

enumerator kStatusGroup_CAAM
Group number for CAAM status codes.

enumerator kStatusGroup_ECSPI
Group number for ECSPI status codes.

enumerator kStatusGroup_USDHC
Group number for USDHC status codes.

enumerator kStatusGroup_LPC_I2C
Group number for LPC_I2C status codes.

enumerator kStatusGroup_DCP
Group number for DCP status codes.

enumerator kStatusGroup_MSCAN
Group number for MSCAN status codes.

enumerator kStatusGroup_ESAI
Group number for ESAI status codes.

enumerator kStatusGroup_FLEXSPI
Group number for FLEXSPI status codes.

enumerator kStatusGroup_MMDC
Group number for MMDC status codes.

enumerator kStatusGroup_PDM
Group number for MIC status codes.

enumerator kStatusGroup_SDMA
Group number for SDMA status codes.

enumerator kStatusGroup_ICS
Group number for ICS status codes.

enumerator kStatusGroup_SPDIF
Group number for SPDIF status codes.

enumerator kStatusGroup_LPC_MINISPI
Group number for LPC_MINISPI status codes.

enumerator kStatusGroup_HASHCRYPT
Group number for Hashcrypt status codes

enumerator kStatusGroup_LPC_SPI_SSP
Group number for LPC_SPI_SSP status codes.

enumerator kStatusGroup_I3C
Group number for I3C status codes

enumerator kStatusGroup_LPC_I2C_1
Group number for LPC_I2C_1 status codes.

enumerator kStatusGroup_NOTIFIER
Group number for NOTIFIER status codes.

enumerator kStatusGroup_DebugConsole
Group number for debug console status codes.

enumerator kStatusGroup_SEMC
Group number for SEMC status codes.

enumerator kStatusGroup_ApplicationRangeStart
Starting number for application groups.

enumerator kStatusGroup_IAP
Group number for IAP status codes

enumerator kStatusGroup_SFA
Group number for SFA status codes

enumerator kStatusGroup_SPC
Group number for SPC status codes.

enumerator kStatusGroup_PUF
Group number for PUF status codes.

enumerator kStatusGroup_TOUCH_PANEL
Group number for touch panel status codes

enumerator kStatusGroup_VBAT
Group number for VBAT status codes

enumerator kStatusGroup_XSPI
Group number for XSPI status codes

enumerator kStatusGroup_PNGDEC
Group number for PNGDEC status codes

enumerator kStatusGroup_JPEGDEC
Group number for JPEGDEC status codes

enumerator kStatusGroup_HAL_GPIO
Group number for HAL GPIO status codes.

enumerator kStatusGroup_HAL_UART
Group number for HAL UART status codes.

enumerator kStatusGroup_HAL_TIMER
Group number for HAL TIMER status codes.

enumerator kStatusGroup_HAL_SPI
Group number for HAL SPI status codes.

enumerator kStatusGroup_HAL_I2C
Group number for HAL I2C status codes.

enumerator kStatusGroup_HAL_FLASH
Group number for HAL FLASH status codes.

enumerator kStatusGroup_HAL_PWM
Group number for HAL PWM status codes.

enumerator kStatusGroup_HAL_RNG
Group number for HAL RNG status codes.

enumerator kStatusGroup_HAL_I2S
Group number for HAL I2S status codes.

enumerator kStatusGroup_HAL_ADC_SENSOR
Group number for HAL ADC SENSOR status codes.

enumerator kStatusGroup_TIMERMANAGER
Group number for TiMER MANAGER status codes.

enumerator kStatusGroup_SERIALMANAGER
Group number for SERIAL MANAGER status codes.

enumerator kStatusGroup_LED
Group number for LED status codes.

enumerator kStatusGroup_BUTTON
Group number for BUTTON status codes.

enumerator kStatusGroup_EXTERN_EEPROM
Group number for EXTERN EEPROM status codes.

enumerator kStatusGroup_SHELL
Group number for SHELL status codes.

enumerator kStatusGroup_MEM_MANAGER
Group number for MEM MANAGER status codes.

enumerator kStatusGroup_LIST
Group number for List status codes.

enumerator kStatusGroup_OSA
Group number for OSA status codes.

enumerator kStatusGroup_COMMON_TASK
Group number for Common task status codes.

enumerator kStatusGroup_MSG
Group number for messaging status codes.

enumerator kStatusGroup_SDK_OCOTP
Group number for OCOTP status codes.

enumerator kStatusGroup_SDK_FLEXSPINOR
Group number for FLEXSPINOR status codes.

enumerator kStatusGroup_CODEC
Group number for codec status codes.

enumerator kStatusGroup_ASRC
Group number for codec status ASRC.

enumerator kStatusGroup_OTFAD
Group number for codec status codes.

enumerator kStatusGroup_SDIOSLV
Group number for SDIOSLV status codes.

enumerator kStatusGroup_MECC
Group number for MECC status codes.

enumerator kStatusGroup_ENET_QOS
Group number for ENET_QOS status codes.

enumerator kStatusGroup_LOG
Group number for LOG status codes.

enumerator kStatusGroup_I3CBUS
Group number for I3CBUS status codes.

enumerator kStatusGroup_QSCI
Group number for QSCI status codes.

enumerator kStatusGroup_ELEMU
Group number for ELEMU status codes.

enumerator kStatusGroup_QUEUEDSPI
Group number for QSPI status codes.

enumerator kStatusGroup_POWER_MANAGER
Group number for POWER_MANAGER status codes.

enumerator kStatusGroup_IPED
Group number for IPED status codes.

enumerator kStatusGroup_ELS_PKC
Group number for ELS PKC status codes.

enumerator kStatusGroup_CSS_PKC
Group number for CSS PKC status codes.

enumerator kStatusGroup_HOSTIF
Group number for HOSTIF status codes.

enumerator kStatusGroup_CLIF
Group number for CLIF status codes.

enumerator kStatusGroup_BMA
Group number for BMA status codes.

enumerator kStatusGroup_NETC
Group number for NETC status codes.

enumerator kStatusGroup_ELE
Group number for ELE status codes.

enumerator kStatusGroup_GLIKEY
Group number for GLIKEY status codes.

enumerator kStatusGroup_AON_POWER
Group number for AON_POWER status codes.

enumerator kStatusGroup_AON_COMMON
Group number for AON_COMMON status codes.

enumerator kStatusGroup_ENDAT3
Group number for ENDAT3 status codes.

enumerator kStatusGroup_HIPERFACE
Group number for HIPERFACE status codes.

enumerator kStatusGroup_NPX
Group number for NPX status codes.

enumerator kStatusGroup_ELA_CSEC
Group number for ELA_CSEC status codes.

enumerator kStatusGroup_FLEXIO_T_FORMAT
Group number for T-format status codes.

enumerator kStatusGroup_FLEXIO_A_FORMAT
Group number for A-format status codes.

Generic status return codes.

Values:

enumerator kStatus_Success
Generic status for Success.

enumerator kStatus_Fail
Generic status for Fail.

enumerator kStatus_ReadOnly
Generic status for read only failure.

enumerator kStatus_OutOfRange
Generic status for out of range access.

enumerator kStatus_InvalidArgument
Generic status for invalid argument check.

enumerator kStatus_Timeout
Generic status for timeout.

enumerator kStatus_NoTransferInProgress
Generic status for no transfer in progress.

enumerator kStatus_Busy
Generic status for module is busy.

enumerator kStatus_NoData
Generic status for no data is found for the operation.

typedef int32_t status_t
Type used for all status and error return values.

void *SDK_Malloc(size_t size, size_t alignbytes)
Allocate memory with given alignment and aligned size.

This is provided to support the dynamically allocated memory used in cache-able region.

Parameters

- size – The length required to malloc.
- alignbytes – The alignment size.

Return values
The – allocated memory.

void SDK_Free(void *ptr)
Free memory.

Parameters

- ptr – The memory to be release.

void SDK_DelayAtLeastUs(uint32_t delayTime_us, uint32_t coreClock_Hz)
Delay at least for some time. Please note that, this API uses while loop for delay, different run-time environments make the time not precise, if precise delay count was needed, please implement a new delay function with hardware timer.

Parameters

- delayTime_us – Delay time in unit of microsecond.
- coreClock_Hz – Core clock frequency with Hz.

static inline *status_t* EnableIRQ(IRQn_Type interrupt)
Enable specific interrupt.

Enable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only enables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt enabled successfully
- kStatus_Fail – Failed to enable the interrupt

static inline *status_t* DisableIRQ(IRQn_Type interrupt)

Disable specific interrupt.

Disable LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only disables the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ number.

Return values

- kStatus_Success – Interrupt disabled successfully
- kStatus_Fail – Failed to disable the interrupt

static inline *status_t* EnableIRQWithPriority(IRQn_Type interrupt, uint8_t priNum)

Enable the IRQ, and also set the interrupt priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to Enable.
- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_SetPriority(IRQn_Type interrupt, uint8_t priNum)

Set the IRQ priority.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The IRQ to set.

- priNum – Priority number set to interrupt controller register.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline *status_t* IRQ_ClearPendingIRQ(IRQn_Type interrupt)

Clear the pending IRQ flag.

Only handle LEVEL1 interrupt. For some devices, there might be multiple interrupt levels. For example, there are NVIC and intmux. Here the interrupts connected to NVIC are the LEVEL1 interrupts, because they are routed to the core directly. The interrupts connected to intmux are the LEVEL2 interrupts, they are routed to NVIC first then routed to core.

This function only handles the LEVEL1 interrupts. The number of LEVEL1 interrupts is indicated by the feature macro FSL_FEATURE_NUMBER_OF_LEVEL1_INT_VECTORS.

Parameters

- interrupt – The flag which IRQ to clear.

Return values

- kStatus_Success – Interrupt priority set successfully
- kStatus_Fail – Failed to set the interrupt priority.

static inline uint32_t DisableGlobalIRQ(void)

Disable the global IRQ.

Disable the global interrupt and return the current primask register. User is required to provided the primask register for the EnableGlobalIRQ().

Returns
Current primask value.

static inline void EnableGlobalIRQ(uint32_t primask)

Enable the global IRQ.

Set the primask register with the provided primask value but not just enable the primask. The idea is for the convenience of integration of RTOS. some RTOS get its own management mechanism of primask. User is required to use the EnableGlobalIRQ() and DisableGlobalIRQ() in pair.

Parameters

- primask – value of primask register to be restored. The primask value is supposed to be provided by the DisableGlobalIRQ().

static inline bool _SDK_AtomicLocalCompareAndSet(uint32_t *addr, uint32_t expected, uint32_t newValue)

static inline uint32_t _SDK_AtomicTestAndSet(uint32_t *addr, uint32_t newValue)

FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ

Macro to use the default weak IRQ handler in drivers.

MAKE_STATUS(group, code)

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

MAKE_VERSION(major, minor, bugfix)

Construct the version number for drivers.

The driver version is a 32-bit number, for both 32-bit platforms(such as Cortex M) and 16-bit platforms(such as DSC).

```
| Unused    || Major Version || Minor Version ||  Bug Fix    |
31       25  24          17  16          9  8           0
```

ARRAY_SIZE(**x**)

Computes the number of elements in an array.

UINT64_H(**X**)

Macro to get upper 32 bits of a 64-bit value

UINT64_L(**X**)

Macro to get lower 32 bits of a 64-bit value

SUPPRESS_FALL_THROUGH_WARNING()

For switch case code block, if case section ends without "break;" statement, there wil be fallthrough warning with compiler flag -Wextra or -Wimplicit-fallthrough=n when using armgcc. To suppress this warning, "SUPPRESS_FALL_THROUGH_WARNING();" need to be added at the end of each case section which misses "break;"statement.

MSDK_REG_SECURE_ADDR(**x**)

Convert the register address to the one used in secure mode.

MSDK_REG_NONSECURE_ADDR(**x**)

Convert the register address to the one used in non-secure mode.

MSDK_INVALID_IRQ_HANDLER

Invalid IRQ handler address.

2.32 Lin_lpuart_driver

FSL_LIN_LPUART_DRIVER_VERSION

LIN LPUART driver version.

enum _lin_lpuart_stop_bit_count

Values:

enumerator kLPUART_OneStopBit

One stop bit

enumerator kLPUART_TwoStopBit

Two stop bits

enum _lin_lpuart_flags

Values:

enumerator kLPUART_TxDataRegEmptyFlag

Transmit data register empty flag, sets when transmit buffer is empty

enumerator kLPUART_TransmissionCompleteFlag

Transmission complete flag, sets when transmission activity complete

enumerator kLPUART_RxDataRegFullFlag

Receive data register full flag, sets when the receive data buffer is full

enumerator kLPUART_IdleLineFlag

Idle line detect flag, sets when idle line detected

enumerator kLPUART_RxOverrunFlag

Receive Overrun, sets when new data is received before data is read from receive register

enumerator kLPUART_NoiseErrorFlag
Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets

enumerator kLPUART_FramingErrorFlag
Frame error flag, sets if logic 0 was detected where stop bit expected

enumerator kLPUART_ParityErrorFlag
If parity enabled, sets upon parity error detection

enumerator kLPUART_LinBreakFlag
LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled

enumerator kLPUART_RxActiveEdgeFlag
Receive pin active edge interrupt flag, sets when active edge detected

enumerator kLPUART_RxActiveFlag
Receiver Active Flag (RAF), sets at beginning of valid start bit

enumerator kLPUART_DataMatch1Flag
The next character to be read from LPUART_DATA matches MA1

enumerator kLPUART_DataMatch2Flag
The next character to be read from LPUART_DATA matches MA2

enumerator kLPUART_NoiseErrorInRxDataRegFlag
NOISY bit, sets if noise detected in current data word

enumerator kLPUART_ParityErrorInRxDataRegFlag
PARITY bit, sets if noise detected in current data word

enumerator kLPUART_TxFifoEmptyFlag
TXEMPT bit, sets if transmit buffer is empty

enumerator kLPUART_RxFifoEmptyFlag
RXEMPT bit, sets if receive buffer is empty

enumerator kLPUART_TxFifoOverflowFlag
TXOF bit, sets if transmit buffer overflow occurred

enumerator kLPUART_RxFifoUnderflowFlag
RXUF bit, sets if receive buffer underflow occurred

enum _lin_lpuart_interrupt_enable
Values:

enumerator kLPUART_LinBreakInterruptEnable
LIN break detect.

enumerator kLPUART_RxActiveEdgeInterruptEnable
Receive Active Edge.

enumerator kLPUART_TxDataRegEmptyInterruptEnable
Transmit data register empty.

enumerator kLPUART_TransmissionCompleteInterruptEnable
Transmission complete.

enumerator kLPUART_RxDataRegFullInterruptEnable
Receiver data register full.

enumerator kLPUART_IdleLineInterruptEnable
Idle line.

enumerator kLPUART_RxOverrunInterruptEnable
Receiver Overrun.

enumerator kLPUART_NoiseErrorInterruptEnable
Noise error flag.

enumerator kLPUART_FramingErrorInterruptEnable
Framing error flag.

enumerator kLPUART_ParityErrorInterruptEnable
Parity error flag.

enumerator kLPUART_TxFifoOverflowInterruptEnable
Transmit FIFO Overflow.

enumerator kLPUART_RxFifoUnderflowInterruptEnable
Receive FIFO Underflow.

enum _lin_lpuart_status
Values:

enumerator kStatus_LPUART_TxBusy
TX busy

enumerator kStatus_LPUART_RxBusy
RX busy

enumerator kStatus_LPUART_TxIdle
LPUART transmitter is idle.

enumerator kStatus_LPUART_RxIdle
LPUART receiver is idle.

enumerator kStatus_LPUART_TxWatermarkTooLarge
TX FIFO watermark too large

enumerator kStatus_LPUART_RxWatermarkTooLarge
RX FIFO watermark too large

enumerator kStatus_LPUART_FlagCannotClearManually
Some flag can't manually clear

enumerator kStatus_LPUART_Error
Error happens on LPUART.

enumerator kStatus_LPUART_RxRingBufferOverrun
LPUART RX software ring buffer overrun.

enumerator kStatus_LPUART_RxHardwareOverrun
LPUART RX receiver overrun.

enumerator kStatus_LPUART_NoiseError
LPUART noise error.

enumerator kStatus_LPUART_FramingError
LPUART framing error.

enumerator kStatus_LPUART_ParityError
LPUART parity error.

enum lin_lpuart_bit_count_per_char_t

Values:

enumerator LPUART_8_BITS_PER_CHAR

8-bit data characters

enumerator LPUART_9_BITS_PER_CHAR

9-bit data characters

enumerator LPUART_10_BITS_PER_CHAR

10-bit data characters

typedef enum *_lin_lpuart_stop_bit_count* lin_lpuart_stop_bit_count_t

static inline bool LIN_LPUART_GetRxDataPolarity(const LPUART_Type *base)

static inline void LIN_LPUART_SetRxDataPolarity(LPUART_Type *base, bool polarity)

static inline void LIN_LPUART_WriteByte(LPUART_Type *base, uint8_t data)

static inline void LIN_LPUART_ReadByte(const LPUART_Type *base, uint8_t *readData)

status_t LIN_LPUART_CalculateBaudRate(LPUART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz, uint32_t *osr, uint16_t *sbr)

Calculates the best osr and sbr value for configured baudrate.

Parameters

- base – LPUART peripheral base address
- baudRate_Bps – user configuration structure of type #lin_user_config_t
- srcClock_Hz – pointer to the LIN_LPUART driver state structure
- osr – pointer to osr value
- sbr – pointer to sbr value

Returns

An error code or lin_status_t

void LIN_LPUART_SetBaudRate(LPUART_Type *base, uint32_t *osr, uint16_t *sbr)

Configure baudrate according to osr and sbr value.

Parameters

- base – LPUART peripheral base address
- osr – pointer to osr value
- sbr – pointer to sbr value

lin_status_t LIN_LPUART_Init(LPUART_Type *base, lin_user_config_t *linUserConfig, lin_state_t *linCurrentState, uint32_t linSourceClockFreq)

Initializes an LIN_LPUART instance for LIN Network.

The caller provides memory for the driver state structures during initialization. The user must select the LIN_LPUART clock source in the application to initialize the LIN_LPUART. This function initializes a LPUART instance for operation. This function will initialize the run-time state structure to keep track of the on-going transfers, initialize the module to user defined settings and default settings, set break field length to be 13 bit times minimum, enable the break detect interrupt, Rx complete interrupt, frame error detect interrupt, and enable the LPUART module transmitter and receiver

Parameters

- base – LPUART peripheral base address

- linUserConfig – user configuration structure of type #lin_user_config_t
- linCurrentState – pointer to the LIN_LPUART driver state structure

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_Deinit(LPUART_Type *base)

Shuts down the LIN_LPUART by disabling interrupts and transmitter/receiver.

Parameters

- base – LPUART peripheral base address

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_SendFrameDataBlocking(LPUART_Type *base, const uint8_t *txBuff, uint8_t txSize, uint32_t timeoutMSec)

Sends Frame data out through the LIN_LPUART module using blocking method. This function will calculate the checksum byte and send it with the frame data. Blocking means that the function does not return until the transmission is complete.

Parameters

- base – LPUART peripheral base address
- txBuff – source buffer containing 8-bit data chars to send
- txSize – the number of bytes to send
- timeoutMSec – timeout value in milli seconds

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_SendFrameData(LPUART_Type *base, const uint8_t *txBuff, uint8_t txSize)

Sends frame data out through the LIN_LPUART module using non-blocking method. This enables an a-sync method for transmitting data. Non-blocking means that the function returns immediately. The application has to get the transmit status to know when the transmit is complete. This function will calculate the checksum byte and send it with the frame data.

Parameters

- base – LPUART peripheral base address
- txBuff – source buffer containing 8-bit data chars to send
- txSize – the number of bytes to send

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_GetTransmitStatus(LPUART_Type *base, uint8_t *bytesRemaining)

Get status of an on-going non-blocking transmission While sending frame data using non-blocking method, users can use this function to get status of that transmission. This function return LIN_TX_BUSY while sending, or LIN_TIMEOUT if timeout has occurred, or return LIN_SUCCESS when the transmission is complete. The bytesRemaining shows number of bytes that still needed to transmit.

Parameters

- base – LPUART peripheral base address
- bytesRemaining – Number of bytes still needed to transmit

Returns
lin_status_t LIN_TX_BUSY, LIN_SUCCESS or LIN_TIMEOUT

lin_status_t LIN_LPUART_RecvFrmDataBlocking(LPUART_Type *base, uint8_t *rxBuff, uint8_t rxSize, uint32_t timeoutMSec)

Receives frame data through the LIN_LPUART module using blocking method. This function will check the checksum byte. If the checksum is correct, it will receive the frame data. Blocking means that the function does not return until the reception is complete.

Parameters

- base – LPUART peripheral base address
- rxBuff – buffer containing 8-bit received data
- rxSize – the number of bytes to receive
- timeoutMSec – timeout value in milli seconds

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_RecvFrmData(LPUART_Type *base, uint8_t *rxBuff, uint8_t rxSize)

Receives frame data through the LIN_LPUART module using non-blocking method. This function will check the checksum byte. If the checksum is correct, it will receive it with the frame data. Non-blocking means that the function returns immediately. The application has to get the receive status to know when the reception is complete.

Parameters

- base – LPUART peripheral base address
- rxBuff – buffer containing 8-bit received data
- rxSize – the number of bytes to receive

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_AbortTransferData(LPUART_Type *base)

Aborts an on-going non-blocking transmission/reception. While performing a non-blocking transferring data, users can call this function to terminate immediately the transferring.

Parameters

- base – LPUART peripheral base address

Returns
An error code or lin_status_t

lin_status_t LIN_LPUART_GetReceiveStatus(LPUART_Type *base, uint8_t *bytesRemaining)

Get status of an on-going non-blocking reception While receiving frame data using non-blocking method, users can use this function to get status of that receiving. This function return the current event ID, LIN_RX_BUSY while receiving and return LIN_SUCCESS, or timeout (LIN_TIMEOUT) when the reception is complete. The bytesRemaining shows number of bytes that still needed to receive.

Parameters

- base – LPUART peripheral base address
- bytesRemaining – Number of bytes still needed to receive

Returns
lin_status_t LIN_RX_BUSY, LIN_TIMEOUT or LIN_SUCCESS

lin_status_t LIN_LPUART_GoToSleepMode(LPUART_Type *base)

This function puts current node to sleep mode This function changes current node state to LIN_NODE_STATE_SLEEP_MODE.

Parameters

- base – LPUART peripheral base address

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_GotoIdleState(LPUART_Type *base)

Puts current LIN node to Idle state This function changes current node state to LIN_NODE_STATE_IDLE.

Parameters

- base – LPUART peripheral base address

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_SendWakeupSignal(LPUART_Type *base)

Sends a wakeup signal through the LIN_LPUART interface.

Parameters

- base – LPUART peripheral base address

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_MasterSendHeader(LPUART_Type *base, uint8_t id)

Sends frame header out through the LIN_LPUART module using a non-blocking method. This function sends LIN Break field, sync field then the ID with correct parity.

Parameters

- base – LPUART peripheral base address
- id – Frame Identifier

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_EnableIRQ(LPUART_Type *base)

Enables LIN_LPUART hardware interrupts.

Parameters

- base – LPUART peripheral base address

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_DisableIRQ(LPUART_Type *base)

Disables LIN_LPUART hardware interrupts.

Parameters

- base – LPUART peripheral base address

Returns

An error code or lin_status_t

lin_status_t LIN_LPUART_AutoBaudCapture(uint32_t instance)

This function capture bits time to detect break char, calculate baudrate from sync bits and enable transceiver if autobaud successful. This function should only be used in Slave. The timer should be in mode input capture of both rising and falling edges. The timer input capture pin should be externally connected to RXD pin.

Parameters

- instance – LPUART instance

Returns
lin_status_t

void LIN_LPUART_IRQHandler(LPUART_Type *base)

LIN_LPUART RX TX interrupt handler.

Parameters

- base – LPUART peripheral base address

Returns
void

LIN_LPUART_TRANSMISSION_COMPLETE_TIMEOUT

Max loops to wait for LPUART transmission complete.

When de-initializing the LIN LPUART module, the program shall wait for the previous transmission to complete. This parameter defines how many loops to check completion before return error. If defined as 0, driver will wait forever until completion.

AUTOBAUD_BAUDRATE_TOLERANCE

BIT_RATE_TOLERANCE_UNSYNC

BIT_DURATION_MAX_19200

BIT_DURATION_MIN_19200

BIT_DURATION_MAX_14400

BIT_DURATION_MIN_14400

BIT_DURATION_MAX_9600

BIT_DURATION_MIN_9600

BIT_DURATION_MAX_4800

BIT_DURATION_MIN_4800

BIT_DURATION_MAX_2400

BIT_DURATION_MIN_2400

TWO_BIT_DURATION_MAX_19200

TWO_BIT_DURATION_MIN_19200

TWO_BIT_DURATION_MAX_14400

TWO_BIT_DURATION_MIN_14400

TWO_BIT_DURATION_MAX_9600

TWO_BIT_DURATION_MIN_9600

TWO_BIT_DURATION_MAX_4800

TWO_BIT_DURATION_MIN_4800

TWO_BIT_DURATION_MAX_2400

TWO_BIT_DURATION_MIN_2400

AUTOBAUD_BREAK_TIME_MIN

2.33 LLWU: Low-Leakage Wakeup Unit Driver

static inline void LLWU_GetVersionId(LLWU_Type *base, *llwu_version_id_t* *versionId)

Gets the LLWU version ID.

This function gets the LLWU version ID, including the major version number, the minor version number, and the feature specification number.

Parameters

- base – LLWU peripheral base address.
- versionId – A pointer to the version ID structure.

static inline void LLWU_GetParam(LLWU_Type *base, *llwu_param_t* *param)

Gets the LLWU parameter.

This function gets the LLWU parameter, including a wakeup pin number, a module number, a DMA number, and a pin filter number.

Parameters

- base – LLWU peripheral base address.
- param – A pointer to the LLWU parameter structure.

void LLWU_SetExternalWakeupPinMode(LLWU_Type *base, uint32_t pinIndex, *llwu_external_pin_mode_t* pinMode)

Sets the external input pin source mode.

This function sets the external input pin source mode that is used as a wake up source.

Parameters

- base – LLWU peripheral base address.
- pinIndex – A pin index to be enabled as an external wakeup source starting from 1.
- pinMode – A pin configuration mode defined in the llwu_external_pin_modes_t.

bool LLWU_GetExternalWakeupPinFlag(LLWU_Type *base, uint32_t pinIndex)

Gets the external wakeup source flag.

This function checks the external pin flag to detect whether the MCU is woken up by the specific pin.

Parameters

- base – LLWU peripheral base address.
- pinIndex – A pin index, which starts from 1.

Returns

True if the specific pin is a wakeup source.

void LLWU_ClearExternalWakeupPinFlag(LLWU_Type *base, uint32_t pinIndex)

Clears the external wakeup source flag.

This function clears the external wakeup source flag for a specific pin.

Parameters

- base – LLWU peripheral base address.
- pinIndex – A pin index, which starts from 1.

static inline void LLWU_EnableInternalModuleInterruptWakup(LLWU_Type *base, uint32_t moduleIndex, bool enable)

Enables/disables the internal module source.

This function enables/disables the internal module source mode that is used as a wake up source.

Parameters

- base – LLWU peripheral base address.
- moduleIndex – A module index to be enabled as an internal wakeup source starting from 1.
- enable – An enable or a disable setting

static inline void LLWU_EnableInternalModuleDmaRequestWakup(LLWU_Type *base, uint32_t moduleIndex, bool enable)

Enables/disables the internal module DMA wakeup source.

This function enables/disables the internal DMA that is used as a wake up source.

Parameters

- base – LLWU peripheral base address.
- moduleIndex – An internal module index which is used as a DMA request source, starting from 1.
- enable – Enable or disable the DMA request source

void LLWU_SetPinFilterMode(LLWU_Type *base, uint32_t filterIndex, *llwu_external_pin_filter_mode_t* filterMode)

Sets the pin filter configuration.

This function sets the pin filter configuration.

Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index used to enable/disable the digital filter, starting from 1.
- filterMode – A filter mode configuration

bool LLWU_GetPinFilterFlag(LLWU_Type *base, uint32_t filterIndex)

Gets the pin filter configuration.

This function gets the pin filter flag.

Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index, which starts from 1.

Returns

True if the flag is a source of the existing low-leakage power mode.

void LLWU_ClearPinFilterFlag(LLWU_Type *base, uint32_t filterIndex)

Clears the pin filter configuration.

This function clears the pin filter flag.

Parameters

- base – LLWU peripheral base address.
- filterIndex – A pin filter index to clear the flag, starting from 1.

void LLWU_SetResetPinMode(LLWU_Type *base, bool pinEnable, bool pinFilterEnable)

Sets the reset pin mode.

This function determines how the reset pin is used as a low leakage mode exit source.

Parameters

- base – LLWU peripheral base address.
- pinEnable – Enable reset the pin filter
- pinFilterEnable – Specify whether the pin filter is enabled in Low-Leakage power mode.

FSL_LLWU_DRIVER_VERSION

LLWU driver version.

enum _llwu_external_pin_mode

External input pin control modes.

Values:

enumerator kLLWU_ExternalPinDisable

Pin disabled as a wakeup input.

enumerator kLLWU_ExternalPinRisingEdge

Pin enabled with the rising edge detection.

enumerator kLLWU_ExternalPinFallingEdge

Pin enabled with the falling edge detection.

enumerator kLLWU_ExternalPinAnyEdge

Pin enabled with any change detection.

enum _llwu_pin_filter_mode

Digital filter control modes.

Values:

enumerator kLLWU_PinFilterDisable

Filter disabled.

enumerator kLLWU_PinFilterRisingEdge

Filter positive edge detection.

enumerator kLLWU_PinFilterFallingEdge

Filter negative edge detection.

enumerator kLLWU_PinFilterAnyEdge

Filter any edge detection.

typedef enum *_llwu_external_pin_mode* llwu_external_pin_mode_t

External input pin control modes.

typedef enum *_llwu_pin_filter_mode* llwu_pin_filter_mode_t

Digital filter control modes.

typedef struct *_llwu_version_id* llwu_version_id_t
IP version ID definition.

typedef struct *_llwu_param* llwu_param_t
IP parameter definition.

typedef struct *_llwu_external_pin_filter_mode* llwu_external_pin_filter_mode_t
An external input pin filter control structure.

LLWU_REG_VAL(x)

struct __llwu_version_id
#include <fsl_llwu.h> IP version ID definition.

Public Members

uint16_t feature
A feature specification number.

uint8_t minor
The minor version number.

uint8_t major
The major version number.

struct __llwu_param
#include <fsl_llwu.h> IP parameter definition.

Public Members

uint8_t filters
A number of the pin filter.

uint8_t dmas
A number of the wakeup DMA.

uint8_t modules
A number of the wakeup module.

uint8_t pins
A number of the wake up pin.

struct __llwu_external_pin_filter_mode
#include <fsl_llwu.h> An external input pin filter control structure.

Public Members

uint32_t pinIndex
A pin number

llwu_pin_filter_mode_t filterMode
Filter mode

2.34 LPTMR: Low-Power Timer

void LPTMR_Init(LPTMR_Type *base, const *lptmr_config_t* *config)

Ungates the LPTMR clock and configures the peripheral for a basic operation.

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

Parameters

- base – LPTMR peripheral base address
- config – A pointer to the LPTMR configuration structure.

void LPTMR_Deinit(LPTMR_Type *base)

Gates the LPTMR clock.

Parameters

- base – LPTMR peripheral base address

void LPTMR_GetDefaultConfig(*lptmr_config_t* *config)

Fills in the LPTMR configuration structure with default settings.

The default values are as follows.

```
config->timerMode = kLPTMR_TimerModeTimeCounter;
config->pinSelect = kLPTMR_PinSelectInput_0;
config->pinPolarity = kLPTMR_PinPolarityActiveHigh;
config->enableFreeRunning = false;
config->bypassPrescaler = true;
config->prescalerClockSource = kLPTMR_PrescalerClock_1;
config->value = kLPTMR_Prescale_Glitch_0;
```

Parameters

- config – A pointer to the LPTMR configuration structure.

static inline void LPTMR_EnableInterrupts(LPTMR_Type *base, uint32_t mask)

Enables the selected LPTMR interrupts.

Parameters

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

static inline void LPTMR_DisableInterrupts(LPTMR_Type *base, uint32_t mask)

Disables the selected LPTMR interrupts.

Parameters

- base – LPTMR peripheral base address
- mask – The interrupts to disable. This is a logical OR of members of the enumeration lptmr_interrupt_enable_t.

static inline uint32_t LPTMR_GetEnabledInterrupts(LPTMR_Type *base)

Gets the enabled LPTMR interrupts.

Parameters

- base – LPTMR peripheral base address

Returns
The enabled interrupts. This is the logical OR of members of the enumeration lptmr_interrupt_enable_t

static inline uint32_t LPTMR_GetStatusFlags(LPTMR_Type *base)

Gets the LPTMR status flags.

Parameters

- base – LPTMR peripheral base address

Returns
The status flags. This is the logical OR of members of the enumeration lptmr_status_flags_t

static inline void LPTMR_ClearStatusFlags(LPTMR_Type *base, uint32_t mask)

Clears the LPTMR status flags.

Parameters

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

static inline void LPTMR_SetTimerPeriod(LPTMR_Type *base, uint32_t ticks)

Sets the timer period in units of count.

Timers counts from 0 until it equals the count value set here. The count value is written to the CMR register.

Note:

a. The TCF flag is set with the CNR equals the count provided here and then increments.

b. Call the utility macros provided in the fsl_common.h to convert to ticks.

Parameters

- base – LPTMR peripheral base address
- ticks – A timer period in units of ticks, which should be equal or greater than 1.

static inline uint32_t LPTMR_GetCurrentTimerCount(LPTMR_Type *base)

Reads the current timer counting value.

This function returns the real-time timer counting value in a range from 0 to a timer period.

Note: Call the utility macros provided in the fsl_common.h to convert ticks to usec or msec.

Parameters

- base – LPTMR peripheral base address

Returns
The current counter value in ticks

static inline void LPTMR_StartTimer(LPTMR_Type *base)

Starts the timer.

After calling this function, the timer counts up to the CMR register value. Each time the timer reaches the CMR value and then increments, it generates a trigger pulse and sets the timeout interrupt flag. An interrupt is also triggered if the timer interrupt is enabled.

Parameters

- base – LPTMR peripheral base address

static inline void LPTMR_StopTimer(LPTMR_Type *base)

Stops the timer.

This function stops the timer and resets the timer's counter register.

Parameters

- base – LPTMR peripheral base address

FSL_LPTMR_DRIVER_VERSION

Driver Version

enum _lptmr_pin_select

LPTMR pin selection used in pulse counter mode.

Values:

enumerator kLPTMR_PinSelectInput_0

Pulse counter input 0 is selected

enumerator kLPTMR_PinSelectInput_1

Pulse counter input 1 is selected

enumerator kLPTMR_PinSelectInput_2

Pulse counter input 2 is selected

enumerator kLPTMR_PinSelectInput_3

Pulse counter input 3 is selected

enum _lptmr_pin_polarity

LPTMR pin polarity used in pulse counter mode.

Values:

enumerator kLPTMR_PinPolarityActiveHigh

Pulse Counter input source is active-high

enumerator kLPTMR_PinPolarityActiveLow

Pulse Counter input source is active-low

enum _lptmr_timer_mode

LPTMR timer mode selection.

Values:

enumerator kLPTMR_TimerModeTimeCounter

Time Counter mode

enumerator kLPTMR_TimerModePulseCounter

Pulse Counter mode

enum _lptmr_prescaler_glitch_value

LPTMR prescaler/glitch filter values.

Values:

enumerator kLPTMR_Prescale_Glitch_0

Prescaler divide 2, glitch filter does not support this setting

enumerator kLPTMR_Prescale_Glitch_1

Prescaler divide 4, glitch filter 2

enumerator kLPTMR_Prescale_Glitch_2
Prescaler divide 8, glitch filter 4

enumerator kLPTMR_Prescale_Glitch_3
Prescaler divide 16, glitch filter 8

enumerator kLPTMR_Prescale_Glitch_4
Prescaler divide 32, glitch filter 16

enumerator kLPTMR_Prescale_Glitch_5
Prescaler divide 64, glitch filter 32

enumerator kLPTMR_Prescale_Glitch_6
Prescaler divide 128, glitch filter 64

enumerator kLPTMR_Prescale_Glitch_7
Prescaler divide 256, glitch filter 128

enumerator kLPTMR_Prescale_Glitch_8
Prescaler divide 512, glitch filter 256

enumerator kLPTMR_Prescale_Glitch_9
Prescaler divide 1024, glitch filter 512

enumerator kLPTMR_Prescale_Glitch_10
Prescaler divide 2048 glitch filter 1024

enumerator kLPTMR_Prescale_Glitch_11
Prescaler divide 4096, glitch filter 2048

enumerator kLPTMR_Prescale_Glitch_12
Prescaler divide 8192, glitch filter 4096

enumerator kLPTMR_Prescale_Glitch_13
Prescaler divide 16384, glitch filter 8192

enumerator kLPTMR_Prescale_Glitch_14
Prescaler divide 32768, glitch filter 16384

enumerator kLPTMR_Prescale_Glitch_15
Prescaler divide 65536, glitch filter 32768

enum _lptmr_prescaler_clock_select
LPTMR prescaler/glitch filter clock select.

Note: Clock connections are SoC-specific

Values:

enumerator kLPTMR_PrescalerClock_0
Prescaler/glitch filter clock 0 selected.

enumerator kLPTMR_PrescalerClock_1
Prescaler/glitch filter clock 1 selected.

enumerator kLPTMR_PrescalerClock_2
Prescaler/glitch filter clock 2 selected.

enumerator kLPTMR_PrescalerClock_3
Prescaler/glitch filter clock 3 selected.

enum _lptmr_interrupt_enable

List of the LPTMR interrupts.

Values:

enumerator kLPTMR_TimerInterruptEnable

Timer interrupt enable

enum _lptmr_status_flags

List of the LPTMR status flags.

Values:

enumerator kLPTMR_TimerCompareFlag

Timer compare flag

typedef enum *_lptmr_pin_select* lptmr_pin_select_t

LPTMR pin selection used in pulse counter mode.

typedef enum *_lptmr_pin_polarity* lptmr_pin_polarity_t

LPTMR pin polarity used in pulse counter mode.

typedef enum *_lptmr_timer_mode* lptmr_timer_mode_t

LPTMR timer mode selection.

typedef enum *_lptmr_prescaler_glitch_value* lptmr_prescaler_glitch_value_t

LPTMR prescaler/glitch filter values.

typedef enum *_lptmr_prescaler_clock_select* lptmr_prescaler_clock_select_t

LPTMR prescaler/glitch filter clock select.

Note: Clock connections are SoC-specific

---

typedef enum *_lptmr_interrupt_enable* lptmr_interrupt_enable_t

List of the LPTMR interrupts.

typedef enum *_lptmr_status_flags* lptmr_status_flags_t

List of the LPTMR status flags.

typedef struct *_lptmr_config* lptmr_config_t

LPTMR config structure.

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

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

static inline void LPTMR_EnableTimerDMA(LPTMR_Type *base, bool enable)

Enable or disable timer DMA request.

Parameters

- base – base LPTMR peripheral base address
- enable – Switcher of timer DMA feature. “true” means to enable, “false” means to disable.

struct _lptmr_config

#include <fsl_lptmr.h> LPTMR config structure.

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

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

Public Members

lptmr_timer_mode_t timerMode
Time counter mode or pulse counter mode

lptmr_pin_select_t pinSelect
LPTMR pulse input pin select; used only in pulse counter mode

lptmr_pin_polarity_t pinPolarity
LPTMR pulse input pin polarity; used only in pulse counter mode

bool enableFreeRunning
True: enable free running, counter is reset on overflow False: counter is reset when the compare flag is set

bool bypassPrescaler
True: bypass prescaler; false: use clock from prescaler

lptmr_prescaler_clock_select_t prescalerClockSource
LPTMR clock source

lptmr_prescaler_glitch_value_t value
Prescaler or glitch filter value

2.35 LPUART: Low Power Universal Asynchronous Receiver/Transmitter Driver

2.36 LPUART DMA Driver

void LPUART_TransferCreateHandleDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle, *lpuart_dma_transfer_callback_t* callback, void *userData, *dma_handle_t* *txDmaHandle, *dma_handle_t* *rxDmaHandle)

Initializes the LPUART handle which is used in transactional functions.

Note: This function disables all LPUART interrupts.

Parameters

- base – LPUART peripheral base address.
- handle – Pointer to lpuart_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 LPUART_TransferSendDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle, *lpuart_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 – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART DMA transfer structure. See lpuart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_LPUART_TxBusy – Previous transfer on going.
- kStatus_InvalidArgument – Invalid argument.

status_t LPUART_TransferReceiveDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle, *lpuart_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 – LPUART peripheral base address.
- handle – Pointer to lpuart_dma_handle_t structure.
- xfer – LPUART DMA transfer structure. See lpuart_transfer_t.

Return values

- kStatus_Success – if succeed, others failed.
- kStatus_LPUART_RxBusy – Previous transfer on going.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferAbortSendDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle)

Aborts the sent data using DMA.

This function aborts send data using DMA.

Parameters

- base – LPUART peripheral base address
- handle – Pointer to lpuart_dma_handle_t structure

void LPUART_TransferAbortReceiveDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle)

Aborts the received data using DMA.

This function aborts the received data using DMA.

Parameters

- base – LPUART peripheral base address
- handle – Pointer to lpuart_dma_handle_t structure

status_t LPUART_TransferGetSendCountDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle, uint32_t *count)

Gets the number of bytes written to the LPUART TX register.

This function gets the number of bytes that have been written to LPUART TX register by DMA.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t LPUART_TransferGetReceiveCountDMA(LPUART_Type *base, *lpuart_dma_handle_t* *handle, uint32_t *count)

Gets the number of received bytes.

This function gets the number of received bytes.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Receive bytes count.

Return values

- kStatus_NoTransferInProgress – No receive in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

void LPUART_TransferDMAHandleIRQ(LPUART_Type *base, void *lpuartDmaHandle)

LPUART DMA IRQ handle function.

This function handles the LPUART tx complete IRQ request and invoke user callback.

Note: This function is used as default IRQ handler by double weak mechanism. If user's specific IRQ handler is implemented, make sure this function is invoked in the handler.

Parameters

- base – LPUART peripheral base address.
- lpuartDmaHandle – LPUART handle pointer.

FSL_LPUART_DMA_DRIVER_VERSION

LPUART DMA driver version.

typedef struct *_lpuart_dma_handle* lpuart_dma_handle_t

typedef void (*lpuart_dma_transfer_callback_t)(LPUART_Type *base, *lpuart_dma_handle_t* *handle, *status_t* status, void *userData)

LPUART transfer callback function.

struct _lpuart_dma_handle

#include <fsl_lpuart_dma.h> LPUART DMA handle.

Public Members

lpuart_dma_transfer_callback_t callback

Callback function.

void *userData

LPUART callback function parameter.

size_t rxDataSizeAll

Size of the data to receive.

size_t txDataSizeAll

Size of the data to send out.

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

2.37 LPUART Driver

static inline void LPUART_SoftwareReset(LPUART_Type *base)

Resets the LPUART using software.

This function resets all internal logic and registers except the Global Register. Remains set until cleared by software.

Parameters

- base – LPUART peripheral base address.

status_t LPUART_Init(LPUART_Type *base, const *lpuart_config_t* *config, uint32_t srcClock_Hz)

Initializes an LPUART instance with the user configuration structure and the peripheral clock.

This function configures the LPUART module with user-defined settings. Call the LPUART_GetDefaultConfig() function to configure the configuration structure and get the default configuration. The example below shows how to use this API to configure the LPUART.

```
lpuart_config_t lpuartConfig;
lpuartConfig.baudRate_Bps = 115200U;
lpuartConfig.parityMode = kLPUART_ParityDisabled;
lpuartConfig.dataBitsCount = kLPUART_EightDataBits;
lpuartConfig.isMsb = false;
lpuartConfig.stopBitCount = kLPUART_OneStopBit;
lpuartConfig.txFifoWatermark = 0;
lpuartConfig.rxFifoWatermark = 1;
LPUART_Init(LPUART1, &lpuartConfig, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- config – Pointer to a user-defined configuration structure.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – LPUART initialize succeed

void LPUART_Deinit(LPUART_Type *base)

Deinitializes a LPUART instance.

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

- base – LPUART peripheral base address.

void LPUART_GetDefaultConfig(*lpuart_config_t* *config)

Gets the default configuration structure.

This function initializes the LPUART configuration structure to a default value. The default values are: lpuartConfig->baudRate_Bps = 115200U; lpuartConfig->parityMode = kLPUART_ParityDisabled; lpuartConfig->dataBitsCount = kLPUART_EightDataBits; lpuartConfig->isMsb = false; lpuartConfig->stopBitCount = kLPUART_OneStopBit; lpuartConfig->txFifoWatermark = 0; lpuartConfig->rxFifoWatermark = 1; lpuartConfig->rxIdleType = kLPUART_IdleTypeStartBit; lpuartConfig->rxIdleConfig = kLPUART_IdleCharacter1; lpuartConfig->enableTx = false; lpuartConfig->enableRx = false;

Parameters

- config – Pointer to a configuration structure.

status_t LPUART_SetBaudRate(LPUART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the LPUART instance baudrate.

This function configures the LPUART module baudrate. This function is used to update the LPUART module baudrate after the LPUART module is initialized by the LPUART_Init.

```
LPUART_SetBaudRate(LPUART1, 115200U, 20000000U);
```

Parameters

- base – LPUART peripheral base address.
- baudRate_Bps – LPUART baudrate to be set.
- srcClock_Hz – LPUART clock source frequency in HZ.

Return values

- kStatus_LPUART_BaudrateNotSupport – Baudrate is not supported in the current clock source.
- kStatus_Success – Set baudrate succeeded.

void LPUART_Enable9bitMode(LPUART_Type *base, bool enable)

Enable 9-bit data mode for LPUART.

This function set the 9-bit mode for LPUART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – LPUART peripheral base address.
- enable – true to enable, flase to disable.

static inline void LPUART_SetMatchAddress(LPUART_Type *base, uint16_t address1, uint16_t address2)

Set the LPUART address.

This function configures the address for LPUART module that works as slave in 9-bit data mode. One or two address fields can be configured. When the address field's match enable bit is set, the frame it receices with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note: Any LPUART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

- base – LPUART peripheral base address.
- address1 – LPUART slave address1.
- address2 – LPUART slave address2.

static inline void LPUART_EnableMatchAddress(LPUART_Type *base, bool match1, bool match2)

Enable the LPUART match address feature.

Parameters

- base – LPUART peripheral base address.
- match1 – true to enable match address1, false to disable.
- match2 – true to enable match address2, false to disable.

static inline void LPUART_SetRxFifoWatermark(LPUART_Type *base, uint8_t water)

Sets the rx FIFO watermark.

Parameters

- base – LPUART peripheral base address.
- water – Rx FIFO watermark.

static inline void LPUART_SetTxFifoWatermark(LPUART_Type *base, uint8_t water)

Sets the tx FIFO watermark.

Parameters

- base – LPUART peripheral base address.
- water – Tx FIFO watermark.

static inline void LPUART_TransferEnable16Bit(*lpuart_handle_t* *handle, bool enable)

Sets the LPUART using 16bit transmit, only for 9bit or 10bit mode.

This function Enable 16bit Data transmit in lpuart_handle_t.

Parameters

- handle – LPUART handle pointer.
- enable – true to enable, false to disable.

uint32_t LPUART_GetStatusFlags(LPUART_Type *base)

Gets LPUART status flags.

This function gets all LPUART status flags. The flags are returned as the logical OR value of the enumerators _lpuart_flags. To check for a specific status, compare the return value with enumerators in the _lpuart_flags. For example, to check whether the TX is empty:

```
if (kLPUART_TxDataRegEmptyFlag & LPUART_GetStatusFlags(LPUART1))
{
   ...
}
```

Parameters

- base – LPUART peripheral base address.

Returns

LPUART status flags which are ORed by the enumerators in the _lpuart_flags.

status_t LPUART_ClearStatusFlags(LPUART_Type *base, uint32_t mask)

Clears status flags with a provided mask.

This function clears LPUART status flags with a provided mask. Automatically cleared flags can't be cleared by this function. Flags that can only cleared or set by hardware are: kLPUART_TxDataRegEmptyFlag, kLPUART_TransmissionCompleteFlag, kLPUART_RxDataRegFullFlag, kLPUART_RxActiveFlag, kLPUART_NoiseErrorFlag, kLPUART_ParityErrorFlag, kLPUART_TxFifoEmptyFlag,kLPUART_RxFifoEmptyFlag Note: This API should be called when the Tx/Rx is idle, otherwise it takes no effects.

Parameters

- base – LPUART peripheral base address.
- mask – the status flags to be cleared. The user can use the enumerators in the _lpuart_status_flag_t to do the OR operation and get the mask.

Return values

- kStatus_LPUART_FlagCannotClearManually – The flag can't be cleared by this function but it is cleared automatically by hardware.
- kStatus_Success – Status in the mask are cleared.

Returns

0 succeed, others failed.

void LPUART_EnableInterrupts(LPUART_Type *base, uint32_t mask)

Enables LPUART interrupts according to a provided mask.

This function enables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See the _lpuart_interrupt_enable. This examples shows how to enable TX empty interrupt and RX full interrupt:

```
LPUART_EnableInterrupts(LPUART1,kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to enable. Logical OR of _lpuart_interrupt_enable.

void LPUART_DisableInterrupts(LPUART_Type *base, uint32_t mask)

Disables LPUART interrupts according to a provided mask.

This function disables the LPUART interrupts according to a provided mask. The mask is a logical OR of enumeration members. See _lpuart_interrupt_enable. This example shows how to disable the TX empty interrupt and RX full interrupt:

```
LPUART_DisableInterrupts(LPUART1,kLPUART_TxDataRegEmptyInterruptEnable | kLPUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – LPUART peripheral base address.
- mask – The interrupts to disable. Logical OR of _lpuart_interrupt_enable.

uint32_t LPUART_GetEnabledInterrupts(LPUART_Type *base)

Gets enabled LPUART interrupts.

This function gets the enabled LPUART interrupts. The enabled interrupts are returned as the logical OR value of the enumerators _lpuart_interrupt_enable. To check a specific interrupt enable status, compare the return value with enumerators in _lpuart_interrupt_enable. For example, to check whether the TX empty interrupt is enabled:

```
uint32_t enabledInterrupts = LPUART_GetEnabledInterrupts(LPUART1);

if (kLPUART_TxDataRegEmptyInterruptEnable & enabledInterrupts)
{
    ...
}
```

Parameters

- base – LPUART peripheral base address.

Returns

LPUART interrupt flags which are logical OR of the enumerators in _lpuart_interrupt_enable.

static inline uintptr_t LPUART_GetDataRegisterAddress(LPUART_Type *base)

Gets the LPUART data register address.

This function returns the LPUART data register address, which is mainly used by the DMA/eDMA.

Parameters

- base – LPUART peripheral base address.

Returns

LPUART data register addresses which are used both by the transmitter and receiver.

static inline void LPUART_EnableTxDMA(LPUART_Type *base, bool enable)

Enables or disables the LPUART transmitter DMA request.

This function enables or disables the transmit data register empty flag, STAT[TDRE], to generate DMA requests.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_EnableRxDMA(LPUART_Type *base, bool enable)

Enables or disables the LPUART receiver DMA.

This function enables or disables the receiver data register full flag, STAT[RDRF], to generate DMA requests.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

uint32_t LPUART_GetInstance(LPUART_Type *base)

Get the LPUART instance from peripheral base address.

Parameters

- base – LPUART peripheral base address.

Returns

LPUART instance.

static inline void LPUART_EnableTx(LPUART_Type *base, bool enable)

Enables or disables the LPUART transmitter.

This function enables or disables the LPUART transmitter.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_EnableRx(LPUART_Type *base, bool enable)

Enables or disables the LPUART receiver.

This function enables or disables the LPUART receiver.

Parameters

- base – LPUART peripheral base address.
- enable – True to enable, false to disable.

static inline void LPUART_WriteByte(LPUART_Type *base, uint8_t data)

Writes to the transmitter register.

This function writes data to the transmitter register directly. The upper layer must ensure that the TX register is empty or that the TX FIFO has room before calling this function.

Parameters

- base – LPUART peripheral base address.
- data – Data write to the TX register.

static inline uint8_t LPUART_ReadByte(LPUART_Type *base)

Reads the receiver register.

This function reads data from the receiver register directly. The upper layer must ensure that the receiver register is full or that the RX FIFO has data before calling this function.

Parameters

- base – LPUART peripheral base address.

Returns

Data read from data register.

static inline uint8_t LPUART_GetRxFifoCount(LPUART_Type *base)

Gets the rx FIFO data count.

Parameters

- base – LPUART peripheral base address.

Returns

rx FIFO data count.

static inline uint8_t LPUART_GetTxFifoCount(LPUART_Type *base)

Gets the tx FIFO data count.

Parameters

- base – LPUART peripheral base address.

Returns

tx FIFO data count.

void LPUART_SendAddress(LPUART_Type *base, uint8_t address)

Transmit an address frame in 9-bit data mode.

Parameters

- base – LPUART peripheral base address.
- address – LPUART slave address.

status_t LPUART_WriteBlocking(LPUART_Type *base, const uint8_t *data, size_t length)

Writes to the transmitter register using a blocking method.

This function polls the transmitter register, first waits for the register to be empty or TX FIFO to have room, and writes data to the transmitter buffer, then waits for the dat to be sent out to the bus.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t LPUART_WriteBlocking16bit(LPUART_Type *base, const uint16_t *data, size_t length)

Writes to the transmitter register using a blocking method in 9bit or 10bit mode.

Note: This function only support 9bit or 10bit transfer. Please make sure only 10bit of data is valid and other bits are 0.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t LPUART_ReadBlocking(LPUART_Type *base, uint8_t *data, size_t length)

Reads the receiver data register using a blocking method.

This function polls the receiver register, waits for the receiver register full or receiver FIFO has data, and reads data from the TX register.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

Return values

- kStatus_LPUART_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus_LPUART_NoiseError – Noise error happened while receiving data.
- kStatus_LPUART_FramingError – Framing error happened while receiving data.
- kStatus_LPUART_ParityError – Parity error happened while receiving data.
- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

status_t LPUART_ReadBlocking16bit(LPUART_Type *base, uint16_t *data, size_t length)

Reads the receiver data register in 9bit or 10bit mode.

Note: This function only support 9bit or 10bit transfer.

Parameters

- base – LPUART peripheral base address.
- data – Start address of the buffer to store the received data by 16bit, only 10bit is valid.
- length – Size of the buffer.

Return values

- kStatus_LPUART_RxHardwareOverrun – Receiver overrun happened while receiving data.
- kStatus_LPUART_NoiseError – Noise error happened while receiving data.
- kStatus_LPUART_FramingError – Framing error happened while receiving data.
- kStatus_LPUART_ParityError – Parity error happened while receiving data.
- kStatus_LPUART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

void LPUART_TransferCreateHandle(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_callback_t* callback, void *userData)

Initializes the LPUART handle.

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

The LPUART driver supports the "background" receiving, which means that user can set up an RX ring buffer optionally. Data received is stored into the ring buffer even when the user doesn't call the LPUART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly. The ring buffer is disabled if passing NULL as ringBuffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- callback – Callback function.
- userData – User data.

status_t LPUART_TransferSendNonBlocking(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_t* *xfer)

Transmits a buffer of data using the interrupt method.

This function send data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data written to the transmitter register. When all data is written to the TX register in the ISR, the LPUART driver calls the callback function and passes the kStatus_LPUART_TxIdle as status parameter.

Note: The kStatus_LPUART_TxIdle is passed to the upper layer when all data are written to the TX register. However, there is no check to ensure that all the data sent out. Before disabling the TX, check the kLPUART_TransmissionCompleteFlag to ensure that the transmit is finished.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART transfer structure, see lpuart_transfer_t.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_LPUART_TxBusy – Previous transmission still not finished, data not all written to the TX register.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferStartRingBuffer(LPUART_Type *base, *lpuart_handle_t* *handle, uint8_t *ringBuffer, size_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received is stored into the ring buffer even when the user doesn't call the UART_TransferReceiveNonBlocking() API. If there is already data received in the ring buffer, the user can get the received data from the ring buffer directly.

Note: When using RX ring buffer, one byte is reserved for internal use. In other words, if ringBufferSize is 32, then only 31 bytes are used for saving data.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- ringBuffer – Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
- ringBufferSize – size of the ring buffer.

void LPUART_TransferStopRingBuffer(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

size_t LPUART_TransferGetRxRingBufferLength(LPUART_Type *base, *lpuart_handle_t* *handle)

Get the length of received data in RX ring buffer.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

Returns

Length of received data in RX ring buffer.

void LPUART_TransferAbortSend(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the interrupt-driven data transmit.

This function aborts the interrupt driven data sending. The user can get the remainBtyes to find out how many bytes are not sent out.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

status_t LPUART_TransferGetSendCount(LPUART_Type *base, *lpuart_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been sent out to bus.

This function gets the number of bytes that have been sent out to bus by an interrupt method.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t LPUART_TransferReceiveNonBlocking(LPUART_Type *base, *lpuart_handle_t* *handle, *lpuart_transfer_t* *xfer, size_t *receivedBytes)

Receives a buffer of data using the interrupt method.

This function receives data using an interrupt method. This is a non-blocking function which returns without waiting to ensure that all data are received. If the RX ring buffer is used and not empty, the data in the ring buffer is copied and the parameter receivedBytes shows how many bytes are copied from the ring buffer. After copying, if the data in the ring buffer is not enough for read, the receive request is saved by the LPUART driver. When the new data arrives, the receive request is serviced first. When all data is received, the LPUART driver notifies the upper layer through a callback function and passes a status parameter kStatus_UART_RxIdle. For example, the upper layer needs 10 bytes but there are only 5 bytes in ring buffer. The 5 bytes are copied to xfer->data, which returns with the parameter receivedBytes set to 5. For the remaining 5 bytes, the newly arrived data is saved from xfer->data[5]. When 5 bytes are received, the LPUART driver notifies the upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to xfer->data. When all data is received, the upper layer is notified.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- xfer – LPUART transfer structure, see uart_transfer_t.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into the transmit queue.
- kStatus_LPUART_RxBusy – Previous receive request is not finished.
- kStatus_InvalidArgument – Invalid argument.

void LPUART_TransferAbortReceive(LPUART_Type *base, *lpuart_handle_t* *handle)

Aborts the interrupt-driven data receiving.

This function aborts the interrupt-driven data receiving. The user can get the remainBytes to find out how many bytes not received yet.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.

status_t LPUART_TransferGetReceiveCount(LPUART_Type *base, *lpuart_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- base – LPUART peripheral base address.
- handle – LPUART handle pointer.
- count – Receive bytes count.

Return values

- kStatus_NoTransferInProgress – No receive in progress.
- kStatus_InvalidArgument – Parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

void LPUART_TransferHandleIRQ(LPUART_Type *base, void *irqHandle)

LPUART IRQ handle function.

This function handles the LPUART transmit and receive IRQ request.

Parameters

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART_TransferHandleErrorIRQ(LPUART_Type *base, void *irqHandle)

LPUART Error IRQ handle function.

This function handles the LPUART error IRQ request.

Parameters

- base – LPUART peripheral base address.
- irqHandle – LPUART handle pointer.

void LPUART_DriverIRQHandler(uint32_t instance)

LPUART driver IRQ handler common entry.

This function provides the common IRQ request entry for LPUART.

Parameters

- instance – LPUART instance.

FSL_LPUART_DRIVER_VERSION

LPUART driver version.

Error codes for the LPUART driver.

Values:

enumerator kStatus_LPUART_TxBusy

TX busy

enumerator kStatus_LPUART_RxBusy

RX busy

enumerator kStatus_LPUART_TxIdle

LPUART transmitter is idle.

enumerator kStatus_LPUART_RxIdle

LPUART receiver is idle.

enumerator kStatus_LPUART_TxWatermarkTooLarge

TX FIFO watermark too large

enumerator kStatus_LPUART_RxWatermarkTooLarge

RX FIFO watermark too large

enumerator kStatus_LPUART_FlagCannotClearManually

Some flag can't manually clear

enumerator kStatus_LPUART_Error

Error happens on LPUART.

enumerator kStatus_LPUART_RxRingBufferOverrun

LPUART RX software ring buffer overrun.

enumerator kStatus_LPUART_RxHardwareOverrun
LPUART RX receiver overrun.

enumerator kStatus_LPUART_NoiseError
LPUART noise error.

enumerator kStatus_LPUART_FramingError
LPUART framing error.

enumerator kStatus_LPUART_ParityError
LPUART parity error.

enumerator kStatus_LPUART_BaudrateNotSupport
Baudrate is not support in current clock source

enumerator kStatus_LPUART_IdleLineDetected
IDLE flag.

enumerator kStatus_LPUART_Timeout
LPUART times out.

enum _lpuart_parity_mode
LPUART parity mode.

Values:

enumerator kLPUART_ParityDisabled
Parity disabled

enumerator kLPUART_ParityEven
Parity enabled, type even, bit setting: PE|PT = 10

enumerator kLPUART_ParityOdd
Parity enabled, type odd, bit setting: PE|PT = 11

enum _lpuart_data_bits
LPUART data bits count.

Values:

enumerator kLPUART_EightDataBits
Eight data bit

enumerator kLPUART_SevenDataBits
Seven data bit

enum _lpuart_stop_bit_count
LPUART stop bit count.

Values:

enumerator kLPUART_OneStopBit
One stop bit

enumerator kLPUART_TwoStopBit
Two stop bits

enum _lpuart_transmit_cts_source
LPUART transmit CTS source.

Values:

enumerator kLPUART_CtsSourcePin
CTS resource is the LPUART_CTS pin.

enumerator kLPUART_CtsSourceMatchResult
CTS resource is the match result.

enum _lpuart_transmit_cts_config
LPUART transmit CTS configure.

Values:

enumerator kLPUART_CtsSampleAtStart
CTS input is sampled at the start of each character.

enumerator kLPUART_CtsSampleAtIdle
CTS input is sampled when the transmitter is idle

enum _lpuart_idle_type_select
LPUART idle flag type defines when the receiver starts counting.

Values:

enumerator kLPUART_IdleTypeStartBit
Start counting after a valid start bit.

enumerator kLPUART_IdleTypeStopBit
Start counting after a stop bit.

enum _lpuart_idle_config
LPUART idle detected configuration. This structure defines the number of idle characters that must be received before the IDLE flag is set.

Values:

enumerator kLPUART_IdleCharacter1
the number of idle characters.

enumerator kLPUART_IdleCharacter2
the number of idle characters.

enumerator kLPUART_IdleCharacter4
the number of idle characters.

enumerator kLPUART_IdleCharacter8
the number of idle characters.

enumerator kLPUART_IdleCharacter16
the number of idle characters.

enumerator kLPUART_IdleCharacter32
the number of idle characters.

enumerator kLPUART_IdleCharacter64
the number of idle characters.

enumerator kLPUART_IdleCharacter128
the number of idle characters.

enum _lpuart_interrupt_enable
LPUART interrupt configuration structure, default settings all disabled.

This structure contains the settings for all LPUART interrupt configurations.

Values:

enumerator kLPUART_LinBreakInterruptEnable
LIN break detect. bit 7

enumerator kLPUART_RxActiveEdgeInterruptEnable
Receive Active Edge. bit 6

enumerator kLPUART_TxDataRegEmptyInterruptEnable
Transmit data register empty. bit 23

enumerator kLPUART_TransmissionCompleteInterruptEnable
Transmission complete. bit 22

enumerator kLPUART_RxDataRegFullInterruptEnable
Receiver data register full. bit 21

enumerator kLPUART_IdleLineInterruptEnable
Idle line. bit 20

enumerator kLPUART_RxOverrunInterruptEnable
Receiver Overrun. bit 27

enumerator kLPUART_NoiseErrorInterruptEnable
Noise error flag. bit 26

enumerator kLPUART_FramingErrorInterruptEnable
Framing error flag. bit 25

enumerator kLPUART_ParityErrorInterruptEnable
Parity error flag. bit 24

enumerator kLPUART_Match1InterruptEnable
Parity error flag. bit 15

enumerator kLPUART_Match2InterruptEnable
Parity error flag. bit 14

enumerator kLPUART_TxFifoOverflowInterruptEnable
Transmit FIFO Overflow. bit 9

enumerator kLPUART_RxFifoUnderflowInterruptEnable
Receive FIFO Underflow. bit 8

enumerator kLPUART_AllInterruptEnable

enum _lpuart_flags
LPUART status flags.

This provides constants for the LPUART status flags for use in the LPUART functions.

Values:

enumerator kLPUART_TxDataRegEmptyFlag
Transmit data register empty flag, sets when transmit buffer is empty. bit 23

enumerator kLPUART_TransmissionCompleteFlag
Transmission complete flag, sets when transmission activity complete. bit 22

enumerator kLPUART_RxDataRegFullFlag
Receive data register full flag, sets when the receive data buffer is full. bit 21

enumerator kLPUART_IdleLineFlag
Idle line detect flag, sets when idle line detected. bit 20

enumerator kLPUART_RxOverrunFlag
Receive Overrun, sets when new data is received before data is read from receive register. bit 19

enumerator kLPUART_NoiseErrorFlag
Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets. bit 18

enumerator kLPUART_FramingErrorFlag
Frame error flag, sets if logic 0 was detected where stop bit expected. bit 17

enumerator kLPUART_ParityErrorFlag
If parity enabled, sets upon parity error detection. bit 16

enumerator kLPUART_LinBreakFlag
LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled. bit 31

enumerator kLPUART_RxActiveEdgeFlag
Receive pin active edge interrupt flag, sets when active edge detected. bit 30

enumerator kLPUART_RxActiveFlag
Receiver Active Flag (RAF), sets at beginning of valid start. bit 24

enumerator kLPUART_DataMatch1Flag
The next character to be read from LPUART_DATA matches MA1. bit 15

enumerator kLPUART_DataMatch2Flag
The next character to be read from LPUART_DATA matches MA2. bit 14

enumerator kLPUART_TxFifoEmptyFlag
TXEMPT bit, sets if transmit buffer is empty. bit 7

enumerator kLPUART_RxFifoEmptyFlag
RXEMPT bit, sets if receive buffer is empty. bit 6

enumerator kLPUART_TxFifoOverflowFlag
TXOF bit, sets if transmit buffer overflow occurred. bit 1

enumerator kLPUART_RxFifoUnderflowFlag
RXUF bit, sets if receive buffer underflow occurred. bit 0

enumerator kLPUART_AllClearFlags

enumerator kLPUART_AllFlags

typedef enum *_lpuart_parity_mode* lpuart_parity_mode_t
LPUART parity mode.

typedef enum *_lpuart_data_bits* lpuart_data_bits_t
LPUART data bits count.

typedef enum *_lpuart_stop_bit_count* lpuart_stop_bit_count_t
LPUART stop bit count.

typedef enum *_lpuart_transmit_cts_source* lpuart_transmit_cts_source_t
LPUART transmit CTS source.

typedef enum *_lpuart_transmit_cts_config* lpuart_transmit_cts_config_t
LPUART transmit CTS configure.

typedef enum *_lpuart_idle_type_select* lpuart_idle_type_select_t
LPUART idle flag type defines when the receiver starts counting.

typedef enum *_lpuart_idle_config* lpuart_idle_config_t
LPUART idle detected configuration. This structure defines the number of idle characters that must be received before the IDLE flag is set.

typedef struct *_lpuart_config* lpuart_config_t
LPUART configuration structure.

typedef struct *_lpuart_transfer* lpuart_transfer_t
LPUART transfer structure.

typedef struct *_lpuart_handle* lpuart_handle_t

typedef void (*lpuart_transfer_callback_t)(LPUART_Type *base, *lpuart_handle_t* *handle, *status_t* status, void *userData)
LPUART transfer callback function.

typedef void (*lpuart_isr_t)(LPUART_Type *base, void *handle)

void *s_lpuartHandle[]

const IRQn_Type s_lpuartTxIRQ[]

lpuart_isr_t s_lpuartIsr[]

UART_RETRY_TIMES
Retry times for waiting flag.

struct _lpuart_config
#include <fsl_lpuart.h> LPUART configuration structure.

Public Members

uint32_t baudRate_Bps
LPUART baud rate

lpuart_parity_mode_t parityMode
Parity mode, disabled (default), even, odd

lpuart_data_bits_t dataBitsCount
Data bits count, eight (default), seven

bool isMsb
Data bits order, LSB (default), MSB

lpuart_stop_bit_count_t stopBitCount
Number of stop bits, 1 stop bit (default) or 2 stop bits

uint8_t txFifoWatermark
TX FIFO watermark

uint8_t rxFifoWatermark
RX FIFO watermark

bool enableRxRTS
RX RTS enable

bool enableTxCTS
TX CTS enable

lpuart_transmit_cts_source_t txCtsSource
TX CTS source

lpuart_transmit_cts_config_t txCtsConfig
TX CTS configure

lpuart_idle_type_select_t rxIdleType
RX IDLE type.

lpuart_idle_config_t rxIdleConfig
RX IDLE configuration.

bool enableTx
Enable TX

bool enableRx
Enable RX

struct _lpuart_transfer
#include <fsl_lpuart.h> LPUART transfer structure.

Public Members

size_t dataSize
The byte count to be transfer.

struct _lpuart_handle
#include <fsl_lpuart.h> LPUART handle structure.

Public Members

volatile size_t txDataSize
Size of the remaining data to send.

size_t txDataSizeAll
Size of the data to send out.

volatile size_t rxDataSize
Size of the remaining data to receive.

size_t rxDataSizeAll
Size of the data to receive.

size_t rxRingBufferSize
Size of the ring buffer.

volatile uint16_t rxRingBufferHead
Index for the driver to store received data into ring buffer.

volatile uint16_t rxRingBufferTail
Index for the user to get data from the ring buffer.

lpuart_transfer_callback_t callback
Callback function.

void *userData
LPUART callback function parameter.

volatile uint8_t txState
TX transfer state.

volatile uint8_t rxState
RX transfer state.

bool isSevenDataBits
Seven data bits flag.

bool is16bitData
16bit data bits flag, only used for 9bit or 10bit data

union ___unnamed15___

Public Members

uint8_t *data
The buffer of data to be transfer.

uint8_t *rxData
The buffer to receive data.

uint16_t *rxData16
The buffer to receive data.

const uint8_t *txData
The buffer of data to be sent.

const uint16_t *txData16
The buffer of data to be sent.

union ___unnamed17___

Public Members

const uint8_t *volatile txData
Address of remaining data to send.

const uint16_t *volatile txData16
Address of remaining data to send.

union ___unnamed19___

Public Members

uint8_t *volatile rxData
Address of remaining data to receive.

uint16_t *volatile rxData16
Address of remaining data to receive.

union ___unnamed21___

Public Members

uint8_t *rxRingBuffer
Start address of the receiver ring buffer.

uint16_t *rxRingBuffer16
Start address of the receiver ring buffer.

2.38 MCM: Miscellaneous Control Module

FSL_MCM_DRIVER_VERSION
MCM driver version.

Enum _mcm_interrupt_flag. Interrupt status flag mask. .

Values:

enumerator kMCM_CacheWriteBuffer
Cache Write Buffer Error Enable.

enumerator kMCM_ParityError
Cache Parity Error Enable.

enumerator kMCM_FPUInvalidOperation
FPU Invalid Operation Interrupt Enable.

enumerator kMCM_FPUDivideByZero
FPU Divide-by-zero Interrupt Enable.

enumerator kMCM_FPUOverflow
FPU Overflow Interrupt Enable.

enumerator kMCM_FPUUnderflow
FPU Underflow Interrupt Enable.

enumerator kMCM_FPUInexact
FPU Inexact Interrupt Enable.

enumerator kMCM_FPUInputDenormalInterrupt
FPU Input Denormal Interrupt Enable.

typedef union *_mcm_buffer_fault_attribute* mcm_buffer_fault_attribute_t
The union of buffer fault attribute.

typedef union *_mcm_lmem_fault_attribute* mcm_lmem_fault_attribute_t
The union of LMEM fault attribute.

static inline void MCM_EnableCrossbarRoundRobin(MCM_Type *base, bool enable)
Enables/Disables crossbar round robin.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable crossbar round robin.
  - **true** Enable crossbar round robin.
  - **false** disable crossbar round robin.

static inline void MCM_EnableInterruptStatus(MCM_Type *base, uint32_t mask)
Enables the interrupt.

Parameters

- base – MCM peripheral base address.
- mask – Interrupt status flags mask(_mcm_interrupt_flag).

static inline void MCM_DisableInterruptStatus(MCM_Type *base, uint32_t mask)

Disables the interrupt.

Parameters

- base – MCM peripheral base address.
- mask – Interrupt status flags mask(_mcm_interrupt_flag).

static inline uint16_t MCM_GetInterruptStatus(MCM_Type *base)

Gets the Interrupt status .

Parameters

- base – MCM peripheral base address.

static inline void MCM_ClearCacheWriteBufferErroStatus(MCM_Type *base)

Clears the Interrupt status .

Parameters

- base – MCM peripheral base address.

static inline uint32_t MCM_GetBufferFaultAddress(MCM_Type *base)

Gets buffer fault address.

Parameters

- base – MCM peripheral base address.

static inline void MCM_GetBufferFaultAttribute(MCM_Type *base, *mcm_buffer_fault_attribute_t* *bufferfault)

Gets buffer fault attributes.

Parameters

- base – MCM peripheral base address.

static inline uint32_t MCM_GetBufferFaultData(MCM_Type *base)

Gets buffer fault data.

Parameters

- base – MCM peripheral base address.

static inline void MCM_LimitCodeCachePeripheralWriteBuffering(MCM_Type *base, bool enable)

Limit code cache peripheral write buffering.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable limit code cache peripheral write buffering.
  - **true** Enable limit code cache peripheral write buffering.
  - **false** disable limit code cache peripheral write buffering.

static inline void MCM_BypassFixedCodeCacheMap(MCM_Type *base, bool enable)

Bypass fixed code cache map.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable bypass fixed code cache map.
  - **true** Enable bypass fixed code cache map.
  - **false** disable bypass fixed code cache map.

static inline void MCM_EnableCodeBusCache(MCM_Type *base, bool enable)

Enables/Disables code bus cache.

Parameters

- base – MCM peripheral base address.
- enable – Used to disable/enable code bus cache.
  - **true** Enable code bus cache.
  - **false** disable code bus cache.

static inline void MCM_ForceCodeCacheToNoAllocation(MCM_Type *base, bool enable)

Force code cache to no allocation.

Parameters

- base – MCM peripheral base address.
- enable – Used to force code cache to allocation or no allocation.
  - **true** Force code cache to no allocation.
  - **false** Force code cache to allocation.

static inline void MCM_EnableCodeCacheWriteBuffer(MCM_Type *base, bool enable)

Enables/Disables code cache write buffer.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable code cache write buffer.
  - **true** Enable code cache write buffer.
  - **false** Disable code cache write buffer.

static inline void MCM_ClearCodeBusCache(MCM_Type *base)

Clear code bus cache.

Parameters

- base – MCM peripheral base address.

static inline void MCM_EnablePcParityFaultReport(MCM_Type *base, bool enable)

Enables/Disables PC Parity Fault Report.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable PC Parity Fault Report.
  - **true** Enable PC Parity Fault Report.
  - **false** disable PC Parity Fault Report.

static inline void MCM_EnablePcParity(MCM_Type *base, bool enable)

Enables/Disables PC Parity.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable PC Parity.
  - **true** Enable PC Parity.
  - **false** disable PC Parity.

static inline void MCM_LockConfigState(MCM_Type *base)

Lock the configuration state.

Parameters

- base – MCM peripheral base address.

static inline void MCM_EnableCacheParityReporting(MCM_Type *base, bool enable)

Enables/Disables cache parity reporting.

Parameters

- base – MCM peripheral base address.
- enable – Used to enable/disable cache parity reporting.
  - **true** Enable cache parity reporting.
  - **false** disable cache parity reporting.

static inline uint32_t MCM_GetLmemFaultAddress(MCM_Type *base)

Gets LMEM fault address.

Parameters

- base – MCM peripheral base address.

static inline void MCM_GetLmemFaultAttribute(MCM_Type *base, *mcm_lmem_fault_attribute_t* *lmemFault)

Get LMEM fault attributes.

Parameters

- base – MCM peripheral base address.

static inline uint64_t MCM_GetLmemFaultData(MCM_Type *base)

Gets LMEM fault data.

Parameters

- base – MCM peripheral base address.

MCM_LMFATR_TYPE_MASK

MCM_LMFATR_MODE_MASK

MCM_LMFATR_BUFF_MASK

MCM_LMFATR_CACH_MASK

MCM_ISCR_STAT_MASK

FSL_COMPONENT_ID

union _mcm_buffer_fault_attribute

#include <fsl_mcm.h> The union of buffer fault attribute.

Public Members

uint32_t attribute

Indicates the faulting attributes, when a properly-enabled cache write buffer error interrupt event is detected.

struct *_mcm_buffer_fault_attribute._mcm_buffer_fault_attribut* attribute_memory

struct _mcm_buffer_fault_attribut

#include <fsl_mcm.h>

Public Members

uint32_t busErrorDataAccessType
: Indicates the type of cache write buffer access.

uint32_t busErrorPrivilegeLevel
: Indicates the privilege level of the cache write buffer access.

uint32_t busErrorSize
: Indicates the size of the cache write buffer access.

uint32_t busErrorAccess
: Indicates the type of system bus access.

uint32_t busErrorMasterID
: Indicates the crossbar switch bus master number of the captured cache write buffer bus error.

uint32_t busErrorOverrun
: Indicates if another cache write buffer bus error is detected.

union __mcm__lmem__fault__attribute
: *#include <fsl_mcm.h>* The union of LMEM fault attribute.

Public Members

uint32_t attribute
: Indicates the attributes of the LMEM fault detected.

struct *_mcm_lmem_fault_attribute._mcm_lmem_fault_attribut* attribute__memory

struct __mcm__lmem__fault__attribut
: *#include <fsl_mcm.h>*

Public Members

uint32_t parityFaultProtectionSignal
: Indicates the features of parity fault protection signal.

uint32_t parityFaultMasterSize
: Indicates the parity fault master size.

uint32_t parityFaultWrite
: Indicates the parity fault is caused by read or write.

uint32_t backdoorAccess
: Indicates the LMEM access fault is initiated by core access or backdoor access.

uint32_t parityFaultSyndrome
: Indicates the parity fault syndrome.

uint32_t overrun
: Indicates the number of faultss.

2.39 PIT: Periodic Interrupt Timer

void PIT_Init(PIT_Type *base, const *pit_config_t* *config)

Ungates the PIT clock, enables the PIT module, and configures the peripheral for basic operations.

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

Parameters

- base – PIT peripheral base address
- config – Pointer to the user's PIT config structure

void PIT_Deinit(PIT_Type *base)

Gates the PIT clock and disables the PIT module.

Parameters

- base – PIT peripheral base address

static inline void PIT_GetDefaultConfig(*pit_config_t* *config)

Fills in the PIT configuration structure with the default settings.

The default values are as follows.

```
config->enableRunInDebug = false;
```

Parameters

- config – Pointer to the configuration structure.

static inline void PIT_SetTimerChainMode(PIT_Type *base, *pit_chnl_t* channel, bool enable)

Enables or disables chaining a timer with the previous timer.

When a timer has a chain mode enabled, it only counts after the previous timer has expired. If the timer n-1 has counted down to 0, counter n decrements the value by one. Each timer is 32-bits, which allows the developers to chain timers together and form a longer timer (64-bits and larger). The first timer (timer 0) can't be chained to any other timer.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number which is chained with the previous timer
- enable – Enable or disable chain. true: Current timer is chained with the previous timer. false: Timer doesn't chain with other timers.

static inline void PIT_EnableInterrupts(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Enables the selected PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- mask – The interrupts to enable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

static inline void PIT_DisableInterrupts(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Disables the selected PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

- mask – The interrupts to disable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

static inline uint32_t PIT_GetEnabledInterrupts(PIT_Type *base, *pit_chnl_t* channel)

Gets the enabled PIT interrupts.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns

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

static inline uint32_t PIT_GetStatusFlags(PIT_Type *base, *pit_chnl_t* channel)

Gets the PIT status flags.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns

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

static inline void PIT_ClearStatusFlags(PIT_Type *base, *pit_chnl_t* channel, uint32_t mask)

Clears the PIT status flags.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- mask – The status flags to clear. This is a logical OR of members of the enumeration pit_status_flags_t

static inline void PIT_SetTimerPeriod(PIT_Type *base, *pit_chnl_t* channel, uint32_t count)

Sets the timer period in units of count.

Timers begin counting from the value set by this function until it reaches 0, then it generates an interrupt and load this register value again. Writing a new value to this register does not restart the timer. Instead, the value is loaded after the timer expires.

Note: Users can call the utility macros provided in fsl_common.h to convert to ticks.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number
- count – Timer period in units of ticks

static inline uint32_t PIT_GetCurrentTimerCount(PIT_Type *base, *pit_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: Users can call the utility macros provided in fsl_common.h to convert ticks to usec or msec.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number

Returns
Current timer counting value in ticks

static inline void PIT_StartTimer(PIT_Type *base, *pit_chnl_t* channel)

Starts the timer counting.

After calling this function, timers load period value, count down to 0 and then load the respective start value again. Each time a timer reaches 0, it generates a trigger pulse and sets the timeout interrupt flag.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number.

static inline void PIT_StopTimer(PIT_Type *base, *pit_chnl_t* channel)

Stops the timer counting.

This function stops every timer counting. Timers reload their periods respectively after the next time they call the PIT_DRV_StartTimer.

Parameters

- base – PIT peripheral base address
- channel – Timer channel number.

FSL_PIT_DRIVER_VERSION

PIT Driver Version 2.2.0.

enum _pit_chnl

List of PIT channels.

Note: Actual number of available channels is SoC dependent

Values:

enumerator kPIT_Chnl_0

PIT channel number 0

enumerator kPIT_Chnl_1

PIT channel number 1

enumerator kPIT_Chnl_2

PIT channel number 2

enumerator kPIT_Chnl_3

PIT channel number 3

enum _pit_interrupt_enable

List of PIT interrupts.

Values:

enumerator kPIT_TimerInterruptEnable

Timer interrupt enable

enum _pit_status_flags

List of PIT status flags.

Values:

enumerator kPIT_TimerFlag

Timer flag

typedef enum *_pit_chnl* pit_chnl_t

List of PIT channels.

Note: Actual number of available channels is SoC dependent

typedef enum *_pit_interrupt_enable* pit_interrupt_enable_t

List of PIT interrupts.

typedef enum *_pit_status_flags* pit_status_flags_t

List of PIT status flags.

typedef struct *_pit_config* pit_config_t

PIT configuration structure.

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

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

uint64_t PIT_GetLifetimeTimerCount(PIT_Type *base)

Reads the current lifetime counter value.

The lifetime timer is a 64-bit timer which chains timer 0 and timer 1 together. Timer 0 and 1 are chained by calling the PIT_SetTimerChainMode before using this timer. The period of lifetime timer is equal to the "period of timer 0 * period of timer 1". For the 64-bit value, the higher 32-bit has the value of timer 1, and the lower 32-bit has the value of timer 0.

Parameters

- base – PIT peripheral base address

Returns

Current lifetime timer value

struct _pit_config

#include <fsl_pit.h> PIT configuration structure.

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

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

Public Members

bool enableRunInDebug

true: Timers run in debug mode; false: Timers stop in debug mode

2.40 PMC: Power Management Controller

static inline void PMC_GetVersionId(PMC_Type *base, *pmc_version_id_t* *versionId)

Gets the PMC version ID.

This function gets the PMC version ID, including major version number, minor version number, and a feature specification number.

Parameters

- base – PMC peripheral base address.
- versionId – Pointer to version ID structure.

void PMC_GetParam(PMC_Type *base, *pmc_param_t* *param)

Gets the PMC parameter.

This function gets the PMC parameter including the VLPO enable and the HVD enable.

Parameters

- base – PMC peripheral base address.
- param – Pointer to PMC param structure.

void PMC_ConfigureLowVoltDetect(PMC_Type *base, const *pmc_low_volt_detect_config_t* *config)

Configures the low-voltage detect setting.

This function configures the low-voltage detect setting, including the trip point voltage setting, enables or disables the interrupt, enables or disables the system reset.

Parameters

- base – PMC peripheral base address.
- config – Low-voltage detect configuration structure.

static inline bool PMC_GetLowVoltDetectFlag(PMC_Type *base)

Gets the Low-voltage Detect Flag status.

This function reads the current LVDF status. If it returns 1, a low-voltage event is detected.

Parameters

- base – PMC peripheral base address.

Returns

Current low-voltage detect flag

- true: Low-voltage detected
- false: Low-voltage not detected

static inline void PMC_ClearLowVoltDetectFlag(PMC_Type *base)

Acknowledges clearing the Low-voltage Detect flag.

This function acknowledges the low-voltage detection errors (write 1 to clear LVDF).

Parameters

- base – PMC peripheral base address.

void PMC_ConfigureLowVoltWarning(PMC_Type *base, const *pmc_low_volt_warning_config_t* *config)

Configures the low-voltage warning setting.

This function configures the low-voltage warning setting, including the trip point voltage setting and enabling or disabling the interrupt.

Parameters

- base – PMC peripheral base address.

- config – Low-voltage warning configuration structure.

static inline bool PMC_GetLowVoltWarningFlag(PMC_Type *base)

Gets the Low-voltage Warning Flag status.

This function polls the current LVWF status. When 1 is returned, it indicates a low-voltage warning event. LVWF is set when V Supply transitions below the trip point or after reset and V Supply is already below the V LVW.

Parameters

- base – PMC peripheral base address.

Returns

Current LVWF status

- true: Low-voltage Warning Flag is set.
- false: the Low-voltage Warning does not happen.

static inline void PMC_ClearLowVoltWarningFlag(PMC_Type *base)

Acknowledges the Low-voltage Warning flag.

This function acknowledges the low voltage warning errors (write 1 to clear LVWF).

Parameters

- base – PMC peripheral base address.

void PMC_ConfigureHighVoltDetect(PMC_Type *base, const *pmc_high_volt_detect_config_t* *config)

Configures the high-voltage detect setting.

This function configures the high-voltage detect setting, including the trip point voltage setting, enabling or disabling the interrupt, enabling or disabling the system reset.

Parameters

- base – PMC peripheral base address.
- config – High-voltage detect configuration structure.

static inline bool PMC_GetHighVoltDetectFlag(PMC_Type *base)

Gets the High-voltage Detect Flag status.

This function reads the current HVDF status. If it returns 1, a low voltage event is detected.

Parameters

- base – PMC peripheral base address.

Returns

Current high-voltage detect flag

- true: High-voltage detected
- false: High-voltage not detected

static inline void PMC_ClearHighVoltDetectFlag(PMC_Type *base)

Acknowledges clearing the High-voltage Detect flag.

This function acknowledges the high-voltage detection errors (write 1 to clear HVDF).

Parameters

- base – PMC peripheral base address.

void PMC_ConfigureBandgapBuffer(PMC_Type *base, const *pmc_bandgap_buffer_config_t* *config)

Configures the PMC bandgap.

This function configures the PMC bandgap, including the drive select and behavior in low-power mode.

Parameters

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

static inline bool PMC_GetPeriphIOIsolationFlag(PMC_Type *base)

Gets the acknowledge Peripherals and I/O pads isolation flag.

This function reads the Acknowledge Isolation setting that indicates whether certain peripherals and the I/O pads are in a latched state as a result of having been in the VLLS mode.

Parameters

- base – PMC peripheral base address.
- base – Base address for current PMC instance.

Returns

ACK isolation 0 - Peripherals and I/O pads are in a normal run state. 1 - Certain peripherals and I/O pads are in an isolated and latched state.

static inline void PMC_ClearPeriphIOIsolationFlag(PMC_Type *base)

Acknowledges the isolation flag to Peripherals and I/O pads.

This function clears the ACK Isolation flag. Writing one to this setting when it is set releases the I/O pads and certain peripherals to their normal run mode state.

Parameters

- base – PMC peripheral base address.

static inline bool PMC_IsRegulatorInRunRegulation(PMC_Type *base)

Gets the regulator regulation status.

This function returns the regulator to run a regulation status. It provides the current status of the internal voltage regulator.

Parameters

- base – PMC peripheral base address.
- base – Base address for current PMC instance.

Returns

Regulation status 0 - Regulator is in a stop regulation or in transition to/from the regulation. 1 - Regulator is in a run regulation.

FSL_PMC_DRIVER_VERSION

PMC driver version.

Version 2.0.3.

enum _pmc_low_volt_detect_volt_select

Low-voltage Detect Voltage Select.

Values:

enumerator kPMC_LowVoltDetectLowTrip

Low-trip point selected (VLVD = VLVDL)

enumerator kPMC_LowVoltDetectHighTrip
High-trip point selected (VLVD = VLVDH)

enum _pmc_low_volt_warning_volt_select
Low-voltage Warning Voltage Select.

Values:

enumerator kPMC_LowVoltWarningLowTrip
Low-trip point selected (VLVW = VLVW1)

enumerator kPMC_LowVoltWarningMid1Trip
Mid 1 trip point selected (VLVW = VLVW2)

enumerator kPMC_LowVoltWarningMid2Trip
Mid 2 trip point selected (VLVW = VLVW3)

enumerator kPMC_LowVoltWarningHighTrip
High-trip point selected (VLVW = VLVW4)

enum _pmc_high_volt_detect_volt_select
High-voltage Detect Voltage Select.

Values:

enumerator kPMC_HighVoltDetectLowTrip
Low-trip point selected (VHVD = VHVDL)

enumerator kPMC_HighVoltDetectHighTrip
High-trip point selected (VHVD = VHVDH)

enum _pmc_bandgap_buffer_drive_select
Bandgap Buffer Drive Select.

Values:

enumerator kPMC_BandgapBufferDriveLow
Low-drive.

enumerator kPMC_BandgapBufferDriveHigh
High-drive.

enum _pmc_vlp_freq_option
VLPx Option.

Values:

enumerator kPMC_FreqRestrict
Frequency is restricted in VLPx mode.

enumerator kPMC_FreqUnrestrict
Frequency is unrestricted in VLPx mode.

typedef enum *_pmc_low_volt_detect_volt_select* pmc_low_volt_detect_volt_select_t
Low-voltage Detect Voltage Select.

typedef enum *_pmc_low_volt_warning_volt_select* pmc_low_volt_warning_volt_select_t
Low-voltage Warning Voltage Select.

typedef enum *_pmc_high_volt_detect_volt_select* pmc_high_volt_detect_volt_select_t
High-voltage Detect Voltage Select.

typedef enum *_pmc_bandgap_buffer_drive_select* pmc_bandgap_buffer_drive_select_t
Bandgap Buffer Drive Select.

typedef enum *_pmc_vlp_freq_option* pmc_vlp_freq_mode_t
VLPx Option.

typedef struct *_pmc_version_id* pmc_version_id_t
IP version ID definition.

typedef struct *_pmc_param* pmc_param_t
IP parameter definition.

typedef struct *_pmc_low_volt_detect_config* pmc_low_volt_detect_config_t
Low-voltage Detect Configuration Structure.

typedef struct *_pmc_low_volt_warning_config* pmc_low_volt_warning_config_t
Low-voltage Warning Configuration Structure.

typedef struct *_pmc_high_volt_detect_config* pmc_high_volt_detect_config_t
High-voltage Detect Configuration Structure.

typedef struct *_pmc_bandgap_buffer_config* pmc_bandgap_buffer_config_t
Bandgap Buffer configuration.

struct _pmc_version_id
#include <fsl_pmc.h> IP version ID definition.

Public Members

uint16_t feature
Feature Specification Number.

uint8_t minor
Minor version number.

uint8_t major
Major version number.

struct _pmc_param
#include <fsl_pmc.h> IP parameter definition.

Public Members

bool vlpoEnable
VLPO enable.

bool hvdEnable
HVD enable.

struct _pmc_low_volt_detect_config
#include <fsl_pmc.h> Low-voltage Detect Configuration Structure.

Public Members

bool enableInt
Enable interrupt when Low-voltage detect

bool enableReset
Enable system reset when Low-voltage detect

pmc_low_volt_detect_volt_select_t voltSelect
Low-voltage detect trip point voltage selection

struct _pmc_low_volt_warning_config
#include <fsl_pmc.h> Low-voltage Warning Configuration Structure.

Public Members

bool enableInt
Enable interrupt when low-voltage warning

pmc_low_volt_warning_volt_select_t voltSelect
Low-voltage warning trip point voltage selection

struct _pmc_high_volt_detect_config
#include <fsl_pmc.h> High-voltage Detect Configuration Structure.

Public Members

bool enableInt
Enable interrupt when high-voltage detect

bool enableReset
Enable system reset when high-voltage detect

pmc_high_volt_detect_volt_select_t voltSelect
High-voltage detect trip point voltage selection

struct _pmc_bandgap_buffer_config
#include <fsl_pmc.h> Bandgap Buffer configuration.

Public Members

bool enable
Enable bandgap buffer.

bool enableInLowPowerMode
Enable bandgap buffer in low-power mode.

pmc_bandgap_buffer_drive_select_t drive
Bandgap buffer drive select.

2.41 PORT: Port Control and Interrupts

static inline void PORT_SetPinConfig(PORT_Type *base, uint32_t pin, const *port_pin_config_t* *config)
Sets the port PCR register.

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

```
// Define a digital input pin PCR configuration
port_pin_config_t config = {
    kPORT_PullUp,
    kPORT_FastSlewRate,
    kPORT_PassiveFilterDisable,
    kPORT_OpenDrainDisable,
    kPORT_LowDriveStrength,
    kPORT_MuxAsGpio,
    kPORT_UnLockRegister,
};
```

Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.
- config – PORT PCR register configuration structure.

static inline void PORT_SetMultiplePinsConfig(PORT_Type *base, uint32_t mask, const *port_pin_config_t* *config)

Sets the port PCR register for multiple pins.

This is an example to define input pins or output pins PCR configuration.

```
Define a digital input pin PCR configuration
port_pin_config_t config = {
    kPORT_PullUp ,
    kPORT_PullEnable,
    kPORT_FastSlewRate,
    kPORT_PassiveFilterDisable,
    kPORT_OpenDrainDisable,
    kPORT_LowDriveStrength,
    kPORT_MuxAsGpio,
    kPORT_UnlockRegister,
};
```

Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- config – PORT PCR register configuration structure.

static inline void PORT_SetMultipleInterruptPinsConfig(PORT_Type *base, uint32_t mask, *port_interrupt_t* config)

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

Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- config – PORT pin interrupt configuration.
  - kPORT_InterruptOrDMADisabled: Interrupt/DMA request disabled.
  - kPORT_DMARisingEdge : DMA request on rising edge(if the DMA requests exit).
  - kPORT_DMAFallingEdge: DMA request on falling edge(if the DMA requests exit).
  - kPORT_DMAEitherEdge : DMA request on either edge(if the DMA requests exit).
  - kPORT_FlagRisingEdge : Flag sets on rising edge(if the Flag states exit).
  - kPORT_FlagFallingEdge : Flag sets on falling edge(if the Flag states exit).
  - kPORT_FlagEitherEdge : Flag sets on either edge(if the Flag states exit).
  - kPORT_InterruptLogicZero : Interrupt when logic zero.
  - kPORT_InterruptRisingEdge : Interrupt on rising edge.
  - kPORT_InterruptFallingEdge: Interrupt on falling edge.
  - kPORT_InterruptEitherEdge : Interrupt on either edge.

- kPORT_InterruptLogicOne : Interrupt when logic one.
- kPORT_ActiveHighTriggerOutputEnable : Enable active high-trigger output (if the trigger states exit).
- kPORT_ActiveLowTriggerOutputEnable : Enable active low-trigger output (if the trigger states exit)..

static inline void PORT_SetPinMux(PORT_Type *base, uint32_t pin, *port_mux_t* mux)

Configures the pin muxing.

Note: : This function is NOT recommended to use together with the PORT_SetPinsConfig, because the PORT_SetPinsConfig need to configure the pin mux anyway (Otherwise the pin mux is reset to zero : kPORT_PinDisabledOrAnalog). This function is recommended to use to reset the pin mux

---

Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.
- mux – pin muxing slot selection.
  - kPORT_PinDisabledOrAnalog: Pin disabled or work in analog function.
  - kPORT_MuxAsGpio : Set as GPIO.
  - kPORT_MuxAlt2 : chip-specific.
  - kPORT_MuxAlt3 : chip-specific.
  - kPORT_MuxAlt4 : chip-specific.
  - kPORT_MuxAlt5 : chip-specific.
  - kPORT_MuxAlt6 : chip-specific.
  - kPORT_MuxAlt7 : chip-specific.

static inline void PORT_EnablePinsDigitalFilter(PORT_Type *base, uint32_t mask, bool enable)

Enables the digital filter in one port, each bit of the 32-bit register represents one pin.

Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.
- enable – PORT digital filter configuration.

static inline void PORT_SetDigitalFilterConfig(PORT_Type *base, const *port_digital_filter_config_t* *config)

Sets the digital filter in one port, each bit of the 32-bit register represents one pin.

Parameters

- base – PORT peripheral base pointer.
- config – PORT digital filter configuration structure.

static inline void PORT_SetPinInterruptConfig(PORT_Type *base, uint32_t pin, *port_interrupt_t* config)

Configures the port pin interrupt/DMA request.

Parameters

- base – PORT peripheral base pointer.

- pin – PORT pin number.
- config – PORT pin interrupt configuration.
  - kPORT_InterruptOrDMADisabled: Interrupt/DMA request disabled.
  - kPORT_DMARisingEdge : DMA request on rising edge(if the DMA requests exit).
  - kPORT_DMAFallingEdge: DMA request on falling edge(if the DMA requests exit).
  - kPORT_DMAEitherEdge : DMA request on either edge(if the DMA requests exit).
  - kPORT_FlagRisingEdge : Flag sets on rising edge(if the Flag states exit).
  - kPORT_FlagFallingEdge : Flag sets on falling edge(if the Flag states exit).
  - kPORT_FlagEitherEdge : Flag sets on either edge(if the Flag states exit).
  - kPORT_InterruptLogicZero : Interrupt when logic zero.
  - kPORT_InterruptRisingEdge : Interrupt on rising edge.
  - kPORT_InterruptFallingEdge: Interrupt on falling edge.
  - kPORT_InterruptEitherEdge : Interrupt on either edge.
  - kPORT_InterruptLogicOne : Interrupt when logic one.
  - kPORT_ActiveHighTriggerOutputEnable : Enable active high-trigger output (if the trigger states exit).
  - kPORT_ActiveLowTriggerOutputEnable : Enable active low-trigger output (if the trigger states exit).

static inline void PORT_SetPinDriveStrength(PORT_Type *base, uint32_t pin, uint8_t strength)

Configures the port pin drive strength.

Parameters

- base – PORT peripheral base pointer.
- pin – PORT pin number.
- strength – PORT pin drive strength
  - kPORT_LowDriveStrength = 0U - Low-drive strength is configured.
  - kPORT_HighDriveStrength = 1U - High-drive strength is configured.

static inline uint32_t PORT_GetPinsInterruptFlags(PORT_Type *base)

Reads the whole port status flag.

If a pin is configured to generate the DMA request, the corresponding flag is cleared automatically at the completion of the requested DMA transfer. Otherwise, the flag remains set until a logic one is written to that flag. If configured for a level sensitive interrupt that remains asserted, the flag is set again immediately.

Parameters

- base – PORT peripheral base pointer.

Returns

Current port interrupt status flags, for example, 0x00010001 means the pin 0 and 16 have the interrupt.

static inline void PORT_ClearPinsInterruptFlags(PORT_Type *base, uint32_t mask)

Clears the multiple pin interrupt status flag.

Parameters

- base – PORT peripheral base pointer.
- mask – PORT pin number macro.

FSL_PORT_DRIVER_VERSION
PORT driver version.

enum _port_pull
Internal resistor pull feature selection.

Values:

enumerator kPORT_PullDisable
Internal pull-up/down resistor is disabled.

enumerator kPORT_PullDown
Internal pull-down resistor is enabled.

enumerator kPORT_PullUp
Internal pull-up resistor is enabled.

enum _port_slew_rate
Slew rate selection.

Values:

enumerator kPORT_FastSlewRate
Fast slew rate is configured.

enumerator kPORT_SlowSlewRate
Slow slew rate is configured.

enum _port_open_drain_enable
Open Drain feature enable/disable.

Values:

enumerator kPORT_OpenDrainDisable
Open drain output is disabled.

enumerator kPORT_OpenDrainEnable
Open drain output is enabled.

enum _port_passive_filter_enable
Passive filter feature enable/disable.

Values:

enumerator kPORT_PassiveFilterDisable
Passive input filter is disabled.

enumerator kPORT_PassiveFilterEnable
Passive input filter is enabled.

enum _port_drive_strength
Configures the drive strength.

Values:

enumerator kPORT_LowDriveStrength
Low-drive strength is configured.

enumerator kPORT_HighDriveStrength
High-drive strength is configured.

enum _port_lock_register

Unlock/lock the pin control register field[15:0].

Values:

enumerator kPORT_UnlockRegister

Pin Control Register fields [15:0] are not locked.

enumerator kPORT_LockRegister

Pin Control Register fields [15:0] are locked.

enum _port_mux

Pin mux selection.

Values:

enumerator kPORT_PinDisabledOrAnalog

Corresponding pin is disabled, but is used as an analog pin.

enumerator kPORT_MuxAsGpio

Corresponding pin is configured as GPIO.

enumerator kPORT_MuxAlt0

Chip-specific

enumerator kPORT_MuxAlt1

Chip-specific

enumerator kPORT_MuxAlt2

Chip-specific

enumerator kPORT_MuxAlt3

Chip-specific

enumerator kPORT_MuxAlt4

Chip-specific

enumerator kPORT_MuxAlt5

Chip-specific

enumerator kPORT_MuxAlt6

Chip-specific

enumerator kPORT_MuxAlt7

Chip-specific

enumerator kPORT_MuxAlt8

Chip-specific

enumerator kPORT_MuxAlt9

Chip-specific

enumerator kPORT_MuxAlt10

Chip-specific

enumerator kPORT_MuxAlt11

Chip-specific

enumerator kPORT_MuxAlt12

Chip-specific

enumerator kPORT_MuxAlt13

Chip-specific

enumerator kPORT_MuxAlt14
Chip-specific

enumerator kPORT_MuxAlt15
Chip-specific

enum _port_interrupt
Configures the interrupt generation condition.

Values:

enumerator kPORT_InterruptOrDMADisabled
Interrupt/DMA request is disabled.

enumerator kPORT_DMARisingEdge
DMA request on rising edge.

enumerator kPORT_DMAFallingEdge
DMA request on falling edge.

enumerator kPORT_DMAEitherEdge
DMA request on either edge.

enumerator kPORT_FlagRisingEdge
Flag sets on rising edge.

enumerator kPORT_FlagFallingEdge
Flag sets on falling edge.

enumerator kPORT_FlagEitherEdge
Flag sets on either edge.

enumerator kPORT_InterruptLogicZero
Interrupt when logic zero.

enumerator kPORT_InterruptRisingEdge
Interrupt on rising edge.

enumerator kPORT_InterruptFallingEdge
Interrupt on falling edge.

enumerator kPORT_InterruptEitherEdge
Interrupt on either edge.

enumerator kPORT_InterruptLogicOne
Interrupt when logic one.

enumerator kPORT_ActiveHighTriggerOutputEnable
Enable active high-trigger output.

enumerator kPORT_ActiveLowTriggerOutputEnable
Enable active low-trigger output.

enum _port_digital_filter_clock_source
Digital filter clock source selection.

Values:

enumerator kPORT_BusClock
Digital filters are clocked by the bus clock.

enumerator kPORT_LpoClock
Digital filters are clocked by the 1 kHz LPO clock.

typedef enum *_port_mux* port_mux_t
Pin mux selection.

typedef enum *_port_interrupt* port_interrupt_t
Configures the interrupt generation condition.

typedef enum *_port_digital_filter_clock_source* port_digital_filter_clock_source_t
Digital filter clock source selection.

typedef struct *_port_digital_filter_config* port_digital_filter_config_t
PORT digital filter feature configuration definition.

typedef struct *_port_pin_config* port_pin_config_t
PORT pin configuration structure.

FSL_COMPONENT_ID

struct _port_digital_filter_config
#include <fsl_port.h> PORT digital filter feature configuration definition.

Public Members

uint32_t digitalFilterWidth
Set digital filter width

port_digital_filter_clock_source_t clockSource
Set digital filter clockSource

struct _port_pin_config
#include <fsl_port.h> PORT pin configuration structure.

Public Members

uint16_t pullSelect
No-pull/pull-down/pull-up select

uint16_t slewRate
Fast/slow slew rate Configure

uint16_t passiveFilterEnable
Passive filter enable/disable

uint16_t openDrainEnable
Open drain enable/disable

uint16_t driveStrength
Fast/slow drive strength configure

uint16_t lockRegister
Lock/unlock the PCR field[15:0]

2.42 RCM: Reset Control Module Driver

static inline void RCM_GetVersionId(RCM_Type *base, *rcm_version_id_t* *versionId)
Gets the RCM version ID.

This function gets the RCM version ID including the major version number, the minor version number, and the feature specification number.

Parameters

- base – RCM peripheral base address.
- versionId – Pointer to the version ID structure.

static inline uint32_t RCM_GetResetSourceImplementedStatus(RCM_Type *base)

Gets the reset source implemented status.

This function gets the RCM parameter that indicates whether the corresponding reset source is implemented. Use source masks defined in the rcm_reset_source_t to get the desired source status.

This is an example.

```
uint32_t status;

To test whether the MCU is reset using Watchdog.
status = RCM_GetResetSourceImplementedStatus(RCM) & (kRCM_SourceWdog | kRCM_SourcePin);
```

Parameters

- base – RCM peripheral base address.

Returns

All reset source implemented status bit map.

static inline uint32_t RCM_GetPreviousResetSources(RCM_Type *base)

Gets the reset source status which caused a previous reset.

This function gets the current reset source status. Use source masks defined in the rcm_reset_source_t to get the desired source status.

This is an example.

```
uint32_t resetStatus;

To get all reset source statuses.
resetStatus = RCM_GetPreviousResetSources(RCM) & kRCM_SourceAll;

To test whether the MCU is reset using Watchdog.
resetStatus = RCM_GetPreviousResetSources(RCM) & kRCM_SourceWdog;

To test multiple reset sources.
resetStatus = RCM_GetPreviousResetSources(RCM) & (kRCM_SourceWdog | kRCM_SourcePin);
```

Parameters

- base – RCM peripheral base address.

Returns

All reset source status bit map.

static inline uint32_t RCM_GetStickyResetSources(RCM_Type *base)

Gets the sticky reset source status.

This function gets the current reset source status that has not been cleared by software for a specific source.

This is an example.

```
uint32_t resetStatus;

To get all reset source statuses.
resetStatus = RCM_GetStickyResetSources(RCM) & kRCM_SourceAll;
```

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```
To test whether the MCU is reset using Watchdog.
resetStatus = RCM_GetStickyResetSources(RCM) & kRCM_SourceWdog;

To test multiple reset sources.
resetStatus = RCM_GetStickyResetSources(RCM) & (kRCM_SourceWdog | kRCM_SourcePin);
```

Parameters

- base – RCM peripheral base address.

Returns

All reset source status bit map.

static inline void RCM_ClearStickyResetSources(RCM_Type *base, uint32_t sourceMasks)

Clears the sticky reset source status.

This function clears the sticky system reset flags indicated by source masks.

This is an example.

```
Clears multiple reset sources.
RCM_ClearStickyResetSources(kRCM_SourceWdog | kRCM_SourcePin);
```

Parameters

- base – RCM peripheral base address.
- sourceMasks – reset source status bit map

void RCM_ConfigureResetPinFilter(RCM_Type *base, const *rcm_reset_pin_filter_config_t* *config)

Configures the reset pin filter.

This function sets the reset pin filter including the filter source, filter width, and so on.

Parameters

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

static inline bool RCM_GetEasyPortModePinStatus(RCM_Type *base)

Gets the EZP_MS_B pin assert status.

This function gets the easy port mode status (EZP_MS_B) pin assert status.

Parameters

- base – RCM peripheral base address.

Returns

status true - asserted, false - reasserted

static inline *rcm_boot_rom_config_t* RCM_GetBootRomSource(RCM_Type *base)

Gets the ROM boot source.

This function gets the ROM boot source during the last chip reset.

Parameters

- base – RCM peripheral base address.

Returns

The ROM boot source.

static inline void RCM_ClearBootRomSource(RCM_Type *base)

Clears the ROM boot source flag.

This function clears the ROM boot source flag.

Parameters

- base – Register base address of RCM

void RCM_SetForceBootRomSource(RCM_Type *base, *rcm_boot_rom_config_t* config)

Forces the boot from ROM.

This function forces booting from ROM during all subsequent system resets.

Parameters

- base – RCM peripheral base address.
- config – Boot configuration.

static inline void RCM_SetSystemResetInterruptConfig(RCM_Type *base, uint32_t intMask, *rcm_reset_delay_t* delay)

Sets the system reset interrupt configuration.

For a graceful shut down, the RCM supports delaying the assertion of the system reset for a period of time when the reset interrupt is generated. This function can be used to enable the interrupt and the delay period. The interrupts are passed in as bit mask. See rcm_int_t for details. For example, to delay a reset for 512 LPO cycles after the WDOG timeout or loss-of-clock occurs, configure as follows: RCM_SetSystemResetInterruptConfig(kRCM_IntWatchDog | kRCM_IntLossOfClk, kRCM_ResetDelay512Lpo);

Parameters

- base – RCM peripheral base address.
- intMask – Bit mask of the system reset interrupts to enable. See rcm_interrupt_enable_t for details.
- delay – Bit mask of the system reset interrupts to enable.

FSL_RCM_DRIVER_VERSION

RCM driver version 2.0.4.

enum _rcm_reset_source

System Reset Source Name definitions.

Values:

enumerator kRCM_SourceWakeup

Low-leakage wakeup reset

enumerator kRCM_SourceLvd

Low-voltage detect reset

enumerator kRCM_SourceLoc

Loss of clock reset

enumerator kRCM_SourceLol

Loss of lock reset

enumerator kRCM_SourceWdog

Watchdog reset

enumerator kRCM_SourcePin

External pin reset

enumerator kRCM_SourcePor
Power on reset

enumerator kRCM_SourceJtag
JTAG generated reset

enumerator kRCM_SourceLockup
Core lock up reset

enumerator kRCM_SourceSw
Software reset

enumerator kRCM_SourceMdmap
MDM-AP system reset

enumerator kRCM_SourceEzpt
EzPort reset

enumerator kRCM_SourceSackerr
Parameter could get all reset flags

enumerator kRCM_SourceAll

enum _rcm_run_wait_filter_mode
Reset pin filter select in Run and Wait modes.

Values:

enumerator kRCM_FilterDisable
All filtering disabled

enumerator kRCM_FilterBusClock
Bus clock filter enabled

enumerator kRCM_FilterLpoClock
LPO clock filter enabled

enum _rcm_boot_rom_config
Boot from ROM configuration.

Values:

enumerator kRCM_BootFlash
Boot from flash

enumerator kRCM_BootRomCfg0
Boot from boot ROM due to BOOTCFG0

enumerator kRCM_BootRomFopt
Boot from boot ROM due to FOPT[7]

enumerator kRCM_BootRomBoth
Boot from boot ROM due to both BOOTCFG0 and FOPT[7]

enum _rcm_reset_delay
Maximum delay time from interrupt asserts to system reset.

Values:

enumerator kRCM_ResetDelay8Lpo
Delay 8 LPO cycles.

enumerator kRCM_ResetDelay32Lpo
Delay 32 LPO cycles.

enumerator kRCM_ResetDelay128Lpo
Delay 128 LPO cycles.

enumerator kRCM_ResetDelay512Lpo
Delay 512 LPO cycles.

enum _rcm_interrupt_enable
System reset interrupt enable bit definitions.

Values:

enumerator kRCM_IntNone
No interrupt enabled.

enumerator kRCM_IntLossOfClk
Loss of clock interrupt.

enumerator kRCM_IntLossOfLock
Loss of lock interrupt.

enumerator kRCM_IntWatchDog
Watch dog interrupt.

enumerator kRCM_IntExternalPin
External pin interrupt.

enumerator kRCM_IntGlobal
Global interrupts.

enumerator kRCM_IntCoreLockup
Core lock up interrupt

enumerator kRCM_IntSoftware
software interrupt

enumerator kRCM_IntStopModeAckErr
Stop mode ACK error interrupt.

enumerator kRCM_IntCore1
Core 1 interrupt.

enumerator kRCM_IntAll
Enable all interrupts.

typedef enum *_rcm_reset_source* rcm_reset_source_t
System Reset Source Name definitions.

typedef enum *_rcm_run_wait_filter_mode* rcm_run_wait_filter_mode_t
Reset pin filter select in Run and Wait modes.

typedef enum *_rcm_boot_rom_config* rcm_boot_rom_config_t
Boot from ROM configuration.

typedef enum *_rcm_reset_delay* rcm_reset_delay_t
Maximum delay time from interrupt asserts to system reset.

typedef enum *_rcm_interrupt_enable* rcm_interrupt_enable_t
System reset interrupt enable bit definitions.

typedef struct *_rcm_version_id* rcm_version_id_t
IP version ID definition.

typedef struct *_rcm_reset_pin_filter_config* rcm_reset_pin_filter_config_t
Reset pin filter configuration.

struct _rcm_version_id
#include <fsl_rcm.h> IP version ID definition.

Public Members

uint16_t feature
Feature Specification Number.

uint8_t minor
Minor version number.

uint8_t major
Major version number.

struct _rcm_reset_pin_filter_config
#include <fsl_rcm.h> Reset pin filter configuration.

Public Members

bool enableFilterInStop
Reset pin filter select in stop mode.

rcm_run_wait_filter_mode_t filterInRunWait
Reset pin filter in run/wait mode.

uint8_t busClockFilterCount
Reset pin bus clock filter width.

2.43 RTC: Real Time Clock

void RTC_Init(RTC_Type *base, const *rtc_config_t* *config)
Ungates the RTC clock and configures the peripheral for basic operation.

This function issues a software reset if the timer invalid flag is set.

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

Parameters

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

static inline void RTC_Deinit(RTC_Type *base)
Stops the timer and gate the RTC clock.

Parameters

- base – RTC peripheral base address

void RTC_GetDefaultConfig(*rtc_config_t* *config)

Fills in the RTC config struct with the default settings.

The default values are as follows.

```
config->wakeupSelect = false;
config->updateMode = false;
config->supervisorAccess = false;
config->compensationInterval = 0;
config->compensationTime = 0;
```

Parameters

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

status_t RTC_SetDatetime(RTC_Type *base, const *rtc_datetime_t* *datetime)

Sets the RTC date and time according to the given time structure.

The RTC counter must be stopped prior to calling this function because writes to the RTC seconds register fail if the RTC counter is running.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the RTC kStatus_InvalidArgument: Error because the datetime format is incorrect

void RTC_GetDatetime(RTC_Type *base, *rtc_datetime_t* *datetime)

Gets the RTC time and stores it in the given time structure.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to the structure where the date and time details are stored.

status_t RTC_SetAlarm(RTC_Type *base, const *rtc_datetime_t* *alarmTime)

Sets the RTC alarm time.

The function checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error.

Parameters

- base – RTC peripheral base address
- alarmTime – Pointer to the structure where the alarm time is stored.

Returns

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

void RTC_GetAlarm(RTC_Type *base, *rtc_datetime_t* *datetime)

Returns the RTC alarm time.

Parameters

- base – RTC peripheral base address
- datetime – Pointer to the structure where the alarm date and time details are stored.

void RTC_EnableInterrupts(RTC_Type *base, uint32_t mask)

Enables the selected RTC interrupts.

Parameters

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

void RTC_DisableInterrupts(RTC_Type *base, uint32_t mask)

Disables the selected RTC interrupts.

Parameters

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

uint32_t RTC_GetEnabledInterrupts(RTC_Type *base)

Gets the enabled RTC interrupts.

Parameters

- base – RTC peripheral base address

Returns

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

uint32_t RTC_GetStatusFlags(RTC_Type *base)

Gets the RTC status flags.

Parameters

- base – RTC peripheral base address

Returns

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

void RTC_ClearStatusFlags(RTC_Type *base, uint32_t mask)

Clears the RTC status flags.

Parameters

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

static inline void RTC_EnableOscillatorClock(RTC_Type *base, bool enable)

Enable/Disable RTC 32kHz Oscillator clock.

Note: After setting this bit, wait the oscillator startup time before enabling the time counter to allow the 32.768 kHz clock time to stabilize.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable RTC 32.768 kHz clock

static inline void RTC_SetClockSource(RTC_Type *base)

Set RTC clock source.

Deprecated:

Do not use this function. It has been superceded by RTC_EnableOscillatorClock

---

Note: After setting this bit, wait the oscillator startup time before enabling the time counter to allow the 32.768 kHz clock time to stabilize.

Parameters

- base – RTC peripheral base address

static inline void RTC_EnableLPOClock(RTC_Type *base, bool enable)

Enable/Disable RTC 1kHz LPO clock.

Note: After setting this bit, RTC prescaler increments using the LPO 1kHz clock and not the RTC 32kHz crystal clock.

Parameters

- base – RTC peripheral base address
- enable – Enable/Disable RTC 1kHz LPO clock

static inline void RTC_StartTimer(RTC_Type *base)

Starts the RTC time counter.

After calling this function, the timer counter increments once a second provided SR[TOF] or SR[TIF] are not set.

Parameters

- base – RTC peripheral base address

static inline void RTC_StopTimer(RTC_Type *base)

Stops the RTC time counter.

RTC's seconds register can be written to only when the timer is stopped.

Parameters

- base – RTC peripheral base address

void RTC_GetMonotonicCounter(RTC_Type *base, uint64_t *counter)

Reads the values of the Monotonic Counter High and Monotonic Counter Low and returns them as a single value.

Parameters

- base – RTC peripheral base address
- counter – Pointer to variable where the value is stored.

void RTC_SetMonotonicCounter(RTC_Type *base, uint64_t counter)

Writes values Monotonic Counter High and Monotonic Counter Low by decomposing the given single value. The Monotonic Overflow Flag in RTC_SR is cleared due to the API.

Parameters

- base – RTC peripheral base address

- counter – Counter value

status_t RTC_IncrementMonotonicCounter(RTC_Type *base)

Increments the Monotonic Counter by one.

Increments the Monotonic Counter (registers RTC_MCLR and RTC_MCHR accordingly) by setting the monotonic counter enable (MER[MCE]) and then writing to the RTC_MCLR register. A write to the monotonic counter low that causes it to overflow also increments the monotonic counter high.

Parameters

- base – RTC peripheral base address

Returns

kStatus_Success: success kStatus_Fail: error occurred, either time invalid or monotonic overflow flag was found

FSL_RTC_DRIVER_VERSION

Version 2.3.3

enum _rtc_interrupt_enable

List of RTC interrupts.

Values:

enumerator kRTC_TimeInvalidInterruptEnable

Time invalid interrupt.

enumerator kRTC_TimeOverflowInterruptEnable

Time overflow interrupt.

enumerator kRTC_AlarmInterruptEnable

Alarm interrupt.

enumerator kRTC_MonotonicOverflowInterruptEnable

Monotonic Overflow Interrupt Enable

enumerator kRTC_SecondsInterruptEnable

Seconds interrupt.

enumerator kRTC_TestModeInterruptEnable

enumerator kRTC_FlashSecurityInterruptEnable

enumerator kRTC_TamperPinInterruptEnable

enumerator kRTC_SecurityModuleInterruptEnable

enumerator kRTC_LossOfClockInterruptEnable

enum _rtc_status_flags

List of RTC flags.

Values:

enumerator kRTC_TimeInvalidFlag

Time invalid flag

enumerator kRTC_TimeOverflowFlag

Time overflow flag

enumerator kRTC_AlarmFlag

Alarm flag

enumerator kRTC_MonotonicOverflowFlag
Monotonic Overflow Flag

enumerator kRTC_TamperInterruptDetectFlag
Tamper interrupt detect flag

enumerator kRTC_TestModeFlag

enumerator kRTC_FlashSecurityFlag

enumerator kRTC_TamperPinFlag

enumerator kRTC_SecurityTamperFlag

enumerator kRTC_LossOfClockTamperFlag

enum __rtc_osc_cap_load
List of RTC Oscillator capacitor load settings.

Values:

enumerator kRTC_Capacitor_2p
2 pF capacitor load

enumerator kRTC_Capacitor_4p
4 pF capacitor load

enumerator kRTC_Capacitor_8p
8 pF capacitor load

enumerator kRTC_Capacitor_16p
16 pF capacitor load

typedef enum *_rtc_interrupt_enable* rtc_interrupt_enable_t
List of RTC interrupts.

typedef enum *_rtc_status_flags* rtc_status_flags_t
List of RTC flags.

typedef enum *_rtc_osc_cap_load* rtc_osc_cap_load_t
List of RTC Oscillator capacitor load settings.

typedef struct *_rtc_datetime* rtc_datetime_t
Structure is used to hold the date and time.

typedef struct *_rtc_pin_config* rtc_pin_config_t
RTC pin config structure.

typedef struct *_rtc_config* rtc_config_t
RTC config structure.

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

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

static inline uint32_t RTC_GetTamperTimeSeconds(RTC_Type *base)
Get the RTC tamper time seconds.

Parameters

- base – RTC peripheral base address

static inline void RTC_SetOscCapLoad(RTC_Type *base, uint32_t capLoad)

This function sets the specified capacitor configuration for the RTC oscillator.

Parameters

- base – RTC peripheral base address
- capLoad – Oscillator loads to enable. This is a logical OR of members of the enumeration rtc_osc_cap_load_t

static inline void RTC_Reset(RTC_Type *base)

Performs a software reset on the RTC module.

This resets all RTC registers except for the SWR bit and the RTC_WAR and RTC_RAR registers. The SWR bit is cleared by software explicitly clearing it.

Parameters

- base – RTC peripheral base address

static inline void RTC_EnableWakeUpPin(RTC_Type *base, bool enable)

Enables or disables the RTC Wakeup Pin Operation.

This function enable or disable RTC Wakeup Pin. The wakeup pin is optional and not available on all devices.

Parameters

- base – RTC_Type base pointer.
- enable – true to enable, false to disable.

struct _rtc_datetime

#include <fsl_rtc.h> Structure is used to hold the date and time.

Public Members

uint16_t year

Range from 1970 to 2099.

uint8_t month

Range from 1 to 12.

uint8_t day

Range from 1 to 31 (depending on month).

uint8_t hour

Range from 0 to 23.

uint8_t minute

Range from 0 to 59.

uint8_t second

Range from 0 to 59.

struct _rtc_pin_config

#include <fsl_rtc.h> RTC pin config structure.

Public Members

bool inputLogic

true: Tamper pin input data is logic one. false: Tamper pin input data is logic zero.

bool pinActiveLow

true: Tamper pin is active low. false: Tamper pin is active high.

bool filterEnable

true: Input filter is enabled on the tamper pin. false: Input filter is disabled on the tamper pin.

bool pullSelectNegate

true: Tamper pin pull resistor direction will negate the tamper pin. false: Tamper pin pull resistor direction will assert the tamper pin.

bool pullEnable

true: Pull resistor is enabled on tamper pin. false: Pull resistor is disabled on tamper pin.

struct _rtc_config

#include <fsl_rtc.h> RTC config structure.

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

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

Public Members

bool wakeupSelect

true: Wakeup pin outputs the 32 KHz clock; false:Wakeup pin used to wakeup the chip

bool updateMode

true: Registers can be written even when locked under certain conditions, false: No writes allowed when registers are locked

bool supervisorAccess

true: Non-supervisor accesses are allowed; false: Non-supervisor accesses are not supported

uint32_t compensationInterval

Compensation interval that is written to the CIR field in RTC TCR Register

uint32_t compensationTime

Compensation time that is written to the TCR field in RTC TCR Register

2.44 SIM: System Integration Module Driver

FSL_SIM_DRIVER_VERSION

Driver version.

enum _sim_usb_volt_reg_enable_mode

USB voltage regulator enable setting.

Values:

enumerator kSIM_UsbVoltRegEnable

Enable voltage regulator.

enumerator kSIM_UsbVoltRegEnableInLowPower

Enable voltage regulator in VLPR/VLPW modes.

enumerator kSIM_UsbVoltRegEnableInStop
Enable voltage regulator in STOP/VLPS/LLS/VLLS modes.

enumerator kSIM_UsbVoltRegEnableInAllModes
Enable voltage regulator in all power modes.

enum _sim_flash_mode
Flash enable mode.

Values:

enumerator kSIM_FlashDisableInWait
Disable flash in wait mode.

enumerator kSIM_FlashDisable
Disable flash in normal mode.

typedef struct *_sim_uid* sim_uid_t
Unique ID.

void SIM_SetUsbVoltRegulatorEnableMode(uint32_t mask)
Sets the USB voltage regulator setting.

This function configures whether the USB voltage regulator is enabled in normal RUN mode, STOP/VLPS/LLS/VLLS modes, and VLPR/VLPW modes. The configurations are passed in as mask value of _sim_usb_volt_reg_enable_mode. For example, to enable USB voltage regulator in RUN/VLPR/VLPW modes and disable in STOP/VLPS/LLS/VLLS mode, use:

SIM_SetUsbVoltRegulatorEnableMode(kSIM_UsbVoltRegEnable | kSIM_UsbVoltRegEnableInLowPower);

Parameters

- mask – USB voltage regulator enable setting.

void SIM_GetUniqueId(*sim_uid_t* *uid)
Gets the unique identification register value.

Parameters

- uid – Pointer to the structure to save the UID value.

static inline void SIM_SetFlashMode(uint8_t mode)
Sets the flash enable mode.

Parameters

- mode – The mode to set; see _sim_flash_mode for mode details.

struct _sim_uid
#include <fsl_sim.h> Unique ID.

Public Members

uint32_t H
UIDH.

uint32_t M
SIM_UIDM.

uint32_t L
UIDL.

2.45 SLCD: Segment LCD Driver

void SLCD_Init(LCD_Type *base, *slcd_config_t* *configure)

Initializes the SLCD, ungates the module clock, initializes the power setting, enables all used plane pins, and sets with interrupt and work mode with the configuration.

Parameters

- base – SLCD peripheral base address.
- configure – SLCD configuration pointer. For the configuration structure, many parameters have the default setting and the SLCD_Getdefaultconfig() is provided to get them. Use it verified for their applications. The others have no default settings, such as "clkConfig", and must be provided by the application before calling the SLCD_Init() API.

void SLCD_Deinit(LCD_Type *base)

Deinitializes the SLCD module, gates the module clock, disables an interrupt, and displays the SLCD.

Parameters

- base – SLCD peripheral base address.

void SLCD_GetDefaultConfig(*slcd_config_t* *configure)

Gets the SLCD default configuration structure. The purpose of this API is to get default parameters of the configuration structure for the SLCD_Init(). Use these initialized parameters unchanged in SLCD_Init() or modify fields of the structure before the calling SLCD_Init(). All default parameters of the configure structuration are listed.

```
config.displayMode         = kSLCD_NormalMode;
config.powerSupply         = kSLCD_InternalVll3UseChargePump;
config.voltageTrim         = kSLCD_RegulatedVolatgeTrim00;
config.lowPowerBehavior    = kSLCD_EnabledInWaitStop;
config.interruptSrc        = 0;
config.faultConfig         = NULL;
config.frameFreqIntEnable =  false;
```

Parameters

- configure – The SLCD configuration structure pointer.

static inline void SLCD_StartDisplay(LCD_Type *base)

Enables the SLCD controller, starts generation, and displays the front plane and back plane waveform.

Parameters

- base – SLCD peripheral base address.

static inline void SLCD_StopDisplay(LCD_Type *base)

Stops the SLCD controller. There is no waveform generator and all enabled pins only output a low value.

Parameters

- base – SLCD peripheral base address.

void SLCD_StartBlinkMode(LCD_Type *base, *slcd_blink_mode_t* mode, *slcd_blink_rate_t* rate)

Starts the SLCD blink mode.

Parameters

- base – SLCD peripheral base address.
- mode – SLCD blink mode.
- rate – SLCD blink rate.

static inline void SLCD_StopBlinkMode(LCD_Type *base)

Stops the SLCD blink mode.

Parameters

- base – SLCD peripheral base address.

static inline void SLCD_SetBackPlanePhase(LCD_Type *base, uint32_t pinIndx, *slcd_phase_type_t* phase)

Sets the SLCD back plane pin phase.

This function sets the SLCD back plane pin phase. "kSLCD_PhaseXActivate" setting means the phase X is active for the back plane pin. "kSLCD_NoPhaseActivate" setting means there is no phase active for the back plane pin. For example, set the back plane pin 20 for phase A.

```
SLCD_SetBackPlanePhase(LCD, 20, kSLCD_PhaseAActivate);
```

Parameters

- base – SLCD peripheral base address.
- pinIndx – SLCD back plane pin index. Range from 0 to 63.
- phase – The phase activates for the back plane pin.

static inline void SLCD_SetFrontPlaneSegments(LCD_Type *base, uint32_t pinIndx, uint8_t operation)

Sets the SLCD front plane segment operation for a front plane pin.

This function sets the SLCD front plane segment on or off operation. Each bit turns on or off the segments associated with the front plane pin in the following pattern: HGFEDCBA (most significant bit controls segment H and least significant bit controls segment A). For example, turn on the front plane pin 20 for phase B and phase C.

```
SLCD_SetFrontPlaneSegments(LCD, 20, (kSLCD_PhaseBActivate | kSLCD_PhaseCActivate));
```

Parameters

- base – SLCD peripheral base address.
- pinIndx – SLCD back plane pin index. Range from 0 to 63.
- operation – The operation for the segment on the front plane pin. This is a logical OR of the enumeration :: slcd_phase_type_t.

static inline void SLCD_SetFrontPlaneOnePhase(LCD_Type *base, uint32_t pinIndx, *slcd_phase_index_t* phaseIndx, bool enable)

Sets one SLCD front plane pin for one phase.

This function can be used to set one phase on or off for the front plane pin. It can be call many times to set the plane pin for different phase indexes. For example, turn on the front plane pin 20 for phase B and phase C.

```
SLCD_SetFrontPlaneOnePhase(LCD, 20, kSLCD_PhaseBIndex, true);
SLCD_SetFrontPlaneOnePhase(LCD, 20, kSLCD_PhaseCIndex, true);
```

Parameters

- base – SLCD peripheral base address.

- pinIndx – SLCD back plane pin index. Range from 0 to 63.
- phaseIndx – The phase bit index slcd_phase_index_t.
- enable – True to turn on the segment for phaseIndx phase false to turn off the segment for phaseIndx phase.

static inline void SLCD_EnablePadSafeState(LCD_Type *base, bool enable)

Enables/disables the SLCD pad safe state.

Forces the safe state on the LCD pad controls. All LCD front plane and backplane functions are disabled.

Parameters

- base – SLCD peripheral base address.
- enable – True enable, false disable.

static inline uint32_t SLCD_GetFaultDetectCounter(LCD_Type *base)

Gets the SLCD fault detect counter.

This function gets the number of samples inside the fault detection sample window.

Parameters

- base – SLCD peripheral base address.

Returns

The fault detect counter. The maximum return value is 255. If the maximum 255 returns, the overflow may happen. Reconfigure the fault detect sample window and fault detect clock prescaler for proper sampling.

void SLCD_EnableInterrupts(LCD_Type *base, uint32_t mask)

Enables the SLCD interrupt. For example, to enable fault detect complete interrupt and frame frequency interrupt, for FSL_FEATURE_SLCD_HAS_FRAME_FREQUENCY_INTERRUPT enabled case, do the following.

```
SLCD_EnableInterrupts(LCD,kSLCD_FaultDetectCompleteInterrupt | kSLCD_FrameFreqInterrupt);
```

Parameters

- base – SLCD peripheral base address.
- mask – SLCD interrupts to enable. This is a logical OR of the enumeration :: slcd_interrupt_enable_t.

void SLCD_DisableInterrupts(LCD_Type *base, uint32_t mask)

Disables the SLCD interrupt. For example, to disable fault detect complete interrupt and frame frequency interrupt, for FSL_FEATURE_SLCD_HAS_FRAME_FREQUENCY_INTERRUPT enabled case, do the following.

```
SLCD_DisableInterrupts(LCD,kSLCD_FaultDetectCompleteInterrupt | kSLCD_FrameFreqInterrupt);
```

Parameters

- base – SLCD peripheral base address.
- mask – SLCD interrupts to disable. This is a logical OR of the enumeration :: slcd_interrupt_enable_t.

uint32_t SLCD_GetInterruptStatus(LCD_Type *base)

Gets the SLCD interrupt status flag.

Parameters

- base – SLCD peripheral base address.

Returns

The event status of the interrupt source. This is the logical OR of members of the enumeration :: slcd_interrupt_enable_t.

void SLCD_ClearInterruptStatus(LCD_Type *base, uint32_t mask)

Clears the SLCD interrupt events status flag.

Parameters

- base – SLCD peripheral base address.
- mask – SLCD interrupt source to be cleared. This is the logical OR of members of the enumeration :: slcd_interrupt_enable_t.

FSL_SLCD_DRIVER_VERSION

SLCD driver version.

enum _slcd_clock_prescaler

SLCD clock prescaler to generate frame frequency.

Values:

enumerator kSLCD_ClkPrescaler00

Prescaler 0.

enumerator kSLCD_ClkPrescaler01

Prescaler 1.

enumerator kSLCD_ClkPrescaler02

Prescaler 2.

enumerator kSLCD_ClkPrescaler03

Prescaler 3.

enumerator kSLCD_ClkPrescaler04

Prescaler 4.

enumerator kSLCD_ClkPrescaler05

Prescaler 5.

enumerator kSLCD_ClkPrescaler06

Prescaler 6.

enumerator kSLCD_ClkPrescaler07

Prescaler 7.

enum _slcd_blink_rate

SLCD blink rate.

Values:

enumerator kSLCD_BlinkRate00

SLCD blink rate is LCD clock/((2^12)).

enumerator kSLCD_BlinkRate01

SLCD blink rate is LCD clock/((2^13)).

enumerator kSLCD_BlinkRate02

SLCD blink rate is LCD clock/((2^14)).

enumerator kSLCD_BlinkRate03

SLCD blink rate is LCD clock/((2^15)).

enumerator kSLCD_BlinkRate04
SLCD blink rate is LCD clock/((2^16)).

enumerator kSLCD_BlinkRate05
SLCD blink rate is LCD clock/((2^17)).

enumerator kSLCD_BlinkRate06
SLCD blink rate is LCD clock/((2^18)).

enumerator kSLCD_BlinkRate07
SLCD blink rate is LCD clock/((2^19)).

enum _slcd_power_supply_option
SLCD power supply option.

Values:

enumerator kSLCD_InternalVll3UseChargePump
VLL3 connected to VDD internally, charge pump is used to generate VLL1 and VLL2.

enumerator kSLCD_ExternalVll3UseResistorBiasNetwork
VLL3 is driven externally and resistor bias network is used to generate VLL1 and VLL2.

enumerator kSLCD_ExteranlVll3UseChargePump
VLL3 is driven externally and charge pump is used to generate VLL1 and VLL2.

enumerator kSLCD_InternalVll1UseChargePump
VIREG is connected to VLL1 internally and charge pump is used to generate VLL2 and VLL3.

enum _slcd_regulated_voltage_trim
SLCD regulated voltage trim parameter, be used to meet the desired contrast.

Values:

enumerator kSLCD_RegulatedVolatgeTrim00
Increase the voltage to 0.91 V.

enumerator kSLCD_RegulatedVolatgeTrim01
Increase the voltage to 1.01 V.

enumerator kSLCD_RegulatedVolatgeTrim02
Increase the voltage to 0.96 V.

enumerator kSLCD_RegulatedVolatgeTrim03
Increase the voltage to 1.06 V.

enumerator kSLCD_RegulatedVolatgeTrim04
Increase the voltage to 0.93 V.

enumerator kSLCD_RegulatedVolatgeTrim05
Increase the voltage to 1.03 V.

enumerator kSLCD_RegulatedVolatgeTrim06
Increase the voltage to 0.98 V.

enumerator kSLCD_RegulatedVolatgeTrim07
Increase the voltage to 1.07 V.

enumerator kSLCD_RegulatedVolatgeTrim08
Increase the voltage to 0.92 V.

enumerator kSLCD_RegulatedVolatgeTrim09
Increase the voltage to 1.02 V.

enumerator kSLCD_RegulatedVolatgeTrim10
Increase the voltage to 0.97 V.

enumerator kSLCD_RegulatedVolatgeTrim11
Increase the voltage to 1.08 V.

enumerator kSLCD_RegulatedVolatgeTrim12
Increase the voltage to 0.94 V.

enumerator kSLCD_RegulatedVolatgeTrim13
Increase the voltage to 1.05 V.

enumerator kSLCD_RegulatedVolatgeTrim14
Increase the voltage to 0.99 V.

enumerator kSLCD_RegulatedVolatgeTrim15
Increase the voltage to 1.09 V.

enum _slcd_load_adjust
SLCD load adjust to handle different LCD glass capacitance or configure the LCD charge pump clock source. Adjust the LCD glass capacitance if resistor bias network is enabled: kSLCD_LowLoadOrFastestClkSrc - Low load (LCD glass capacitance 2000pF or lower. LCD or GPIO function can be used on VLL1,VLL2,Vcap1 and Vcap2 pins) kSLCD_LowLoadOrIntermediateClkSrc - low load (LCD glass capacitance 2000pF or lower. LCD or GPIO function can be used on VLL1,VLL2,Vcap1 and Vcap2 pins) kSLCD_HighLoadOrIntermediateClkSrc - high load (LCD glass capacitance 8000pF or lower. LCD or GPIO function can be used on Vcap1 and Vcap2 pins) kSLCD_HighLoadOrSlowestClkSrc - high load (LCD glass capacitance 8000pF or lower LCD or GPIO function can be used on Vcap1 and Vcap2 pins) Adjust clock for charge pump if charge pump is enabled: kSLCD_LowLoadOrFastestClkSrc - Fasten clock source (LCD glass capacitance 8000pF or 4000pF or lower if Fast Frame Rate is set) kSLCD_LowLoadOrIntermediateClkSrc - Intermediate clock source (LCD glass capacitance 4000pF or 2000pF or lower if Fast Frame Rate is set) kSLCD_HighLoadOrIntermediateClkSrc - Intermediate clock source (LCD glass capacitance 2000pF or 1000pF or lower if Fast Frame Rate is set) kSLCD_HighLoadOrSlowestClkSrc - slowest clock source (LCD glass capacitance 1000pF or 500pF or lower if Fast Frame Rate is set)

Values:

enumerator kSLCD_LowLoadOrFastestClkSrc
Adjust in low load or selects fastest clock.

enumerator kSLCD_LowLoadOrIntermediateClkSrc
Adjust in low load or selects intermediate clock.

enumerator kSLCD_HighLoadOrIntermediateClkSrc
Adjust in high load or selects intermediate clock.

enumerator kSLCD_HighLoadOrSlowestClkSrc
Adjust in high load or selects slowest clock.

enum _slcd_clock_src
SLCD clock source.

Values:

enumerator kSLCD_DefaultClk
Select default clock ERCLK32K.

enumerator kSLCD_AlternateClk1
Select alternate clock source 1 : MCGIRCLK.

enumerator kSLCD_AlternateClk2
Select alternate clock source 2 : OSCERCLK.

enum _slcd_alt_clock_div
SLCD alternate clock divider.

Values:

enumerator kSLCD_AltClkDivFactor1
No divide for alternate clock.

enumerator kSLCD_AltClkDivFactor64
Divide alternate clock with factor 64.

enumerator kSLCD_AltClkDivFactor256
Divide alternate clock with factor 256.

enumerator kSLCD_AltClkDivFactor512
Divide alternate clock with factor 512.

enum _slcd_duty_cycle
SLCD duty cycle.

Values:

enumerator kSLCD_1Div1DutyCycle
LCD use 1 BP 1/1 duty cycle.

enumerator kSLCD_1Div2DutyCycle
LCD use 2 BP 1/2 duty cycle.

enumerator kSLCD_1Div3DutyCycle
LCD use 3 BP 1/3 duty cycle.

enumerator kSLCD_1Div4DutyCycle
LCD use 4 BP 1/4 duty cycle.

enumerator kSLCD_1Div5DutyCycle
LCD use 5 BP 1/5 duty cycle.

enumerator kSLCD_1Div6DutyCycle
LCD use 6 BP 1/6 duty cycle.

enumerator kSLCD_1Div7DutyCycle
LCD use 7 BP 1/7 duty cycle.

enumerator kSLCD_1Div8DutyCycle
LCD use 8 BP 1/8 duty cycle.

enum _slcd_phase_type
SLCD segment phase type.

Values:

enumerator kSLCD_NoPhaseActivate
LCD wareform no phase activates.

enumerator kSLCD_PhaseAActivate
LCD waveform phase A activates.

enumerator kSLCD_PhaseBActivate
LCD waveform phase B activates.

enumerator kSLCD_PhaseCActivate
LCD waveform phase C activates.

enumerator kSLCD_PhaseDActivate
LCD waveform phase D activates.

enumerator kSLCD_PhaseEActivate
LCD waveform phase E activates.

enumerator kSLCD_PhaseFActivate
LCD waveform phase F activates.

enumerator kSLCD_PhaseGActivate
LCD waveform phase G activates.

enumerator kSLCD_PhaseHActivate
LCD waveform phase H activates.

enum _slcd_phase_index
SLCD segment phase bit index.

Values:

enumerator kSLCD_PhaseAIndex
LCD phase A bit index.

enumerator kSLCD_PhaseBIndex
LCD phase B bit index.

enumerator kSLCD_PhaseCIndex
LCD phase C bit index.

enumerator kSLCD_PhaseDIndex
LCD phase D bit index.

enumerator kSLCD_PhaseEIndex
LCD phase E bit index.

enumerator kSLCD_PhaseFIndex
LCD phase F bit index.

enumerator kSLCD_PhaseGIndex
LCD phase G bit index.

enumerator kSLCD_PhaseHIndex
LCD phase H bit index.

enum _slcd_display_mode
SLCD display mode.

Values:

enumerator kSLCD_NormalMode
LCD Normal display mode.

enumerator kSLCD_AlternateMode
LCD Alternate display mode. For four back planes or less.

enumerator kSLCD_BlankMode
LCD Blank display mode.

enum _slcd_blink_mode
SLCD blink mode.

Values:

enumerator kSLCD_BlankDisplayBlink
Display blank during the blink period.

enumerator kSLCD_AltDisplayBlink
Display alternate display during the blink period if duty cycle is lower than 5.

enum _slcd_fault_detect_clock_prescaler
SLCD fault detect clock prescaler.

Values:

enumerator kSLCD_FaultSampleFreqDivider1
Fault detect sample clock frequency is 1/1 bus clock.

enumerator kSLCD_FaultSampleFreqDivider2
Fault detect sample clock frequency is 1/2 bus clock.

enumerator kSLCD_FaultSampleFreqDivider4
Fault detect sample clock frequency is 1/4 bus clock.

enumerator kSLCD_FaultSampleFreqDivider8
Fault detect sample clock frequency is 1/8 bus clock.

enumerator kSLCD_FaultSampleFreqDivider16
Fault detect sample clock frequency is 1/16 bus clock.

enumerator kSLCD_FaultSampleFreqDivider32
Fault detect sample clock frequency is 1/32 bus clock.

enumerator kSLCD_FaultSampleFreqDivider64
Fault detect sample clock frequency is 1/64 bus clock.

enumerator kSLCD_FaultSampleFreqDivider128
Fault detect sample clock frequency is 1/128 bus clock.

enum _slcd_fault_detect_sample_window_width
SLCD fault detect sample window width.

Values:

enumerator kSLCD_FaultDetectWindowWidth4SampleClk
Sample window width is 4 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth8SampleClk
Sample window width is 8 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth16SampleClk
Sample window width is 16 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth32SampleClk
Sample window width is 32 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth64SampleClk
Sample window width is 64 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth128SampleClk
Sample window width is 128 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth256SampleClk
Sample window width is 256 sample clock cycles.

enumerator kSLCD_FaultDetectWindowWidth512SampleClk
Sample window width is 512 sample clock cycles.

enum _slcd_interrupt_enable

SLCD interrupt source.

Values:

enumerator kSLCD_FaultDetectCompleteInterrupt

SLCD fault detection complete interrupt source.

enumerator kSLCD_FrameFreqInterrupt

SLCD frame frequency interrupt source. Not available in all low-power modes.

enum _slcd_lowpower_behavior

SLCD behavior in low power mode.

Values:

enumerator kSLCD_EnabledInWaitStop

SLCD works in wait and stop mode.

enumerator kSLCD_EnabledInWaitOnly

SLCD works in wait mode and is disabled in stop mode.

enumerator kSLCD_EnabledInStopOnly

SLCD works in stop mode and is disabled in wait mode.

enumerator kSLCD_DisabledInWaitStop

SLCD is disabled in stop mode and wait mode.

typedef enum *_slcd_clock_prescaler* slcd_clock_prescaler_t

SLCD clock prescaler to generate frame frequency.

typedef enum *_slcd_blink_rate* slcd_blink_rate_t

SLCD blink rate.

typedef enum *_slcd_power_supply_option* slcd_power_supply_option_t

SLCD power supply option.

typedef enum *_slcd_regulated_voltage_trim* slcd_regulated_voltage_trim_t

SLCD regulated voltage trim parameter, be used to meet the desired contrast.

typedef enum *_slcd_load_adjust* slcd_load_adjust_t

SLCD load adjust to handle different LCD glass capacitance or configure the LCD charge pump clock source. Adjust the LCD glass capacitance if resistor bias network is enabled: kSLCD_LowLoadOrFastestClkSrc - Low load (LCD glass capacitance 2000pF or lower. LCD or GPIO function can be used on VLL1,VLL2,Vcap1 and Vcap2 pins) kSLCD_LowLoadOrIntermediateClkSrc - low load (LCD glass capacitance 2000pF or lower. LCD or GPIO function can be used on VLL1,VLL2,Vcap1 and Vcap2 pins) kSLCD_HighLoadOrIntermediateClkSrc - high load (LCD glass capacitance 8000pF or lower. LCD or GPIO function can be used on Vcap1 and Vcap2 pins) kSLCD_HighLoadOrSlowestClkSrc - high load (LCD glass capacitance 8000pF or lower LCD or GPIO function can be used on Vcap1 and Vcap2 pins) Adjust clock for charge pump if charge pump is enabled: kSLCD_LowLoadOrFastestClkSrc - Fasten clock source (LCD glass capacitance 8000pF or 4000pF or lower if Fast Frame Rate is set) kSLCD_LowLoadOrIntermediateClkSrc - Intermediate clock source (LCD glass capacitance 4000pF or 2000pF or lower if Fast Frame Rate is set) kSLCD_HighLoadOrIntermediateClkSrc - Intermediate clock source (LCD glass capacitance 2000pF or 1000pF or lower if Fast Frame Rate is set) kSLCD_HighLoadOrSlowestClkSrc - slowest clock source (LCD glass capacitance 1000pF or 500pF or lower if Fast Frame Rate is set)

typedef enum *_slcd_clock_src* slcd_clock_src_t

SLCD clock source.

typedef enum *_slcd_alt_clock_div* slcd_alt_clock_div_t
SLCD alternate clock divider.

typedef struct *_slcd_clock_config* slcd_clock_config_t
SLCD clock configuration structure.

typedef enum *_slcd_duty_cycle* slcd_duty_cycle_t
SLCD duty cycle.

typedef enum *_slcd_phase_type* slcd_phase_type_t
SLCD segment phase type.

typedef enum *_slcd_phase_index* slcd_phase_index_t
SLCD segment phase bit index.

typedef enum *_slcd_display_mode* slcd_display_mode_t
SLCD display mode.

typedef enum *_slcd_blink_mode* slcd_blink_mode_t
SLCD blink mode.

typedef enum *_slcd_fault_detect_clock_prescaler* slcd_fault_detect_clock_prescaler_t
SLCD fault detect clock prescaler.

typedef enum *_slcd_fault_detect_sample_window_width*
slcd_fault_detect_sample_window_width_t
SLCD fault detect sample window width.

typedef enum *_slcd_interrupt_enable* slcd_interrupt_enable_t
SLCD interrupt source.

typedef enum *_slcd_lowpower_behavior* slcd_lowpower_behavior
SLCD behavior in low power mode.

typedef struct *_slcd_fault_detect_config* slcd_fault_detect_config_t
SLCD fault frame detection configuration structure.

typedef struct *_slcd_config* slcd_config_t
SLCD configuration structure.

struct _slcd_clock_config
#include <fsl_slcd.h> SLCD clock configuration structure.

Public Members

slcd_clock_src_t clkSource
Clock source. “slcd_clock_src_t” is recommended to be used. The SLCD is optimized to operate using a 32.768kHz clock input.

slcd_alt_clock_div_t altClkDivider
The divider to divide the alternate clock used for alternate clock source.

slcd_clock_prescaler_t clkPrescaler
Clock prescaler.

bool fastFrameRateEnable
Fast frame rate enable flag.

struct _slcd_fault_detect_config
#include <fsl_slcd.h> SLCD fault frame detection configuration structure.

Public Members

bool faultDetectIntEnable
: Fault frame detection interrupt enable flag.

bool faultDetectBackPlaneEnable
: True means the pin id fault detected is back plane otherwise front plane.

uint8_t faultDetectPinIndex
: Fault detected pin id from 0 to 63.

slcd_fault_detect_clock_prescaler_t faultPrescaler
: Fault detect clock prescaler.

slcd_fault_detect_sample_window_width_t width
: Fault detect sample window width.

struct _slcd_config
: *#include <fsl_slcd.h>* SLCD configuration structure.

Public Members

slcd_power_supply_option_t powerSupply
: Power supply option.

slcd_regulated_voltage_trim_t voltageTrim
: Regulated voltage trim used for the internal regulator VIREG to adjust to facilitate contrast control.

slcd_clock_config_t *clkConfig
: Clock configure.

slcd_load_adjust_t loadAdjust
: Load adjust to handle glass capacitance.

slcd_display_mode_t displayMode
: SLCD display mode.

slcd_duty_cycle_t dutyCycle
: Duty cycle.

slcd_lowpower_behavior lowPowerBehavior
: SLCD behavior in low power mode.

bool frameFreqIntEnable
: Frame frequency interrupt enable flag.

uint32_t slcdLowPinEnabled
: Setting enabled SLCD pin 0 ~ pin 31. Setting bit n to 1 means enable pin n.

uint32_t slcdHighPinEnabled
: Setting enabled SLCD pin 32 ~ pin 63. Setting bit n to 1 means enable pin (n + 32).

uint32_t backPlaneLowPin
: Setting back plane pin 0 ~ pin 31. Setting bit n to 1 means setting pin n as back plane. It should never have the same bit setting as the frontPlane Pin.

uint32_t backPlaneHighPin
: Setting back plane pin 32 ~ pin 63. Setting bit n to 1 means setting pin (n + 32) as back plane. It should never have the same bit setting as the frontPlane Pin.

slcd_fault_detect_config_t *faultConfig
: Fault frame detection configure. If not requirement, set to NULL.

2.46 Smart Card

FSL_SMARTCARD_DRIVER_VERSION
Smart card driver version 2.3.0.

Smart card Error codes.

Values:

enumerator kStatus_SMARTCARD_Success
Transfer ends successfully

enumerator kStatus_SMARTCARD_TxBusy
Transmit in progress

enumerator kStatus_SMARTCARD_RxBusy
Receiving in progress

enumerator kStatus_SMARTCARD_NoTransferInProgress
No transfer in progress

enumerator kStatus_SMARTCARD_Timeout
Transfer ends with time-out

enumerator kStatus_SMARTCARD_Initialized
Smart card driver is already initialized

enumerator kStatus_SMARTCARD_PhyInitialized
Smart card PHY drive is already initialized

enumerator kStatus_SMARTCARD_CardNotActivated
Smart card is not activated

enumerator kStatus_SMARTCARD_InvalidInput
Function called with invalid input arguments

enumerator kStatus_SMARTCARD_OtherError
Some other error occur

enum _smartcard_control
Control codes for the Smart card protocol timers and misc.

Values:

enumerator kSMARTCARD_EnableADT

enumerator kSMARTCARD_DisableADT

enumerator kSMARTCARD_EnableGTV

enumerator kSMARTCARD_DisableGTV

enumerator kSMARTCARD_ResetWWT

enumerator kSMARTCARD_EnableWWT

enumerator kSMARTCARD_DisableWWT

enumerator kSMARTCARD_ResetCWT

enumerator kSMARTCARD_EnableCWT

enumerator kSMARTCARD_DisableCWT

enumerator kSMARTCARD_ResetBWT

enumerator kSMARTCARD_EnableBWT

enumerator kSMARTCARD_DisableBWT

enumerator kSMARTCARD_EnableInitDetect

enumerator kSMARTCARD_EnableAnack

enumerator kSMARTCARD_DisableAnack

enumerator kSMARTCARD_ConfigureBaudrate

enumerator kSMARTCARD_SetupATRMode

enumerator kSMARTCARD_SetupT0Mode

enumerator kSMARTCARD_SetupT1Mode

enumerator kSMARTCARD_EnableReceiverMode

enumerator kSMARTCARD_DisableReceiverMode

enumerator kSMARTCARD_EnableTransmitterMode

enumerator kSMARTCARD_DisableTransmitterMode

enumerator kSMARTCARD_ResetWaitTimeMultiplier

enum _smartcard_card_voltage_class

Defines Smart card interface voltage class values.

Values:

enumerator kSMARTCARD_VoltageClassUnknown

enumerator kSMARTCARD_VoltageClassA5_0V

enumerator kSMARTCARD_VoltageClassB3_3V

enumerator kSMARTCARD_VoltageClassC1_8V

enum _smartcard_transfer_state

Defines Smart card I/O transfer states.

Values:

enumerator kSMARTCARD_IdleState

enumerator kSMARTCARD_WaitingForTSState

enumerator kSMARTCARD_InvalidTSDetecetedState

enumerator kSMARTCARD_ReceivingState

enumerator kSMARTCARD_TransmittingState

enum _smartcard_reset_type

Defines Smart card reset types.

Values:

enumerator kSMARTCARD_ColdReset

enumerator kSMARTCARD_WarmReset

enumerator kSMARTCARD_NoColdReset

enumerator kSMARTCARD_NoWarmReset

enum _smartcard_transport_type

Defines Smart card transport protocol types.

Values:

enumerator kSMARTCARD_T0Transport

enumerator kSMARTCARD_T1Transport

enum _smartcard_parity_type

Defines Smart card data parity types.

Values:

enumerator kSMARTCARD_EvenParity

enumerator kSMARTCARD_OddParity

enum _smartcard_card_convention

Defines data Convention format.

Values:

enumerator kSMARTCARD_DirectConvention

enumerator kSMARTCARD_InverseConvention

enum _smartcard_interface_control

Defines Smart card interface IC control types.

Values:

enumerator kSMARTCARD_InterfaceSetVcc

enumerator kSMARTCARD_InterfaceSetClockToResetDelay

enumerator kSMARTCARD_InterfaceReadStatus

enum _smartcard_direction

Defines transfer direction.

Values:

enumerator kSMARTCARD_Receive

enumerator kSMARTCARD_Transmit

typedef enum *_smartcard_control* smartcard_control_t

Control codes for the Smart card protocol timers and misc.

typedef enum *_smartcard_card_voltage_class* smartcard_card_voltage_class_t

Defines Smart card interface voltage class values.

typedef enum *_smartcard_transfer_state* smartcard_transfer_state_t

Defines Smart card I/O transfer states.

typedef enum *_smartcard_reset_type* smartcard_reset_type_t

Defines Smart card reset types.

typedef enum *_smartcard_transport_type* smartcard_transport_type_t
Defines Smart card transport protocol types.

typedef enum *_smartcard_parity_type* smartcard_parity_type_t
Defines Smart card data parity types.

typedef enum *_smartcard_card_convention* smartcard_card_convention_t
Defines data Convention format.

typedef enum *_smartcard_interface_control* smartcard_interface_control_t
Defines Smart card interface IC control types.

typedef enum *_smartcard_direction* smartcard_direction_t
Defines transfer direction.

typedef void (*smartcard_interface_callback_t)(void *smartcardContext, void *param)
Smart card interface interrupt callback function type.

typedef void (*smartcard_transfer_callback_t)(void *smartcardContext, void *param)
Smart card transfer interrupt callback function type.

typedef void (*smartcard_time_delay_t)(uint32_t us)
Time Delay function used to passive waiting using RTOS [us].

typedef struct *_smartcard_card_params* smartcard_card_params_t
Defines card-specific parameters for Smart card driver.

typedef struct *_smartcard_timers_state* smartcard_timers_state_t
Smart card defines the state of the EMV timers in the Smart card driver.

typedef struct *_smartcard_interface_config* smartcard_interface_config_t
Defines user specified configuration of Smart card interface.

typedef struct *_smartcard_xfer* smartcard_xfer_t
Defines user transfer structure used to initialize transfer.

typedef struct *_smartcard_context* smartcard_context_t
Runtime state of the Smart card driver.

SMARTCARD_INIT_DELAY_CLOCK_CYCLES
Smart card global define which specify number of clock cycles until initial 'TS' character has to be received.

SMARTCARD_EMV_ATR_DURATION_ETU
Smart card global define which specify number of clock cycles during which ATR string has to be received.

SMARTCARD_TS_DIRECT_CONVENTION
Smart card specification initial TS character definition of direct convention.

SMARTCARD_TS_INVERSE_CONVENTION
Smart card specification initial TS character definition of inverse convention.

struct _smartcard_card_params
#include <fsl_smartcard.h> Defines card-specific parameters for Smart card driver.

Public Members

uint16_t Fi
4 bits Fi - clock rate conversion integer

uint8_t fMax
: Maximum Smart card frequency in MHz

uint8_t WI
: 8 bits WI - work wait time integer

uint8_t Di
: 4 bits DI - baud rate divisor

uint8_t BWI
: 4 bits BWI - block wait time integer

uint8_t CWI
: 4 bits CWI - character wait time integer

uint8_t BGI
: 4 bits BGI - block guard time integer

uint8_t GTN
: 8 bits GTN - extended guard time integer

uint8_t IFSC
: Indicates IFSC value of the card

uint8_t modeNegotiable
: Indicates if the card acts in negotiable or a specific mode.

uint8_t currentD
: 4 bits DI - current baud rate divisor

uint8_t status
: Indicates smart card status

bool t0Indicated
: Indicates ff T=0 indicated in TD1 byte

bool t1Indicated
: Indicates if T=1 indicated in TD2 byte

bool atrComplete
: Indicates whether the ATR received from the card was complete or not

bool atrValid
: Indicates whether the ATR received from the card was valid or not

bool present
: Indicates if a smart card is present

bool active
: Indicates if the smart card is activated

bool faulty
: Indicates whether smart card/interface is faulty

smartcard_card_convention_t convention
: Card convention, kSMARTCARD_DirectConvention for direct convention, kSMARTCARD_InverseConvention for inverse convention

struct __smartcard__timers__state
: *#include <fsl_smartcard.h>* Smart card defines the state of the EMV timers in the Smart card driver.

Public Members

volatile bool adtExpired
: Indicates whether ADT timer expired

volatile bool wwtExpired
: Indicates whether WWT timer expired

volatile bool cwtExpired
: Indicates whether CWT timer expired

volatile bool bwtExpired
: Indicates whether BWT timer expired

volatile bool initCharTimerExpired
: Indicates whether reception timer for initialization character (TS) after the RST has expired

struct _smartcard_interface_config
: *#include <fsl_smartcard.h>* Defines user specified configuration of Smart card interface.

Public Members

uint32_t smartCardClock
: Smart card interface clock [Hz]

uint32_t clockToResetDelay
: Indicates clock to RST apply delay [smart card clock cycles]

uint8_t clockModule
: Smart card clock module number

uint8_t clockModuleChannel
: Smart card clock module channel number

uint8_t clockModuleSourceClock
: Smart card clock module source clock [e.g., BusClk]

smartcard_card_voltage_class_t vcc
: Smart card voltage class

uint8_t controlPort
: Smart card PHY control port instance

uint8_t controlPin
: Smart card PHY control pin instance

uint8_t irqPort
: Smart card PHY Interrupt port instance

uint8_t irqPin
: Smart card PHY Interrupt pin instance

uint8_t resetPort
: Smart card reset port instance

uint8_t resetPin
: Smart card reset pin instance

uint8_t vsel0Port
: Smart card PHY Vsel0 control port instance

uint8_t vsel0Pin
Smart card PHY Vsel0 control pin instance

uint8_t vsel1Port
Smart card PHY Vsel1 control port instance

uint8_t vsel1Pin
Smart card PHY Vsel1 control pin instance

uint8_t dataPort
Smart card PHY data port instance

uint8_t dataPin
Smart card PHY data pin instance

uint8_t dataPinMux
Smart card PHY data pin mux option

uint8_t tsTimerId
Numerical identifier of the External HW timer for Initial character detection

struct _smartcard_xfer
#include <fsl_smartcard.h> Defines user transfer structure used to initialize transfer.

Public Members

smartcard_direction_t direction
Direction of communication. (RX/TX)

uint8_t *buff
The buffer of data.

size_t size
The number of transferred units.

struct _smartcard_context
#include <fsl_smartcard.h> Runtime state of the Smart card driver.

Public Members

void *base
Smart card module base address

smartcard_direction_t direction
Direction of communication. (RX/TX)

uint8_t *xBuff
The buffer of data being transferred.

volatile size_t xSize
The number of bytes to be transferred.

volatile bool xIsBusy
True if there is an active transfer.

uint8_t txFifoEntryCount
Number of data word entries in transmit FIFO.

uint8_t rxFifoThreshold
The max value of the receiver FIFO threshold.

smartcard_interface_callback_t interfaceCallback
: Callback to invoke after interface IC raised interrupt.

smartcard_transfer_callback_t transferCallback
: Callback to invoke after transfer event occur.

void *interfaceCallbackParam
: Interface callback parameter pointer.

void *transferCallbackParam
: Transfer callback parameter pointer.

smartcard_time_delay_t timeDelay
: Function which handles time delay defined by user or RTOS.

smartcard_reset_type_t resetType
: Indicates whether a Cold reset or Warm reset was requested.

smartcard_transport_type_t tType
: Indicates current transfer protocol (T0 or T1)

volatile *smartcard_transfer_state_t* transferState
: Indicates the current transfer state

smartcard_timers_state_t timersState
: Indicates the state of different protocol timers used in driver

smartcard_card_params_t cardParams
: Smart card parameters(ATR and current) and interface slots states(ATR and current)

uint8_t IFSD
: Indicates the terminal IFSD

smartcard_parity_type_t parity
: Indicates current parity even/odd

volatile bool rxtCrossed
: Indicates whether RXT thresholds has been crossed

volatile bool txtCrossed
: Indicates whether TXT thresholds has been crossed

volatile bool wtxRequested
: Indicates whether WTX has been requested or not

volatile bool parityError
: Indicates whether a parity error has been detected

uint8_t statusBytes[2]
: Used to store Status bytes SW1, SW2 of the last executed card command response

smartcard_interface_config_t interfaceConfig
: Smart card interface configuration structure

bool abortTransfer
: Used to abort transfer.

2.47 Smart Card PHY Driver

void SMARTCARD_PHY_GetDefaultConfig(*smartcard_interface_config_t* *config)

Fills in the configuration structure with default values.

Parameters

- config – The Smart card user configuration structure which contains configuration structure of type smartcard_interface_config_t. Function fill in members: clockToResetDelay = 42000, vcc = kSmartcardVoltageClassB3_3V, with default values.

status_t SMARTCARD_PHY_Init(void *base, *smartcard_interface_config_t* const *config, uint32_t srcClock_Hz)

Initializes a Smart card interface instance.

Parameters

- base – The Smart card peripheral base address.
- config – The user configuration structure of type smartcard_interface_config_t. Call the function SMARTCARD_PHY_GetDefaultConfig() to fill the configuration structure.
- srcClock_Hz – Smart card clock generation module source clock.

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

void SMARTCARD_PHY_Deinit(void *base, *smartcard_interface_config_t* const *config)

De-initializes a Smart card interface, stops the Smart card clock, and disables the VCC.

Parameters

- base – The Smart card peripheral module base address.
- config – The user configuration structure of type smartcard_interface_config_t.

status_t SMARTCARD_PHY_Activate(void *base, *smartcard_context_t* *context, *smartcard_reset_type_t* resetType)

Activates the Smart card IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- resetType – type of reset to be performed, possible values = kSmartcardColdReset, kSmartcardWarmReset

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

status_t SMARTCARD_PHY_Deactivate(void *base, *smartcard_context_t* *context)

De-activates the Smart card IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

status_t SMARTCARD_PHY_Control(void *base, *smartcard_context_t* *context, *smartcard_interface_control_t* control, uint32_t param)

Controls the Smart card interface IC.

Parameters

- base – The Smart card peripheral module base address.
- context – A pointer to a Smart card driver context structure.
- control – A interface command type.
- param – Integer value specific to control type

Return values

kStatus_SMARTCARD_Success – or kStatus_SMARTCARD_OtherError in case of error.

SMARTCARD_ATR_DURATION_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles during which an ATR string has to be received.

SMARTCARD_INIT_DELAY_CLOCK_CYCLES_ADJUSTMENT

Smart card definition which specifies the adjustment number of clock cycles until an initial 'TS' character has to be received.

2.48 Smart Card PHY GPIO Driver

2.49 Smart Card UART Driver

void SMARTCARD_UART_GetDefaultConfig(*smartcard_card_params_t* *cardParams)

Fills in the smartcard_card_params structure with default values according to the EMV 4.3 specification.

Parameters

- cardParams – The configuration structure of type smartcard_interface_config_t. Function fill in members: Fi = 372; Di = 1; currentD = 1; WI = 0x0A; GTN = 0x00; with default values.

status_t SMARTCARD_UART_Init(UART_Type *base, *smartcard_context_t* *context, uint32_t srcClock_Hz)

Initializes a UART peripheral for the Smart card/ISO-7816 operation.

This function un-gates the UART clock, initializes the module to EMV default settings, configures the IRQ, enables the module-level interrupt to the core, and initializes the driver context.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a smart card driver context structure.
- srcClock_Hz – Smart card clock generation module source clock.

Returns

An error code or kStatus_SMARTCARD_Success.

void SMARTCARD_UART_Deinit(UART_Type *base)

This function disables the UART interrupts, disables the transmitter and receiver, and flushes the FIFOs (for modules that support FIFOs) and gates UART clock in SIM.

Parameters

- base – The UART peripheral base address.

int32_t SMARTCARD_UART_GetTransferRemainingBytes(UART_Type *base, *smartcard_context_t* *context)

Returns whether the previous UART transfer has finished.

When performing an async transfer, call this function to ascertain the context of the current transfer: in progress (or busy) or complete (success). If the transfer is still in progress, the user can obtain the number of words that have not been transferred by reading xSize of smart card context structure.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.

Returns

The number of bytes not transferred.

status_t SMARTCARD_UART_AbortTransfer(UART_Type *base, *smartcard_context_t* *context)

Terminates an asynchronous UART transfer early.

During an async UART transfer, the user can terminate the transfer early if the transfer is still in progress.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.

Return values

- kStatus_SMARTCARD_Success – The transfer abort was successful.
- kStatus_SMARTCARD_NoTransmitInProgress – No transmission is currently in progress.

status_t SMARTCARD_UART_TransferNonBlocking(UART_Type *base, *smartcard_context_t* *context, *smartcard_xfer_t* *xfer)

Transfers data using interrupts.

A non-blocking (also known as asynchronous) function means that the function returns immediately after initiating the transfer function. The application has to get the transfer status to see when the transfer is complete. In other words, after calling non-blocking (asynchronous) transfer function, the application must get the transfer status to check if transmit is completed or not.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.
- xfer – A pointer to Smart card transfer structure where the linked buffers and sizes are stored.

Returns

An error code or kStatus_SMARTCARD_Success.

status_t SMARTCARD_UART_Control(UART_Type *base, *smartcard_context_t* *context, *smartcard_control_t* control, uint32_t param)

Controls the UART module per different user requests.

return An kStatus_SMARTCARD_OtherError in case of error return kStatus_SMARTCARD_Success in success

Parameters

- base – The UART peripheral base address.
- context – A pointer to a smart card driver context structure.
- control – Smart card command type.
- param – Integer value specific to a control command.

void SMARTCARD_UART_IRQHandler(UART_Type *base, *smartcard_context_t* *context)

Interrupt handler for UART.

This handler uses the buffers stored in the smartcard_context_t structures to transfer data. The Smart card driver requires this function to call when the UART interrupt occurs.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.

void SMARTCARD_UART_ErrIRQHandler(UART_Type *base, *smartcard_context_t* *context)

Error interrupt handler for UART.

This function handles error conditions during a transfer.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.

void SMARTCARD_UART_TSExpiryCallback(UART_Type *base, *smartcard_context_t* *context)

Handles initial TS character timer time-out event.

Parameters

- base – The UART peripheral base address.
- context – A pointer to a Smart card driver context structure.

void smartcard_uart_TimerStart(uint8_t channel, uint32_t time)

Initializes timer specific channel with input period, enable channel interrupt and start counter.

Parameters

- channel – The timer channel.
- time – The time period.

SMARTCARD_EMV_RX_NACK_THRESHOLD

EMV RX NACK interrupt generation threshold.

SMARTCARD_EMV_TX_NACK_THRESHOLD

EMV TX NACK interrupt generation threshold.

SMARTCARD_EMV_RX_TO_TX_GUARD_TIME_T0

EMV TX & RX GUART TIME default value.

SBR_CAL_ADJUST_D1_T0

BRFA_CAL_ADJUST_D1_T0

SBR_CAL_ADJUST_D2_T0

BRFA_CAL_ADJUST_D2_T0

SBR_CAL_ADJUST_D4_T0

BRFA_CAL_ADJUST_D4_T0

SBR_CAL_ADJUST_D1_T1

BRFA_CAL_ADJUST_D1_T1

SBR_CAL_ADJUST_D2_T1

BRFA_CAL_ADJUST_D2_T1

SBR_CAL_ADJUST_D4_T1

BRFA_CAL_ADJUST_D4_T1

2.50 SMC: System Mode Controller Driver

static inline void SMC_GetVersionId(SMC_Type *base, *smc_version_id_t* *versionId)

Gets the SMC version ID.

This function gets the SMC version ID, including major version number, minor version number, and feature specification number.

Parameters

- base – SMC peripheral base address.
- versionId – Pointer to the version ID structure.

void SMC_GetParam(SMC_Type *base, *smc_param_t* *param)

Gets the SMC parameter.

This function gets the SMC parameter including the enabled power mdoes.

Parameters

- base – SMC peripheral base address.
- param – Pointer to the SMC param structure.

static inline void SMC_SetPowerModeProtection(SMC_Type *base, uint8_t allowedModes)

Configures all power mode protection settings.

This function configures the power mode protection settings for supported power modes in the specified chip family. The available power modes are defined in the smc_power_mode_protection_t. This should be done at an early system level initialization stage. See the reference manual for details. This register can only write once after the power reset.

The allowed modes are passed as bit map. For example, to allow LLS and VLLS, use SMC_SetPowerModeProtection(kSMC_AllowPowerModeVlls | kSMC_AllowPowerModeVlps). To allow all modes, use SMC_SetPowerModeProtection(kSMC_AllowPowerModeAll).

Parameters

- base – SMC peripheral base address.
- allowedModes – Bitmap of the allowed power modes.

static inline *smc_power_state_t* SMC_GetPowerModeState(SMC_Type *base)

Gets the current power mode status.

This function returns the current power mode status. After the application switches the power mode, it should always check the status to check whether it runs into the specified mode or not. The application should check this mode before switching to a different mode. The system requires that only certain modes can switch to other specific modes. See the reference manual for details and the smc_power_state_t for information about the power status.

Parameters

- base – SMC peripheral base address.

Returns

Current power mode status.

void SMC_PreEnterStopModes(void)

Prepares to enter stop modes.

This function should be called before entering STOP/VLPS/LLS/VLLS modes.

void SMC_PostExitStopModes(void)

Recovers after wake up from stop modes.

This function should be called after wake up from STOP/VLPS/LLS/VLLS modes. It is used with SMC_PreEnterStopModes.

void SMC_PreEnterWaitModes(void)

Prepares to enter wait modes.

This function should be called before entering WAIT/VLPW modes.

void SMC_PostExitWaitModes(void)

Recovers after wake up from stop modes.

This function should be called after wake up from WAIT/VLPW modes. It is used with SMC_PreEnterWaitModes.

status_t SMC_SetPowerModeRun(SMC_Type *base)

Configures the system to RUN power mode.

Parameters

- base – SMC peripheral base address.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeHsrun(SMC_Type *base)

Configures the system to HSRUN power mode.

Parameters

- base – SMC peripheral base address.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeWait(SMC_Type *base)

Configures the system to WAIT power mode.

Parameters

- base – SMC peripheral base address.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeStop(SMC_Type *base, *smc_partial_stop_option_t* option)

Configures the system to Stop power mode.

Parameters

- base – SMC peripheral base address.
- option – Partial Stop mode option.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeVlpr(SMC_Type *base, bool wakeupMode)

Configures the system to VLPR power mode.

Parameters

- base – SMC peripheral base address.
- wakeupMode – Enter Normal Run mode if true, else stay in VLPR mode.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeVlpw(SMC_Type *base)

Configures the system to VLPW power mode.

Parameters

- base – SMC peripheral base address.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeVlps(SMC_Type *base)

Configures the system to VLPS power mode.

Parameters

- base – SMC peripheral base address.

Returns

SMC configuration error code.

status_t SMC_SetPowerModeLls(SMC_Type *base, const *smc_power_mode_lls_config_t* *config)

Configures the system to LLS power mode.

Parameters

- base – SMC peripheral base address.
- config – The LLS power mode configuration structure

Returns

SMC configuration error code.

status_t SMC_SetPowerModeVlls(SMC_Type *base, const *smc_power_mode_vlls_config_t* *config)

Configures the system to VLLS power mode.

Parameters

- base – SMC peripheral base address.
- config – The VLLS power mode configuration structure.

Returns

SMC configuration error code.

FSL_SMC_DRIVER_VERSION

SMC driver version.

enum _smc_power_mode_protection
Power Modes Protection.

Values:

enumerator kSMC_AllowPowerModeVlls
Allow Very-low-leakage Stop Mode.

enumerator kSMC_AllowPowerModeLls
Allow Low-leakage Stop Mode.

enumerator kSMC_AllowPowerModeVlp
Allow Very-Low-power Mode.

enumerator kSMC_AllowPowerModeHsrun
Allow High-speed Run mode.

enumerator kSMC_AllowPowerModeAll
Allow all power mode.

enum _smc_power_state
Power Modes in PMSTAT.

Values:

enumerator kSMC_PowerStateRun
0000_0001 - Current power mode is RUN

enumerator kSMC_PowerStateStop
0000_0010 - Current power mode is STOP

enumerator kSMC_PowerStateVlpr
0000_0100 - Current power mode is VLPR

enumerator kSMC_PowerStateVlpw
0000_1000 - Current power mode is VLPW

enumerator kSMC_PowerStateVlps
0001_0000 - Current power mode is VLPS

enumerator kSMC_PowerStateLls
0010_0000 - Current power mode is LLS

enumerator kSMC_PowerStateVlls
0100_0000 - Current power mode is VLLS

enumerator kSMC_PowerStateHsrun
1000_0000 - Current power mode is HSRUN

enum _smc_run_mode
Run mode definition.

Values:

enumerator kSMC_RunNormal
Normal RUN mode.

enumerator kSMC_RunVlpr
Very-low-power RUN mode.

enumerator kSMC_Hsrun
High-speed Run mode (HSRUN).

enum _smc_stop_mode
Stop mode definition.

Values:

enumerator kSMC_StopNormal
Normal STOP mode.

enumerator kSMC_StopVlps
Very-low-power STOP mode.

enumerator kSMC_StopLls
Low-leakage Stop mode.

enumerator kSMC_StopVlls
Very-low-leakage Stop mode.

enum _smc_stop_submode
VLLS/LLS stop sub mode definition.

Values:

enumerator kSMC_StopSub0
Stop submode 0, for VLLS0/LLS0.

enumerator kSMC_StopSub1
Stop submode 1, for VLLS1/LLS1.

enumerator kSMC_StopSub2
Stop submode 2, for VLLS2/LLS2.

enumerator kSMC_StopSub3
Stop submode 3, for VLLS3/LLS3.

enum _smc_partial_stop_mode
Partial STOP option.

Values:

enumerator kSMC_PartialStop
STOP - Normal Stop mode

enumerator kSMC_PartialStop1
Partial Stop with both system and bus clocks disabled

enumerator kSMC_PartialStop2
Partial Stop with system clock disabled and bus clock enabled

_smc_status, SMC configuration status.

Values:

enumerator kStatus_SMC_StopAbort
Entering Stop mode is abort

typedef enum *_smc_power_mode_protection* smc_power_mode_protection_t
Power Modes Protection.

typedef enum *_smc_power_state* smc_power_state_t
Power Modes in PMSTAT.

typedef enum *_smc_run_mode* smc_run_mode_t
Run mode definition.

typedef enum *_smc_stop_mode* smc_stop_mode_t
Stop mode definition.

typedef enum *_smc_stop_submode* smc_stop_submode_t
VLLS/LLS stop sub mode definition.

typedef enum *_smc_partial_stop_mode* smc_partial_stop_option_t
Partial STOP option.

typedef struct *_smc_version_id* smc_version_id_t
IP version ID definition.

typedef struct *_smc_param* smc_param_t
IP parameter definition.

typedef struct *_smc_power_mode_lls_config* smc_power_mode_lls_config_t
SMC Low-Leakage Stop power mode configuration.

typedef struct *_smc_power_mode_vlls_config* smc_power_mode_vlls_config_t
SMC Very Low-Leakage Stop power mode configuration.

struct _smc_version_id
#include <fsl_smc.h> IP version ID definition.

Public Members

uint16_t feature
Feature Specification Number.

uint8_t minor
Minor version number.

uint8_t major
Major version number.

struct _smc_param
#include <fsl_smc.h> IP parameter definition.

Public Members

bool hsrunEnable
HSRUN mode enable.

bool llsEnable
LLS mode enable.

bool lls2Enable
LLS2 mode enable.

bool vlls0Enable
VLLS0 mode enable.

struct _smc_power_mode_lls_config
#include <fsl_smc.h> SMC Low-Leakage Stop power mode configuration.

Public Members

smc_stop_submode_t subMode
Low-leakage Stop sub-mode

bool enableLpoClock
Enable LPO clock in LLS mode

struct _smc_power_mode_vlls_config
#include <fsl_smc.h> SMC Very Low-Leakage Stop power mode configuration.

Public Members

smc_stop_submode_t subMode
Very Low-leakage Stop sub-mode

bool enablePorDetectInVlls0
Enable Power on reset detect in VLLS mode

bool enableRam2InVlls2
Enable RAM2 power in VLLS2

bool enableLpoClock
Enable LPO clock in VLLS mode

2.51 SPI: Serial Peripheral Interface Driver

2.52 SPI DMA Driver

void 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.

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)

Get the transferred bytes for SPI slave DMA.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- count – Transferred bytes.

Return values

- kStatus_SPI_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

static inline void 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.

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)

Get the transferred bytes for SPI slave DMA.

Parameters

- base – SPI peripheral base address.
- handle – SPI DMA handle pointer.
- count – Transferred bytes.

Return values

- kStatus_SPI_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

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

bool txInProgress
: Send transfer finished

bool rxInProgress
: Receive transfer finished

dma_handle_t *txHandle
: DMA handler for SPI send

dma_handle_t *rxHandle
: DMA handler for SPI receive

uint8_t bytesPerFrame
: Bytes in a frame for SPI transfer

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

2.53 SPI Driver

void SPI_MasterGetDefaultConfig(*spi_master_config_t* *config)
: Sets the SPI master configuration structure to default values.

  The purpose of this API is to get the configuration structure initialized for use in SPI_MasterInit(). User may use the initialized structure unchanged in SPI_MasterInit(), or modify some fields of the structure before calling SPI_MasterInit(). After calling this API, the master is ready to transfer. Example:

```
spi_master_config_t config;
SPI_MasterGetDefaultConfig(&config);
```

  Parameters

  - config – pointer to master config structure

void SPI_MasterInit(SPI_Type *base, const *spi_master_config_t* *config, uint32_t srcClock_Hz)
: Initializes the SPI with master configuration.

  The configuration structure can be filled by user from scratch, or be set with default values by SPI_MasterGetDefaultConfig(). After calling this API, the slave is ready to transfer. Example

```
spi_master_config_t config = {
.baudRate_Bps = 400000,
...
};
SPI_MasterInit(SPI0, &config);
```

  Parameters

- base – SPI base pointer
- config – pointer to master configuration structure
- srcClock_Hz – Source clock frequency.

void SPI_SlaveGetDefaultConfig(*spi_slave_config_t* *config)

Sets the SPI slave configuration structure to default values.

The purpose of this API is to get the configuration structure initialized for use in SPI_SlaveInit(). Modify some fields of the structure before calling SPI_SlaveInit(). Example:

```
spi_slave_config_t config;
SPI_SlaveGetDefaultConfig(&config);
```

Parameters

- config – pointer to slave configuration structure

void SPI_SlaveInit(SPI_Type *base, const *spi_slave_config_t* *config)

Initializes the SPI with slave configuration.

The configuration structure can be filled by user from scratch or be set with default values by SPI_SlaveGetDefaultConfig(). After calling this API, the slave is ready to transfer. Example

```
spi_slave_config_t config = {
.polarity = kSPIClockPolarity_ActiveHigh;
.phase = kSPIClockPhase_FirstEdge;
.direction = kSPIMsbFirst;
...
};
SPI_MasterInit(SPI0, &config);
```

Parameters

- base – SPI base pointer
- config – pointer to master configuration structure

void SPI_Deinit(SPI_Type *base)

De-initializes the SPI.

Calling this API resets the SPI module, gates the SPI clock. The SPI module can't work unless calling the SPI_MasterInit/SPI_SlaveInit to initialize module.

Parameters

- base – SPI base pointer

static inline void SPI_Enable(SPI_Type *base, bool enable)

Enables or disables the SPI.

Parameters

- base – SPI base pointer
- enable – pass true to enable module, false to disable module

uint32_t SPI_GetStatusFlags(SPI_Type *base)

Gets the status flag.

Parameters

- base – SPI base pointer

Returns
SPI Status, use status flag to AND _spi_flags could get the related status.

static inline void SPI_ClearInterrupt(SPI_Type *base, uint8_t mask)

Clear the interrupt if enable INCTLR.

Parameters

- base – SPI base pointer
- mask – Interrupt need to be cleared The parameter could be any combination of the following values:
  - kSPI_RxFullAndModfInterruptEnable
  - kSPI_TxEmptyInterruptEnable
  - kSPI_MatchInterruptEnable
  - kSPI_RxFifoNearFullInterruptEnable
  - kSPI_TxFifoNearEmptyInterruptEnable

void SPI_EnableInterrupts(SPI_Type *base, uint32_t mask)

Enables the interrupt for the SPI.

Parameters

- base – SPI base pointer
- mask – SPI interrupt source. The parameter can be any combination of the following values:
  - kSPI_RxFullAndModfInterruptEnable
  - kSPI_TxEmptyInterruptEnable
  - kSPI_MatchInterruptEnable
  - kSPI_RxFifoNearFullInterruptEnable
  - kSPI_TxFifoNearEmptyInterruptEnable

void SPI_DisableInterrupts(SPI_Type *base, uint32_t mask)

Disables the interrupt for the SPI.

Parameters

- base – SPI base pointer
- mask – SPI interrupt source. The parameter can be any combination of the following values:
  - kSPI_RxFullAndModfInterruptEnable
  - kSPI_TxEmptyInterruptEnable
  - kSPI_MatchInterruptEnable
  - kSPI_RxFifoNearFullInterruptEnable
  - kSPI_TxFifoNearEmptyInterruptEnable

static inline void SPI_EnableDMA(SPI_Type *base, uint8_t mask, bool enable)

Enables the DMA source for SPI.

Parameters

- base – SPI base pointer
- mask – SPI DMA source.
- enable – True means enable DMA, false means disable DMA

static inline uint32_t SPI_GetDataRegisterAddress(SPI_Type *base)

Gets the SPI tx/rx data register address.

This API is used to provide a transfer address for the SPI DMA transfer configuration.

Parameters

- base – SPI base pointer

Returns

data register address

uint32_t SPI_GetInstance(SPI_Type *base)

Get the instance for SPI module.

Parameters

- base – SPI base address

static inline void SPI_SetPinMode(SPI_Type *base, *spi_pin_mode_t* pinMode)

Sets the pin mode for transfer.

Parameters

- base – SPI base pointer
- pinMode – pin mode for transfer AND _spi_pin_mode could get the related configuration.

void SPI_MasterSetBaudRate(SPI_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the baud rate for SPI transfer. This is only used in master.

Parameters

- base – SPI base pointer
- baudRate_Bps – baud rate needed in Hz.
- srcClock_Hz – SPI source clock frequency in Hz.

static inline void SPI_SetMatchData(SPI_Type *base, uint32_t matchData)

Sets the match data for SPI.

The match data is a hardware comparison value. When the value received in the SPI receive data buffer equals the hardware comparison value, the SPI Match Flag in the S register (S[SPMF]) sets. This can also generate an interrupt if the enable bit sets.

Parameters

- base – SPI base pointer
- matchData – Match data.

void SPI_EnableFIFO(SPI_Type *base, bool enable)

Enables or disables the FIFO if there is a FIFO.

Parameters

- base – SPI base pointer
- enable – True means enable FIFO, false means disable FIFO.

status_t SPI_WriteBlocking(SPI_Type *base, uint8_t *buffer, size_t size)

Sends a buffer of data bytes using a blocking method.

Note: This function blocks via polling until all bytes have been sent.

Parameters

- base – SPI base pointer
- buffer – The data bytes to send
- size – The number of data bytes to send

Returns
kStatus_SPI_Timeout The transfer timed out and was aborted.

void SPI_WriteData(SPI_Type *base, uint16_t data)

Writes a data into the SPI data register.

Parameters

- base – SPI base pointer
- data – needs to be write.

uint16_t SPI_ReadData(SPI_Type *base)

Gets a data from the SPI data register.

Parameters

- base – SPI base pointer

Returns
Data in the register.

void SPI_SetDummyData(SPI_Type *base, uint8_t dummyData)

Set up the dummy data.

Parameters

- base – SPI peripheral address.
- dummyData – Data to be transferred when tx buffer is NULL.

void SPI_MasterTransferCreateHandle(SPI_Type *base, *spi_master_handle_t* *handle, *spi_master_callback_t* callback, void *userData)

Initializes the SPI master handle.

This function initializes the SPI master handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – Callback function.
- userData – User data.

status_t SPI_MasterTransferBlocking(SPI_Type *base, *spi_transfer_t* *xfer)

Transfers a block of data using a polling method.

Parameters

- base – SPI base pointer
- xfer – pointer to spi_xfer_config_t structure

Return values

- kStatus_Success – Successfully start a transfer.
- kStatus_InvalidArgument – Input argument is invalid.

status_t SPI_MasterTransferNonBlocking(SPI_Type *base, *spi_master_handle_t* *handle, *spi_transfer_t* *xfer)

Performs a non-blocking SPI interrupt transfer.

Note: The API immediately returns after transfer initialization is finished. Call SPI_GetStatusIRQ() to get the transfer status.

Note: If SPI transfer data frame size is 16 bits, the transfer size cannot be an odd number.

Parameters

- base – SPI peripheral base address.
- handle – pointer to spi_master_handle_t structure which stores the transfer state
- xfer – pointer to spi_xfer_config_t 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_MasterTransferGetCount(SPI_Type *base, *spi_master_handle_t* *handle, size_t *count)

Gets the bytes of the SPI interrupt transferred.

Parameters

- base – SPI peripheral base address.
- handle – Pointer to SPI transfer handle, this should be a static variable.
- count – Transferred bytes of SPI master.

Return values

- kStatus_SPI_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

void SPI_MasterTransferAbort(SPI_Type *base, *spi_master_handle_t* *handle)

Aborts an SPI transfer using interrupt.

Parameters

- base – SPI peripheral base address.
- handle – Pointer to SPI transfer handle, this should be a static variable.

void SPI_MasterTransferHandleIRQ(SPI_Type *base, *spi_master_handle_t* *handle)

Interrupts the handler for the SPI.

Parameters

- base – SPI peripheral base address.
- handle – pointer to spi_master_handle_t structure which stores the transfer state.

void SPI_SlaveTransferCreateHandle(SPI_Type *base, *spi_slave_handle_t* *handle, *spi_slave_callback_t* callback, void *userData)

Initializes the SPI slave handle.

This function initializes the SPI slave handle which can be used for other SPI slave transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

Parameters

- base – SPI peripheral base address.
- handle – SPI handle pointer.
- callback – Callback function.
- userData – User data.

status_t SPI_SlaveTransferNonBlocking(SPI_Type *base, *spi_slave_handle_t* *handle, *spi_transfer_t* *xfer)

Performs a non-blocking SPI slave interrupt transfer.

Note: The API returns immediately after the transfer initialization is finished. Call SPI_GetStatusIRQ() to get the transfer status.

Note: If SPI transfer data frame size is 16 bits, the transfer size cannot be an odd number.

Parameters

- base – SPI peripheral base address.
- handle – pointer to spi_slave_handle_t structure which stores the transfer state
- xfer – pointer to spi_xfer_config_t 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.

static inline *status_t* SPI_SlaveTransferGetCount(SPI_Type *base, *spi_slave_handle_t* *handle, size_t *count)

Gets the bytes of the SPI interrupt transferred.

Parameters

- base – SPI peripheral base address.
- handle – Pointer to SPI transfer handle, this should be a static variable.
- count – Transferred bytes of SPI slave.

Return values

- kStatus_SPI_Success – Succeed get the transfer count.
- kStatus_NoTransferInProgress – There is not a non-blocking transaction currently in progress.

static inline void SPI_SlaveTransferAbort(SPI_Type *base, *spi_slave_handle_t* *handle)

Aborts an SPI slave transfer using interrupt.

Parameters

- base – SPI peripheral base address.
- handle – Pointer to SPI transfer handle, this should be a static variable.

void SPI_SlaveTransferHandleIRQ(SPI_Type *base, *spi_slave_handle_t* *handle)

Interrupts a handler for the SPI slave.

Parameters

- base – SPI peripheral base address.
- handle – pointer to spi_slave_handle_t structure which stores the transfer state

FSL_SPI_DRIVER_VERSION

SPI driver version.

Return status for the SPI driver.

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_Timeout

SPI timeout polling status flags.

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 SPSCK occurs at the middle of the first cycle of a data transfer.

enumerator kSPI_ClockPhaseSecondEdge

First edge on SPSCK occurs at the start of the first cycle of a data 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_ss_output_mode
SPI slave select output mode options.

Values:

enumerator kSPI_SlaveSelectAsGpio
Slave select pin configured as GPIO.

enumerator kSPI_SlaveSelectFaultInput
Slave select pin configured for fault detection.

enumerator kSPI_SlaveSelectAutomaticOutput
Slave select pin configured for automatic SPI output.

enum _spi_pin_mode
SPI pin mode options.

Values:

enumerator kSPI_PinModeNormal
Pins operate in normal, single-direction mode.

enumerator kSPI_PinModeInput
Bidirectional mode. Master: MOSI pin is input; Slave: MISO pin is input.

enumerator kSPI_PinModeOutput
Bidirectional mode. Master: MOSI pin is output; Slave: MISO pin is output.

enum _spi_data_bitcount_mode
SPI data length mode options.

Values:

enumerator kSPI_8BitMode
8-bit data transmission mode

enumerator kSPI_16BitMode
16-bit data transmission mode

enum _spi_interrupt_enable
SPI interrupt sources.

Values:

enumerator kSPI_RxFullAndModfInterruptEnable
Receive buffer full (SPRF) and mode fault (MODF) interrupt

enumerator kSPI_TxEmptyInterruptEnable
Transmit buffer empty interrupt

enumerator kSPI_MatchInterruptEnable
Match interrupt

enumerator kSPI_RxFifoNearFullInterruptEnable
Receive FIFO nearly full interrupt

enumerator kSPI_TxFifoNearEmptyInterruptEnable
Transmit FIFO nearly empty interrupt

enum _spi_flags

SPI status flags.

Values:

enumerator kSPI_RxBufferFullFlag

Read buffer full flag

enumerator kSPI_MatchFlag

Match flag

enumerator kSPI_TxBufferEmptyFlag

Transmit buffer empty flag

enumerator kSPI_ModeFaultFlag

Mode fault flag

enumerator kSPI_RxFifoNearFullFlag

Rx FIFO near full

enumerator kSPI_TxFifoNearEmptyFlag

Tx FIFO near empty

enumerator kSPI_TxFifoFullFlag

Tx FIFO full

enumerator kSPI_RxFifoEmptyFlag

Rx FIFO empty

enumerator kSPI_TxFifoError

Tx FIFO error

enumerator kSPI_RxFifoError

Rx FIFO error

enumerator kSPI_TxOverflow

Tx FIFO Overflow

enumerator kSPI_RxOverflow

Rx FIFO Overflow

enum _spi_w1c_interrupt

SPI FIFO write-1-to-clear interrupt flags.

Values:

enumerator kSPI_RxFifoFullClearInterrupt

Receive FIFO full interrupt

enumerator kSPI_TxFifoEmptyClearInterrupt

Transmit FIFO empty interrupt

enumerator kSPI_RxNearFullClearInterrupt

Receive FIFO nearly full interrupt

enumerator kSPI_TxNearEmptyClearInterrupt

Transmit FIFO nearly empty interrupt

enum _spi_txfifo_watermark

SPI TX FIFO watermark settings.

Values:

enumerator kSPI_TxFifoOneFourthEmpty
SPI tx watermark at 1/4 FIFO size

enumerator kSPI_TxFifoOneHalfEmpty
SPI tx watermark at 1/2 FIFO size

enum _spi_rxfifo_watermark
SPI RX FIFO watermark settings.

Values:

enumerator kSPI_RxFifoThreeFourthsFull
SPI rx watermark at 3/4 FIFO size

enumerator kSPI_RxFifoOneHalfFull
SPI rx watermark at 1/2 FIFO size

enum _spi_dma_enable_t
SPI DMA source.

Values:

enumerator kSPI_TxDmaEnable
Tx DMA request source

enumerator kSPI_RxDmaEnable
Rx DMA request source

enumerator kSPI_DmaAllEnable
All DMA request source

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_shift_direction* spi_shift_direction_t
SPI data shifter direction options.

typedef enum *_spi_ss_output_mode* spi_ss_output_mode_t
SPI slave select output mode options.

typedef enum *_spi_pin_mode* spi_pin_mode_t
SPI pin mode options.

typedef enum *_spi_data_bitcount_mode* spi_data_bitcount_mode_t
SPI data length mode options.

typedef enum *_spi_w1c_interrupt* spi_w1c_interrupt_t
SPI FIFO write-1-to-clear interrupt flags.

typedef enum *_spi_txfifo_watermark* spi_txfifo_watermark_t
SPI TX FIFO watermark settings.

typedef enum *_spi_rxfifo_watermark* spi_rxfifo_watermark_t
SPI RX FIFO watermark settings.

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_master_handle* spi_master_handle_t

typedef *spi_master_handle_t* spi_slave_handle_t
Slave handle is the same with master handle

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 master callback for finished transmit.

volatile uint8_t g_spiDummyData[]
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.

struct _spi_master_config
#include <fsl_spi.h> SPI master user configure structure.

Public Members

bool enableMaster
Enable SPI at initialization time

bool enableStopInWaitMode
SPI stop in wait mode

spi_clock_polarity_t polarity
Clock polarity

spi_clock_phase_t phase
Clock phase

spi_shift_direction_t direction
MSB or LSB

spi_data_bitcount_mode_t dataMode
8bit or 16bit mode

spi_txfifo_watermark_t txWatermark
Tx watermark settings

spi_rxfifo_watermark_t rxWatermark
Rx watermark settings

spi_ss_output_mode_t outputMode
SS pin setting

spi_pin_mode_t pinMode
SPI pin mode select

uint32_t baudRate_Bps
Baud Rate for SPI in Hz

struct _spi_slave_config
#include <fsl_spi.h> SPI slave user configure structure.

Public Members

bool enableSlave
Enable SPI at initialization time

bool enableStopInWaitMode
SPI stop in wait mode

spi_clock_polarity_t polarity
Clock polarity

spi_clock_phase_t phase
Clock phase

spi_shift_direction_t direction
MSB or LSB

spi_data_bitcount_mode_t dataMode
8bit or 16bit mode

spi_txfifo_watermark_t txWatermark
Tx watermark settings

spi_rxfifo_watermark_t rxWatermark
Rx watermark settings

spi_pin_mode_t pinMode
SPI pin mode select

struct _spi_transfer
#include <fsl_spi.h> SPI transfer structure.

Public Members

const uint8_t *txData
Send buffer

uint8_t *rxData
Receive buffer

size_t dataSize
Transfer bytes

uint32_t flags
SPI control flag, useless to SPI.

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
Send data remaining in bytes

volatile size_t rxRemainingBytes
Receive data remaining in bytes

volatile uint32_t state
SPI internal state

size_t transferSize
Bytes to be transferred

uint8_t bytePerFrame
SPI mode, 2bytes or 1byte in a frame

uint8_t watermark
Watermark value for SPI transfer

spi_master_callback_t callback
SPI callback

void *userData
Callback parameter

2.54 TPM: Timer PWM Module

uint32_t TPM_GetInstance(TPM_Type *base)
Gets the instance from the base address.

Parameters

- base – TPM peripheral base address

Returns
The TPM instance

void TPM_Init(TPM_Type *base, const *tpm_config_t* *config)
Ungates the TPM clock and configures the peripheral for basic operation.

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

Parameters

- base – TPM peripheral base address
- config – Pointer to user's TPM config structure.

void TPM_Deinit(TPM_Type *base)
Stops the counter and gates the TPM clock.

Parameters

- base – TPM peripheral base address

void TPM_GetDefaultConfig(*tpm_config_t* *config)

Fill in the TPM config struct with the default settings.

The default values are:

```
    config->prescale = kTPM_Prescale_Divide_1;
    config->useGlobalTimeBase = false;
    config->syncGlobalTimeBase = false;
    config->dozeEnable = false;
    config->dbgMode = false;
    config->enableReloadOnTrigger = false;
    config->enableStopOnOverflow = false;
    config->enableStartOnTrigger = false;
#if FSL_FEATURE_TPM_HAS_PAUSE_COUNTER_ON_TRIGGER
    config->enablePauseOnTrigger = false;
#endif
    config->triggerSelect = kTPM_Trigger_Select_0;
#if FSL_FEATURE_TPM_HAS_EXTERNAL_TRIGGER_SELECTION
    config->triggerSource = kTPM_TriggerSource_External;
    config->extTriggerPolarity = kTPM_ExtTrigger_Active_High;
#endif
#if defined(FSL_FEATURE_TPM_HAS_POL) && FSL_FEATURE_TPM_HAS_POL
    config->chnlPolarity = 0U;
#endif
```

Parameters

- config – Pointer to user's TPM config structure.

tpm_clock_prescale_t TPM_CalculateCounterClkDiv(TPM_Type *base, uint32_t counterPeriod_Hz, uint32_t srcClock_Hz)

Calculates the counter clock prescaler.

This function calculates the values for SC[PS].

return Calculated clock prescaler value.

Parameters

- base – TPM peripheral base address
- counterPeriod_Hz – The desired frequency in Hz which corresponding to the time when the counter reaches the mod value
- srcClock_Hz – TPM counter clock in Hz

status_t TPM_SetupPwm(TPM_Type *base, const *tpm_chnl_pwm_signal_param_t* *chnlParams, uint8_t numOfChnls, *tpm_pwm_mode_t* mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)

Configures the PWM signal parameters.

User calls this function to configure the PWM signals period, mode, dutycycle and edge. Use this function to configure all the TPM channels that will be used to output a PWM signal

Parameters

- base – TPM peripheral base address
- chnlParams – Array of PWM channel parameters to configure the channel(s)
- numOfChnls – Number of channels to configure, this should be the size of the array passed in

- mode – PWM operation mode, options available in enumeration tpm_pwm_mode_t
- pwmFreq_Hz – PWM signal frequency in Hz
- srcClock_Hz – TPM counter clock in Hz

Returns
kStatus_Success if the PWM setup was successful, kStatus_Error on failure

status_t TPM_UpdatePwmDutycycle(TPM_Type *base, *tpm_chnl_t* chnlNumber, *tpm_pwm_mode_t* currentPwmMode, uint8_t dutyCyclePercent)

Update the duty cycle of an active PWM signal.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number. In combined mode, this represents the channel pair number
- currentPwmMode – The current PWM mode set during PWM setup
- dutyCyclePercent – New PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

Returns
kStatus_Success if the PWM setup was successful, kStatus_Error on failure

void TPM_UpdateChnlEdgeLevelSelect(TPM_Type *base, *tpm_chnl_t* chnlNumber, uint8_t level)

Update the edge level selection for a channel.

Note: When the TPM has PWM pause level select feature (FSL_FEATURE_TPM_HAS_PAUSE_LEVEL_SELECT = 1), the PWM output cannot be turned off by selecting the output level. In this case, must use TPM_DisableChannel API to close the PWM output.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- level – The level to be set to the ELSnB:ELSnA field; valid values are 00, 01, 10, 11. See the appropriate SoC reference manual for details about this field.

static inline uint8_t TPM_GetChannelContorlBits(TPM_Type *base, *tpm_chnl_t* chnlNumber)

Get the channel control bits value (mode, edge and level bit fileds).

This function disable the channel by clear all mode and level control bits.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number

Returns
The contorl bits value. This is the logical OR of members of the enumeration tpm_chnl_control_bit_mask_t.

static inline void TPM_DisableChannel(TPM_Type *base, *tpm_chnl_t* chnlNumber)

Dsiable the channel.

This function disable the channel by clear all mode and level control bits.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number

static inline void TPM_EnableChannel(TPM_Type *base, *tpm_chnl_t* chnlNumber, uint8_t control)

Enable the channel according to mode and level configs.

This function enable the channel output according to input mode/level config parameters.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- control – The contorl bits value. This is the logical OR of members of the enumeration tpm_chnl_control_bit_mask_t.

void TPM_SetupInputCapture(TPM_Type *base, *tpm_chnl_t* chnlNumber, *tpm_input_capture_edge_t* captureMode)

Enables capturing an input signal on the channel using the function parameters.

When the edge specified in the captureMode argument occurs on the channel, the TPM counter is captured into the CnV register. The user has to read the CnV register separately to get this value.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- captureMode – Specifies which edge to capture

void TPM_SetupOutputCompare(TPM_Type *base, *tpm_chnl_t* chnlNumber, *tpm_output_compare_mode_t* compareMode, uint32_t compareValue)

Configures the TPM to generate timed pulses.

When the TPM counter matches the value of compareVal argument (this is written into CnV reg), the channel output is changed based on what is specified in the compareMode argument.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- compareMode – Action to take on the channel output when the compare condition is met
- compareValue – Value to be programmed in the CnV register.

void TPM_SetupDualEdgeCapture(TPM_Type *base, *tpm_chnl_t* chnlPairNumber, const *tpm_dual_edge_capture_param_t* *edgeParam, uint32_t filterValue)

Configures the dual edge capture mode of the TPM.

This function allows to measure a pulse width of the signal on the input of channel of a channel pair. The filter function is disabled if the filterVal argument passed is zero.

Parameters

- base – TPM peripheral base address
- chnlPairNumber – The TPM channel pair number; options are 0, 1, 2, 3

- edgeParam – Sets up the dual edge capture function
- filterValue – Filter value, specify 0 to disable filter.

void TPM_SetupQuadDecode(TPM_Type *base, const *tpm_phase_params_t* *phaseAParams, const *tpm_phase_params_t* *phaseBParams, *tpm_quad_decode_mode_t* quadMode)

Configures the parameters and activates the quadrature decode mode.

Parameters

- base – TPM peripheral base address
- phaseAParams – Phase A configuration parameters
- phaseBParams – Phase B configuration parameters
- quadMode – Selects encoding mode used in quadrature decoder mode

static inline void TPM_SetChannelPolarity(TPM_Type *base, *tpm_chnl_t* chnlNumber, bool enable)

Set the input and output polarity of each of the channels.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- enable – true: Set the channel polarity to active high; false: Set the channel polarity to active low;

static inline void TPM_EnableChannelExtTrigger(TPM_Type *base, *tpm_chnl_t* chnlNumber, bool enable)

Enable external trigger input to be used by channel.

In input capture mode, configures the trigger input that is used by the channel to capture the counter value. In output compare or PWM mode, configures the trigger input used to modulate the channel output. When modulating the output, the output is forced to the channel initial value whenever the trigger is not asserted.

Note: No matter how many external trigger sources there are, only input trigger 0 and 1 are used. The even numbered channels share the input trigger 0 and the odd numbered channels share the second input trigger 1.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number
- enable – true: Configures trigger input 0 or 1 to be used by channel; false: Trigger input has no effect on the channel

void TPM_EnableInterrupts(TPM_Type *base, uint32_t mask)

Enables the selected TPM interrupts.

Parameters

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

void TPM_DisableInterrupts(TPM_Type *base, uint32_t mask)

Disables the selected TPM interrupts.

Parameters

- base – TPM peripheral base address
- mask – The interrupts to disable. This is a logical OR of members of the enumeration tpm_interrupt_enable_t

uint32_t TPM_GetEnabledInterrupts(TPM_Type *base)

Gets the enabled TPM interrupts.

Parameters

- base – TPM peripheral base address

Returns

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

void TPM_RegisterCallBack(TPM_Type *base, *tpm_callback_t* callback)

Register callback.

If channel or overflow interrupt is enabled by the user, then a callback can be registered which will be invoked when the interrupt is triggered.

Parameters

- base – TPM peripheral base address
- callback – Callback function

static inline uint32_t TPM_GetChannelValue(TPM_Type *base, *tpm_chnl_t* chnlNumber)

Gets the TPM channel value.

Note: The TPM channel value contain the captured TPM counter value for the input modes or the match value for the output modes.

Parameters

- base – TPM peripheral base address
- chnlNumber – The channel number

Returns

The channle CnV regisyer value.

static inline uint32_t TPM_GetStatusFlags(TPM_Type *base)

Gets the TPM status flags.

Parameters

- base – TPM peripheral base address

Returns

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

static inline void TPM_ClearStatusFlags(TPM_Type *base, uint32_t mask)

Clears the TPM status flags.

Parameters

- base – TPM peripheral base address

- mask – The status flags to clear. This is a logical OR of members of the enumeration tpm_status_flags_t

static inline void TPM_SetTimerPeriod(TPM_Type *base, uint32_t ticks)

Sets the timer period in units of ticks.

Timers counts from 0 until it equals the count value set here. The count value is written to the MOD register.

Note:

a. This API allows the user to use the TPM module as a timer. Do not mix usage of this API with TPM's PWM setup API's.

b. Call the utility macros provided in the fsl_common.h to convert usec or msec to ticks.

Parameters

- base – TPM peripheral base address
- ticks – A timer period in units of ticks, which should be equal or greater than 1.

static inline uint32_t TPM_GetCurrentTimerCount(TPM_Type *base)

Reads the current timer counting value.

This function returns the real-time timer counting value in a range from 0 to a timer period.

Note: Call the utility macros provided in the fsl_common.h to convert ticks to usec or msec.

Parameters

- base – TPM peripheral base address

Returns

The current counter value in ticks

static inline void TPM_StartTimer(TPM_Type *base, *tpm_clock_source_t* clockSource)

Starts the TPM counter.

Parameters

- base – TPM peripheral base address
- clockSource – TPM clock source; once clock source is set the counter will start running

static inline void TPM_StopTimer(TPM_Type *base)

Stops the TPM counter.

Parameters

- base – TPM peripheral base address

FSL_TPM_DRIVER_VERSION

TPM driver version 2.3.5.

enum _tpm_chnl

List of TPM channels.

Note: Actual number of available channels is SoC dependent

Values:

enumerator kTPM_Chnl_0
TPM channel number 0

enumerator kTPM_Chnl_1
TPM channel number 1

enumerator kTPM_Chnl_2
TPM channel number 2

enumerator kTPM_Chnl_3
TPM channel number 3

enumerator kTPM_Chnl_4
TPM channel number 4

enumerator kTPM_Chnl_5
TPM channel number 5

enumerator kTPM_Chnl_6
TPM channel number 6

enumerator kTPM_Chnl_7
TPM channel number 7

enum _tpm_pwm_mode
TPM PWM operation modes.

Values:

enumerator kTPM_EdgeAlignedPwm
Edge aligned PWM

enumerator kTPM_CenterAlignedPwm
Center aligned PWM

enumerator kTPM_CombinedPwm
Combined PWM (Edge-aligned, center-aligned, or asymmetrical PWMs can be obtained in combined mode using different software configurations)

enum _tpm_pwm_level_select
TPM PWM output pulse mode: high-true, low-true or no output.

Note: When the TPM has PWM pause level select feature, the PWM output cannot be turned off by selecting the output level. In this case, the channel must be closed to close the PWM output.

Values:

enumerator kTPM_NoPwmSignal
No PWM output on pin

enumerator kTPM_LowTrue
Low true pulses

enumerator kTPM_HighTrue
High true pulses

enum _tpm_chnl_control_bit_mask
List of TPM channel modes and level control bit mask.

Values:

enumerator kTPM_ChnlELSnAMask
Channel ELSA bit mask.

enumerator kTPM_ChnlELSnBMask
Channel ELSB bit mask.

enumerator kTPM_ChnlMSAMask
Channel MSA bit mask.

enumerator kTPM_ChnlMSBMask
Channel MSB bit mask.

enum _tpm_trigger_select
Trigger sources available.

This is used for both internal & external trigger sources (external trigger sources available in certain SoC's)

Note: The actual trigger sources available is SoC-specific.

Values:

enumerator kTPM_Trigger_Select_0

enumerator kTPM_Trigger_Select_1

enumerator kTPM_Trigger_Select_2

enumerator kTPM_Trigger_Select_3

enumerator kTPM_Trigger_Select_4

enumerator kTPM_Trigger_Select_5

enumerator kTPM_Trigger_Select_6

enumerator kTPM_Trigger_Select_7

enumerator kTPM_Trigger_Select_8

enumerator kTPM_Trigger_Select_9

enumerator kTPM_Trigger_Select_10

enumerator kTPM_Trigger_Select_11

enumerator kTPM_Trigger_Select_12

enumerator kTPM_Trigger_Select_13

enumerator kTPM_Trigger_Select_14

enumerator kTPM_Trigger_Select_15

enum _tpm_trigger_source
Trigger source options available.

Note: This selection is available only on some SoC's. For SoC's without this selection, the only trigger source available is internal triger.

Values:

enumerator kTPM_TriggerSource_External
Use external trigger input

enumerator kTPM_TriggerSource_Internal
Use internal trigger (channel pin input capture)

enum _tpm_ext_trigger_polarity
External trigger source polarity.

Note: Selects the polarity of the external trigger source.

Values:

enumerator kTPM_ExtTrigger_Active_High
External trigger input is active high

enumerator kTPM_ExtTrigger_Active_Low
External trigger input is active low

enum _tpm_output_compare_mode
TPM output compare modes.

Values:

enumerator kTPM_NoOutputSignal
No channel output when counter reaches CnV

enumerator kTPM_ToggleOnMatch
Toggle output

enumerator kTPM_ClearOnMatch
Clear output

enumerator kTPM_SetOnMatch
Set output

enumerator kTPM_HighPulseOutput
Pulse output high

enumerator kTPM_LowPulseOutput
Pulse output low

enum _tpm_input_capture_edge
TPM input capture edge.

Values:

enumerator kTPM_RisingEdge
Capture on rising edge only

enumerator kTPM_FallingEdge
Capture on falling edge only

enumerator kTPM_RiseAndFallEdge
Capture on rising or falling edge

enum _tpm_quad_decode_mode
TPM quadrature decode modes.

Note: This mode is available only on some SoC's.

Values:

enumerator kTPM_QuadPhaseEncode
Phase A and Phase B encoding mode

enumerator kTPM_QuadCountAndDir
Count and direction encoding mode

enum _tpm_phase_polarity
TPM quadrature phase polarities.

Values:

enumerator kTPM_QuadPhaseNormal
Phase input signal is not inverted

enumerator kTPM_QuadPhaseInvert
Phase input signal is inverted

enum _tpm_clock_source
TPM clock source selection.

Values:

enumerator kTPM_SystemClock
System clock

enumerator kTPM_ExternalClock
External TPM_EXTCLK pin clock

enumerator kTPM_ExternalInputTriggerClock
Selected external input trigger clock

enum _tpm_clock_prescale
TPM prescale value selection for the clock source.

Values:

enumerator kTPM_Prescale_Divide_1
Divide by 1

enumerator kTPM_Prescale_Divide_2
Divide by 2

enumerator kTPM_Prescale_Divide_4
Divide by 4

enumerator kTPM_Prescale_Divide_8
Divide by 8

enumerator kTPM_Prescale_Divide_16
Divide by 16

enumerator kTPM_Prescale_Divide_32
Divide by 32

enumerator kTPM_Prescale_Divide_64
Divide by 64

enumerator kTPM_Prescale_Divide_128
Divide by 128

enum _tpm_interrupt_enable
List of TPM interrupts.

Values:

enumerator kTPM_Chnl0InterruptEnable
Channel 0 interrupt.

enumerator kTPM_Chnl1InterruptEnable
Channel 1 interrupt.

enumerator kTPM_Chnl2InterruptEnable
Channel 2 interrupt.

enumerator kTPM_Chnl3InterruptEnable
Channel 3 interrupt.

enumerator kTPM_Chnl4InterruptEnable
Channel 4 interrupt.

enumerator kTPM_Chnl5InterruptEnable
Channel 5 interrupt.

enumerator kTPM_Chnl6InterruptEnable
Channel 6 interrupt.

enumerator kTPM_Chnl7InterruptEnable
Channel 7 interrupt.

enumerator kTPM_TimeOverflowInterruptEnable
Time overflow interrupt.

enum _tpm_status_flags
List of TPM flags.

Values:

enumerator kTPM_Chnl0Flag
Channel 0 flag

enumerator kTPM_Chnl1Flag
Channel 1 flag

enumerator kTPM_Chnl2Flag
Channel 2 flag

enumerator kTPM_Chnl3Flag
Channel 3 flag

enumerator kTPM_Chnl4Flag
Channel 4 flag

enumerator kTPM_Chnl5Flag
Channel 5 flag

enumerator kTPM_Chnl6Flag
Channel 6 flag

enumerator kTPM_Chnl7Flag
Channel 7 flag

enumerator kTPM_TimeOverflowFlag
Time overflow flag

typedef enum *_tpm_chnl* tpm_chnl_t
List of TPM channels.

Note: Actual number of available channels is SoC dependent

typedef enum *_tpm_pwm_mode* tpm_pwm_mode_t

TPM PWM operation modes.

typedef enum *_tpm_pwm_level_select* tpm_pwm_level_select_t

TPM PWM output pulse mode: high-true, low-true or no output.

Note: When the TPM has PWM pause level select feature, the PWM output cannot be turned off by selecting the output level. In this case, the channel must be closed to close the PWM output.

typedef enum *_tpm_chnl_control_bit_mask* tpm_chnl_control_bit_mask_t

List of TPM channel modes and level control bit mask.

typedef struct *_tpm_chnl_pwm_signal_param* tpm_chnl_pwm_signal_param_t

Options to configure a TPM channel's PWM signal.

typedef enum *_tpm_trigger_select* tpm_trigger_select_t

Trigger sources available.

This is used for both internal & external trigger sources (external trigger sources available in certain SoC's)

Note: The actual trigger sources available is SoC-specific.

typedef enum *_tpm_trigger_source* tpm_trigger_source_t

Trigger source options available.

Note: This selection is available only on some SoC's. For SoC's without this selection, the only trigger source available is internal triger.

typedef enum *_tpm_ext_trigger_polarity* tpm_ext_trigger_polarity_t

External trigger source polarity.

Note: Selects the polarity of the external trigger source.

typedef enum *_tpm_output_compare_mode* tpm_output_compare_mode_t

TPM output compare modes.

typedef enum *_tpm_input_capture_edge* tpm_input_capture_edge_t

TPM input capture edge.

typedef struct *_tpm_dual_edge_capture_param* tpm_dual_edge_capture_param_t

TPM dual edge capture parameters.

Note: This mode is available only on some SoC's.

typedef enum *_tpm_quad_decode_mode* tpm_quad_decode_mode_t

TPM quadrature decode modes.

Note: This mode is available only on some SoC's.

typedef enum *_tpm_phase_polarity* tpm_phase_polarity_t

TPM quadrature phase polarities.

typedef struct *_tpm_phase_param* tpm_phase_params_t

TPM quadrature decode phase parameters.

typedef enum *_tpm_clock_source* tpm_clock_source_t

TPM clock source selection.

typedef enum *_tpm_clock_prescale* tpm_clock_prescale_t

TPM prescale value selection for the clock source.

typedef struct *_tpm_config* tpm_config_t

TPM config structure.

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

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

typedef enum *_tpm_interrupt_enable* tpm_interrupt_enable_t

List of TPM interrupts.

typedef enum *_tpm_status_flags* tpm_status_flags_t

List of TPM flags.

typedef void (*tpm_callback_t)(TPM_Type *base)

TPM callback function pointer.

Param base

TPM peripheral base address.

static inline void TPM_Reset(TPM_Type *base)

Performs a software reset on the TPM module.

Reset all internal logic and registers, except the Global Register. Remains set until cleared by software.

Note: TPM software reset is available on certain SoC's only

Parameters

- base – TPM peripheral base address

void TPM_DriverIRQHandler(uint32_t instance)

TPM driver IRQ handler common entry.

This function provides the common IRQ request entry for TPM.

Parameters

- instance – TPM instance.

TPM_MAX_COUNTER_VALUE(x)

Help macro to get the max counter value.

struct _tpm_chnl_pwm_signal_param

#include <fsl_tpm.h> Options to configure a TPM channel's PWM signal.

Public Members

tpm_chnl_t chnlNumber

TPM channel to configure. In combined mode (available in some SoC's), this represents the channel pair number

tpm_pwm_level_select_t level

PWM output active level select

uint8_t dutyCyclePercent

PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=always active signal (100% duty cycle)

uint8_t firstEdgeDelayPercent

Used only in combined PWM mode to generate asymmetrical PWM. Specifies the delay to the first edge in a PWM period. If unsure, leave as 0. Should be specified as percentage of the PWM period, (dutyCyclePercent + firstEdgeDelayPercent) value should be not greate than 100.

bool enableComplementary

Used only in combined PWM mode. true: The combined channels output complementary signals; false: The combined channels output same signals;

uint8_t deadTimeValue[2]

The dead time value for channel n and n+1 in combined complementary PWM mode. Deadtime insertion is disabled when this value is zero, otherwise deadtime insertion for channel n/n+1 is configured as (deadTimeValue * 4) clock cycles. deadTimeValue's available range is 0 ~ 15.

struct __tpm__dual__edge__capture__param

#include <fsl_tpm.h> TPM dual edge capture parameters.

Note: This mode is available only on some SoC's.

Public Members

bool enableSwap

true: Use channel n+1 input, channel n input is ignored; false: Use channel n input, channel n+1 input is ignored

tpm_input_capture_edge_t currChanEdgeMode

Input capture edge select for channel n

tpm_input_capture_edge_t nextChanEdgeMode

Input capture edge select for channel n+1

struct __tpm__phase__param

#include <fsl_tpm.h> TPM quadrature decode phase parameters.

Public Members

uint32_t phaseFilterVal

Filter value, filter is disabled when the value is zero

tpm_phase_polarity_t phasePolarity

Phase polarity

struct _tpm_config

#include <fsl_tpm.h> TPM config structure.

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

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

Public Members

tpm_clock_prescale_t prescale

Select TPM clock prescale value

bool useGlobalTimeBase

true: The TPM channels use an external global time base (the local counter still use for generate overflow interrupt and DMA request); false: All TPM channels use the local counter as their timebase

bool syncGlobalTimeBase

true: The TPM counter is synchronized to the global time base; false: disabled

tpm_trigger_select_t triggerSelect

Input trigger to use for controlling the counter operation

tpm_trigger_source_t triggerSource

Decides if we use external or internal trigger.

tpm_ext_trigger_polarity_t extTriggerPolarity

when using external trigger source, need selects the polarity of it.

bool enableDoze

true: TPM counter is paused in doze mode; false: TPM counter continues in doze mode

bool enableDebugMode

true: TPM counter continues in debug mode; false: TPM counter is paused in debug mode

bool enableReloadOnTrigger

true: TPM counter is reloaded on trigger; false: TPM counter not reloaded

bool enableStopOnOverflow

true: TPM counter stops after overflow; false: TPM counter continues running after overflow

bool enableStartOnTrigger

true: TPM counter only starts when a trigger is detected; false: TPM counter starts immediately

bool enablePauseOnTrigger

true: TPM counter will pause while trigger remains asserted; false: TPM counter continues running

uint8_t chnlPolarity

Defines the input/output polarity of the channels in POL register

2.55 UART: Universal Asynchronous Receiver/Transmitter Driver

2.56 UART DMA Driver

void UART_TransferCreateHandleDMA(UART_Type *base, *uart_dma_handle_t* *handle, *uart_dma_transfer_callback_t* callback, void *userData, *dma_handle_t* *txDmaHandle, *dma_handle_t* *rxDmaHandle)

Initializes the UART handle which is used in transactional functions and sets the callback.

Parameters

- base – UART peripheral base address.
- handle – Pointer to the uart_dma_handle_t structure.
- callback – UART callback, NULL means no callback.
- userData – User callback function data.
- rxDmaHandle – User requested DMA handle for the RX DMA transfer.
- txDmaHandle – User requested DMA handle for the TX DMA transfer.

status_t UART_TransferSendDMA(UART_Type *base, *uart_dma_handle_t* *handle, *uart_transfer_t* *xfer)

Sends data using DMA.

This function sends data using DMA. This is non-blocking function, which returns right away. When all data is sent, the send callback function is called.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.
- xfer – UART DMA transfer structure. See uart_transfer_t.

Return values

- kStatus_Success – if succeeded; otherwise failed.
- kStatus_UART_TxBusy – Previous transfer ongoing.
- kStatus_InvalidArgument – Invalid argument.

status_t UART_TransferReceiveDMA(UART_Type *base, *uart_dma_handle_t* *handle, *uart_transfer_t* *xfer)

Receives data using DMA.

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

Parameters

- base – UART peripheral base address.
- handle – Pointer to the uart_dma_handle_t structure.
- xfer – UART DMA transfer structure. See uart_transfer_t.

Return values

- kStatus_Success – if succeeded; otherwise failed.
- kStatus_UART_RxBusy – Previous transfer on going.
- kStatus_InvalidArgument – Invalid argument.

void UART_TransferAbortSendDMA(UART_Type *base, *uart_dma_handle_t* *handle)

Aborts the send data using DMA.

This function aborts the sent data using DMA.

Parameters

- base – UART peripheral base address.
- handle – Pointer to uart_dma_handle_t structure.

void UART_TransferAbortReceiveDMA(UART_Type *base, *uart_dma_handle_t* *handle)

Aborts the received data using DMA.

This function abort receive data which using DMA.

Parameters

- base – UART peripheral base address.
- handle – Pointer to uart_dma_handle_t structure.

status_t UART_TransferGetSendCountDMA(UART_Type *base, *uart_dma_handle_t* *handle, uint32_t *count)

Gets the number of bytes written to UART TX register.

This function gets the number of bytes written to UART TX register by DMA.

Parameters

- base – UART peripheral base address.
- handle – UART 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 UART_TransferGetReceiveCountDMA(UART_Type *base, *uart_dma_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- base – UART peripheral base address.
- handle – UART 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 UART_TransferDMAHandleIRQ(UART_Type *base, void *uartDmaHandle)

UART DMA IRQ handle function.

This function handles the UART transmit complete IRQ request and invoke user callback.

Parameters

- base – UART peripheral base address.
- uartDmaHandle – UART handle pointer.

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UART DMA driver version.

typedef struct *_uart_dma_handle* uart_dma_handle_t

typedef void (*uart_dma_transfer_callback_t)(UART_Type *base, *uart_dma_handle_t* *handle, *status_t* status, void *userData)
UART transfer callback function.

struct _uart_dma_handle
#include <fsl_uart_dma.h> UART DMA handle.

Public Members

UART_Type *base
UART peripheral base address.

uart_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

2.57 UART Driver

status_t UART_Init(UART_Type *base, const *uart_config_t* *config, uint32_t srcClock_Hz)
Initializes a UART instance with a user configuration structure and peripheral clock.

This function configures the UART module with the user-defined settings. The user can configure the configuration structure and also get the default configuration by using the UART_GetDefaultConfig() function. The example below shows how to use this API to configure UART.

```
uart_config_t uartConfig;
uartConfig.baudRate_Bps = 115200U;
uartConfig.parityMode = kUART_ParityDisabled;
uartConfig.stopBitCount = kUART_OneStopBit;
uartConfig.txFifoWatermark = 0;
uartConfig.rxFifoWatermark = 1;
UART_Init(UART1, &uartConfig, 20000000U);
```

Parameters

- base – UART peripheral base address.
- config – Pointer to the user-defined configuration structure.
- srcClock_Hz – UART clock source frequency in HZ.

Return values

- kStatus_UART_BaudrateNotSupport – Baudrate is not support in current clock source.
- kStatus_Success – Status UART initialize succeed

void UART_Deinit(UART_Type *base)

Deinitializes a UART instance.

This function waits for TX complete, disables TX and RX, and disables the UART clock.

Parameters

- base – UART peripheral base address.

void UART_GetDefaultConfig(*uart_config_t* *config)

Gets the default configuration structure.

This function initializes the UART configuration structure to a default value. The default values are as follows. uartConfig->baudRate_Bps = 115200U; uartConfig->bitCountPerChar = kUART_8BitsPerChar; uartConfig->parityMode = kUART_ParityDisabled; uartConfig->stopBitCount = kUART_OneStopBit; uartConfig->txFifoWatermark = 0; uartConfig->rxFifoWatermark = 1; uartConfig->idleType = kUART_IdleTypeStartBit; uartConfig->enableTx = false; uartConfig->enableRx = false;

Parameters

- config – Pointer to configuration structure.

status_t UART_SetBaudRate(UART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

Sets the UART instance baud rate.

This function configures the UART module baud rate. This function is used to update the UART module baud rate after the UART module is initialized by the UART_Init.

```
UART_SetBaudRate(UART1, 115200U, 20000000U);
```

Parameters

- base – UART peripheral base address.
- baudRate_Bps – UART baudrate to be set.
- srcClock_Hz – UART clock source frequency in Hz.

Return values

- kStatus_UART_BaudrateNotSupport – Baudrate is not support in the current clock source.
- kStatus_Success – Set baudrate succeeded.

void UART_Enable9bitMode(UART_Type *base, bool enable)

Enable 9-bit data mode for UART.

This function set the 9-bit mode for UART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

- base – UART peripheral base address.
- enable – true to enable, flase to disable.

static inline void UART_SetMatchAddress(UART_Type *base, uint8_t address1, uint8_t address2)

Set the UART slave address.

This function configures the address for UART module that works as slave in 9-bit data mode. One or two address fields can be configured. When the address field's match enable bit is set, the frame it receices with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note: Any UART 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 – UART peripheral base address.
- address1 – UART slave address 1.
- address2 – UART slave address 2.

static inline void UART_EnableMatchAddress(UART_Type *base, bool match1, bool match2)

Enable the UART match address feature.

Parameters

- base – UART peripheral base address.
- match1 – true to enable match address1, false to disable.
- match2 – true to enable match address2, false to disable.

static inline void UART_Set9thTransmitBit(UART_Type *base)

Set UART 9th transmit bit.

Parameters

- base – UART peripheral base address.

static inline void UART_Clear9thTransmitBit(UART_Type *base)

Clear UART 9th transmit bit.

Parameters

- base – UART peripheral base address.

uint32_t UART_GetStatusFlags(UART_Type *base)

Gets UART status flags.

This function gets all UART status flags. The flags are returned as the logical OR value of the enumerators _uart_flags. To check a specific status, compare the return value with enumerators in _uart_flags. For example, to check whether the TX is empty, do the following.

```
if (kUART_TxDataRegEmptyFlag & UART_GetStatusFlags(UART1))
{
    ...
}
```

Parameters

- base – UART peripheral base address.

Returns

UART status flags which are ORed by the enumerators in the _uart_flags.

status_t UART_ClearStatusFlags(UART_Type *base, uint32_t mask)

Clears status flags with the provided mask.

This function clears UART status flags with a provided mask. An automatically cleared flag can't be cleared by this function. These flags can only be cleared or set by hardware. kUART_TxDataRegEmptyFlag, kUART_TransmissionCompleteFlag, kUART_RxDataRegFullFlag, kUART_RxActiveFlag, kUART_NoiseErrorInRxDataRegFlag, kUART_ParityErrorInRxDataRegFlag, kUART_TxFifoEmptyFlag,kUART_RxFifoEmptyFlag

---

Note: that this API should be called when the Tx/Rx is idle. Otherwise it has no effect.

Parameters

- base – UART peripheral base address.
- mask – The status flags to be cleared; it is logical OR value of _uart_flags.

Return values

- kStatus_UART_FlagCannotClearManually – The flag can't be cleared by this function but it is cleared automatically by hardware.
- kStatus_Success – Status in the mask is cleared.

void UART_EnableInterrupts(UART_Type *base, uint32_t mask)

Enables UART interrupts according to the provided mask.

This function enables the UART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _uart_interrupt_enable. For example, to enable TX empty interrupt and RX full interrupt, do the following.

```
UART_EnableInterrupts(UART1,kUART_TxDataRegEmptyInterruptEnable | kUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – UART peripheral base address.
- mask – The interrupts to enable. Logical OR of _uart_interrupt_enable.

void UART_DisableInterrupts(UART_Type *base, uint32_t mask)

Disables the UART interrupts according to the provided mask.

This function disables the UART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _uart_interrupt_enable. For example, to disable TX empty interrupt and RX full interrupt do the following.

```
UART_DisableInterrupts(UART1,kUART_TxDataRegEmptyInterruptEnable | kUART_
↪RxDataRegFullInterruptEnable);
```

Parameters

- base – UART peripheral base address.
- mask – The interrupts to disable. Logical OR of _uart_interrupt_enable.

uint32_t UART_GetEnabledInterrupts(UART_Type *base)

Gets the enabled UART interrupts.

This function gets the enabled UART interrupts. The enabled interrupts are returned as the logical OR value of the enumerators _uart_interrupt_enable. To check a specific interrupts enable status, compare the return value with enumerators in _uart_interrupt_enable. For example, to check whether TX empty interrupt is enabled, do the following.

```
uint32_t enabledInterrupts = UART_GetEnabledInterrupts(UART1);

if (kUART_TxDataRegEmptyInterruptEnable & enabledInterrupts)
{
    ...
}
```

Parameters

- base – UART peripheral base address.

Returns

UART interrupt flags which are logical OR of the enumerators in _uart_interrupt_enable.

static inline uint32_t UART_GetDataRegisterAddress(UART_Type *base)

Gets the UART data register address.

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

- base – UART peripheral base address.

Returns

UART data register addresses which are used both by the transmitter and the receiver.

static inline void UART_EnableTxDMA(UART_Type *base, bool enable)

Enables or disables the UART transmitter DMA request.

This function enables or disables the transmit data register empty flag, S1[TDRE], to generate the DMA requests.

Parameters

- base – UART peripheral base address.
- enable – True to enable, false to disable.

static inline void UART_EnableRxDMA(UART_Type *base, bool enable)

Enables or disables the UART receiver DMA.

This function enables or disables the receiver data register full flag, S1[RDRF], to generate DMA requests.

Parameters

- base – UART peripheral base address.
- enable – True to enable, false to disable.

static inline void UART_EnableTx(UART_Type *base, bool enable)

Enables or disables the UART transmitter.

This function enables or disables the UART transmitter.

Parameters

- base – UART peripheral base address.
- enable – True to enable, false to disable.

static inline void UART_EnableRx(UART_Type *base, bool enable)

Enables or disables the UART receiver.

This function enables or disables the UART receiver.

Parameters

- base – UART peripheral base address.
- enable – True to enable, false to disable.

static inline void UART_WriteByte(UART_Type *base, uint8_t data)

Writes to the TX register.

This function writes data to the TX register directly. The upper layer must ensure that the TX register is empty or TX FIFO has empty room before calling this function.

Parameters

- base – UART peripheral base address.
- data – The byte to write.

static inline uint8_t UART_ReadByte(UART_Type *base)

Reads the RX register directly.

This function reads data from the RX register directly. The upper layer must ensure that the RX register is full or that the TX FIFO has data before calling this function.

Parameters

- base – UART peripheral base address.

Returns

The byte read from UART data register.

static inline uint8_t UART_GetRxFifoCount(UART_Type *base)

Gets the rx FIFO data count.

Parameters

- base – UART peripheral base address.

Returns

rx FIFO data count.

static inline uint8_t UART_GetTxFifoCount(UART_Type *base)

Gets the tx FIFO data count.

Parameters

- base – UART peripheral base address.

Returns

tx FIFO data count.

void UART_SendAddress(UART_Type *base, uint8_t address)

Transmit an address frame in 9-bit data mode.

Parameters

- base – UART peripheral base address.
- address – UART slave address.

status_t UART_WriteBlocking(UART_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 – UART peripheral base address.
- data – Start address of the data to write.
- length – Size of the data to write.

Return values

- kStatus_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully wrote all data.

status_t UART_ReadBlocking(UART_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 reads data from the TX register.

Parameters

- base – UART peripheral base address.
- data – Start address of the buffer to store the received data.
- length – Size of the buffer.

Return values

- kStatus_UART_RxHardwareOverrun – Receiver overrun occurred while receiving data.
- kStatus_UART_NoiseError – A noise error occurred while receiving data.
- kStatus_UART_FramingError – A framing error occurred while receiving data.
- kStatus_UART_ParityError – A parity error occurred while receiving data.
- kStatus_UART_Timeout – Transmission timed out and was aborted.
- kStatus_Success – Successfully received all data.

void UART_TransferCreateHandle(UART_Type *base, *uart_handle_t* *handle, *uart_transfer_callback_t* callback, void *userData)

Initializes the UART handle.

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

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.
- callback – The callback function.
- userData – The parameter of the callback function.

void UART_TransferStartRingBuffer(UART_Type *base, *uart_handle_t* *handle, uint8_t *ringBuffer, size_t ringBufferSize)

Sets up the RX ring buffer.

This function sets up the RX ring buffer to a specific UART handle.

When the RX ring buffer is used, data received are stored into the ring buffer even when the user doesn't call the UART_TransferReceiveNonBlocking() API. If data is already 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, only 31 bytes are used for saving data.

Parameters

- base – UART peripheral base address.
- handle – UART 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 UART_TransferStopRingBuffer(UART_Type *base, *uart_handle_t* *handle)

Aborts the background transfer and uninstalls the ring buffer.

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.

size_t UART_TransferGetRxRingBufferLength(*uart_handle_t* *handle)

Get the length of received data in RX ring buffer.

Parameters

- handle – UART handle pointer.

Returns

Length of received data in RX ring buffer.

status_t UART_TransferSendNonBlocking(UART_Type *base, *uart_handle_t* *handle, *uart_transfer_t* *xfer)

Transmits a buffer of data using the interrupt method.

This function sends data using an interrupt method. This is a non-blocking function, which returns directly without waiting for all data to be written to the TX register. When all data is written to the TX register in the ISR, the UART driver calls the callback function and passes the kStatus_UART_TxIdle as status parameter.

Note: The kStatus_UART_TxIdle is passed to the upper layer when all data is written to the TX register. However, it does not ensure that all data is sent out. Before disabling the TX, check the kUART_TransmissionCompleteFlag to ensure that the TX is finished.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.
- xfer – UART transfer structure. See uart_transfer_t.

Return values

- kStatus_Success – Successfully start the data transmission.
- kStatus_UART_TxBusy – Previous transmission still not finished; data not all written to TX register yet.
- kStatus_InvalidArgument – Invalid argument.

void UART_TransferAbortSend(UART_Type *base, *uart_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 not sent out.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.

status_t UART_TransferGetSendCount(UART_Type *base, *uart_handle_t* *handle, uint32_t *count)

Gets the number of bytes sent out to bus.

This function gets the number of bytes sent out to bus by using the interrupt method.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.
- count – Send bytes count.

Return values

- kStatus_NoTransferInProgress – No send in progress.
- kStatus_InvalidArgument – The parameter is invalid.
- kStatus_Success – Get successfully through the parameter count;

status_t UART_TransferReceiveNonBlocking(UART_Type *base, *uart_handle_t* *handle, *uart_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 UART driver. When the new data arrives, the receive request is serviced first. When all data is received, the UART driver notifies the upper layer through a callback function and passes the status parameter kStatus_UART_RxIdle. For example, 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 UART 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 – UART peripheral base address.
- handle – UART handle pointer.
- xfer – UART transfer structure, see uart_transfer_t.
- receivedBytes – Bytes received from the ring buffer directly.

Return values

- kStatus_Success – Successfully queue the transfer into transmit queue.
- kStatus_UART_RxBusy – Previous receive request is not finished.
- kStatus_InvalidArgument – Invalid argument.

void UART_TransferAbortReceive(UART_Type *base, *uart_handle_t* *handle)

Aborts the interrupt-driven data receiving.

This function aborts the interrupt-driven data receiving. The user can get the remainBytes to know how many bytes are not received yet.

Parameters

- base – UART peripheral base address.
- handle – UART handle pointer.

status_t UART_TransferGetReceiveCount(UART_Type *base, *uart_handle_t* *handle, uint32_t *count)

Gets the number of bytes that have been received.

This function gets the number of bytes that have been received.

Parameters

- base – UART peripheral base address.
- handle – UART 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 UART_EnableTxFIFO(UART_Type *base, bool enable)

Enables or disables the UART Tx FIFO.

This function enables or disables the UART Tx FIFO.

param base UART peripheral base address. param enable true to enable, false to disable. retval kStatus_Success Successfully turn on or turn off Tx FIFO. retval kStatus_Fail Fail to turn on or turn off Tx FIFO.

status_t UART_EnableRxFIFO(UART_Type *base, bool enable)

Enables or disables the UART Rx FIFO.

This function enables or disables the UART Rx FIFO.

param base UART peripheral base address. param enable true to enable, false to disable. retval kStatus_Success Successfully turn on or turn off Rx FIFO. retval kStatus_Fail Fail to turn on or turn off Rx FIFO.

static inline void UART_SetRxFifoWatermark(UART_Type *base, uint8_t water)

Sets the rx FIFO watermark.

Parameters

- base – UART peripheral base address.
- water – Rx FIFO watermark.

static inline void UART_SetTxFifoWatermark(UART_Type *base, uint8_t water)

Sets the tx FIFO watermark.

Parameters

- base – UART peripheral base address.
- water – Tx FIFO watermark.

void UART_TransferHandleIRQ(UART_Type *base, void *irqHandle)

UART IRQ handle function.

This function handles the UART transmit and receive IRQ request.

Parameters

- base – UART peripheral base address.
- irqHandle – UART handle pointer.

void UART_TransferHandleErrorIRQ(UART_Type *base, void *irqHandle)

UART Error IRQ handle function.

This function handles the UART error IRQ request.

Parameters

- base – UART peripheral base address.
- irqHandle – UART handle pointer.

FSL_UART_DRIVER_VERSION

UART driver version.

Error codes for the UART driver.

Values:

enumerator kStatus_UART_TxBusy

Transmitter is busy.

enumerator kStatus_UART_RxBusy

Receiver is busy.

enumerator kStatus_UART_TxIdle

UART transmitter is idle.

enumerator kStatus_UART_RxIdle

UART receiver is idle.

enumerator kStatus_UART_TxWatermarkTooLarge

TX FIFO watermark too large

enumerator kStatus_UART_RxWatermarkTooLarge

RX FIFO watermark too large

enumerator kStatus_UART_FlagCannotClearManually

UART flag can't be manually cleared.

enumerator kStatus_UART_Error

Error happens on UART.

enumerator kStatus_UART_RxRingBufferOverrun

UART RX software ring buffer overrun.

enumerator kStatus_UART_RxHardwareOverrun
UART RX receiver overrun.

enumerator kStatus_UART_NoiseError
UART noise error.

enumerator kStatus_UART_FramingError
UART framing error.

enumerator kStatus_UART_ParityError
UART parity error.

enumerator kStatus_UART_BaudrateNotSupport
Baudrate is not support in current clock source

enumerator kStatus_UART_IdleLineDetected
UART IDLE line detected.

enumerator kStatus_UART_Timeout
UART times out.

enum _uart_parity_mode
UART parity mode.

Values:

enumerator kUART_ParityDisabled
Parity disabled

enumerator kUART_ParityEven
Parity enabled, type even, bit setting: PE|PT = 10

enumerator kUART_ParityOdd
Parity enabled, type odd, bit setting: PE|PT = 11

enum _uart_stop_bit_count
UART stop bit count.

Values:

enumerator kUART_OneStopBit
One stop bit

enumerator kUART_TwoStopBit
Two stop bits

enum _uart_idle_type_select
UART idle type select.

Values:

enumerator kUART_IdleTypeStartBit
Start counting after a valid start bit.

enumerator kUART_IdleTypeStopBit
Start counting after a stop bit.

enum _uart_interrupt_enable
UART interrupt configuration structure, default settings all disabled.

This structure contains the settings for all of the UART interrupt configurations.

Values:

enumerator kUART_LinBreakInterruptEnable
LIN break detect interrupt.

enumerator kUART_RxActiveEdgeInterruptEnable
RX active edge interrupt.

enumerator kUART_TxDataRegEmptyInterruptEnable
Transmit data register empty interrupt.

enumerator kUART_TransmissionCompleteInterruptEnable
Transmission complete interrupt.

enumerator kUART_RxDataRegFullInterruptEnable
Receiver data register full interrupt.

enumerator kUART_IdleLineInterruptEnable
Idle line interrupt.

enumerator kUART_RxOverrunInterruptEnable
Receiver overrun interrupt.

enumerator kUART_NoiseErrorInterruptEnable
Noise error flag interrupt.

enumerator kUART_FramingErrorInterruptEnable
Framing error flag interrupt.

enumerator kUART_ParityErrorInterruptEnable
Parity error flag interrupt.

enumerator kUART_RxFifoOverflowInterruptEnable
RX FIFO overflow interrupt.

enumerator kUART_TxFifoOverflowInterruptEnable
TX FIFO overflow interrupt.

enumerator kUART_RxFifoUnderflowInterruptEnable
RX FIFO underflow interrupt.

enumerator kUART_AllInterruptsEnable

UART status flags.

This provides constants for the UART status flags for use in the UART functions.

Values:

enumerator kUART_TxDataRegEmptyFlag
TX data register empty flag.

enumerator kUART_TransmissionCompleteFlag
Transmission complete flag.

enumerator kUART_RxDataRegFullFlag
RX data register full flag.

enumerator kUART_IdleLineFlag
Idle line detect flag.

enumerator kUART_RxOverrunFlag
RX overrun flag.

enumerator kUART_NoiseErrorFlag
RX takes 3 samples of each received bit. If any of these samples differ, noise flag sets

enumerator kUART_FramingErrorFlag
Frame error flag, sets if logic 0 was detected where stop bit expected

enumerator kUART_ParityErrorFlag
If parity enabled, sets upon parity error detection

enumerator kUART_LinBreakFlag
LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled

enumerator kUART_RxActiveEdgeFlag
RX pin active edge interrupt flag,sets when active edge detected

enumerator kUART_RxActiveFlag
Receiver Active Flag (RAF), sets at beginning of valid start bit

enumerator kUART_NoiseErrorInRxDataRegFlag
Noisy bit, sets if noise detected.

enumerator kUART_ParityErrorInRxDataRegFlag
Parity bit, sets if parity error detected.

enumerator kUART_TxFifoEmptyFlag
TXEMPT bit, sets if TX buffer is empty

enumerator kUART_RxFifoEmptyFlag
RXEMPT bit, sets if RX buffer is empty

enumerator kUART_TxFifoOverflowFlag
TXOF bit, sets if TX buffer overflow occurred

enumerator kUART_RxFifoOverflowFlag
RXOF bit, sets if receive buffer overflow

enumerator kUART_RxFifoUnderflowFlag
RXUF bit, sets if receive buffer underflow

typedef enum *_uart_parity_mode* uart_parity_mode_t
UART parity mode.

typedef enum *_uart_stop_bit_count* uart_stop_bit_count_t
UART stop bit count.

typedef enum *_uart_idle_type_select* uart_idle_type_select_t
UART idle type select.

typedef struct *_uart_config* uart_config_t
UART configuration structure.

typedef struct *_uart_transfer* uart_transfer_t
UART transfer structure.

typedef struct *_uart_handle* uart_handle_t

typedef void (*uart_transfer_callback_t)(UART_Type *base, *uart_handle_t* *handle, *status_t* status, void *userData)
UART transfer callback function.

typedef void (*uart_isr_t)(UART_Type *base, void *handle)

void *s_uartHandle[]
Pointers to uart handles for each instance.

const IRQn_Type s_uartIRQ[]

uart_isr_t s_uartIsr
Pointer to uart IRQ handler for each instance.

uint32_t UART_GetInstance(UART_Type *base)
Get the UART instance from peripheral base address.

Parameters

- base – UART peripheral base address.

Returns
UART instance.

UART_RETRY_TIMES
Retry times for waiting flag.

struct _uart_config
#include <fsl_uart.h> UART configuration structure.

Public Members

uint32_t baudRate_Bps
UART baud rate

uart_parity_mode_t parityMode
Parity mode, disabled (default), even, odd

uart_stop_bit_count_t stopBitCount
Number of stop bits, 1 stop bit (default) or 2 stop bits

uint8_t txFifoWatermark
TX FIFO watermark

uint8_t rxFifoWatermark
RX FIFO watermark

bool enableRxRTS
RX RTS enable

bool enableTxCTS
TX CTS enable

uart_idle_type_select_t idleType
IDLE type select.

bool enableTx
Enable TX

bool enableRx
Enable RX

struct _uart_transfer
#include <fsl_uart.h> UART transfer structure.

Public Members

size_t dataSize
The byte count to be transfer.

struct __uart_handle
#include <fsl_uart.h> UART handle structure.

Public Members

const uint8_t *volatile txData
Address of remaining data to send.

volatile size_t txDataSize
Size of the remaining data to send.

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.

uart_transfer_callback_t callback
Callback function.

void *userData
UART callback function parameter.

volatile uint8_t txState
TX transfer state.

volatile uint8_t rxState
RX transfer state

union ___unnamed29___

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.

2.58 VREF: Voltage Reference Driver

status_t VREF_Init(VREF_Type *base, const *vref_config_t* *config)

Enables the clock gate and configures the VREF module according to the configuration structure.

This function must be called before calling all other VREF driver functions, read/write registers, and configurations with user-defined settings. The example below shows how to set up vref_config_t parameters and how to call the VREF_Init function by passing in these parameters. This is an example.

```
vref_config_t vrefConfig;
vrefConfig.bufferMode = kVREF_ModeHighPowerBuffer;
vrefConfig.enableExternalVoltRef = false;
vrefConfig.enableLowRef = false;
VREF_Init(VREF, &vrefConfig);
```

Parameters

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

Return values

- kStatus_Success – run success.
- kStatus_Timeout – timeout occurs.

void VREF_Deinit(VREF_Type *base)

Stops and disables the clock for the VREF module.

This function should be called to shut down the module. This is an example.

```
vref_config_t vrefUserConfig;
VREF_Init(VREF);
VREF_GetDefaultConfig(&vrefUserConfig);
...
VREF_Deinit(VREF);
```

Parameters

- base – VREF peripheral address.

void VREF_GetDefaultConfig(*vref_config_t* *config)

Initializes the VREF configuration structure.

This function initializes the VREF configuration structure to default values. This is an example.

```
vrefConfig->bufferMode = kVREF_ModeHighPowerBuffer;
vrefConfig->enableExternalVoltRef = false;
vrefConfig->enableLowRef = false;
```

Parameters

- config – Pointer to the initialization structure.

status_t VREF_SetTrimVal(VREF_Type *base, uint8_t trimValue)

Sets a TRIM value for the reference voltage.

This function sets a TRIM value for the reference voltage. Note that the TRIM value maximum is 0x3F.

Parameters

- base – VREF peripheral address.
- trimValue – Value of the trim register to set the output reference voltage (maximum 0x3F (6-bit)).

Return values

- kStatus_Success – run success.
- kStatus_Timeout – timeout occurs.

static inline uint8_t VREF_GetTrimVal(VREF_Type *base)

Reads the value of the TRIM meaning output voltage.

This function gets the TRIM value from the TRM register.

Parameters

- base – VREF peripheral address.

Returns

Six-bit value of trim setting.

status_t VREF_SetTrim2V1Val(VREF_Type *base, uint8_t trimValue)

Sets a TRIM value for the reference voltage (2V1).

This function sets a TRIM value for the reference voltage (2V1). Note that the TRIM value maximum is 0x3F.

Parameters

- base – VREF peripheral address.
- trimValue – Value of the trim register to set the output reference voltage (maximum 0x3F (6-bit)).

Return values

- kStatus_Success – run success.
- kStatus_Timeout – timeout occurs.

static inline uint8_t VREF_GetTrim2V1Val(VREF_Type *base)

Reads the value of the TRIM meaning output voltage (2V1).

This function gets the TRIM value from the VREF_TRM4 register.

Parameters

- base – VREF peripheral address.

Returns

Six-bit value of trim setting.

status_t VREF_SetLowReferenceTrimVal(VREF_Type *base, uint8_t trimValue)

Sets the TRIM value for the low voltage reference.

This function sets the TRIM value for low reference voltage. Note the following.

- The TRIM value maximum is 0x05U
- The values 111b and 110b are not valid/allowed.

Parameters

- base – VREF peripheral address.
- trimValue – Value of the trim register to set output low reference voltage (maximum 0x05U (3-bit)).

Return values

- kStatus_Success – run success.
- kStatus_Timeout – timeout occurs.

static inline uint8_t VREF_GetLowReferenceTrimVal(VREF_Type *base)

Reads the value of the TRIM meaning output voltage.

This function gets the TRIM value from the VREFL_TRM register.

Parameters

- base – VREF peripheral address.

Returns

Three-bit value of the trim setting.

FSL_VREF_DRIVER_VERSION

Version 2.1.3.

VREF_INTERNAL_VOLTAGE_STABLE_TIMEOUT

Max loops to wait for VREF internal voltage stable.

This parameter defines how many loops to check completion before return timeout. If defined as 0, driver will wait forever until completion.

enum _vref_buffer_mode

VREF modes.

Values:

enumerator kVREF_ModeBandgapOnly

Bandgap on only, for stabilization and startup

enumerator kVREF_ModeHighPowerBuffer

High-power buffer mode enabled

enumerator kVREF_ModeLowPowerBuffer

Low-power buffer mode enabled

typedef enum *_vref_buffer_mode* vref_buffer_mode_t

VREF modes.

typedef struct *_vref_config* vref_config_t

The description structure for the VREF module.

VREF_SC_MODE_LV

VREF_SC_REGEN

VREF_SC_VREFEN

VREF_SC_ICOMPEN

VREF_SC_REGEN_MASK

VREF_SC_VREFST_MASK

VREF_SC_VREFEN_MASK

VREF_SC_MODE_LV_MASK

VREF_SC_ICOMPEN_MASK

TRM

VREF_TRM_TRIM

VREF_TRM_CHOPEN_MASK

VREF_TRM_TRIM_MASK

VREF_TRM_CHOPEN_SHIFT

VREF_TRM_TRIM_SHIFT

VREF_SC_MODE_LV_SHIFT

VREF_SC_REGEN_SHIFT

VREF_SC_VREFST_SHIFT

VREF_SC_ICOMPEN_SHIFT

struct _vref_config

#include <fsl_vref.h> The description structure for the VREF module.

Public Members

vref_buffer_mode_t bufferMode

Buffer mode selection

bool enableLowRef

Set VREFL (0.4 V) reference buffer enable or disable

bool enableExternalVoltRef

Select external voltage reference or not (internal)

bool enable2V1VoltRef

Enable Internal Voltage Reference (2.1V)

Chapter 3

Middleware

3.1 Motor Control

3.1.1 FreeMASTER

Communication Driver User Guide

Introduction

What is FreeMASTER? FreeMASTER is a PC-based application developed by NXP for NXP customers. It is a versatile tool usable as a real-time monitor, visualization tool, and a graphical control panel of embedded applications based on the NXP processing units.

This document describes the embedded-side software driver which implements an interface between the application and the host PC. The interface covers the following communication:

- **Serial** UART communication either over plain RS232 interface or more typically over a USB-to-Serial either external or built in a debugger probe.
- **USB** direct connection to target microcontroller
- **CAN bus**
- **TCP/IP network** wired or WiFi
- **Segger J-Link RTT**
- **JTAG** debug port communication
- ...and all of the above also using a **Zephyr** generic drivers.

The driver also supports so-called "packet-driven BDM" interface which enables a protocol-based communication over a debugging port. The BDM stands for Background Debugging Module and its physical implementation is different on each platform. Some platforms leverage a semi-standard JTAG interface, other platforms provide a custom implementation called BDM. Regardless of the name, this debugging interface enables non-intrusive access to the memory space while the target CPU is running. For basic memory read and write operations, there is no communication driver required on the target when communicating with the host PC. Use this driver to get more advanced FreeMASTER protocol features over the BDM interface. The driver must be configured for the packet-driven BDM mode, in which the host PC uses the debugging interface to write serial command frames directly to the target memory buffer. The same method is then used to read response frames from that memory buffer.

Similar to “packet-driven BDM”, the FreeMASTER also supports a communication over [J-Link RTT]((https://www.segger.com/products/debug-probes/j-link/technology/about-real-time-transfer/) interface defined by SEGGER Microcontroller GmbH for ARM CortexM-based microcontrollers. This method also uses JTAG physical interface and enables high-speed real time communication to run over the same channel as used for application debugging.

Driver version 3 This document describes version 3 of the FreeMASTER Communication Driver. This version features the implementation of the new Serial Protocol, which significantly extends the features and security of its predecessor. The new protocol internal number is v4 and its specification is available in the documentation accompanying the driver code.

Driver V3 is deployed to modern 32-bit MCU platforms first, so the portfolio of supported platforms is smaller than for the previous V2 versions. It is recommended to keep using the V2 driver for legacy platforms, such as S08, S12, ColdFire, or Power Architecture. Reach out to FreeMASTER community or to the local NXP representative with requests for more information or to port the V3 driver to legacy MCU devices.

Thanks to a layered approach, the new driver simplifies the porting of the driver to new UART, CAN or networking communication interfaces significantly. Users are encouraged to port the driver to more NXP MCU platforms and contribute the code back to NXP for integration into future releases. Existing code and low-level driver layers may be used as an example when porting to new targets.

Note: Using the FreeMASTER tool and FreeMASTER Communication Driver is only allowed in systems based on NXP microcontroller or microprocessor unit. Use with non-NXP MCU platforms is **not permitted** by the license terms.

Target platforms The driver implementation uses the following abstraction mechanisms which simplify driver porting and supporting new communication modules:

- **General CPU Platform** (see source code in the src/platforms directory). The code in this layer is only specific to native data type sizes and CPU architectures (for example; alignment-aware memory copy routines). This driver version brings two generic implementations of 32-bit platforms supporting both little-endian and big-endian architectures. There are also implementations customized for the 56F800E family of digital signal controllers and S12Z MCUs. **Zephyr** is treated as a specific CPU platform as it brings unified user configuration (Kconfig) and generic hardware device drivers. With Zephyr, the transport layer and low-level communication layers described below are configured automatically using Kconfig and Device Tree technologies.
- **Transport Communication Layer** - The Serial, CAN, Networking, PD-BDM, and other methods of transport logic are implemented as a driver layer called FMSTR_TRANSPORT with a uniform API. A support of the Network transport also extends single-client modes of operation which are native for Serial, USB and CAN by a concept of multiple client sessions.
- **Low-level Communication Driver** - Each type of transport further defines a low-level API used to access the physical communication module. For example, the Serial transport defines a character-oriented API implemented by different serial communication modules like UART, LPUART, USART, and also USB-CDC. Similarly, the CAN transport defines a message-oriented API implemented by the FlexCAN or MCAN modules. Moreover, there are multiple different implementations for the same kind of communication peripherals. The difference between the implementation is in the way the low-level hardware registers are accessed. The *mcuxsdk* folder contains implementations which use MCUXpresso SDK drivers. These drivers should be used in applications based on the NXP MCUXpresso SDK. The “ampsdk” drivers target automotive-specific MCUs and their respective SDKs. The “dreg” implementations use a plain C-language access to hardware register addresses which makes it a universal and the most portable solution. In this case, users are encouraged to add more drivers for other communication modules or other respective SDKs and contribute the code back to NXP for integration.

The low-level drivers defined for the Networking transport enable datagram-oriented UDP and stream TCP communication. This implementation is demonstrated using the lwIP software stack but shall be portable to other TCP/IP stacks. It may sound surprisingly, but also the Segger J-Link RTT communication driver is linked to the Networking transport (RTT is stream oriented communication handled similarly to TCP).

Replacing existing drivers For all supported platforms, the driver described in this document replaces the V2 implementation and also older driver implementations that were available separately for individual platforms (PC Master SCI drivers).

Clocks, pins, and peripheral initialization The FreeMASTER communication driver is only responsible for runtime processing of the communication and must be integrated with an user application code to function properly. The user application code is responsible for general initialization of clock sources, pin multiplexers, and peripheral registers related to the communication speed. Such initialization should be done before calling the FMSTR_Init function.

It is recommended to develop the user application using one of the Software Development Kits (SDKs) available from third parties or directly from NXP, such as MCUXpresso SDK, MCUXpresso IDE, and related tools. This approach simplifies the general configuration process significantly.

MCUXpresso SDK The MCUXpresso SDK is a software package provided by NXP which contains the device initialization code, linker files, and software drivers with example applications for the NXP family of MCUs. The MCUXpresso Config Tools may be used to generate the clock-setup and pin-multiplexer setup code suitable for the selected processor.

The MCUXpresso SDK also contains this FreeMASTER communication driver as a "middleware" component which may be downloaded along with the example applications from https://mcuxpresso.nxp.com/en/welcome.

MCUXpresso SDK on GitHub The FreeMASTER communication driver is also released as one of the middleware components of the MCUXpresso SDK on the GitHub. This release enables direct integration of the FreeMASTER source code Git repository into a target applications including Zephyr applications.

Related links:

- The official FreeMASTER middleware repository.
- Online version of this document

FreeMASTER in Zephyr The FreeMASTER middleware repository can be used with MCUXpresso SDK as well as a Zephyr module. Zephyr-specific samples which include examples of Kconfig and Device Tree configurations for Serial, USB and Network communications are available in separate repository. West manifest in this sample repository fetches the full Zephyr package including the FreeMASTER middleware repository used as a Zephyr module.

Example applications

MCUX SDK Example applications There are several example applications available for each supported MCU platform.

- **fmstr_uart** demonstrates a plain serial transmission, typically connecting to a computer's physical or virtual COM port. The typical transmission speed is 115200 bps.

- **fmstr_can** demonstrates CAN bus communication. This requires a suitable CAN interface connected to the computer and interconnected with the target MCU using a properly terminated CAN bus. The typical transmission speed is 500 kbps. A FreeMASTER-over-CAN communication plug-in must be used.
- **fmstr_usb_cdc** uses an on-chip USB controller to implement a CDC communication class. It is connected directly to a computer's USB port and creates a virtual COM port device. The typical transmission speed is above 1 Mbps.
- **fmstr_net** demonstrates the Network communication over UDP or TCP protocol. Existing examples use lwIP stack to implement the communication, but in general, it shall be possible to use any other TCP/IP stack to achieve the same functionality.
- **fmstr_wifi** is the fmstr_net application modified to use a WiFi network interface instead of a wired Ethernet connection.
- **fmstr_rtt** demonstrates the communication over SEGGER J-Link RTT interface. Both fmstr_net and fmstr_rtt examples require the FreeMASTER TCP/UDP communication plug-in to be used on the PC host side.
- **fmstr_eonce** uses the real-time data unit on the JTAG EOnCE module of the 56F800E family to implement pseudo-serial communication over the JTAG port. The typical transmission speed is around 10 kbps. This communication requires FreeMASTER JTAG/EOnCE communication plug-in.
- **fmstr_pdbdm** uses JTAG or BDM debugging interface to access the target RAM directly while the CPU is running. Note that such approach can be used with any MCU application, even without any special driver code. The computer reads from and writes into the RAM directly without CPU intervention. The Packet-Driven BDM (PD-BDM) communication uses the same memory access to exchange command and response frames. With PD-BDM, the FreeMASTER tool is able to go beyond basic memory read/write operations and accesses also advanced features like Recorder, TSA, or Pipes. The typical transmission speed is around 10 kbps. A PD-BDM communication plug-in must be used in FreeMASTER and configured properly for the selected debugging interface. Note that this communication cannot be used while a debugging interface is used by a debugger session.
- **fmstr_any** is a special example application which demonstrates how the NXP MCUXpresso Config Tools can be used to configure pins, clocks, peripherals, interrupts, and even the FreeMASTER "middleware" driver features in a graphical and user friendly way. The user can switch between the Serial, CAN, and other ways of communication and generate the required initialization code automatically.

Zephyr sample spplications Zephyr sample applications demonstrate Kconfig and Device Tree configuration which configure the FreeMASTER middleware module for a selected communication option (Serial, CAN, Network or RTT).

Refer to *readme.md* files in each sample directory for description of configuration options required to implement FreeMASTER connectivity.

Description

This section shows how to add the FreeMASTER Communication Driver into application and how to configure the connection to the FreeMASTER visualization tool.

Features The FreeMASTER driver implements the FreeMASTER protocol V4 and provides the following features which may be accessed using the FreeMASTER visualization tool:

- Read/write access to any memory location on the target.
- Optional password protection of the read, read/write, and read/write/flash access levels.

- Atomic bit manipulation on the target memory (bit-wise write access).
- Optimal size-aligned access to memory which is also suitable to access the peripheral register space.
- Oscilloscope access—real-time access to target variables. The sample rate may be limited by the communication speed.
- Recorder— access to the fast transient recorder running on the board as a part of the FreeMASTER driver. The sample rate is only limited by the MCU CPU speed. The length of the data recorded depends on the amount of available memory.
- Multiple instances of Oscilloscopes and Recorders without the limitation of maximum number of variables.
- Application commands—high-level message delivery from the PC to the application.
- TSA tables—describing the data types, variables, files, or hyperlinks exported by the target application. The TSA newly supports also non-memory mapped resources like external EEPROM or SD Card files.
- Pipes—enabling the buffered stream-oriented data exchange for a general-purpose terminal-like communication, diagnostic data streaming, or other data exchange.

The FreeMASTER driver features:

- Full FreeMASTER protocol V4 implementation with a new V4 style of CRC used.
- Layered approach supporting Serial, CAN, Network, PD-BDM, and other transports.
- Layered low-level Serial transport driver architecture enabling to select UART, LPUART, USART, and other physical implementations of serial interfaces, including USB-CDC.
- Layered low-level CAN transport driver architecture enabling to select FlexCAN, msCAN, MCAN, and other physical implementations of the CAN interface.
- Layered low-level Networking transport enabling to select TCP, UDP or J-Link RTT communication.
- TSA support to write-protect memory regions or individual variables and to deny the access to the unsafe memory.
- The pipe callback handlers are invoked whenever new data is available for reading from the pipe.
- Two Serial Single-Wire modes of operation are enabled. The “external” mode has the RX and TX shorted on-board. The “true” single-wire mode interconnects internally when the MCU or UART modules support it.

The following sections briefly describe all FreeMASTER features implemented by the driver. See the PC-based FreeMASTER User Manual for more details on how to use the features to monitor, tune, or control an embedded application.

Board Detection The FreeMASTER protocol V4 defines the standard set of configuration values which the host PC tool reads to identify the target and to access other target resources properly. The configuration includes the following parameters:

- Version of the driver and the version of the protocol implemented.
- MTU as the Maximum size of the Transmission Unit (for example; communication buffer size).
- Application name, description, and version strings.
- Application build date and time as a string.
- Target processor byte ordering (little/big endian).
- Protection level that requires password authentication.

- Number of the Recorder and Oscilloscope instances.
- RAM Base Address for optimized memory access commands.

Memory Read This basic feature enables the host PC to read any data memory location by specifying the address and size of the required memory area. The device response frame must be shorter than the MTU to fit into the outgoing communication buffer. To read a device memory of any size, the host uses the information retrieved during the Board Detection and splits the large-block request to multiple partial requests.

The driver uses size-aligned operations to read the target memory (for example; uses proper read-word instruction when an address is aligned to 4 bytes).

Memory Write Similarly to the Memory Read operation, the Memory Write feature enables to write to any RAM memory location on the target device. A single write command frame must be shorter than the MTU to fit into the target communication buffer. Larger requests must be split into smaller ones.

The driver uses size-aligned operations to write to the target memory (for example; uses proper write-word instruction when an address is aligned to 4 bytes).

Masked Memory Write To implement the write access to a single bit or a group of bits of target variables, the Masked Memory Write feature is available in the FreeMASTER protocol and it is supported by the driver using the Read-Modify-Write approach.

Be careful when writing to bit fields of volatile variables that are also modified in an application interrupt. The interrupt may be serviced in the middle of a read-modify-write operation and it may cause data corruption.

Oscilloscope The protocol and driver enables any number of variables to be read at once with a single request from the host. This feature is called Oscilloscope and the FreeMASTER tool uses it to display a real-time graph of variable values.

The driver can be configured to support any number of Oscilloscope instances and enable simultaneously running graphs to be displayed on the host computer screen.

Recorder The protocol enables the host to select target variables whose values are then periodically recorded into a dedicated on-board memory buffer. After such data sampling stops (either on a host request or by evaluating a threshold-crossing condition), the data buffer is downloaded to the host and displayed as a graph. The data sampling rate is not limited by the speed of the communication line, so it enables displaying the variable transitions in a very high resolution.

The driver can be configured to support multiple Recorder instances and enable multiple recorder graphs to be displayed on the host screen. Having multiple recorders also enables setting the recording point differently for each instance. For example; one instance may be recording data in a general timer interrupt while another instance may record at a specific control algorithm time in the PWM interrupt.

TSA With the TSA feature, data types and variables can be described directly in the application source code. Such information is later provided to the FreeMASTER tool which may use it instead of reading symbol data from the application ELF executable file.

The information is encoded as so-called TSA tables which become direct part of the application code. The TSA tables contain descriptors of variables that shall be visible to the host tool. The descriptors can describe the memory areas by specifying the address and size of the memory

block or more conveniently using the C variable names directly. Different set of TSA descriptors can be used to encode information about the structure types, unions, enumerations, or arrays.

The driver also supports special types of TSA table entries to describe user resources like external EEPROM and SD Card files, memory-mapped files, virtual directories, web URL hyperlinks, and constant enumerations.

TSA Safety When the TSA is enabled in the application, the TSA Safety can be enabled and validate the memory accesses directly by the embedded-side driver. When the TSA Safety is turned on, any memory request received from the host is validated and accepted only if it belongs to a TSA-described object. The TSA entries can be declared as Read-Write or Read-Only so that the driver can actively deny the write access to the Read-Only objects.

Application commands The Application Commands are high-level messages that can be delivered from the PC Host to the embedded application for further processing. The embedded application can either poll the status, or be called back when a new Application Command arrives to be processed. After the embedded application acknowledges that the command is handled, the host receives the Result Code and reads the other return data from memory. Both the Application Commands and the Result Codes are specific to a given application and it is user's responsibility to define them. The FreeMASTER protocol and the FreeMASTER driver only implement the delivery channel and a set of API calls to enable the Application Command processing in general.

Pipes The Pipes enable buffered and stream-oriented data exchange between the PC Host and the target application. Any pipe can be written to and read from at both ends (either on the PC or the MCU). The data transmission is acknowledged using the special FreeMASTER protocol commands. It is guaranteed that the data bytes are delivered from the writer to the reader in a proper order and without losses.

Serial single-wire operation The MCU Serial Communication Driver natively supports normal dual-wire operation. Because the protocol is half-duplex only, the driver can also operate in two single-wire modes:

- "External" single-wire operation where the Receiver and Transmitter pins are shorted on the board. This mode is supported by default in the MCU driver because the Receiver and Transmitter units are enabled or disabled whenever needed. It is also easy to extend this operation for the RS485 communication.
- "True" single-wire mode which uses only a single pin and the direction switching is made by the UART module. This mode of operation must be enabled by defining the FMSTR_SERIAL_SINGLEWIRE configuration option.

Multi-session support With networking interface it is possible for multiple clients to access the target MCU simultaneously. Reading and writing of target memory is processed atomically so there is no risk of data corruption. The state-full resources such as Recorders or Oscilloscopes are locked to a client session upon first use and access is denied to other clients until lock is released..

Zephyr-specific

Dedicated communication task FreeMASTER communication may run isolated in a dedicated task. The task automates the FMSTR_Init and FMSTR_Poll calls together with periodic activities enabling the FreeMASTER UI to fetch information about tasks and CPU utilization. The task can be started automatically or manually, and it must be assigned a priority to be able to react on interrupts and other communication events. Refer to Zephyr FreeMASTER sample applications which all use this communication task.

Zephyr shell and logging over FreeMASTER pipe FreeMASTER implements a shell backend which may use FreeMASTER pipe as a I/O terminal and logging output. Refer to Zephyr FreeMASTER sample applications which all use this feature.

Automatic TSA tables TSA tables can be declared as "automatic" in Zephyr which make them automatically registered in the table list. This may be very useful when there are many TSA tables or when the tables are defined in different (often unrelated) libraries linked together. In this case user does not need to build a list of all tables manually.

Driver files The driver source files can be found in a top-level src folder, further divided into the sub-folders:

- ***src/platforms*** platform-specific folder—one folder exists for each supported processor platform (for example; 32-bit Little Endian platform). Each such folder contains a platform header file with data types and a code which implements the potentially platform-specific operations, such as aligned memory access.
- ***src/common*** folder—contains the common driver source files shared by the driver for all supported platforms. All the *.c* files must be added to the project, compiled, and linked together with the application.
  - *freemaster.h* - master driver header file, which declares the common data types, macros, and prototypes of the FreeMASTER driver API functions.
  - *freemaster_cfg.h.example* - this file can serve as an example of the FreeMASTER driver configuration file. Save this file into a project source code folder and rename it to *freemaster_cfg.h*. The FreeMASTER driver code includes this file to get the project-specific configuration options and to optimize the compilation of the driver.
  - *freemaster_defcfg.h* - defines the default values for each FreeMASTER configuration option if the option is not set in the *freemaster_cfg.h* file.
  - *freemaster_protocol.h* - defines the FreeMASTER protocol constants used internally by the driver.
  - *freemaster_protocol.c* - implements the FreeMASTER protocol decoder and handles the basic Get Configuration Value, Memory Read, and Memory Write commands.
  - *freemaster_rec.c* - handles the Recorder-specific commands and implements the Recorder sampling and triggering routines. When the Recorder is disabled by the FreeMASTER driver configuration file, this file only compiles to empty API functions.
  - *freemaster_scope.c* - handles the Oscilloscope-specific commands. If the Oscilloscope is disabled by the FreeMASTER driver configuration file, this file compiles as void.
  - *freemaster_pipes.c* - implements the Pipes functionality when the Pipes feature is enabled.
  - *freemaster_appcmd.c* - handles the communication commands used to deliver and execute the Application Commands within the context of the embedded application. When the Application Commands are disabled by the FreeMASTER driver configuration file, this file only compiles to empty API functions.

  - *freemaster_tsa.c* - handles the commands specific to the TSA feature. This feature enables the FreeMASTER host tool to obtain the TSA memory descriptors declared in the embedded application. If the TSA is disabled by the FreeMASTER driver configuration file, this file compiles as void.
  - *freemaster_tsa.h* - contains the declaration of the macros used to define the TSA memory descriptors. This file is indirectly included into the user application code (via *freemaster.h*).
  - *freemaster_sha.c* - implements the SHA-1 hash code used in the password authentication algorithm.
  - *freemaster_private.h* - contains the declarations of functions and data types used internally in the driver. It also contains the C pre-processor statements to perform the compile-time verification of the user configuration provided in the *freemaster_cfg.h* file.
  - *freemaster_serial.c* - implements the serial protocol logic including the CRC, FIFO queuing, and other communication-related operations. This code calls the functions of the low-level communication driver indirectly via a character-oriented API exported by the specific low-level driver.
  - *freemaster_serial.h* - defines the low-level character-oriented Serial API.
  - *freemaster_can.c* - implements the CAN protocol logic including the CAN message preparation, signalling using the first data byte in the CAN frame, and other communication-related operations. This code calls the functions of the low-level communication driver indirectly via a message-oriented API exported by the specific low-level driver.
  - *freemaster_can.h* - defines the low-level message-oriented CAN API.
  - *freemaster_net.c* - implements the Network protocol transport logic including multiple session management code.
  - *freemaster_net.h* - definitions related to the Network transport.
  - *freemaster_pdbdm.c* - implements the packet-driven BDM communication buffer and other communication-related operations.
  - *freemaster_utils.c* - aligned memory copy routines, circular buffer management and other utility functions
  - *freemaster_utils.h* - definitions related to utility code.
- ***src/drivers/[sdk]/serial*** - contains the code related to the serial communication implemented using one of the supported SDK frameworks.
  - *freemaster_serial_XXX.c* and *.h* - implement low-level access to the communication peripheral registers. Different files exist for the UART, LPUART, USART, and other kinds of Serial communication modules.
- ***src/drivers/[sdk]/can*** - contains the code related to the serial communication implemented using one of the supported SDK frameworks.
  - *freemaster_XXX.c* and *.h* - implement low-level access to the communication peripheral registers. Different files exist for the FlexCAN, msCAN, MCAN, and other kinds of CAN communication modules.
- ***src/drivers/[sdk]/network*** - contains low-level code adapting the FreeMASTER Network transport to an underlying TCP/IP or RTT stack.
  - *freemaster_net_lwip_tcp.c* and *_udp.c* - default networking implementation of TCP and UDP transports using lwIP stack.
  - *freemaster_net_segger_rtt.c* - implementation of network transport using Segger J-Link RTT interface

Driver configuration The driver is configured using a single header file (*freemaster_cfg.h*). Create this file and save it together with other project source files before compiling the driver code. All FreeMASTER driver source files include the *freemaster_cfg.h* file and use the macros defined here for the conditional and parameterized compilation. The C compiler must locate the configuration file when compiling the driver files. Typically, it can be achieved by putting this file into a folder where the other project-specific included files are stored.

As a starting point to create the configuration file, get the *freemaster_cfg.h.example* file, rename it to *freemaster_cfg.h*, and save it into the project area.

Note: It is NOT recommended to leave the *freemaster_cfg.h* file in the FreeMASTER driver source code folder. The configuration file must be placed at a project-specific location, so that it does not affect the other applications that use the same driver.

Configurable items This section describes the configuration options which can be defined in *freemaster_cfg.h*.

Interrupt modes

```
#define FMSTR_LONG_INTR   [0|1]
#define FMSTR_SHORT_INTR  [0|1]
#define FMSTR_POLL_DRIVEN [0|1]
```

Value Type boolean (0 or 1)

Description Exactly one of the three macros must be defined to non-zero. The others must be defined to zero or left undefined. The non-zero-defined constant selects the interrupt mode of the driver. See *Driver interrupt modes*.

- FMSTR_LONG_INTR — long interrupt mode
- FMSTR_SHORT_INTR — short interrupt mode
- FMSTR_POLL_DRIVEN — poll-driven mode

Note: Some options may not be supported by all communication interfaces. For example, the FMSTR_SHORT_INTR option is not supported by the USB_CDC interface.

Protocol transport

```
#define FMSTR_TRANSPORT [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER source code. Specify one of existing instances to make use of the protocol transport.

Description Use one of the pre-defined constants, as implemented by the FreeMASTER code. The current driver supports the following transports:

- **FMSTR_SERIAL** - serial communication protocol
- **FMSTR_CAN** - using CAN communication
- **FMSTR_PDBDM** - using packet-driven BDM communication
- **FMSTR_NET** - network communication using TCP or UDP protocol

Serial transport This section describes configuration parameters used when serial transport is used:

```
#define FMSTR_TRANSPORT FMSTR_SERIAL
```

FMSTR_SERIAL_DRV Select what low-level driver interface will be used when implementing the Serial communication.

```
#define FMSTR_SERIAL_DRV [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing serial driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/serial* implementation):

- **FMSTR_SERIAL_MCUX_UART** - UART driver
- **FMSTR_SERIAL_MCUX_LPUART** - LPUART driver
- **FMSTR_SERIAL_MCUX_USART** - USART driver
- **FMSTR_SERIAL_MCUX_MINIUSART** - miniUSART driver
- **FMSTR_SERIAL_MCUX_QSCI** - DSC QSCI driver
- **FMSTR_SERIAL_MCUX_USB** - USB/CDC class driver (also see code in the */support/mcuxsdk_usb* folder)
- **FMSTR_SERIAL_56F800E_EONCE** - DSC JTAG EOnCE driver

Other SDKs or BSPs may define custom low-level driver interface structure which may be used as FMSTR_SERIAL_DRV. For example:

- **FMSTR_SERIAL_DREG_UART** - demonstrates the low-level interface implemented without the MCUXpresso SDK and using direct access to peripheral registers.

FMSTR_SERIAL_BASE

```
#define FMSTR_SERIAL_BASE [address|symbol]
```

Value Type Optional address value (numeric or symbolic)

Description Specify the base address of the UART, LPUART, USART, or other serial peripheral module to be used for the communication. This value is not defined by default. User application should call `FMSTR_SetSerialBaseAddress()` to select the peripheral module.

FMSTR_COMM_BUFFER_SIZE

```
#define FMSTR_COMM_BUFFER_SIZE [number]
```

Value Type 0 or a value in range 32...255

Description Specify the size of the communication buffer to be allocated by the driver. Default value, which suits all driver features, is used when this option is defined as 0.

FMSTR_COMM_RQUEUE_SIZE

```
#define FMSTR_COMM_RQUEUE_SIZE [number]
```

Value Type Value in range 0...255

Description Specify the size of the FIFO receiver queue used to quickly receive and store characters in the FMSTR_SHORT_INTR interrupt mode.
The default value is 32 B.

FMSTR_SERIAL_SINGLEWIRE

```
#define FMSTR_SERIAL_SINGLEWIRE [0|1]
```

Value Type Boolean 0 or 1.

Description Set to non-zero to enable the "True" single-wire mode which uses a single MCU pin to communicate. The low-level driver enables the pin direction switching when the MCU peripheral supports it.

CAN Bus transport This section describes configuration parameters used when CAN transport is used:

```
#define FMSTR_TRANSPORT FMSTR_CAN
```

FMSTR_CAN_DRV Select what low-level driver interface will be used when implementing the CAN communication.

```
#define FMSTR_CAN_DRV [identifier]
```

Value Type Driver identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing CAN driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/can implementation*):

- **FMSTR_CAN_MCUX_FLEXCAN** - FlexCAN driver
- **FMSTR_CAN_MCUX_MCAN** - MCAN driver
- **FMSTR_CAN_MCUX_MSCAN** - msCAN driver
- **FMSTR_CAN_MCUX_DSCFLEXCAN** - DSC FlexCAN driver
- **FMSTR_CAN_MCUX_DSCMSCAN** - DSC msCAN driver

Other SDKs or BSPs may define the custom low-level driver interface structure which may be used as FMSTR_CAN_DRV.

FMSTR_CAN_BASE

```
#define FMSTR_CAN_BASE [address|symbol]
```

Value Type Optional address value (numeric or symbolic)

Description Specify the base address of the FlexCAN, msCAN, or other CAN peripheral module to be used for the communication. This value is not defined by default. User application should call FMSTR_SetCanBaseAddress() to select the peripheral module.

FMSTR_CAN_CMDID

```
#define FMSTR_CAN_CMDID [number]
```

Value Type CAN identifier (11-bit or 29-bit number)

Description CAN message identifier used for FreeMASTER commands (direction from PC Host tool to target application). When declaring 29-bit identifier, combine the numeric value with FMSTR_CAN_EXTID bit. Default value is 0x7AA.

FMSTR_CAN_RSPID

```
#define FMSTR_CAN_RSPID [number]
```

Value Type CAN identifier (11-bit or 29-bit number)

Description CAN message identifier used for responding messages (direction from target application to PC Host tool). When declaring 29-bit identifier, combine the numeric value with FMSTR_CAN_EXTID bit. Note that both *CMDID* and *RSPID* values may be the same. Default value is 0x7AA.

FMSTR_FLEXCAN_TXMB

```
#define FMSTR_FLEXCAN_TXMB [number]
```

Value Type Number in range of 0..N where N is number of CAN message-buffers supported by HW module.

Description Only used when the FlexCAN low-level driver is used. Define the FlexCAN message buffer for CAN frame transmission. Default value is 0.

FMSTR_FLEXCAN_RXMB

```
#define FMSTR_FLEXCAN_RXMB [number]
```

Value Type Number in range of 0..N where N is number of CAN message-buffers supported by HW module.

Description Only used when the FlexCAN low-level driver is used. Define the FlexCAN message buffer for CAN frame reception. Note that the FreeMASTER driver may also operate with a common message buffer used by both TX and RX directions. Default value is 1.

Network transport This section describes configuration parameters used when Network transport is used:

```
#define FMSTR_TRANSPORT FMSTR_NET
```

FMSTR_NET_DRV Select network interface implementation.

```
#define FMSTR_NET_DRV [identifier]
```

Value Type Identifiers are structure instance names defined in FreeMASTER drivers code. Specify one of existing NET driver instances.

Description When using MCUXpresso SDK, use one of the following constants (see */drivers/mcuxsdk/network implementation*):

- **FMSTR_NET_LWIP_TCP** - TCP communication using lwIP stack
- **FMSTR_NET_LWIP_UDP** - UDP communication using lwIP stack
- **FMSTR_NET_SEGGER_RTT** - Communication using SEGGER J-Link RTT interface

Other SDKs or BSPs may define the custom networking interface which may be used as FMSTR_CAN_DRV.

Add another row below:

FMSTR_NET_PORT

```
#define FMSTR_NET_PORT [number]
```

Value Type TCP or UDP port number (short integer)

Description Specifies the server port number used by TCP or UDP protocols.

FMSTR_NET_BLOCKING_TIMEOUT

```
#define FMSTR_NET_BLOCKING_TIMEOUT [number]
```

Value Type Timeout as number of milliseconds

Description This value specifies a timeout in milliseconds for which the network socket operations may block the execution inside *FMSTR_Poll*. This may be set high (e.g. 250) when a dedicated RTOS task is used to handle FreeMASTER protocol polling. Set to a lower value when the polling task is also responsible for other operations. Set to 0 to attempt to use non-blocking socket operations.

FMSTR_NET_AUTODISCOVERY

```
#define FMSTR_NET_AUTODISCOVERY [0|1]
```

Value Type Boolean 0 or 1.

Description This option enables the FreeMASTER driver to use a separate UDP socket to broadcast auto-discovery messages to network. This helps the FreeMASTER tool to discover the target device address, port and protocol options.

Debugging options

FMSTR_DISABLE

```
#define FMSTR_DISABLE [0|1]
```

Value Type boolean (0 or 1)

Description Define as non-zero to disable all FreeMASTER features, exclude the driver code from build, and compile all its API functions empty. This may be useful to remove FreeMASTER without modifying any application source code. Default value is 0 (false).

FMSTR_DEBUG_TX

```
#define FMSTR_DEBUG_TX [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to enable the driver to periodically transmit test frames out on the selected communication interface (SCI or CAN). With the debug transmission enabled, it is simpler to detect problems in the baudrate or other communication configuration settings.

The test frames are transmitted until the first valid command frame is received from the PC Host tool. The test frame is a valid error status frame, as defined by the protocol format. On the serial line, the test frame consists of three printable characters (+©W) which are easy to capture using the serial terminal tools.

This feature requires the FMSTR_Poll() function to be called periodically. Default value is 0 (false).

FMSTR_APPLICATION_STR

```
#define FMSTR_APPLICATION_STR
```

Value Type String.

Description Name of the application visible in FreeMASTER host application.

Memory access

FMSTR_USE_READMEM

```
#define FMSTR_USE_READMEM [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Memory Read command and enable FreeMASTER to have read access to memory and variables. The access can be further restricted by using a TSA feature.
Default value is 1 (true).

FMSTR_USE_WRITEMEM

```
#define FMSTR_USE_WRITEMEM [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Memory Write command.
The default value is 1 (true).

Oscilloscope options

FMSTR_USE_SCOPE

```
#define FMSTR_USE_SCOPE [number]
```

Value Type Integer number.

Description Number of Oscilloscope instances to be supported. Set to 0 to disable the Oscilloscope feature.
Default value is 0.

FMSTR_MAX_SCOPE_VARS

```
#define FMSTR_MAX_SCOPE_VARS [number]
```

Value Type Integer number larger than 2.

Description Number of variables to be supported by each Oscilloscope instance.
Default value is 8.

Recorder options

FMSTR_USE_RECORDER

```
#define FMSTR_USE_RECORDER [number]
```

Value Type Integer number.

Description Number of Recorder instances to be supported. Set to 0 to disable the Recorder feature.
Default value is 0.

FMSTR_REC_BUFF_SIZE

```
#define FMSTR_REC_BUFF_SIZE [number]
```

Value Type Integer number larger than 2.

Description Defines the size of the memory buffer used by the Recorder instance #0.
Default: not defined, user shall call 'FMSTR_RecorderCreate()" API function to specify this parameter in run time.

FMSTR_REC_TIMEBASE

```
#define FMSTR_REC_TIMEBASE [time specification]
```

Value Type Number (nanoseconds time).

Description Defines the base sampling rate in nanoseconds (sampling speed) Recorder instance #0.

Use one of the following macros:

- FMSTR_REC_BASE_SECONDS(x)
- FMSTR_REC_BASE_MILLISEC(x)
- FMSTR_REC_BASE_MICROSEC(x)
- FMSTR_REC_BASE_NANOSEC(x)

Default: not defined, user shall call 'FMSTR_RecorderCreate()" API function to specify this parameter in run time.

FMSTR_REC_FLOAT_TRIG

```
#define FMSTR_REC_FLOAT_TRIG [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the floating-point triggering. Be aware that floating-point triggering may grow the code size by linking the floating-point standard library.

Default value is 0 (false).

Application Commands options

FMSTR_USE_APPCMD

```
#define FMSTR_USE_APPCMD [0|1]
```

Value Type Boolean 0 or 1.

Description Define as non-zero to implement the Application Commands feature.
Default value is 0 (false).

FMSTR_APPCMD_BUFF_SIZE

```
#define FMSTR_APPCMD_BUFF_SIZE [size]
```

Value Type Numeric buffer size in range 1..255

Description The size of the Application Command data buffer allocated by the driver. The buffer stores the (optional) parameters of the Application Command which waits to be processed.

FMSTR_MAX_APPCMD_CALLS

```
#define FMSTR_MAX_APPCMD_CALLS [number]
```

Value Type Number in range 0..255

Description The number of different Application Commands that can be assigned a callback handler function using FMSTR_RegisterAppCmdCall(). Default value is 0.

TSA options

FMSTR_USE_TSA

```
#define FMSTR_USE_TSA [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the FreeMASTER TSA feature to be used. With this option enabled, the TSA tables defined in the applications are made available to the FreeMASTER host tool.
Default value is 0 (false).

FMSTR_USE_TSA_SAFETY

```
#define FMSTR_USE_TSA_SAFETY [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the memory access validation in the FreeMASTER driver. With this option, the host tool is not able to access the memory which is not described by at least one TSA descriptor. Also a write access is denied for objects defined as read-only in TSA tables.
Default value is 0 (false).

FMSTR_USE_TSA_INROM

```
#define FMSTR_USE_TSA_INROM [0|1]
```

Value Type Boolean 0 or 1.

Description Declare all TSA descriptors as *const*, which enables the linker to put the data into the flash memory. The actual result depends on linker settings or the linker commands used in the project.
Default value is 0 (false).

FMSTR_USE_TSA_DYNAMIC

```
#define FMSTR_USE_TSA_DYNAMIC [0|1]
```

Value Type Boolean 0 or 1.

Description Enable runtime-defined TSA entries to be added to the TSA table by the FMSTR_SetUpTsaBuff() and FMSTR_TsaAddVar() functions.
Default value is 0 (false).

Pipes options

FMSTR_USE_PIPES

```
#define FMSTR_USE_PIPES [0|1]
```

Value Type Boolean 0 or 1.

Description Enable the FreeMASTER Pipes feature to be used.
Default value is 0 (false).

FMSTR_MAX_PIPES_COUNT

```
#define FMSTR_MAX_PIPES_COUNT [number]
```

Value Type Number in range 1..63.

Description The number of simultaneous pipe connections to support.
The default value is 1.

Driver interrupt modes To implement the communication, the FreeMASTER driver handles the Serial or CAN module's receive and transmit requests. Use the *freemaster_cfg.h* configuration file to select whether the driver processes the communication automatically in the interrupt service routine handler or if it only polls the status of the module (typically during the application idle time).

This section describes each of the interrupt mode in more details.

Completely Interrupt-Driven operation Activated using:

```
#define FMSTR_LONG_INTR 1
```

In this mode, both the communication and the FreeMASTER protocol decoding is done in the *FMSTR_SerialIsr*, *FMSTR_CanIsr*, or other interrupt service routine. Because the protocol execution may be a lengthy task (especially with the TSA-Safety enabled) it is recommended to use this mode only if the interrupt prioritization scheme is possible in the application and the FreeMASTER interrupt is assigned to a lower (the lowest) priority.

In this mode, the application code must register its own interrupt handler for all interrupt vectors related to the selected communication interface and call the FMSTR_SerialIsr or FMSTR_CanIsr functions from that handler.

Mixed Interrupt and Polling Modes Activated using:

```
#define FMSTR_SHORT_INTR 1
```

In this mode, the communication processing time is split between the interrupt routine and the main application loop or task. The raw communication is handled by the *FMSTR_SerialIsr, FMSTR_CanIsr*, or other interrupt service routine, while the protocol decoding and execution is handled by the *FMSTR_Poll* routine. Call *FMSTR_Poll* during the idle time in the application main loop.

The interrupt processing in this mode is relatively fast and deterministic. Upon a serial-receive event, the received character is only placed into a FIFO-like queue and it is not further processed. Upon a CAN receive event, the received frame is stored into a receive buffer. When transmitting, the characters are fetched from the prepared transmit buffer.

In this mode, the application code must register its own interrupt handler for all interrupt vectors related to the selected communication interface and call the *FMSTR_SerialIsr* or *FMSTR_CanIsr* functions from that handler.

When the serial interface is used as the serial communication interface, ensure that the *FMSTR_Poll* function is called at least once per *N* character time periods. *N* is the length of the FreeMASTER FIFO queue (*FMSTR_COMM_RQUEUE_SIZE*) and the character time is the time needed to transmit or receive a single byte over the SCI line.

Completely Poll-driven

```
#define FMSTR_POLL_DRIVEN 1
```

In this mode, both the communication and the FreeMASTER protocol decoding are done in the *FMSTR_Poll* routine. No interrupts are needed and the *FMSTR_SerialIsr*, *FMSTR_CanIsr*, and similar handlers compile to an empty code.

When using this mode, ensure that the *FMSTR_Poll* function is called by the application at least once per the serial "character time" which is the time needed to transmit or receive a single character.

In the latter two modes (*FMSTR_SHORT_INTR* and *FMSTR_POLL_DRIVEN*), the protocol handling takes place in the FMSTR_Poll routine. An application interrupt can occur in the middle of the

Read Memory or Write Memory commands' execution and corrupt the variable being accessed by the FreeMASTER driver. In these two modes, some issues or glitches may occur when using FreeMASTER to visualize or monitor volatile variables modified in interrupt servicing code.

The same issue may appear even in the full interrupt mode (FMSTR_LONG_INTR), if volatile variables are modified in the interrupt code with a priority higher than the priority of the communication interrupt.

Data types Simple portability was one of the main requirements when writing the FreeMASTER driver. This is why the driver code uses the privately-declared data types and the vast majority of the platform-dependent code is separated in the platform-dependent source files. The data types used in the driver API are all defined in the platform-specific header file.

To prevent name conflicts with the symbols used in the application, all data types, macros, and functions have the FMSTR_ prefix. The only global variables used in the driver are the transport and low-level API structures exported from the driver-implementation layer to upper layers. Other than that, all private variables are declared as static and named using the fmstr_ prefix.

Communication interface initialization The FreeMASTER driver does not perform neither the initialization nor the configuration of the peripheral module that it uses to communicate. It is the application startup code responsibility to configure the communication module before the FreeMASTER driver is initialized by the FMSTR_Init call.

When the Serial communication module is used as the FreeMASTER communication interface, configure the UART receive and transmit pins, the serial communication baud rate, parity (no-parity), the character length (eight bits), and the number of stop bits (one) before initializing the FreeMASTER driver. For either the long or the short interrupt modes of the driver (see *Driver interrupt modes*), configure the interrupt controller and register an application-specific interrupt handler for all interrupt sources related to the selected serial peripheral module. Call the FMSTR_SerialIsr function from the application handler.

When a CAN module is used as the FreeMASTER communication interface, configure the CAN receive and transmit pins and the CAN module bit rate before initializing the FreeMASTER driver. For either the long or the short interrupt modes of the driver (see *Driver interrupt modes*), configure the interrupt controller and register an application-specific interrupt handler for all interrupt sources related to the selected CAN peripheral module. Call the FMSTR_CanIsr function from the application handler.

Note: It is not necessary to enable or unmask the serial nor the CAN interrupts before initializing the FreeMASTER driver. The driver enables or disables the interrupts and communication lines, as required during runtime.

FreeMASTER Recorder calls When using the FreeMASTER Recorder in the application (FMSTR_USE_RECORDER > 0), call the FMSTR_RecorderCreate function early after FMSTR_Init to set up each recorder instance to be used in the application. Then call the FMSTR_Recorder function periodically in the code where the data recording should occur. A typical place to call the Recorder routine is at the timer or PWM interrupts, but it can be anywhere else. The example applications provided together with the driver code call the FMSTR_Recorder in the main application loop.

In applications where FMSTR_Recorder is called periodically with a constant period, specify the period in the Recorder configuration structure before calling FMSTR_RecorderCreate. This setting enables the PC Host FreeMASTER tool to display the X-axis of the Recorder graph properly scaled for the time domain.

Driver usage Start using or evaluating FreeMASTER by opening some of the example applications available in the driver setup package.

Follow these steps to enable the basic FreeMASTER connectivity in the application:

- Make sure that all *.c files of the FreeMASTER driver from the *src/common/platforms/[your_platform]* folder are a part of the project. See *Driver files* for more details.
- Configure the FreeMASTER driver by creating or editing the *freemaster_cfg.h* file and by saving it into the application project directory. See *Driver configuration* for more details.
- Include the *freemaster.h* file into any application source file that makes the FreeMASTER API calls.
- Initialize the Serial or CAN modules. Set the baud rate, parity, and other parameters of the communication. Do not enable the communication interrupts in the interrupt mask registers.
- For the FMSTR_LONG_INTR and FMSTR_SHORT_INTR modes, install the application-specific interrupt routine and call the FMSTR_SerialIsr or FMSTR_CanIsr functions from this handler.
- Call the FMSTR_Init function early on in the application initialization code.
- Call the FMSTR_RecorderCreate functions for each Recorder instance to enable the Recorder feature.
- In the main application loop, call the FMSTR_Poll API function periodically when the application is idle.
- For the FMSTR_SHORT_INTR and FMSTR_LONG_INTR modes, enable the interrupts globally so that the interrupts can be handled by the CPU.

Communication troubleshooting The most common problem that causes communication issues is a wrong baud rate setting or a wrong pin multiplexer setting of the target MCU. When a communication between the PC Host running FreeMASTER and the target MCU cannot be established, try enabling the FMSTR_DEBUG_TX option in the *freemaster_cfg.h* file and call the FMSTR_Poll function periodically in the main application task loop.

With this feature enabled, the FreeMASTER driver periodically transmits a test frame through the Serial or CAN lines. Use a logic analyzer or an oscilloscope to monitor the signals at the communication pins of the CPU device to examine whether the bit rate and signal polarity are configured properly.

Driver API

This section describes the driver Application Programmers' Interface (API) needed to initialize and use the FreeMASTER serial communication driver.

Control API There are three key functions to initialize and use the driver.

FMSTR_Init

Prototype

```
FMSTR_BOOL FMSTR_Init(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_protocol.c*

Description This function initializes the internal variables of the FreeMASTER driver and enables the communication interface. This function does not change the configuration of the selected communication module. The hardware module must be initialized before the *FMSTR_Init* function is called.

A call to this function must occur before calling any other FreeMASTER driver API functions.

FMSTR_Poll

Prototype

```
void FMSTR_Poll(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_protocol.c*

Description In the poll-driven or short interrupt modes, this function handles the protocol decoding and execution (see *Driver interrupt modes*). In the poll-driven mode, this function also handles the communication interface with the PC. Typically, the *FMSTR_Poll* function is called during the "idle" time in the main application task loop.

To prevent the receive data overflow (loss) on a serial interface, make sure that the FMSTR_Poll function is called at least once per the time calculated as:

*N * Tchar*

where:

- *N* is equal to the length of the receive FIFO queue (configured by the FMSTR_COMM_RQUEUE_SIZE macro). *N* is 1 for the poll-driven mode.
- *Tchar* is the character time, which is the time needed to transmit or receive a single byte over the SCI line.

Note: In the long interrupt mode, this function typically compiles as an empty function and can still be called. It is worthwhile to call this function regardless of the interrupt mode used in the application. This approach enables a convenient switching between the different interrupt modes only by changing the configuration macros in the *freemaster_cfg.h* file.

FMSTR_SerialIsr / FMSTR_CanIsr

Prototype

```
void FMSTR_SerialIsr(void);
void FMSTR_CanIsr(void);
```

- Declaration: *freemaster.h*
- Implementation: *hw-specific low-level driver C file*

Description This function contains the interrupt-processing code of the FreeMASTER driver. In long or short interrupt modes (see *Driver interrupt modes*), this function must be called from the application interrupt service routine registered for the communication interrupt vector. On platforms where the communication module uses multiple interrupt vectors, the application should register a handler for all vectors and call this function at each interrupt.

Note: In a poll-driven mode, this function is compiled as an empty function and does not have to be used.

Recorder API

FMSTR_RecorderCreate

Prototype

```
FMSTR_BOOL FMSTR_RecorderCreate(FMSTR_INDEX recIndex, FMSTR_REC_BUFF* buffCfg);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function registers a recorder instance and enables it to be used by the PC Host tool. Call this function for all recorder instances from 0 to the maximum number defined by the FMSTR_USE_RECORDER configuration option (minus one). An exception to this requirement is the recorder of instance *0* which may be automatically configured by FMSTR_Init when the *freemaster_cfg.h* configuration file defines the *FMSTR_REC_BUFF_SIZE* and *FMSTR_REC_TIMEBASE* options.

For more information, see *Configurable items*.

FMSTR_Recorder

Prototype

```
void FMSTR_Recorder(FMSTR_INDEX recIndex);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function takes a sample of the variables being recorded using the FreeMASTER Recorder instance *recIndex*. If the selected Recorder is not active when the *FMSTR_Recorder* function is being called, the function returns immediately. When the Recorder is active, the values of the variables being recorded are copied into the recorder buffer and the trigger conditions are evaluated.

If a trigger condition is satisfied, the Recorder enters the post-trigger mode, where it counts down the follow-up samples (number of *FMSTR_Recorder* function calls) and de-activates the Recorder when the required post-trigger samples are finished.

The *FMSTR_Recorder* function is typically called in the timer or PWM interrupt service routines. This function can also be called in the application main loop (for testing purposes).

FMSTR_RecorderTrigger

Prototype

```
void FMSTR_RecorderTrigger(FMSTR_INDEX recIndex);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_rec.c*

Description This function forces the Recorder trigger condition to happen, which causes the Recorder to be automatically deactivated after the post-trigger samples are sampled. Use this function in the application code for programmatic control over the Recorder triggering. This can be useful when a more complex triggering conditions need to be used.

Fast Recorder API The Fast Recorder feature is not available in the FreeMASTER driver version 3. This feature was heavily dependent on the target platform and it was only available for the 56F8xxxx DSCs.

TSA Tables When the TSA is enabled in the FreeMASTER driver configuration file (by setting the FMSTR_USE_TSA macro to a non-zero value), it defines the so-called TSA tables in the application. This section describes the macros that must to be used to define the TSA tables.

There can be any number of TSA tables spread across the application source files. There must be always exactly one TSA Table List defined, which informs the FreeMASTER driver about the active TSA tables.

When there is at least one TSA table and one TSA Table List defined in the application, the TSA information automatically appears in the FreeMASTER symbols list. The symbols can then be used to create FreeMASTER variables for visualization or control.

TSA table definition The TSA table describes the static or global variables together with their address, size, type, and access-protection information. If the TSA-described variables are of a structure type, the TSA table may also describe this type and provide an access to the individual structure members of the variable.

The TSA table definition begins with the FMSTR_TSA_TABLE_BEGIN macro with a *table_id* identifying the table. The *table_id* shall be a valid C-langiage symbol.

```
FMSTR_TSA_TABLE_BEGIN(table_id)
```

After this opening macro, the TSA descriptors are placed using these macros:

```
/* Adding variable descriptors */
FMSTR_TSA_RW_VAR(name, type)  /* read/write variable entry */
FMSTR_TSA_RO_VAR(name, type)  /* read-only variable entry */

/* Description of complex data types */
FMSTR_TSA_STRUCT(struct_name) /* structure or union type entry */
FMSTR_TSA_MEMBER(struct_name, member_name, type)  /* structure member entry */

/* Memory blocks */
FMSTR_TSA_RW_MEM(name, type, address, size) /* read/write memory block */
FMSTR_TSA_RO_MEM(name, type, address, size) /* read-only memory block */
```

The table is closed using the FMSTR_TSA_TABLE_END macro:

```
FMSTR_TSA_TABLE_END()
```

TSA descriptor parameters The TSA descriptor macros accept these parameters:

- *name* — variable name. The variable must be defined before the TSA descriptor references it.
- *type* — variable or member type. Only one of the pre-defined type constants may be used (see below).
- *struct_name* — structure type name. The type must be defined (typedef) before the TSA descriptor references it.

- *member_name* — structure member name.

Note: The structure member descriptors (FMSTR_TSA_MEMBER) must immediately follow the parent structure descriptor (FMSTR_TSA_STRUCT) in the table.

Note: To write-protect the variables in the FreeMASTER driver (FMSTR_TSA_RO_VAR), enable the TSA-Safety feature in the configuration file.

TSA variable types The table lists *type* identifiers which can be used in TSA descriptors:

Constant	Description
FMSTR_TSA_UINT*n*	Unsigned integer type of size *n* bits (n=8,16,32,64)
FMSTR_TSA_SINT*n*	Signed integer type of size *n* bits (n=8,16,32,64)
FMSTR_TSA_FRAC*n*	Fractional number of size *n* bits (n=16,32,64).
FMSTR_TSA_FRAC_Q(*m*,*n*)	Signed fractional number in general Q form (m+n+1 total bits)
FMSTR_TSA_FRAC_UQ(*m*,*n*)	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)
FMSTR_TSA_USERTYPE(*name*)	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 */
```

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```
/* The readme.txt file will be accessible at the fmstr://text_files/readme.txt URL */
FMSTR_TSA_MEMFILE("readme.txt", readme_txt, sizeof(readme_txt)) /* memory-mapped file */

/* Files can also be specified with a full path so the DIRECTORY entry does not apply */
FMSTR_TSA_MEMFILE("/index.htm", index, sizeof(index))          /* memory-mapped file */
FMSTR_TSA_MEMFILE("/prj/demo.pmp", demo_pmp, sizeof(demo_pmp)) /* memory-mapped file */

/* Hyperlinks can point to a local MEMFILE object or to the Internet */
FMSTR_TSA_HREF("Board's Built-in Welcome Page", "/index.htm")
FMSTR_TSA_HREF("FreeMASTER Home Page", "http://www.nxp.com/freemaster")

/* Project file links simplify opening the projects from any URLs */
FMSTR_TSA_PROJECT("Demonstration Project (embedded)", "/prj/demo.pmp")
FMSTR_TSA_PROJECT("Full Project (online)", "http://mycompany.com/prj/demo.pmp")

FMSTR_TSA_TABLE_END()
```

TSA API

FMSTR_SetUpTsaBuff

Prototype

```
FMSTR_BOOL FMSTR_SetUpTsaBuff(FMSTR_ADDR buffAddr, FMSTR_SIZE buffSize);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_tsa.c*

Arguments

- *buffAddr* [in] - address of the memory buffer for the dynamic TSA table
- *buffSize* [in] - size of the memory buffer which determines the maximum number of TSA entries to be added in the runtime

Description This function must be used to assign the RAM memory buffer to the TSA subsystem when FMSTR_USE_TSA_DYNAMIC is enabled. The memory buffer is then used to store the TSA entries added dynamically to the runtime TSA table using the FMSTR_TsaAddVar function call. The runtime TSA table is processed by the FreeMASTER PC Host tool along with all static tables as soon as the communication port is open.

The size of the memory buffer determines the number of TSA entries that can be added dynamically. Depending on the MCU platform, one TSA entry takes either 8 or 16 bytes.

FMSTR_TsaAddVar

Prototype

```
FMSTR_BOOL FMSTR_TsaAddVar(FMSTR_TSATBL_STRPTR tsaName, FMSTR_TSATBL_STRPTR
↪tsaType,
    FMSTR_TSATBL_VOIDPTR varAddr, FMSTR_SIZE32 varSize,
    FMSTR_SIZE flags);
```

- Declaration: *freemaster.h*

- Implementation: *freemaster_tsa.c*

Arguments

- *tsaName* [in] - name of the object
- *tsaType* [in] - name of the object type
- *varAddr* [in] - address of the object
- *varSize* [in] - size of the object
- *flags* [in] - access flags; a combination of these values:
  - *FMSTR_TSA_INFO_RO_VAR* — read-only memory-mapped object (typically a variable)
  - *FMSTR_TSA_INFO_RW_VAR* — read/write memory-mapped object
  - *FMSTR_TSA_INFO_NON_VAR* — other entry, describing structure types, structure members, enumerations, and other types

Description This function can be called only when the dynamic TSA table is enabled by the FMSTR_USE_TSA_DYNAMIC configuration option and when the FMSTR_SetUpTsaBuff function call is made to assign the dynamic TSA table memory. This function adds an entry into the dynamic TSA table. It can be used to register a read-only or read/write memory object or describe an item of the user-defined type.

See *TSA table definition* for more details about the TSA table entries.

Application Commands API

FMSTR_GetAppCmd

Prototype

```
FMSTR_APPCMD_CODE FMSTR_GetAppCmd(void);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Description This function can be used to detect if there is an Application Command waiting to be processed by the application. If no command is pending, this function returns the FMSTR_APPCMDRESULT_NOCMD constant. Otherwise, this function returns the code of the Application Command that must be processed. Use the FMSTR_AppCmdAck call to acknowledge the Application Command after it is processed and to return the appropriate result code to the host.

The FMSTR_GetAppCmd function does not report the commands for which a callback handler function exists. If the FMSTR_GetAppCmd function is called when a callback-registered command is pending (and before it is actually processed by the callback function), this function returns FMSTR_APPCMDRESULT_NOCMD.

FMSTR_GetAppCmdData

Prototype

```
FMSTR_APPCMD_PDATA FMSTR_GetAppCmdData(FMSTR_SIZE* dataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *dataLen* [out] - pointer to the variable that receives the length of the data available in the buffer. It can be NULL when this information is not needed.

Description This function can be used to retrieve the Application Command data when the application determines that an Application Command is pending (see *FMSTR_GetAppCmd*).

There is just a single buffer to hold the Application Command data (the buffer length is FMSTR_APPCMD_BUFF_SIZE bytes). If the data are to be used in the application after the command is processed by the FMSTR_AppCmdAck call, copy the data out to a private buffer.

FMSTR_AppCmdAck

Prototype

```
void FMSTR_AppCmdAck(FMSTR_APPCMD_RESULT resultCode);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultCode* [in] - the result code which is to be returned to FreeMASTER

Description This function is used when the Application Command processing finishes in the application. The resultCode passed to this function is returned back to the host and the driver is re-initialized to expect the next Application Command.

After this function is called and before the next Application Command arrives, the return value of the FMSTR_GetAppCmd function is FMSTR_APPCMDRESULT_NOCMD.

FMSTR_AppCmdSetResponseData

Prototype

```
void FMSTR_AppCmdSetResponseData(FMSTR_ADDR resultDataAddr, FMSTR_SIZE resultDataLen);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *resultDataAddr* [in] - pointer to the data buffer that is to be copied to the Application Command data buffer
- *resultDataLen* [in] - length of the data to be copied. It must not exceed the FMSTR_APPCMD_BUFF_SIZE value.

Description This function can be used before the Application Command processing finishes, when there are data to be returned back to the PC.

The response data buffer is copied into the Application Command data buffer, from where it is accessed when the host requires it. Do not use FMSTR_GetAppCmdData and the data buffer after FMSTR_AppCmdSetResponseData is called.

Note: The current version of FreeMASTER does not support the Application Command response data.

FMSTR_RegisterAppCmdCall

Prototype

```
FMSTR_BOOL FMSTR_RegisterAppCmdCall(FMSTR_APPCMD_CODE appCmdCode, FMSTR_
↪PAPPCMDFUNC callbackFunc);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_appcmd.c*

Arguments

- *appCmdCode* [in] - the Application Command code for which the callback is to be registered
- *callbackFunc* [in] - pointer to the callback function that is to be registered. Use NULL to unregister a callback registered previously with this Application Command.

Return value This function returns a non-zero value when the callback function was successfully registered or unregistered. It can return zero when trying to register a callback function for more than FMSTR_MAX_APPCMD_CALLS different Application Commands.

Description This function can be used to register the given function as a callback handler for the Application Command. The Application Command is identified using single-byte code. The callback function is invoked automatically by the FreeMASTER driver when the protocol decoder obtains a request to get the application command result code.

The prototype of the callback function is

```
FMSTR_APPCMD_RESULT HandlerFunction(FMSTR_APPCMD_CODE nAppcmd,
    FMSTR_APPCMD_PDATA pData, FMSTR_SIZE nDataLen);
```

Where:

- *nAppcmd* -Application Command code
- *pData* —points to the Application Command data received (if any)
- *nDataLen* —information about the Application Command data length

The return value of the callback function is used as the Application Command Result Code and returned to FreeMASTER.

Note: The FMSTR_MAX_APPCMD_CALLS configuration macro defines how many different Application Commands may be handled by a callback function. When FMSTR_MAX_APPCMD_CALLS is undefined or defined as zero, the FMSTR_RegisterAppCmdCall function always fails.

Pipes API

FMSTR_PipeOpen

Prototype

```
FMSTR_HPIPE FMSTR_PipeOpen(FMSTR_PIPE_PORT pipePort, FMSTR_PPIPEFUNC pipeCallback,
↪
    FMSTR_ADDR pipeRxBuff, FMSTR_PIPE_SIZE pipeRxSize,
    FMSTR_ADDR pipeTxBuff, FMSTR_PIPE_SIZE pipeTxSize,
    FMSTR_U8 type, const FMSTR_CHAR *name);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipePort* [in] - port number that identifies the pipe for the client
- *pipeCallback* [in] - pointer to the callback function that is called whenever a pipe data status changes
- *pipeRxBuff* [in] - address of the receive memory buffer
- *pipeRxSize* [in] - size of the receive memory buffer
- *pipeTxBuff* [in] - address of the transmit memory buffer
- *pipeTxSize* [in] - size of the transmit memory buffer
- *type* [in] - a combination of FMSTR_PIPE_MODE_xxx and FMSTR_PIPE_SIZE_xxx constants describing primary pipe data format and usage. This type helps FreeMASTER decide how to access the pipe by default. Optional, use 0 when undetermined.
- *name* [in] - user name of the pipe port. This name is visible to the FreeMASTER user when creating the graphical pipe interface.

Description This function initializes a new pipe and makes it ready to accept or send the data to the PC Host client. The receive memory buffer is used to store the received data before they are read out by the FMSTR_PipeRead call. When this buffer gets full, the PC Host client denies the data transmission into this pipe until there is enough free space again. The transmit memory buffer is used to store the data transmitted by the application to the PC Host client using the FMSTR_PipeWrite call. The transmit buffer can get full when the PC Host is disconnected or when it is slow in receiving and reading out the pipe data.

The function returns the pipe handle which must be stored and used in the subsequent calls to manage the pipe object.

The callback function (if specified) is called whenever new data are received through the pipe and available for reading. This callback is also called when the data waiting in the transmit buffer are successfully pushed to the PC Host and the transmit buffer free space increases. The prototype of the callback function provided by the user application must be as follows. The *PipeHandler* name is only a placeholder and must be defined by the application.

```
void PipeHandler(FMSTR_HPIPE pipeHandle);
```

FMSTR_PipeClose

Prototype

```
void FMSTR_PipeClose(FMSTR_HPIPE pipeHandle);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call

Description This function de-initializes the pipe object. No data can be received or sent on the pipe after this call.

FMSTR_PipeWrite

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeWrite(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE writeGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data to be written
- *pipeDataLen* [in] - length of the data to be written
- *writeGranularity* [in] - size of the minimum unit of data which is to be written

Description This function puts the user-specified data into the pipe's transmit memory buffer and schedules it for transmission. This function returns the number of bytes that were successfully written into the buffer. This number may be smaller than the number of the requested bytes if there is not enough free space in the transmit buffer.

The *writeGranularity* argument can be used to split the data into smaller chunks, each of the size given by the *writeGranularity* value. The FMSTR_PipeWrite function writes as many data chunks as possible into the transmit buffer and does not attempt to write an incomplete chunk. This feature can prove to be useful to avoid the intermediate caching when writing an array of integer values or other multi-byte data items. When making the nGranularity value equal to the nLength value, all data are considered as one chunk which is either written successfully as a whole or not at all. The nGranularity value of 0 or 1 disables the data-chunk approach.

FMSTR_PipeRead

Prototype

```
FMSTR_PIPE_SIZE FMSTR_PipeRead(FMSTR_HPIPE pipeHandle, FMSTR_ADDR pipeData,
    FMSTR_PIPE_SIZE pipeDataLen, FMSTR_PIPE_SIZE readGranularity);
```

- Declaration: *freemaster.h*
- Implementation: *freemaster_pipes.c*

Arguments

- *pipeHandle* [in] - pipe handle returned from the FMSTR_PipeOpen function call
- *pipeData* [in] - address of the data buffer to be filled with the received data
- *pipeDataLen* [in] - length of the data to be read
- *readGranularity* [in] - size of the minimum unit of data which is to be read

Description This function copies the data received from the pipe from its receive buffer to the user buffer for further processing. The function returns the number of bytes that were successfully copied to the buffer. This number may be smaller than the number of the requested bytes if there is not enough data bytes available in the receive buffer.

The readGranularity argument can be used to copy the data in larger chunks in the same way as described in the FMSTR_PipeWrite function.

API data types This section describes the data types used in the FreeMASTER driver. The information provided here can be useful when modifying or porting the FreeMASTER Communication Driver to new NXP platforms.

Note: The licensing conditions prohibit use of FreeMASTER and the FreeMASTER Communication Driver with non-NXP MPU or MCU products.

Public common types The table below describes the public data types used in the FreeMASTER driver API calls. The data types are declared in the *freemaster.h* header file.

Type name	Description
FMSTR_ADDR	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.
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.	
FMSTR_SIZE	Data type used to hold the memory block size.
It is required that this type is unsigned and at least 16 bits wide integer.	
FMSTR_BOOL	Data type used as a general boolean type.
This type is used only in zero/non-zero conditions in the driver code.	
FMSTR_APPCM	Data type used to hold the Application Command code.
Generally, this is an unsigned 8-bit value.	
FMSTR_APPCM	Data type used to create the Application Command data buffer.
Generally, this is an unsigned 8-bit value.	
FMSTR_APPCM	Data type used to hold the Application Command result code.
Generally, this is an unsigned 8-bit value.	

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.

FMSTR_TSA_TII	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 FMSTR_SIZE.	
FMSTR_TSA_TS	Data type used to hold a memory block size, as used in the TSA descriptors.
By default, this is defined as FMSTR_SIZE.	

Public Pipes types The table describes the data types used by the FreeMASTER Pipes API:

FMSTR_HPIPE	Pipe handle that identifies the open-pipe object.
Generally, this is a pointer to a void type.	
FMSTR_PIPE_P	Integer type required to hold at least 7 bits of data.
Generally, this is an unsigned 8-bit or 16-bit type.	
FMSTR_PIPE_SI	Integer type required to hold at least 16 bits of data.
This is used to store the data buffer sizes.	
FMSTR_PPIPEF	Pointer to the pipe handler function.
See *FMSTR_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.

FMSTR_U8	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.
FMSTR_U16	Unsigned 16-bit integer.
FMSTR_U32	Unsigned 32-bit integer.
FMSTR_S8	Signed 8-bit integer.
FMSTR_S16	Signed 16-bit integer.
FMSTR_S32	Signed 32-bit integer.
FMSTR_FLOAT	4-byte standard IEEE floating-point type.
FMSTR_FLAGS	Data type forming a union with a structure of flag bit-fields.
FMSTR_SIZE8	Data type holding a general size value, at least 8 bits wide.
FMSTR_INDEX	General for-loop index. Must be signed, at least 16 bits wide.
FMSTR_BCHR	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.
FMSTR_BPTR	A pointer to the communication buffer (an array of FMSTR_BCHR).

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 coremqtt-agent

The coreMQTT Agent library is a high level API that adds thread safety to the coreMQTT library.

Readme

4.1.8 corepkcs11

PKCS #11 key management library.

Readme

4.1.9 freertos-plus-tcp

Open source RTOS FreeRTOS Plus TCP.

Readme